Design Standards for Small Animals (Rodents) Vivarium

A guide to design standards for small animal vivariums at MD Anderson prepared under the direction of the Animal Research Strategic Advisory Committee (ARSAC)

Issued for use: September 1, 2011

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Design Standards for Small Animals (Rodents) Vivarium
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ARSAC Design Standards for Small Animals (Rodents) Vivarium

Introduction

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1.0 Introduction

1.1 Mission

The University of Texas MD Anderson Cancer Center, as a biomedical research institution, will continue to care for and use animals in ways judged to be scientifically, technically and humanely appropriate. Investigators and animal care takers are obligated to plan and conduct animal experiments in accordance with the highest scientific, humane and ethical principles. All existing and future animal vivarium operations and facilities are expected to be accredited by the Association for Assessment and Accreditation of Laboratory Animal Care, International (AAALAC).

1.2 Background

MD Anderson established the Animal Research Strategic Advisory Committee (ARSAC) to evaluate and coordinate a strategic plan for present and future research animal use at MD Anderson. The ARSAC identified several additional subcommittees to address logistical and technical issues that include:

- Logistical Issues – Population projections, hazardous agent use and breeding colony plans.
- Technical Issues – Design standards, technology, transportation and communication.

The Design Standards Subcommittee was formed on March 27, 2006 with the following membership:

- Arnold Granger, Subcommittee Chair, Director, Lab Design and Construction, Research and Education Facilities.
- Mario Soares, Program Manager, Safety, Environmental Health and Safety (EH&S).
- Gerardo Lozano, Sr. Facilities Project Manager, Research and Education Facilities (REF).
- Stacy LeBlanc, Animal Facility Operations Manager, Department of Veterinary Medicine.
- Peggy Tinkey, Chair and Associate Professor, Department of Veterinary Medicine.
- Mike Green, Director, Operations and Maintenance, REF.

In addition, the following MD Anderson personnel were involved in providing help, guidance and incentive for the completion of the design standard work products:

- Wesley Harrott and Susan Custead, ARSAC liaisons.
- Kenneth Gray, oversight/ peer review.
- David Bammerlin, REF executive sponsor.
- Leonard Zwelling, research executive sponsor and chair of the ARSAC.
- Erin Paul, formatting and editing.
- Jennifer Benitez, administrative support.

The work objective of the Design Standards Subcommittee was to utilize past experiences, industry benchmarking and governmental rules and regulations to establish a set of minimum design standards for use by project teams in the engineering, design and construction of future MD Anderson research animal vivariums.
The subcommittee began its work in April 2006 by reviewing and evaluating the following documentation:

- Various industry standards, guides and regulations. The subcommittee decided that the ruling manual for the industry, relative to research animal use, was the National Research Council's (NRC) Guide for

the Care and Use of Laboratory Animals.
- Basis of design (BOD) for the mechanical, electrical and plumbing systems was used for the George and Cynthia Mitchell Basic Sciences and Research Building (BSRB). This building included the most recently constructed small animal (rodent) vivarium within MD Anderson, completed in 2006.
- Capital Planning and Management (CP&M) project design guidelines were used to convert the existing South Campus Physical Plant Building (existing shop and warehouse space) to a small animal (rodent) vivarium.
- The consulting firm of CUH2A was selected to provide industry benchmarking and state of the art research information about animal vivaria for biomedical research. CUH2A provided MD Anderson with mechanical, electrical and plumbing (MEP) architectural design guidelines used in a scoping document for a new rodent vivarium.

After the subcommittee's review of the available documentation, it became obvious that the species of animal used in biomedical research had a major impact upon the design standards for the specific facility. The subcommittee decided that its initial development design standards effort would be for a vivarium that would house and care for small animals, specifically rodents, because the continuing and increasing use of rodents for animal models in cancer research was evident. The design standards were written to define the minimum requirements for a small animal (rodent) vivarium.

1.3 Process

The subcommittee identified the various topics, subjects, building/ equipment parameters and other facility features that should be specified in a design standards document. This effort resulted in the drafting, review and approval of a design standards table of contents and an outline of what information should be provided in each section.

Once the scope of the standards was identified, assignments and responsibilities were given to each subcommittee to study the available information and draft specific sections of the design standards for review by the other subcommittee members. Approximately 60 individual design standard sections were identified. The subcommittee prioritized the sections for completion in three priority levels, 1, 2 or 3, with Priority 1's being most important.

To facilitate this process, a special area was created in FM's electronic intranet to collect all relevant reference material, outlines, table of contents, calculations, draft design standards, review items and final approval for the Small Animal (Rodent) Vivarium Design Standards. All the subcommittee members and others, as needed, were given access to this FM's intranet via the following link: RESEARCH/SHARE/LAB DESIGN and CONSTRUCTION/ARSAC SUBCOMMITTEE. Several file folders were established in that area to categorize and collect the subcommittee documentation without excessive use of hard paper copies.

A standard operating procedure was established to provide consistency in the review and approval of the design standard sections. This vetting process includes the following steps:

- Drafts prepared by assigned author or member.
- Drafts reviewed or resolved by the subcommittee members.
- Drafts reviewed by Dr. Ken Gray (oversight/peer review).
- Comments resolved.
- Drafts submitted for ARSAC review.
- Comments resolved, drafts revised as necessary.

- Final design standard sections approved by ARSAC for use.

1.4 Future

As the subcommittee reviewed and discussed their collective past experiences relative to the planning, design, construction, commissioning, operation and maintenance of research animal vivaria, one institutional level policy issue seemed to emerge. In the subcommittee's view, some past projects have encountered budgetary issues that have initiated "value engineering" processes, which reduced or removed design requirements to lower project costs. In some cases, these in-process design changes have reduced the flexibility of the facility to accommodate future changes in research needs and methods in return for short term gains.

The subcommittee recommends that the ARSAC approved design standards is implemented through the future projects and any deviations will be submitted to the ARSAC or their designee for approval before any in-process changes.

1.5 2010-2011 Review and Update Process

Two major vivarium capital construction projects were completed since the original issue of the Design Standards for Small Animal (Rodent) Vivariums was approved for use in September 2007. These two projects were the South Campus Vivarium Project, which converted portions of a previous shop/storage building into a rodent vivarium, and the Comparative Medicine Research Building at Bastrop, which was 72,000 gross square feet of newly constructed multi-specie vivarium to house rodents, squirrel and owl monkeys. Neither of these projects were built under the requirements of the September 2007 version of the design standards because it had not been issued before the design of these projects. Based upon the recent design, construction, start-up, commissioning and operations of these new vivarium projects, many "lessons learned" were identified.

In order to capture these "lessons learned," a review and revision of the September 2007 design standards was undertaken with the goal to have the revised MD Anderson standards approved and re-issued for use by September 2011. A review and revision process quite similar to the original preparation process was used to prepare the revision.

1.6 Disclaimer

MD Anderson provides design guidelines and master specifications that are posted on the institution's Web site and available to the public and for use by architectural and engineering firms involved in the design of MD Anderson buildings and facilities. The Design Standards for Small Animals (Rodents) Vivariums is also available on the MD Anderson Web site and is listed under the heading of "Supplemental Information."

This document was originally envisioned to "stand alone" and provide minimum standards for a small animal vivarium. In some areas, there may be an overlap of requirements between the small animal vivarium design standards and the latest posted revisions of the MD Anderson design guidelines. These areas will include the more common systems, such as piping, information technology, site utilities, security, etc. The user should refer to the posted MD Anderson design guidelines for the latest requirements relative to the more common, less complex, systems involved in the small animal vivarium.

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ARSAC Design Standards for Small Animals (Rodents) Vivarium

Piping Systems

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2.0 Piping Systems

2.1 General

Introduction and Background

Piping supply services may include, but not limited to, the following:

- Domestic hot and cold water.
- Reverse osmosis water system.*
- Compressed air.*
- Specialty gases* (oxygen, carbon dioxide, etc.).
- Laboratory vacuum.*
- Natural gas.*
- Liquid nitrogen.*
- Fire protection systems.
- Sanitary waste and vent.
- Storm sewer.
- Site utilities.

*Note: In many cases point-of-use equipment will meet need. The Architectural and Engineering (A/E) team will discuss this with the owner.

Data

1. Individual(s) certified with one of the following will perform plumbing system designs:

- Plumbing Engineering/ Design (C.P.D.) by the American Society of Plumbing Engineers
- Texas licensed professional engineer with five years minimum experience designing the types of plumbing systems included within this project
- A minimum of 10 years direct experience designing the types of plumbing systems included within this project.

2. The A/E team is required to make themselves aware of all applicable codes and ordinances to ensure compliance.

3. The A/E team is required to refer to the MD Anderson design guideline elements and master construction specifications for the most current design and specification information available.

4. The A/E team will also be available to discuss any possible design variances with the owner.

Note: Refer to the Owner's Design Guidelines Website.

5. Systems equipment capacity, pipe sizing and arrangement will accommodate proposed future demand where provisions for future equipment, fixtures or building expansion are required.

6. The A/E team will discuss space allocation for each of the disciplines, which include mechanical, electrical, plumbing, and controls to preclude congestion of commodities within the interstitial space located above the vivarium.

7. Each of the disciplines will have an assigned area and/or elevation designated as their design space.

8. Disciplines will interface to assure access to perform maintenance on the device is possible when one discipline has to enter or pass through a space assigned to another discipline.

9. The A/E team will refer to the most current MD Anderson master specifications for final material selection.

Note: In many cases piping material is identified in the following sections.

Standard

1. The piping distribution systems, with the exception of liquid nitrogen, are anticipated to be routed on a common trapeze pipe rack located in the interstitial space to provide horizontal distribution to vivarium rooms and support areas.

2. Liquid nitrogen will be supported by a dedicated hanger or riser with limited horizontal distribution.

3. Building fire protection will occupy a separate routing coordinated with other utilities.

4. Upper levels of sanitary waste, lab waste, and storm drain systems will be gravity flow systems.

Note: Basement areas will require a pumping system to a level that the systems can discharge into gravity systems.

5. Piping distribution systems located above ceiling spaces and interstitial spaces such as, but not limited to sanitary waste, sanitary vent, acid waste, acid vent or storm drainage that rely solely on gravity flow will have precedent over other pressurized systems or other mechanical systems where conflicts in elevation or locations may occur.

6. All services will utilize chases within the building footprint for vertical routing to multiple floor levels, where applicable.

Note: Chases are to be accessible for maintenance purposes and for future additions. A/E team will discuss access with the owner.

7. Piping distribution systems and primary equipment will be sized using a diversity factor determined for each system based on programming.

8. Piping distribution systems will not be routed above vivarium animal holding spaces to avoid possible flooding and water damage to animals housed below the piping, where possible.

2.2 Domestic Hot, Hot Water Return and Cold Water

Introduction

1. Domestic hot, hot water return and cold water will be provided for all toilet rooms, emergency shower/ eyewash units, lab and vivarium areas and other devices that require a domestic water supply.

2. Domestic water is required for process water, trap filler water, soft water and mechanical make-up water.

3. A domestic water booster pump system will elevate the incoming water pressure to adequate levels to serve upper floors as required.

Note: Lower floors will be protected from overpressure conditions by pressure reducing valves. The booster pumps will draw water from a domestic water surge tank provided in accordance with the City of Houston requirements. The surge tank coating will be MD Anderson standard material and suitable for potable water.

4. Steam-to-water, single wall, semi-instantaneous water heaters in parallel will produce hot water for all building needs.

Note: Water heaters will be supplied with steam to the coils and have water on the shell side. Point of use booster heaters will be employed at equipment such as cage and rack washers, glass washers, and laundry facilities to address special temperature needs.

5. All hot water will be softened.

6. Note: Softeners will normally be duplex, automatic regeneration type. Softening equipment will also serve the animal watering reverse osmosis (RO) system.

7. All domestic cold water, hot water and hot water return piping will be insulated per project specifications.

Background

1. Separate heaters and distribution systems will be employed to provide process hot water to equipment, such as cage and rack washers, glass washers and other equipment required to address special temperature needs.

Note: Water heating equipment and distribution systems will be designed to provide the required temperature and quantity of hot water at all times.

2. Animal watering will utilize reverse osmosis water from a dedicated system.

3. Animal watering will be furnished as part of the packaged automated animal watering system.

4. The animal watering system will be designed and sized to provide a three day supply of purified water in the event there is an interruption of the facility's main incoming domestic water service.

Standard

1. Potable water will be supplied from the city's main service line.

2. Water will be piped to plumbing fixtures, which include water closets, urinals, lavatories, lab sinks, fume hood sinks and all other equipment and fixtures that require water.

3. The water service will be split into two systems after entering the building:

- One system will be potable water for the public areas
- The other system will be for the vivarium areas.

4. The city main will be protected against contamination with the installation of a double check valve assembly on the incoming water service.

5. The building water system will be protected from the vivarium water system with a double reduced pressure back flow preventer.

Note: If a booster pump is required the reduced pressure back flow preventer will be installed after the booster pump assembly.

6. The system will be designed to maintain a maximum velocity of 8 fps in mains and risers and 6 fps in branches at design flow conditions.

7. The system will be designed to prevent water hammer conditions by providing shock arrestors for quick closing valves, individual fixtures and batteries of fixtures.

8. Piping will be sized to maintain a minimum of 30 psi at the most remote flush valve and 8 psi at the most remote lavatory faucet.

9. Shut-off valves will be provided at branch connections.

10. Vacuum breakers will be provided at hot and cold water hose stations and laboratory faucets.

11. All domestic cold water, hot water and hot water return piping will be provided with appropriate pipe labels and directional flow arrows.

12. Delivered water temperature on domestic hot water supply and return lines will be indicated.

13. A triplex booster pump will be provided to elevate the incoming water pressure so it may reach the upper floors with adequate pressure, if required.

Note: The pumps will be set up for a lead-lag-lag operation with a split as designed by the A/E team. The size of the pumps will be determined by the estimated load of the building. Variable speed drive pumps will be used for low flow conditions.

14. Hot water will be generated from a single or multiple semi-instantaneous water heaters, depending on the load requirements.

Note: The heater(s) temperature will be set at 120˚F. The water temperature will be maintained throughout the system by the use of a re-circulation system. Hot water temperature maintenance systems may be utilized as approved by the Owner.

15. Domestic hot water temperature will not exceed 110˚F at faucet and shower outlets.

16. Buried domestic water service entrance piping that is 4 inches and larger will be cement mortar lined Class 53 ductile iron pipe, 350 psi working pressure ductile iron fittings using mechanical joints.

17. All buried ductile iron pipe and fittings will be encased in polyethylene per ANSI/AWWA Standard C105/A21.5, Method A, with a minimum thickness of 8 mil polyethylene.

18. Unburied domestic hot and cold water (potable and laboratory) will be type "L" hard drawn copper pipe and wrought copper or cast copper alloy solder joint fittings using lead-free solder and non-corrosive flux.

Note: Piping sizes 2-1/2 inches and larger may be type "L" hard drawn copper and wrought copper or cast copper alloy roll groove fittings utilizing no-sweat coupling and flange adapter assemblies.

19. Solder for copper piping will be lead-free tin, copper, silver or nickel solder conforming to ASTM B32.

Note: Use water soluble flux recommended by solder manufacturer and conforming to ASTM B813 and NSF 61.

20. All piping, components subject to sweating, heat loss or freezing will be insulated with appropriate thickness of fiberglass insulation with a fire-resistant jacket.

21. All piping in accessible areas will be indicated with system and direction of flow through color coded labels.

2.3 Reverse Osmosis (RO) Water

Introduction

There may be several needs for pure water supply in a small animal vivarium. Some of the experimental research may need pure water supply in procedure room laboratory benches/ sinks. In addition, the animal watering system is also assumed to need a pure water supply for animal hydration. The animal watering system requirements will be addressed in a separate design standard covered by Section 3.1 Mechanical Systems: System Descriptions-Animal Drinking Water.

Background

In most MD Anderson vivarium facilities, the primary source of water comes from a state-approved domestic source, such as a municipal water system. Even though approved for domestic consumption, the water quality from these sources could vary widely in trace mineral content and not be pure enough for use in wet lab experiments or for animal watering.

The National Research Council (NRC) Guide indicates animals should have access to potable, uncontaminated drinking water. Also, water quality and the definition of potable water can vary with locality. Periodic monitoring for pH, hardness and microbial or chemical contamination may be necessary to insure water quality is acceptable. Water can be treated or purified to minimize or eliminate contamination when protocols require highly purified water. The selection of water treatments should be carefully considered because many forms of water treatment have the potential to cause physiologic alterations or effects on experimental results.

In most MD Anderson applications, the domestic/potable water quality will require both water softening to reduce mineral hardness and then further water purification, usually by RO to provide water of the required level of purity for laboratory research and animal watering use.

Special attention should also be placed upon the high purity water distribution system piping connections and integrity. At the BSRB, MD Anderson has experienced continued leaking joints in the polypropylene RO water piping system after the building construction was completed. Many joints and connections are no longer accessible causing significant building damage when joints and connections fail and begin to leak. The failures at that project have been attributed to difficult-to-use electrical joint fusing machines and operator errors during initial installation.

Depending on the actual applications, the pure water requirements in laboratory space may be better met through commercial point-of-use generators that reduce the need for extensive piping distribution systems. In large vivarium applications, the central water treatment/ RO system is probably the correct application to supply animal watering needs via a piping distribution system.

Data

1. Provide water softener systems to reduce hardness as required to supply water heating equipment, pure water production equipment and other systems, fixtures and equipment which hard water may adversely affect operation or longevity.

Note: Water with a hardness of more than 2 grains per gallon will not be delivered to equipment requiring softened water.

2. The facility may be equipped with a high purity water system to serve laboratory needs and other building demands requiring a pure water source.

3. CAP/NCCLS Type III quality water will be produced and supplied to all programmed outlets.

4. Point-of-use polishers will be utilized where higher purity is required by individual users.

5. Dedicated pure water equipment will include a multimedia filter, activated carbon chlorine removal, and double pass, staged reject RO generator.

6. Additional primary equipment will be evaluated based on supply water chemistry analysis and product water needs.

7. The system will be supplied with soft water from the buildings duplex water softener system.

8. Ultra-violet lights will be used to control bio-burden build-up in the circulation system.

9. The animal watering system will utilize RO feedwater from the central RO system.

10. A separate RO water storage tank will be located in the vivarium to provide water to the animal drinking water system.

11. The RO water will be chlorinated before filling the vivarium drinking water storage tank.

12. The vivarium storage tank will be sized to provide a three-day supply of water.

13. Each point of use valve will be looped no greater than six pipe diameters from the loop to minimize the length of dead legs.

14. Each loop will be hydraulically designed according to fabrication drawings required by the contractor to document the system's installation.

15. The distribution piping system, which includes pipe, valves and fittings from the RO system to the animal watering system and all loop piping, will be flame resistant, self-extinguishing polyvinylidene fluoride (PVDF) with heat fusion socket joints.

16. Electrical fusion coil type joints will not be allowed.

17. Provisions will be made in the project specifications to allow for joint sampling to ensure fabrication performance and joint uniformity.

Note: Please see MD Anderson's master specifications for material requirements.

18. High purity water will be continuously circulated in loops at a 5 fps velocity minimum.

19. Each outlet will be assigned a use value of 10 liters per day with an average flow rate of 1 gpm.

20. Equipment loads will use actual manufacturer's consumption loads.

21. All loads will be totaled, a diversity factor applied and the primary equipment sized to provide that volume over a 12-hour period.

22. The main storage tank, located in the mechanical room, will be sized to store 4 hours of peak consumption rate, plus pipe volume and freeboard.

Standard

1. The RO water system standard will comply with the high purity water system, according to Table 2-1.

High Purity Water System	
Water softener required	Supply water hardness will usually require for vivarium and procedure use.
Water quality required	Standard CAP/NCCLS Type III
Central System vs. Point of Use?	Point of Use generators of high purity water preferred for laboratory applications. Central system probably required for supply to animal watering system.
RO water requires recirculation	Yes, at 5 fps minimum flow. Recirculating RO water should be treated by ultra-violet lights.
RO water distribution piping	PVDF with heat fusion socket joints. Fusion process must be reviewed and approved by owner before allowed on job.
Dead legs	Minimize to within six pipe diameters.
Capacity	Use diversity among outlets to reduce storage.

Table 2-1

2.4 Compressed Air

Introduction

1. Compressed air for the vivarium and autoclave areas and for main risers will be provided at 100 psig, regulated as required, and dried to 35°F pressure dew point.

2. Distribution run-outs to lab floors, will be as required for autoclaves, etc.

Standard

1. Production equipment will comply with the following standards:

- Air compressors will be oil-free, scroll type machines, air-cooled, in a duplex configuration. Each compressor will be sized to meet 100% of full load conditions. An alternator will rotate each compressor through the lead position to give equal run time to each machine.
- Air dryers will be refrigerated type to dry the air to 35°F pressure dew point. Two dryer units will be provided, each capable of 100% air load.
- Coalescing and particulate filters will be provided after each compressor.
- Particle filters will be provided downstream of the dryers. Filters will be in parallel with pressure indicators, sized for 100% of systems flow. Particle size of filtration will be 0.1 micron absolute.
- The air compressors will be sized by totaling the CFM required per outlet and using a diversity factor based on the total number of outlets. An air receiver will be provided to absorb heavy system intermittent demand.
- Mains and risers will be sized for distribution at 100 psig.

2. The distribution system will comply with the following standards:

- The compressed air piping system will be Type L copper tube and fittings with 95-5 lead free solder joints. Branches will be taken off the top of the mains and the piping will be pitched for drainage. The distribution system will be sized so that the uniform friction loss does not exceed 10% of the delivered pressure and the velocity does not exceed 4000 feet per minute.

3. Design criteria will comply with the following standards:

- Lab outlets will be assigned a flow value of 1 CFM per outlet. A diversity factor will be applied based on the total number of outlets. Other equipment requiring a compressed air supply will utilize manufacturer's data.
- Medical air, control air and compressed air will be independent of each other.

2.5 Special Gases, Oxygen (O2) and Carbon Dioxide (CO2)

Introduction

1. Special gases will be determined based on the laboratory and vivarium program.

2. Special gases will be supplied from a bottled manifold system located near the lab or in a location selected at design.

3. Each outlet will be assigned a value of 1 standard cubic foot per minute (SCFM)

4. The system will be sized based on the total of all the outlets.

5. Piping will be stainless steel or piping appropriate for the type of gases required.

6. Piping will be purged internally with clean dry compressed air of sufficient quantity that will dislodge sediment or dirt after it's installed.

Background

This design standard section will also cover the use of specific gases, which include O2 and CO2 and unidentified gases noted above.

Standard

1. Employees who work with oxygen (O2) will comply with the following:

- Gaseous oxygen for the procedure rooms will be provided at a pressure of 50 pounds per square inch gauge (psig) at the most remote outlet.
- The oxygen source will be from a cylinder room or similar area with distribution to the required point of use.
- The system piping will be sized by totaling the CFM required per outlet and using a diversity factor based on the total number of outlets.
- The oxygen piping system will be Type "K" copper tube and fittings pre-cleaned and capped for oxygen service per NFPA 99 and ASTM 819 with brazed joints. The distribution system will be sized so that the uniform friction loss does not exceed 10% of the delivered pressure and the velocity does not exceed 4000 feet per minute.
- Outlets will be assigned a flow value of 1 CFM per outlet unless otherwise indicated. A diversity factor

will be applied based on the total number of outlets.
- O2 manifolds will have automatic cylinder changeover.
- Use 4 inch and smaller Type "L" hard drawn seamless copper tubing, factory oxygen cleaned, nitrogenized, capped and bagged.
- The fittings will be wrought copper, solder cup ends, factory oxygen cleaned, nitrogenized, capped and bagged.
- The joints to be brazed with alloy classification BCuP5, with continuous nitrogen gas purge.
- After the piping has been installed it will be cleaned by blowing dry oil-free nitrogen gas.

2. Employee who work with Carbon Dioxide (CO2) will comply with the following:

- Carbon dioxide will come from a bottled manifold system located near the lab or in a location selected at design.
- CO2 will be provided for any procedure rooms and other areas determined by the program.
- CO2 will be distributed to all areas programmed in Type "K" copper tube and fittings pre-cleaned and capped for O2 service NFPA 99 and ASTM B819 with brazed joints.
- Underground piping will be Type "K" copper tubing O2 pre-cleaned and capped per NFPA 99 and ASTM B819 with brazed joints.
- CO2 piping will be sized at 1 CFM per outlet, the flow totaled and a diversity factor applied based on the total number of outlets. Incubators will be assigned a use flow of 5 CFM.
- The joints will be wrought copper, solder cup ends, factory oxygen cleaned, nitrogenized, capped and bagged.
- The joints to be brazed with alloy classification BCuP5 with continuous nitrogen purge.
- After the piping has been installed it will be cleaned by blowing dry oil-free nitrogen gas.

2.6 Laboratory Vacuum

Introduction

The need for a central vacuum system in a small animal vivarium is based on the type of research conducted in the procedure rooms, surgery suites, imaging areas and necropsy rooms. The final vivarium facility program will determine the need, if any, for a central vacuum system in the facility.

Background

The requirements in the following sections will be followed if the program requires a central vacuum system.

Data

1. The A/E team will develop plans, specifications, schematic diagrams, schedules and details indicating all information required to clearly illustrate the intent of system design.

2. Floor plans will include, but not limited to location, sizes and identification of all:

- Piping from source equipment or existing piping connections to terminals.
- Intake and exhaust piping from source equipment to termination through roof or connection to existing. Piping.
- Master and local alarm panels.
- Alarm sensors.
- Pressure gauges.

- Relief valves.
- Relief valve discharge terminals.
- Zone valve wall cabinets.
- In-line shut-off and service valves.
- Future valved connections.
- Source equipment.
- Inlets, outlets and slides.

3. Schematic diagrams will include, but not be limited to, identification and sizes of all of the above information.

4. NFPA 99 guidance will be followed, as appropriate, for the design of a central vacuum system.

Standard

1. The central laboratory vacuum system will deliver 25 inches Mercury (Hg) gauge at the most remote laboratory inlet to serve all lab, fume hood and bio-safety cabinet vacuum inlets, if required.

2. Lab vacuums will be produced by a packaged duplex rotary claw vacuum pump system with receiver and automatic controls.

3. Each vacuum pump will be sized for 100% of full load.

Note: When three or more vacuum pumps are required, each pump (N) will be sized for equal share of full load and N+1 pumps provided. An alternator will rotate each machine through the lead position to give each unit equal run time. A vacuum receiver will be installed to allow any liquids or solids introduced into the piping to be contained.

4. The lab vacuum piping system will be Type “K” or “L” copper pipe and wrought copper fittings with brazed joints and a continuous nitrogen purge.

Note: Refer to project specifications for additional information. The distribution system will be sized so line velocities do not exceed 5000 feet per minute and total friction loss does not exceed 3.5 inches Hg. Vacuum exhaust piping will discharge to atmosphere and utilize the same pipe and fittings as the lab vacuum system.

5. Each vacuum inlet will be assigned a load value of 0.5 standard cubic feet per minute (SCFM).

Note: The total flow will be calculated by totaling all the inlets and applying an appropriate diversity factor. In-line vacuum filters will be provided on each chemical fume hood inlet, BSL2 and BSL3 inlet, bio-safety cabinet inlet, and other inlets as programmed.

6. Laboratory vacuum pumps will be located in a dedicated mechanical room in accordance with NFPA 99.

7. Mechanical room will provide a clean, relatively cool environment (i.e., not to exceed 100˚F ambient temperature).

8. Equipment will be located with adequate access to space for regular monitoring and servicing.

9. Floor drain will be provided adjacent to equipment pads.

Note: Floor drains serving vacuum pumps will be provided with smooth, acid resistant interior coating. Provide a hose bib with a vacuum breaker within mechanical room.

