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To: Rob Para, AIA

Co: Lamoureux-Pagano Assoc. Architects, Inc. (via email)

From: Kevin Seaman. P.E. LEED® AP

Re: Doherty High School: **Preferred Schematic Report HVAC & Plumbing Narrative – New Construction Scheme A.1, A.2, A.3, B.1, C.2**

The following narrative describes the proposed scope of work pertaining to the heating, ventilation and air conditioning (HVAC) systems and the plumbing systems at the Doherty High School for the New Construction Option encompassing either of the A.1, A.2, A.3, B.1 or C.2 schemes.

HVAC

Central Heating Plant:

1. The buildings primary heat source shall be provided by high efficiency (93%+) gas-fired condensing hot water boilers. Pending final load calculations and system design, initially the boiler plant shall consist of four (4) gas-fired condensing fire-tube style boilers each with a gross input capacity of 3,000,000 BTUH similar to Lochinvar Crest or equal by Aerco or Viessman making for a total plant capacity of 12,000,000 BTUH. Boilers shall be located within a central boiler room. Combustion air and flue venting for the boilers shall run up the building to the roof level. Variable speed pumps shall be provided on each boiler tied to the boiler controller to optimize flow with boiler output.

2. Heating distribution to the building shall be via a 2-pipe hydronic hot water system (4-pipe chilled & hot water building system) complete with two (2) sets of tri-plex vertical in-line system pumps as manufactured by Armstrong, Grundfos or equal rated for the system flow for their respective building segments. Hydronic system shall connect to 2-pipe fan coil units, VAV terminals, unit heaters, hot water coils and fin-tube radiation located throughout the building. All terminals shall be designed to operate with a maximum water temperature of 140°F to maximize plant capacity. Pumps shall have premium efficient motors and be fitted with integral variable speed drives so that pump energy matches system flow demand.

3. Intermediate mechanical closets shall be provided on the upper level of the building and shall contain plate-frame heat exchangers and high efficiency pumps with variable speed ECM motors. These heat exchangers shall establish a water to glycol loop interface whereas all packaged rooftop equipment shall be fed with a glycol water mix for improved freeze protection.

Central Cooling Plant:

1. Due to the size and 4-story + nature of the structure we propose a central chilled water plant be utilized. As a minimum either multiple 250-ton + high efficiency air cooled chillers or water chillers would be utilized resulting in a total plant capacity of 500-tons + presuming the roof dehumidification equipment is supported by packaged air cooled equipment (otherwise tonnages would be higher). The plant capacity could grow as high as 750-tons if more chilled water equipment is used. The chillers would incorporate some form of water side economizer either through dry coolers or water decoupling heat exchanger to allow for chilled water operation in cooler months. Each chiller shall incorporate a set of variable speed pumps set to optimize chiller efficiency.
2. Chilled water distribution to the building shall be via a 2-pipe hydronic chilled water system (4-pipe chilled & hot water building system) complete with two (2) sets of tri-plex vertical in-line system pumps as manufactured by Armstrong, Grundfos or equal rated for the system flow for their respective building segments. Hydronic system shall connect to multiple chilled beams, chilled water coils and such located throughout the building. All terminals shall be designed to operate with a minimum water temperature of 58°F to maximize plant capacity. Pumps shall have premium efficient motors and be fitted with integral variable speed drives so that pump energy matches system flow demand.
3. Heat exchanger(s) shall establish a water to glycol loop interface to any exterior chiller or dry cooler to reduce seasonal maintenance. Remote condenser air cooled chiller options shall also be considered to minimize the need for chilled water and component exposure to weather.

Air Distribution and Ventilation:

1. New packaged rooftop units shall be provided which shall have total energy recovery wheels to utilize waste exhaust to temper incoming fresh air, hot water coils, chilled water and/or DX coils, modulating heat pipe and/or hot gas reheat coils for cooling and dehumidification control (see note below). Units shall incorporate premium efficiency direct drive plenum fans on variable speed drives to optimize air delivery volumes based on space temperature and air quality demand as determined by CO2 sensors. The units shall be as manufactured by Aaon, Daiken, Valent or equal. Note: Consideration of air cooled DX vs chilled water cooling in roof top units shall be reviewed for the various systems with focus on long term energy efficiency, control of building humidity and maintenance.
2. Most all classrooms shall be provided with ventilation and air conditioning through the use of a mix of active and passive chilled beams. In areas where high latent loads may exist, the chilled beams shall incorporate condensate drain features or as a minimum moisture sensing switches. Fresh air shall be introduced through active chilled beams.
3. Science lab units shall be configured for 100% OA with exhaust adjusting to maintain space under slight negative pressure with respect to school as well as to match any fume hood exhaust. The units shall be as manufactured by Valent, Aaon, Daikin or equal.

