7.0 DOAS WITH WATER SOURCE HEAT PUMPS ANALYSIS

The air side portion of the mechanical system redesign for the supply center consists of replacing ten of the fourteen VAV and CAV air handling units with dedicated outdoor air units. The AHUs serve offices, conference rooms, the clothing shops and alteration areas, the mail room, and a variety of storage spaces. The remaining AHUs are constant volume make-up air units. Due to the large amount of exhaust in the kitchen and bakery areas, these units are still required for space pressurization reasons. Also, since the 100% outdoor air mode is only needed when the building is in operation, these units have the ability to back the outdoor air intake down to 5% and re-circulate the space air for conditioning purposes. Since it makes sense to keep these area's separated from the rest of the HVAC system, their existing AHUs will remain.

The parallel system working in conjunction with the DOAS is a water source heat pump (WSHP) system. The WSHP system handles the sensible loads in the spaces served by the dedicated units. The latent loads are met by the ventilation air.

7.1 DESIGN OF THE DEDICATED OUTDOOR AIR SYSTEM

Using ASHRAE Standard 62.1-2004, the required amounts of ventilation air that each space in the supply center required per person and per square foot is easily calculated. Dedicated outdoor air systems supply this correct amount of ventilation air to each space with out return air. Therefore there is no need to intake more outdoor air than the minimum amount.

In VAV systems, the ventilation air is part of a large mixture of outdoor air and return air. To ensure that each space receives the proper amount of ventilation air, correction factors are used increasing the total amount of outdoor air brought in by the AHU. This means more outdoor air to condition, and larger ductwork.

Dedicated outdoor air systems require much smaller ductwork sizes since only a small volume of air is required for ventilation as compared to heating and cooling needs. However, the DOAS must also handle the latent loads in the spaces it serves. The DOAS will dehumidify each space, and by doing so will require more outdoor air than the minimum. The DOAS receives chilled water to dehumidify the outdoor air and supplies it at 55°F. Supplying the ventilation air at a low temperature means that it also handles a small portion of the space sensible load, which creates less demand for the parallel system.

The total amount of ventilation air required for dehumidifying and meeting the requirements in ASHRAE Standard 62.1-2004 is 9,791cfm. Table 7-1 compares the amount of outdoor air required in the VAV systems to the DOAS.

Table 7-1 Outdoor Air Supply Comparison

AHU	Outdoor Air Supplied
3	3640
4	5585
5	3000
7	3000
9	1000
10	1125
11	1045
12	1250
13	3000
14	800
Total	**23,445**
DOAS 1	6176
DOAS 2	3615
Total	**9,791**
Difference	**13,654**

7.2 DESIGN OF THE WATER SOURCE HEAT PUMP SYSTEM

The parallel system, as stated above, that handles the sensible load in each space that the dedicated units serve is water source heat pumps. Since the DOAS handles the dehumidifying duties, the water source heat pumps provide heating or cooling to maintain space temperatures.

With many options available for parallel systems, water source heat pumps are used in the redesign for a variety of reasons. First, the application of the water source loop helps in the integration process of other building systems. Second, the system operates with a heat source and heat sink. No refrigeration equipment is required for operation.

ASHRAE Standard 90.1-2004 states that its minimum efficiency requirements for water source heat pumps are tested with the loop temperature maintained at 86°F for summer operation and 68°F for winter. The redesign heat pump system follows this design guideline. A heat source, such as a boiler or recovered heat, adds heat to the water loop in the winter to maintain the 68°F temperature when needed. Since there are many spaces that require cooling year round, heat addition is rare in this situation. When the water loop temperature is above the 86°F in the cooling seasons, a cooling tower is used for heat rejection. The cooling tower duty is shared with what ever other refrigeration equipment is in the building.

Water source heat pumps reduce the amount of energy used for heating and cooling, but do use a significant amount of electricity. The WSHPs used in the redesign are horizontal concealed units located above the drop ceilings in each space or the corridors. Ductwork and overhead diffusers supply the conditioned air to each space. This means that each WSHP requires fan energy for operation, which is a drawback to using this system for the parallel cooling method.

Each WSHP includes it own compressor to perform the thermodynamic functions for space conditioning. This creates another disadvantage in using this system because of maintenance issues. Since there is no noise criteria established for any spaces, using WSHPs is not an issue in regard to noise. The compressors make WSHPs nosier than using fan coils or VAV systems, but this is a non-issue for the situation.

