The property that I discuss is an actual property that I helped to build. My position was as the Facility/Project Manager while the building was under construction. I worked very closely with the Senior Project Manager and was given many opportunities to learn and develop a better understanding of the process.

The property is an operating fiber-optic factory in Grafton, Massachusetts. This company makes only single mode fiber optic cable for devices such as computers and telephones. This company also makes their own ‘pre-forms’, thus all of the specialty gasses and equipment. There are three towers for pulling the glass and several clean rooms for creation of the performs using such devices as hydrogen lathes. This facility also has the only 10,000 volt ionic chamber in New England. This device was built with the help of the Boston University Photonics professors as a cleaning device for both air and water. The device has two main chambers each at 10,000 volts but one is charged positively and the other negatively. A connecting chamber allows the two charged chambers to mingle a calculated quantity of material that will precipitate waste. This waste is then transported into a landfill and rendered harmless by the process. The remaining air and water is allowed by the state via monitoring, to pass into the atmosphere or local waterways.

Please refer to the drawing and notes for each particular plan view.

Site Plan
S1-1 Site Drawing

Electrical
E1-1 Main Electrical Drawing

Mechanical
M1-1 Main Mechanical drawing
M1-2 Mechanical drawing – Mezzanine level
M1-3 Mechanical drawing – level 2
M1-4 Mechanical drawing – level 3
M1-5 Mechanical drawing – level 4

Plumbing
P1-1 Main Plumbing Drawing

Data/Voice
D1-1 Main Data/Voice Drawing
ELECTRICITY

A) Electricity is brought into the complex via two (2) 4” PVC type EB conduits; (one is spare); encased in concrete. It is installed into the top of the encasement, at a minimum of 30 inches below the finished grade. One of the conduits is for Mass. Electric’s primary transformer pad and is with a continuous red “Electrical” warning tape at 18” inches above both conduits. Also installed is a ¼” polypropylene pull rope in both conduits. The conduit is capped to keep out debris and Mass Electric inspected all duct banks before back filling of the trench.

B) The existing Mass. Electric underground transition manhole structure with two (2) 4” PVC stubbed out from the vault.

C) The electrical conduits are brought to the transformer, which has a new poured concrete pad in accordance with the New England Electric Service Companies standard #2583 ‘Foundation-Padmount Transformer 750-250-kVa – 480/ 277. The padmount dimensions are 82” X 83” X 10”. According to the architect, the padmount is to be a minimum ten (10) feet away from the generator. The ground wire has been determined to be a bare soft drawn seven (7) strand copper grid and in a continuous loop around the perimeter of the transformer foundation and set off the ground by twelve (12”) inches.

D) From the transformer pad to the inside of the building electric service panel conductors are six (6) 4” schedule 40 PVC conduits.

E) Five (5) feet from the outside of the building to the Mezzanine are three (3) schedule 40 PVC conduits run for emergency power. The conduits have been extended to the generator.

F) Of these three conduits, two are 1-1/4” schedule PVC conduits that have been run (5) five feet from the outside of the building to the mezzanine. One of the two conduits is for the generator battery charger, block heater, and receptacle. The second conduit is for the generator set-monitor and control wiring. The third conduit is an extra channel for future use.

G) At this location are two (2) 1-1/2” schedule 40 PVC conduits that have been installed from the pump central panel that is located inside of the building to a ‘J-box’ just outside of the pump chamber. One conduit is for power for each of the two (2) pump motors. The second conduit contains four pairs of (12) gauge wire for float devices. Two wires to each pump for pump seal monitors, pump motor heaters and four (4) spare wires; (a total of twenty wires in each conduit).
H) The electrical requirements are for the tank farm, (where several quantities volatile gases are stored), for fiber optic ‘pre-form’ manufacturing. Site lighting according to the architect shall be (3) eight gauge and (1) eight gauge ground for each circuit and run in a common 1-1/2" PVC conduit. This wiring has been sized for future expansion.

I) The electrical panel for the tank farm has been furnished with a NEMA (12) enclosure panel and has been secured to the framework consisting of a steel post and channel.

J) The designations of AB, BC or AC located at each light pole indicate the two phase legs which the pole fixtures are wired. The wires are (3) eight gauge and (1) eight gauge ground for each circuit and run in a common 1-1/2" PVC conduit. This wiring has been sized for future expansion.

K) Main electrical panel, located in data/ electrical closet in office complex. Circuits range from 15amp to 225amp, depending on equipment.

Incoming Service Section
- System Voltage: 480/277 volt, 3-phase, 4-wire
- Mains Rating: 2000 ampere
- Certification: UL
- Neutral: 100%
- Service Entrance Listing: Yes
- Short Circuit Rating: 65,000 ampere
- Available Fault Current to switchboard: 34,000 amperes
- Series Rating: 34,000 amperes
- Incoming Feeder Cables: bottom left hand or as coordinated in field
- Standard Mechanical Lugs: six per phase and neutral
- GE Power Leader EPM 3720
- Single Shipping Sections with separate utility compartment for cold sequence for metering P/T and ct provisions

Main Disconnect
- 2000 ampere rated circuit breaker W/ 2000 ampere trip
- manually operated main
- ground fault protection
- under voltage trip
- pad lock compatibility
L) Secondary electrical panel for generator connection to main power circuits.

This building was designed to run automatically in the event of a power failure. The emergency systems will turnover instantly the main power is lost. The generator is connected to a switch on the mezzanine that will shut down the connections to the generator as soon as main power is once again established.