4. Throughout the building exterior perimeter areas provide fin-tube radiation to support a majority of the space heating load. VAV and/or fan powered VAV units shall be used in all interior area or where fin-tube radiation is not possible or practical.

5. The computer classrooms as well as the MDF room shall be cooled via high efficiency ductless split units (one per room) with fan coil mounted within ceiling and condensing unit on roof.

6. Automotive shop area, if applicable, shall include a dedicated packaged rooftop system. The unit shall have total energy recovery wheels, hot water coils, DX or chilled water coils & hot gas reheat and/or heat pipe coils for cooling and dehumidification control. Unit shall incorporate premium efficiency direct drive plenum fans on variable speed drives to optimize air delivery volumes based on space temperature and air quality demand as determined by CO and NOx sensors. The unit shall be as manufactured by Valent, Aaon, Daikin or equal.

7. High plume style fume hood exhaust fan(s) shall be provided and connected to science lab fume hoods. Fan shall vary flow based on variable flow hood demand. Each hood shall be fitted with sash airflow monitor and branch duct damper control as manufactured by TSI or Phoenix Controls to maintain flow at each hood based on open sash air velocity.

8. Provide kitchen hood ventilation system with energy saving smoke/heat detection systems coupled to variable speed exhaust fan. Provide new gas-fired make-up air system for the kitchen which shall have the ability to reset make-up air system volume in unison with kitchen hood exhaust demand control system. Outdoor make-up air shall be tempered heating only introduced directly in front of the kitchen hoods to minimize the need for cooling the air and impact on the room environment.

9. Locker rooms shall be provided with packaged rooftop units and supply and exhaust ductwork. The units shall have total energy recovery wheels and hot water coils and shall be configured for 100% OA ventilation during occupied periods. Units shall incorporate premium efficiency direct drive plenum fans on variable speed drives to optimize air delivery based on space temperature and air quality demand as determined by humidity and CO_2 sensors. The units shall be as manufactured by McQuay, Trane, Aaon or equal.

10. Restrooms (other than those in the locker room), Janitors closets, etc… shall be exhaust via roof mounted exhaust fans controlled by occupancy sensors located in the respective areas served.

11. In all options if atriums are employed that freely open to three or more floors, smoke evacuation systems shall be employed which reject smoke from the top of the atrium and introduce outside make-up air at the lowest levels. A 3rd party reviewer shall be employed to perform specialized CFD modeling to optimize system design as well as to perform code required peer review and testing.

12. In the A options on the original site, the segments of the structures considered high rise shall incorporate stair tower pressurization in the egress stairs. In addition, in floors which do not have sufficient exterior windows for smoke evacuation the HVAC system shall be

configured for use as a smoke evacuation system during clean-up by the fire department after a fire. This shall be not construed as a floor smoke control system.

13. In the A1 & A2 options there shall be a parking garage under a section of the building. The garage shall be provided with active outdoor air and exhaust ventilation systems controlled by both a CO and NO_2 monitoring system. The interstitial space between the garage ceiling and the floor above shall be provided with heat via hot water unit heaters.

Controls:

1. The city school system utilizes a proprietary control vendor current school Automated Building Systems, Inc. This provider shall incorporate a direct digital control (DDC) energy management system (EMS). The system shall control and monitor most all HVAC systems for efficient use and for proper indoor air quality and temperatures as well as incorporate energy saving routines. The system is designed on PC based architecture and adjustments are made on a graphics based presentation of building systems. The system also supports maintenance and record keeping needs of the facility. Occupancy of the school is based on the standard school year with occupied/unoccupied conditions based on current school day practice. This is an adjustable feature that can be made to reflect additional operating needs and use of the school building by staff or others.

2. The HVAC systems are generally operated on a school day basis coinciding with the occupied/unoccupied schedule of the standard 180-day school year. Adjustments can be made through the DDC system to allow for usage during periods other than the usual school operating periods.

3. Space temperature is monitored by individual space sensors that transmit data to the central monitoring and control station. Space conditions are adjustable through DDC system and can be modified to meet individual needs. Local control of space conditions is limited to predefined adjustments in space temperature and to facilitate a 3-hour occupied override feature.