Figure 7-1 Water Source Heat Pump from McQuay Product Literature

Integration of other building systems is a main goal of the redesign. Using water source heat pumps helps with this process. The walk-in freezers located in the kitchen, as previously explained, uses a condenser water loop for rejecting the produced heat in the refrigeration process. This technique eliminates excess cooling loads in the kitchen spaces, but is the condenser water is cooled back to operating conditions, 65°F, by the chilled water system. The load profiles shown in section 6.0 illustrated that this creates a 106 ton base load for the chilled water plant.

Recovering this waste heat helps integrate other building systems with the HVAC system as well as lowers the load on the chilled water system. The water source loop requires heat addition in the winter time to maintain the required temperatures for operation. Using temperature control valves and a plate frame heat exchanger, the redesigned system recovers the waste heat from the walk-in freezer's condensing units by using it as the water source loop's heat source.

Figure 7-2 illustrates the DOAS configuration with WSHPs and the heat recovery scheme.

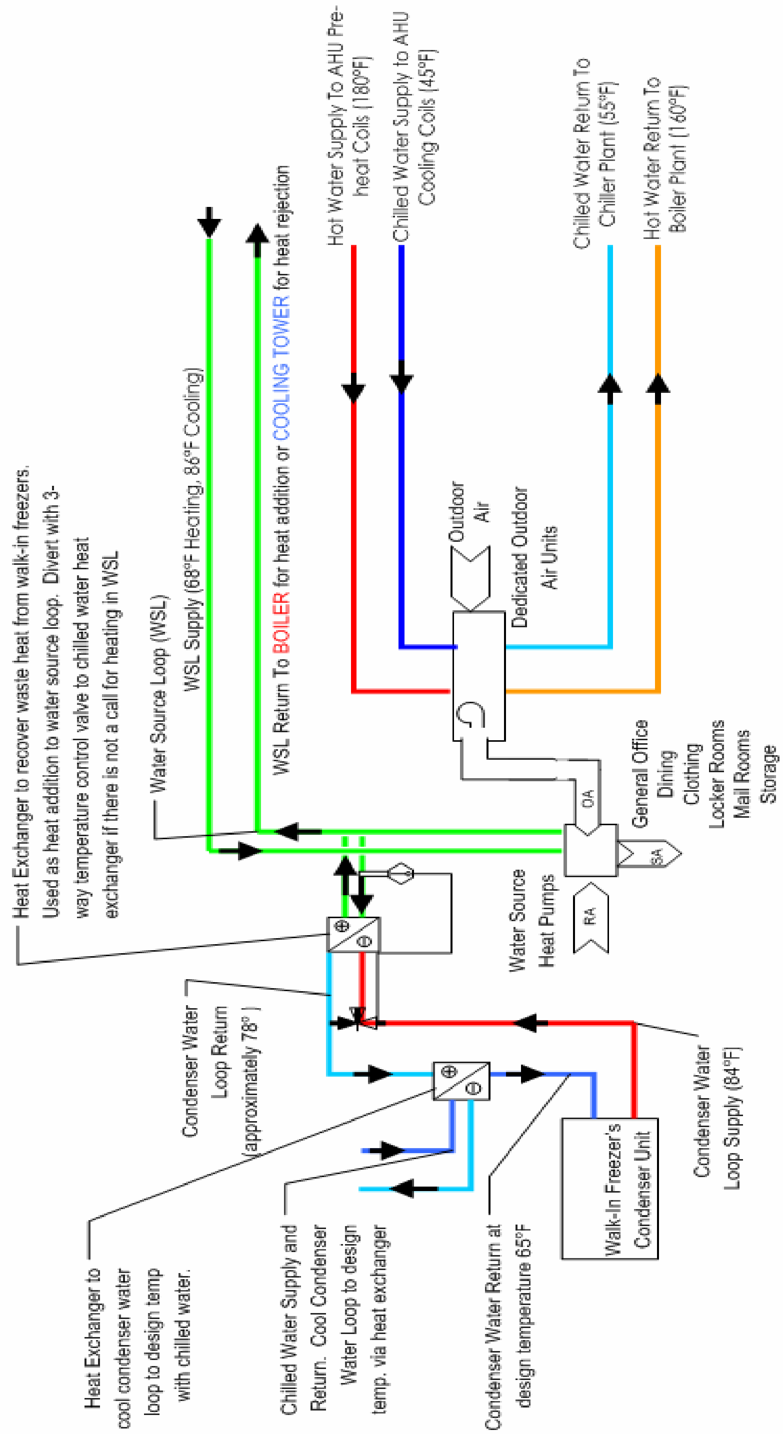

Figure 7-2 DOAS and WSHP Schematic