**MECHANICAL, ELECTRICAL AND PLUMBING**
Basis of Design Narrative

All of the facility mechanical systems will comply with the latest edition of the Facility Design Information (FDI) published by the University of Washington as well as the construction guidelines for the National Institute of Health (NIH). Where conflicts occur, the more stringent guidelines will prevail. The facility will in all cases comply with the Biomedical and Biological Laboratory Guidelines (BMBL) 4th edition published jointly by the NIH and the Centers for Disease Control (CDC).

***HVAC*** - The facility is divided into four functional areas: Office and Administration, Bio-safety Level 2 Laboratories, Bio-Safety Level 3 Laboratories and Bio-Safety Level 3 Vivarium (ABSL-3). Each functional area will have individual air handling systems and not be connected to other areas of the facility. Care must be taken to ensure that cross contamination does not occur between bio-safety level spaces as well as animal holding spaces. In general, the facility will exceed the requirements of the referenced guidelines. This is in response to the requirements for a community relation plan where it can be comfortably stated that this facility is designed to be the safest facility of its type in any location.

To that end, the critical facility systems are designed to meet the NIH requirements for "N+1" redundancy. Common to mission critical facilities found in the commercial sector such as data processing and corporate operation centers, this facility will be able to survive a single point of failure such as a fan, cooling coil control valve, control system, chiller or pump. This approach will be taken for all of the containment (BSL-2, BSL-3 and ABSL-3) air handling systems and all of the central utility systems serving the facility.

***Supply Air Systems*** - Air handling units that serve the high containment spaces will be dual – fan, dual air tunnel as illustrated in Figures 38 & 39. The use of a dual system air handling unit will assure that the system will be able to supply the proper environmental conditions such as temperature, humidity and relative space pressurization and directional air flow throughout the failure of any one component of the air handling unit. Also and most importantly, it allows for routine maintenance to occur without shutdown of the system. The facility must have easily maintainable systems so that all scheduled and planned maintenance can occur on schedule. This is the primary key to avoiding unplanned outages. Refer to the equipment list for details of the capacities and features of each system serving the various functional areas. Air supply to the laboratories will be regulated by a laboratory variable volume control system that will maintain space pressurization through direct measurement and control of that parameter. In addition, the air supply to the barrier animal facility will be HEPA filtered through room side replaceable terminal filters.

***Exhaust Air Systems*** – In similar fashion to the supply air systems, the exhaust air systems will also have N+1 redundancy. While not required by the BMBL, HEPA filtration on the exhaust of BSL-3 labs is optional and will be provided in this facility. For this facility the exhaust from the BSL-2 labs will be HEPA filtered as well. This is a community relations feature to assure the ultimate in safety for he surrounding areas. Figure 40 shows a typical HEPA filter assembly.

Strobic exhaust fans are anticipated for this facility. One of the BSL-2 laboratories will be fitted with a radio-isotope hood. This hood will be exhausted through an activated carbon filter and HEPA filter in series. Figure 41 shows a potential layout for the air systems penthouse.

The units located on the roof will be screened from view. For security reasons, the air intakes of the critical air handling units will not be visible from the street

***Central Utilities –*** A number of central utilities will be provided by the campus central plant. Steam, compressed air, sanitary sewer and domestic water will be brought from central plant supply or civil utilities. In the case of steam, a steam generating plant within the facility will provide the N+1 backup for the central plant. Steam is a critical utility providing the primary means of decontamination in the facility autoclaves, the cage washers for the animal facility, the alkaline hydrolysis unit as well as the heating media for the liquid waste decontamination facility. A failure of the central steam utility serving the facility can cause the inability to maintain bio-containment. A compliment of boilers to serve the facility in full standalone mode is provided.

The building chilled water load is served by 3- 200 ton screw chillers. Any two chillers can serve the facility load with the 3rd chiller serving as the N+1 reserve machine. Likewise 3 cooling tower cells are matched to the three chillers. A separate 50 ton reciprocating compressor chiller will serve any process needs as well as serve low chilled water loads when there is insufficient load to keep one of the large screw machines on line in stable operation.

A plate and frame heat exchanger will serve the cooling needs of the waste treatment plant. The plate and frame heat exchanger will allow the rejection of the heat from the waste treatment plant to the cooling towers. The effluent from the waste treatment plant must be cooled below 140 °F before introduction to the campus sewer system.

Due to the significant animal holding facility planned, the domestic water system will be fed to the building from two separate mains so that the facility can survive the failure of any one campus circuit.

