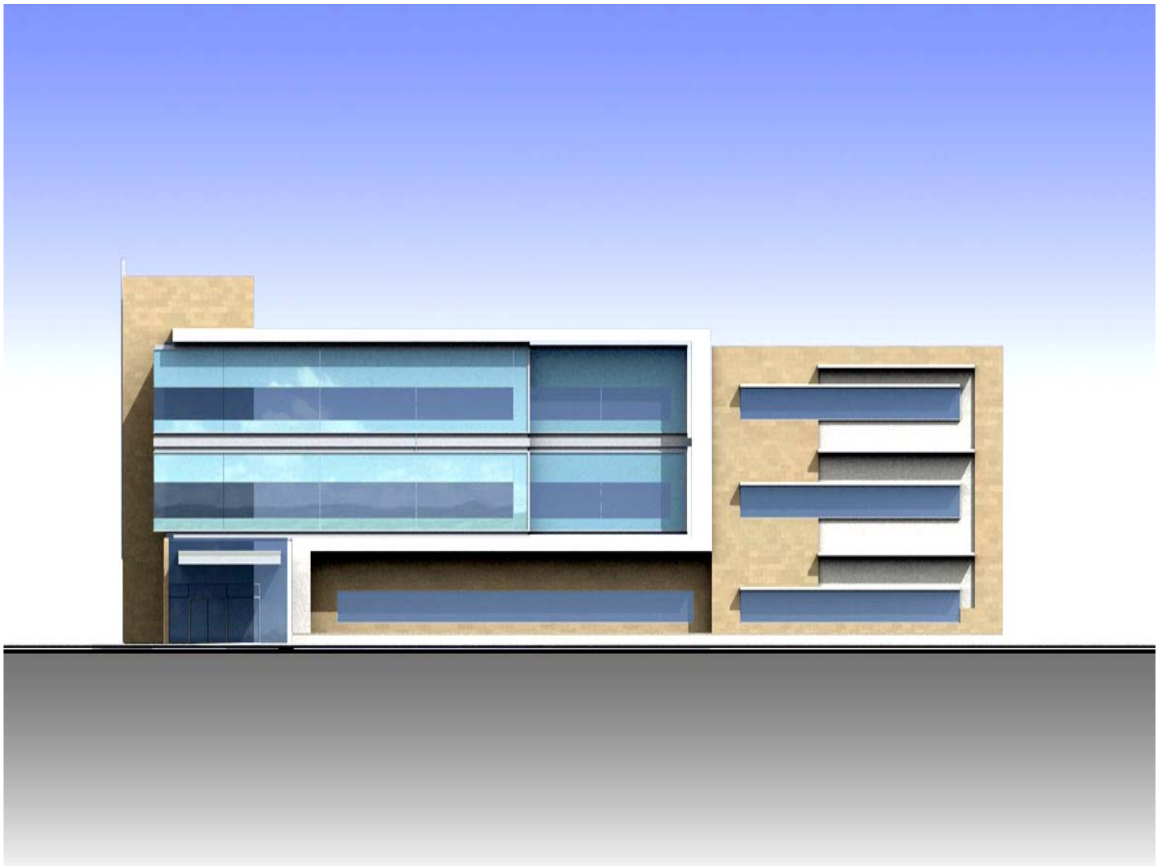
Technical Assignment 3

Mechanical Systems Existing Conditions Evaluation



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Executive Summary

The focus of this report is to provide an in depth look at the mechanical systems for the Amini Medical center and provide a personal critique.

This evaluation will provide a brief overview of the project then discuss aspects that influenced the current design. The current system will then be described in detail with references to maps and diagrams that will act as visual aides. After the Amini Center system has been described, the size, load, and energy impact of the system will be discussed and evaluated.

To conclude the report, a critique of the system has been provided. Overall, the Amini Center's Mechanical system seems to meet all the requirements of the building. It is a versatile system which provides ample control to keep people comfortable in the zones that were created. The system also employs energy saving features to minimize its effect on the environment. Overall, I believe the Amini Center's design to be a very good one.

Project Overview

Building Overview

The Amini Medical Center is the newest addition to the City of Hope campus community located in the Los Angeles, CA suburbs. The community's main functions include cancer research, treatment and education. The Amini facility's role as a part of this community includes blood collection, analysis, processing, transfusion, and storage.

To accommodate the building functions, the Amini Center is designed as a 3 story, 60,000 square foot complex which sits on the East side of campus. (Refer to page 1 of Appendix A for a vicinity map) The floors of the facility are broken down as follows:

Amini Center 1st Floor Breakdown		
Room Types	**Area (ft^2)**	**Function**
Stem Cell Lab/ Support Area	2,500	Biomedical Research and testing
Cryogen Freezer	1,700	Stem Cell / Blood storage
Blood Processing Area/ Freezers	5,300	Blood Processing, testing, logistic work, & temp. storage
Office Space	1,650	Administrative duties
Break Room	320	Making food/ eating
Mechanical/Electrical/IT	1,250	Equip Rooms/Data Centers
Transition/Storage/Restroom	5,800	Storage and walk through areas

Amini Center 2nd Floor Breakdown		
Room Types	**Area (ft^2)**	**Function**
Blood Donation / Transfusion Bays	6,200	Extracting/giving blood from/to donors/patients
Office Space	4,500	Administrative duties
Reception Area	540	Waiting and filling out paperwork
Conference Room	620	Meetings/Training
Break Room	520	Making food/ eating
Mechanical/Electrical/IT	450	Equip Rooms/Data Centers
Transition/Storage/Restroom	5,550	Storage and walk through areas

The third floor of the Amini complex is scheduled to become office space in the future; however, due to the strict budget constraints, the third floor fit-out was not included with this construction submission and, therefore, was not incorporated in this evaluation.

Mechanical Systems Overview

The cooling for this building is provided by a chilled water system while the heating loads are met by converting steam to hot water (HW) for use by HW coils in the air systems.

The bulk of the 1st and 2nd floors of the Amini Center are served by three custom, water cooled, Air Handling Units (AHUs) located on the roof. Small horizontal, water cooled, Fan Coil Units (FCUs), located in the ceiling plenums, serve the remaining areas not being served by an AHU. The areas served by the AHUs are broken down as follows: AHU-1 serves the Stem Cell Lab and support areas located on the 1st floor. AHU-2 serves the Blood Processing area and the Cryogen Freezer on the 1st floor. All remaining spaces on the 1st and 2nd floors are served by AHU-3. Refer to pages 2 and 3 of Appendix A for the outline of AHUs and FCUs service areas. A further discussion and more extensive breakdown of the Amini Center's mechanical systems can be viewed later in this evaluation.

Mechanical Systems Design Influences

Many factors have to be taken into account when designing the mechanical system(s) for any building. Site, utilities, size, occupancy, codes, and owner requirements are just a few factors. This section of the evaluation will examine some of the factors that influenced the mechanical systems of the Amini Center.

Owner/Occupancy Requirements

In the design phase of this project, the engineer was presented with requirements due to the sensitive nature of certain rooms. Some of the requirements that needed to be met were as follows:

- The AHUs for this project are required to have both a 15% efficient pre-filter and 95% efficient final filter.
- All AHUs shall be sized to include 15% spare capacity
- AHU-1, serving the Stem Cell Lab, shall be designed to provide 20 Air Changes per Hour (ACH) for a 10,000/100,000 clean room
- AHU-2, serving the Blood Processing Area and Cryo Freezer, will need redundancy to ensure the Cryo Freezer room does not lose any capacity.
- Chilled water system for this building shall have 100% redundancy.
- Chilled water and heating capacities/pumps shall include the capacities for the future 3rd floor units.

All the above requirements were taken from meeting minutes the design engineer had with the owner and others in regards to the HVAC design approach.

Site Influences

The Amini Center is the newest building on a campus community outside Los Angeles. Because of this location, one site influence the engineers need to account for is seismic vibrations. This fact will probably not have a big effect on the system chosen, but it will definitely influence the restraints and connections for securing the mechanical equipment.

Another site influence comes from being part of this already existing campus. A vicinity map of the campus can be seen on page 1 of Appendix A. For this particular campus, the existing central heating and cooling plants have been oversized to accommodate campus expansion. Because of this, the Amini Center has access to tie into an already existing chilled water loop and high pressure steam system. The site is also believed to have access to a high pressure gas line, but no equipment in the design documents require gas and a gas line cannot be located on the civil drawings.

Monetary Influences

As mentioned earlier in this report, monetary issues have had an effect on the design of the facility's mechanical system. Because the building owner was working with a set budget, aspects of the project had to be cut back for the initial design. These cut backs are thought to be extended to the mechanical system, however, this fact cannot be verified for this evaluation.

Two other monetary influences that had an effect on the design of the Amini Center include California's Savings by Design Program (SBD) and a LEED certification. Both of these programs/procedures offer monetary incentives for reducing the energy usage of a building; another monetary advantage for the owner. The Amini Center has applied for the SBD incentive and is also applying for a LEED-Gold Certification.

With the SBD program, the building owner will have the opportunity to receive up to $150,000 in compensation for upgrades to the design. A LEED-Gold certification will allow the owner to apply for Federal Tax credits which could possibly save the owner millions of dollars.

Design Indoor/Outdoor Conditions

The indoor and outdoor conditions for the existing design were taken from the design engineer's energy model. The following table shows what the design engineer used for their load calculations in the SBD energy model. These values were used for all rooms.

Existing Designed Conditions										
Indoor Conditions			Outdoor Conditions							
Summer		Winter	Summer		Winter	Clearness		Ground Reflectance		CO2 Level
DB	RH	DB	DB	WB	DB	Summer	Winter	Summer	Winter	PPM
72	-	72	96	-	31	-	-	-	-	-

For the energy model simulated in Tech. Assignment 2, the following values were taken from the Trace700 weather data for Pasadena, CA. These values are as follows:

Trace Model from Tech. Assignment 2										
Indoor Conditions			Outdoor Conditions							
Summer		Winter	Summer		Winter	Clearness		Ground Reflectance		CO2 Level
DB	RH	DB	DB	WB	DB	Summer	Winter	Summer	Winter	PPM
72	50	72	95	68	29	1.05	0.95	0.2	0.2	400

Code Requirements

The existing building construction and design were dictated by the following code sources:

- 2002 County of Los Angeles Building Code
- 2005 County of Los Angeles Electrical Code
- 2002 County of Los Angeles Plumbing Code
- 2002 County of Los Angeles Mechanical Code
- 2002 County of Los Angeles Fire Code

Ventilation Requirements

The existing building design ventilation needs to meet the ventilation from the applicable codes above. The design engineers requirements could not obtained with the exception of the Stem Cell Lab needing 20 ACH. From the ventilation report, Tech. Assignment 1, the required outdoor air (OA) needed and provided for each RTU is as follows:

Unit	Trace Program	Design Documents		Unit	Trace Program	Design Documents	
	Input OA cfm	Req. OA cfm	Provided OA cfm		Input OA cfm	Req. OA cfm	Provided OA cfm
AHU-1	4,100	1,101	4,100	AHU-2	6,200	3,025	6,200
AHU-3	6,800	4,830	6,800	FCU-1-1	0	0	0
FCU-1-2	0	30	0	FCU-1-3	0	9	0
FCU-1-4	0	0	0	FCU-1-5	1,200	14	1,200
FCU-2-1	0	15	0	FCU-2-2	0	32	0
FCU-2-3	0	18	0	FCU-2-4	0	20	0

In the table above, the required OA shown is in accordance with ASHRAE 62.1-2007, not the applicable codes the building was designed with.

Discussion

The many factors here are just some of the influences dug up for the Amini Medical Center project. There are many other factors that were, and could have been, taken into account in the actual design of the mechanical system. One such factor is the heat load of the many pieces of equipment located throughout this facility. Either way, the influences listed here can be viewed as the key elements in the design for the existing mechanical system.

Mechanical Systems Description

A brief overview of the mechanical system was given earlier in the evaluation to describe the air systems. This section of the report will further the description by providing an in depth view of the equipment and controls from the heating & cooling plants to the air distribution systems.

Heating Plant & Building Heating System

Heating Plant

What is known about the central plant for this project is that there is high pressure steam (HPS) and steam condensate return piping (PCR) available to serve this the Amini Center. The specifics of the central plant, i.e. steam boiler capacities and types, were not attainable. Even the size of the existing steam and condensate pipes could not be obtained.

Building Heating System

The Amini Center converts available high pressure steam (125 psig) into hot water for the building to use. The connection points to the existing steam and condensate lines are located on the South side of the building. Because of this, a mechanical room was created on the South wall of the first floor to accommodate some of the necessary equipment and piping; this room is the location where a 4” HPS and a 2” PCR enter/leave the Amini Center.

Due to concerns for running high pressure steam throughout the building, the design engineer decided to reduce the HPS to medium pressure steam (MPS), for a domestic water heater, and low pressure steam (LPS) to run to a heat transfer package on the roof. In order to accomplish this, two pressure reducing valves (PRV) are located in the mechanical room to reduce the HPS first down to 25 psig MPS then down again to the 15 psig LPS. The MPS is taken to the Domestic water heater in the mechanical room and heats the domestic water loop from 40 degrees to 140 degrees. The LPS line is taken up to a heat transfer package (HTP) on the roof which heats the hot water loop and pumps the hot water to the air distribution systems (AHUs, and reheat coils).

Refer to page 1 of Appendix B for the Steam/Hot Water Flow Diagram. Refer to Appendix C for available schedules of the heating equipment.

Cooling Plant & Building Cooling System

Cooling Plant

The central cooling plant serving the Amini Center, and many other buildings, has a little more information available then the heating plan did. The central plan is composed of three centrifugal water cooled chillers and one steam absorption chiller. The schedules for these units can be viewed in Appendix C. The system is a primary/secondary system providing chilled water for a good portion of the campus. The plant capacity is a nominal 7,150 Tons supplying a primary loop of 13,104 gpm and a secondary loop of 12,600 gpm. The points of connection for the Amini Center are a 12” chilled water supply (CHWS) and a 12” chilled water return (CHWR) lines located at the South end of the building.

Building Cooling System

Like the heating system for the building, the CHWS & CHWR lines enter/leave the facility in the mechanical room on the first floor. According to the designers load calculations, only 6” CHWS & CHWR lines were necessary to serve the Amini Center. The chilled water entering the building is supplied at 42^{o}F.

Two pumps located in the first floor mechanical room provide circulation of the chilled water to the AHU and FCU cooling coils throughout the building.

Refer to page 2 of Appendix B for the Chilled Water Flow Diagram. Refer to Appendix C for available schedules of the heating equipment.

Air Distribution Systems

AHU-1

AHU-1 is a 23 Ton constant volume (CV) unit serving the 2,500 ft^2 Stem Cell Lab and supporting spaces on the first floor. This AHU is designed to supply 8,200 cfm of air to the space through 2x4 ceiling diffusers with HEPA filters. AHU-1 does not contain a HW heating coil in the unit. All heating for this unit is done through 6 HW duct mounted reheat coils. These reheat coils provide temperature control and zoning for the CV unit.