10. Terminate medical vacuum exhaust discharge outdoors above roof level, at least 25 feet horizontally (may be more depending upon prevailing wind direction and velocity) from all air intakes, doors, windows, louvers or any other building openings.

11. Exhaust from each vacuum pump will be combined into one discharge pipe, sized for no restriction while flowing maximum discharge possible, and will be provide with an isolation valve at the header for each pump served.

12. Exhaust piping for vacuum pumps will be sized using the total SCFM for the system (both lead and lag pumps) and the total developed length of run.

13. Exhaust piping will be sized and arranged to prevent moisture and back-pressure from entering pump

14. Valved drip-leg at base of exhaust stacks will be provided.

Note: Coordinate with vacuum pump system technical representative and verify that proposed sizing of exhaust piping complies with manufacturer's recommendations.

15. Place a source shut-off valve for each vacuum system at the immediate inlet of the source of supply, so that the entire supply source, including all accessory equipment, can be isolated from the entire pipeline system

16. Each main line supply line will be provided with a shut-off valve.

17. Authorized personnel will locate accessible valves downstream of the source valve and outside of the source room, enclosure or where the main valve enters the building.

18. Authorized personnel will provide laboratory vacuum gauges at the source and immediately inside the building, where source is remote from building.

2.7 Natural Gas

Introduction

A small animal vivarium will have the need for cage washing and sterilization. This process is usually done through the use of clean steam, which may be produced by steam boilers or clean steam generators. The normal fuel for steam or hot water boilers is natural gas and the piping requirements for this energy source will be addressed in this section.

Background

In the past, natural gas was centrally piped to serve laboratories and fume hood outlets located in laboratory and vivarium procedure room spaces. This is no longer the case. MD Anderson has established a policy that will not allow natural gas distribution throughout laboratory and vivarium spaces. Instead, point of use heat sources will be used when research procedures dictate the need for sample heating or drying. Electric powered or "Bunsen Burner" type heat sources with a small individual fuel supply tank will be used when necessary.

Data

All natural gas piping on the customer side of the utility meter will be designed, installed and tested in accordance with NFPA 54, Fuel Gas Code.

Standard

The following requirements will be met when natural gas is required in the vivarium to support steam generation for cage cleaning and sterilization:

1. All piping and valves will be located and sized on drawings.

2. The A/E team will include a natural gas system distribution schematic indicating information required to clearly illustrate the intent of system design including, but not limited to, supply source, piping mains, risers, pressure regulating valves, all shut-off valves, branch and individual connection piping to equipment and outlets.

Note: Calculated flow rates and developed piping lengths used for system design will be noted at supply entrance, base of risers, sectional floor valves, branch piping to equipment and outlets, and at each connection to equipment and outlets.

3. The A/E team will include details on contract drawings to clearly identify installation requirements for all natural gas system components included within the project, including but not limited to:

- Service entrance.
- Gas fired equipment connections.
- Emergency shut-off valves.
- Laboratory zone valves.
- Pressure regulator venting.
- Concealed pipe casing venting termination.
- Roof penetrations.
- Floor and wall penetrations.

4. The A/E will include schedules on contract drawings to clearly identify natural gas system demand, pressures and equipment served.

5. Building natural gas distribution systems will be metered and valved in accordance with the gas supplier's requirements.

6. The design of building supply and distribution systems will provide a volume of gas at the required flows and pressures to ensure safe, efficient and code compliant operation during periods of peak demand

7. Piping will be sized in accordance with referenced codes and standards.

8. Natural gas pressures will not exceed five pounds per square inch gauge on customer side of the meter.

9. Readily accessible manual shut-off valve will be provided outside of building at service entrance.

10. Gas piping within confined or unventilated spaces where leaking gas might collect will be avoided.

11. Gas piping will not be located beneath the building slab on grade.

12. Gas piping will not be located within stairways, electrical or telecommunications rooms.

13. Main distribution piping risers will be located exposed within mechanical equipment rooms, where possible.

Note: Where distribution mains cannot be located within mechanical equipment rooms, utilize chases within the building footprint. Natural gas piping installed above ceilings, within chases, within partitions, within spaces utilized as return air plenums, or any non-exposed location will be of 100% welded construction or encased within a sleeve vented to the exterior of the building.

14. Exposed and accessible shut-off valves will be provided as required for proper operation, servicing and troubleshooting of the distribution system and connected components.

Note: Locations will include but not be limited to the following; at the base of each riser, at each branch connection to risers, at each piece of equipment, where recommended by equipment manufacturer and at strategic locations to allow sectional isolation while limiting disruption of services to large portions of the system.

15. Exposed and accessible capped valves will be provided where required for future connections.

16. Valves, regulators, flanges, unions and similar appurtenances will be accessible for operation and servicing and not be located above ceilings, within partitions or spaces utilized as return air plenums.

17. No natural gas line, including service drops will be smaller than ¾” inside diameter. Local connections to individual equipment and outlets may be smaller than ¾” as required for the particular component.

18. Buried natural gas piping outside of the building will be polyethylene, SDR-11 ASTM D2513 with heat fusion socket joints.

19. Unburied natural gas piping will be Schedule 40 black steel pipe with Class 150 black malleable iron threaded fittings or carbon steel butt weld joints up to the emergency shut off valves

Note: See MD Anderson’s master specifications for the latest material requirements. Valves will have screwed or flanged ends. An emergency electric power shut off control will be located at lab exits. Operation of this control will close the emergency gas shut off valve and interrupt natural gas flow to the entire floor.

20. Natural gas piping will be sized at 5 CFH per outlet, the flow totaled, and a diversity factor applied based on the total number of outlets.

2.8 Liquid Nitrogen (LN2)

Introduction

Liquid nitrogen (LN2) temperature is -320˚F. Nitrogen expands 700 times from liquid to gaseous state. These unique characteristics of LN2 provide for specific applications in refrigeration and require unusual design attention for specific applications. Relative to applications in a small animal vivarium, LN2 could be used for cryo-biological freezing and storage of tissue samples.

Background

Because of LN2's low temperature, special piping and insulation requirements must be considered in the design of distribution piping and spaces that will house LN2 freezers or storage equipment.

Data

1. LN2 process piping must conform to the requirements of ASME B31.3 Process Piping Code.

2. Normal pressure rating for LN2 piping is 150 pounds per square inch gauge (psig) with normal applications requiring operating pressures of 20-70 psig.

Standard

1. A LN2 supply system will be provided for LN2 freezers in the segregated freezer rooms.

Note: The LN2 source will be from an exterior bulk liquid nitrogen storage tank.

2. LN2 will be piped to the freezers through a piping system from the exterior bulk system.

Note: O2 depletion monitors will be placed in the freezer rooms. These monitors will have local audio and red visual alarms and be connected to the building automation system (BAS) and alarm when an excessive amount of LN2 is released into the freezer room.

3. Pipe runs will be minimized to limit loss of product.

Note: Distribution piping will be vacuum insulated 304 stainless steel liquid nitrogen piping. The piping will be double wall with the inner space vacuum sealed at the factory to minimize gas conduction and convection. Multi-layer super insulation minimizes radiation and will be sandwiched between the double pipe walls.

4. Super insulation consists of multiple layers of cryogenic grade spacer paper and aluminum foil or double aluminized Mylar.

5. All carrier piping will be schedule 5, type 304 stainless steel (SS) or Invar with all interior connections welded.

Note: SS bellows are required between the inner and outer jacket to account for differential shrinkage due to temperature gradient.

6. Vacuum insulated piping will normally be custom fabricated at the factory with 20 foot sections optimal for manufacturing and shipping.

7. Vacuum insulated LN2 piping sections are usually joined by way of bayonet type connections in the field.

8. Pipe routing will be designed such as to minimize field connections. Pressure relief valves will be required in any section of piping where liquid can be trapped. Pipe should be supported by hangers every 10 feet.

9. Design team should be aware that over-all length of LN2 piping system will shorten 3-1/2 inch per 100 feet of pipe when filled with LN2 due to thermal contraction.

10. O2 monitors in the freezer room will alarm to the BAS upon oxygen depletion due to displacement of oxygen by the heavier nitrogen gas.

Note: The BAS should be programmed to close LN2 feed valve upon O2 depletion in the freezer room.

11. Freezer room exhaust will be located close to the floor in LN2 freezer rooms.

Note: Temperature sensors should also be located in the low exhaust duct to alarm to the BAS upon low temperature caused by leakage of LN2 into the freezer room.

12. The LN2 piping requirements will comply according to Table 2-2.

Liquid Nitrogen Piping Requirements	
Pipe	Schedule 5, type 304 SS double walled vacuum insulated
Insulation	Multiple layers of cryo paper and Al foil or Al. Mylar
Relief Vents	Required wherever liquid can be trapped between valves
Shrinkage	3-1/2 inches per 100 feet of pipe when LN2 filled
O2 Deletion Monitors	Required in freezer rooms with alarms and logic to shutoff to BAS
Room Exhaust	Must be low, 18 inches from floor
Temp Sensor	Should be located in low exhaust alarming to BAS on low temp.

Table 2-2

2.9 Fire Protection

Introduction

1. All areas of the building will be protected by a total coverage automatic wet sprinkler system and a standpipe system, with the exception of elevator shafts and the CenterPoint Energy main power supply vault.

2. Office and general building spaces will be classified as Light Hazard occupancies.

3. Animal holding rooms, animal procedure rooms, penthouse and other mechanical areas will be classifies as Ordinary Hazard Group 1.

4. Dock areas, all laboratories, including corridors between labs, will be classified Ordinary Hazard Group 2.

5. MD Anderson's Environmental Health and Safety (EH&S) team will be consulted on all fire protection design guidelines and will be recognized as the Authority Having Jurisdiction (AHJ).

6. The fire suppression system will be hydraulically designed in accordance with NFPA-13 guidelines and all State and local code requirements.

7. The building fire protection water supply systems will be metered and isolated from the municipal water supply in accordance with City of Houston requirements.

8. Fire pumps will draw water from a break tank in accordance with City of Houston requirements.

Data

1. Areas subject to freezing conditions will be protected by a dry pipe sprinkler system.

2. Hydraulic design densities will be determined from discussions with the insurance underwriter and local fire local fire authorities. Fire hose cabinets (valve without hose) will be provided as directed by the insurance authority.

3. 2-1/2 inch fire department valve connections will be provided in all stairwells at each floor landing and on each floor as required so that a travel distance from a hose valve to most remote points can be serviced with a hose stream with a distance not exceeding 130 feet.

4. A fire pump and jockey pump will be provided to satisfy pressure and flow requirements for the facility to supplement the available pressure and flow from the municipal water system.

5. An appropriately sized break tank will be provided to supply fire protection water and be in accordance with City of Houston requirements.

6. Fire tank may be combined with domestic pump water storage if allowed by code and deemed practical.

7. The fire protection water service to the building will be split from the domestic water service outside the building.

Standard

1. Automatic Sprinklers will comply with the following:

- The maximum allowable velocity permitted in the automatic sprinkler system will be thirty-two (32) feet per second.
- Use fast response sprinkler heads throughout the facility.

2. Water Flow Tests will comply with the following:

- A water flow test must be conducted to determine the characteristics of the water supply. The water flow test will be conducted by a licensed fire protection contractor.
- The insuring agency and local water department will be present to witness the test.
- The procedure utilized for the test including the hydrant locations and the time of day must be recorded.
- For design purposes, a minimum of 10 pounds per square inch gauge (PSIG) safety factor will be applied to the test results to allow for future fall off in the flow and pressure. The fire protection system will be designed with this safety factor applied.

3. Piping and Fittings will comply with the following:

   Note: See MD Anderson master specifications for latest material requirements.

- Underground piping and fittings:

    - Pipe: Class 52 ductile iron, ANSI A21.51.
    - Fittings: Ductile iron mechanical joint, 250 lb., ANSI A21.10.
    - Interior Lining: Cement mortar lining for pipe and fittings, ANSI A21.4.
    - Exterior Coating: Bituminous seal coating.
    - Joints: Push-on gasket joints ANSI A21.11 with neoprene gasket.
    - All buried pipe and fittings will be encased with polyethylene film having a minimum thickness of 8 mils.
    - Optionally, where building structural components permit, water service entry may be composed of a single extended 90 degree fitting of fabricated 304 stainless steel tubing, maximum working pressure of 175 psi with grooved-end connection on the outlet (building) side and a cast iron pipe size coupler on the underground (inlet) side.

- Interior above ground piping and fittings:

    - Piping: Welded or seamless black steel pipe, ASTM A53, A135 or A795.
    - Class: Schedule 40 for 6 inches and smaller and Schedule 30 for 8 inches and larger.
    - Fittings: Malleable iron threaded, Class 150 or 300 ANSI B16.3 as required due to system pressure.
    - Fittings: Cast iron threaded, Class 125 or Class 250, ANSI B16.4 as required due to system pressure.
    - Fittings: Malleable iron mechanical grooved fittings and couplings ASTM A-47, 500 psi minimum with EPDM gasket, U.L. Listed or F.M. Approved.
    - 2-6 inches size – rolled groove type; 8 inch size and larger – cut groove type
    - Fittings: Factory fabricated wrought steel butt-welded, ANSI B16.9.
    - Fittings: Cast iron flanged, Class 125 or 250, ANSI B16.1 with 1/8 inch minimum, red rubber gaskets.
    - Unburied pipe and fittings will be provided with Microbiological Inhibiting Coating (MIC).

2.10 Sanitary Waste and Vent

Introduction

A sanitary system will be provided to serve conventional sanitary plumbing fixtures, bedding disposal, contaminated condensate waste, floor drains located in restrooms, mechanical rooms and other similar plumbing fixtures. A second corrosion resistant waste and vent system will be provided to serve laboratory research areas, aggressive waste discharges, cage wash areas and associated floor drainage and equipment (with the exception of bedding and solid waste disposal), laboratory waste, cage wash wastewater and any wastewater with the potential of having a temperature of 140˚F or higher will be separate from the conventional use sanitary systems. All fixtures will be trapped and vented to atmosphere. The building system is anticipated to flow by gravity to the exterior municipal sanitary sewer. Lift pumps will be provided to serve areas incapable of gravity flow. The duplex sanitary ejector will have each pump sized at 100%. The duplex systems will have a removal system for each pump.

Background

1. The A/E will develop plans, specifications, schedules, isometric or flat riser diagrams and details indicating all information required to clearly illustrate the intent of system design. All piping will be located and sized on contract drawings.

2. Floor plans and riser diagrams will include, but not be limited to identification of all sanitary waste piping from fixtures to connection to exterior sewer, all vent piping from fixtures and stacks to termination through roof, clean outs, fixture and equipment identification, traps and trap primer lines.

3. Calculated fixture units used for system design will be noted at house drains exiting the building, base of stacks, floor branch connections at stacks, ejector pump system discharge and interceptor inlets.

4. Invert elevations will be noted at all drains exiting the building perimeter, connections to exterior sewers, uppermost point of each main and branch line located below ground level, and all other points where required to clearly establish proper slope and coordination with other piping systems and building components.

5. Bottom of pipe elevations will be noted for unburied piping at locations where close coordination is required to prevent conflicts with other systems and/or building components.

6. Graphically identify each stack on plans and riser diagrams. Stack identification on riser diagrams will correspond to stack identification on plans. Graphically indicate floor levels and floor elevations on riser diagrams.

7. Details will be provided for, interceptors, clean outs, roof penetrations, floor and wall penetrations, sewage ejector pump systems and all other components that require installation explanation beyond the information included within plans and riser diagrams.

8. Schedules will clearly identify:

- Capacity.
- Size.
- Model.
- Options and other requirements for all interceptors and sewage ejector pump equipment.
- Piping materials and piping support spacing.

Data

1. The waste systems will be designed using fixture drain loads established by the governing State and local codes, maintaining a minimum 2 FPS velocity.

2. Condensate waste will be insulated to a point 20 feet (minimum) downstream of the point of origin.

3. A sampling manhole will be provided on the building sewer before connection to the municipal sanitary sewer.

4. Clean outs will be accessible from walls or floors and interstitial levels.

Standard

1. Sanitary waste and vent systems will be provided for all plumbing fixtures, floor drains, food service fixtures and equipment, and all other domestic waste producing equipment, systems and devices that are required by code to discharge into the sanitary sewer.

2. Waste and vent systems will be designed using fixture drain loads established by code and provide proper operation during periods of peak demand.

3. Main waste and vent stacks will utilize chases or be located adjacent to columns where possible for vertical routing to multiple floor levels.

4. Capped waste and vent connections for future extensions will be located accessibly and not extend more than 24 inches from an active line.

5. Waste and vent connections will be located at elevations that will allow future installation of properly sloped piping without the need to dismantle or relocate installed ductwork, piping, conduit, light fixtures, etc.

6. The building system is anticipated to flow by gravity to the exterior municipal sanitary sewer.

7. Sanitary waste serving fixtures located below the 500 year flood plane or waste that can't be discharged by gravity will flow into a gas-tight, covered and vented sump from which the waste will be lifted by automatic pumping equipment and discharged into a sanitary waste drain capable of gravity flow.

8. Sewage ejector pumps will be a minimum duplex system sized to discharge peak calculated load with one pump out of service. Pumps will be connected to emergency power source.

9. Sumps and ejectors handling sewage will not receive storm or subsoil/foundation drainage.

10. Above ground floor drains, P-traps and first 20 feet of connected drainage piping receiving condensate or ice machine waste will be properly insulated to prevent condensation.

11. Clean outs at locations and with clearances will be provided as required by the code, at the base of each waste stack and at intervals not exceeding 75 feet in horizontal runs.

12. All interior clean outs will be accessible from walls or floors. Coordinate the location of all clean outs with the architectural features of the building and obtain approval of locations from the Project Architect.

13. No buried waste line will be smaller than 4 inches.

14. No vent line will be smaller than 1-1/2 inches.

15. No roof vent terminal will be smaller than 3 inches.

16. Waste piping serving water closets will not be smaller than 4 inches.

17. Slope drainage lines uniformly at 1/4 inches per foot, for lines 3 inches and less, and 1/8 inches per foot for larger lines, unless noted otherwise.

Note: Maintain gradients through each joint of pipe throughout system.

18. Locate all sanitary vent terminals a minimum of 25 feet horizontally from or 3 feet vertically above all air intakes, operable windows, doors and any other building openings.

19. Avoid locating drains above sensitive equipment or areas where water leakage would cause major property loss or contamination, including but not limited to computer data centers, food preparation, food storage, animal holding rooms, etc.

20. Do not locate drainage or vent piping within stairways, electrical or telecommunications rooms.

21. Floor drains will be provided in all toilet rooms that are designed to be occupied by more than one user at a time (e.g., containing two or more water closets or a combination of one water closet and one urinal).

22. All traps will be properly vented in accordance with the applicable code.

23. All sanitary sewer piping will be provided with appropriate pipe labels and directional flow arrows.

24. Provide electronic trap primers for all floor drains, floor sinks and hub drains that may receive waste from corrosive or chemical waste that may be susceptible to trap seal evaporation.

Note: Trap priming devices that rely upon line pressure differential for activation are not allowed. An electronic trap primer device for floor drains, floor sinks or hub drains will be provided with a readily serviceable strainer immediately upstream of the device solenoid valve where corrosive or chemical waste discharge may occur.

25. Trap seal guard inserts may be provided in lieu of electronic trap primers on condition that the inserts will not be installed in floor drains, floor sinks or hub drains receiving corrosive waste, chemical waste, drains receiving waste that may have temperatures greater than 140˚F or in drains that may receive a discharge greater than 30 gallons per minute.

26. A submersible sump pump(s) will be provided in each elevator pit in accordance with the 2007 edition of ASME A17.1 and the State of Texas Elevator Safety and Licensing requirements.

Note: Pump effluent will discharge indirectly into the sanitary waste system. The elevator pit pumping system will be designed to prevent pump effluent, sewage, odors and gases from entering building spaces and the elevator pit. Provide a sanitary indirect waste receptor having a capacity greater than the maximum flow rate discharge of the pump(s). Pump electrical service will be connected to emergency power source.

27. Sanitary waste and vent piping will be service weight cast iron soil pipe and fittings with hubless connections using clamp type gasketed mechanical fasteners above ground and hub and spigot DWV pipe and fittings with neoprene compression gasket joints for all buried pipe.

28. Cast iron soil pipe compression gaskets will be monolithically molded from an elastomer meeting ASTM C564 and will be of the same manufacturer as the pipe and fittings.

29. Clamps for joining hubless cast iron pipe and fittings sizes 10" and smaller will meet the performance criteria of FM 1680, have 28 gauge type 304 stainless steel jacket, minimum .094 inch thick ASTM C 564 neoprene gasket and type 305 stainless steel band screws designed to be installed with a pre-set torque wrench calibrated at 80 inch pounds.

30. Clamps for joining hubless cast iron pipe and fittings sizes 12 inches and 15 inches will meet the performance criteria of FM 1680, have 24 gauge type 304 stainless steel jacket, minimum .100 inch thick ASTM C 564 neoprene gasket and type 305 stainless steel band screws designed to be installed with a pre-set torque wrench calibrated at 125 inch pounds.

31. Lab sinks and cup sinks in hoods will be piped with schedule 40 flame retardant polypropylene pipe and fittings with mechanical joints above ground.

Note: PVDF pipe and fittings will be used above ground within spaces utilized as air plenums. Fixture traps will be borosilicate glass. Underground acid waste piping will exit the building and enter an approved sample well before to tying back into the sanitary sewer.

2.11 Storm Sewer

Introduction

A storm water drainage system will be provided to convey rainwater from roof and area drains to the site municipal storm sewer system. The system is anticipated to flow by gravity to the site storm water system. Lift pumps will be duplex with each pump sized at 100% provided to serve areas incapable of gravity flow. A building subsoil foundation drain system will be provided as determined by soil boring analysis.

Background

1. The A/E will develop plans, specifications, schedules, isometric or flat riser diagrams and details indicating all information required to clearly illustrate the intent of system design. All piping will be located and sized on contract drawings.

2. Floor plans and riser diagrams will include, but not be limited to identification of all roof drains, overflow drains, area drains and associated piping.

3. Area square footages used for system design will be noted at each roof drain, area drain, house drains exiting the building, base of downspouts, branch connections at downspouts, and sump pump system.

4. Invert elevations will be noted at all drains exiting the building perimeter, connections to exterior sewers, uppermost point of each main and branch line located below ground level, and all other points where required to clearly establish proper slope and coordination with other piping systems and building components.

5. Bottom of pipe elevations will be noted for unburied piping at locations where close coordination is required to prevent conflicts with other systems and/or building components.

6. Graphically identify each roof drain, overflow drain, area drain and downspout on plans and riser diagrams. Identification on riser diagrams will correspond to identification on plans. Graphically indicate floor levels and floor elevations on riser diagrams.

7. Details will be provided for, clean outs, roof drains, overflow drains, area drains, sump pump systems, roof penetrations, floor and wall penetrations, and all other components that require installation explanation beyond the information included within plans and riser diagrams.

8. Schedules will clearly identify:

- Capacity.
- Size.
- Model.
- Options and other requirements for all sump pump equipment.
- Piping materials and piping support spacing.

Data

The storm water system will be designed using 8 inch per hour rainfall intensity in conjunction with code established areas-to-pipe sizes allowed. Horizontal piping inside building will be insulated.

Standard

1. Storm water drainage systems will be provided to convey rainwater from roof and area drains to the site municipal storm sewer system.

Note: Secondary emergency overflow systems will be installed to protect parapeted roof structures in the event of primary system blockage. The overflow system will utilize parapet scuppers or secondary piping discharging through the exterior building wall immediately below the roof level. Aesthetics of scuppers and/or secondary piping termination will be determined by the Project Architect.

2. Primary and secondary roof drain systems will be designed using 8 inches per hour rainfall intensity in conjunction with code established areas-to-pipe sizes allowed.

3. Storm drains that cannot be discharged by gravity will flow into a gas-tight, covered and vented sump from which the drainage will be lifted by automatic pumping equipment and discharged into a storm drain capable of gravity flow.

Note: Storm water lift pumps will be minimum duplex system sized to discharge maximum calculated load with one pump out of service. Pumps will be connected to emergency power source. Sumps and lift pumps handling storm drainage will not receive sanitary drainage.

4. Roof drainage system will not connect to subsoil/foundation drainage or any open storm drain piping located within the building.

5. Roof drain and emergency overflow drain sumps and horizontal piping to first vertical downspout will be insulated to prevent condensation.

6. All above ground roof drain, emergency overflow drain piping and sump discharge piping will be provided with pipe labels and directional flow arrows.

7. Clean outs will be provided at the base of each vertical downspout and at intervals not exceeding 75 feet in horizontal building drain.

Note: Provide clearances as required by code. All interior clean outs will be accessible from walls or floors. Coordinate the location of all clean outs with the architectural features of the building and obtain approval of locations from the Project Architect. Horizontal roof drain piping located above building ground floor level will not require clean outs.

8. No roof drain will have an outlet connection smaller than 3 inches.

9. Avoid locating drain sumps or piping above sensitive equipment or areas where water leakage would cause major property loss or contamination, including but not limited to computer data centers, MRI rooms, food preparation, food storage, food serving, animal housing care areas, etc.

10. Do not locate drain sumps or piping within stairways, electrical or telecommunications rooms.

11. Appropriate subsoil and foundation drainage will be provided as required by the geo-technical report. Due to elevations of foundations and city utilities, all subsoil drainage will be discharged from the building through a lift station with duplex pumps. Each pump will be sized for 100% of design capacity. Sumps and pumps handling sub-soil/foundation drainage will not receive any sewage or roof drainage.

12. Storm drainage piping will be service weight cast iron soil pipe and fittings with hubless connections using clamp type gasketed mechanical fasteners above ground and hub and spigot DWV pipe and fittings with neoprene compression gasket joints for all buried pipe.

13. Cast iron soil pipe compression gaskets will be monolithically molded from an elastomer meeting ASTM C564 and will be of the same manufacturer as the pipe and fittings.

14. Clamps for joining hubless cast iron pipe and fittings sizes 10 inches and smaller will meet the performance criteria of FM 1680, have 28 gauge type 304 stainless steel jacket, minimum .094 inch thick ASTM C 564 neoprene gasket and type 305 stainless steel band screws designed to be installed with a pre-set torque wrench calibrated at 80 inch pounds.

15. Clamps for joining hubless cast iron pipe and fittings sizes 12 inches and 15 inches will meet the

performance criteria of FM 1680, have 24 gauge type 304 stainless steel jacket, minimum .100 inch thick ASTM C 564 neoprene gasket and type 305 stainless steel band screws designed to be installed with a pre-set torque wrench calibrated at 125 inch pounds.

2.12 Site Utilities

Introduction

1. Water services will be brought to the site from the Municipal system.

2. Domestic, fire protection, and lawn irrigation water supply systems will be metered and isolated from the municipal water supply in accordance with City of Houston requirements.

3. Sanitary Sewer services will be brought to the site from the Municipal system. Provide sanitary drainage system to serve site and structures.

4. Storm Sewer services will be brought to the site from the Municipal system. Provide storm drainage system to serve site and structures.

5. Natural gas service will be brought to the site from the Local Gas Supplier's System.

Note: Coordinate with Gas Company for service line easement and meter placement requirements. Coordinate routing of gas service with other site utilities.

