C. MECHANICAL ENGINEERING NARRATIVE

Environmental Design Conditions

Heating Systems
The heating system will be designed based on a winter design outdoor air temperature of 3°F db, in accordance with the ASHRAE 99.6% design temperature. The design will incorporate heating season indoor temperatures of 68°F.
Cooling Systems
The cooling system will be designed based on a summer design outdoor air temperature of 70°F db and 57°F wet bulb, per the ASHRAE 0.4% design temperatures. The indoor temperatures may vary because of the passive cooling strategies, but the target setpoint will be 78°F.
Ventilation Rates
Ventilation, pressurization and air change rates will be provided in accordance with ASHRAE standard 62-1999 (Ventilation for Acceptable Indoor Air Quality) as well as the RFP Performance Requirements. Ventilation rates will be provided varying from 15 to 20 CFM per person (depending on space usage) and 0.05 CFM per square foot in the corridors.
Humidification
The Mechanical Systems design will not include direct humidification control.
Building Loads

- Occupant densities will be based on programmed space, coordinated with the architect.
- Lighting loads will be coordinated with the electrical consultant. Lighting loads will be in the approximate range of 0.5 to 2.0 watts/sqft depending on space usage. Daylighting zones will be incorporated, reducing the heat gain to spaces during daylight hours (solar heat load and daylight zone lighting load are not coincident).
- Miscellaneous loads as required (office equipment etc.)
- Computers (pc's) 150 watts each with a load factor to account for occupant diversity (current technology assumption)

Applicable Codes and Standards

The building mechanical systems will be designed in accordance with the following codes and standards:

International Building Code 2003
International Fire Code 2003
International Mechanical Code - 2003
Uniform Plumbing Code - 2003
Americans with Disabilities Act (ADA)
National Fire Protection Agency (NFPA) 2002 Regulations (NFPA 13)
ASHRAE Energy Standard

Standards

American Society of Heating, Refrigeration and Air Condition Engineers (ASHRAE)
American Society of Plumbing Engineers (ASPE)
Sheet Metal Contractors Association of North America (SMACNA)

Exterior Plumbing Systems

Exterior services beyond 5 ft from the building are covered within the scope of the Civil Engineer on this project. At this schematic design phase of the project, based on the proposed building layout and loads, the following plumbing systems and site services are required:

- Sanitary sewer, 4" pipe diameter
- Storm sewer, 6" pipe diameter
- Water service; 2" diameter domestic service, 6" diameter fire service

In general, the pipe and fitting materials to be per outline mechanical specifications included as part of design submittal.

Interior Plumbing Systems

Domestic Cold Water Systems

The domestic cold water system for each building will consist of:

- double check valve type backflow preventor
- distribution system
- zone isolation valves

Domestic Hot Water Systems

The domestic hot water system will consist of:

- High efficiency fuel oil fired domestic hot water heater with recirculating hot water supply piping to provide hot water to all parts of the building.

Storm Drainage System

The storm drainage system will consist of interior downspouts connecting to roof drains. Overflow drains will be provided as well. Interior rainwater leaders and overflow water piping will be insulated to prevent condensation from forming on the piping. Rainwater piping will be collected below grade and routed out of the building. Overflow piping will be routed to ground level and spilled to grade so that the facilities manager will be aware that the storm drains are clogged. The storm water and overflow piping will be sized to meet the requirements of the Uniform Plumbing Code.

Sanitary Waste and Vent Systems

The sanitary waste and vent system will serve washrooms, isolated fixtures, and floor drains which discharge sanitary waste.

General Interior Plumbing Requirements

- All internal domestic water, and metallic storm piping shall be insulated as recommended by ASHRAE (minimum 1" thick), complete with

vapor sealing on cold water lines. All domestic water systems shall be chemically cleaned to AWWA requirements.

- All standard plumbing fixtures and trim shall be selected with water conservation in mind, with fixture types coordinated with the Architect.
- Sinks will be provided with domestic hot and cold water.
- All plumbing systems shall be pressure tested.
- All piping shall be identified and color-coded as required with appropriate labels and flow arrows.
- Non-freeze hose bibbs will be provided around the exterior of the buildings.
- All piping systems shall be designed to incorporate earthquake restraints as required by the Uniform Building Code.
- Hose bibbs in equipment rooms will be provided with vacuum breakers.
- Floor drains will be provided in new mechanical room.
- For water systems, manufactured shock absorbers will be provided for each group of plumbing fixtures or remotely located plumbing fixture.