AHU-2

AHU-2 is a 38 Ton variable air volume (VAV) unit serving the 1,700 ft^2 Cryogen Freezer room and the 5,300 ft^2 Blood Processing Area on the first floor. This AHU is designed to supply 14,800 cfm through a mixture of CV and VAV terminals. The unit is designed with a pre-heat/main heating HW coil in the unit. Zoning is dictated by the terminal units which also have HW reheat coils. VAV terminal units have a minimum flow of 30% design air.

AHU-3

AHU-3 is a 63 Ton VAV unit serving 7,200 ft^2 of office and misc. space on the 1st floor and 16,700 ft^2 of patient bays, offices, and other misc. spaces on the 2nd floor. This AHU is designed to supply 26,900 cfm through VAV terminals with reheat. The unit is not designed with a heating coil in the unit. The VAV terminal units have a minimum flow of 30% design air and provide the only heating through HW reheat coils.

FCUs

All of the FCUs throughout this facility are horizontal units mounted in the ceiling plenums. These units serve areas with special cooling requirements, like 24/7 cooling for IT rooms. All FCUs have a chilled water coil but no heating coils, therefore these units are used for cooling only. Because these units serve interior spaces and are provided no OA, with the exception of 1 FCU, the heat loss should not be too significant to warrant heating coils. Without any design information for these special areas the loads will have to be assumed to meet what is shown on the schedule. The one FCU that does get OA, FCU-5-1, receives it to maintain the pressure relationship in the Mechanical Pump room.

Exhaust Air Systems

Exhaust air systems are usually added to a design to help with indoor air quality by removing foul or harmful odors/contaminants in the air streams. The Amini Center is no exception; it was designed with 5 exhaust fans that perform different functions. All the exhaust fans for this project are upblast fans grouped near each other and located on the roof, with the exception of EF-5 which is an inline fan located next to the Mechanical Room on the first floor.

EF-1

EF-1 serves five(5) Bio-safety cabinets located in the Stem Cell Lab on the first floor. These cabinets are the locations where potentially harmful bacteria or contaminants can grow in high concentrations while being tested/observed. For this reason, these areas need the air exhausted to the outside to dilute the concentrations.

EF-2

EF-2 serves the Cryo Freezer room on the 1st floor. This fan exhausts air from the room to maintain a negative pressure in that room.

EF-3 & EF-4

EF-3 and EF-4 are two general exhaust fans that serve bathrooms and soiled storage rooms.

EF-5

EF-5 is an exhaust fan for the pump room. Because the exhaust intakes are located above the steam pressure reducing stations, I believe this fan trying to reject heat from these pieces of equipment. No information was obtained regarding the design requirements for this fan.

Control Features

Controls and sequences of operation play a large role in the overall scheme to achieving energy savings, occupant comfort, and proper IAQ. Some of the control features for the Amini Medical Center can be seen below.

General Control Features

The building is equipped with automated DDC system.

The following pieces of equipment are provided with variable frequency drives (VFDs):

VARIABLE FREQUENCY DRIVE SCHEDULE				
SYMBOL	LOCATION	SERVICE	EMERGENCY POWER	REMARKS
VFD-1	ROOFTOP	AHU-1	YES	PROVIDE BYPASS
VFD-2	ROOFTOP	AHU-2	YES	PROVIDE BYPASS
VFD-3	ROOFTOP	AHU-2	YES	PROVIDE BYPASS
VFD-4	ROOFTOP	AHU-2	YES	PROVIDE BYPASS
VFD-5	ROOFTOP	AHU-2	YES	PROVIDE BYPASS
VFD-6	ROOFTOP	AHU-3	YES	PROVIDE BYPASS
VFD-7	ROOFTOP	AHU-3	YES	PROVIDE BYPASS
VFD-8	ROOFTOP	EF-1	YES	PROVIDE BYPASS
VFD-9	ROOFTOP	EF-2A	YES	PROVIDE BYPASS
VFD-10	ROOFTOP	EF-2B	YES	PROVIDE BYPASS

VFD-11	ROOFTOP	EF-3	YES	PROVIDE BYPASS
VFD-12	ROOFTOP	EF-4	YES	PROVIDE BYPASS
VFD-13	183 MECH PUMP	P-1	YES	PROVIDE BYPASS
VFD-14	183 MECH PUMP	P-2	YES	PROVIDE BYPASS
VFD-15	ROOFTOP	HTP-1	YES	PROVIDE BYPASS
VFD-16	ROOFTOP	HTP-1	YES	PROVIDE BYPASS

The following units and exhaust fans are interlocked with each other to maintain the proper pressure relationships in the rooms they are associated with:

- AHU-1 is interlocked with EF-1
- AHU-2 is interlocked with EF-2
- AHU-3 is interlocked with EF-3 & EF-4
- FCU-1-5 is interlocked with EF-5

Due to the VFDs on the chilled water pumps and the HTP pumps, 2-way valves are provided on the cooling and heating coils to take advantage of pump savings when possible.

Sequences of Operation

To aid in the understanding of the sequence of operations for these units, refer to Appendix D for unit diagrams.

AHU-1

Unit shall operate 24/7, but can start and stop on call from DDC. Upon start (EF-1 to start also), OA/RA dampers open to setpoint and fan is energized. Supply airflow station modulates supply fan (SF) VFD to maintain cfm setpoint. Cooling coil valve modulates as necessary to maintain 54^{o}F. OA measuring station shall modulate OA/RA dampers to maintain air quantities. Upon shut-down, the fan shall stop then the OA dampers close.

EF-1

EF-1 shall start when AHU-1 starts. Airflow measuring station shall control fan VFD to exhaust set airflow quantity. EF-1 shall stop running shortly after AHU-1 supply fan shuts down.

AHU-2

Unit shall operate 24/7, but can start and stop on call from DDC (EF-2 shall start and stop when AHU-2 does). When unit is operating correctly, dual supply fans and dual exhaust fans are running simultaneously (at part load). Reheat coil and cooling coil valves shall modulate to maintain a supply air temperature of 54^{o}F. Static pressure sensors, one at blood processing and one at Cryo freezer, shall modulate the supply fans VFDs to maintain setpoint. The units exhaust fan VFDs shall modulate accordingly with the SFs. Minimum OA setpoint shall be used when unit is above 65^{o}F. When OA drops below 65^{o}F, OA dampers can modulate up to 100% OA (RA dampers would simultaneously modulate down to 0%) as long as the preheat valve remains closed (Economizer Mode).

Upon failure one supply fan, or one exhaust fan, its associated EF/SF shall shut down and a damper shall isolate these fans to receive no airflow. The working SF/EF pair shall ramp up to maximum capacity, OA damper shall modulate to setpoint also, and VFD for the SF shall maintain the Cryo Freezer sensor’s static pressure only. All other operations shall remain the same as when the unit is operating correctly.

EF-2

EF-2 shall start when AHU-2 starts. EF-2 shall stop running shortly after AHU-2 supply fan shuts down. EF-2 contains (2) fans, if one does not start or fails, the other shall energize.

AHU-3

Unit shall operate by a schedule and is started and stopped through the DDC system. On start-up, OA/RA dampers shall open to fixed position then fan shall start. Upon shut down CHW valves shall close and fan shall run for another 5 mins. After that time, the fan shall shut down and then the OA dampers to close. EF-3 & EF-4 shall operate when AHU-3 is scheduled to operate.

For morning warm up the unit shall keep the OA dampers closed when the OA temperature is greater then 55°F. The supply fan (SF) and return fan (RF) shall energize and the cooling coil valve shall modulate to maintain 54°F supply air. If OA temperature is 55°F or less, economizer mode shall be initiated and the mixed air damper and outdoor air dampers shall modulate to maintain a mixed air temperature of 60°F with a low limit OA temperature of 45°F.

In occupied mode the minimum OA damper shall open to its setpoint. Above 55°F and below 45°F the other OA damper shall remain closed. Between 45°F-55°F OA temperature, the OA/MA damper shall modulate to maintain 60°F mixed air temperature. Cooling coil valve shall modulate to maintain 54°F supply air.

Rooms with CO_2 sensors shall first increase the airflow available from the air terminal serving it before an increase in outside air is provided. Outside air damper shall slowly modulate open (decreasing the mixed air) until the required ventilation air quantities are provided.

EF-3 & EF-4

EFs 3&4 shall start operate when AHU-3 operates. VFDs shall be used for air balancing. EFs 3&4 shall stop running shortly after AHU-3 supply fan shuts down.

Reheat Coils

Space thermostat shall modulate reheat coil valve to maintain temperature setpoint.

Constant Volume Terminal Units

Air velocity sensor shall modulate damper to maintain cfm setpoint. Space thermostat shall modulate reheat coil valve to maintain temperature setpoint. Zone being served shall be provided with occupied and unoccupied schedule.

Variable Air Volume Terminal Units

Space thermostat shall modulate the VAV damper or reheat coil valve to maintain temperature setpoint. If VAV damper has reached minimum cfm setpoint, reheat valve shall then modulate to maintain temperature setpoint. Zone being served shall be provided with occupied and unoccupied schedule.

Air terminals serving rooms with CO_2 sensors shall increase air quantity on VAV unit, thermostat to modulate reheat valve, until CO_2 reading are acceptable. If continued CO_2 concentration, air handling unit shall gradually increase OA until CO_2 levels are met.

Fan Coil Units (FCU)

Space thermostat shall energize supply fan modulate cooling coil valve to maintain temperature setpoint.

FCU-1-5 is provided with two thermostats in two separate rooms it serves. The higher recorded temperature is the controlling point for the unit cooling setpoint. EF-5 shall operate when FCU-1-5 operates.

EF-5

EF-5 shall start when FCU-1-5 starts. EF-2 shall stop running shortly after FCU-5-1 supply fan shuts down.

Steam Pressure Monitoring

The DDC controls system shall record the steam flow rate measured by the flow meter.
The DDC system shall interface with the mass flow meter for energy monitoring.

Heat Transfer Package

The DDC shall monitor hot water supply (HWS) and return temperatures. Alarm shall be sent to if HWS falls below 160°F.

Chilled Water Plant/Pumps

On a call for cooling by any one of the air distribution systems, the chilled water valve shall open and both pumps shall energize. Pump VFDs shall modulate to maintain differential pressure setpoint. Upon failure of one pump, the other shall operate to maintain necessary setpoint.

Building CHWS and CHWR temperatures shall be monitored. If the differential temperature is above the setpoint by 15°F, then the chilled water bypass valve shall open. If the differential temperature setpoint is 9°F or less, then the chilled water bypass valve shall close.

Lost Rentable Space

Due to the world growing and expanding, land has become harder to come by, especially in large cities. Building owners therefore want as much rentable/useable space inside their building as possible. Obviously a building cannot operate without mechanical and electrical systems, but these systems take up rentable space. For the Amini Center, the lost rentable space to mechanical and electrical systems can be seen in the following table. These values do not incorporate janitor closets, elevator machine rooms, IT rooms, etc.; just mechanical and electrical spaces & chases.

Amini Center Lost Rentable Space		
Floor	Space Type	Area (ft^2)
1st	Mechanical	500
1st	Electrical	600
1st	Chase	30
2nd	Mechanical	0
2nd	Electrical	100
2nd	Chase	205
3rd	Mechanical	0
3rd	Electrical	-

3rd	Chase	205
	Total	1640
	% of Total Area	3%

Because the majority of the equipment was located on the roof, the owner did not lose a large amount of real estate for this building. Much of the space for the mechanical systems is needed in the ceiling plenum. The floor to floor heights of this facility are about 15 ft to accommodate the mechanical systems.

Mechanical Systems First Cost

The overall cost to install and activate the mechanical systems, excluding Electrical hook-up, was estimated to be $2.8 million. This price was taken from a total cost estimation prepared by DPR Construction Inc. Refer to Appendix D for the breakdown of DPR's estimation.

Load and Energy Results

Load and energy calculations were performed for the Amini Center in Technical Assignment 2. Because this evaluation required a more in depth review of the mechanical systems, this section will provide an overview of the Tech. Assignment 2 results and discuss them further.

Load Results Overview

In Tech. Assignment 2 the building loads were simulated using the TraneTrace700 program. Weather data, internal loads, ventilation loads, solar loads and other data was input into the program based on the design documents. Lighting and equipment loads for assignment 2 were input on a W/SF basis, and the ventilation loads were locked in place with the scheduled values. For spaces with no equipment was given, i.e. elev. mach. rm. & IT rooms, equipment loads were taken from the designers EnergyPro model. The cooling loads scheduled and the calculated loads are summarized below.

Unit	Trace Program		Design Documents		Unit	Trace Program		Design Documents	
	Total MBH	Sensible MBH	Total MBH	Sensible MBH		Total MBH	Sensible MBH	Total MBH	Sensible MBH
AHU-1	259.0	145.5	277.6	264.0	AHU-2	392.5	319.9	453.8	440.1
AHU-3	608.3	525.0	751.0	680.6	FCU-1-1	5.0	4.9	10.8	6.2
FCU-1-2	15.1	15.1	47.3	38.3	FCU-1-3	45.2	45.2	100.4	55.2
FCU-1-4	7.6	7.5	17.4	10.4	FCU-1-5	132.1	97.5	91.1	82.9
FCU-2-1	49.4	49.4	72.4	58.6	FCU-2-2	17.3	17.3	3.5	2.8
FCU-2-3	9.3	9.3	3.5	2.8	FCU-2-4	10.4	10.4	8.1	6.5

Energy Results Overview

Also Tech. Assignment 2, the building's energy usage was simulated using the TraneTrace700 program. For this simulation, fan energies, equipment efficiencies, usage schedules, occupancy schedules, cooling/heating plant information, and other factors were input to simulate how the building would operate over the span of one year. The results for the Amini Center's energy usage are summarized below.

Amini Center Annual Energy Consumption						
	Elec Consumption (kwh)	**Purchased Chilled Water (kBtu)**	**Purchased Steam (kBtu)**	**% Total Energy**	**Total Building Energy (kBtu/yr)**	**Total Source Energy (kBtu/yr)**
Primary Htg			26,204	0.54	26,204	34,939
Other Htg Accessories	249			0.02	849	2,548
Primary Cooling		2,233,676		46.07	2,233,676	1,718,212
Supply Fans	113,671			8.00	387,959	1,163,993
Pumps	13,050			0.92	44,539	133,631
Base Utilities	8,038			0.57	27,434	82,310
Lighting	85,055			5.99	290,294	870,968
Receptacle	538,374			37.90	1,837,470	5,512,961
Totals	758,437	2,233,676	26,204	100	4,848,425	9,519,562

To put a dollar amount on the energy usage, a utility rate schedule needed to specified. Because the building is served from a central plant, district chilled water and district steam were simulated with no cost to the building. The only cost incurred by the building was calculated for the electricity used to run the air distribution systems, chilled water pumps, HTP, and the lighting and plug loads of the building. The schedule used for the electricity rate was taken from Southern California Electric website. This rate structure can be viewed below.

