SENTARA PRINCESS ANNE HOSPITAL MECHANICAL DESIGN NARRATIVE

March 28, 2011.

A. General:

Work under the mechanical contract to be performed in accord with the Virginia Uniform Statewide Building Code-USBC- (which adopts and incorporates by reference as an enforceable part of the USBC, the 2006 International Building Code, the 2006 International Mechanical Code, the 2006 International Plumbing Code and the 2006 International Energy Conservation Code), the State Board of Health Rules and Regulations for the Licensure of Hospitals in Virginia (which adopts and incorporates by reference as an enforceable part of the regulation, the Guidelines for Design and Construction of Hospital and Health Care Facilities, The American Institute of Architects , Washington, D.C., 2001 Edition) and other applicable laws, rules, regulations and codes having jurisdiction.

Design conditions. The design of the mechanical systems is based on the following information and conditions.

Exterior Design Conditions.

• Site elevation:	30 ft.
• Winter Design Conditions:	
o ASHRAE 99.6 design dry-bulb temperature:	20 degF.
o Annual extreme temperature:	15 degF.
o Annual Heating Degree Days:	3421
o Prevailing winds from the:	Northwest
• Summer Design Conditions:	
o ASHRAE .4% design dry-bulb temperature:	94 degF.
o ASHRAE .4% coincident wet-bulb temperature:	77 degF.
o Mean daily temperature range:	16 degF.
o Annual extreme temperature:	98 degF.
o Annual Cooling Degree Days:	2000
o Prevailing winds from the:	Southwest

Interior Design Conditions. Requirements for space pressurization, minimum airflow rates, exhaust airflow, space humidity and room temperature are based on the more stringent of the current ASHRAE Guidelines (Applications Handbook, Chapter 7, Table 3) or the AIA Guidelines for Design and Construction of Hospital and Health Care Facilities (Table-Ventilation Requirements for Areas Affecting Patient Care in Hospitals and Outpatient Facilities).

Ventilation Requirements. Outside air ventilation for the Hospital is based on the more stringent of the current ASHRAE Standard 62 or the AIA Guidelines for Design and Construction of Hospitals and Health Care Facilities.

The design includes the following mechanical systems:

- Plumbing systems: Sanitary waste and vent, storm drainage, water distribution, medical gas systems and certification, and plumbing fixtures and carriers.
- HVAC systems: Air handling systems including air distribution and ventilation, heating water distribution, chilled water distribution, steam distribution and humidification system.
- Site utilities: Sanitary sewer, water and storm sewer systems.
- Temperature controls and building automation system.
- Fire protection systems: Sprinkler system and standpipe system.
- HVAC systems test and balance: Air and water distribution systems.

B. Seismic Considerations

The building addition shall be constructed per Seismic Design Category C requirements.

- Provide seismic bracing for all mechanical piping system and equipment as required by Section 1621 of the 2006 IBC and Section 9.6 of the ASCE.

C. Site Utilities

Sanitary sewer system:

- A gravity sanitary sewer system serves the Hospital.
- Three sanitary sewer mains extend from the southwest and south sides of the Hospital and connect to the site sanitary sewer system at new manholes.

Storm drainage system:

- Three storm sewer mains extend from the southwest and south sides of the Hospital and connect to the site storm sewer system at new manholes.

Domestic water system:

- Two domestic water service lines serve the Hospital. The second water service is required by Code for hospitals as redundant water source. The service lines extends from the CUP and connects to the site water loop piping.
- An 8" fire service is provided to serve the Hospital. The service line extends from the CUP and connects to the site water loop piping. The fire service line is provided with a post indicator valve (PIV).
- The City water meter for the domestic water system is installed in a meter pit located near the tap connection to the main site water supply line.

Natural gas system:

- A natural gas service line is provided to serve the Hospital. The service line extends from the CUP and connects to a new natural gas main, which was extended to the site for this building project.

D. Central Utility Plant (CUP)

An independent Central Utility Plant (CUP) designed to serve the entire Hospital, provides HVAC, plumbing, medical gas and fire protection services for the new hospital. The CUP is located directly behind the hospital next to the service drive. This location provides excellent access for equipment maintenance and operational deliveries without disrupting hospital operations. Bulk tanks for oxygen, nitrogen and fuel oil are also located near the CUP. The following utility services are supplied from the CUP to the Hospital via direct buried piping systems:

- Chilled Water for cooling
- Hot Water for heating
- Steam for humidification
- Domestic cold water (8" CW)
- Domestic soft cold water
- Domestic hot water
- Domestic hot water recirculation
- Medium pressure steam for hospital equipment
- Steam condensate return
- Medical compressed air
- Laboratory compressed air
- Medical surgical vacuum
- Nitrogen
- Nitrous Oxide
- Oxygen
- Carbon Dioxide
- Fire protection water

E. Major Mechanical Utility Systems:

Chilled water system:

- The chilled water system consists of three 800 ton centrifugal chillers, three 800 ton cooling towers, three chilled water pumps and three cooling tower pumps. All of the equipment is sized to provide N+1 redundancy. All chillers, cooling tower fans, chilled water pumps and condenser water pumps shall have adjustable frequency drives (AFD's).
- The chilled water pumping system is of the variable primary flow type. The three chilled water pumps will pump directly through the chillers (no secondary pumps are provided) and the system flow rate will vary based on the building cooling load.