In general, pipe and fitting materials used will be as described in the outline mechanical specifications.

Fire Protection Systems

The buildings will be fully sprinkled with a wet system within the building thermal envelop, and dry heads where subject to freezing. Pendant recessed sprinkler heads finished in white for finished areas and brass upright sprinkler heads in the open unfinished areas such as mechanical rooms, etc. will be provided. The system will be complete with supervisory and tamper switches on all main isolation valves, backflow prevention, flow switches, and sprinkler floor control valve assemblies for each floor.

A fire department connection for the sprinkler system will be provided on the Fifth Avenue side of the building.

Heating Systems

A wood chip fired boiler with a modulating burner will provide heating water for all building areas. The boiler plant will be located in a separate building across Fifth Avenue on the site designated for parking and service access. Wood will be obtained from the Forest Service and stored off site. A wood chip hopper will be located in the boiler room, with access for filling through a roll up door. A small fuel oil backup boiler will also be provided. This boiler will operate during cleaning and maintenance of the wood chip boiler, or in case of mechanical failure. The backup boiler will not be full sized, and will not maintain a comfortable temperature during cold weather. A fuel oil tank will be provided for the backup boiler. This tank will store enough fuel for 12 to 24 hours of backup boiler operation.

The heating water system will consist of main distribution 180 degree F hot water supply and return loops. Heating water pumps and piping will supply heating water to the air handling units. A secondary loop and four way valve will provide 120 to 130 degree F tempered water to the radiant floor system. The heating water system will include a pot feeder to enable continuing maintenance of system chemical treatment.

Space heating in the agency office areas will be provided by a radiant floor system. The system will be zoned to separate different uses, and heating loads. Each zone will be controlled by a room thermostat. This separate zoning will allow the temperature in unused areas to be set back to conserve energy.

All piping will be installed parallel with building lines. The entire system shall be drainable and high points shall be equipped with air vents. All piping will be insulated as recommended by ASHRAE (minimum 1" pipe insulation with all service jacketing.

Two way control valves will be utilized on all most radiant floor manifolds and air handling unit heating coils. Three way valves will be provided as required such that heating water is always available at all parts of the heating system.

Balancing devices will be installed on main branches and main pump circuit.
Reduced pressure type Backflow preventor will be installed on heating system make-up.
Spring loaded check valves will be installed on discharge side of pumps.

Cooling Systems

Space cooling will be provided to the majority of spaces through natural ventilation. Perimeter operable windows and the central atrium will allow warm air to escape out of the atrium while pulling cooler outside air in through the open windows. Most areas will require communication with the outside to allow this system to work.

In areas where operable windows are not desired for aesthetic or functional reasons, an under floor air system will provide cooling. Outdoor air will be supplied to these spaces through a raised floor plenum. Heat will rise naturally to the top of the spaces where it will be exhausted from the building. Underfloor systems generally use 63 degree supply temperature. Thermal mass will be provided to absorb the added heat on days when the 63 degree outdoor temperature cannot be met.

In the basement and secure areas, a traditional overhead system will be used. Many of these areas have limited occupancy and no solar heat gain so cooling requirements in these areas will be minimal. An overhead system will supply outside air to cool these spaces. Thermal mass will be provided here as well to absorb excess heat when the outside air temperature is above optimum.

General Considerations of Radiant Heating

At its most basic, hydronic radiant heating involves heating a structure by pumping warm water though specially designed tubing laid within the concrete slab. As the temperature of the concrete approaches the temperature of the water in these tubes, the slab radiates heat to the occupants in the room. This tremendously efficient heat transfer results in even and consistent temperature control.

In a radiant slab system the concrete reacts slowly so there are no wide temperature variations that can be experienced with forced air or radiator systems. Radiant floor systems are also quiet as there are no noisy fans or radiator expansion noises to contend with, enabling a more natural and traditional appearance to spaces where it is applied. Energy efficiency is one of the system's strong points because the system delivers heating where it's needed, with little waste. A thermostat is put in each temperature control zone in the building, with unoccupied zone temperatures set back to save energy. Because heat radiates through the air, occupants feel comfortable at air temperatures several degrees cooler than with other heating systems. Similarly the room may be kept a few degrees warmer in the cooling season. Additional benefits include a reduction in air movement, resulting in fewer drafts. Radiant heating also requires less maintenance as there are no air filters to change, ducts to clean, fan belts to replace or fan motors to be oiled.