Amini Center Input Rate Structure				
Utility	**Customer Charge**		**Rate**	
Electric Demand				
On Peak (Jan. – Dec.)	334.55	$/month	24.95	$/KW
Mid Peak (Jan. – Dec.)			2.58	$/KW
Electric Consumption				
On Peak (Oct. – May)	-		0.0782	$/kwh
Off Peak (Oct. – May)	-		0.056	$/kwh
Mid Peak (Oct. – May)	-		0.0782	$/kwh
On Peak (Jun. - Sept.)	-		0.129	$/kwh
Off Peak (Jun. - Sept.)	-		0.0553	$/kwh
Mid Peak (Jun. - Sept.)	-		0.0694	$/kwh

* Rates are based on SCE rate schedule

This structure coupled with a time of day schedule designating On, Off & Mid peak produces the means to provide a dollar amount for the Amini Center's energy usage. A summary of the facility's cost breakdown is below.

Amini Utility Costs	
Electric	$/yr
On Peak Cons.	$9,327
Off Peak Cons.	$15,425
Mid Peak Cons.	$31,142
On Peak Demand	$48,321
Mid Peak Demand	$8,993
Total:	$113,208
Total $/ft^2	$3.26

Discussion

Because construction of this building is scheduled to be complete in February, 2009, no information concerning energy usage and billing exist. The following discussion will therefore not evaluate any billing differences but discuss aspects of the model and its believed accuracy.

Loads

Loads for any building are subject to estimation and interpolation and the Amini Center is no different. I believe the solar loads and the wall loads calculated by the program are great estimations for the building's performance; as long as the envelope was input correctly. For the internal loads, however, a designer makes estimations for the heat produced in the space based on equipment, people activity, ventilation requirements, and other factors. Many pieces of equipment can be referenced for heat loads, but not all equipment is listed. In the case for this complex, many areas like the labs and research areas contain pieces of equipment which can not be looked up, making it hard to estimate the heat loads without going to the manufacturers. I believe this is the main discrepancy for the differences in loads observed by Tech. Assignment 2 and those scheduled. Another discrepancy that factors into the load differences was the fact that the owner wanted there to by 15% extra capacity on all the AHUs.

Some minor factors I believe to affect the loads include slight differences in weather data, people loads, and lighting loads. These factors will also change the load calculations, but no where near the extent of the previously mentioned factors.

The loads for the FCUs seem to be marginally different from scheduled loads. Considering these W/SF loads were taken from the designer's energy model, I initially thought they were accurate. After further investigation I feel the loads were input wrong or changed by the design team, creating inaccurate loads from what is scheduled.

Energy

The energy results from Tech. Assignment 2 were hard for me to judge because I'm not aware of typical energy costs for a clinical building in the LA area. After a more in depth review of the Amini Center's mechanical systems, I do believe the numbers calculated in Assignment 2 are low compared to what the building will actually see. I feel the building was not correctly modeled with the proper control schemes and loads.

In Assignment 2, the AHUs and EFs were input based on building occupancy schedule, not based on loads. Considering both AHU-1 and AHU-2 are operating 24/7, the energy usage will be greatly different. Other factors that were not incorporated into the model include the rooms with CO_2 sensors and the demand limiting ventilation applied to AHU-3. Other design conditions that might affect the cost include design conditions like oversized units, ventilation requirements, and also the facility's need for positively and negatively pressured rooms.

The last energy issue with the Amini Center is the fact that the numbers given in this evaluation apply only to the first and second floor units. The third floor, future units, were not accounted for.

System Critique

Because the Amini Medical Center is an addition to an already existing campus, it appeared to be a simple choice for the engineer on how the building would be heated and cooled. Having existing chilled water and steam lines gave the designer excellent resources to design an efficient building.

Central Plant

Because there is little known about the central heating plant, there is no room to discuss its design. For a campus facility like this one, I do believe a high pressure steam system provides benefits for the buildings on campus.

The central water cooled chiller plant is also believed to have benefits for a campus community. Not knowing how the chillers are piped (series or parallel) and the control sequencing for them does not allow any critique based on energy consumption.

Building Equipment

For this facility, having the water cooled AHUs on the roof, took up minimal floor area for the tenant. It did however increase the plenum size to allow the necessary duct runs and equipment, there by increasing the overall height of the building.

The specific requirements for the spaces seem to be met very well with the system that has been provided. The temperature control seems to be accounted for with reheat coils on the CV system and the terminal units on the VAV systems. All two way valves were used to gain energy savings on the pumps with VFDs.

One issue I had with the system resulted from the controls of AHU-1. The VFDs on AHU-1 and EF-1 seemed unnecessary to me because it is a constant volume system. I don’t know why these features were added, but it might be a design requirement for the lab it serves.

Another interesting design feature was the dual fan system for AHU-2. This feature was obviously added to provide the Cryo freezer with redundancy, but it seemed out of the ordinary. It had me curious if there was another way to provide redundancy for that space; most likely not without increasing first cost significantly.

Overall I believe the system is a very good design which seems to meet the requirements of the owner and also provides energy efficient strategies.

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ASHRAE. 2005, 2005 ASHRAE Handbook – Fundamentals. American Society of Heating Refrigeration and Air Conditioning Engineers, Inc., Atlanta, GA. 2001.

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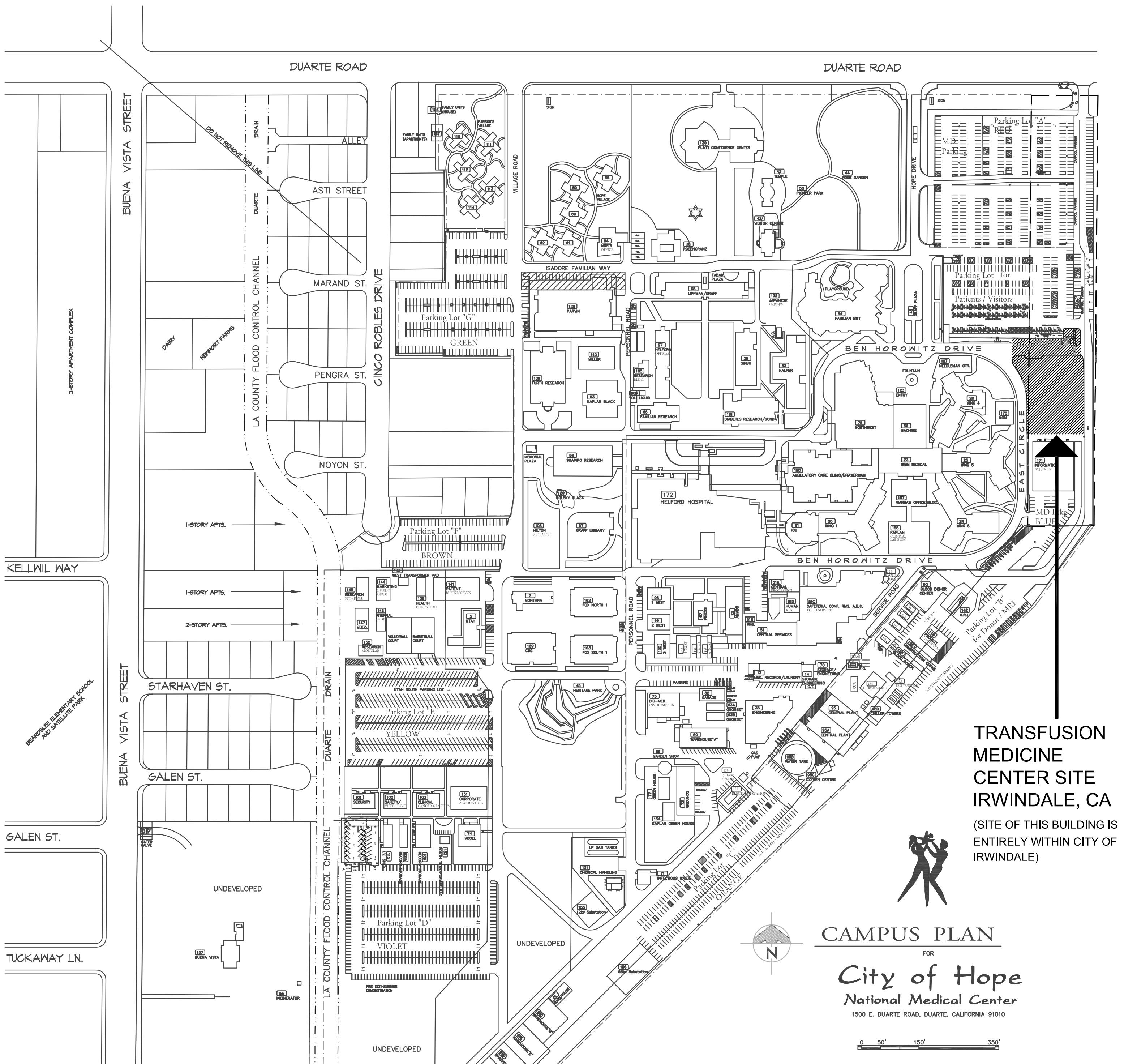
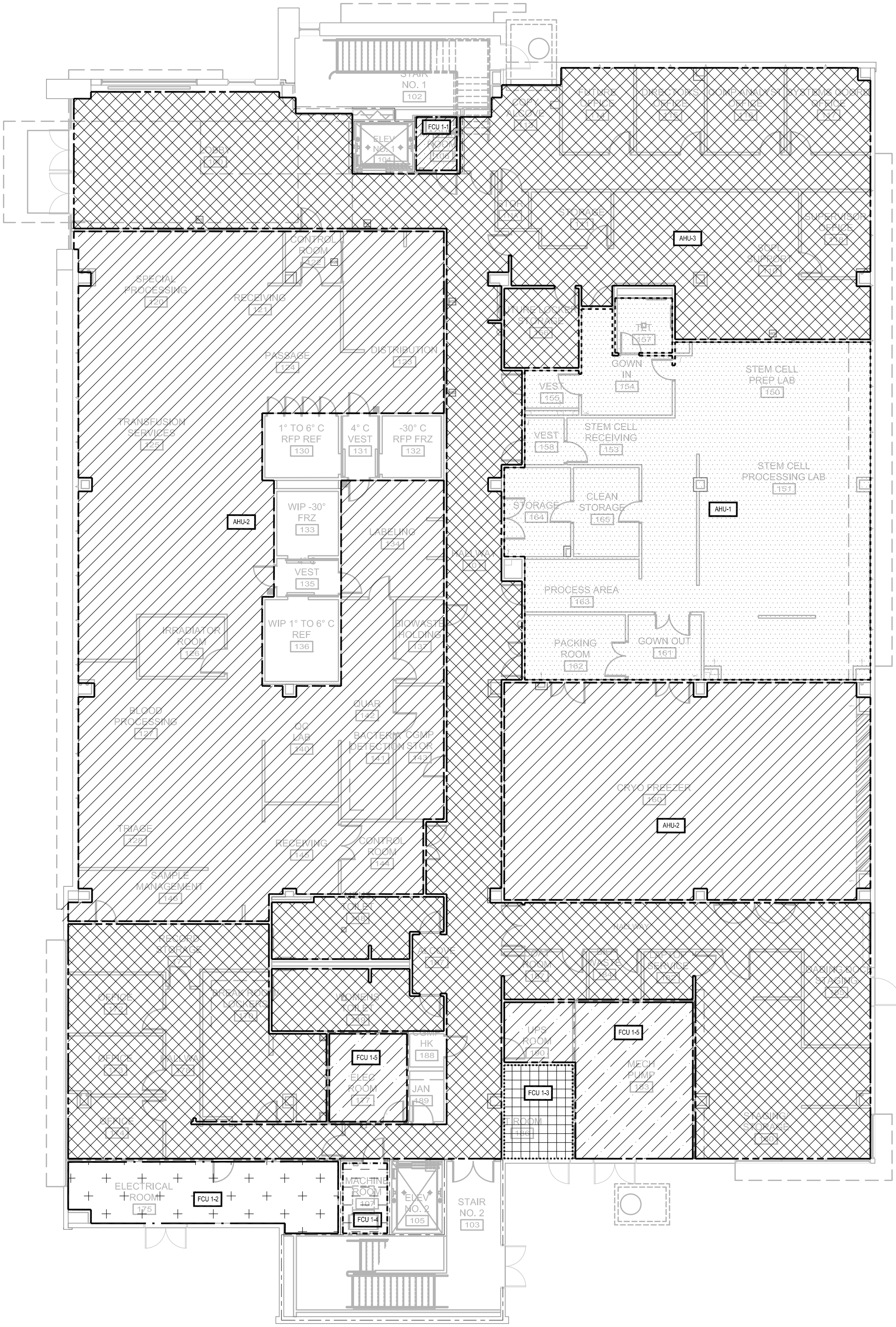
DPR Construction Inc. 2007. City of Hope: Transfusion Medical Center Design Development Estimate. DPR Construction Inc., Newport Beach, CA