- A cooling tower chemical treatment system consisting of a main control panel, chemical feed pumps, chemical storage tanks, water meters, injection nozzles, bleed off assembly, secondary spill containment, etc., is provided.
- A double wall plate and frame heat exchanger is provided to allow for preheating of the domestic hot water with the heat rejected from the chillers.

Steam system:

- The CUP supplies steam as the primary heating medium for the Hospital. 41,400 MBH of heat is provided by three 400 BHP, dual fuel (natural gas/fuel oil), forced draft, scotch marine, fire tube boilers. Each boiler creates 13,800 LBS/HR of 100 PSIG steam.
- Deaerator and surge tank. Deaerater and surge tank units are provided as a boiler feed system. The deaerator is capable of removing oxygen from boiler feed water to not more than .005 CCS/liter. System components include condensate surge tank, condensate transfer pumps (2), deaerated water storage section, boiler feed pumps (3) and all necessary accessories and controls for a complete-operational system.
- The steam pressure is reduced to 80 PSIG to serve hospital equipment, reduced to 40 PSIG to serve the domestic water heaters and reduced to 15 PSIG to serve heating equipment.
- Two of the boilers deliver the necessary heating capacity, a third boiler is provided to meet the redundant heating requirements of healthcare facilities.
- The boilers are piped together in a manifold configuration to allow flexibility in the boiler plant operation and to accommodate future piping connections. Multiple isolation valves assure constant, reliable and maintainable performance.
- Each boiler will have a condensing type flue gas economizer and sophisticated, precise controls to allow for the total boiler package to be very efficient.
- A duplex condensate pump is provided at the CUP to receive condensate from the building heat-heat exchangers and domestic water heaters and pump it back to the condensate surge tank.

Heating hot water system:

- Plant low pressure steam (LPS) is used to produce heating hot water via two steam to hot water heat exchangers located at the CUP. Two heating hot water pumps distribute the heating hot water throughout the Hospital to the perimeter heating system, heating coils at the air-handling units (AHU'S), reheat coils at the air terminal units (ATU's) and cabinet unit heaters at the vestibules and stair towers, to provide building heat.

Fuel oil system for the steam boiler system:

- Two 12, 000 gallon above ground storage tanks store #2 fuel oil for use in boilers.
- Duplex submersible fuel oil pump sets, located at each tank, pump the fuel oil from the main tanks, to the boiler room and back to the main tanks in a continuous loop.
- Fuel oil pumps provided with the boilers transfer the oil from the main piping loop to the boilers as required.

Fuel oil system for the emergency generator system:

- Two 12, 000 gallon above ground storage tanks store diesel fuel for use in the emergency generators.
- Duplex submersible fuel pump sets, located at each tank, pump the diesel fuel from the main tanks, to the generator room and back to the main tanks in a continuous loop.
- Provide one 200 gallon day tank for each emergency generator. A float switch located in the day tank shall open a solenoid valve in the diesel fuel supply piping as required to keep the day tank full.
- Fuel pumps provided with the emergency generators transfer the fuel from the day tanks to the emergency generators.

F. Fire Protection Systems.

- The Hospital has a fire sprinkler system which provides 100% coverage and also has Class I standpipe system.
- A fire pump, to provide adequate water flow and pressure for the Hospital fire protection systems, is located at the CUP. This pump is capable of delivering 1000 GPM and increasing the existing site water pressure by 115 PSI. The fire service is supplied from the City of Virginia Beach water system through an 8" fire service line. The fire pump is served by emergency power to provide 100% availability.
- A 6" fire service main is routed from the pump discharge, to the Hospital to serve the Hospital's fire protection systems. A post indicator valve and fire department connection are provided.

G. Building Plumbing Systems.

Sanitary sewer system:

- A gravity sanitary sewer system serves the Hospital.
- Three sanitary sewer mains receive waste from all plumbing fixtures, exit at the southwest and south sides of the building and connect to the site sanitary sewer system.
- Both traction and hydraulic elevator pits will be equipped with submersible "oil minder" type sump pumps which will discharge to the sanitary sewer system. These units are capable of sensing the presence of oil in the sump pit, which causes the pump to shut down and an alarm to be sent to the Building Management and Control System (BMCS).