Refer to Figure 42 for a layout of the basement mechanical plant:

***Plumbing Systems -*** The laboratory waste systems will be routed in chemical resistant polypropylene piping in accordance with the FDI. All facility waste will be directed to the waste treatment facility with the exception of waste from the office/administration portion of the facility. The waste treatment system is installed to prevent the possibility of any infectious waste from escaping the facility through the sanitary sewer system. Infectious waste can originate in the animal holding facility or any of the high containment laboratories. Although not specifically required for BSL-3 facilities by any guideline, it is recommended to provide this system as a community relation feature.

The domestic water system serving the ABSL-3 facility as well as showers leaving containment will pass through a 10,000 gallon storage tank located on the roof so that gravity feed of domestic water to the facility can be accomplished if water service is interrupted.

Compressed air service is taken from the University compressed air distribution system. This will be backed up with a local 100 SCFM duplex compressed air plant within the facility.

**Electrical Systems**

The facility will be served by a 13.8kV feeder from the University electrical distribution system. This will be brought through a network of three transformers – any two of which will carry the facility. The transformer network will be arranged such that if any two feeders are lost, then the facility can still operate. Two 750 kW diesel generators will be included to provide the N+1 redundancy to the power feed required by NIH. The 7500 gallons of fuel oil storage will allow the generator plant to operate for 68 hours without running the dual fuel boilers. If the boilers need to be fired at full load on fuel oil in lieu of natural gas if that service is out as well, the facility can run for 28 hours on the stored fuel load.

Laboratory power will be distributed to the laboratory modules so that maximum flexibility can be achieved. Each lab (one of more modules) will periodically need to be isolated from the rest of the building to facilitate the renovation without impacting the remainder of the building. All electrical systems shall be down fed to minimize the number of floor penetrations. The interstitial space will provide area for local panel boards, dedicated to individual or small groups of laboratories. Large laboratory loads (cold rooms, etc.) would be served via an exposed bus-duct system in the utility corridor with local disconnects to each piece of equipment served. Such bus-ducts would provide power for spot loads that exceed the per square-foot average. This will also help to minimize the number of floor penetrations. Lab areas will be designed with the capacity of at least 1 power outlet per 30 square feet. Dedicated circuits will be supplied for all refrigerators, centrifuge and specialty devices. Hospital grade receptacles will be used in all laboratory areas. Dedicated receptacles and isolated ground receptacles are often required for special or sensitive equipment. Extensive use of dedicated receptacles in laboratories can quickly use up all the circuit breakers in the branch circuit panel board. The design shall insure that these needs are identified on the room datasheets and that adequate panel space is provided.

The main switchboard will be a double ended main-tie-main board with draw-out circuit breakers. Redundant mechanical equipment will be served from opposite ends of the main-tie-main so that the N+1 is preserved through the electrical service to the building. Refer to Figure 43 for a one-line diagram.

Division 15 - 16 Equipment List

1) Division 15
   a) Air Handling Systems
      i) Office area
         (1) 15,200 CFM
         (2) Air Side Economizer Operation
         (3) 579.0 MBH total cooling capacity (48 tons)
         (4) No Preheat
         (5) 30% efficient pre-filters
         (6) 85% efficient bag filters
         (7) 20 horsepower fan
      ii) BSL-2 Labs dual fan system, dual air tunnels
         (1) 32,500 CFM
         (2) 100% Outside Air
         (3) 1800 MBH total cooling capacity (150 tons)
         (4) 1275 MBH steam pre heat coil
         (5) 785 lbs/hr humidifier
         (6) 30% efficient pre-filters
         (7) 85% efficient bag filters
         (8) 95% final cartridge filter.
         (9) 50 horsepower fans
      iii) BSL-3 Labs - dual fan system, dual air tunnels.
         (1) 17,550 CFM
         (2) 100% Outside Air
         (3) 972.0 MBH total cooling capacity (81 tons)
         (4) 688.7 MBH steam pre heat coil
         (5) 425 lbs/hr humidifier
         (6) 30% efficient pre-filters
         (7) 85% efficient bag filters
         (8) 95% final cartridge filter.
         (9) 40 horsepower fans
      iv) ABSL-3 Vivarium - dual fan system, dual air tunnels
         (1) 22,410 CFM
         (2) 100% outside air
         (3) 1242 MBH total cooling (104 tons)
         (4) 879.4 MBH steam pre heat coil
         (5) 30% efficient pre-filters
         (6) 85% efficient bag filters
         (7) 95% final cartridge filter.
         (8) 540 lbs/hr humidifier
         (9) 50 horsepower fans
   b) Exhaust Fans
      i) BSL-2 Labs
         (1) 32,500 CFM dual Strobic fans on a common plenum base
         (2) 40 horsepower fans
      ii) BSL-3 Labs
         (1) 17,550 CFM dual Strobic fans on a common plenum base
         (2) 25 horsepower fans
      iii) ABSL-3 Vivarium
         (1) 22,410 CFM dual Strobic fans on a common plenum base