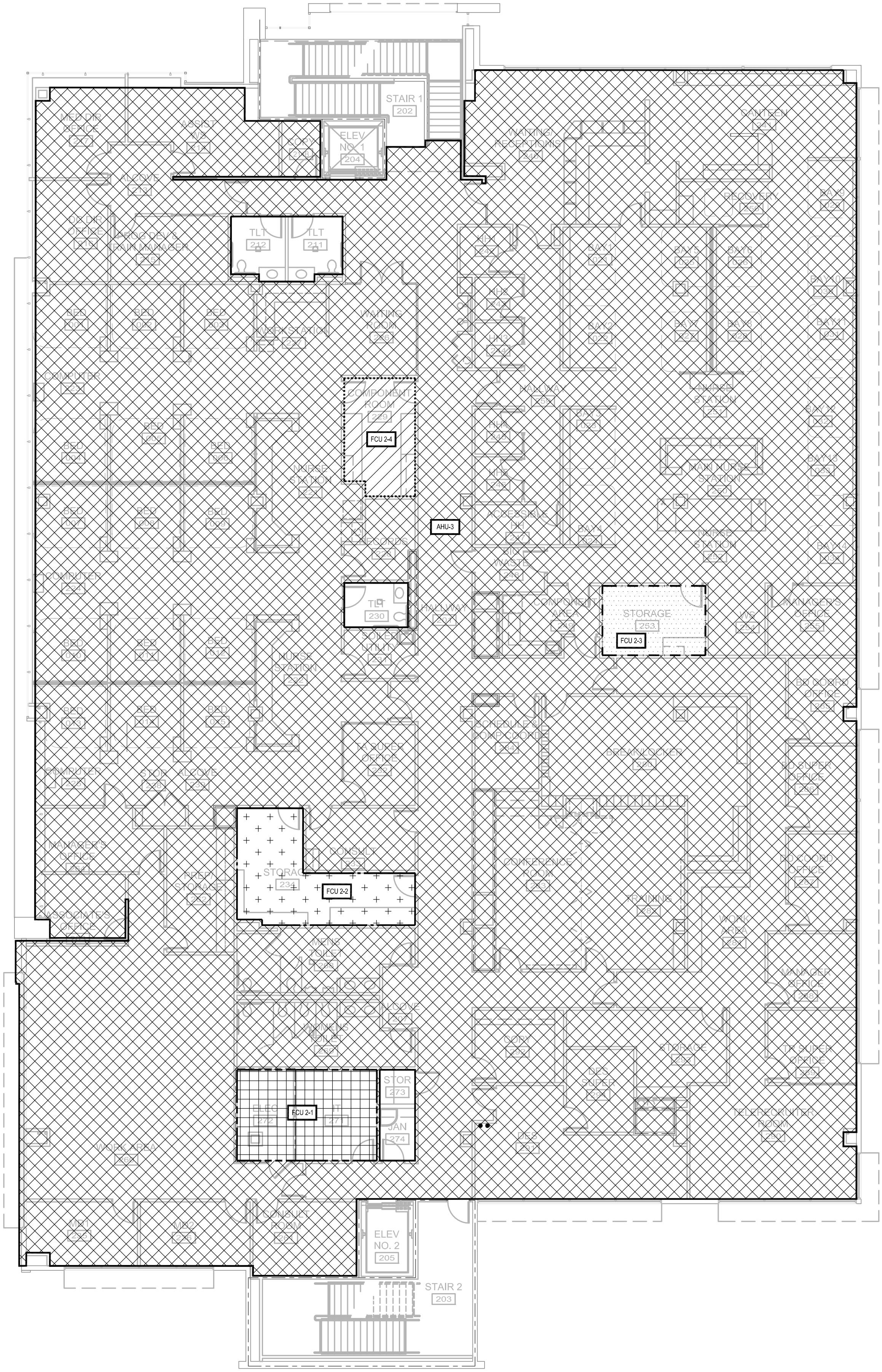
Appendix A
Vicinity Map & Air Distribution Maps


DUARTE ROAD
DUARTE ROAD
BUENA VISTA STREET
ALLEY
ASTI STREET
MARAND ST.
PENGRA ST.
NOYON ST.
CINCO ROBLES DRIVE
LA COUNTY FLOOD CONTROL CHANNEL
DUARTE DRAIN
2-STORY APARTMENT COMPLEX
DAIRY
NEWPORT FARMS
1-STORY APTS.
2-STORY APTS.
KELLWIL WAY
STARHAVEN ST.
GALEN ST.
TUCKAWAY LN.
BEARDSLEE ELEMENTARY SCHOOL AND SATELLITE PARK
VILLAGE ROAD
ISADORE FAMILIAN WAY
Parking Lot "G"
GREEN
Parking Lot "F"
BROWN
Parking Lot "E"
YELLOW
Parking Lot "D"
VIOLET
Parking Lot "A"
MD Parking
Parking Lot for Patients / Visitors
HOPE DRIVE
BEN HOROWITZ DRIVE
EAST CIRCLE
PERSONNEL ROAD
SERVICE ROAD
PLATT CONFERENCE CENTER
ROSE GARDEN
PIONEER PARK
VISITOR CENTER
TEMPLE
HOPE VILLAGE
PARVIN
LIPPMAN/GRAFF
JAPANESE GARDEN
PLAYGROUND
FAMILIAN BMT
MILLER
FURTH RESEARCH
KAPLAN BLACK
HELFORD
SIRBU
HALPER
FAMILIAN RESEARCH
DIABETES RESEARCH/GONDA
NEEDLEMAN CTR.
FOUNTAIN
ENTRY
NORTHWEST
MACHRIS
MAIN MEDICAL
AMBULATORY CARE CLINIC/BRAVERMAN
WARSAW OFFICE BLDG.
KAPLAN
WING 1
WING 4
WING 5
WING 6
ICU
MEMORIAL PLAZA
SHAPIRO RESEARCH
HELFORD HOSPITAL
HILTON RESEARCH
GRAFF LIBRARY
MONTANA
FOX NORTH 1
FOX SOUTH 1
CBG
HERITAGE PARK
1 WEST
2 WEST
CENTRAL SERVICES
CAFETERIA, CONF. RMS. A,B,C,
BLOOD DONOR CENTER
Parking Lot "B" for Donor / MRI
MED. RECORDS/LAUNDRY
STORAGE/ENGINEERING
BIO-MED
GARAGE
QUONSET
ENGINEERING
CENTRAL PLANT
CHILLER TOWERS
WAREHOUSE"A"
GARDEN SHOP
GAS PUMP
WATER TANK
OXYGEN CENTER
KAPLAN GREEN HOUSE
LP GAS TANKS
CHEMICAL HANDLING
INFECTIOUS WASTE
Parking Lot "C"
ORANGE
UNDEVELOPED
BUENA VISTA
INCINERATOR
UTAH SOUTH PARKING LOT
WEST TRANSFORMER PAD
MARKETING
PATIENT
HEALTH EDUCATION
RESEARCH
INTERNAL
M.S.O.
VOLLEYBALL COURT
BASKETBALL COURT
UTAH
SECURITY
SAFETY/
CLINICAL
CORPORATE
VOGEL
FIRE EXTINGUISHER DEMONSTRATION
TRANSFUSION MEDICINE CENTER SITE IRWINDALE, CA
(SITE OF THIS BUILDING IS ENTIRELY WITHIN CITY OF IRWINDALE)
N
CAMPUS PLAN
FOR
City of Hope
National Medical Center
1500 E. DUARTE ROAD, DUARTE, CALIFORNIA 91010
0 50' 150' 350'



FIRST FLOOR AIR HANDLING UNIT ZONING CHART

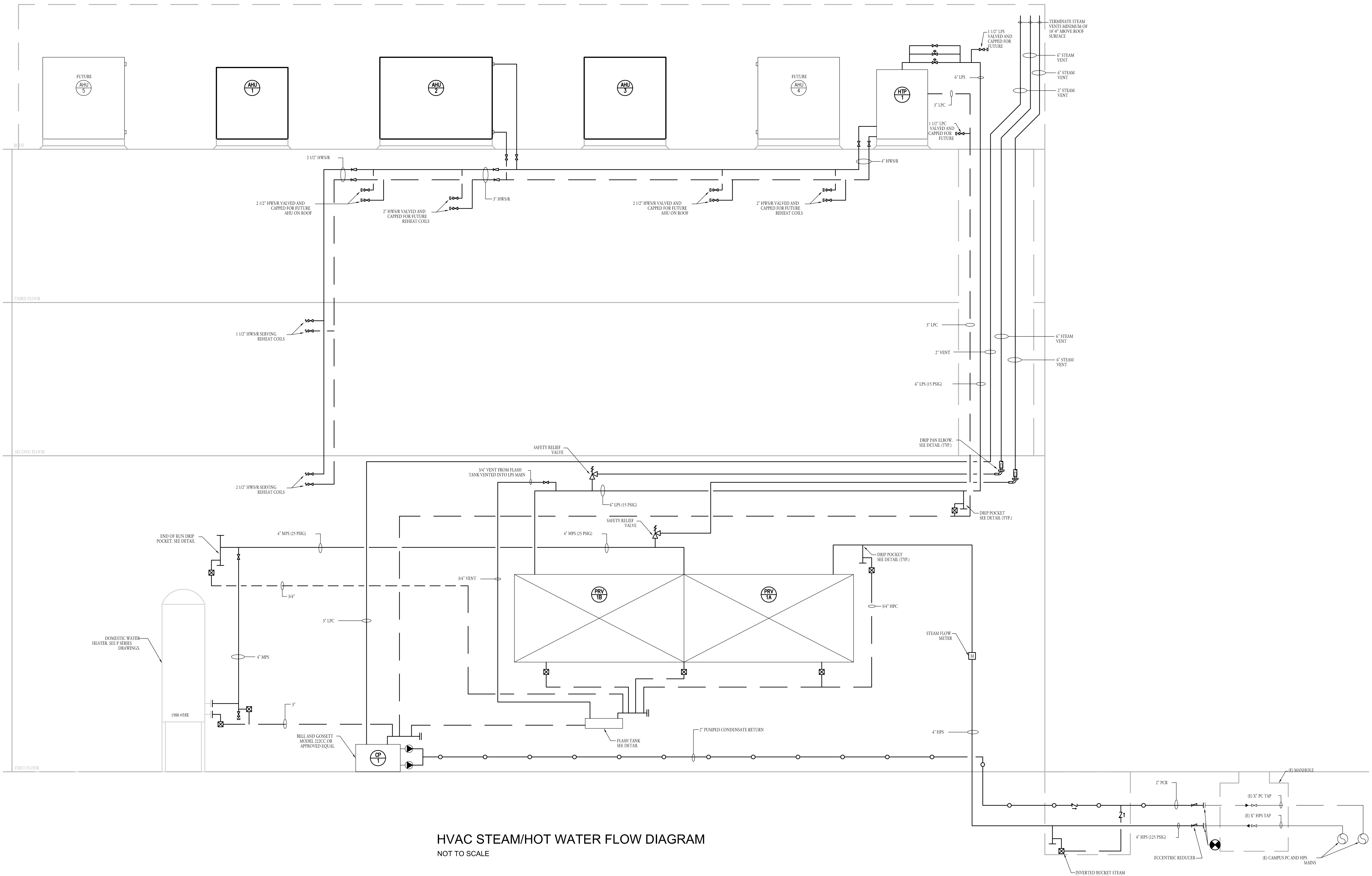
HATCH CODE	AHU DESCRIPTION	AHU TAG	AIRFLOW RATES SUPPLY	AIRFLOW RATES OUTSIDE	REMARKS
	STEM CELL PROCESSING LAB	(N) AHU-1	8,200	3,800	46% OA, CAV
	BLOOD BANK/CRYOGEN	(N) AHU-2	14,800	6,200	42% OA, CAV
	ADMINISTRATION	(N) AHU-3	6,770	960	VAV, FIRST FLOOR ONLY. CO2 SENSOR
	106 MACHINE ROOM	(N) FCU 1-1	300	-	CAV
	175 ELECTRICAL ROOM	(N) FCU 1-2	1,800	-	CAV
	186 IT ROOM	(N) FCU 1-3	2,600	-	CAV
	107 MACHINE ROOM	(N) FCU 1-4	630	-	CAV
	183 MECH & 190 UPS ROOM	(N) FCU 1-5	2,400	-	CAV



SECOND FLOOR AIR HANDLING UNIT ZONING CHART

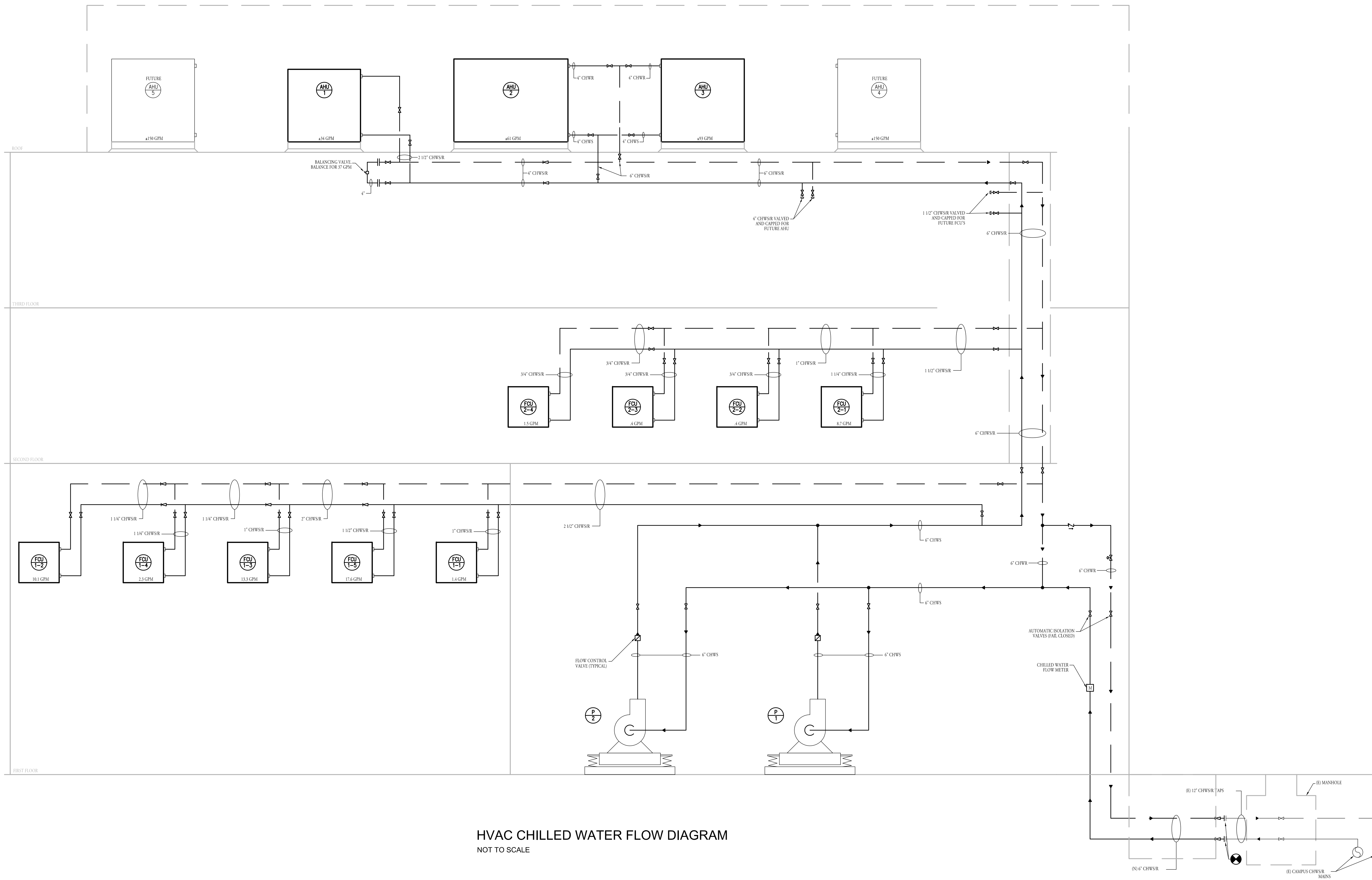
HATCH CODE	AHU DESCRIPTION	AHU TAG	AIRFLOW RATES		REMARKS
			SUPPLY	OUTSIDE	
	ADMINISTRATION	(N) AHU-3	20,135	5,445	VAV, SECOND FLOOR ONLY, CO2 SENSOR
	271 IT & 272 ELECTRICAL	(N) FCU 2-1	2,760	-	CAV
+ +	234 STORAGE	(N) FCU 2-2	134	-	CAV
	253 STORAGE	(N) FCU 2-3	134	-	CAV
	229 COMPONENT ROOM	(N) FCU 2-4	308	-	CAV