Storm drainage system:

- System will include roof drains, overflow roof drains and associated piping.
- Three storm sewer mains serve the primary roof drainage system, exit at the southwest and south sides of the building and connect to the site storm drainage system.
- The overflow roof drainage system discharges to visible-above grade locations

Domestic water system:

- Domestic water service will enter the facility at the CUP. The CUP houses dual reduced pressure backflow preventers installed in parallel and a domestic water pressure booster system consisting of three variable speed pumps. Domestic cold water will be distributed throughout the Hospital from this point.
- Domestic hot water system. Domestic cold water is heated by three instantaneous type, steam fired water heaters, each sized at 33-1/3% of maximum building hot water demand requirement. The domestic water heaters are located in the CUP. A domestic hot water recirculation system will be provided to insure prompt delivery of hot water to fixtures in all areas of the building.
- Plumbing fixtures and trim. All fixtures will be new. Provide carriers for wall- mounted fixtures. Provide wall hydrants for use outside of the building. Water closets are wall hung in patient and clinical areas and floor set-back outlet in public areas. All fixtures will be provided with backflow prevention devices as required by Code.
- System isolation valves. Isolation valves will be provided at the building entrance (as applicable), at each floor level and as required to adequately service and maintain all systems and equipment.
- A small duplex water softener (WS-1) is provided at the CUP to remove the hardness (calcium) from the water through an ion exchange process. This soft water is then use to provide make-up water for the boiler system and the pure water system(s) serving the laboratory and the Central Sterile Department.
- Emergency eyewash units are provided at all locations where gluderaldihyde is used and at Med, CT, Ultrasound (GUS) and housekeeping rooms.

H. Medical Gas System:

Medical and Laboratory Gases.

- The following services are housed within the CUP and piped to the hospital. This arrangement allows maintenance and service to be done in the CUP with disrupting hospital functions.

Medical Compressed Air.

- A pentaplex air compressed air plant provides compressed air to the Hospital for medical uses. The compressed air system is NFPA 99 compliant.

Laboratory Compressed Air.

- A Duplex air compressed air plant provides compressed air for laboratory and miscellaneous uses.

Medical Surgical Vacuum and Waste Anesthesia Gas Disposal.

- A quadraplex medical vacuum plant provides vacuum service for the hospital. Both Medical Surgical Vacuum and Waste Anesthesia Gas Disposal are connected to this vacuum system. The two systems are separately isolated at each area of use and join together at the vacuum main in the ceiling space.

Nitrogen.

- Liquid nitrogen is stored at a large bulk tank farm located adjacent to the CUP. Nitrogen from this tank farm is used to serve the hospital.

Nitrous Oxide.

- Nitrous Oxide is provided through multiple compressed gas cylinders manifolded together. The manifold consists of two complete sets of cylinders (12 bottles per side) with automatic switchover when one set becomes depleted. Back-up cylinders is also stored at the CUP.

Carbon Dioxide.

- Carbon Dioxide is provided through multiple compressed gas cylinders manifolded together. The manifold consists of two complete sets of cylinders (12 bottles per side) with automatic switchover when one set becomes depleted. Back-up cylinders is also stored at the CUP.

Oxygen.

- Liquid oxygen is stored at a large bulk tank farm located adjacent to the CUP. Oxygen gas is boiled-off from this tank farm and used to serve the hospital.

Medical Gas Alarms.

- Local, area and master medical gas alarms are provided Per NFPA requirements. Local alarms are located at supervised nurses stations. The Master alarm panels are located at the main security desk and at the facilities office.

System isolation valves:

- Isolation valves will be provided as required to adequately service and maintain all systems and equipment.

I. Heating, Ventilating and Air-Conditioning Systems.

Air-handling units are provided for this building project. The air-handling units will have components as described below:

- Return air plenum section.
- Return air sound attenuators (3 ft. long).
- Single or dual (see equipment schedule) plenum type return fans (direct drive) with adjustable frequency drives.
- Relief air plenum with motorized dampers.
- Return air/outside air section with motorized dampers. Include provisions for measuring outside air quantity.
- Prefilter section (40% efficient).
- Heating coil section (hot water with circulating pump).
- Steam grid humidifier.
- Cooling coil section (chilled water).
- Second cooling coil section (chilled water)-**For "Surgery" AHU only**.
- Single or dual (see equipment schedule) plenum type supply fans (direct drive) with adjustable frequency drives.
- Supply air sound attenuators (3 ft. long).
- Final filter section (95% efficient).
- Supply air discharge plenum section.