Background

1. The site utilities will be designed by an approved and licensed Civil Engineering consultant.

2. Sanitary and storm drainage systems will be entirely separate.

3. All storm sewer lines and structures will be constructed according to City of Houston standards.

4. Provide on-site detention as required by the City of Houston.

5. All sanitary sewer lines and structures will be constructed according to City of Houston standards.

6. All site natural gas lines and structures will be constructed according to NFPA 54 and the Gas Company's standards.

Standard

1. Water Services will comply with the following:

- Provide fire hydrants as required by City of Houston Fire Marshal. Maximum spacing between hydrants should not exceed 300 feet. Locate such that any portion of the exterior of any building will be within 300 feet of a hydrant, with consideration given to accessibility and obstructions. Nominal distance between a fire hydrant and the building fire department connection should not exceed 100 feet.

- The building water supply will be provided by the existing municipal water main.
- The building fire protection water supply will be provided from the building water system.
- The building water supply will connect to the existing municipal water main.
- A single feed will run into the building and split inside the building to a domestic supply and fire protection supply. Back flow protection to the municipal main will be provided in the form of parallel reduced pressure back flow preventers.
- The building fire protection water supply will be a sub-system of the building's internal water supply. A fire department Siamese connection will be provided.

2. Sanitary Services will comply with the following:

- The building sanitary sewer will flow by gravity to the city sanitary sewer system.
- Manholes will be placed approximately 200 feet apart.
- System design will prevent site sanitary waste water from flowing backwards into the building sanitary waste piping systems. Provide backwater valves manufactured by Tideflex on inlet piping of manholes, area inlets or junction boxes directly receiving discharge from building systems.
- Wastes that are likely to damage or increase maintenance costs on the sanitary sewer system, detrimentally affect sewage treatment or contaminate surface or subsurface waters will be pretreated to render them innocuous before discharge into a drainage system.
- Detailed plans and specifications will be provided for the pretreatment facilities to the Municipal Authority when such plans and specifications will aid in enforcing the provisions of the Municipality's Codes, Laws or Ordinances.
- Piping conveying wastes from their point of origin to sewer connected pretreatment facilities will be of such material and design as to adequately perform its intended function to the satisfaction of the Administrative Authority.
- Drainage discharge piping from pretreatment facilities or interceptors will conform to standard drainage installation procedure.
- Provide interceptors for all drainage that may contain fats, oils, grease sand, lint, fuel or solids. Interceptors will be precast concrete with two-compartments (construction and size based on the City of Houston Plumbing Code).
- Each compartment will be provided with two gas and water tight 24 inch minimum diameter manholes for access. Interceptors will be properly vented to atmosphere and located outside the building footprint convenient to vehicular access for servicing.
- Provide interceptors with traffic bearing lids where applicable.
- Provide waste sampling well immediately downstream of interceptor per City of Houston requirements.
- Provide chemical waste treatment basins when effluent is expected to have a pH less than 6 or more than 10 before discharging into municipal sewer systems.
- Basins will be provided with gas and water tight cover of adequate size for servicing. Basins will be properly vented to atmosphere and located outside the building footprint convenient to vehicular access for servicing.
- Provide waste sampling well immediately downstream of basin per City of Houston requirements.
- Effluent having a temperature above 113° F will not be discharged to the municipal drainage system.

3. Storm Sewer Services will comply with the following:

- The building storm sewer will flow by gravity to the city storm sewerage system. Manholes will be placed approximately 200 feet apart. Multiple storm sewer connections are anticipated due to the area being drained.
- System design will prevent site storm water from flowing backwards into the building storm piping systems. Provide backwater valves manufactured by Tideflex on inlet piping of manholes, area inlets or junction boxes directly receiving discharge from building systems.

4. Natural Gas Services will comply with the following:

- The A/E team will investigate natural gas availability, service location, available service pressure, and any restrictions on the use of the natural gas.
- Interruptible and non-interruptible gas services will be evaluated regarding program requirements. Ownership and maintenance of proposed gas service will be determined.
- Include an "allowance" in the project equal to the estimated costs (quote) of the utility company as a separate item in design phase estimates.
- Unless otherwise approved by the Owner, the A/E will include all costs associated with the installation of gas service (including materials, labor, procurement, scheduling, etc.) in the bid documents as the Contractor's responsibility, both during bidding and construction.
- Where natural gas service piping, meters, regulators, and other appurtenances are provided by the utility company, and the construction costs are assessed to MD Anderson, the A/E will obtain from the utility company a written scope of work, quote, contact person, and any scheduling requirements.
- Finished site work, such as concrete/asphalt paving, seeding, directly related to the natural gas line installation, or other miscellaneous work associated with the natural gas service installation will be determined and defined in the bidding documents as the responsibility of the contractor, rather than the utility company.
- Natural gas pressures will not exceed five pounds per square inch gauge on customer side of the meter.

5. Site Utility Services will comply according to Table 2-3.

Site Utility Services	
Pipe Material (See master specifications.):	1. Sanitary sewer piping will be service weight cast iron. 2. Storm sewer piping will be reinforced concrete piping, ABS ASTM D 2751, SDR 35, SDR 42 (Refer to MD ANDERSON Master Specification for latest material requirements). 3. Water supply will be Class 53 ductile iron piping.

Table 2-3

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ARSAC Design Standards for Small Animals (Rodents) Vivarium

Mechanical Systems

General criteria, system descriptions and redundancy requirements

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3.0 Mechanical Systems: General Criteria

Temperature and Humidity Design Conditions

Introduction

Laboratory animals must be housed in comfortable, clean, temperature and humidity-controlled rooms. Animal welfare must be considered in the design process and the HVAC system must provide a comfortable environment for both the research animals and human staff. There can be a marked difference between the environment in the primary and secondary enclosure. Temperature/humidity ranges are recommended for the secondary enclosure (animal room) with the historical assumption that these conditions produce an acceptable environment.

Background

Most laboratory animals prefer a relative humidity around 50%, but can tolerate a range of 30 – 70% as long as it remains relatively constant and the temperature range is appropriate. The ventilation system should be capable of adjustments in dry-bulb temperatures of ±1ºC (± 2ºF) and usually range from 61ºF to 84ºF.

Standard

Recommended Dry-Bulb Temperatures and Humidity for Animal Housing		
Animal	**Temperature (ºF)**	**Humidity**
Mouse	64ºF to 79ºF	40-70% RH
Hamster	64ºF to 79ºF	40-70% RH
Guinea pig	64ºF to 79ºF	40-70% RH
Rabbit	61ºF to 72ºF	40-70% RH
Dog	64ºF to 84ºF	30-70% RH
Non-human primate	64ºF to 84ºF	30-70% RH
Chicken	61ºF to 81ºF	45-70% RH

Table 3-1

Building Heating, Ventilating and Air Conditioning (HVAC) Loads

Introduction

In the past MD Anderson has not required the MEP consultant to provide building load calculations for vivaria, labs or any other type building. It is the intent of this document to require the consultant to provide electronic load calculations for all projects. The intent of this process is to identify room requirements early in the design so that there is an understanding of what cooling load is anticipated for each room in the building. The load calculations and associated notes made in the software inputs will:

1. Allow all parties to review and agree on what is anticipated for each room early in the project.
2. Serve as a basis of design document that can be updated as project changes are made.
3. Allow utilities management to plan for chilled water and steam requirements early in the project.
4. Select most stringent requirement to determine room air quantity (heat load or air change).
5. Allow user to see how many animals were assumed in the room calculation (notes).
6. Allow user to see what equipment was assumed in the room calculation (notes).
7. Allow verification of envelope energy requirements.

Background

Computer based heating, ventilating and air conditioning (HVAC) load calculation programs have been available for many years and are typically used by most consultants on all projects. What is being asked of the consultant that is normally not done, is to itemize a list of equipment expected for each room as well as assumed animal counts. The software is generally used for commercial applications. Inputs are specific to lighting, equipment, people and the building envelope. Therefore, the equipment input must sum up the animal and equipment heat loads. To allow all parties to know what is included in the equipment input, the notes section for each zone will break down how many animals were used for the calculation and what equipment and heat load was assumed for the calculation. Additionally, the notes shall describe other room requirements such as: type and number of BSCs expected in the room, quantity of exhaust required for the BSC or the room, and relative room pressurization (positive or negative), etc.

Data

In past projects, identification of specific room requirements has been limited to the programming architect or the equipment consultant. Eventually, the information is then forwarded to the engineer to begin the design process. The goal is to include the engineer early in the design process so that a document is generated that clearly identifies specific room requirements. These room requirements can then be calculated and submitted to the owner for review prior to system layout or equipment selection. The goal is to speed up the design process by allowing faculty, users, project managers and internal engineering to review one design document all at one time. The review comments are then incorporated into the load calculation software, verified and then used by the engineer to begin the design of the supply and exhaust systems.

Standard

The consultant shall input all project rooms/entire building heat loads into the calculation. The software employed by the consultant shall include all ASHRAE standards. The MD Anderson preferred software is Elite Software – CHVAC Commercial HVAC Loads. The load calculations shall be based on project programming and shall be submitted to the owner through the project manager for review by all parties. An architectural floor plan with room numbers shall be provided to correlate the plan with the load calculation printout.

Noise and Vibration

Introduction

Many animals are extremely sensitive to noise and vibration, which can produce detrimental effects on research. Designers shall take every opportunity to control vibration and to locate vibration sources away from animals and activities sensitive to vibration. Specific vibration recommendations will be made by an experienced vibration consultant early in the design process. Steel structures shall not be precluded for use in structural design relative to vibration without analysis. Blanket use of sound attenuators at the room zone level should be avoided.

Background

Animal housing and most procedure spaces should be carefully designed to facilitate animal wellbeing; meet research requirements; minimize experimental variables; and provide isolation from wide variations in vibration and noise sources.

Noise controls should be considered in all facility designs and operations. Moreover, the facility should assess the following factors: intensity, frequency, rapidity of onset, duration, vibration potential of sound, hearing range, noise-exposure history, and sound-affect susceptibility of species, stock, or strain. Exposure to sound louder than 85 dB can have numerous adverse affects on animals. Examples of these adverse effects include: increased nervousness, irritability, hearing impairment, anxiety, hypertension and decreased productivity.

When designing a renovation or new construction all items should be considered and noise abatement measures should be implemented as needed. When selecting sound absorption materials, the ergonomics of sanitizing and handling the materials in the facility should also be kept in mind.

Consideration shall be given to vibration of floor-framing systems caused by mechanical and electrical equipment such as pumps, chillers, fans, emergency generators, and transformers and other sources such as foot traffic, parking garage traffic, and movement of heavy equipment.

Designers should consider the effects of noise generated by equipment and materials in facilities. Likewise, designers should separate animal housing and procedures areas from high noise areas and activities and consider installing sound attenuating material as needed. Small-animal holding rooms should be located convenient to a central cagewash, but at a minimum they should be separated from the cagewash by a corridor. Likewise, to minimize the impact of noise and vibration, the holding rooms should be separated from mechanical rooms or other noise-generating areas in the facility. This is particularly necessary for barrier areas where genetically sensitive animals are housed.

Rodents can hear ultrasound. Their hearing range is from 20 Hz to 100 KHz. Since ultrasonic motion detectors transmit ultrasonic sound waves in the frequency range from 25 KHz to 40 KHz, the lab rodents may be subject to auditory stress. A sister cancer research institution had ultrasonic motion detectors installed in the vivarium corridors. The ultrasonic sound waves could not penetrate the walls at low level. However, when the doors of the animal rooms were opened, the rodents were stressed with full level of ultrasound which decreased reproductive performance. After the removal of the ultrasound sources, the rodents reproductive performance returned to normal levels.

MD Anderson selected CSTI Acoustics, a noise and sound consultant, to perform a study of actual sound levels in operating vivaria and to provide guidance and information on design principles to reduce the impact of noise and vibration in Small Animal Vivaria. Their final report, MD Anderson Noise, Vibration and Ultrasound Design Guide, is located on MD Anderson's Owner's Design Guidelines-Supplemental Information webpage. The following figure summarizes the vivarium noise criteria for rodents:

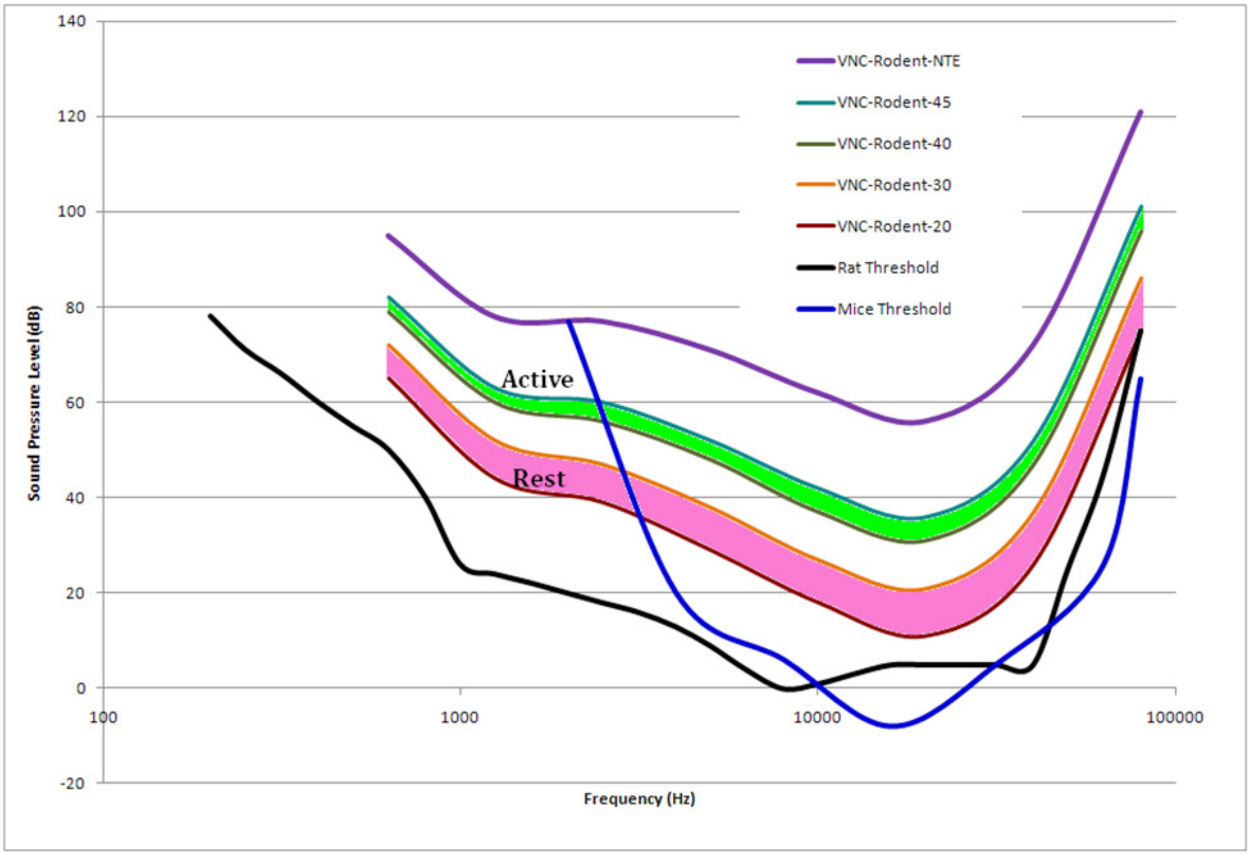

Figure 3-1: Vivarium Noise Criteria for Rodents

Standard

The A/E team will consider the following items during the early design phases to control vibration transmitted into the animal facility space, according to Table 3-2.

Noise and Vibration Standard	
Recommendation	**Justification**
Structural system should have relatively short column spacing and be relatively stiff so that any transmitted vibration occurs at high frequencies.	Vibrations occurring at higher frequencies are more easily dampened with instrumentation vibration-dampening systems and isolation tables than vibrations occurring at lower frequencies.

Noise and Vibration Standard	
Recommendation	**Justification**
Framed floors, corridors and animal facility spaces should not be combined in the same structural bay.	To reduce vibration occurrences and reduce detrimental effects on research animals and personnel.
Animal facility spaces should be located away from sources of vibration.	To reduce vibration occurrences and reduce detrimental effects on research animals and personnel.
Animal facilities should be located on grade-supported slabs.	This not only reduces vibration concerns but more easily accommodates pits required for cage and rack processing, and the risk of water leakage to lower levels is eliminated.
Ultrasonic motion detectors should not be used for lighting controls or security.	Ultrasonic motion detectors should not be used in vivarium corridors. Ultrasound noise levels should not be more than 15 dB above normal (ambient) ultrasound levels in cage rack rooms. Other possible application is passive infrared (PIR) occupant sensors.
Small-animal holding rooms should be separated from the cagewash by a corridor.	To reduce vibration occurrences and reduce detrimental effects on research animals.
Vibration isolators should be installed appropriately on equipment that may be a source of vibration.	To reduce point source vibrations and reduce detrimental effects on research animals.

Table 3-2

Building Pressure Relationships

Introduction

Differential pressures can be used to inhibit the passage of pathogenic material between rooms. Higher pressures are used in clean areas relative to dirty or bio-hazardous areas in order to minimize contamination.

Background

Consideration will be given to the manipulation of air-pressure differentials in surgical, procedural, housing and service rooms. For example, areas for quarantine, housing of non-human primates, and use of animals exposed to hazardous agents should be kept under relative negative pressure; whereas areas for surgery, for clean-equipment use and storage, and for housing of pathogen-free animals should be kept under relative positive pressure with clean air.

The HVAC system must be adequate and adaptable so that pressure relationships can be modified as required over the life of the facility.

Standard

Room Type	Negative Pressure	Positive Pressure
Quarantine rooms	X	
Housing rooms of non-human primates	X	
Housing rooms for animals exposed to hazardous agents	X	
Cage wash - Soiled side to corridor	X	
Cage wash – Clean side to corridor		X
Necropsy rooms	X	
Autoclave - Equipment preparation	X	
Autoclave – Sterile staging		X
Surgery		X
Clean-equipment use and storage rooms		X
Housing rooms of pathogen-free animals		X
Bedding and feed storage rooms		X

Table 3-3

Pipe Sizing

Introduction

Steam, chilled and heating hot water piping represent the majority and largest piping systems serving the vivarium and support spaces. These systems support all the air handling systems and the vivarium process equipment,and are part of the HVAC system. Pipe systems such as storm, sanitary, domestic water, RO water, lab gases, LN2, fire protection, etc. although equally as important, have been excluded from the general sizing criteria since project specifics in many cases drive the design and sizing criteria. The following criteria will be used in sizing the HVAC piping systems:

1. All piping sized for actual need without over sizing, to minimize initial pipe, valve, fitting, insulation and installation cost.

2. All piping sized for actual load to avoid unnecessary energy losses through pipe, steam piping in particular.

3. Maintain lower steam velocities near vivarium areas as needed to avoid noise transmission into occupied spaces.

4. Maintain higher chilled water delta where possible to reduce pipe sizes.

Background

To maintain the cooling and heating needs of the vivarium, the steam, steam condensate, heating hot water and process water systems shall be sized to accommodate current and future needs. Sizing for future load should be included only when an actual load is anticipated. System diversity should also be considered by the A/E team at the various building mains and risers. Smaller branch piping directly off the main and the end of mains, should follow the tabled criteria below.

Data

Based on reviewing many past MD Anderson projects, HVAC piping is always generally over sized. The A/E team shall look at possible diversity in the different systems to avoid the additional cost associated with oversized pipe. There are no known utility problems associated with pipe mains being too small.

Standard

HVAC Piping Sizing Requirements	
Item	**Direction**
Chilled and Process Water Piping	
¾-2 inches	1.5-2.5 feet friction loss per 100 feet of pipe. Not to exceed 4 FPS.
2 inches and greater	2-3 feet friction loss per 100 feet of pipe. Not to exceed 7 FPS.
Heating Hot Water Piping	
¾-2 inches	1.5-2.5 feet friction loss per 100 feet of pipe. Not to exceed 4 FPS.
2 inches and greater	2-3 feet friction loss per 100 feet of pipe. Not to exceed 7 FPS.
Steam Piping	
Low (5-15 PSIG) and Medium (16-80 PSIG) pressure piping	50-80 feet per second (3000-4800 FPM)
High Pressure Piping	
(81-120 PSIG)	80-100 feet per second (4800-6000 FPM)
Condensate Return Piping	
5-30 PSIG return line	Maximum 10 inch water gage per 100 feet of travel using twice the running load
31 PSIG and greater	66 feet per second maximum

Table 3-3

Ductwork Sizing

Introduction

Sheet metal ductwork distributes supply air or gathers exhaust air from the various vivarium spaces. Duct size, along with duct construction class determine the limits at which air can be effectively moved by the building air handling units and exhaust fans. Since duct construction is so intertwined with duct sizing, both topics are discussed herein. A typical duct system will include low and medium pressure duct construction classes. Generally, the duct sized for a low pressure class has a lower duct velocity or feet per minute (FPM) and requires less rigidity than a medium pressure duct that has a greater duct velocity. The lower velocity duct is normally at and around the room air device and is separated from the higher velocity medium pressure duct mains by a terminal unit that acts like a pressure regulator. This allows the main distribution ductwork to be smaller and maintain higher velocities which in turn reduces initial cost and requires less space above the ceiling. Exhaust systems requiring HEPA and charcoal filtration fall into the high pressure construction class. The duct classes are typically broken out as follows:

1. Low Pressure Ductwork - 2-4 inch water gauge (pressure measurement)

2. Medium Pressure Ductwork - 6 inch water gauge (pressure measurement)

3. High Pressure Ductwork - 10 inch water gauge (pressure measurement)

Once installed, each pressure class of duct is tested with an inclined or U-tube manometer, tubing, calibrated orifice and a test fan. Before the system ducts are attached to their respective fans or terminal units, a tube is inserted into the duct being tested. The other end of the tube is attached to one end of the manometer. The test exhaust fan is then energized and regulated to raise the fluid (water column or gauge) in the manometer to a 2, 6 or 10 inch differential to meet the duct pressure class being tested, as needed. During the test the duct should not experience any opening of joints, tearing of joint corners, screw or rivet pullout, longitudinal seam separation, sealant failure or excessive deflection (oil canning). If any of these occur, the affected area will be evaluated for repair or replacement, corrective measures taken and the entire system retested.

Background

The duct systems must move air as efficiently and quietly (NC-45 or less measured in the room, excluding IIA BSC noise) as possible to maintain the requirements of the vivarium. The duct systems must also be constructed to withstand abnormal conditions which occur during loss of power, control failures or equipment failures. The duct systems must also accommodate normal air fluctuations associated with variable air flow without any flexing or oil canning of the ductwork. Oil canning of any ductwork is unacceptable in the vivarium. Typically, round duct is less susceptible to oil canning and is preferred.

Improperly sized duct, normally undersized, can cause discomfort or insufficient air change rate in vivarium spaces because designed air quantities cannot be achieved. Undersized duct and improper duct fittings also require the amount of horsepower needed to supply and exhaust vivarium spaces to increase. When the horsepower increases, the static pressure in the duct also increases and so will the air noise in the duct. If the duct static pressure increases beyond the limits of the duct construction rating, duct failures can occur. The duct static pressure ratings and criteria noted in the table below are minimum standards. The A\E team shall fully investigate the duct systems required for the project and increase the duct size and construction class as required to meet specific project requirements. The A\E team shall also carefully review ductwork shop drawings so that ducts, fittings and transitions effectively move air without increasing system static pressures. The duct systems should deliver the air to and from the building in the most efficient manner through proper duct sizing. Ductwork, however should not be oversized.

Data

Based on shared experience between designer and maintenance provider, the following elements listed in the table below should be used in designing an MD Anderson vivarium.

Standard

Ductwork Sizing and Construction Requirements Vivarium and Support Areas	
Item	**Direction**
Supply duct from air handling unit (AHU) to risers and mains. Exhaust duct from mains and risers to exhaust fans.	Galvanized duct (unless otherwise noted) constructed to 6 inch pressure class. Duct sized for maximum friction loss of 0.15 inches/100 feet or 2000 FPM velocity, whichever is lower. Vertical risers serving multiple floors may be sized at 2500 FPM. End of main shall be sized for .05 inches/100 feet.
Supply duct from main to terminal unit. Exhaust duct from terminal unit to main.	Galvanized duct (unless otherwise noted) constructed to 6 inches pressure class. Maximum duct friction loss of 0.12 inches/100 feet preferred.
Supply duct from terminal unit to room air device. Exhaust duct from air device to terminal unit.	Galvanized duct (unless otherwise noted) constructed to 2 inch pressure class. Duct sized for maximum friction loss of 0.08 inches/100 feet or as required to meet room noise criteria level (could involve lowering duct velocity/larger duct size).
Biological Safety Cabinet exhaust to terminal unit	Galvanized duct constructed to 6 inch pressure class (304 stainless steel for IIB2). 10-12 inch round duct minimum. Generally duct size equals terminal unit connection size.
Chemical Fume Hood (includes Radioisotope type) to terminal unit	316 (or 304, if approved by owner) stainless steel duct constructed to 6 inch pressure class. 12 inch round duct minimum. Generally duct size equals terminal unit connection size. Duct may be connected to galvanized general exhaust main.
Cage wash exhaust from grille/equipment to terminal unit	304 stainless steel duct (unless otherwise noted) constructed to 3 inch pressure class. Duct sized for friction loss of 0.15 inches/100 feet or 1800 FPM velocity for tunnel and rack washers. Exhaust ductwork serving grilles in large open areas in the cage wash area may be sized for 0.10 inches/100 feet and may be galvanized, if not subject to constant moisture.

Ductwork Sizing and Construction Requirements Vivarium and Support Areas	
Item	**Direction**
Cage wash exhaust from terminal unit to main. Cage wash exhaust from main to exhaust fan	304 stainless steel duct meeting 6 inch pressure class. Duct sized for friction loss of 0.2 inches/100 feet or 1500-2200 FPM velocity. Where one exhaust fan system serves all vivarium general exhaust and cage wash exhaust, a dedicated stainless steel main from the cage wash shall be routed to the exhaust fan plenum.
Exhaust main upstream of filter caisson including run out to terminal unit.	304 stainless steel duct constructed to 6 inch pressure class. Duct sized for maximum friction loss of 0.15 inches/100 feet or 2000 FPM velocity, whichever is lower. End of exhaust main shall be sized for .05 inches/100 feet.
Exhaust main downstream of caisson, where required.	304 stainless steel duct constructed to 10 inch pressure class. Duct sized for maximum friction loss of 0.15 inches/100 feet or 2000 FPM velocity, whichever is lower.
Office Areas on Separate Air Handling Unit	
Supply duct from AHU to risers and mains	Galvanized duct constructed to 4 inch pressure class. Duct sized for maximum friction loss of 0.15 inches/100 feet or 1600 FPM velocity, whichever is lower. Vertical risers serving multiple floors may be sized at 2000 FPM. End of supply main shall be sized for .05 inches/100 feet.
Duct from main to terminal unit.	Galvanized duct constructed to 4 inch pressure class. Duct sized for maximum friction loss of 0.12 inches/100 feet preferred.
Duct from terminal unit to air device	Galvanized duct constructed to 2 inch pressure class. Duct sized for maximum friction loss of 0.08 inches/100 feet or as required to meet room noise criteria (could involve lowering duct velocity/larger duct size). Runout ducts to individual diffusers may use a maximum of 6 foot flexible duct. Remaining runout length will be rigid galvanized duct.
Return and outside air ducts to air handling unit	Galvanized duct constructed to 4 inch pressure class. Duct sized for maximum friction loss of 0.10 inches/100 feet or 1600 FPM velocity, whichever is lower.
Return air transfer openings, boots and duct	Openings and ducts near mechanical room sized at 500 FPM, all other openings sized at 300 FPM.
Joining, Fittings, and Duct Sealing Standards (All Areas)	

Ductwork Sizing and Construction Requirements Vivarium and Support Areas	
Item	**Direction**
Joining	Sheet Metal and Air Conditioning Contractors National Association, Inc (SMACNA) approved Flanged and gasketed transverse joints for medium and high pressure galvanized systems. Low pressure joints and transverse and longitudinal joints shall be minimum Pittsburgh Lock with sealant. All stainless steel duct joints shall be welded.
Fittings	Rectangular supply elbows will have turning vanes, round or radius rectangular elbows will be full radius, offsets will be mitered or radius and transitions will not exceed 30 degree angle for concentric or eccentric transitions.
Duct Sealing	All galvanized duct seams and joints must be sealed with an owner approved sealant and fiberglass scrim tape for a tighter, low leakage duct system.