Appendix B
Flow Diagrams



HVAC STEAM/HOT WATER FLOW DIAGRAM

NOT TO SCALE



HVAC CHILLED WATER FLOW DIAGRAM

NOT TO SCALE

Appendix C
Equipment Schedules

Centrifugal Water Chiller Schedule									
Tag	Manufacturer Model No.	Nominal Capacity (Tons)	Evaporative Side			Condenser Side			
			Flow (GPM)	EWT (°F)	LWT (°F)	Flow (GPM)	EWT (°F)	LWT (°F)
CH-1	York 2S2J4-DEBO	1750	3111	54	40.5	5250	83.5	92.85
CH-2	York 2S2J4-DEBO	1750	3111	54	40.5	5250	83.5	92.85
CH-3	York 2S2J4-DEBO	1750	3111	54	40.5	5250	83.5	92.85
	Summation	**5250**	**9333**					

Steam Absporption Chiller Schedule											
Tag	Model No.	Nominal Capacity (Tons)	Evaporative Side				Condenser Side				
			MBH	EWT (°F)	LWT (°F)	GPM	EWT (°F)	LWT (°F)	GPM	LB/Hr	
ABCH-1	Broad B56000	1900	23800	56	44	4553	85	95	8005	16967	

AIR HANDLING UNIT SCHEDULE

SYMBOL	TYPE (SEE NOTE 1)	SERVICE	LOCATION	DESIGN CFM	RATED CFM	MIN OA CFM	WEIGHT (LB.)	SUPPLY FAN DATA (SEE NOTES 2 & 3) SP/IN.WG. EXT.	SP/IN.WG. TOT.	TYPE	MOTOR HP	RETURN FAN DATA (SEE NOTES 2 & 3) CFM	SP/IN.WG. EXT.	SP/IN.WG. TOT.	TYPE	MOTOR HP
AHU-1	CV	STEM CELL RESEARCH	ROOF	8,200	8,700	2,800	6,648	4		PLENUM	15	-	-	-	-	-
AHU-2	VAV	BLOOD PROCESSING/CRYO	ROOF	7,100 7100	10,000 10000	7,500	16,645	2.25		PLENUM	2 @ 30	6700 6700	1.25		PLENUM	2 @ 7.5
AHU-3	VAV	ADMINISTRATIVE AREAS	ROOF	26,300	26,300	6,700	16,050	2.25		PLENUM	50	19600	1.25		PLENUM	15

SYMBOL	COOLING COIL EAT %%DF DB	EAT %%DF WB	LAT %%DF DB	LAT %%DF WB	MBH TOT.	MBH SENS.	MAX. FACE VEL./ FPM	APD/ IN. WG	WATER (SEE NOTE 4) GPM	WATER PD/FT. WG	MIN. ROWS	MAX FINS/IN.
AHU-1	79.9	62.7	52.5	52	262.8	257.5	500		34			10
AHU-2	85.5	64.3	52.5	52	731.6	712.8	500		98			10
AHU-3	78.7	62.6	54.1	52.6	787.7	698.8	500		105			10

SYMBOL	PREHEAT/HEATING COIL (SEE NOTES 5, 6, 7, 8) LOC	EAT %%DF	LAT %%DF	MBH	FACE VEL. FPM	APD/ IN. WG	WATER GPM	FILTERS (SEE NOTE 9) LOC	APD/IN WG INIT.	APD/IN WG FINAL	SIZE WxHxD/ IN.	EFF. %	TYPE	MAX. AHU SIZE (INCHES) L	W	H	REMARKS (SEE NOTES 11 & 12)
AHU-1	-	-	-	-	-	-	-	PF FF	0.25 0.5	0.5 1		30 95	FLAT CART	284	64	67.5	OUTDOOR ROOFTOP UNIT
AHU-2		44	55	172.8	600		17.3	PF FF	0.25 0.5	0.5 1		30 95	FLAT CART	375	112	91.5	DUAL FAN OUTDOOR ROOFTOP UNIT (NOTE 13)
AHU-3	-	-	-	-	-	-	-	PF FF	0.25 0.5	0.5 1		30 95	FLAT CART	321	98	118	OUTDOOR ROOFTOP UNIT

NOTES:

1. VAV = VARIABLE AIR VOLUME (W/ VFD ON SUPPLY FAN & ON RETURN FAN) CV - CONSTANT VOLUME
2. TOTAL SP IS AN ESTIMATED VALUE BASED ON INFORMATION OF ONE MANUFACTURER OF AHU's. ADJUST TOTAL AS REQUIRED BASED ON ACTUAL UNIT AND COIL LOSSES AND SPECIFIED EXTERNAL AND FILTER FINAL SP.
3. TYPE - BI= BACKWARD INCLINED, AF = AIR FOIL, FC = FORWARD CURVED
4. ENTERING CHILLED WATER TEMPERATURE OF 42%%DF.
5. LOC - P=PREHEAT LOCATION H=HEATING OR REHEAT LOCATION
6. PRIMARY HEATING WATER EWT = 160%%DF & LWT = 140%%DF.
7. NOT USED
8. ALL PREHEAT COILS SHALL BE PARALLEL FLOW TYPE SIZED FOR MINIMUM TUBE VELOCITY OF 3 FT/S.
9. LOC - PF=PREFILTER LOCATION AF=AFTERFILTER LOCATION
10. SEE DIAGRAM BELOW FOR ADDITIONAL ACCESSORY AND ARRANGEMENT INFORMATION
11. SEE ACOUSTICAL PERFORMANCE SCHEDULE.
12. FANS ARE TO BE INTERNALLY ISOLATED WITH SPRING ISOLATORS (2" DEFLECTION)
13. BOTH SUPPLY FANS TO BE SIZED FOR 10,000 CFM, UNDER NORMAL OPERATING CONDITIONS, BOTH FANS WILL OPERATE AT 7,100 CFM. PHC CONDITIONS BASED ON 10,000 CFM
14. AIR HANDLERS SHALL BE SET ON ROOF CURBS; EXCEPT AHU-3 WHICH IS SECURED TO AN EQUIPMENT PAD.
15. ROOF CURBS SHALL PROVIDE A LEVEL SURFACE FOR AIR HANDLERS. COORDINATE ROOF CURB REQUIREMENTS WITH ROOF SLOPE AND STRUCTURE.

REHEAT COIL SCHEDULE

SYMBOL	SERVICE OR LOCATION	CFM	MBH	EAT %%DF	LAT %%DF	MAX APD/ IN. WG	WATER				DUCT WxH (IN.)
							EWT %%DF	GPM	PD/ FT. WG	BRANCH PIPE SIZE / IN.	
RHC-1-1	GOWN OUT 161	730	15.8	55	75	0.2	160	1.6	5	SEE PLANS	16x12
RHC-1-2	PROCESS AREA 163	2160	46.7	55	75	0.2	160	4.7	5	SEE PLANS	26x20
RHC-1-3	CRF 152	560	12.1	55	75	0.2	160	1.2	5	SEE PLANS	12x12
RHC-1-4	STEM CELL LAB 151	1680	36.3	55	75	0.2	160	3.6	5	SEE PLANS	20x20
RHC-1-5	STEM CELL PREP 150	1120	24.2	55	75	0.2	160	2.4	5	SEE PLANS	18x16
RHC-1-6	GOWN IN 154	1280	27.6	55	75	0.2	160	2.8	5	SEE PLANS	18x18

HEAT TRANSFER PACKAGE

SYMBOL	LOCATION	SERVICE	MBH	FOULING FACTOR	TUBE SIDE									SHELL SIDE				WEIGHT
					FLOW GPM	EWT %%DF	LWT %%DF	PD/ FT.WG.	NO. OF PASSES	CONN. SIZE	PUMP HEAD	PUMP HP	PUMP RPM	STEAM PSIG	LBS/ HR	CONN. SIZE SUP.	CONN. SIZE RET.	
HTP-1	ROOF	HEATING WATER	1964	0.00045	200	140	160	0.8		1/4/1900	80	7.5	1750	5	2045	4	1	5100

NOTES:

1. CUSTOM UNIT DUPLEX PUMPS (B & G SERIES 1510 MODEL 2BC), AIR VENT, SEPARATOR, BLADDER TANK, (B & G EXPANSION MODEL B200), FILL VALVE, SINGLE SHELL AND TUBE HEAT EXCHANGER (B & G MODEL SU-103-2).
2. PROVIDE UNIT DISCONNECT SWITCH WITH HEAT TRANSFER PACKAGE AND REMOTE CONTROL PANEL WITH VARIABLE FREQUENCY DRIVES.
3. PROVIDE ET WITH 12 PSIG FILL PRESSURE AND RELIEF VALVE SET AT 50 PSIG.
4. PROVIDE VIBRATION ISOLATION/SEISMIC RESTRAINT ASSEMBLY.

STEAM PRESSURE REDUCING STATION SCHEDULE

SYMBOL	LOCATION	PRESSURE REDUCING VALVE				RELIEF VALVE		REMARKS
		SIZE (IN.)	FLOW LBS/HR.	INIT. PSIG	FIN. PSIG	FLOW LBS/HR.	SET PSIG	
PRV-1A	PUMP ROOM 183	2	5050	125	30	5050	40	PROVIDE SV73 2 1/2" RELIEF VALVE
PRV-1B	PUMP ROOM 183	2	2050	30	15	2050	25	PROVIDE SV73 2" RELIEF VALVE

AHU-2 AIR VOLUME CONTROL BOX SCHEDULE												
SYMBOL	TYPE	SERVICE	INLET SIZE IN.	PRIMARY AIR COOLING (CFM)		WO SP (NOTE 1)	HEATING COIL				
				MAX.	MIN.		HTG CFM	MBH	EAT %%DF	LAT %%DF	WATER (NOTE 3) GPM
CVS-2-1	CV	QUAR. 142	8	670	670	0.1	670	16.6	55	78.0	1.7
CVS-2-2	CV	QC LAB	10	940	940	0.1	940	23.3	55	78.0	2.3
CVS-2-3	CV	CONTROL RM 144	9	770	770	0.1	770	19.1	55	78.0	1.9
CVS-2-4	CV	TRIAGE 128	10	940	940	0.1	940	23.3	55	78.0	2.3
CVS-2-5	CV	BLOOD PROCESSING 127	10	940	940	0.1	940	23.3	55	78.0	2.3
CVS-2-6	CV	BLOOD PROCESSING 127	12	1050	1050	0.1	1050	26.1	55	78.0	2.6
CVS-2-7	CV	TRANSFUSION SVCS. 126	10	940	940	0.1	940	23.3	55	78.0	2.3
CVS-2-8	CV	TRANSFUSION SVCS. 126	10	940	940	0.1	940	23.3	55	78.0	2.3
CVS-2-9	CV	DISTRIBUTION 123	12	1000	1000	0.1	1000	24.8	55	78.0	2.5
CVS-2-10	CV	SPECIAL PROCESSING 120	10	940	940	0.1	940	23.3	55	78.0	2.3
CVS-2-11	CV	CRYO FREEZER 160	12	1360	1360	0.1	-	-	-	-	-
CVS-2-12	CV	CRYO FREEZER 160	12	1360	1360	0.1	-	-	-	-	-
CVS-2-13	CV	CRYO FREEZER 160	16	2040	2040	0.1	2040	50.7	55	78.0	5.1
CVS-2-14	CV	CRYO FREEZER 160	12	1360	1360	0.1	-	-	-	-	-

NOTES:

1. BOX WIDE OPEN STATIC PRESSURE LOSS, IN. WG. INCLUDING HEATING COIL
2. MAXIMUM MANUFACTURER'S RATED NC AT STATIC PRESSURE DROP OF X.X" WG BASED ON 10 dB-12 ROOM ABSORPTION, 5'-0" LONG ACOUSTICALLY LINED DISCHARGE DUCT AND END REFLECTION DUE TO A SINGLE DIFFUSER (NOTE: ACTUAL INSTALLATION MAY VARY FROM BASIS OF RATING).
3. CAPACITY BASED ON 160 deg F ENTERING WATER TEMPERATURE. 3/4" BRANCH PIPE SIZE TO WATER COIL UNLESS OTHERWISE NOTED ON DRAWINGS. TWO OR THREE WAY ATC VALVE AS NOTED.
4. UNITS TO HAVE PRESSURE INDEPENDENT PRIMARY AIR CONTROL, MULTI-POINT INLET VELOCITY SENSOR, BOTTOM ACCESS, INTEGRAL 24V CONTROL TRANSFORMER, SINGLE POINT ENTRY.