(2) 30 horsepower fans.

c) Cooling plant – No connection to central chiller plant
   i) 3 – 200 ton water cooled rotary screw machines – 42 deg F supply water – 54 deg F return water
   ii) 1 – 50 ton reciprocating water cooled chiller
   iii) 3 - 400 GPM chilled water pumps – 15 HP each
   iv) 1 -100 GPM chilled water pump – 5 HP each
   v) 3 – 600 GPM condenser water pumps – 20 HP each
   vi) 1 – 150 GPM condenser water pump – 5 HP each
   vii) 3 – 600 GPM cooling towers – 7.5 horsepower fans each.
   viii) 450 GPM plate and frame heat exchanger for Waste water treatment plant (WWTP) cooling
   ix) 1- 450 GPM WWTP cooling pump – 25 HP each
d) Heating Plant – connection from central steam plant at 15,000 lbs/hr @185 psig 8" ASTM A-106 gr. B schedule 40 pipe connection
   i) 2- 7500 lbs/hr steam boilers
   ii) 1 – 15,000 lbs/hr deareator boiler feed units with dual pumps
   iii) 1 – condensate return unit and receiver with 2 – 30 hp motors
   iv) 2- 3000 MBH Steam to Hot water converters
   v) 2- 200 GPM hot water pumps 15 HP each.
e) Waste Treatment Plant
   i) 2 – 2000 gallon processing tanks skid systems
   ii) 1- vent relief skid
f) Alkaline digestor
   i) 1- 100 lb capacity digester and associated tanks.
g) HEPA Filters – See Schedule Below
h) RO/DI water system
   i) Allow for 6 Millipore Milli-Q point of use 18 mOhm polishers.

2) Division 16
   a) 2 – 750 KW diesel generators
   b) 1- 7500 gallon above ground diesel storage tank
   c) 3 – 1000 KVA 5 kV – 480 V transformer network
   d) 1 – 2500 amp double ended switchboard with main-tie-main configuration with draw-out circuit breakers
   e) 4 –300 kVA 480 – 208 v transformers
   f) 2- 480 v mechanical equipment motor control centers

HEPA FILTER SCHEDULE

| MARK | ROOM # | CFM | PREFILTER | INLET SECTION | 1ST FILTER | COMBINATION SECTION | 2ND FILTER | OUTLET SECTION |
|---|---|---|---|---|---|---|---|---|
| FL-1-1 | 1st floor ABSL-3 | 375 | 6" | TSI | 1H1W-GC-F | | | PS |
| | 1st floor ABSL-3 BSC | 660 | 6" | TSI | 1H1W-GG-F | | | PS |
| | 1st floor ABSL-3 BSC | 660 | 6" | TSI | 1H1W-GG-F | | | PS |
| FL-1-2 | 1st floor ABSL-3 | 375 | 6" | TSI | 1H1W-GC-F | | | PS |

| HEPA FILTER SCHEDULE | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| MARK | ROOM # | CFM | PREFILTER | INLET SECTION | 1ST FILTER | COMBINATION SECTION | 2ND FILTER | OUTLET SECTION |
| | 1st floor ABSL-3 BSC | 660 | 6" | TSI | 1H1W-GG-F | | | PS |
| | 1st floor ABSL-3 BSC | 660 | 6" | TSI | 1H1W-GG-F | | | PS |
| FL-1-3 | 1st floor ABSL-3 | 375 | 6" | TSI | 1H1W-GC-F | | | PS |
| | 1st floor ABSL-3 BSC | 660 | 6" | TSI | 1H1W-GG-F | | | PS |
| | 1st floor ABSL-3 BSC | 660 | 6" | TSI | 1H1W-GG-F | | | PS |
| FL-1-4 | 1st Floor Diagnostic/Necropsy | 1750 | 6" | TSI | 2H1W-GG-F | | | PS |
| FL-1-5 | Shower/Change | 1820 | 6" | TSI | 2H1W-GG-F | | | PS |
| FL-1-6 | Aero-biology Cages | 760 | 6" | TSI | 1H1W-GG-F | | | PS |
| FL-1-7 | Aero-biology Cages | 760 | 6" | TSI | 1H1W-GG-F | | | PS |
| FL-1-8 | Aero Biology BSC's | 1320 | 6' | TSI | 2H1W-GG-F | | | PS |
| FL-1-9 | Molecular Biology BSC | 660 | 6' | TSI | 1H1W-GG-F | | | PS |
| | Tissue Processing BSC | 660 | 6" | TSI | 1H1W-GG-F | | | PS |
| | Sequencing | 660 | 6" | TSI | 1H1W-GG-F | | | PS |
| | Molecular Biology BSC | 660 | 6" | TSI | 4" dimple pleat HEPA - Model 22 | | | PS |
| FL-1-10 | Aero-biology supply | 500 | 6" | TSI | 4" dimple pleat HEPA - Model 22 | | | PS |
| FL-1-11 | Molecular Biology - BSC | 660 | 6" | TSI | 1H1W-GG-F | | | PS |
| | Tissue Processing - BSC | 660 | 6" | TSI | 1H1W-GG-F | | | PS |
| | Sequencing | 250 | 6" | TSI | 1H1W-CG-F | | | PS |
| FL-1-12 | Animal Dock Quarantine | 2700 | 6" | TSI | 2H1W-GG-F | | | PS |
| FL-1-13 | Cage Wash/Staging/ Food Bedding | 3900 | 6" | | 2H2W-GG-F | | | |
| FL-1-14 | BSL-3 Core Instrument | 2050 | 6" | TSI | 2H1W-GG-F | | | PS |