Table 3-4

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3.1 Mechanical Systems: System Descriptions

Plant Steam and Condensate

Introduction

Plant steam is used directly or indirectly for four processes; heating the building systems, creating clean steam, providing the heat source for washing and sterilizing of animal caging, and providing the heat source for washing and sterilizing glassware for the laboratory function. All four processes require an uninterrupted steam source to support the day-to-day vivarium operations. Generally, steam is extended to a piece of equipment for heat transfer. As the steam comes in contact with cooler surfaces, it is converted to liquid condensate. In most cases, this condensate is reclaimed and returned to the steam generator (boiler) to be reheated and returned to a high pressure gas state. However, some condensate will not be returned to the steam generator because of system inefficiencies or the condensate is not suitable for reuse. Softened makeup water is then preheated and extended to the generator to begin the steam generating process once again. Steam is either generated within the building or is generated at a central utility plant. The fuel source for the steam generation is usually natural gas.

The following represents the majority of the system types serving MD Anderson's buildings:

1. Central steam generating utility plant (Thermal Energy Cooperative, or TECO) serving multiple buildings in the Medical Center (All MD Anderson Main/North Campus buildings)

2. Dedicated steam boiler system serving one building (South Campus – SRB, SCV, Bastrop –CMRB).

3. Steam boiler system serving multiple MD Anderson buildings (Smithville – Lab 1, Lab 2, Conference Center, Griffin Building, Bastrop – Main Building and Service Building).

Background

High pressure debris free steam must be extended to the various support equipment to maintain the requirements of the 24 hour and 365 day vivarium operation. On the Main/North Campus, steam enters the building central plant at approximately 225 pounds per square inch gauge (PSIG) (could be as high as 425 PSIG) and is reduced to 70-150 PSIG through pressure reducing stations. Each station shall consist of a 1/3 capacity pressure reducing valve (PRV), 2/3 capacity valve and a full line valved bypass. A/E will confirm bypass need. Pressure reductions greater than 100 PSI shall involve at least two reduction stages. Dedicated building steam boiler pressures should not exceed 100 PSIG. High steam pressures will be limited to equipment within the central plant. Steam to equipment on the vivarium floor shall not exceed 80 PSIG.

Within the building main mechanical room, steam is used to heat domestic hot water, heat the heating hot water and create clean steam. Heat exchangers are used for the steam to steam or steam to heated liquid transfer. Steam to the vivarium decontamination bulk sterilizers, rack washers, tunnel washers, sterile bulk sterilizers and glassware washers and sterilizers shall not exceed 70 PSIG. Verify steam requirements with equipment supplier. Steam flow to all cage wash and glasswash equipment shall be controlled by the equipment served. Steam to clean steam generators and heating hot water exchangers shall be controlled through 1/3, 2/3 valve arrangement. All plant steam piping shall be carbon steel.

Steam traps will be provided at steam pressure reducing stations, equipment, end of pipe run, extended pipe runs, bottom of risers, steam headers, flash tanks, etc. All high pressure steam condensate shall be routed through flash tanks before being returned to the condensate return pump receiver. At the Main/North Campus, the condensate return pump shall pump condensate to the condensate transfer pump for return to TECO. For boiler systems, the condensate return pump shall pump condensate to the de-aerator boiler feed unit to be reused for makeup to the steam boiler. Condensate return pumps shall be duplex electric or steam powered. All pressure reliefs and vents shall be extended through the roof.

Plant steam will have no direct contact with clean steam generator vessels, clean steam piping system, clean steam de-aerator vessel or direct injection into sterilizer chambers. The A/E, owner and washing/sterilizing equipment provider shall establish and coordinate washing and sterilizing requirements at the programming phase.

Data

The following elements listed below should be used in designing the MD Anderson vivarium based on shared experience between user, builder and maintenance provider, according to Table 3-5.

Standard

Steam System Requirements	
Item	**Direction**
Steam Pressure Ranges PSIG	
5-14	Low Pressure
15-80	Medium Pressure
81-120	High Pressure
121-425	High Pressure (TECO)
Note: Maximum steam pressure to equipment, although lower more efficient steam pressures are recommended. Consult washing/sterilizing equipment manufacturer for exact steam pressure, quantities and steam quality required.	
Heating Hot Water System	80 PSIG max
Domestic Hot Water System	80 PSIG max
Clean Steam Generator	80 PSIG max
De-aerator	30 PSIG max
Bulk Sterilizer	70 PSIG max
Rack washer	70 PSIG max
Tunnel washer	70 PSIG max
Glass washer	70 PSIG max
Glass Dryer	70 PSIG max
Glass Autoclave	70 PSIG max
Distribution Piping	
Steam – All pressures	Standard weight carbon steel

Steam System Requirements	
Item	**Direction**
Condensate – All pressures	Schedule 80 carbon steel for piping smaller than 1 inch. Standard weight for piping larger than 1 inch
Screwed Pipe	Low and Medium pressure steam and condensate piping smaller than 2 ½ inches.
Welded pipe	Low and Medium pressure steam and condensate piping larger than 2 inches, and all high pressure steam and condensate piping.
Pipe slope	Maintain gravity condensate return as much as possible. Steam piping shall slope opposite steam flow
Pressure Reducing and Control valves	Pilot operated
Boilers (where required)	Minimum 2 - Gas fired water tube boilers each at 100% capacity, on emergency power. Three boilers each at 50% preferred. Boiler designed for 100 PSIG maximum. Modulating feedwater system with variable speed feedwater pumps.
De-aerator (where required)	Minimum 1 – de-aerator with 1 receiver and multiple feed pumps (1 standby) all on emergency power. Unit shall be equipped with steam preheat option to maintain boiler feed water at 210 degrees. Softened water boiler feed.
Condensate transfer pump (where required)	Minimum 1 receiver with multiple pumps on emergency power (1 standby). Pumps shall accommodate TECO condensate return system pressures 35-60 PSIG and 25-150 GPM flow rate.
Condensate return pump	All condensate return pumps shall be low pressure. Electric condensate return pumps shall be duplex on emergency power. Steam pressure powered condensate return pumps require only one pump.
Blowdown separator	1 required with discharge tempered to 120 degrees maximum.
General	Boilers and de-aerators shall be of the same manufacturer where possible.

Table 3-5

Clean Steam

Introduction

Clean steam is used for humidification and sterilization. Clean steam is considered clean because there are no chemicals (amines) added to the steam to protect the distribution piping from corrosion. This clean steam is considered suitable for injection into the supply air serving the vivarium and support area air handling units during low humidity days. A relative humidity of 50% should be maintained year round. Clean steam is also injected into the glasswash and bulk sterilizers to complete the sterilization process. Clean steam can be generated by a plant steam to clean steam exchanger or by an electric clean steam generator. The water used to generate the steam is usually a combination of condensed clean steam (condensate) accumulated in the distribution piping and reverse osmosis (RO) makeup water. These two makeup water sources are gathered at a clean steam de-aerator. The de-aerator removes the oxygen from the liquid by heating it to 212 degrees before pumping it to the clean steam generator. The generator receives the heated water and converts it to steam at the desired pressure. The steam is then distributed by way of stainless steel piping to the air handlers and sterilizers. Currently, all clean steam serving MD Anderson vivaria is generated through plant steam to clean steam generators.

Background

The clean steam must be available 24 hours and 365 days a year to maintain the environmental conditions of the animals. Therefore, redundant clean steam generators are required. Generally, 70 PSIG clean steam is extended to the washing and sterilizing equipment. The pressure is reduced to 15 PSIG for the clean steam humidification system serving the air handlers. All metals in contact with the clean steam shall be stainless steel to avoid corrosion in the system. This should also include pipe vents and reliefs that could allow condensation to drip and mix with the clean steam.

The A/E team will coordinate the specification of all humidification, washing and sterilizing equipment with the manufacturer, so that all metals in contact with the clean steam are made of stainless steel. Any lapse in this requirement compromises the entire clean steam system. Some individual washing and sterilizing equipment will require both clean and plant steam. Needs should be coordinated with equipment manufacturer.

Data

Based on shared experience between user, builder designer and maintenance provider, the following elements shall also be used in designing an MD Anderson vivarium.

Standard

Clean Steam System Requirements	
Item	**Direction**
Steam Pressure Ranges PSIG	
5-15	Low Pressure
16-80	Medium Pressure
Note: Maximum steam pressure to equipment, although lower more efficient steam pressures are recommended. Consult washing/sterilizing equipment manufacturer for exact steam pressure, quantities and steam quality required.	
De-aerator	30 PSIG max
Bulk Sterilizer	70 PSIG max
Rack washer	70 PSIG max
Tunnel washer	70 PSIG max

Clean Steam System Requirements	
Item	**Direction**
Glass washer	70 PSIG max
Glass Dryer	70 PSIG max
Glass Autoclave	70 PSIG max
AHU Humidifiers	15 PSIG max.
Distribution Piping	
Steam – All pressures	304 schedule 40, seamless stainless steel.
Condensate – All pressures	304 schedule 40, seamless stainless steel.
Welded pipe	All steam and condensate piping.
Pipe slope	Maintain gravity condensate return as much as possible. Steam piping will slope opposite steam flow.
Pressure Reducing Valves (station)	Pilot operated. Valves sized 1/3, 2/3 with bypass.
Clean Steam Generators	Minimum of two steam-to-steam generators each sized for 85-90% capacity. Parts in contact with clean steam will be 304 stainless steel. Generators shall produce 70 PSIG steam. All related controls shall be on emergency power.
Packaged Clean Steam De-aerator	Minimum of one de-aerator with one receiver and multiple feed pumps (one standby) all on emergency power. Unit shall be equipped with steam preheat option to maintain generator feed water at 210°F. All surfaces in contact with clean steam shall be stainless steel. Where screwed pipe is required on the system, provide thread sealers or seal tapes compatible with metal and high temperature. Provide RO makeup water.
Condensate return pumps	Provide steam pressure powered condensate return pump where required. All parts in contact with clean steam condensate shall be 304 stainless steel.
Blowdown Separator	One required, discharge blowdown will be tempered to 120 °F maximum.

Table 3-6

Heating Hot Water

Introduction

Heating hot water is used for the vivarium air handlers to preheat the 100% outside air to 45-50 °F in the winter. As the air is ducted to the individual animal rooms and support areas, a hot water reheat coil in the duct further heats the air as needed to maintain the desired temperature in the animal room or support zone. Generally, a thermostat in the room controls the reheat coil and the coil is in use year round to reheat the supply air. The air handler discharge ranges from 50-52 °F. One heating hot water system will normally serve the entire building even if other occupancy types share the building. Natural gas is used to fuel a steam boiler that allows an exchanger (converter) to convert the steam to a heating hot water source, or natural gas is used to fuel a heating hot water boiler directly. In some cases steam may be used to preheat and reheat the air. Also, in some cases, the gas boilers are outfitted to handle fuel oil as an alternate fuel, but only in an emergency. Steam preheat/reheat is not recommended.

The following represents the majority of the MD Anderson's heating systems:

1. Central gas fired steam generating plant (TECO) serving multiple TMC buildings. High pressure steam routed to MD Anderson main campus, reduced and extended to hot water converter (Main Campus).

2. Dedicated gas fired heating hot water boiler serving single or multiple MD Anderson buildings (South Campus – SCRB 1&2, El Rio, Naomi, Smithville – Lab III & IV).

3. Dedicated gas fired steam boiler serving single or multiple MD Anderson buildings. Medium pressure steam extended to heating hot water converter (South Campus – SRB, SCV, Bastrop – CMRB, Main Building).

4. Dedicated small central gas fired steam generating plant serving multiple MD Anderson buildings. Medium pressure steam extended to heating hot water converter (Smithville - Lab I, Lab II, Conference Center, Griffin Building).

Background

To meet the 24 hour and 365 day environmental heating requirement of the vivarium, the heating hot water system must maintain 140-160 degrees to the building air handling units and reheat coils. Generally, a 20 degree delta between heating hot water supply and return is required year round. A circulation pump shall be provided at the air handling unit preheat coil to maintain constant water flow through the coil. This will minimize the chance of freezing the coil when outside air temperatures are slightly below freezing.

The heating hot water system shall include an air separator and expansion tank to remove air in the piping system. The air separator shall be located on the suction side of the pump. Heating hot water return from the building shall first enter the steam to hot water exchanger/converter, then through the air separator and finally distributed to the building by the pump. Heating hot water distribution piping is generally schedule 40 black steel sized to 2 to 3 feet. friction loss per 100 feet of pipe. Where feasible, copper may be substituted for smaller branch lines. Piping shall be no smaller than ¾ inches.

Data

Based on shared experience between user, builder, designer and maintenance provider, the following elements listed in the table below should be used in designing an MD Anderson vivarium.

Standard

Heating Hot Water Requirements	
Item	**Direction**
Building heating hot water pumps	End suction pumps, minimum of two pumps each sized for 100% capacity and on emergency power. Pumps will be provided with variable speed drives (VSD), isolation valves, strainer, check valve, flex connectors and housekeeping pad (inertia base where required). Typical for all buildings.
Distribution piping	Piping shall be schedule 40 black steel. Small branch lines may be copper where feasible. Di-electric unions shall be provided where dissimilar metals come in contact. Gaskets in the system shall be able to meet the maximum system temperature range plus 10% increase.
Air Separator	Provide at suction to pump
Expansion Tank	Provide and connect to air separator or provide at system high point. A/E team to verify best location.
Isolation Valves	Provide heating hot water supply and return isolation valves at bottom of riser, each floor take off from riser and at each piece of equipment.
Steam to Heating Hot Water Converter/Heat exchanger (where applicable)	A minimum of two converters each sized for 100% capacity. Three converters at 50% each preferred.
Gas Fired Hot Water Boiler (where applicable)	A minimum of two water tube boilers each sized for 100% of the building capacity and on emergency power.
AHU preheat coil pump	One in-line pump per air handling unit, on emergency power.
Entire heating hot water system	All system components including controls shall be on emergency power.

Table 3-7

Chilled Water

Introduction

Chilled water is the means by which heat is rejected from the building to the outdoors. Normally, heat from lighting fixtures, people, equipment and solar radiation is transferred to the chilled water system through various heat exchange devices located throughout the building. Since the vivarium portion of the building requires 100% outside air, all ambient heat is rejected at the air handler. The additional heat gained within the vivarium will be removed by the 100% exhaust system. Rejected heat at the air handlers and exchangers is then removed from the building through chilled water return lines leading back to the chilling source. The chiller, through the use of refrigerants, re-cools the water and the chilled water is returned to the building to begin the cycle again. The chiller must at the same time reject the heat to the atmosphere through either an air cooled or water source method. The following represents the majority of the MD Anderson chilled water system configurations:

1. Central MD Anderson water cooled chilled water plant serving multiple MD Anderson buildings (South Campus serving CABIR, CTT, SCRB 1-4, SRB, PPB and SCV)

2. Dedicated building water cooled chillers serving single or multiple MD Anderson buildings (South Campus- SCRB1,SCRB2, SRB/PPB, Bastrop-BREB)

3. Central water cooled Utility Plant (TECO) serving chilled water to MD Anderson buildings and other TMC buildings (Main Campus-All)

4. Dedicated air cooled chillers serving single or multiple MD Anderson buildings (Bastrop-All, except CMRB, South Campus-El Rio, Naomi)

5. Central water cooled Utility Plant serving multiple MD Anderson buildings (Smithville-All)

Background

Chilled water typically in the range of 42°F to meet the 24 hour and 365 day chilled water needs of the vivarium and must be delivered to the building and distributed to the various air handlers to maintain interior environmental conditions. Discharge air temperatures from the air handlers ranges from 50-52°F. Chilled water is also delivered to the process water loop, if required. The process water loop is used to reject heat from equipment such as environmental rooms, autoclaves and other miscellaneous high heat producing equipment that requires chilled water at 60°F in lieu of the typical 42°F. Typically, the process water loop is separated from the chilled water loop by a plate and frame heat exchanger. Process water side pumps should include a redundant pump with all pumps being on emergency power.

Return temperatures from the building shall be at least 14°F warmer than chilled water supply during peak, or greater if returning to TECO. The A/E consultant must verify the design requirements of the existing system providing the chilled water. Generally, higher chilled water temperature deltas are recommended at the Main Campus air handling unit coils to reduce the gallons per minute (GPM) flow required by the building. This allows reduced pipe size, pump size, energy use and reduced GPM requirement from TECO. Where central utility provides chilled water to secondary pumps serving a one story building or low rise portion of a high rise building or heat exchangers located at the lower levels, a bypass shall be provided around the pumps to allow pumping from the main utility pumps during light load conditions.

Chilled water distribution piping is generally Schedule 40 black steel sized for 2 to 3 feet friction loss per 100 feet of pipe. Where feasible, copper may be substituted for smaller branch lines. Piping will be no smaller than ¾ inch.

Data

Based on shared experience between user, builder, designer and maintenance provider, the following elements listed in the table below should be used in designing an MD Anderson vivarium.

Standard

Chilled Water System Requirements	
Building chilled water pumps and process water pumps	Horizontal splitcase pumps, minimum two pumps each sized for 100% capacity and on emergency power, three pumps at 50% preferred. Pumps will be provided with VFD, isolation valves, strainer, check valve, flex connectors and housekeeping pad (inertia pad where required). Typical for plant, building primary or secondary chilled water pumps as applicable.
Distribution piping-Chilled and Process water	Piping will be schedule 40 black steel. Small branch lines may be copper where feasible. Where chilled water piping also serves the high rise portion of the building, the A/E team shall investigate need for 150 PSI versus 300 PSI class fittings. Dielectric unions shall be provided where dissimilar metal come in contact.
Isolation valves	Provide chilled water supply and return isolation valves at TECO entrance, bottom of each riser, each floor take-off from riser and each piece of equipment.
Air Cooled Chiller (where applicable) Water cooled chiller and cooling tower (where applicable)	A minimum of two chillers each sized for 100% capacity, three chillers at 50% preferred. All on emergency power.
Building chilled water and process water plate and frame heat exchangers (where applicable)	A minimum of two heat exchangers each sized for 100% capacity shall be provided.
Entire chilled and process water systems serving vivarium space and equipment	Completely on emergency power along with associated controls.

Table 3-8

Supply Air and Filtration

Introduction

Supply air to the vivarium and associated support areas will be of the best quality. Generally vivaria will require 100% outside air once through cooling. Support office areas where feasible shall be provided with a re-circulating type system. The 100% outside air from its introduction into the building, conditioning process, distribution and final dispersion into the various vivarium rooms, require significant consideration by the A/E consultant. The supply air introduced into the vivarium shall be taken from the outdoors at points in the building that are free from contaminants such as vehicular emissions, sewer gases, boiler gases and lab exhaust. Wind studies shall be performed through the A\E consultant prior to the design phase, to verify the selected vivarium intake area will be free of hazards when modeled for the various seasonal wind currents.

Background

As the air is drawn into the building through louvers, velocities shall remain low to eliminate any chance of wind drawn rain into the building and ultimately air handling unit pre-filters. To maintain the 24 hour/365 day a year 52-55°F supply air environmental requirements of the vivarium, each 100% outside air handling unit shall consist of an intake plenum, isolation damper (as needed), 30% prefilter, 65% prefilter, preheat coil (energy recovery if required), clean steam humidifier, cooling coil, fan section, sound attenuator (as needed), HEPA filter (located downstream of blower), discharge plenum, isolation damper and variable frequency drive. Multiple air handlers manifolded together will be provided for the vivarium air quantity requirement, including partial redundancy in order to meet environmental conditions with one fan out-of-service. The A/E consultant when designing the system shall build into the design and selection of air handling unit equipment, component failures, emergency air reduction measures and automated control sequences that maintain the environmental conditions of the animals at all times. While maintaining supply air to animal areas for environmental conditions is of most importance, the A/E consultant will also be cognizant of ultimately maintaining pressure gradients across barrier and biohazard areas. In the event pressure gradients cannot be maintained, the design and control of the supply air along with the exhaust air shall be coordinated so that all spaces at minimum remain neutral.

The supply air shall be distributed from the air handler to the vivarium spaces through galvanized ductwork designed to minimize noise transmission into the vivarium spaces during both normal operations and start-up/shut-down sequences and minimize energy losses associated with poor duct distribution or construction. Individual room supply air control shall be maintained by pressure independent terminal units outfitted with reheat coils to maintain temperature control. The terminal unit maintains a constant air quantity to the room to maintain room pressures while the reheat coil maintains space temperature. The terminal unit shall be capable of multiple control modes to accommodate positive, negative or zero air flow (as would be required by sanitization of the animal room). Terminal unit up sizing generally will minimize the noise transmission into the rooms. Although not preferred, some applications may require an additional sound attenuator for noise control. Low pressure galvanized ductwork from the terminal unit to the dispersion air device shall be selected to minimize air noise transmission into the animal room.

Dispersion of supply air into the room shall be studied by the A/E consultant to determine the most effective distribution. In the animal holding rooms, supply air distribution is of utmost importance. Generally the supply air is distributed from the center of the ceiling to maintain even flow across the room to avoid cold or drafty spots. Radial flow diffusers provide even supply air distribution in animal related rooms. Louvered face diffusers are effective in all other support spaces, but should be evaluated on an as needed basis by the A/E consultant. Radial face supply air diffusers should be provided at biological safety cabinet and fume hood locations to avoid disturbance of hood face velocity flows.

Data

Based on shared experience between user, builder, designer and maintenance provider on past projects, the following elements listed in the table below should be used in designing an MD Anderson vivarium:

Standard

Supply Air, Conditioning, Filtering and Distribution Requirements	
Item	**Direction**
Outside Air	
Air quality at intake location	Wind study
Intake louver sizing	Less than 500 FPM
Conditioning Air Handling Unit (AHU)	
Intake plenum	Size for smooth transition into filter section at low velocity.
AHU intake isolation (if needed)	Opposed blade damper
Pre filter bank 1 and 2	Bank One-Minimum 30%, Bank 2-65%
Access sections	Required between filter, coil and fan sections
Heating coil	Maintain 50 degree @ winter
Humidifier	Maintain 50% relative @ winter
Cooling coil 1 pre cool	Maximum 400 FPM
Cooling coil 2 final cool	Maximum 400 FPM @ 52-56
Supply fan	Direct drive plug type
Final filter	HEPA
Discharge plenum	Size for effective filtration and duct takeoff
Discharge isolation damper	Used for unit isolation and shutdown
Variable frequency drive	Control system static pressure
Distribution Ductwork	
Supply low/medium pressure duct	Galvanized (externally insulated)
Duct sizing for low/medium pressure duct	Size duct to minimize air noise, avoid pressure losses.
Duct construction for low and medium pressure duct	Use round duct where possible or reinforce to avoid duct flexing during system shutdown/startup or variable airflow
Animal holding, animal suite corridors, procedure, necropsy, surgery, cagewash and lab - pressure independent terminal unit device for each room	Tracking supply valve with reheat to include 4 preset control modes capable of positive or negative control while maintaining room offsets. Also provide with 100% shutoff control and constant volume in animal areas. Fail position shall be last position (except biohazard areas required to close supply 100%). Valves similar to Phoenix type system.
Storage, support areas, support area corridors and office area - pressure independent terminal unit/s for each room. Multiple offices or rooms with similar requirements can be served from one terminal unit (not to exceed 4 offices).	Variable air volume supply air valve with reheat. Similar to Titus industries units. Internal insulation shall be lined.
Room Distribution Device	
Animal, procedure and lab hood room air device	Flush face radial air distribution design.
All support areas	Flush louvered or perforated face diffusers.

Table 3-9

Ventilation and Air Change Rates

Introduction

According to the Guide for the Care and Use of Laboratory Animals (National Research Council, 1996), the guideline of 10 to 15 fresh-air changes per hour has been used for vivarium room envelopes for many years and is considered an acceptable general standard. The purposes of ventilation which manifests itself in the form of room air change rates are to:

1. Supply adequate oxygen.

2. Remove thermal loads caused by animal respiration, lights, equipment and personnel.

3. Dilute gaseous and particulate contaminates and control odors.

4. Adjust the moisture content of room air.

5. Create static-pressure differentials between adjoining spaces.

Background

Even though calculations can be used to determine minimal ventilation needed to prevent heat buildup, other factors such as odor control, allergen control, particle generation and control of metabolically generated gases might necessitate ventilation beyond the calculated minimum for heat load. In addition, the method of animal cage ventilation, the operational use of a fume hood or a BSC during procedures involving animal cage cleaning and animal examinations should also be considered. In general, the recirculation of air in a vivarium is prohibited. Typical animal holding and procedure rooms from BSRB vivarium were modeled and used for the basis of ACR calculations. The assumptions and results of these calculations are provided in the Appendix. The calculations indicate that the small animal holding room's heat load required an ACR of approximately six air changes per hour while the larger, more equipment driven procedure room required approximately 10 air changes per hour. These ACR calculations only account for heat load and do not address the other factors such as odor control, etc.

Vivarium spaces must be protected against contamination from outside sources. High-efficiency particulate air (HEPA) filters are recommended for air supplied to animal-holding, procedural and surgical facilities. Also, consideration should be given to the regulation of air-pressure differentials in surgical, procedural, housing and service areas. For example, areas for quarantine, housing and use of animals exposed to hazardous materials should be kept under negative pressure; whereas areas for surgery, for clean equipment storage and for housing of pathogen-free animals should be kept under positive pressure with clean air. The HVAC system must be adaptable so that pressure relationships can be modified as required over the life of the facility.

Data

A study was done by Facilities Management and DVMS departments seeking a consensus of opinion regarding minimally acceptable air change rates from reputable and well-known owner / operators of facilities housing animals used in research. Based on information gathered and reviewed by members of the

ARSAC Design Standards Subcommittee, the following table of air change rates is presented as representing the consensus of opinion found. The rates given, therefore, comprise the minimum acceptable building air change rate settings for the various small animal rodent vivarium areas.

Standard

Acceptable Minimum Air Changes Per Hour (ACH) By Room Type	
Animal Housing (100% ventilated cage racks)	10
Animal Housing (any number of static cage racks)	15
Procedure Rooms	10
Dirty side Cage Wash	30 occupied / 15 unoccupied
Autoclaves	30 occupied / 15 unoccupied
Clean side Cage Wash	14 occupied/7 unoccupied
Sterile	20 occupied/10 unoccupied
Support (clinic, cryogenics, irradiator, x-ray, etc.)	10
Necropsy	15

Table 3-10

Exhaust and Filtration

Introduction

Exhaust air from the vivarium and associated support areas shall exit the building at or near the highest part of the building and away from any fresh air intakes. The exhaust fan locations should be evaluated by the A/E team to minimize noise and odor levels at the street level. Wind studies will be performed by the A/E consultant prior to the design phase. Generally, separate biohazard/radioisotope exhaust and general exhaust systems suffice; however in larger vivaria the systems should be divided into cage wash, biohazard, radioisotope (RI) and general exhaust systems to minimize duct riser sizes up through multi-story buildings.