AHU-3 AIR VOLUME CONTROL BOX SCHEDULE

SYMBOL	TYPE	SERVICE	INLET SIZE IN.	PRIMARY AIR COOLING (CFM) MAX.	PRIMARY AIR COOLING (CFM) MIN.	WO SP (NOTE 1)	HEATING COIL HTG CFM	HEATING COIL MBH	HEATING COIL EAT %%DF	HEATING COIL LAT %%DF	HEATING COIL WATER (NOTE 3) GPM
VAV-3-1	VAV	HALLWAY 101	5	200	60	0.1	60	1.5	55	78.0	0.1
VAV-3-2	VAV	SCPL SUPPORT 110	8	600	180	0.1	180	4.5	55	78.0	0.4
VAV-3-3	VAV	LOBBY 100	8	600	180	0.1	180	5.4	55	83.0	0.5
VAV-3-4	VAV	DIRECTORS OFFICE 115	9	700	210	0.1	210	6.4	55	83.0	0.6
VAV-3-5	VAV	SYSTEMS COORD. OFFICE 117	5	210	65	0.1	65	2.0	55	83.0	0.2
VAV-3-6	VAV	SUPERVISOR OFFICE 118	5	200	60	0.1	60	1.8	55	83.0	0.2
VAV-3-7	VAV	TOILET 148/149	10	840	255	0.1	255	6.3	55	78.0	0.6
VAV-3-8											
VAV-3-9	VAV	BREAK/LOCKER ROOM 170	9	720	220	0.1	220	5.5	55	78.0	0.5
VAV-3-10	VAV	OFFICE 173	9	650	195	0.1	195	5.9	55	83.0	0.6
VAV-3-11	VAV	LAPTOP SERVICE 182	7	410	125	0.1	125	3.1	55	78.0	0.3
VAV-3-12	VAV	STAGING/STORAGE 180	8	580	175	0.1	175	4.3	55	78.0	0.4
VAV-3-13	VAV	LOADING DOCK STAGING 185	10	730	220	0.1	220	6.7	55	83.0	0.7
VAV-3-14	VAV	HALLWAY 201	10	860	260	0.1	260	6.5	55	78.0	0.6
VAV-3-15	VAV	HALLWAY 201	7	430	130	0.1	130	3.2	55	78.0	0.3
VAV-3-16	VAV	TRAINING 282	7	440	135	0.1	135	3.4	55	78.0	0.3
VAV-3-17	VAV	T A SUPER OFFICE 232	5	200	60	0.1	60	1.5	55	78.0	0.1
VAV-3-18	VAV	NURSE STATION 222	12	1120	340	0.1	340	8.4	55	78.0	0.8
VAV-3-19	VAV	BED 012/015	12	1095	330	0.1	330	10.0	55	83.0	1.0
VAV-3-20	VAV	WAITING/RECEPTIONIST 240	6	320	100	0.1	100	2.5	55	78.0	0.2
VAV-3-21	VAV	COMPONENT ROOM 229	7	400	120	0.1	120	3.0	55	78.0	0.3
VAV-3-22	VAV	BED 005/008	12	1095	330	0.1	330	10.0	55	83.0	1.0
VAV-3-23	VAV	BED 006/009	12	1095	330	0.1	330	10.0	55	83.0	1.0
VAV-3-24	VAV	DC DIR. OFFICE 216	6	330	100	0.1	100	2.5	55	78.0	0.2
VAV-3-25	VAV	ASSISTANT W S 214	7	480	145	0.1	145	4.4	55	83.0	0.4
VAV-3-26	VAV	MED. DIR. OFFICE 217	7	410	125	0.1	125	3.8	55	83.0	0.4
VAV-3-27	VAV	CONSULT ROOM 261	7	390	120	0.1	120	3.0	55	78.0	0.3
VAV-3-28	VAV	WORK AREA 260	10	885	270	0.1	270	6.7	55	78.0	0.7
VAV-3-29	VAV	MANAGERS OFFICE 264	6	300	90	0.1	90	2.2	55	78.0	0.2
VAV-3-30	VAV	WORK AREA 260	8	590	180	0.1	180	5.4	55	83.0	0.5
VAV-3-31	VAV	MD1 235	5	270	85	0.1	85	2.1	55	78.0	0.2
VAV-3-32	VAV	DES SUPER 294	5	260	80	0.1	80	2.0	55	78.0	0.2
VAV-3-33	VAV	DES 291	9	700	210	0.1	210	5.2	55	78.0	0.5
VAV-3-34	VAV	WORK AREA 281	5	280	85	0.1	85	2.1	55	78.0	0.2
VAV-3-35	VAV	MANAGER OFFICE 288	6	340	105	0.1	105	2.6	55	78.0	0.3
VAV-3-36	VAV	TELERECRUITER 290	10	840	255	0.1	255	6.3	55	78.0	0.6
VAV-3-37	VAV	BD SUPER OFFICE 286	9	640	195	0.1	195	4.8	55	78.0	0.5
VAV-3-38	VAV	CONF. 283	7	460	140	0.1	140	3.5	55	78.0	0.3
VAV-3-39	VAV	BREAK/LOCKER 280	12	1200	360	0.1	360	8.9	55	78.0	0.9
VAV-3-40	VAV	SCHEDULE AND COMP. COORD. 284	4	100	30	0.1	30	0.7	55	78.0	0.1
VAV-3-41	VAV	MANAGERS OFFICE 255	4	170	55	0.1	55	1.4	55	78.0	0.1
VAV-3-42	VAV	COMPONENT AREA 249	7	370	115	0.1	115	2.9	55	78.0	0.3
VAV-3-43	VAV	NURSE STATION 250	12	990	300	0.1	300	7.5	55	78.0	0.7
VAV-3-44	VAV	BAY 3/4 023/024	8	660	200	0.1	200	5.0	55	78.0	0.5
VAV-3-45	VAV	HALLWAY 259	10	800	240	0.1	240	6.0	55	78.0	0.6
VAV-3-46	VAV	BAY8/RECOVERY 021/256	8	660	200	0.1	200	5.0	55	78.0	0.5
VAV-3-47	VAV	BAY 1/2 021/022	8	660	200	0.1	200	5.0	55	78.0	0.5
VAV-3-48	VAV	CANTEEN 241	7	380	115	0.1	115	3.5	55	83.0	0.3

NOTES:

1. BOX WIDE OPEN STATIC PRESSURE LOSS, IN. WG. INCLUDING HEATING COI
2. MAXIMUM MANUFACTURER'S RATED NC AT STATIC PRESSURE DROP OF X.X" WG BASED ON 10 dB-12 ROOM ABSORPTION, 5'-0" LONG ACOUSTICALLY LINE DISCHARGE DUCT AND END REFLECTION DUE TO A SINGLE DIFFUSER (NOTE: ACTUAL INSTALLATION MAY VARY FROM BASIS OF RATING
3. CAPACITY BASED ON 160 deg F ENTERING WATER TEMPERATURE. 3/4" BRANCH PIPE SIZE T(WATER COIL UNLESS OTHERWISE NOTED ON DRAWINGS. TWO OR THREE WAY ATC VALVE AS NOTEC
4. UNITS TO HAVE PRESSURE INDEPENDENT PRIMARY AIR CONTROL, MULTI-POINT INLET VELOCITY SENSOR, BOTTOM ACCESS, INTEGRAL 24 CONTROL TRANSFORMER, SINGLE POINT ENTRY

FAN SCHEDULE

SYMBOL	TYPE	LOCATION	SERVICE	CFM	SP/ IN. WG	RPM	MOTOR		MOUNTING
							MAX. BHP	HP	TYPE
EF-1	UP	ROOF	BIO-SAFETY CABINETS	3,000	3.5	1993	4	5	BELT
EF-2	UP	ROOF	CRYO FREEZER RM	9,000	2	1725	7.59	2 @ 10	BELT
EF-3	UP	ROOF	GENERAL EXHAUST	4,000	2	1882	3.78	5	BELT
EF-4	UP	ROOF	GENERAL EXHAUST	3,800	0.75	1022	1.57	2	BELT
EF-5	CAB	STAGING/STORAGE 180	PUMP ROOM EXHAUST	1,200	0.5	896	0.18	1/3	BELT

NOTES:

1. FANS WITH SPEED CONTROLS SHALL BE SELECTED FOR SCHEDULED FAN PERFORMANCE AT MEDIAN AVAILABLE RPM.
2. ALL FANS TO BE BELT DRIVEN UNLESS NOTED OTHERWISE.
3. ALL FANS ARE TO BE PROVIDED WITH BACK DRAFT DAMPERS.
4. PROVIDE FANS WITH ALL OPTIONAL GUARDS, COVERS AND SAFETY DEVICES.
5. CENT = CENTRIFUGAL, PROP = PROPELLER, UTIL = UTILITY SET, UP = UPBLAST, CAB = CABINET
6. PROVIDE VIBRATION ISOLATION/SEISMIC RESTRAINT ASSEMBLY.

PUMP SCHEDULE

SYMBOL	TYPE	SERVICE	GPM	TOTAL HEAD FT. WG	MAX. NPSH FT. WG	OPER. TEMP. %%DF	SIZE IN.		EFF. %	RPM	HP	REMARKS
							SUCT.	DISCH.				
P-1	END SUCTION	CHILLED WATER	750	70	10.3	52	5	4	83.47	1750	20	
P-2	END SUCTION	CHILLED WATER	750	70	10.3	52	5	4	83.47	1750	20	STANDBY

NOTES:

1. PUMPS TO BE NON-OVERLOADING AT EVERY POINT ON PUMP CURVE.
2. PROVIDE SUCTION DIFFUSER FOR ALL PUMPS.
3. PROVIDE VIBRATION ISOLATION/SEISMIC RESTRAINT ASSEMBLY.

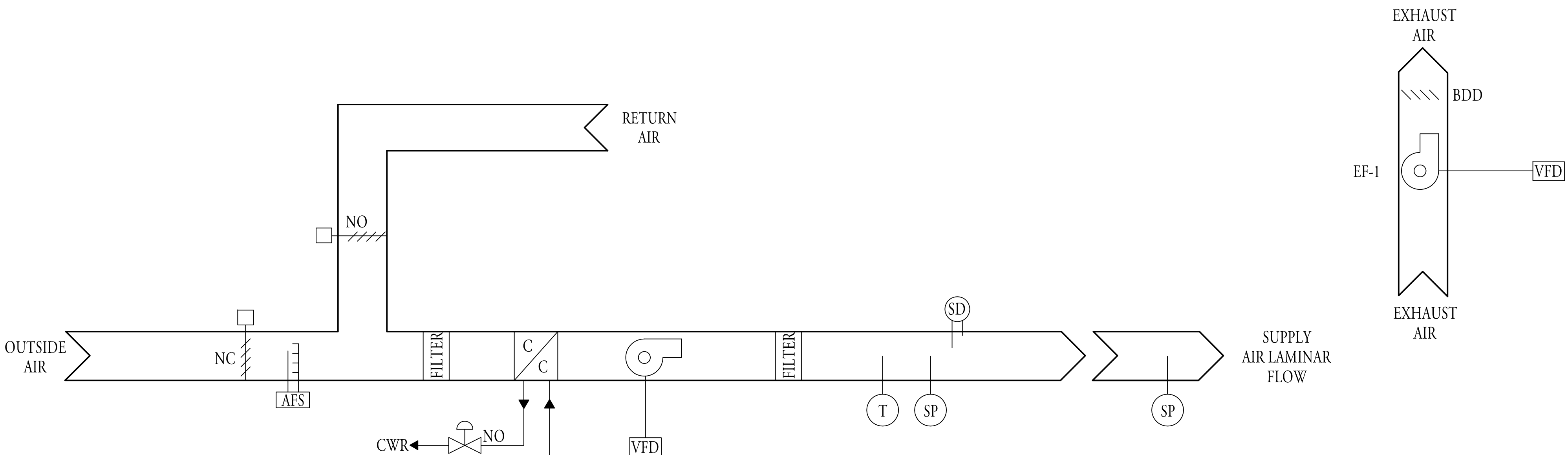
FAN COIL UNIT SCHEDULE

SYMBOL	SERVICE	TYPE (SEE NOTE 1)	FAN				COOLING							NC	WEIGHT (LB.)
			CFM	ESP IN. WG	HP	RPM	EAT DB %%DF	EAT WB %%DF	EWT %%DF	GPM	SENS. MBH	TOTAL MBH	PD/ FT. WG		
FCU-1-1	MACHINE ROOM 106	CH	330	0.3	.1	HIGH	75	67	42	1.4	6.2	10.8	1.62	35	60
FCU-1-2	ELEC. 175	CH	1000	0.5	.5	1183	75	67	42	4.2	18.4	31.7	2.89	35	130
FCU-1-3	IT 177	CH	2600	0.5	1.5	1090	75	67	42	13.3	55.2	100.4	1.25	35	230
FCU-1-4	MACHINE ROOM 107	CH	630	0.3	.1	HIGH	75	67	42	2.3	10.4	17.4	4.24	35	60
FCU-1-5	PUMP/E.P. 183/186	CH	2000	0.5	1.5	975	90	66	42	10.1	69.4	76.3	0.95	35	230
FCU-2-1	IT 271/ELEC 272	CH	2700	0.5	1.5	1107	75	67	42	13.7	56.9	103.4	1.35	35	268
FCU-2-2	STORAGE 234	CH	330	0.3	.1	HIGH	75	67	42	1.4	6.2	10.8	1.62	35	60
FCU-2-3	STORAGE 253	CH	330	0.3	.1	HIGH	75	67	42	1.4	6.2	10.8	1.62	35	60
FCU-2-4	COMPONENT RM 229	CH	330	0.3	.1	HIGH	75	67	42	1.4	6.2	10.8	1.62	35	60

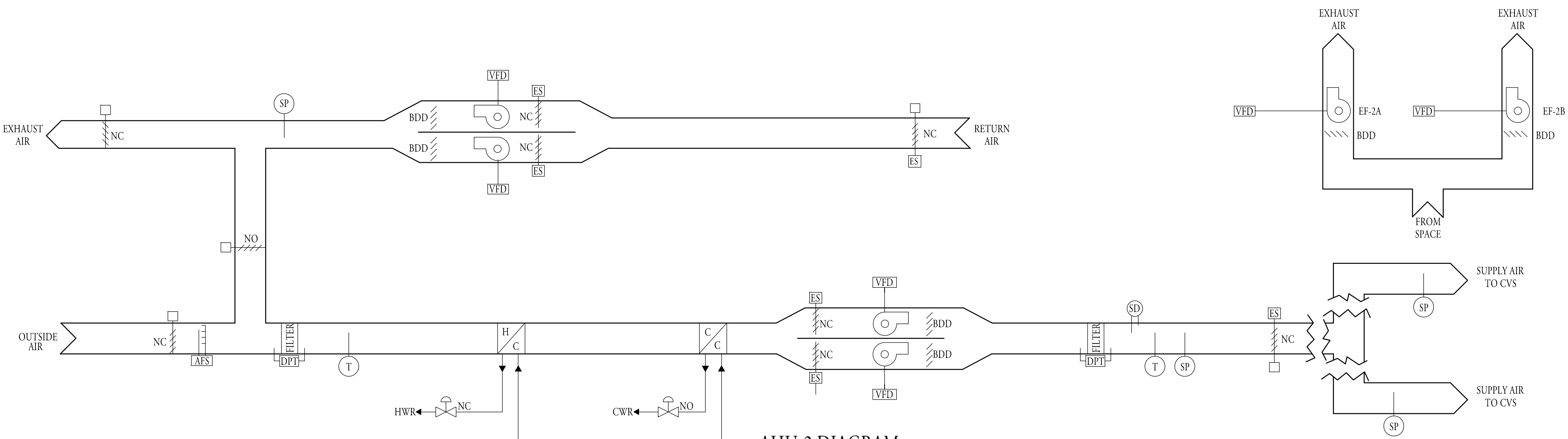
NOTES:

1. TYPE - 4P = 4 PIPE, 2P = 2 PIPE, VHR = VERTICAL HIGH RISE, EH = EXPOSED HORIZONTAL, CH = CONCEALED HORIZONTAL, CAB = VERTICAL CABINET.
2. PROVIDE VIBRATION ISOLATION/SEISMIC RESTRAINT ASSEMBLY.
3. PROVIDE FIELD FABRICATED SECONDARY DRAIN PAN FOR ALL FAN COILS LOCATED ABOVE CEILINGS.