Ventilation Systems

During the cooling months ventilation will be supplied naturally through operable windows in most areas. The layout of all naturally ventilated spaces will be designed to adequately ventilate the building and maintain specific comfort levels without air conditioning for most times of the year. This will be verified by natural ventilation computer modeling software prior to design development, allowing expected indoor temperatures to be identified to the client group for determining acceptability.

During the heating season the operable windows will be sealed shut against the cold weather. Ventilation will be provided by a minimum outdoor air system. This system will minimize energy costs by supplying the minimum amount of outdoor air required to maintain good indoor air quality. Carbon dioxide sensors will be used in conference rooms and auditoriums to determine occupancy levels and provide ventilation to match.

Areas where natural ventilation is undesirable because of noise, security, or light control issues will be mechanically ventilated through traditional overhead ductwork or through an underfloor air plenum.

Natural ventilation schemes will be evaluated using a computer modeling software package. The thermal modeling will allow us to predict indoor comfort levels (temperatures) taking into account window openings, weather data, wind velocity, solar

data, building configuration and construction, and internal loads such as computer equipment and people. Output data can then be summarized, indicating the duration of time (on an annual basis) that indoor conditions exceed a predetermined comfort level.

Whenever possible, an integrated design approach will be used to minimize heat gain in the summer and heat loss in the winter. This may include measures such as reducing solar heat gain, using energy efficient lighting, and heat absorbing thermal mass in the summer, and insulated shutters and maximizing solar heat gain in the winter.

Ventilation and underfloor duct systems installed will be designed in accordance with ASHRAE recommendations and SMACNA, HVAC Duct Construction Standards.

Vibration isolation will be provided for any required air handling and exhaust equipment. Seismic restraints will be provided in conformance to the UBC.

General Considerations of Natural Ventilation Design

A naturally ventilated building uses the basic physical principles of buoyancy and air pressure differences to drive air through the spaces. Where a ventilation shaft is used, warm air rises and in doing so, it pulls other air into the void that it left behind. The air that is “pulled in” or induced comes from the outdoors and serves to cool the space. In the case of using only openable windows, a pressure gradient induces outdoor air to travel through the building via the windows. With a well-designed building, the quantity of air is maintain a comfortable space temperature most times of the year without and provides good indoor air quality.

One advantage of natural ventilation is that there are fewer major pieces of air handling equipment to purchase, run, or maintain. Using natural ventilation less mechanical ductwork would be required in the spaces enabling a higher ceiling. Another advantage is higher indoor air quality. Higher outside air quantities during summer flush out indoor contaminants quicker than a traditional system.

The Atrium offers some excellent opportunities for natural ventilation. In particular, the high space will help promote natural ventilation through all of the floors. Specific design criteria regarding location and size of openings, thermal mass, nighttime flushing/pre-cooling and/or solar shading is established by the thermal analysis.

Temperature Control System

A direct digital control (DDC) system will be provided for temperature control. The system will use the BACnet open protocol to allow for flexibility in any future modifications or expansion. This system will control the underfloor air system, boiler, radiant slab system, minimum ventilation system to maintain space temperatures. The natural ventilation system will be operated manually by the building occupants. Manual

control allows the users to directly influence their environment without relying on a computerized system that may not recognize personal desires.

Zoning

The systems will be zoned such that unused areas of the building may conserve energy through limited heating without affecting other areas of the building. Areas that will be zoned separately include the main lobby, multi-purpose room, exhibit hall, meeting rooms, and a portion of the agency offices.

Alternatives to Address the Percentage of Available Budget

The narrative above describes the 90% proposed system. Changes to this system to achieve 100% and 75% are as follows:

<u>100% Alternative:</u>

- Add heat and air to air heat recovery system to the ventilation system. This option would save energy on ventilation air heating. Ductwork would be added to return air to the mechanical room and route it through a heat wheel type heat exchanger. Heat recovery will be added on the underfloor air system.
- Increase the number of control zones so that most areas have individual control. This option would more finely control each space, and may allow more zones to be set back to a lower heating level when the occupants are not in the space.

<u>75% Alternative:</u>

- Replace the wood fired boiler with a propane or fuel oil fired boiler. These boilers are less expensive to install, but fuel costs would increase.
- Remove heating zones from the DDC system. Each zone would have local control saving significant cost in control points. The DDC system would still control the central boiler and pumps, but would not control individual zones.
- Replace the radiant floor system with baseboard fin-tube convection heaters. While these units are less expensive they will take up wall space.

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