Background

The vivarium exhaust systems serve multiple space types. Generally, toilet, janitor closet, animal holding, animal holding corridor, procedure room, cage wash, sterilization, storage, bedding storage and lab exhaust is considered general exhaust. B1 biological safety cabinet and chemical fume hood exhaust shall also be included in the general exhaust system. B2 biological safety cabinet and radioisotope hood exhaust shall be routed to the combined biohazard/radioisotope exhaust fan system. In some cases, the biohazard and radioisotope exhaust have a separate exhaust fan system as well as separate filtration requirements. The animal biohazard general exhaust system shall support all biohazard animal holding rooms, quarantine and necropsy. If there are research-specific exhaust filtration requirements, they should be established early in the programming phase.

All fan systems shall operate 24 hours and 365 days a year. Each fan system shall include an intake plenum, sound attenuator (as needed), fan, individual exhaust fan isolation, bypass damper and discharge at least 15 feet above the roof. Exhaust discharge velocity shall not be less than 3000 feet per minute (FPM) with 3500 FPM preferred. Multiple fans grouped/manifolded together shall make up the exhaust requirement for each fan system. The A/E consultant when designing the system shall build into the design and selection of the fans, component failures, emergency air reduction measures and automated control sequences that maintain the environmental conditions of the animals at all times. Ultimately, the A/E will be cognizant of maintaining pressure gradients across barrier and biohazard areas. In the event pressure gradients cannot be maintained, the control of the exhaust along with the supply air shall be coordinated so that all spaces at minimum remain neutral.

The exhaust air ducts from the vivarium spaces to the exhaust fans shall be designed to minimize noise transmission and energy losses associated with poor duct distribution or construction. Individual room exhaust air control shall be maintained by pressure independent terminal units. The terminal unit maintains a constant air flow and tracks the supply air terminal unit to maintain the vivarium spaces positive or negative as required by the program. The terminal unit shall be capable of multiple air quantity control modes to accommodate positive, negative or zero air flow (as would be required for sanitation of the animal room). Terminal unit up sizing generally will minimize the noise transmission into the rooms. Although not preferred, some applications may require an additional sound attenuator at the terminal unit. Low pressure galvanized ductwork from the room exhaust device to the terminal unit will be sized to minimize air noise transmission into the animal room.

The exhaust air devices in animal holding rooms shall consist of a series of thimbles and exhaust grilles. The thimbles penetrate through the ceiling to receive the exhaust duct from the ventilator racks but can also be used as general exhaust directly from the animal room when static cage racks are used. Generally, up to two racks can be accommodated by one thimble. In rooms with library style racks, an exhaust stack maybe used on a blower directing the rack exhaust to a trough exhaust system. An additional general exhaust grille shall exhaust the additional air required by the room air change rate requirement. In the animal rooms, the thimbles and general exhaust grille are located in the ceiling and served by one terminal unit. In procedure rooms, generally one thimble is provided to receive a ventilator rack and shall be provided with a dedicated terminal unit. All other exhaust air devices shall be standard perforated face or louver type grille.

Standard

Exhaust Air, Filtering and Distribution Requirements	
Item	**Direction**
Exhaust Air Dispersion	
Exhaust Air dispersion location	Highest roof level. Provide wind study.
Minimum dispersion velocity. FPM (feet per minute)	Minimum 3000 FPM, 3500 FPM preferred minimum.
Minimum exhaust discharge height above roof.	15 feet-0 inches
Typical Exhaust Fan System	
Exhaust fan discharge	Provide high velocity nozzle.
Exhaust fan discharge sound attenuator if required	Confirm requirement with sound consultant.
Fan isolation	Provide individual automatic fan isolation with stainless steel or aluminum damper construction.

Exhaust Air, Filtering and Distribution Requirements	
Item	**Direction**
Fan motor	Direct drive with vibration cutout switch.
Fan system type	High plume and high velocity laboratory exhaust systems as manufactured by Strobic Tri-stack or Greenheck Vector
Number of fans in fan set.	Two, three, four or six fan sets. Each fan set will require one backup fan.
Fan intake plenum (double wall with stainless steel internal liner).	Double wall plenum sized to accommodate all exhaust fans.
Plenum intake velocity range	Between 900 – 1200 FPM.
Bypass damper.	Minimum of two per system.
Biohazard and Radioisotope Filtration	Depends on agents used. Contact EH&S for exact filtration requirement
Filter inlet and outlet isolation	Bubble tight damper.
Filter Caisson construction	304 stainless steel
Filter Caisson	Provide one redundant unit for each filter set required.
Prefilter efficiency (bag in/bag out)	30% pleat
Final filter	99.97 % HEPA
Prefilter/final filter maximum velocity	250 FPM.
Charcoal filter media	Coconut shell carbon in stainless steel trays.
Charcoal filter residence time	No less than .25 seconds. Size caisson accordingly.
Distribution Ductwork	
Duct sizing for low/medium pressure duct.	Size duct to minimize air noise, avoid pressure losses.
Duct construction for low/medium pressure duct.	Use galvanized round duct where possible or reinforce to avoid duct flexing during system shutdown, startup or variable airflow
Animal holding, animal suite corridors, procedure, necropsy, surgery, cage wash and lab – pressure independent terminal unit device for each room.	Tracking exhaust valve to include four preset air quantities capable of positive or negative control while maintaining room offsets. Also provide with 100% shutoff control and constant volume in animal areas. Fail position shall be last position. Valves shall be similar to Phoenix type system.
Storage, support areas, support area corridors and office area – pressure independent terminal unit device for each room.	Variable air volume exhaust terminals shall be equal to Titus Industries. Match supply air room grouping.
Biohazard B2 cabinets and radioisotope hood ductwork	Welded 304 stainless steel from BSC/hood to exhaust fan plenum.
Room Exhaust Device	
Ventilated cage rack exhaust for procedure rooms and animal holding rooms	Provide one 6” drop to receive thimble for every two racks. Single racks will also require one 6” drop for thimble.

Exhaust Air, Filtering and Distribution Requirements	
Item	**Direction**
Animal holding and procedure rooms	Painted stainless steel perforated face or louvered grille.
All support areas	Painted steel perforated face

Table 3-11

Control Systems

Introduction

The building mechanical systems include some of the largest and the majority of the equipment serving a vivarium. The HVAC represents the majority of the mechanical equipment. The HVAC system continuously maintains air flow, air cleanliness, temperature, humidity, odor transmission and containment. It is for this reason that the HVAC control system is tasked with monitoring the plumbing and electrical systems, monitoring user critical equipment and controlling and monitoring the HVAC systems. Through the individual system sensors and controllers, the BAS must automatically react to continuous temperature changes and sudden system failures to maintain the required vivarium and vivarium support space environmental conditions. Fire protection, elevators, communication systems and security system are not controlled or monitored by the BAS, although the fire protection system does provide control interface to some HVAC systems to shutdown or energize in case of fire or smoke.

Background

Most MD Anderson buildings are controlled and monitored through the existing Siemens Apogee building automation system. The building automation system in new buildings shall accommodate the existing system infrastructure and accomplish building control and monitoring functions through direct digital control (DDC), regardless of vendor. The system architecture includes the master building controllers (MBC) provided to interface and monitor modular equipment controllers and application specific controllers. Modular equipment controllers (MEC) will provide control and monitoring of systems through system devices, as well as specific points such as critical alarms. Application specific controllers (ASC) provided for control and monitoring of packaged equipment, typically not Siemens, are monitored by the MBC. Communication between controllers will occur through Ethernet communication protocol. The building shall be monitored and controlled locally at the building operator work station or other approved EH&S work stations and monitored remotely at EH&S Monitoring Services. All AC power to the BAS controllers will be on emergency power. The need for uninterrupted power systems (UPS) for the various controllers will be evaluated by the A/E, conformant to the requirements of the various spaces. Typically the controller and the system equipment should be on the same power source, however if this is not possible, the equipment sequences will be designed to incorporate loss of power, power transfer, equipment failure and initiation of redundant equipment scenarios. Maintaining pressure relationships during power failures is one of the main considerations.

The BAS system, including all component devices and controllers will maintain memory during power losses, restart quickly after power failure, have high speed communication, be capable of supporting good laboratory practices (GLP) quality verification, include accurate graphic representation of the various systems and allow for system trending. The BAS components will be of the latest manufacturer generation at the time of submittal, but will be of tested and proven design and reliability. The BAS will exchange information with other specialized control systems such as the Edstrom Watchdog system, which controls and monitors animal room lighting and watering and receives temperature and humidity conditions from the Siemens system. The Phoenix air tracking system will also be interfaced with the Siemens BAS to send temperature, airflow and alarm conditions for each zone.

Data

The following elements listed below should be used in designing an MD Anderson vivarium based on shared experience between user, builder, designer and maintenance provider on past projects, according to Table 3-12.

Standard

General Control System Highlights	
Item	**Direction**
Building Automation System	Siemens Apogee unless otherwise directed by the Project Management Team, in consultation with DVMS and REF.
Typical animal holding room controller	One stand alone controller per room (1 additional misc. space can be included on controller)
Typical animal holding room alarms	Low/high temperature, low/high room pressure differential, air valve out of range.
Typical user critical equipment alarm to monitoring services.	Environmental rooms, incubators, freezers, LN2 freezers, etc.
Typical equipment alarmed locally at building operator console.	B1 and B2 biological safety cabinets and fume hoods.
Typical systems using application specific controllers, although Siemens controlled system equipment is preferred.	Control air, vacuum, RO, water softener, domestic water pumps, clean steam generators, steam boilers, etc.
Application Specific Controllers provided by packaged equipment	Provide dry set of contacts for connection to BAS to pick up general alarm, plus allow for pick up of individual sensing devices at controller.
Control valve and damper actuators	All electric

Table 3-12

Animal Drinking Water

Introduction

A normal rodent drinks approximately 0.1 ml of water per gram of body weight daily. In older caging systems, water is provided via glass or plastic water bottles that fit on the wire bar lid of the cage. A standard mouse drinking water bottle contains 250 ml and rat bottles 500 ml. Water bottles must be changed at least as often as the cage, if not more often depending on the size and condition of the animal. Water bottles must also be changed at least weekly to prevent the formation of bio-film. An automated drinking water system allows for a constant supply of fresh drinking water without the need for water bottles. Care should be taken in the design to avoid malfunctions which lead to flooded cages and, conversely, obstruction of water flow.

Background

The National Research Council (NRC) Guide indicates animals should have access to potable, uncontaminated drinking water. Also, water quality and the definition of potable water can vary with locality. Periodic monitoring for pH, hardness and microbial or chemical contamination may be necessary to insure water quality is acceptable. Water can be purified and/or treated to minimize or eliminate contamination when protocols require highly purified water. The selection of water treatments should be carefully considered because many forms of water treatment have the potential to cause physiologic alterations or effects on experimental results.

In most MD Anderson applications, the domestic/potable water quality will require both water softening to reduce mineral hardness and then further water purification, usually by reverse osmosis (RO) to provide water of the required level of purity for laboratory research and animal drinking water use.

Special attention should also be placed upon the high purity water distribution system piping connections and integrity. At the BSRB, MD Anderson has experienced continued leaking joints in the polypropylene RO water piping system since the building construction was completed. Many joints and connections are no longer accessible causing significant building damage when joints and connections fail and begin to leak. The failures at that project have been attributed to difficult-to-use electrical joint fusing machines and operator errors during initial installation.

Standard

Drinking water is distributed to animal cages via a stainless steel distribution system composed of two separate pipes: one for delivery of fresh drinking water and one for disposal of flush waste water. Clean drinking water from the source point is delivered to the pressure reducing station (PRS) via appropriate piping material. From the PRS, all distribution piping is stainless steel to the cage rack connection points and waste flush termination. At each cage rack position, there is a recoil hose from the delivery pipe to the cage rack inlet on the rack manifold. From the terminal end of the rack, a recoil hose connects to the flush piping which discharges into a sink or floor drain (waste flush water is discarded, never re-circulated). The animal drinking water system should be computer controlled to allow for user-defined flush schedules. The system must generate alarms for abnormal conditions, such as prolonged flow, flush failure, pressure problems, etc., with user-defined alarm and notification parameters and schedules. Notification methods include phone call, email, paging, and critical alarming to the BAS.

See Appendix for the following detailed sections on the Animal Drinking Water System:

1. Stainless Steel Room Distribution System.

2. Pressure Reducing Station.

3. Reverse Osmosis System.

4. Recoil Hose Flush Station.

5. Chlorine Injection Station.

6. Rack Manifold Flush Station.

Bedding Delivery and Removal

Introduction

The rodent colony uses bedding at a rate of approximately 8-10 ounces of clean bedding per processed cage each day. Soiled bedding is generally at least 1.25 times heavier than clean bedding. For example, the current (as of 3/21/07) census of 15,000 cages has a daily cage change rate of 3,000 cages. At this rate, 1,500-1,875 pounds of clean bedding and approximately 1,875-2300 pounds of soiled bedding are processed each normal work day. As the colony grows, the washroom must become more efficient in terms of staff time. The vacuum bedding system allows for maximum efficiency on both the clean bedding delivery side and the soiled bedding removal side.

Background

Bedding was received as pallets of 50, 40 pound bags before the advent of automated bedding delivery and removal systems. Clean bedding delivery was accomplished by manually dumping each bag into the bedding dispenser, which could average as much as 5 minutes per bag., The hopper only holds approximately two to three bags' worth of bedding, so manual filling was required quite often. Given the amount of bedding used each day, this task could require up to 0.5 FTE each day. The automated system uses ½ ton bulk bags, out of which the bedding is vacuumed via a wand into the storage silos and requires approximately 10-15 minutes per bulk bag. At a rate of two bulk bags (the equivalent of 50, 40 pound bags), this requires less than 0.1 FTE per day. As the bedding dispenser requires clean bedding, the system conveys the clean bedding directly from the storage silo to the dispenser.

On the soiled side, cage waste was previously dumped into a rolling dumpster that could only be filled to ¾ full so that the compactor cart lifter could handle it. The dumpster then had to be rolled up to the institutional waste compactor which could take as much as 30 minutes per trip. Given the amount of cage waste generated each day, at least 4 trips to the dumpster had to be made, requiring up to 0.5 FTE each day. The automated system uses a dump station, into which the bedding waste is dumped. The waste is conveyed from the dump station directly to a dedicated waste container, thus requiring 0 FTE.

Standard

Clean Bedding Delivery Requirements	
Item	**Direction**
Filling	Both wand for bulk bags (or a dump station provided we have adequate ceiling clearance) and dump station for bags must be provided. The control panel should be located so that it is conveniently reached by either filling area.
Storage and delivery	All components should be 304 stainless steel. Filling funnel should have a drain trap to facilitate rinsing.
Storage silo	Provide storage for 2.0 to 3.5 cubic yards of bedding material. Silo should have alarming capabilities for high and low bedding levels. Silo interface with delivery piping must be optimized to prevent eddying or dead space. Bulk bags suspended over a dump station can be used in lieu of silos but system must accommodate at least two suspended bags at one time.
Bedding dispenser interface	The bedding dispensers' storage hoppers must have level sensors to indicate a full/not full bedding level and automatically replenish the bedding volume. A control panel for the clean bedding delivery system should be located near the bedding dispenser storage hopper.
Delivery piping	Readily accessible clean outs must be provided at reasonable intervals to facilitate cleaning and servicing. Piping must be routed with minimal bends and turns.
Soiled Bedding Collection Requirements	
Collection and delivery piping	Must be constructed of 304 stainless steel. Readily accessible clean outs must be provided at reasonable intervals to facilitate cleaning and servicing. Piping must be routed with minimal bends and turns.
Waste Collection Funnel	The waste collection funnel should have a drain trap to facilitate rinsing. It should be positioned at the load end of the washer in the most ergonomically feasible location.
Controls	The waste collection control panel should be located near the waste collection funnel.

Table 3-13

Soiled Bedding Collection Requirements	
Item	**Direction**
Collection and delivery piping	Must be constructed of 304 stainless steel. Readily accessible clean outs must be provided at reasonable intervals to facilitate cleaning and servicing. Piping must be routed with minimal bends and turns.
Waste Collection Funnel	The waste collection funnel should have a drain trap to facilitate rinsing. It should be positioned at the load end of the washer in the most ergonomically feasible location.
Controls	The waste collection control panel should be located near the waste collection funnel.

Table 3-14

Cage Wash and Sterilization

Introduction

Cage washing and sanitation is the backbone of the animal care program. Proper sanitization and sterilization is of paramount importance in maintaining colony health, well being, personnel health and safety.

Background

Washing times and conditions should be sufficient to kill vegetative forms of common bacteria and other organisms that are presumed to be controllable by the sanitation program. When hot water is used alone, it is the combined effect of the temperature and the length of time that a given temperature (cumulative heat factor) is applied to the surface of the item that disinfects. Effective disinfection can be achieved with wash and rinse water at 143-1800°F or more. The traditional 82.20°C (1800°F) temperature requirement for rinse water refers to the water in the tank or in the sprayer manifold.

Conventional methods of cleaning and disinfection are adequate for most animal-care equipment. However, if pathogenic microorganisms are present or if animals with highly defined microbiologic flora or compromised immune systems are maintained, it might be necessary to sterilize caging and associated equipment after cleaning and disinfection. Sterilizers should be regularly calibrated and monitored to ensure their safety and effectiveness. Hazardous waste must be rendered safe by sterilization, containment, or other appropriate means before being removed from the facility (US EPA 1986).

Standard

Cage Rack Type Washer Requirements	
Item	**Direction**
Seven phase	Pre-wash, wash, 2nd wash (alkaline or acid), soak, first rinse, second rinse, final rinse, exhaust/dry

Cage Rack Type Washer Requirements	
Item	**Direction**
Temperature guarantee	180°F guarantee on wash and rinse phases, with visual and audible alarming
Chamber construction	All stainless steel
Chamber Size	Chamber: 46" wide x 87" long x 87" high
Pit Size	Minimum 86" wide x 101" long x 6" deep, nominal, to be coordinated with equipment. Washer chamber to align with finished floor. Drain location coordinated with equipment.
Microprocessor Control	Controls to be programmable by end user and password protected.

Table 3-15

Tunnel Type Washer Requirements	
Item	**Direction**
Five phases / Sections	Pre-wash, wash, re-circulated rinse, final rinse, dryer
Temperature guarantee	180°F guarantee on wash and rinse phases, with visual and audible alarming
Chamber construction	All stainless steel
Conveyor	36 inch wide stainless steel roller-type, gravity-type with corrosion free bearings and shafts. Belt speed to be adjustable from 2-10 feet per minute. Photo-electric eye at discharge end to automatically stop belt when an item reaches the end, with a visual and audible alarm for a stopped condition. Capable of conveying all rodent caging components without modification, other than racks, from the load end all the way to the end of the conveyor on the upload end.
Dryer	99% plastic cage drying
Microprocessor Control	Controls to be programmable by end user and password protected.

Table 3-16

Sterilization Requirements	
Item	**Direction**
Cycles	Allow for general purpose steam sterilization of unwrapped equipment, wrapped instruments and utensils, and liquids in vented or unsealed containers at temperatures ranging from 105-135°C (220°F - 275°F).
Temperature uniformity	

Sterilization Requirements	
Item	**Direction**
	Within chamber, +/- 18°C during cycles.
Vacuum Pump Materials	
	Vacuum pump impeller and pump housing will be made of stainless steel materials able to withstand clean steam conditions.
Microprocessor controls	Control all system functions, monitor system operations, visually and audibly alert operator of cycle malfunctions and on command visually indicate chamber temperature and pressure. Control system to be compatible with PC/DOS support software.
Non-operating end controls	Consists of only door operations, chamber pressure gauge, emergency stop, and displaying process conditions. Mount in the fascia on the unload side of the sterilizers opposite the door.

Table 3-17

Monitoring Instrumentation

Introduction

Fluctuations in environmental conditions can compromise animal health and well-being. Design standards exist that define the acceptable ranges for these conditions, but there must be a way of ensuring that conditions remain inside the acceptable range for the following parameters:

1. Temperature.

2. Humidity.

3. Differential pressure.

4. Actual supply and exhaust air flow rates.

5. Air change rate (air changes per hour).

Background

Regular monitoring of the HVAC system is important and is best done at the individual-room level. All monitoring devices must communicate with an electronic system that records measurements at regular intervals. A separate, independent Vivarium Management System (VMS) capable of monitoring temperature and relative humidity is preferred in order to provide confirmation of room environmental conditions. The system should allow for easy manipulation of point logging intervals, alarm parameters, alarm notification structure, and other critical elements. The VMS provides the animal facility management staff instant access to critical environmental information as well as reports designed to meet regulatory requirements. An open protocol will allow for information to be shared across platforms (i.e., BAS and VMS so that BAS information (air flow, differential pressure, etc.) can be incorporated into VMS reporting.

Standard

Parameter	Monitoring Device Requirements
Temperature & Relative Humidity	1. Monitor devices located within the room, not the ductwork 2. Stainless steel, watertight housing enclosure 3. Guard to protect sensor probes 4. NIST traceable sensors 5. Temp sensor: 100 OHM platinum thin-film RTD 6. Humidity sensor: interchangeable capacitive element with filter 7. Calibrated accuracy to within +/- 1°F & +/- 5%RH 8. Temperature range 0-120°F (-18 – 49°C) 9. Humidity Range 20-85%RH
Differential Pressure	*4-20 MA Current Loop* 1. Pressure range: 0.0 to +/-0.1, 0.0 +/-0.25 inches of water column bi-directional 2. Accuracy +/-3% full scale 3. 4-20 MA linear output
Air flow	*Duct mounted sensor* 1. Size to provide a single monitoring point near the center of the duct cross sectional area 2. Mounting hardware: stainless steel 3. Sensor: PVC plastic 4. Air tight installation 5. Transducer 6. 4-20 MA Current Loop 7. Calibration accuracy CFM +/-10% 8. Pressure range 0--.1, 0-.025, and 0-0.5 inches of water column unidirectional set to 65% scale at design of air supply flow 9. 4-20 MA current loop to panel analog input 10. Connection to sensor with flexible PVC twin tubing; barbed connections

Table 3-18

Sequence of Operations

Introduction and Background

The interaction of the operation of the vivarium mechanical and electrical equipment is monitored and controlled by the BAS. How the BAS controls the equipment is defined in instructions and contingency plans defined in the pre-established building controls program. The control functions are defined by way of system logic diagrams that are based upon the A/E team's expected sequence of operations for various facility operational conditions.

The vivarium design team must specify the logic of equipment sequence of operations. In many cases, the sequence of operation is specified only in general, and often ambiguous, terms with much of the sequence left to the Contractor's controls programmer. The controls programmer should not be put in the position of having to complete the design sequence which often results in sequences which are not optimal or desired for the project. Therefore, logic diagrams must be included in design documents provided by the design team and approved by the owner. To assist the design team with this, MD Anderson provides design guideline and master specification documents that help define functional intent of the system operation.

Data

The design team must consider the following range of facility operational conditions in developing the sequence of operations logic:

1. Normal operations (start/stop permissives and interlocks).

2. Loss of normal power (re-start on emergency power) and return to normal power.

3. System safety interlocks.

4. Equipment and component failure modes.

5. N-1 operational contingencies (redundancy with single failure).

6. N-2 failure curtailment strategies (system unable to operate at full load).

7. Critical alarms.

8. Maintenance of room pressure relationships during upset conditions.

Standard

In all cases, the vivarium design team is responsible for identifying and documenting the sequence of operation for the facility early in the project's design life. This design information must be prepared with input from MD Anderson and must be reviewed and agreed upon prior to the preparation of construction documents by the design team.

Sequence of Operations	
Identify Possible Failure Modes	Design Team
Identify Expected Levels of Redundancy	Design Team and MD Anderson
Preparation of Logic Diagrams	Design Team Using MD Anderson Standards
Prepare Detailed Sequence of Operations	Design Team
Review and Accept Sequence of Operations	MD Anderson as owner and end user

Table 3-19

Waste Disposal

Introduction

Types of waste generated within the animal facility include conventional, biological, and hazardous. Waste should be collected in leak-proof containers with tight fitting lids and disposable liners. Adequate staging and storage space must be provided within the facility footprint to accommodate the accumulation of waste during the normal work day. Storage of collected waste in corridors is not desirable. Storage rooms should be free of feral and/or loose rodents, insects, and other vermin. Care must be taken during design to ensure that adequate waste stream management space is included.

Background

Non-hazardous, conventional waste can be disposed of as regular institutional waste and taken to an approved landfill by the institution's waste collection contractor. Biological waste must be rendered safe by sterilization, containment, or other appropriate means before being removed from the facility (US EPA 1986). Infectious waste, including animal carcasses, is placed in an acceptable biohazard bag inside a biohazard box, which is collected by a licensed contractor and removed to an incineration facility. Radioactive waste must be collected, contained appropriately, and stored in a dedicated room for the duration of the radioactive decay period as appropriate for the radioisotopes involved.

Standard

Waste Disposal Requirements	
Item	**Direction**
Conventional	Landfill by approved institutional contractor
Biological	Rendered safe by sterilization and contained before removal
Infectious	Bagged and boxed before incineration by outside contractor
Radioactive	Contained and stored in separate room during applicable decay period prior to disposal by qualified contractor

Table 3-20

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3.2 Mechanical Systems: Redundancy Requirements

General Information

Introduction

Research animals cannot easily be relocated for a myriad of reasons including, but not limited to, colony size, health status, cage type, and time constraints. Thus, animal housing facilities must remain operational at all times, i.e., normal environmental conditions that pose no health hazard to the animals. Redundant mechanical and electrical systems must be provided to ensure uninterrupted service for the following areas:

1. Environmental control – temperature, relative humidity.

2. Differential pressure (room to suite, suite to corridor, etc.).

3. Animal housing sanitization equipment (cage washers).

4. Equipment decontamination and sterilization equipment (autoclaves).

Background

Mechanical systems that serve animal housing and use areas must be able to maintain required conditions during both planned and unplanned outages. For example, an air handing unit may be equipped with three fans each able to provide 50% of the CFM capacity. If one fan is down for any reason, the other two fans are able to provide 100% of the required CFM. The institution recognizes, however, that this is just one method in which to accomplish the goal of redundancy.

According to the National Research Council Guide, when a partial HVAC system failure occurs, systems should be designed to supply facility needs at a reduced level. It is essential that life-threatening heat accumulation or loss be prevented during mechanical failure. Acceptable reduced levels for areas requiring uninterrupted service are defined in each specific Design Standard (e.g., ventilation rates, environmental conditions, bio-containment, etc.).

American Society for Heating, Refrigeration, Air Conditioning Engineers (ASHRAE) states that animal room conditions must be constantly maintained. This may require year round availability of refrigeration and, in some case, dual/standby chillers and emergency electrical power for motors and control instrumentation.

The National Institute of Health outlines in its Vivarium Design Policy and Guidelines – without exceptions - HVAC systems must be reliable, redundant, and operate without interruption. Since most animal studies are of long duration, they must be performed under consistent conditions in order to achieve repeatable results. Thus, the failure of the HVAC system is unacceptable. Therefore, the HVAC system must be designed to provide backup in the event of component failure. Central HVAC systems thus should be provided with multiple chillers, pumps, cooling towers, etc. to improve reliability.

Standard

Standards for redundancy will depend on the building project requirements. The A/E consultant is expected to provide the most cost effective method for providing uninterrupted service based on the specific project.