4. All classroom systems shall incorporate space occupancy sensors to reset ventilation levels when room is unoccupied during a regularly scheduled occupied period. Systems serving high occupancy areas such as the cafeteria and gymnasium also include carbon dioxide (CO_2) indoor air quality (IAQ) sensors which optimize the fresh outdoor air ventilation levels in response to variations in space occupancies.

5. The system shall incorporate many energy-saving features such as 1) water temperature reset controls, 2) static pressure reset controls, 3) occupancy based controls and 4) ventilation reset controls to name just a few.

6. The building shall be connected to emergency power source for operation of heating boilers and pumps during loss of primary power. Systems on emergency power may include MDF and IDF rooms as well as areas deemed critical by the Owner.

Sustainable Opportunities:

Many of the proposed system and control sequences noted above minimize energy consumption however, further optimization may be obtained by investigating the use of high efficiency water cooled chillers which have inherently better energy performance than air cooled equipment albeit at a higher maintenance cost. A life cycle evaluation must be performed as size and length of cooling system run time will impact overall value.

In addition to the water cooled cooling option, consideration could also be given to a geothermal based option. A geothermal chiller/heater could support building cooling loads in the summer as well as provide supplemental heating to the building by preheating both the heating water and domestic hot water thereby reducing the demand on the building fossil fuel boilers. A geothermal well field analysis as well as a life cycle cost would need to be performed to verify economic viability.

Two solar based options to consider would be passive solar wall design using air passing through a wall assembly facing South to preheat air and/or vacuum tube thermal solar panels mounted on the roof to directly supplement the building heating and domestic hot water systems.

Plumbing

Distribution & Conveying Systems

The water distribution system throughout the building shall consist of copper piping with lead-free fittings and products. Although 'A' options built at the existing site employ some high rise features domestic water pressure boosters are not anticipated.

All sanitary sewer and rain water conductors shall be constructed of cast iron. An acid waste system consisting of acid rated piping and a neutralizing system shall be provided for the science labs.

All waste from the kitchen(s) shall be piped to a large (1,500 gallon+/-) exterior grease trap prior to discharge to the municipal sewer system.

Domestic Hot Water

High efficiency (93%+) gas-fired condensing boiler/water heaters and tanks shall be used to support the buildings domestic hot water needs. In addition, this system shall be coupled to the heat output of thermal solar panels, if selected. The use of these supplemental systems will be dependent on their life cycle cost and require further study.

Dual water tempering valve stations shall be provided at the water heater to maintain water heater temperatures above 140°F to prevent bacterial growth in the tank while delivering 125°F water to service fixtures for sanitation and 110°F hot water to public lavatory sinks and other student and public use fixtures to prevent scalding.

Fixtures

All fixtures shall be of the code compliant water conserving type. In addition, to achieve improved LEED® compliance and further water savings we recommend ultra-low flush water closets and urinals be utilized. The ultra low flush water closets use 1.28 gallons per flush as opposed to the 1.6 gallon per flush allowed by today's code and the urinals use 1 pint (0.13 gallons) per flush as opposed to the current 1 gallon per flush allowed. The combination of these two can result in substantial savings overtime. However, these fixtures should only be used when connecting to well-pitched (more than code minimum) sewer lines as the low flow fixtures do have a tendency to result in line blockages if the sewer line pitch is not good.

Lavatory faucets shall be of the low flow metered type controlled by either a wired or battery powered sensor operated faucet. Use of these faucets promotes good hygiene as well as water conservation.

Natural Gas Service:

All proposed sites appear to have gas service located either on property or on the public way abutting the property. It is anticipated that the gas service shall support the heating boilers, domestic water heaters, kitchen equipment and make-up air systems. Once loads are confirmed a review with the local gas utility (Eversource) shall take place to confirm adequate supply.

Sustainable Opportunities:

Many of the proposed fixtures and control sequences noted above minimize water usage and conserve energy however, further optimization may be obtained by investigating the use of storm water recovery systems. These systems collect, filter and utilize storm water to supply water to water closets and urinals throughout the building. A life cycle evaluation must be performed to ascertain the initial first costs, annual operating costs and projected savings associated with such a system.

Use of vacuum tube thermal solar panels shall be further considered, if desired, as part of a life cycle study analysis.

End of HVAC & Plumbing Narrative