| HEPA FILTER SCHEDULE | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| MARK | ROOM # | CFM | PREFILTER | INLET SECTION | 1ST FILTER | COMBINATION SECTION | 2ND FILTER | OUTLET SECTION |
| FL-1-15 | 1st floor BSL-2 | 4620 | 6" | | 2H2W-GG-F | | | |
| FL-2-1 | 2nd floor BSL-BSC | 660 | 6" | TSI | 1H1W-GG-F | | | PS |
| | 2nd floor BSL-BSC | 660 | 6" | TSI | 1H1W-GG-F | | | PS |
| FL-2-2 | 2nd floor BSL-GB | 100 | 6" | TSI | 1H1W-CC-D | | | PS |
| FL-2-3 | 2nd floor BSL-BSC | 660 | 6" | TSI | 1H1W-GG-F | | | PS |
| | 2nd floor BSL-BSC | 660 | 6" | TSI | 1H1W-GG-F | | | PS |
| FL-2-4 | 2nd floor BSL-GB | 100 | 6" | TSI | 1H1W-CC-D | | | PS |
| FL-2-5 | 2nd floor BSL-BSC | 660 | 6" | TSI | 1H1W-GG-F | | | PS |
| | 2nd floor BSL-BSC | 660 | 6" | TSI | 1H1W-GG-F | | | PS |
| FL-2-6 | 2nd floor BSL-GB | 100 | 6" | TSI | 1H1W-CC-D | | | PS |
| FL-2-7 | 2nd floor BSL-3 | 2200 | 6" | TSI | 2H1W-CC-D | | | PS |
| FL-2-8 | 2nd floor BSL-BSC | 660 | 6" | TSI | 1H1W-GG-F | | | PS |
| | 2nd floor BSL-BSC | 660 | 6" | TSI | 1H1W-GG-F | | | PS |
| FL-2-9 | 2nd floor BSL-GB | 100 | 6" | TSI | 1H1W-CC-D | | | PS |
| FL-2-10 | 2nd floor BSL-BSC | 660 | 6" | TSI | 1H1W-GG-F | | | PS |
| | 2nd floor BSL-BSC | 660 | 6" | TSI | 1H1W-GG-F | | | PS |
| FL-2-11 | 2nd floor BSL-GB | 100 | 6" | TSI | 1H1W-CC-D | | | PS |
| FL-2-12 | 2nd floor BSL-BSC | 660 | 6" | TSI | 1H1W-GG-F | | | PS |
| | 2nd floor BSL-BSC | 660 | 6" | TSI | 1H1W-GG-F | | | PS |
| FL-2-13 | 2nd floor BSL-GB | 100 | 6" | TSI | 1H1W-CC-D | | | PS |
| FL-2-14 | 2nd Floor Isotope bag-in/bag-out | 1100 | 6" | TSI | 1H1W-AG-T2-30 N-Grade 0.25 sec residence | PS-TSC | 1H1W-GG | PS |
| FL-2-15 | 2nd floor BSL-3 | 2200 | 6" | TSI | 1H1W-CC-D | | | PS |
| FL-2-16 | 2nd floor BSL-2 | 8460 | 6" | | 2H4W-GG-F | | | |
| FL-2- | 2rd floor BSL-2 | 9930 | 6" | | 2H4W-GG-F | | | |

| HEPA FILTER SCHEDULE | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| MARK | ROOM # | CFM | PREFILTER | INLET SECTION | 1ST FILTER | COMBINATION SECTION | 2ND FILTER | OUTLET SECTION |
| 17 | | | | | | | | |
| FL-2-18 | Vaccine Lab | 2600 | 6" | TSI | 2H1W-GG-F | | | PS |