Lighting for the building consists of all parking and interior lighting. Some types of lighting are metal halide, recessed parabolic fluorescent fixtures for office area, luminaries for site lighting, recessed incandescent down-lights and slot-fixtures, chain hung fluorescents and fluorescent troffers.

The electrical circuits also run all other equipment from the ionizer to all fans and apparatus as well as an elaborate computer system.
MECHANICAL

The Mechanical system consists of primarily all HVAC, Sprinkler and/or Fire Protection systems. The main HVAC unit is located on the first mezzanine adjacent to generator switching. There is a cooling tower for release of heated air and the vents for outside air, (makeup air). The outside air is drawn into the complex by the three AHU’s, (Air Handler Units). From these units, the heating or air conditioning is called by the thermostats and depending on what is required the, AHU is set to output to the area making the request. Be it either heat from the automated gas furnaces or air conditioning from the redundant Carrier chillers or just fresh air.

Many devices interact between the AHU’s and the output and are too many to list. However, there are some main devices I would like to briefly discuss. As with any commercial building, there are more than a few devices that help with the distribution of airflow.

One in particular is the V.A.V, or ‘variable air volume control’. V.A.V. boxes provide constant or ‘variable air’ depending on the temperature load of the desired space. As the temperature raises the V.A.V. damper opens to send a calculated amount of airflow to the room. There are many different types of V.A.V. units: Single Duct; Dual Duct; Reheat; Fan Powered and Series Fan. V.A.V. boxes can also be categorized as ‘pressure independent/ dependent’ instruments. A pressure independent V.A.V. measures c.f.m. (cubic feet per minute) and will maintain the proper airflow regardless of the box inlet static (fixed) pressure provided by the main air handling unit. A pressure dependent V.A.V. does not measure airflow. The c.f.m. will change depending on the inlet static pressure. V.A.V. systems in addition are usually designed with a range factor, which means that the main air handler designed airflow is less than the aggregate of the total airflow of all the V.A.V.’s. This is a common design because not all of the V.A.V.’s in a building will be in full cooling or maximum c.f.m. all at the same time. There are three ways that a V.A.V. can be controlled; pneumatic, electric, or Environmental Management Systems (EMS). Pneumatic control systems are becoming obsolete. The V.A.V. damper is opened and closed by a controller sending air pressure to an actuator hooked to the V.A.V. damper. Electric simply sends a signal from the thermostat in volts to an electric motor connected to the V.A.V. damper. EMS works the same as the electric except there is a main computer set up in the building that gets information from all the V.A.V.’s and air handlers displaying it in text and graphics form. The possibilities are endless with automated controls and are truly a huge leap forward in the HVAC industry.

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**Chillers** and the process or operation of the chillers is through a simple refrigeration study. Cold refrigerant gas is passed through a heat exchanger while an exact opposite proportion of liquid passes through the other side of the heat exchanger. It is in this heat exchanger, that a heat transfer takes place. Heat energy is lost from the fluid medium and absorbed by the refrigerant gas. The refrigerant gas is then compressed by the compressor into a high pressure and high temperature gas. This gas is then sent to a condenser coil. In the condenser coil, ambient air is passed over the coil by fans. The air passing over the coil removes heat from the high pressure, high temperature refrigerant and causes it to condense into a high pressure, warm temperature liquid. The liquid refrigerant is then sent to the 'Thermal Expansion' device, otherwise known as an expansion valve. The expansion valve is a metering device for the liquid refrigerant. As the liquid refrigerant passes through the expansion valve, a large pressure drop takes place. Imagine when you take an aerosol can and spray it. You know there is liquid paint inside the can under high pressure. What comes out is a fine mist of paint. As you spray the paint, the can starts to become colder. The can becomes colder because of the large pressure drop caused by the expelling of pressure through the spray nozzle of the can. This is somewhat the same as what happens at the expansion valve of a refrigeration system. As the liquid refrigerant passes through the expansion valve, a large pressure drop occurs, the refrigerant becomes very cold. The refrigerant is now a very cold mist. Then the condenser uses city water passed through a heat exchanger device, which has the hot refrigerant gas passing through the other side. The cooler water cools the gas and causes it to condense into liquid refrigerant again. The chilled water is pumped into the air handler unit where air is passed over the coils of the chilled water and the air is cooled. This air is then sent to the areas of the building where it is needed.

**Cooling Towers** are heat-transfer units, used to remove heat from any water-cooled system. The cooled water is then re-circulated and recycled back into the system. Water is cooled by removal of excess heat via evaporation where some of the finer water particles are allowed to evaporate into a moving air stream thus significantly cooling the remainder of the water stream. The heat of the water is transferred to the air stream which raises the air’s temperature and the relative humidity to 100% and this air is discharged into the atmosphere. Evaporative cooling in the cooling towers greatly lowers water temperatures far greater than what can be accomplished by the chillers. The water is cooled as it falls through the filters by gravity while in direct contact with air that passes over it. The cooled water is then collected in a cold water basin below the filters from which it is pumped back through the process to absorb more heat. The heated and moisture laden air leaving the filters is discharged to the atmosphere at a point isolated enough from the air inlets to prevent its being drawn back into the cooling tower.
PLUMBING

Plumbing is usually discussed within the Mechanical framework, in this paper, it has been singled it out to be easier to discuss on its own merits.