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ARSAC Design Standards for Small Animals (Rodents) Vivarium

Electrical Systems

General criteria and system descriptions

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4.0 Electrical Systems

Design Criteria

Introduction

The electrical system in an animal research facility will be designed to safely provide adequate, reliable and cost-effective power. In such facilities, the electrical system is as critical as the mechanical and plumbing systems. Redundancy is of primary concern in the system. Electrical systems must accommodate a large, redundant mechanical system with its air handlers, associated pumps and fans for supply and exhaust systems and a system to provide appropriate lighting under normal and emergency operating situations.

Background

Because of the inability of the vivarium operator to easily relocate the animal occupants of the facility for any reason, the electrical system must have the ability to provide power on an uninterrupted basis to the building systems serving animal housing areas. Other rooms, because of the nature of hazardous materials present, also have extremely stringent ventilation and room pressure offset requirements that must be maintained at all times. Life safety and research integrity preservation issues must be considered in the facility design philosophy.

Data

Some of the systems that must remain functional in both normal and abnormal conditions are:

1. Air supply.
2. Air exhaust.
3. Animal room lighting.
4. Animal feeding and watering system.
5. Data gathering and building control system.
6. Environmental rooms.
7. Security system.
8. Cage washing and sanitizing equipment (at reduced capacity).
9. Ventilated animal cages and cage systems.
10. CCTV cameras and equipment.

In facilities containing animal operating rooms, applicable regulations covering hospitals may be used as a guideline for those rooms. These would include but not necessarily be limited to special grounding systems, isolation/voltage regulation-type transformers, surgical or high-intensity overhead lighting, and local operating room type distribution grounding panels.

Standard

Electrical System Design Criteria	
Code Compliant	National Electric Code (latest edition)
Normal Power	Separate, redundant feeders from the local power distribution company with automatic switch over capability
Emergency Power	All animal life support backed up by emergency generator sized for N+1 capacity
Loading	All emergency equipment to be prioritized for re-start on emergency power

Table 4-1

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4.1 Electrical Systems: System Descriptions

Normal Power Service and Distribution

Introduction

Laboratory animals must be housed in comfortable, clean, temperature- and humidity–controlled rooms. A laboratory animal facility must facilitate research by minimizing undesirable experimental variables while providing for the physiological, social and behavioral requirements of the animals. The challenging task requires a reliable normal power distribution system to support the other building systems. Electrical redundancy is of primary focus. Electrical systems in animal research facilities should be designed to provide adequate, reliable, and cost-effective power. Electrical systems must accommodate a large, redundant mechanical system, including air conditioning equipment, segregated redundant exhaust systems, appropriate lighting system as well as life safety systems under both normal and emergency operating situations.

Background

In MD Anderson vivarium facilities, the primary source of normal electrical power is obtained from public utility. While some of the MD Anderson vivarium facilities are fed by 4160 volts utility source, others at remote locations are fed by 480 volts

The A/E will evaluate the degree of reliability required for a given project. Design issues such as separately routed primary feeders, transformer placement, and switch gear location all bear on the reliability issue.

Unless otherwise approved by the owner, the A/E will include all costs associated with the establishment of electrical service in the bid documents as the Contractor's responsibility.

Standard

1. The primary power distribution system will comply with the standards as follows:

- Primary power for the facility will be obtained from a local public utility usually at 4.16 kV.
- The primary system will be dual fed, double ended. Two of these circuits will be routed to the new utility vault on the site. 34.5 kV to 4.16 kV transformers will be installed in the vault in the building or outdoor pad mounted on-site per utility company requirement to provide power at service voltage.
- The dual utility feeders will be independently fed from two separate utility substations to preserve electrical reliability. Each of the utility feeder shall be sized to serve the entire facility should the other feeder fails.
- Primary 4.16 kV switch gear will consist of medium voltage vacuum circuit breakers. The circuit breakers will be draw-out mounted type capable of being withdrawn on rails for inspection and maintenance. The breakers will be electrically operated.
- Primary power will be distributed to secondary unit substations by means of dedicated feeders.
- The primary switch gear shall provide automatic transfer of all loads to one utility feeder circuit in the

event one of the two feeders fails.
- The switch gear will be provided with ground fault protection. The switch gear main over current protection device shall be coordinated with the utility over current devices.

2. The secondary power distribution system will comply with the standards as follows:

- Utilization voltage of 480/277 volts, three-phase level will be obtained from 4.16 kV to 480/277 volts step-down transformers. These transformers will be arranged in a double-ended arrangement with a normally open bus tie breakers between the secondary switch gears. Transient voltage surge suppression shall be provided at the main switch gears.
- 480-volt, three-phase power will be distributed to motor control centers (MCC's) to serve concentrated motor loads. These MCC's will contain combination disconnect starter units, 120-volt control transformers, control devices on front cover, and push-to-test pilot lights.
- 480/277 volt, three-phase power shall be distributed to proper distribution panels to serve 277-volt lighting panels and step-down transformers to obtain 208/120 volts.
- 208/120 volts shall be distributed from branch circuit panel boards to serve receptacles and equipment. Panel boards will be sized to include extra 25 percent capacity and spaces as a projection of future additional loads. Transient voltage surge suppression shall be installed in each branch circuit panel board where required. Additional TVSS shall be installed for some building control panels (e.g., Apogee panel) at the power input point of use.
- All equipment and control unit associated to it shall be fed from the same electrical riser. The origin of power source for the control panels will be clearly indicated on drawing.
- The double-ended substation arrangement provides electrical service over two primary feeders through two transformers. Each transformer is connected through a secondary main breaker to a distribution section, which provides radial feeds to the total substation load.
- The bus tie breaker provides for connecting the two secondary distribution sections together. Normally, this tie breaker is open and the system operates as two parallel systems independent of each other beyond the power supply points. The tie breaker will be interlocked with the secondary main breakers to prevent paralleling of the transformers per utility company requirements.
- If a primary feeder or transformer fault occurs half of the substation load is dropped. Service can be restored by opening the main breaker of the affected switchboard and closing the tie breaker.
- Secondary circuit breakers will be mounted on a rail allowing draw-out of each unit for testing and maintenance. Interlocking will be provided to prevent closing of the circuit breaker when in the test position. Circuit breakers shall be provided with microprocessor trip devices with fully adjustable characteristics necessary to protect and coordinate the system.

Emergency Power Systems and Distribution

Introduction

Conditions in animal rooms must be a maintained constant. This may require year-round availability of refrigeration and, in some cases, dual/standby chillers and emergency power for motors and control instrumentation. It is essential that emergency equipment that is supported by emergency power be available to maintain environmental temperatures, particularly in rooms housing small laboratory animals. In an animal facility, the electrical system is very critical in supporting the core research activities under consistent conditions in order to achieve repeatable results.

Background

In MD Anderson vivarium facilities, the emergency electrical power is obtained from locally installed diesel engine generator(s) at 4160 volts or 480 volts.

The A/E will evaluate generator supply voltage that is suitable for equipment being supported. The A/E will also analyze the cost associated with emergency generator(s) at different voltages, whether at 4160 volts vs. 480 volts.

Design issues, such as avoiding possibilities of re-entraining exhaust into the building (or an adjacent building's) ventilation system and unpleasant diesel exhaust odors in the building, will be taken into consideration.

Emergency generator(s) should be preferably installed on first floor (or outside at grade level) above 500-year flood plain to allow easy access for maintenance. This will also provide the opportunities for utilizing portable load bank for routine maintenance tests, therefore eliminating the need of permanently mounted load bank in order to save the costs for initial construction and future maintenance.

Standard

1. The emergency power system will comply with the standards as follows:

- Emergency power will be provided by diesel engine generator sets on site. The units will generate 4160 volts or 480 volts determined by design, three-phase power, which will be connected to a paralleling switch gear. This switch gear will serve the emergency distribution panels in the building. Automatic transfer switches will be utilized to connect to the emergency source based upon a pre-set priority if the normal source of power fails. Transfer switches shall be located near the normal source unit substation.
- A permanently mounted load bank will be provided to allow for the required routine maintenance testing of generators, if the generator(s) is installed on a floor above the first floor and utilizing portable load bank is not feasible.
- The quantity of generators will allow a generator to be taken out of service while the remaining generators can assume the load.
- 480 volt, three-phase power will serve motors and large equipment loads, such as system pumps, air handling units and exhaust fans. 480/277 volt, three-phase power will serve life safety lighting and step-down transformers to obtain 208/120 volts.
- 208/120 volts will serve the fire alarm system, selected receptacles and small critical equipment loads.
- Loads other than life safety types to be served would include but not be limited to freezers, cold rooms, incubators, receptacles in communication, electrical and mechanical rooms, selected receptacles in laboratories and selected MEP equipment as identified by the design team. If the building contains rooms requiring pressure offsets, additional loads will require connection to the emergency power system such as ventilation and control systems that will ensure such pressure offsets are maintained at all times. If the building is classified as a high-rise building, additional loads include but not limited to elevator, and stair pressurization systems will require connection to emergency power system.

- On-site fuel storage will be sized to adequately support seventy-two-hour full load run.
- Emergency power will backup UPS systems that support BAS. A comprehensive study and design will be initiated early in the design phase dealing with prioritization of startup sequence upon the loss of normal power. The A/E will submit such design for owner's review no later than the end of design development phase, and obtain approval from the owner.
- Failure of the normal source of power will be sensed by devices in each automatic transfer switch. Upon detection of power failure a signal will be sent to the generator switch gear, which will send a start signal to all active generators. The first generator, which achieves proper voltage and frequency, will connect to the emergency switch gear bus. The remaining generator(s) will synchronize with the first generator prior to connecting to the bus. The automatic transfer switches will connect to the emergency bus when the voltage and frequency reach the correct levels.
- A load sensing system will be provided such that if one generator can carry the emergency load requirement, the remaining generator(s) can be shut down. Conversely, if the switch gear senses the operating generator is becoming overloaded, a signal shall be sent to start a second generator.
- When the normal source returns and after a preset time delay (to establish that the presence of the normal source is not temporary), the transfer switch will connect the load to the normal source. After removal of the load from the engine generator, the unit shall continue to run for a preset cool-down time period before stopping.

Lighting

Introduction

Strict control of light cycles in animal housing rooms is essential. It is standard practice for all animal housing room lights to be automatically controlled. In addition, there should be positive feedback to assure proper functioning of the lights, such as a photocell located in the room. It should not be assumed that by monitoring the status of the relay controlling the lights, the lighting within the room is also monitored. According to a 2004 study, disturbed lighting for socially-housed male mice can cause physiological and behavioral changes indicative of stress, not only leading to much higher levels of corticosterone, but also to shorter agnostic latency within the groups. (Van der Meer)

Background

Our typical set up is lights on at 0700 and off at 1900. However, there are applications requiring light/dark cycles that differ from the standard. Therefore, the light control system must be easily manipulated to make necessary changes. The lighting system must provide a means of positive feedback to indicate alarm conditions.

Researchers need to access their animals at all times of the day and night, according to their research requirements. Access during dark hours must be accommodated by the use of an override switch located at the animal room. Ideally, this dark cycle override would be a red lamp which is invisible to most rodents. Override should be for a fixed period of time, typically 15 minutes, to prevent light cycle disruption. Light override period should be adjustable to allow for periods shorter or longer than the typical override period.

Light fixtures must be sealed to prevent the transfer of air and potential contaminates between the room and above ceiling space. Surface mounted fixtures are preferable, as they are more easily sealed. Fixtures with perforations in the ballast housing are totally unacceptable.

Standard

Light Levels	
Off / Dark Cycle	0 ft-C
Override (Red Lamps)	10-15 ft-C
Low/ Animal Housing Light Cycle	25-35 ft-C
High/Procedure Room Light Cycle, Sanitation of room between populations	80+ ft-C

Table 4-2

Lighting Standard Requirements	
Cycle Controls	Individual room Light/Dark cycles are controlled centrally by the Edstrom Watchdog System to ensure consistency in diurnal cycles. On/Off times and override durations are easily changed by authorized Animal Facility personnel. The system will allow rooms to be programmed individually.
Monitoring	A photocell connected to the Edstrom Watchdog System is located in each room to monitor the actual lighting condition in the room. Ideally, the photocell records the actual light level in foot-candles. Minimally, the photocell records lights on or off.
Override	A local switch is located at the room to override the lights. Duration of override is programmable by the authorized Animal Facility personnel. During light cycle, the override switch turns the lights off. During the dark cycle, the override switch turns the red lights on..
Fixtures	Fixtures are gasketed and weatherproof. Surface mounted fixtures are preferred, since they are easier to seal. Fixtures do not have any perforations that would allow air exchange between the room and the space above the fixture.
Alarming	Conditions outside normal settings must generate an alarm, both within the system and as a critical alarm, via dry contact, to Monitoring Services.

Table 4-3

Wiring Devices

Introduction

The electrical wiring devices used in animal vivaria construction follow design parameters of other systems to provide a safe, consistent environment for the animals and human occupants during both normal and emergency operating conditions.

Background

The electrical devices provided for a vivarium are generally no different from those in other installations. Consideration is, however, given to a few areas, making the use of the devices more suitable considering the animal inhabitants of the building. Two such considerations are in vermin control and damage from moisture.

Data

Light fixtures, timers, switches, outlets and other devices will be properly sealed to prevent vermin from living there. Wiring devices can become warm during use, and would provide good breeding areas for vermin if allowed access inside the devices. Surface mounted, energy-efficient fluorescent lights are most commonly used in animal facilities. As another precaution, light bulbs or fixtures should be equipped with protective covers to ensure the safety of the animals and personnel.

The electrical devices in some rooms in a vivarium should be capable of operating safely in high-moisture areas, simply because water is used regularly in the areas by operating personnel to maintain cleanliness of the rooms. Moisture-resistant switches and outlets protected by ground-fault interrupter circuitry should be used in areas of high water use. Operating personnel should be consulted during the design stage for recommendations of which rooms should have such devices.

If there is the possibility of using ventilated cage systems, change hoods or other electrical equipment in an animal room, this will be taken into consideration when planning the location and distribution of power to the room.

Electrical outlets will be strategically located throughout the facility to accommodate most portable electrical equipment without requiring the use of extension cords.

Surface metal raceway with snap-on covers will not be used in vivariums due to the requirements for washdown cleaning.

Standard

Vivarium Wiring Device Requirements	
Seal all wiring devices	Prevent access by vermin
Seal and waterproof wiring devices and light fixtures	Prevent water damage and air leakage

Table 4-4

Uninterrupted Power Supply (UPS)

Introduction

Uninterrupted Power Supply (UPS) systems are used to provide power to electrical devices in the event of failure of the device primary power source. UPS systems are only designed to provide power for a short period of time, sometimes only long enough to allow the equipment to perform an orderly shut down automatically, or to give the equipment operator time to shut the system down in an orderly manual sequence. A UPS system may also provide smooth, uninterrupted power to a device during the interim time between loss of normal power and establishment of emergency power coming from a facility emergency generator. Such transfers sometimes are accompanied by power "spikes" or other anomalies. If such anomalies are considered harmful to a device, then the use of a dedicated UPS system may be called for to minimize the risk of harm in a power failure event.

Background

In the context of this design standard, UPS systems are not to be confused with Emergency Power Systems, described elsewhere.

Standard

No provision for a large, centralized UPS system will be provided. UPS systems, if applicable, will be provided for critical BAS equipment. UPS systems, if required by equipment used by the occupants, should be provided by the owner of that equipment.

Lightning Protection

Introduction

Studies by the American Geophysical Union confirm that conventional lightning protection systems are highly effective in reducing lightning-caused fires and damage to buildings and structures. Specifying compliance with UL or NFPA standards is key to safe and effective lightning protection system performance.

Background

MD Anderson facilities basis of design (BOD) documents indicate past practice of specifying lightning protection systems meeting Underwriters Laboratories Master Label Certification requirements.

Standard

1. Lightning protection systems will be designed and installed to receive the UL Master Label Certificate to comply with national standards and include all of the following specified components:

- Network of rooftop air terminals.
- Network of grounding terminations.
- Network of conductors interconnecting the air terminals and grounds.
- Interconnections with metallic bodies.
- Lightning protection surge arrestor devices on all incoming power and communication lines.

2. The A/E will take the aesthetic appearance of roof-top lightning protection components into consideration during design.

3. System components on roof can be built to be hide architectural elements and protect from mechanical displacement, and environmental effects.

4. Aesthetic advantages can be gained by concealment, especially for low-rise buildings where exposed lightning protection components on building roof can be highly visible.

5. The approximate locations and quantity of lightning protection elements are indicated on original drawings provided by the A/E.

6. Drawings provided by the A/E will conspicuously state "Lightning protection system shown on the drawings are diagrammatic in nature and shall be furnished and installed per code."

7. The lightning protection systems contractor will promptly report to the owner and A/E, in writing, the discovery of any apparent error, omission or inconsistency in the Contract Documents prior to the execution of the work.

8. The lightning protection systems contractor will ascertain final construction documents and installation are in compliance with applicable laws, codes or regulations.

Note: When performing as a construction manager-at-risk, the Contractor has a shared responsibility for discovery and resolution of discrepancies, errors, and omissions in the Contract Documents. When performing as a design-build firm, the lightning protection systems contractor has sole responsibility for discrepancies, errors, and omissions in the drawings and specifications.

9. The lightning protection systems contractor will check the layout as provided in the construction documents and augment the design on their shop drawings and record drawings in compliance with all applicable codes.

Note: The final construction documents will be sealed by a Texas licensed electrical engineer or licensed lightning protection installer representing the Contractor.

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ARSAC Design Standards for Small Animals (Rodents) Vivarium

Information Technology (IT) Systems

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5.0 Information Technology (IT) Systems

5.1 IT Cabling

Introduction

Data, voice and visual communication (IT Systems) capability is vitally important in an animal vivarium facility. The foundation of the IT systems installed in any facility is that of the various cabling materials used in those systems. Quality of the installed IT system as well as its capability to be successfully upgraded in the future are both dependent upon the selection of cabling materials.

Background

The communications cabling will be designed following the tenets of MD Anderson's Premise Distribution System Standards document in accordance with AVAYA Communication Certified Systimax Structured Cabling System parameters to provide a vendor-neutral network transport.

The communications cabling will be specified as a competitively bid structured cabling system equivalent to the AVAYA Systimax Structured Cabling System.

The IT structured cabling system will be designed and sized to accommodate the cabling needs of all low voltage systems not identified with proprietary cabling requirements. The IT structured cabling system will be defined as, and comprised of, raceways, conduits, sleeves, cable tray and runway, copper cabling and fiber optic cabling serving low voltage systems. This system will function to provide interconnectivity for low voltage systems that will meet the needs of current systems and those requirements in the future.

Data

1. IT systems will comply with the following applicable codes, guidelines and standards:

    - NFPA 70-National Electrical Code (NEC).
    - BICSI Telecommunications Distribution Methods 11th Edition .
    - ANSI/TIA/EIA-568-A Commercial Building Telecommunications Cabling Standards.
    - ANSI/TIA/EIA-569-A Commercial Building Standards for Telecommunications Pathways and Spaces.
    - ANSI/TIA/EIA-606 The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings.
    - ANSI/TIA/EIA-607 Commercial Building Grounding and Bonding Requirements for Telecommunications.
    - TIA/EIA 568-A-5 568-A Addendum 5 - Category 6a.
    - TIA/EIA TSB-67 Transmissions Performance Specifications for Field Testing of Unshielded Twisted-Pair Cabling Systems.
    - TIA/EIA TSB-72 Centralized Optical Fiber Cabling Guidelines.
    - AVAYA Communication Certified SYSTIMAX Structured Cabling system Technical Specifications.

Standard

1. Load calculation criteria will comply with the following:

- Device locations will be established during the IT user meetings and are to be indicated on the 100% construction documents for review by MD Anderson.
- The standard information outlet (SIO) device for office and support spaces is configured typically in a "quad" faceplate with two copper data jacks and two copper voice jacks.
- Each SIO for vivarium and double module laboratory spaces will be configured into a "duplex" faceplate with one copper data jack and one copper voice jack. Provisions have been included in the raceway sizing criteria for one pair of multimode fiber optic cable. SIO details will be included on drawings.
- All SIO locations will be confirmed with Telecom & Network Services for final voice and data jack configurations. Each SIO type to be indicated on the plan set and detailed.

2. Equipment sizing criteria will comply with the following:

- Preliminary Backbone Sizing:

  - Voice Riser Cabling: Pair count is based on one and a half riser pairs for each voice station jack served by the intermediate distribution frame (IDF) Room. The riser cables will be sized to contain a minimum of 20% unallocated pairs for future use.
  - Data Riser Cabling: Fiber count has been preliminarily set at twenty-four multimode and six strands off singlemode fibers and twelve single-mode fibers routed to each IDF.
  - Data Interconnecting Cabling: Fiber count had been preliminarily set at six strands of multimode fibers routed across each floor between IDF's.
  - Pathway capacities will be utilized to the maximum of 40% to 50% fill and sized to allow for 50% future growth. At least one spare riser sleeve or conduit will be provided between floors.

3. IT equipment rooms will comply with the following:

- Building Entrance Facility (BEF):

  - The building BEF will be located on plan level 1 within the BEF/main distribution frame (MDF) room and will be the point where the building connects to the campus networks. All fiber optic and copper cabling coming into the building will terminate in this room. This room will contain the building demarcation point, lightning protection, and cable transition. Connections to the MDF will bring services to the distribution switch.
  - Data network services will enter the building through optical fiber cabling from the existing IDF Room.
  - Voice services will be provided in the building either through copper cabling provided by the local exchange carrier or by a local PBX.
  - Space should be designed into the BEF/MDF room to accommodate an owner provided PBX system or LEC system equipment.

- MDF:

- The building MDF will be co-located with the BEF within the BEF/MDF room and will be the point from which the building services originate. The Distribution network switch will be located in the MDF, distributing network services to the entire building via the Fiber data backbone.
- The MDF will also provide the cross-connect point to distribute telephone service from the telephone switch equipment to each IDF. The telephone switch equipment cabinets will be rack mounted. From the backplane of the telephone switch equipment cabinets, telephone services will be distributed to a rack mounted termination point. From the telephone switch equipment blocks, cross-connects will route telephone service to intra-building backbone cables. All communications cabling within this room will be secured using a Velcro type "Tie-Wrap" instead of the plastic type "Tie-Wrap".

- IDF:

    - IDF's will be located in an area convenient to the floor it will serve to provide a lockable protected and climate controlled environment for terminating all backbone and station cabling on that floor. Workgroup access layer wwitches will also be housed in the IDF's, distributing network services to the entire floor via the data station cabling.
    - Each network device will be configured with redundant power supplies and will require two, 120 volt, 20 amp branch circuits. All circuits for active electronics will be fed from the standby power system with rack mounted uninterrupted power system (UPS) units provided by the owner for each equipment rack.
    - All 120 volt circuits for active electronics will be specified as dedicated, with separate neutral and equipment grounding conductors routed back to the nearest stand-by power panel without mechanical equipment loads. One convenience outlet fed from the normal power system will be provided in each IDF.
    - Equipment panels for security, fire alarm, building automation systems, etc. will be centrally located within the interstitial spaces and co-located on the wall space(s) designated by Network Service within the IDF's on those floors without interstitial spaces.

4. Electrical requirements will comply with the following:

- Each network device will be configured with redundant power supplies and will require two, 120 volt, 20 amp branch circuits. A minimum of one, 120 volt, 30 amp branch circuit will be provided. All circuits for active electronics will be fed from the standby power system with rack mounted uninterrupted power units (UPS) provided for each equipment rack. Owner will verify all power requirements for equipment provided.
- All 120 volt circuits for active electronics will be specified as dedicated, with separate neutral and equipment grounding conductors routed back to the nearest stand-by power panel without mechanical equipment loads. Convenience outlets fed from the normal power system will be provided 25 feet on center on the perimeter wall of the IDF room.
- Fluorescent lighting, fed from the standby power system will be installed within the HUB room.

5. Equipment and material will comply with the following:

- Cabling System Pathways:

    - Multiple 4 inch conduits and cable tray shall connect the MDF to the stacked IDF's, and 4" sleeves

will be provided between IDF's on each floor.
  - Each IDF room shall be provided with cable runway over the equipment racks. The cable runway will be bonded and properly grounded in compliance with the NEC to the cable tray system.
  - Horizontal distribution will start with multiple 4" conduit sleeves from the IDF cable runway to a cable tray. The cable tray will be run through the public corridors of the floor plate on floors without an interstitial space and routed throughout the interstitial spaces to serve the station conduits for the spaces on the interstitial level and the floor below. Cable tray will be an aluminum, ladder-type.
  - Station conduits will be run from the cable tray to the outlet location. Conduits will be a 1 inch minimum, with end bushings and metallic grounding clamps for bonding the conduit to the cable tray.

- Voice Backbone Cabling:

  - Intra-building voice backbone cabling will be high pair count copper cables. Both ends will be terminated on rack-mounted extra large building entrance terminal frames (X-LBET) 110 style connection blocks. The MDF will connect to the IDF with an intra-building voice backbone cable. These cables will create the cross-connect fields to distribute telephone services throughout the building.

- Voice Station Cabling:

  - Each voice jack in the building will be connected to the IDF on that floor by a 4-pair UTP, category 6a cable. All four pairs of the cable will terminate at the outlet location and in the IDF using the T568B wiring scheme. Category 6a rated 8P8C type jacks will be used at the outlet locations, and category 6a rated, rack mounted type termination points will be used in the IDF's. Plenum cabling will be specified in all areas designed with plenum return air systems.

- Data Backbone Cabling:

  - Data backbone cabling will be multi-mode and single-mode optical fiber cable, and all IDF's will be a home run connection to the MDF. Data backbone cabling will be terminated in rack mounted, rack installed, Light shelf terminations (LST's) using AVAYA SC type fiber connectors.

- Data Station Cabling:

  - Each data jack in the building will be connected to the IDF on that floor by a 4-pair UTP, category 6a cable. All four pairs of the cable will terminate at the outlet location and in the IDF using the T568B wiring scheme. Category 6a rated 8P8C type jacks will be used at the outlet locations, and category 6a rated, rack mounted style termination point will be used in the IDF's. Plenum cabling is specified in all areas designed with plenum return air systems

- Data Patch Cables:

  - Owner provided, data patch cables will be provided to match the rack mounted terminations. These cables will complete the category 6a rated channel.
  - Pre-terminated multi-mode optical fiber patch cables will be provided to match the jack-fields,

outlet, and cable equipment.

- Inner Duct:
  - Backbone fiber optic cabling will be installed in flexible, corrugated, nonmetallic inner duct. This inner duct will protect the cables and segregate conduits and conduit sleeves. Inner duct is specified as UL listed and comply with NFPA 70 for all installations.
- Equipment Racks:
  - Fiber optic data patch panels will be rack mounted in each IDF and rack mounted on X-LBET frames with in the BEF/MDF room. Active electronic equipment will be installed in floor mounted equipment racks. Vertical and horizontal wire management will be provided.

1. Cable Runway:
   - Cable runway will be used in the BEF/MDF room and IDF's. The runway provides flexibility in the tight confines of the communications rooms and helps to insure an orderly cabling installation. It is also used to help brace the equipment racks.
2. Communications Ground:
   - A communications grounding system will be installed to connect all of the building IDF's with the HUB room. The grounding system will be derived from the building electrical service to insure there is no difference in potential between it and the building communications systems.
3. Wireless Access Points:
   - Category 6a cabling will be pulled into designated locations specified by Network Services to accommodate Wireless Access Points.
   - Wireless Access Points will be installed by owner.