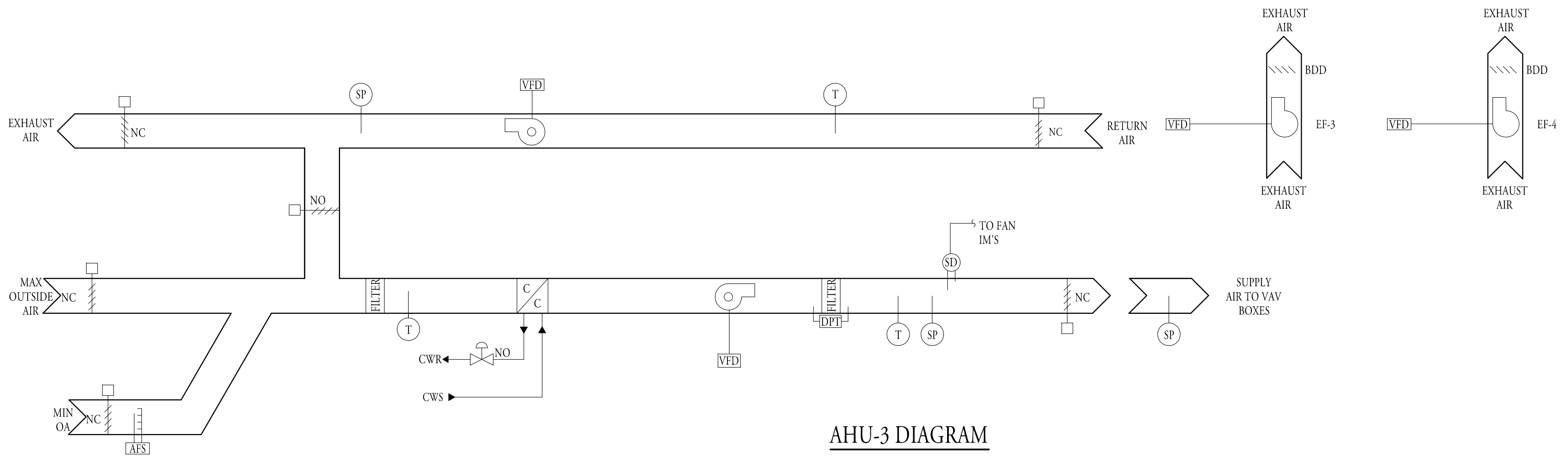
Appendix D
Unit Diagrams



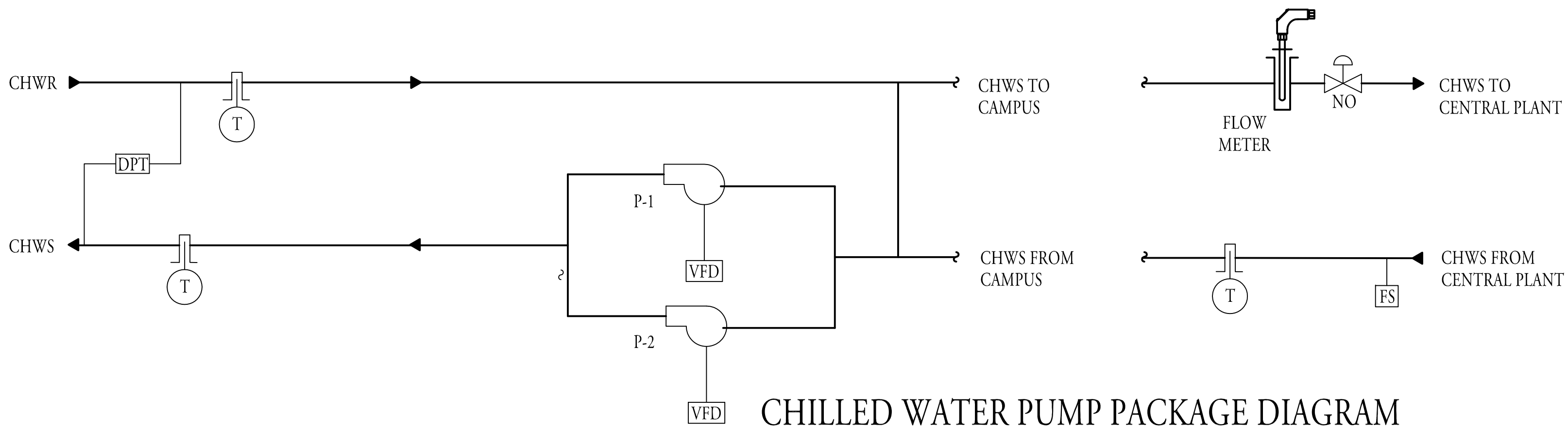
AHU-1 DIAGRAM



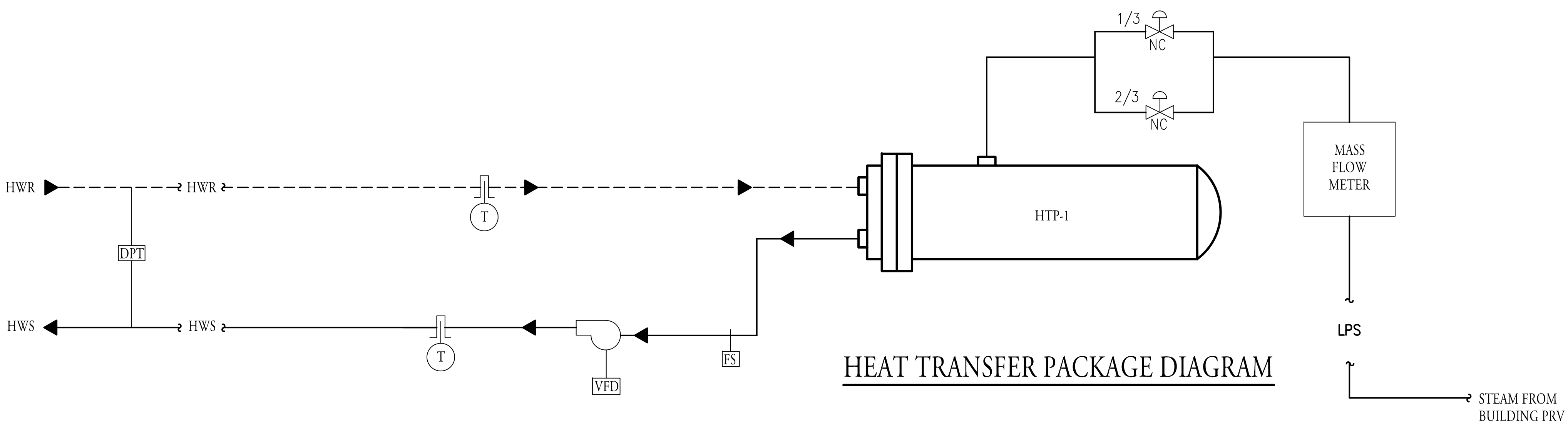
AHU-2 DIAGRAM



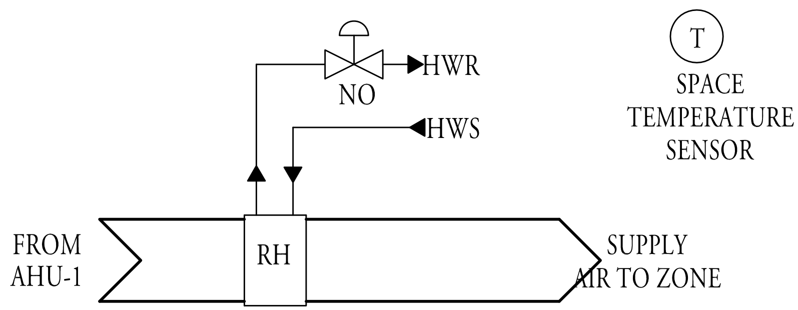
AHU-3 DIAGRAM



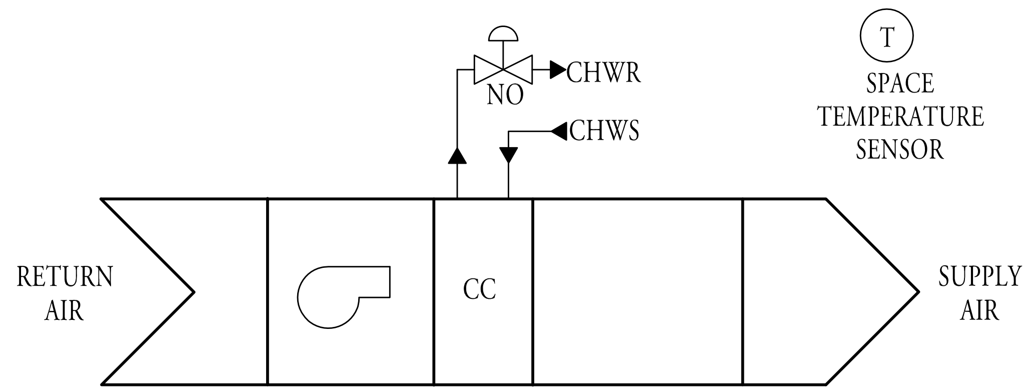
CHILLED WATER PUMP PACKAGE DIAGRAM



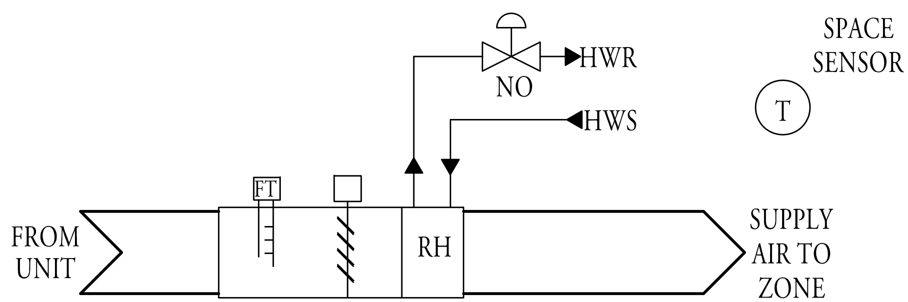
HEAT TRANSFER PACKAGE DIAGRAM



TYPICAL REHEAT COIL DIAGRAM



TYPICAL FCU DIAGRAM



TYPICAL VAV BOX DIAGRAM

Appendix E
DPR Mechanical Cost Estimation

DPR Construction Inc.

SYSTEMS BACK-UP
Design Development Estimate

PROJECT: Transfusion Medicine Center
LOCATION: Duarte, CA
ARCHITECT: EwingCole
CLIENT: City of Hope

DPR JOB NO: 06-25012-00
ESTIMATE NO: Design Development
DATE: 07/16/07
ESTIMATOR: DS/MH/MP/DS/CC

SYS NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL	COMMENTS
	SUBTOTAL: 12 - FIRE PROTECTION					279,600	
13	MECHANICAL						
	HVAC Project Req.						
	Hoisting/Equipment Rentals- (Allow)	1.0	ls	55,000.00	55,000		
	Vibration Isolation/ Seismic Reqmnt's	1.0	ls	25,000.00	25,000		
	Install Owner Furnished Equip- (EXCLD)	1.0	ls	0.01	0		
	Install Duct Mtd Detector-FBO	40.0	mh	68.00	2,720		
	CAD Detailing/As-Built Dwg's- (INCLD)	1.0	ls	0.01	0		
	Cut/Patch/Core Drill- (Allow)	1.0	ls	4,000.00	4,000		
	Firestopping	1.0	ls	5,500.00	5,500		
	SUBTOTAL: HVAC Project Req.				92,220		
	Chilled Water Piping						
	CHW- Type "L" Cu Pipe- 1" --> 21/2" dia	1,200.0	lf	29.00	34,800		
	CHW- Sched40 Blk Stl Pipe- 3" (W)	80.0	lf	61.00	4,880		
	CHW- Sched40 Blk Stl Pipe- 4" (W)	60.0	lf	75.00	4,500		
	CHW- Sched40 Blk Stl Pipe- 6" (W)	300.0	lf	105.00	31,500		
	Install Flow Meter- FBO	1.0	loc	1,750.00	1,750		
	Install Control Devices- FBO	1.0	ls	3,000.00	3,000		
	Valves-(Allow)	1.0	ls	7,500.00	7,500		
	Valve Tags, Charts and Pipe ID	1.0	ls	4,000.00	4,000		
	Central Plant Piping Per OSHPD - (Allow)	1.0	ls	15,000.00	15,000		
	CHW- Sched40 CS- 8" dia (UG)- Pre-Insulated Pipe	160.0	lf	135.00	21,600		
	Pre-Insulated Fittings-(Allow)	4.0	ea	1,350.00	5,400		
	Valves- Isolation	4.0	loc	600.00	2,400		
	Tracer Wire	160.0	lf	2.50	400		
	Thrust Blocks/Restraints	2.0	loc	750.00	1,500		
	Excavation/Backfill	160.0	lf	55.00	8,800		
	Pipe Bedding- Sand	40.0	cy	65.00	2,600		
	POC @ Manhole	2.0	loc	1,250.00	2,500		
	SUBTOTAL: Chilled Water Piping				152,130		
	Hot Water Piping						
	HHW- Type "L" Cu Pipe- 1/2 --> 3/4" dia Run-Out to RHC's (25 FT Avg)	2,610.0	lf	14.00	36,540		
	HHW- Type "L" Cu Pipe- 1" --> 2-1/2" dia Loop Piping for RHC's	1,540.0	lf	29.00	44,660		
	HHW- Type "L" Cu Pipe- 1" --> 2-1/2" dia	160.0	lf	29.00	4,640		
	HHW- Sched40 Blk Stl Pipe- 3"dia (W)	50.0	lf	61.00	3,050		
	HHW- Sched40 Blk Stl Pipe- 4" dia (W)	80.0	lf	75.00	6,000		
	Valves- (Allow)	1.0	ls	8,500.00	8,500		
	Valve Tags, Charts and Pipe ID	1.0	ls	7,500.00	7,500		
	SUBTOTAL: Hot Water Piping				110,890		
	Steam/Condensate Piping						
	MPS- Sched40 CS- 6" dia (UG)- Pre-Insulated Pipe	75.0	lf	135.00	10,125		
	SCR- Sched40 CS- 4" dia (UG)- Pre-Insulated Pipe	75.0	lf	90.00	6,750		
	Pre-Insulated Fittings- (Allow)	4.0	ea	1,250.00	5,000		
	Valves/Specialities- (Allow)	1.0	ls	4,500.00	4,500		
	Tracer Wire	150.0	lf	2.50	375		

DPR Construction Inc.