All occupied spaces of the hospital are climate controlled. To serve the various HVAC requirements and to provide a straightforward maintainable mechanical system a forced air reheat design is used. This system allows flexibility and provides for the varying demands of hospital occupancy without compromising the requirements of the occupants. Conditioned air is supplied through a combination of factory packaged and factory custom air handling units (AHU's) located within mechanical rooms and mechanical penthouses throughout the facility. These units have capacity to supply approximately 440,000 CFM of conditioned air to meet the conditioning requirements of the building. The conditioned air is delivered through ductwork to the individual areas, zones, and rooms. Variable volume reheat systems with minimum air flows as appropriate to meet the minimum airflow requirements of the space served are used in the patient care areas of the building. More conventional variable volume reheat systems, with minimum airflows of 40%, are provided to serve the more standard administrative and public areas throughout the facility. The variable volume air flow systems provide energy savings during times of reduced occupancy. One of the most important factors in maintaining clean/healthy spaces within the building is pressurization. Forced air systems maintain space and overall building pressurization to control airflow and contaminate movement within the building. The pressurization capabilities of this system are critical for maintaining positive/negative pressure relationships within the hospital. Tracking boxes (ATU's located in the return air or exhaust air ductwork) will be provided to "track" the supply side ATU's to insure pressure relationship maintenance in operating rooms, isolation rooms and protective environment rooms. The forced air system also promotes adequate indoor air quality through the use of building pressurization, air filtration and outside air ventilation as required by the design criteria outlined above. The HVAC systems

are integrated with other building systems and with the building itself to optimize space usage and to allow for future maintenance and modification. This design affords a high level of reliability, performance, and flexibility without adding undo maintenance and operational demands.

Operating Rooms.

- Additional air filtration is provided for the operating rooms. Laminar flow diffusers with HEPA filters are provided at each operating room. These filters remove 99.97% of 0.3 micron particulates from the air stream to provide a clean operating environment.
- The operating rooms are designed to meet the AIA Guidelines for temperature and humidity for typical surgery spaces. These guidelines call for temperature anywhere between 68 and 73 degrees F. and relative humidity anywhere between 30 and 60 percent.

Air distribution system:

- Supply air system, from AHU discharge to the air-terminal units, will be of the high pressure design (6" Wg pressure).
- Exhaust air ductwork and return air ductwork (other than the main return air trunk ducts and isolation exhaust ducts) and discharge air ductwork downstream of the air terminal units will be of the low pressure design (2" Wg pressure).
- Main return air trunk ducts and all isolation room exhaust ducts will be medium pressure design (3" Wg).
- All ductwork will be sealed to SMACA Seal Class A requirements.
- Low pressure ductwork will be sized for .1 IN Wg /100 ft. maximum pressure drop and 1500 FPM maximum velocity.
- Medium and high pressure ductwork will be sized for .25 IN Wg /100 ft. maximum pressure drop and 1800 FPM maximum velocity.

Exhaust systems:

- Hospital exhaust air needs are served by multiple dedicated exhaust air systems. General exhaust is provided for restrooms, janitor closets, soiled utilities, equipment rooms and other miscellaneous exhaust needs. Fans located in the mechanical penthouses serve this large exhaust system.
- Separate local exhaust systems are provided to serve the laboratory, shop areas, central sterile and kitchen exhaust needs. Up-blast type exhaust fans located on the roof serve these systems.
- Additional exhaust is provided to serve isolation rooms within the hospital. These rooms are monitored and alarmed to assure that correct pressure requirements are maintained. The fans for these systems are located in the mechanical penthouses.

Separate stand-alone, DX cooling systems will be provided for the Communications Rooms, Data Centers and the Elevator Equipment Rooms.

The Hospital is heated from reheat coils located in the air terminal units, heating coils at the air-handling unit, cabinet unit heaters at building entrance vestibules and in the stair wells, unit heaters in the mechanical room and CUP, soffit heating systems (providing heat at all soffit areas which are exposed to weather) and a perimeter heating system as required.

- The perimeter heating system will consist of radiant ceiling panels or finned tube at all "large" exterior glass areas and cabinet unit heaters at the exterior stair towers and the entrance vestibules. Warm air from the air terminal units is used to heat the "smaller" windows.
- Heating hot water will be produced by steam to hot water heat exchangers located at the CUP. Variable speed heating hot water pumps, also located at the CUP, will distribute the heating hot water to the various heating terminal units located throughout the building.
- System isolation valves. Isolation valves will be provided as required to adequately service and maintain all systems and equipment.

J. Heating, Ventilating and Air-Conditioning Systems Controls:

A direct digital type Energy Management and Control System (EMCS) is provided to monitor and control all mechanical systems from a centralized location.