6. Distribution will comply with the following:

- Cable distribution within the building will be accomplished using the IT structured cabling system in conduits, conduit sleeves, cable trays and cable runways.
- Line voltage, BAS, Security, CCTV and speaker cabling will NOT be routed in the IT structured cabling raceway. All "other" cabling will be routed in the pathway designated for the IT structured cabling system to insure coordination of all system cabling paths.
- D-rings and cable runways will be used only in the BEF/MDF room and IDF's.

5.2 Security

Introduction

The objective of security is to ensure the safety of the animals, staff, equipment, and data. Conventional entrances, such as man-doors and dock bay doors, must be equipped to control access to the animal facility. Proximity card readers and number pads are used within the vivarium. Security must be designed so that approved users may move about the facility easily with minimal hindrance while unapproved individuals are denied access.

In addition to conventional entrances, security at other potential entry points must be considered. Windows, air intakes, and other central utility entrances and exits must be protected from intruders.

Background

The levels of security required for the animal facility are:

1. External Perimeter: Entrances leading into the vivarium from non-vivarium spaces.
2. Internal Perimeter: Entrances from vivarium administrative space into animal housing and use space.
3. Functional Area Perimeter: Entrances into specific areas within the facility, e.g., imaging suite, cryo-preservation laboratory, irradiator rooms, animal receiving and quarantine, receiving dock, etc.
4. Animal Housing Suite: Entrance into discrete group of animal housing and procedure rooms
5. Animal Housing/Procedure Room: Entrance into a specific housing/procedure room

Standard

Security Requirements	
Item	**Direction**
Perimeters and Suites	University of Texas Police Department (UTPD) card readers, digital recording security cameras trained on all external and internal perimeter entrances and throughout animal housing area corridors
Housing/Procedure Rooms	Individual room control requiring a PIN to enter, programmable through the electronic facility management system (e.g., Edstrom Watch-Dog)
Non conventional entry points	Intrusion alarms, mesh covers, or other appropriate means of preventing entry
Duress Alarms	One in each locker room, central administrative area, each animal housing suite, strategic locations in housing area corridors
Card Reader and PIN access systems	Must be programmable and able to allow multiple levels of security clearances

Table 5-1

5.3 Closed Circuit Television (CCTV) Surveillance

Introduction

Security in the animal facility is of paramount importance. Proximity card readers, locks and keys, and PIN key pads afford a level of perimeter and internal access control. However, it is important to monitor the movements of people and equipment once inside the facility via strategically located surveillance cameras. CCTV surveillance cameras are used to identify events such as individuals entering the facility inappropriately (e.g., "tailgating," insufficient or incorrect protective clothing, etc.), individuals behaving in an inappropriate manner (e.g., incorrect animal transport, horse playing, etc.), and unauthorized use or removal of property.

Background

University of Texas Police Department (UTPD) Crime Prevention and Technical Services groups will be involved from the beginning of a project to allow for thorough assessment of security needs. Ideally, there would be virtually total surveillance coverage of all main corridors.Minimally, all perimeter entrances and internal entrances, like locker rooms, must be visually monitored and recorded by UTPD. Many requests to review surveillance camera recording are in response to inappropriate behavior, rather than true security issues, so it is desirable for DVMS to also be able to monitor animal facility CCTVs. Since the videos are used to positively identify individuals and what they are doing, it is very important that the camera produce a clear image that can be zoomed and remain clear when zoomed. Communication between camera and monitoring devices must be secured against tampering or other damage.

Standard

CCTV Requirements	
Item	**Direction**
Cameras	Must provide clear view of the area of coverage, even when zoomed on the monitor. Should be able to zoom and pan.
Camera locations	• All perimeter entrances to the facility. • All locker room or other entrances into the animal housing area. • All elevator lobbies and elevators. • All main corridors.
Recording devices	• Multi-camera capabilities. • Programmable alarming. • Network client software license for DVMS project manager (PM).
Cable Security	

CCTV Requirements	
Item	**Direction**
Monitoring	All animal facility CCTVs are monitored by UTPD. Ideally, all vivarium CCTVs are also monitored in the DVMS Project Management office through the use of an Intellex or comparable recording device. Minimally, all perimeter and internal entrance CCTVs are monitored in DVMS the PM's office.

Table 5-2

5.4 Fire Alarm

Introduction

Life safety in the animal facility is of paramount importance. However, this must be balanced by the needs of the animals. An acceptable compromise must be reached that accomplishes the goal of adequately notifying human occupants of a danger while causing the least disruption to the animal colony.

Background

Many times, an alarm is triggered in the absence of a real danger to life safety. It is desirable that these false alarms cause no disruption to the animal colony. Audible alarms must be able to emit a chime, rather than a horn, within the animal housing suites and main hallways. Only visual alarms are allowed within animal housing rooms and must have red lenses.

A variance from the Texas Department of Licensing and Regulation (TDLR) was required to allow visual only fire alarms within animal rooms. (See Variance Application for details in the Appendix.)

Standard

Fire Alarm Requirements	
Item	**Direction**
Animal room visual alarms	Red lens, weatherproof gasket, sealed

Table 5-3

5.5 Wireless Data

Introduction

The modern animal housing facility is equipped with many different computer-based systems including, but not limited to, building automation, vivarium management, breeding colony management, and communications. Access to these systems is often required away from a hard-wired wall jack.

The term "wireless network" can be used to describe any type of network that is wireless, but the term is most commonly used to describe a telecommunications network that does not use wires to establish interconnections between nodes. Wireless computer networks are examples of these types of telecommunications networks.

Wireless Fidelity (Wi-Fi) is a commonly used wireless computer network that uses radio waves. Radio technologies called IEEE 802.11 are transmitted from access points. Wireless devices use receivers to detect the signal. A Wi-Fi network can be used to connect computers to each other, to other wireless devices & networks, or to the Internet.

Background

Wireless network use has increased steadily in business, medical, and research environments over the past five years. The goals of using wireless networks in hospitals include speed and reliability of obtaining patient monitoring data, with resulting improved patient outcome and response times, decreased costs of medical records maintenance, increased staff efficiencies, and increased HIPPA compliance. In factory settings, deployment of wireless networks demonstrated positive return on investment by increasing communication among staff, reducing errors, lowering costs, and increasing productivity. (Larkins and Larkins 2006) Use of a wireless system allows transmission of data directly from cageside in the animal housing room using barcode scanners, transponder readers, and physiologic monitoring equipment. This minimizes manual data entry, increases efficiency and productivity, and reduces transcription errors.(Larkins and Larkins 2006) The use of wireless networks in academic, business, and healthcare environments will continue to increase because of widespread availability of wireless-capable devices, ease of network deployment, and portability.

MD Anderson's Information Security (IS) policy states that neither external hardware nor telecommunication devices may be connected to any part of the MD Anderson network, computer, terminal or lines unless explicitly authorized in writing by appropriate management. Additionally, software or hardware that defeats approved security software or controls may not be applied. Any wireless network, other than the institutional MD Anderson wireless network supported by Network Services, is prohibited. Any system outside of MD Anderson approved systems will not be used to bridge two networks.

The increasing use of radio transmitters in personal communication devices is resulting in more incidences of unintentional interferences with other electronic equipment. The wireless network interfaces, cellular phones, personal digital assistants, and two-way radios contain transmitters that are powerful enough to cause interferences in many electronic systems such as telephones, personal computers, electronic control systems, etc. Some research centers have experienced interferences in their freezer electronic control systems, electronic actuators controlling air dampers, and transducers controlling branch line pressure when a handheld two-way radio is operated nearby.

Data

Wi-Fi operates on different frequencies on unlicensed radio bands. Wi-Fi networks operate in the 2.4 GHz (802.11b/g) or 5 GHz (802.11a/h) frequencies, at transmission rates (802.11b = 11 Mbps; 802.11a or g = 54 Mbps; or dual band products).

Standard

Wireless Data Requirements	
Item	**Direction**
Accessibility	Internal only – within the M. D. Anderson firewall
Access node coverage	Must provide uninterrupted signal strength throughout the animal facility, including support and administrative areas.
Frequency	2.4 or 5 GHz, as recommended by IS project team
Band	802.11 a/b/g/n, as recommended by IS project team
Interference	Must be shown not to operate on or interfere with other mission critical networks, such as building automation system components, personnel communication devices, such as two-way radios & pagers, or other electronic equipment.

Table 5-4

5.6 Communication

Introduction

Communication within and between animal facilities is an important aspect of departmental operations. Staff members must be able to communicate quickly and accurately. Most of the animal care staff do not carry institutional pagers, so there must be a mechanism for communication to and from these individuals. Overhead paging and hallway telephones serve this purpose. Hallway telephones also allow for returning pages, for those individuals with pagers or Blackberry devices. The wireless system allows uninterrupted computer communication throughout the facility. (e.g., for animal care staff moving from room to room using ViewPort or other data management system to enter data.)

Background

A number of communication devices are used in the animal facility, including but not limited to, phones, pagers, Blackberry devices, wireless computers, and ViewPort. It is imperative that these devices be configured with wiring or signaling devices such that they have uninterrupted service throughout the facility. It is unacceptable to have “dead spots” where a signal may be lost. On the other hand, the increasing use of radio transmitters in personal communication devices is resulting in more incidences of unintentional interferences with other electronic equipment. The wireless network interfaces, cellular phones, personal digital assistants, and two-way radios contain transmitters that are powerful enough to cause interferences in many electronic systems such as telephones, personal computers, electronic control systems, etc. Some research centers have experienced interferences in their freezer electronic control systems, electronic actuators controlling air dampers, and transducers controlling branch line pressure when a handheld two-way radio is operated nearby.

Standard

Communication Requirements	
Item	**Direction**
Telephones - Avaya	Inside suites and in major corridors: wall mounted, internal 5-digit phone number only, directory auto-dial feature, and UTPD direct dial button.
Telephones - cellular	Only cell phones with Sprint service are to be considered a primary means of communication.
Paging – overhead	Overhead paging speakers should be located in all corridors. Overhead paging is accomplished through the telephones.
Paging – pagers	Paging repeaters must be located so that paging signal strength is adequate for coverage throughout the entire animal facility, including support and administrative spaces.
Blackberry devices	Sprint repeaters must be located so that signal strength is adequate for coverage throughout the entire animal facility, including support and administrative spaces.
Wireless computer devices	Wireless access points must be located so that signal strength is adequate for coverage throughout the entire animal facility, including support and administrative spaces. Wireless must be considered as a primary means of connectivity in the animal facility.
Edstrom ViewPort Vivarium touch-screens	ViewPort Vivarium touch-screens must be located in each animal housing suite to allow access to the system for anyone without computer access.

Table 5-5

5.7 Database Information Management

Introduction

A vast amount of information is generated in the animal facility on a daily basis. Environmental conditions must be recorded on a regular basis through the BAS and/or other environmental monitoring systems. As the animal care staff performs routine procedures, completion of the procedures must be documented. Any other activity that has a relationship to animal health and wellbeing should also be documented. Electronic management of data is preferred to paper copies, since electronic records may be sorted, graphed, searched, and archived.

Background

Commercially available database systems are available for collection, documentation, and manipulation of vivarium information. The system should allow for easy data entry, searchable records, and reporting capabilities. Data security is of paramount importance and must be protected through the use of passwords, restricted access based on job function, and other appropriate controls.

Standard

Database Information Management Requirements	
Item	**Direction**
Data security	System must follow policies and guidelines described in the M. D. Anderson Information Security's Security Policy and Operations Manual and Information Security institutional policy.
Multiple Users	System must allow multiple users at any given time
System to system interface	Ideally, the system will utilize an open protocol to allow communication between database systems
User interface	Must be user-friendly and intuitive.
Must be customizable and tailored to the specific facility.	
Compliance	Comply with 21 CFR Part 11, Electronic Records; Electronic Signatures

Table 5-6

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ARSAC Design Standards for Small Animals (Rodents) Vivarium

Architectural Materials and Finishes

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6.0 Architectural Materials and Finishes

6.1 Functional Areas

Introduction and Background

An animal research facility is a specially designed building type. The design and size of the facility depends on the scope of the animal research program, the species to be used, the physical location in relation to the other research areas, and the geographic location. The vivarium must maintain closely controlled environmental conditions and must be designed to protect the research animals from exposure to conditions, pathogens, and agents that could alter research results. Functional areas must be defined in order to develop a well-planned and efficient facility.

Data

1. Functional areas of an animal facility may include:

- Animal Housing Rooms (AHRs) - AHRs can be organized as individual rooms accessed from a corridor system or multiple rooms could be organized into self-contained suites.
- Procedure Rooms – procedure rooms should be located within or close to the AHRs. Maximum flexibility is maintained by designing procedure rooms that can be used interchangeably as animal housing rooms, i.e., procedure rooms should be identical to animal housing rooms. Procedure room furniture and fixtures should be modular and mobile, to allow for total room conversion between procedure and housing.
- Barrier Facilities – This area is designed to maintain bio-security for specific pathogen free animals. The rooms operate under positive pressure to keep contaminants out. As in containment facilities, control and monitoring systems and equipment are utilized in barrier facilities to maintain the required pressures and flows.
- Barrier Elements - Airlocks, locker rooms, pass-through autoclaves, pass-through vaporized hydrogen peroxide rooms, etc., provide the primary barrier and access control that separates the controlled animal care environment from external influences.
- Cagewash – The cagewash complex is the central area for decontamination, cleaning, and sanitizing of animal care equipment and supplies. These areas are dominated by equipment-generated heat, moisture, noise, and vibration. The major equipment items include cage & rack washers, tunnel washers, autoclaves, bedding dispensers and dump stations, and bottle filling stations.
- Cage Storage – Storage space is required for items that are used in daily operations, such as staged or processed cages, bottles, racks, carts, etc.
- Feed, bedding and equipment storage – This storage area should be located to facilitate operational flow. Appropriate separate storage areas for these and other items should be included.
- Quarantine – A specialized containment area is needed to house incoming animals that could be a source of infection. This area should be physically separate from the central housing area to minimize the potential for contamination.
- Dedicated Receiving Dock - A dock specific to animal functions is generally required. An elevator dedicated to animal usage should be located near the dock.

- Necropsy - This area is used for post mortem procedures on euthanatized or otherwise deceased animals. This function should either be located physically separate from “clean” areas or separated by a pressurized pass-through air lock.
- Containment Facilities - These areas are designed for working with potentially infectious biological agents. They operate under negative pressure to prevent the escape of air to the general environment. Wastes and effluents are separately contained and decontaminated.
- Veterinary Care – This area may include laboratory, surgery, and clinical care functions.
- Office Space – Office area is required inside the vivarium for veterinary and animal care staff.
- Staff Support Areas—Break area, cafeterias, workstation, lockers, and rest-room facilities. All are intended to support veterinary and research staff during their work shift.
- Mechanical/Electrical Equipment Spaces – This area includes mechanical equipment rooms, and electrical and telecommunications closets. It is desirable to locate the spaces and devices in a manner that allows the separation of maintenance functions from animal care functions.
- Corridors - These will be wide enough to accommodate animal rack, cart, and material traffic flow, not just egress requirements. Corridors should have a clear width of 7 to 8 feet. Corridors will have impervious finishes so that they are easy to clean and maintain. Protective components, such as bumper and corner guards, bull nose blocks and cove bases, are frequently employed to protect walls and doors from heavy, abusive traffic.
- The general organization of a vivarium is illustrated in Figure 6-1: Animal Facility Diagramatic Model Showing Basic Flows and Spatial Relationships.

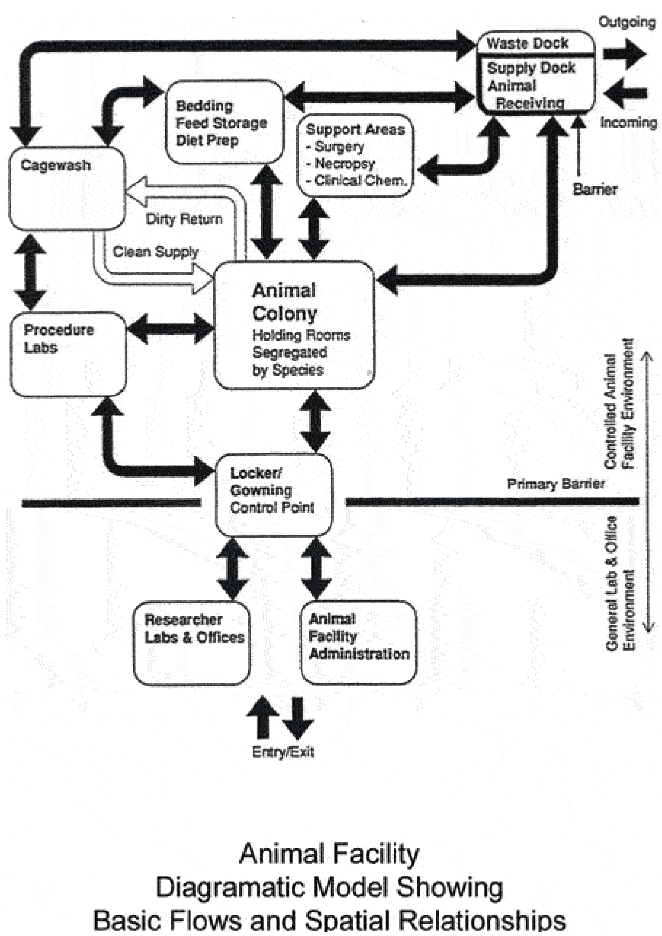

Figure 6-1: Animal Facility Diagramatic Model Showing Basic Flows and Spatial Relationships

2. Important attributes are listed as follows:

- Internal circulation systems need some form of control over clean vs. dirty (or supply vs. return) traffic.
- The cagewash complex is divided by walls into type-of-use areas, including decontamination, soiled equipment processing, clean equipment processing, autoclave equipment preparation, and autoclave sterile staging.
- Areas of potential contamination, such as necropsy and quarantine, should be located outside the central housing area.
- The animal receiving areas should be subdivided to distinguish between incoming animals and receiving, and outgoing waste.

6.2 Corridors

Introduction

Animal facilities will be constructed to be practical, functional and efficient. Corridors within animal facilities must be able to accommodate the passage of large equipment, bulk materials and supplies, animal transport crates, and research equipment and personnel. The use of single or dual corridor systems is a basic decision that must be made early in facility design.

Background

The decision regarding single or dual corridor systems should be based on the following factors: available space, need for contamination control, species to be housed, and cost constraints. Corridors will be wide enough to facilitate the movement of personnel and equipment. Corridors 8 feet wide can accommodate the needs of most facilities. Floor-wall junctions should be designed to facilitate cleaning. In corridors leading to dog and swine housing facilities, cage-washing facilities, and other high-noise areas, double-door entry or other noise traps should be considered. Wherever possible, water lines, drainpipes, electric-service connections, and other utilities should be accessible through access panels or chases in corridors outside the animal rooms. Fire alarms, fire extinguishers, and telephones should be recessed or installed high enough to prevent damage from the movement of large equipment. A map of the corridor system will be provided in main hallways to facilitate wayfinding.

Data

Clean-dirty dual corridors systems will be used whenever possible to promote contamination control. Main facility corridors should be 8 feet wide. Junctions between floors, wall, and ceilings should be sealed. Bumper rails or guards and corner guards should be used to protect walls from damage.

Standard

Table Listing Standard	
Corridor system	Dual; clean-dirty traffic flow
Minimum width	8 feet

Table 6-1

6.3 Animal Room Doors

Introduction and Background

Doors are installed in animal facilities in corridors and animal rooms. Corridor doors are required to separate functional areas, provide noise control, and enhance facility security. Doors in animal rooms provide many functions, including providing enclosure for the animals, maintaining air balance, providing noise control, and enhancing facility security.

Standard

1. Corridor doors will be wide and tall enough to accommodate the movement of equipment and animals.

2. Double-door (vestibule) entries will be considered in corridors that separate high-noise areas.

Note: Corridor doors and doors in other high traffic areas are subject to the most extreme abuse in the vivarium.

3. Push button actuators will be provided to discourage people from forcing the doors open with a rack, cart or other piece of equipment.

Note: In addition, these doors may require a piano style hinge in order to ensure long term durability.

4. Doors separating elevator lobbies and doors with hold opens will be pocketed or shielded to protect the edge of the door from impacts.

Note: The hardware will be carefully chosen to avoid being clipped off by a rack, cart or other piece of equipment.

5. Animal room doors will be large enough to accommodate the movement of cages and equipment.

6. Animal room doors will have seamless construction with smooth, flush surfaces, without visible joints or seams on exposed faces or edges.

7. Animal room doors will be painted hollow metal or FRP, 4 feet wide by 7 feet-10 inches tall (minimum above finished floor) and will be equipped with recessed or shielded handles, threshold sweeps and kick-plates.

8. All frames should be grout-filled, welded hollow metal with a painted finish.

9. Procedure room doors should be sound retarding painted steel doors with acoustical seals, engineered for attenuation rating of 45 STC minimum.

10. Animal room doors should normally open inward and be self-closing.

Note: If code requires outward opening, the door can be recessed into the corridor wall.

11. Animal housing and procedure room doors will have a view window with shutter.

Note: The view window can be coated with a red film similar to that found in a photo darkroom. The red filter will allow animal care staff to check the room without disturbing the animals' day/night cycle. The spectral energy/light range in which mice are sensitive is approximately 325nm to 625nm, so the red film should be chosen based on its ability to screen within that range.

12. Sliding automatic breakaway aluminum entrance doors should be installed at cage wash and clean cage storage.

13. Hardware protection (bumpers) will be installed for all locksets at holding and procedure rooms.

6.4 Exterior Windows

Introduction

In general, exterior windows are not recommended for animal research facilities and are inappropriate for areas within animal facilities where their presence interferes with the ability to control room temperature (due to heat loss) or photoperiod. Windows can be acceptable in rooms for some species, such as nonhuman primates, dogs, and other large mammals and might be considered as part of the environmental enrichment program for these species. Direct sunlight may even be required in some species of neo-tropical primates in order to obtain necessary vitamin D.

Background

The traditional use of windows in building design was to provide light, view, and fresh air for building occupants. This need has diminished over the past few decades as buildings have become more sealed, mechanically ventilated, and electrically lit. There is a growing recognition that the presence of windows makes an important contribution to the occupant's job satisfaction, health, and productivity.

Despite these advantages for the human occupants, windows are not generally recommended for rodent facilities because they:

1. Allow fluctuations of photoperiod and light intensity within the housing room during daylight hours;
2. Interfere with room temperature control due to solar heating; and
3. Reduce building security.

Since small animals such as rodents need strictly controlled light and dark cycles to maintain animal health and breeding, exterior windows are not normally provided in small animal housing rooms.

Standard

Exterior Windows	
Rodent housing room	None
Rodent procedure room	None
Support spaces	Variable based on function and presence of animals

Table 6-2

6.5 Floors

Introduction

Floors will be moisture-resistant, nonabsorbent, impact-resistant, and relatively smooth, although textured surfaces might be required in some high-moisture areas and for some species, such as farm animals. Floors should be resistant to the action of urine and other biologic materials and to the adverse effects of hot water and detergent cleaning agents as well as chemicals commonly used in holding and procedure rooms.. They should be capable of supporting racks, equipment, and stored items without becoming gouged, cracked, or pitted. Floors in wet areas should have a positive slope to drain of 3/16 inches per 1 foot. Depending on their use, floors will be monolithic or have a minimal number of joints. If sills are installed at the entrance to a room, they will be designed to allow for convenient passage of equipment.(1991; (U.S.) 1996) Flooring material will be carried up the walls a minimum of 150 mm (6 inches) to provide an integral covered base for ease of cleaning. (Facilities 2006) Floors will receive a waterproof membrane prior to the installation of the finish materials. The membrane selection should be coordinated with the flooring manufacturer.

Floors will be:

1. Durable and capable of supporting heavy equipment and caging systems.
2. Nonabsorbent and easily sanitized.
3. Smooth but with non-slip surfaces.
4. Able to be carried up the wall for at least 150mm.

Background

Some materials that have proved satisfactory are epoxy aggregates, hard-surface sealed concrete, and special hardened rubber-base aggregates. Correct installation is essential to ensure long-term stability of the surface. Resinous epoxy flooring is recommended for all floors within animal facilities that are subject to abuse, frequent cleaning, and continuous movement of cages and equipment. Areas that are hosed down shall be surfaced with resinous flooring materials.

Some areas within the animal facility may not require the same amount of cleaning and disinfecting as the areas in which cages and animals are held or transported. These areas are program driven and may consider the use of a monolithic sheet vinyl flooring material. (Facilities 2006)

Microbial inhibiting polymer flooring should be considered for use in areas where the control of microbial contamination is desirable, such as surgical suites, necropsy areas, or barrier facilities.

Standard

Vivarium Floors	
Animal holding and procedure rooms	Resinous epoxy
Necropsy rooms	Microbial Inhibiting Polymer
Corridors	Resinous epoxy
Cage wash and sterilization areas	Resinous epoxy
Loading docks	Hard surface sealed concrete
Support areas	Monolithic sheet vinyl
Offices	Monolithic sheet vinyl

Table 6-3

6.6 Drainage

Introduction

Adequate drainage is essential in animal facilities. These facilities produce large volumes of waste water during equipment sanitation and animal husbandry tasks. Drainage for either sinks and/or floor drains may be required in support areas, animal procedure rooms, and holding rooms. Floor drains are required in cage wash areas, many equipment processing areas (for autoclaves, etc.), large animal or aquatic animal holding rooms, and janitorial rooms. Many rodent holding rooms and clean support areas can be effectively sanitized by vacuuming and mopping rather than by wet wash down; in these areas, floor drains are not required or desired. The main advantage of including floor drains in these areas is to gain flexibility. Disadvantages include: installation costs, higher rate of insect infestation, contamination resulting from sewage backups, rack instability due to sloped flooring, escape of sewer gas from underutilized drains, and reduction of floor space due to drain troughs. Any unused drain in an animal housing or procedure room must be plugged to create a seal against sewer gas escape, vermin traffic, and other permeating issues so that it may be readily removed if the drain becomes needed in the room.

Background

Floors should be sloped at least 1.5 cm per M (3/16 in/feet) to floor drains to ensure rapid removal of water and drying of surfaces. Variation in the substrate (floor flatness) should not exceed 1/8th in/10 feet. Drains should be located at the lowest point of the floor or drain trough. The bottom of troughs should be sloped a minimum of 2 cm per m (1/4 in/feet). Floor drains should always be sealed effectively by continuously containing fluids or other means. Automatic trap priming is required unless shown to be impractical in specific applications as a method to ensure that traps remain continuously filled. Drain pipes should be at least 4 inches (10.2 cm) in diameter; larger pipes are recommended in some areas, such as large animal runs and farm-animal facilities. A run-flush drain or heavy-duty disposal unit is recommended for disposal of solid waste.

Standard

Drainage Standard Requirements	
Sloped floor required for floor drains	Minimum slope = 1.5cm/M
Sloped trough required for drain troughs	Minimum slope = 2.0cm/M
Floor substrate variation	< 1/8th in/10 feet
Minimum drain diameter	4 in
Trap priming	Automatic
Disposal unit	Preferred for solid waste

Table 6-4

6.7 Walls

Introduction

Walls should be smooth, moisture-resistant, nonabsorbent, and resistant to damage from impact. They should be free of cracks, of unsealed utility penetrations, and of imperfect junctions with doors, ceilings, floors, and corners. Surface materials should be capable of withstanding cleaning with detergents and disinfectants and the impact of water under high pressure. The use of curbs, guardrails or bumpers, and corner guards is required to protect walls and corners from damage. All joints between walls and appurtenances such as bumpers or guardrails must be sealed with an owner approved caulk or sealant. Walls must provide sound isolation. Other requirements include:

1. Durable and capable of withstanding moderate impact;
2. Non-absorbent, free of cracks & crevices, and easily sanitized ; and
3. All penetrations must be sealed.