SYSTEMS BACK-UP
Design Development Estimate

PROJECT:	Transfusion Medicine Center	DPR JOB NO:	06-25012-00
LOCATION:	Duarte, CA	ESTIMATE NO	Design Development
ARCHITECT:	EwingCole	DATE:	07/16/07
CLIENT:	City of Hope	ESTIMATOR:	DS/MH/MP/DS/CC

SYS NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL	COMMENTS
	Thrust Blocks/Restraints	2.0	loc	750.00	1,500		
	Excavation/Backfill	150.0	lf	55.00	8,250		
	Pipe Bedding- Sand	35.0	cy	65.00	2,275		
	POC @ Manhole	2.0	ea	1,250.00	2,500		
	MPS- Blk Stl Sched40- 6" dia (W)	60.0	lf	105.00	6,300		
	LPS- Blk Stl Sched40- 6" dia (W)	140.0	lf	75.00	10,500		
	LPS- Blk Stl Sched40- 1-1/4" dia --> 2-1/2" dia (W)	100.0	lf	60.00	6,000		
	LPC- Blk Stl Sched40- 1-1/2" dia --> 2-1/2" (W)	240.0	lf	60.00	14,400		
	Install Steam Meter- FBO	1.0	loc	1,750.00	1,750		
	PRV Station- Main	1.0	loc	15,000.00	15,000		
	PRV Station @ PH	1.0	loc	15,000.00	15,000		
	Misc. Steam Specialities- (Allow)	1.0	ls	7,500.00	7,500		
	SUBTOTAL: Steam/Condensate Piping				**117,725**		
	Relief Piping/Equip. Vent						
	HHW Equipment Relief/Venting Reqmnt's- (Allow)	1.0	ls	7,500.00	7,500		
	Misc. STM/CR Equip. Relief/Venting Reqmnt's- (Allow)	1.0	ls	10,000.00	10,000		
	SUBTOTAL: Relief Piping/Equip. Vent				**17,500**		
	Piping Connections						
	HW Reheat Coils	71.0	ea	500.00	35,500		
	CHW Coils @ FCU- 1"d	6.0	ea	1,500.00	9,000		
	CHW Coils @ AHU- 2"d	1.0	ea	2,500.00	2,500		
	CHW Coils @ AHU- 2-1/2"d	1.0	ea	3,000.00	3,000		
	CHW Coils @ AHU- 3"d	1.0	ea	3,500.00	3,500		
	HHW Coils @ AHU- 1"d	2.0	ls	1,500.00	3,000		
	HHW Coils @ AHU- 1-1/2"d	1.0	ls	1,750.00	1,750		
	HHW Coils @ AHU- 2"d	1.0	ls	2,250.00	2,250		
	Duct Mtd Humidifier @ AHU	3.0	loc	5,000.00	15,000		
	Heat X-fer Skid- (HHW /STM/ CR)	2.0	ea	6,500.00	13,000		
	Connect to Environmental Rooms	0.0	loc				Excluded
	TCHW Pumps- (w/ Trim)	2.0	ea	5,000.00	10,000		
	Dplx SCR Pumps	1.0	ea	4,000.00	4,000		
	Clean Steam HX	1.0	ea	4,500.00	4,500		
	SUBTOTAL: Piping Connections				**107,000**		
	Insulation						
	Pipe Insulation- HHW - 1" Thk- Run-Out Piping to RHC's	2,610.0	lf	6.00	15,660		
	Pipe Insulation- HHW - 1" Thk- Loop Piping for RHC's	1,440.0	lf	7.00	10,080		
	Pipe Insulation- CHW - 1" Thk- 1" --> 2-1/2"d	1,200.0	lf	7.00	8,400		
	Pipe Insulation- CHW - 1" Thk- 3"d	80.0	lf	9.00	720		
	Pipe Insulation- CHW - 2" Thk- 4"d	60.0	lf	13.00	780		
	Pipe Insulation- CHW - 2" Thk- 6"d	300.0	lf	15.00	4,500		
	Pipe Insulation- HHW - 1" Thk- 1"d --> 2-1/2"d	160.0	lf	9.00	1,440		
	Pipe Insulation- HHW - 2" Thk- 3"d	40.0	lf	11.00	440		
	Pipe Insulation- HHW - 2" Thk- 4"d	80.0	lf	13.00	1,040		
	Insulation @ RHC Connections (HHW)	65.0	loc	175.00	11,375		
	Insulation @ Fan-Coil Unit Connections (CHW)	6.0	loc	175.00	1,050		

PROJECT: Transfusion Medicine Center
LOCATION: Duarte, CA
ARCHITECT: EwingCole
CLIENT: City of Hope

DPR JOB NO: 06-25012-00
ESTIMATE NO Design Development
DATE: 07/16/07
ESTIMATOR: DS/MH/MP/DS/CC

SYS NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL	COMMENTS
	Insulation @ Equip. Connections (HHW)	2.0	loc	750.00	1,500		
	Insulation @ AHU Coil Connections (CHW/HHW)	6.0	loc	750.00	4,500		
	Add for 0.016" Thk Al Jkt- HHW Mains Exposed @ Roof	200.0	lf	12.00	2,400		
	Add for 0.016" Thk Al Jkt- CHW Mains Exposed @ Roof	160.0	lf	12.00	1,920		
	Pipe Insulation- STM/SCR- 2" Thk - 1" --> 3"d	540.0	lf	12.00	6,480		
	Insulation @ STM/SCR Equipment Piping Connections- (Allow)	10.0	loc	750.00	7,500		
	Insulation @ AHU STM/SCR Piping Connections- (Allow)	3.0	loc	750.00	2,250		
	Ductwork- FG ASJ - 2"Thk- 1-1/2 #/CF- Admin	53,000.0	sf	3.00	159,000		
	Ductwork Rigid Board- 2"Thk- 3 lb/CF (Risers + Equip.Rm)- Admin	5,000.0	sf	5.00	25,000		
	Equipment Insulation- (Allow)	1.0	ls	7,500.00	7,500		
	SUBTOTAL: Insulation				**273,535**		
	Hydronic Specialties						
	Expansion Tank - (CHW)	1.0	ea	4,065.00	4,065		
	CHW- Air Separator- 6" dia	1.0	ea	3,745.00	3,745		
	CHW- Triple Duty Valve- 6" dia	1.0	ea	1,885.00	1,885		
	CHW- Suction Difuser - 6" dia	1.0	ea	1,140.00	1,140		
	Chemical Pot Feeder	2.0	ea	520.00	1,040		
	Misc. Hydronic Specialties	2.0	ea	585.00	1,170		
	SUBTOTAL: Hydronic Specialties				**13,045**		
	Steam & Condensate Equip						
	Dplx Press Powered CR Pumps (w/ Receiver)	1.0	ea	7,500.00	7,500		
	Duct Mtd Steam Humidifier	3.0	loc	7,500.00	22,500		
	SUBTOTAL: Steam & Condensate Equip				**30,000**		
	Cooling Equipment						
	TCHW Pumps- 250 GPM @ 20 HP	2.0	ea	4,995.00	9,990		
	VFD @ TCHW Pumps- 20 HP	2.0	ea	4,650.00	9,300		
	SUBTOTAL: Cooling Equipment				**19,290**		
	Heat Exchangers						
	Clean Steam HX- Shell & Tube- Humidification- (Allow)	1.0	ea	25,000.00	25,000		
	Heat X-fer Skid	2.0	ea	60,180.00	120,360		
	SUBTOTAL: Heat Exchangers				**145,360**		
	AHU Rooftop CHW & HW Coil						
	AHU- 1 (w/ VFD)- Stem Cell Research (Energylabs)	1.0	ea	64,175.00	64,175		
	AHU- 2 (w/ VFD)- Blood Processing / Cryo (Energylabs)	1.0	ea	115,245.00	115,245		
	AHU- 3 (w/ VFD)- Admin. (Energylabs)	1.0	ea	103,070.00	103,070		
	AHU- 4 (w/ VFD)- Future Shell West (Energylabs)	0.0	ea				
	AHU- 5 (w/ VFD)- Future Shell East (Energylabs)	0.0	ea				
	Vibration Isolation AHU - #1 --> #3	1.0	ls	16,080.00	16,080		

DPR Construction Inc.

SYSTEMS BACK-UP
Design Development Estimate

PROJECT: Transfusion Medicine Center
LOCATION: Duarte, CA
ARCHITECT: EwingCole
CLIENT: City of Hope

DPR JOB NO: 06-25012-00
ESTIMATE NO: Design Development
DATE: 07/16/07
ESTIMATOR: DS/MH/MP/DS/CC

SYS NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL	COMMENTS
	Future Vibration Isolation AHU - #4 --> #5	0.0	ls				
	SUBTOTAL: AHU Rooftop CHW & HW Coil				**298,570**		
	HVAC Equipment						
	EA Hood- 48" x 48"- Glass Wash	2.0	ea	1,850.00	3,700		
	Fan-Coil Unit- (2-Pipe)- IT/Elect Rm/Elev Mach Rm/ Mech Equip Rm	6.0	ea	2,000.00	12,000		
	Fan-Coil Unit- 600 CFM (4-Pipe)- Stairs	2.0	ea	2,100.00	4,200		
	Re-Heat Coils- (2-Pipe) - Stem Cell	6.0	ea	500.00	3,000		
	SUBTOTAL: HVAC Equipment				**22,900**		
	Exhaust/Return Fans						
	EF- 1- Bio-Saftey Cabinets	1.0	ea	10,450.00	10,450		
	EF- 2 - Cryo Freezer Room	1.0	ea	27,470.00	27,470		
	EF- 3 - General Exhaust	1.0	ea	17,420.00	17,420		
	VFD @ EF - 1 (5 HP)	1.0	ea	2,300.00	2,300		
	VFD @ EF - 2 (10 HP)	2.0	ea	3,990.00	7,980		
	VFD @ EF - 3 (5 HP)	1.0	ea	3,680.00	3,680		
	Misc. Ventilation Reqmnts- (Allow)	1.0	ls	5,000.00	5,000		
	SUBTOTAL: Exhaust/Return Fans				**74,300**		
	Air Filtration						
	BI/BO w/housing 24" x 24"-(F3 - F6)	1.0	ls	16,800.00	16,800		
	Roll Media at RTU's - Construction	1.0	ea	250.00	250		
	SUBTOTAL: Air Filtration				**17,050**		
	Sup/Ret/Gen. Exh. Duct						
	Ductwork- Galvanized	59,000.0	lb	8.00	472,000		
	Ductwork- 316 SS (Humidifier Sect)- Allow	2,000.0	lb	14.00	28,000		
	Ductwork- 316 SS (Lo-Wall Return & Exhaust)(Stem Cell)- Allow	3,000.0	lb	14.00	42,000		
	POC for Duct (FH's,BSC's,Etc)	5.0	ea	350.00	1,750		
	SUBTOTAL: Sup/Ret/Gen. Exh. Duct				**543,750**		
	Misc. Ductwork						
	Louver Blank-Off Panels	30.0	sf	65.00	1,950		
	Drain Pans- FCU's	6.0	ea	300.00	1,800		
	SUBTOTAL: Misc. Ductwork				**3,750**		
	Flexible Duct						
	Insulated- 10" dia- (Avg)	320.0	pcs	65.00	20,800		
	Air Distribution Devices						
	SA Diffusers	208.0	ea	80.00	16,640		
	RA Grilles	153.0	ea	75.00	11,475		
	RA Grilles- SS	10.0	ea	350.00	3,500		
	RA Grilles- SS @ (Low Wall)	9.0	ea	350.00	3,150		
	Wire Mesh Screen	50.0	loc	15.00	750		
	EA Registers	40.0	ea	75.00	3,000		
	Linear Diffuser @ Lobby- (Allow)	48.0	lf	150.00	7,200		
	Misc. GRD's- (Allow)	36.0	ea	75.00	2,700		
	Volume Dampers	299.0	ea	15.00	4,485		
	CV/VAV Boxes w/ RHC's	65.0	ea	1,060.00	68,900		
	Supply & Return Valves @ (Stem Cell Area) Bio safety cab.	1.0	ls	83,380.00	83,380		Phoenix valves

DPR Construction Inc.

SYSTEMS BACK-UP
Design Development Estimate

PROJECT:	Transfusion Medicine Center	DPR JOB NO:	06-25012-00
LOCATION:	Duarte, CA	ESTIMATE NO	Design Development
ARCHITECT:	EwingCole	DATE:	07/16/07
CLIENT:	City of Hope	ESTIMATOR:	DS/MH/MP/DS/CC

SYS NO.	DESCRIPTION	QUANTITY	UNIT	UNIT COST	SUBTOTAL	TOTAL	COMMENTS
	Install Supply & Return Valves @ Ductwork	10.0	loc	200.00	2,000		
	SUBTOTAL: Air Distribution Devices				**207,180**		
	Terminal Filter Units						
	HEPA Filter Module- 24" x 48" (Filter Frame, Ports, Trim and Install)	25.0	ea	1,265.00	31,625		
	HEPA Filter Media- 4" Thk (99.99%)- (EXCLD)	25.0	ea	0.01	0		
	SUBTOTAL: Terminal Filter Units				**31,625**		
	Air Dist. Accessories						
	Gravity Vents Barometric Dampers- (Stairs)	2.0	loc	1,200.00	2,400		
	Roof Curbs- Duct Penetrations	3.0	loc	450.00	1,350		
	SAD- Return Air	3.0	ea	1,715.00	5,145		
	SAD- Supply Air	3.0	ea	2,070.00	6,210		
	Flexible Connectors- AHU	5.0	ea	250.00	1,250		
	Flexible Connectors- EF's	4.0	ea	90.00	360		
	Flexible Connectors- Misc. EF's	1.0	ls	200.00	200		
	Flexible Connectors- FCU's	12.0	ea	90.00	1,080		
	Fire/Smoke Dampers- (Allow)	1.0	ls	25,130.00	25,130		
	AD's @ Ductwork	2.0	ls	2,000.00	4,000		
	AD's @ Finished Construction- (Furnish)	1.0	ls	1,500.00	1,500		
	SUBTOTAL: Air Dist. Accessories				**48,625**		
	ATC Controls						
	DDC Control- (Allowance)	2.0	ls	164,250.00	328,500		
	Air & Water Balancing						
	CV/VAV Boxes w/ RHC's	65.0	ea	75.00	4,875		
	Supply & Return Valves @ (Stem Cell Area)	10.0	ea	120.00	1,200		
	EF's	3.0	ea	115.00	345		
	Misc. EF's- (Allow)	1.0	ls	1,000.00	1,000		
	Air Outlets- (SA/RA/EA/Misc.)	417.0	ea	40.00	16,680		
	AHU's	3.0	ea	1,250.00	3,750		
	Fan-Coil Units	6.0	ea	250.00	1,500		
	Heat X-fer Skid	2.0	ea	750.00	1,500		
	Pumps- CHW	2.0	ea	250.00	500		
	Duct Mtd Humidifier	1.0	ea	125.00	125		
	Clean Steam HX	1.0	ea	375.00	375		
	SCR Pumps (w/ Receiver)	2.0	ea	250.00	500		
	Report	1.0	ls	1,750.00	1,750		
	Report	1.0	ls	750.00	750		
	SUBTOTAL: Air & Water Balancing				**34,850**		
	Misc. HVAC						
	Equip Start-Up/Commissioning	400.0	mh	68.00	27,200		
	Chemical Treatment- (Allow)	1.0	ls	10,000.00	10,000		
	Flashings/Counterflashings	1.0	ls	3,000.00	3,000		
	Leak Test Ductwork- (Mains Only)	120.0	mh	68.00	8,160		
	Grout Inertia Bases- Pumps	2.0	ea	250.00	500		
	Validation Assistance- (EXCLD)	1.0	ls	0.01	0		
	SUBTOTAL: Misc. HVAC				**48,860**		
	SUBTOTAL: 13 - MECHANICAL					**2,759,455**	