Background

Concrete masonry units (CMU) are effective for walls, but the block must be sealed with two coats of epoxy block filler before the application of epoxy finish coating system to prevent moisture absorption and the joints must be tooled to prevent collection of dirt. Ceramic tile and glazed block are not recommended because of the number of exposed joints. Cement fiber wallboard may be a viable alternative building material to replace CMU. Gypsum wallboard can be considered for certain applications in low moisture, low traffic areas. Cement fiber or gypsum wallboard surface must be properly prepared and coated with approved primer and topcoat to reduce the potential for moisture intrusion. Cement fiber or gypsum wallboard must have bumper guards installed in areas where equipment is moved including within animal rooms.

Standard

Vivarium Wall Requirements	
Animal holding and procedure rooms	Cement fiber wallboard or CMU
Necropsy rooms	Cement fiber wallboard or CMU
Corridors	Cement fiber wallboard or CMU
Cage wash and sterilization areas	CMU
Loading docks	CMU
Support areas	Cement fiber wallboard or CMU
Offices	Gypsum wallboard

Table 6-5

6.8 Ceilings

Introduction

Ceilings should be smooth, moisture-resistant, and free of imperfect junctions. Surface materials should be capable of withstanding cleaning with detergents and disinfectants. Ceilings of suspended plaster or fire-proof cement fiber wallboard should be sealed with an epoxy coating and finished with a washable paint. Exposed plumbing, ductwork, and light fixtures are undesirable unless the surfaces can be readily cleaned. Access panels are not desirable in animal housing and procedure rooms. Where access panels are required, the panels should be corrosion-resistant and gasketed.

Other requirements include:

1. Able to withstand disinfection.
2. Moisture-resistant, free of cracks and crevices, and easily sanitized.
3. All penetrations must be sealed.
4. Exposed pipes are not acceptable.
5. Surface mounted versus recessed light fixtures should be discussed with the owner before implementation. Either fixture must be sealed and gasketed to prevent air exchange between the room and the above ceiling space.

Background

Suspended plaster or cement fiber wallboard are acceptable construction materials for ceilings. Ceilings formed by the concrete floor above are satisfactory if they are smoothed and sealed or are painted. Generally, suspended tile ceilings are undesirable unless they are fabricated of impervious materials and free of imperfect junctions.

Standard

Vivarium Ceiling Requirements	
Animal holding and procedure rooms	Cement fiber wallboard
Necropsy rooms	Cement fiber wallboard
Corridors	Cement fiber wallboard
Cage wash and sterilization areas	Cement fiber wallboard
Loading docks	Cement fiber wallboard or suspended plaster
Support areas	Cement fiber wallboard
Offices	Suspended lay-in tile

Table 6-6

6.9 Ratio of Procedure Rooms to Animal Holding Rooms

Introduction and Background

Animal research requires that procedures be conducted on the animals. The trend is to avoid removing animals from the vivarium for the following reasons: public health – to minimize exposure of public to animals, allergens, infections; public relations and security; animal health; and to minimize the impact on research, which includes the stress of movement, and exposure to an uncontrolled environment. Support space for procedures should be provided within the vivarium. Examples of support space include:

- Procedure laboratories.
- Surgery suites.
- Necropsy.
- Radiology.
- Imaging.
- Space for other equipment like irradiators.

Data

The recommended ratio of animal holding rooms to procedure rooms varies depending on the species to be housed and the research needs. Dedicated procedure space must be allotted for specialized procedure areas such as surgery, imaging, radiotherapy, clinical pathology, or anatomic pathology. The amount of space needed in each procedure room also varies with the intended use of the room; more space is required in rooms designated for surgery or radiology because space must be allowed for personnel to move around surgery or exam tables or radiology and imaging equipment. Consideration must also be given as to whether animals will be housed within the procedure room; rooms containing specialized research equipment are often designed to allow 1 rack of animals to be housed in the room during the procedures.

The ratio of rodent holding rooms to generic rodent procedure rooms varies from 1 procedure room to 4 housing rooms up to 1 procedure room to 8-12 housing rooms. Although the ratio of procedure rooms to animal holding rooms has steadily increased, the real ratio that should be applied is procedure rooms to cages. Assuming 420-mouse cages/animal room, the ratio of procedure room to cages will be 1:840 or

1:1,260. Dedicated procedure space may be reduced significantly if animal housing rooms are equipped with a sink and a biological safety cabinet, because many routine procedures can be performed in the housing room. Conversely, if the consequence of infection is high, additional procedure space should be considered. Ideally, procedure rooms are located in close proximity to animal holding rooms.

Standard

The recommended standard ratio for MD Anderson's rodent vivaria is one procedure room to 1260 cages.

6.10 Location and Flood Protection

Introduction

Research animal facilities must effectively support the research community that uses them. The location of the animal facility should be close to research laboratories and designed to enhance effective management and optimal utilization of the facility. The choice of location for any new building must include consideration of emergency management concepts. The impacts of disasters are similar, regardless of the cause of the disaster, resulting in operational disruptions and property damage. Disaster planning must be part of the basis for deciding vivarium location on a site and within a building. Flood protection must be included in the building design.

Background

The best site location for a vivarium is based on many factors. This decision is a compromise between the need to locate the facility in close proximity to the research laboratories, while isolating the animal functions for reasons of public health, public relations, security, animal health, and animal husbandry requirements. The best location for the vivarium within the building is also a compromise of competing priorities. For animal facilities that are below grade, the potential risk of flooding is only one of the components that must be considered; others include design considerations to achieve the square footage desired within the building footprint, proximity to other research components, utilities, security, dock operations, materials handling, and code requirements.

Vivarium operations are similar to hospitals and prisons in that the population of interest (in this case, the animals) can't always be readily evacuated out of the building, as is typical in other commercial buildings. For these reasons, building codes written for hospitals and prisons will be considered during vivarium planning. This may include designing reinforced interior rooms to act as safe zones within the vivarium. Other design elements may include annunciators and wiring to have longer fire resistance ratings to allow longer time for staff to move the animals to safety.

Data

Buildings housing animal facilities should be physically connected to research laboratory buildings when possible. Pedestrian pathways which include patient or public corridors and general employee use areas, such as cafeterias and break areas will not exist between animal facilities and research laboratories. Potential building sites should not be within flood plains whenever possible. All building entrances, penetrations, or building connections that are below grade must be waterproof and protected by flood walls or gates to one foot above the 500 year flood level. "Bathtub" style flood protection is specified for any MD Anderson facility construction that is below grade. The foundation and exterior walls below the flood level must be waterproofed by application of reinforced membrane waterproofing. The general MD Anderson preference is not to house research animals in a basement structure, but accepts the fact that it is unavoidable in some specific project circumstances.

Standard

Vivarium Location and Flood Protection	
Site location	Outside of flood plain
Location within building	At or above grade preferred
Flood level protection	One foot above 500 yr flood level
Style of flood protection	Bathtub
Waterproofing of foundation and exterior walls	Reinforced membrane

Table 6-7

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ARSAC Design Standards for Small Animals (Rodents) Vivarium

Specialized Facilities and Areas

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7.0 Specialized Facilities and Areas

7.1 Introduction and Background

An animal research facility is a specially designed building type. Functional spaces within typical vivaria include rooms/areas for animal housing, procedures, support functions, animal and materials receiving and storage. Within this specialized facility, there can be the need for even more specialized functional areas that have unique design requirements. These areas should be identified and planned for during programming. Care must be taken by the A/E Team to work with the owner to identify required specialized facilities and subsequent unique design and engineering requirements. Additionally, infrastructure to support potential future specialized areas should be considered.

7.2 Data

1. Specialized functional areas of an animal facility may include:

- Animal holding rooms for specialized containment – typical containment facilities are designed to contain microbiological or chemical hazards. Containment of radioisotopes and other radiological hazards require specialized room shielding, radiation monitors, and areas for donning personal protective equipment. Animals involved in behavior related studies may require stricter noise controls.
- Specialized Procedure Rooms are procedure rooms designed for specialized studies, which may require specific design criteria. They include specializations such as teaching and training facilities, necropsy, clinic, and short-term holding rooms. But also include specialized procedure rooms according to Table 7-1.

Specialized Procedure Room Examples	
Irradiation Facilities	Special shielding may be required for use of gamma, laser, or ultraviolet radiation. Specialized utilities, such as 220V electrical circuits, may be required by some equipment.
Imaging Facilities	Use of near-infrared or bioluminescent imaging may require specialized lighting or the ability to dim lights in selected parts of the room. Special electromagnetic field shielding may also be required in some cases.
Behavioral Facilities	Use of water filled swim tanks, conditioning chambers, mazes, or other behavioral equipment may require specialized utilities, room layouts and adjacencies, and noise controls.
Non-Traditional Animal Housing	Use of frogs, fish, sea urchins, or other non-mammalian animals require housing and environmental controls appropriate to the species.

Table 7-1

2. Important attributes:

- Accessibility – specialized areas meant for general use should be able to accommodate both barrier and non-barrier animals, while also minimizing the risks of cross contamination.
- Environmental Control – typically, specialized areas must meet the same environmental standards as regular animal housing rooms. Deviation from standard is only allowed if necessary for the function of the specialized area.
- Sanitizeable – fixtures and finishes of specialized areas must be sanitizeable, in accordance with The Guide. Deviations from standards are only allowed if necessary for the function of the specialized area.

7.3 Standard

Within this specialized facility, there can be the need for even more specialized functional areas that have unique design requirements. These areas should be identified and planned for during programming.
Care must be taken by the A/E Team to work with the owner to identify required specialized facilities and subsequent unique design and engineering requirements.

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Design Standards for Small Animals (Rodents) Vivarium

Appendix

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Appendix A: HVAC Requirements

Typical Small Animal Holding Room – HVAC Requirements

Typical Small Animal Holding Room – HVAC Requirements	
Physical (using typical BSRB arrangement)	
Room Dimensions	23 feet-3 inches X 16 feet
Ceiling Height	9 feet
Room Volume	23 feet-3 inches x 16 feet x 9 feet = 3348 cubic feet
Air Changes	
23 feet-3 inches x 16 feet x 9 feet x 20 air changes/ 60 min.	1116 CFM
23 feet-3 inches x 16 feet x 9 feet x 15 air changes/ 60 min.	837 CFM
23-3 inches x 16 feet x 9 feet x 10 air changes/ 60 min.	558 CFM
Heat Loads	
Lighting	6 fixtures x 4 lamps x 32 watts = 768 watts
Ballast Heat	768 watts x 1.25 = 960 watts Conversion 960 watts x 3.41 = 3274 btuh = 3274
Mice	126 mice x 6 racks x 5 x 1.1 btuh = 4158
People	2 researchers @ 300 btuh + 1 caretaker @ 565 btuh (sensible) = 1165
Equipment: • 4 feet BSC non ducted llA • Bedding Disposal Unit • Vent Rack Blower Trolley	 • 2040 • 900 • 156 btuh x 3 = 468
Heat Load Calculations (Data based on 50° entering air temperature and 68.5° in the room)	
Case 1 – Static Rack System	
Lighting	3274
Mice	4158
People	1165
Equipment: 4 feet BCS	2040
Bedding Disposal Unit	900
Total:	**11,537**
Air Requirement	11,537 btuh/ 1.08 x 18.5 = 577 CFM or 577 CFM x 60 minutes/3348 (room volume) = 10.34 air changes
Case 2	

Typical Small Animal Holding Room – HVAC Requirements	
If the BSC were ducted, no people were in the room and the disposal unit is not in the room, then the room load would only include the mice and lighting heat load: 3274 + 4158 btuh/ 1.08 x 18.5 = 371 CFM or 371 CFM x 60 minutes/3348 (room volume) = 6.65 air changes. (This heat load calculation does not take into account odor and air quality.)	
Case 3 - Ventilated Rack System	
Lighting	3274
Mice (heat rejected directly to the exhaust system)	0
People	1165
Equipment: 4 feet BSC	2040
Bedding Disposal Unit	900
Vent Rack Blower Trolley	468
Total:	**7847**
Air Requirement (based on heat load)	7,847 btuh/ 1.08 x 18.5 = 392 CFM
Air Requirement (based on one ventilator per two rack requirement)	110 CFM x 3 = 330 CFM or 330 CFM x 60 minutes/3348 (room volume) = 5.91 air changes for this room.

Table 8-1

Typical Procedure Room – HVAC Requirements

Typical Procedure Room – HVAC Requirements	
Physical (using typical BSRB layout)	
Room dimensions	26 feet-6 inches x 14 feet-9 inches
Room Area	390.875 square feet
Ceiling Height	9feet
Room Volume	26 feet-6 inches x 14 feet-9 inches x 9feet =3517.875 (3518 cubic feet)
Air Changes	
26 feet-6 inches x 14 feet-9 inches x 9 feet x 20 air changes/ 60 min.	1173 CFM
26 feet-6 inches x 14 feet-9 inches x 9 feet x 15 air changes/ 60 min.	880 CFM
26 feet-6 inches x 14 feet-9 inches x 9 feet x 10 air changes/ 60 min.	586 CFM
(Actual CFM to room is 900 CFM supply - TAB report dated 6/8/06)	
Heat Load Assumptions	

Typical Procedure Room – HVAC Requirements	
Lighting	6 fixtures x 4 lamps x 32 watts = 768 watts
Ballast Heat	768 watts x 1.25 = 960 watts (960 watts x 3.41 = 3274 btuh)
Mice	126 mice x 1 racks x 5 x 1.1 btuh = 693
People	Three researchers @ 300 btuh each = 900
Equipment: • 4 feet BSC non ducted llA • Ultra Low • Refrigerator/ Freezer • Incubator • Computer • Vent Rack Blower Trolley	 • 2040 • 3000 • 1000 • 1300 • 500 • 156
Heat Load Calculations (Data based on 50° entering air temperature and 68.5° in the room)	
Case 1	
Mice	126 mice x 1 rack x 5 x 1.1 btuh = 693
Lighting	3274
People	900
Equipment: 4 feet BSC (recirc)	2040
Ultra Low	3000
Computer	500
Incubator	1300
Vent Rack Trolley	156
Total:	**11,863**
Air Requirement	11,863 btuh/ 1.08 x 18.5 = 593 CFM or 593 CFM x 60 minutes/3518 (room volume) = 10.1 air changes.
Air Requirement (If room is 53° not 50°)	11,863 btuh/ 1.08 x 15.5 = 708 CFM (Based on maintaining 68.5° in the room)

Table 8-2

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Appendix B: Animal Watering System Details

Stainless Steel Room Distribution System

Standard

The stainless steel distribution system will comply with the following:

- The stainless steel room distribution system is a water delivery piping system designed specifically for an animal automated drinking water system. The system operates normally at a low pressure of 3-5 psi, but is subjected to flushing pressures up to 50 psi.
- This specification applies to the receiving, handling, storage, and installation of stainless steel tubing and fittings for an animal drinking water system.
- Furnish all materials in accordance with ANSI/ASTM Standard A450 Stainless Steel Tubing and manufacture in accordance with applicable codes and standards.
- Purchase the complete piping system from a single manufacturer. Factory cut and fabricate the tubing to system designed lengths, electro-polish, passivate and then cap and/or seal in a bag and suitably box for shipping protection. Individually bag each fitting and suitably box for shipping protection.
- Inspect shipping cartons upon delivery for damage and material cleanliness. Report promptly to the manufacturer any damaged material.
- Handle tubing to avoid bending or damage. Keep materials clean and free from grease and oil. Store all tubing and fittings in their original package until ready to use.
- Store all system material in an area segregated from other construction material. Choose a location inside a building protected from any corrosive atmosphere. Limit access to protect against physical damage, loss and contamination.

Products

1. Room distribution piping and fittings will comply as follows and according to Table 8-3:

- Distributes water from a pressure reducing station into and around each animal room and to flush drain points. Pressure rating is 200 psi minimum. Use piping/fitting design to allow mechanical dismantling for repair or replacement of individual components. Soldered, brazed or adhesive bonded joints are not permitted. Electro-polish externally and passivate all water contact surfaces to attain a uniform inactive oxide surface film.

Room Distribution Piping and Fittings Standards	
Stainless Steel Welded Tubing	1. .50 inches OD x .035 inches wall 2. 316 L grade

Room Distribution Piping and Fittings Standards	
Electro-polish/ Passivation Process	1. Electro-polish in 135°F solution of 65% phosphoric - 35% sulfuric acid 2. Passivate in 105°F solution of 20% nitric - 80% water 3. Final rinse with 125°F RO water to remove all chemical residues 4. Electro-polish and passivate after all fabrication and welding
Coupling, Elbow and Tee Fittings	1. Clean Fitting or equivalent sanitary type 2. 316 L grade stainless steel 3. ID: .43 inches to exactly match tubing ID 4. Electro-polish both internally and externally and passivate in accordance with Piping Systems specifications to a finish of 32 RA or better on all water contact surfaces 5. Joint Seal 6. High grade FDA approved silicone 7. Seal edge width: .05 inches 8. ID: .43 inches for flush internal joint 9. Ferrule: 316 Stainless Steel 10. Retainer hex nut: 303 stainless steel

Table 8-3

2. Interconnect station (I/C) assemblies will comply as follows and according to Table 8-4:

- Prefabricated piping assembly with a Quick Disconnect (QD)/half coupling fitting welded to one end.
- Clean Fitting connection or equivalent sanitary type.
- Design characteristics in accordance with Piping Systems specifications with base fitting of QD welded at branch port

Quick Disconnect (QD) Standards	
QD Type	Industry Standard 1/4 inches universal style socket
QD Base Fitting	1. .16 L grade stainless steel 2. Fitting length of 1.03 inches from tubing ID to QD seal
QD Components	1. 316 grade stainless steel 2. Electro-polish both internally and externally and passivate in accordance with 2.1.2 to a finish of 32 RA or better on all machined water contact surfaces 3. QD Seal: High grade FDA approved silicone (De-bur open end of pipe to make it clean fitting ready for field assembly)

Table 8-4

3. Pipe/ coupler assemblies will comply with the following:

- Prefabricated piping assembly with a half coupling fitting welded to one end
- Clean Fitting connection or equivalent sanitary type
- Design characteristics in accordance with Piping Systems specifications.
- De-bur open end of pipe to make it clean fitting ready for field assembly

4. I/Cs will comply with the following:

- Located in each animal room as shown on drawings and/or to adequately accommodate manifold connection for mobile or stationary racks or kennel/pen arrangements.
- I/C Connection: Edstrom I/C Assembly with universal style QD socket for hose connection
- Use pipe/coupler assembly for all piping runs not requiring I/C connections

5. Detachable Kynar recoil hose will comply according to Table 8-5.

Detachable Kynar Recoil Hose Standards	
Tubing coil	Black PVDF (Kynar) (3/8 inches OD x 1/4 inches ID, NSF standard 61, FDA grade, chlorine tolerance of .5 to 50 ppm)
Extended Reach	6 feet
Autoclavability	Maximum temperature of 250°F

Detachable Kynar Recoil Hose Standards	
QD Couplings-Universal Style	1. QD plug on upper end 2. QD socket on lower end 3. 316 grade stainless steel 4. Electro-polish both internally and externally and passivate in accordance with 2.1.2 to a finish of 32 RA or better on all machined water contact surfaces 5. Push lock barb connection
QD Seal	High grade FDA approved silicone
Stainless steel spring supports	3 inches long both ends

Table 8-5

6. Solenoid flush valves will comply with the following according to Table 8-6:

- Solenoid valve located down stream from the water supply rack connection points at the terminating end of each room distribution piping run for room distribution flushing or in the flush drain header at each rack location for on-line rack flushing.

Solenoid Flush Valve Standards	
Body Material	Electro-polished 316 stainless steel
Input Power	24 Volts Direct Current (VDC), 0.5 amp; Watertight junction box connection with screw connectors
Coil	Epoxy encapsulated one piece
Ports	3/8 inches FPT
Diaphragm	Teflon

Table 8-6

7. Rack flush recoil hoses will comply with the following according to Table 8-7:

- Animal rack flush hose/check valve/fitting assembly that connects the terminating point of the rack manifold to the drain header. QD plug on lower end of hose to plug into supply line/recoil hose QD socket when rack position is vacant.

Rack Flush Recoil Hose Standards	
Tubing coil	Black PVDF (Kynar) (3/8 inches OD x 1/4 inches ID, NSF standard 61, FDA grade, chlorine tolerance of .5 to 50 ppm)
Extended Reach	6 feet
Autoclavability	Maximum temperature of 250°F

Rack Flush Recoil Hose Standards	
Hose Fittings	1. Swivel nut with o-ring seal on upper end 2. QD plug on lower end – Universal style 3. 316 grade stainless steel - wetted parts 4. Push lock barb connection
Stainless steel spring supports	3 inches long both ends
Check Valve	Polyproplene body EPDM O-ring seal Stainless steel spring

Table 8-7

8. Capabilities and features will comply with the following:

- Stainless steel tubing and fittings to be passive in tap water, 10 ppm chlorinated water or 2.5 pH acidified water
- Edstrom Clean Fitting design provides a consistent, smooth, inside diameter conduit for unobstructed water flow throughout the system piping.
- Edstrom Clean Fitting seal design assures that no cracks or crevices exist between edge of tubing and mating fitting shoulder when fitting is fully assembled.
- Pocket created by the QD port in the I/C Assembly to be less than 2-1/2 tubing diameters long to allow for water exchange during flushing and to minimize the opportunity for microbial growth.

9. The execution will comply with the following:

- Perform installation with factory certified technicians on the Clean Fitting system or pre-qualify/train on-site technicians with factory authorized personnel. Instruct on all aspects of cutting tube, de-burring, tube bending and Clean Fitting assembly.

10. The fabrication will comply with the following:

- Factory de-bur ends of cut tubing so it is ready to assemble into the clean fitting
- Make field cuts with a stainless steel tubing cutter supplied by the system manufacturer and used only on stainless steel and chamfer outside and inside edges per assembly instructions to remove any burrs.
- Make square cuts to accurate lengths and assemble joints tightly.
- Use tube bending whenever possible for corners and offsets with a bender supplied by system manufacturer and used only on stainless steel.

11. Installation and mounting will comply with the following:

- Attach tubing to the wall, ceilings or other suitable support structure with 18 GA stainless steel clamps and other appropriate brackets. Use stainless steel mounting hardware.
- Provide a two-hole clamp at each I/C station within 2 inches of the QD fitting to provide adequate rigidity and support. Provide one-hole clamps at all other mounting points where suitable support can be attained. Space clamps not to exceed 36 inches.
- Provide plastic stand-off spacers under each clamp for wall mounting applications to mount piping off

the wall by 1/2 inch with plastic screw anchors and stainless steel self tap screws (#10 x 1-1/4 inches).

- Install the entire piping system at a consistent level throughout at a height of 84-96 inches above the floor. Limit any rises and drops.
- Provide a stainless steel wall plate on each side of the wall for wall break penetrations. Use silicone sealant to affix the plate to the wall and to make an air tight seal around the pipe. Avoid any mechanical joints inside walls. Do not use wall sleeves.

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Appendix C: Pressure Reducing Station

Standard

General

The Pressure Reducing Station is a panel assembly to provide animal drinking water at a normal operating pressure of 3-4 +/-1/2 pounds per square inch (PSI) with a minimum flow of one gallon per minute (GPM).

Edstrom Model 8550 Digital Display Station with Auto Flush and Monitoring Sensors.

Products

1. The enclosure/ panel will comply with the following:

- All parts will be constructed of 18 gauge 300 Series Stainless Steel, except back panel of 16 gauge, with commercial satin finish on all exposed surfaces. The two gasketed doors will have stainless hinges at each side to swing open and provide full access to all components:
    - Surface Mount Cabinet: 16 inches H x 25.5 inches W x 6.5 inches D.
    - Recessed Back Box: 16 inches H x 25.5 inches W x 6.5 inches D.
    - Recessed Door Frame: 17.5 inches H x 26.5 inches W.

2. The display/ interface module will comply with the following:

- Door mounted with digital readout of system pressure and LED Indicators for function status.
- Enclosure- ABS plastic, water resistant.
- Three-Character Display with pressure reading in psi, kPa/bar.
- Signal outputs for digital or network system connections.
- Output: 24 vdc to solenoid valve.
- Inputs: Pressure transducer, flow switch.
- LED Indicators: High and low pressure, flow, solenoid power and service.
- Plug-in cable connectors.

3. Wetted components for piping, fittings, valves, etc. will comply according to Table 8-8.

Wetted Components Standards	
Piping	1/2 inches OD Tubing- 316 L Stainless Steel
Fittings	Thread/Clean Joint Compression - 316 L Stainless Steel
Shut-off Valve	Ball Valve - 316 Stainless Steel
Flexible Hose	Silicone Hose reinforced with polyester braid

Wetted Components Standards	
Inlet Connection	Clean Joint Fitting - 1/2 inches Tube x 1/2 inches male pipe thread (MPT)
Outlet Connection	Flexible Hose with Clean Joint Fitting for 1/2 inches Tube

Table 8-8

4. Water filters will have a 5 inch housing standard (other options available) and comply according to Table 8-9.

Water Filter Standards	
Housing	Polypropylene with 3/8 inches female pipe thread (FPT) ports
Replacement Cartridge	5 micron spun polypropylene
Flow Rate	5 GPM at 50 psi
Screen	50 mesh Stainless Steel -unfiltered model only

Table 8-9

5. Pressure regulators will be a high flow design and comply according to Table 8-10.

Pressure Regulator Standards	
Materials- wetted parts	316 Stainless Steel Diaphragm: Silicone, 6 inch diameter Seat: Silicone
Ports	1/2 inches MPT inlet, 3/4 inches MPT outlet
Pressure Capacity	75 psi (max) inlet
Low Pressure Unit	Range: 2-8 psi adjustable outlet Standard setting: 3 psi Flow rate: 10 GPM @ 3 psi setting
High Pressure Unit	Range: 4-17 psi adjustable outlet Standard setting: 15 psi Flow rate: 14 GPM @ 10 psi setting

Table 8-9

6. Pressure transducers (CE approved) will comply as follows:

- Range: 0-25 psi (0.5% accuracy)
- Wetted Materials: 316 Stainless Steel

7. Flow switch non-adjustable (UL Recognized) will comply according to Table 8-10.

Flow Switch Standards	
Wetted Materials	Ryton-R4 and 316 Stainless Steel
Flow Rate Actuation of Switch	80 +/- 20 ml/min
Switch Function	N.O. (normally open with no flow)

Flow Switch Standards	
Switch Rating	Single Pole Single Throw (SPST) .17 amp at 120 Volts AC

Table 8-10

8. Solenoid valves will comply with the following:

- Normally closed (UL Listed).
- Wetted Materials: Electro-polished 316 Stainless Steel Body.
- Ports: 3/8 inch FPT.
- Coil: Epoxy encapsulated one piece 24 volts direct current (vdc), .5 amps.

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Appendix D: RO Water Purification System

Standard

General

The RO water purification system is a complete pre-engineered system designed specifically for animal drinking water applications. The water purification system is custom designed and built to meet the requirements for a specific application. Custom factors include the quality and quantity of water provided, storage tank capacity, distribution pump output, and pre-treatment and/or post-treatment options. A microprocessor controller automatically controls and monitors the system operation. V5-Watchdog ready interface is standard for remote monitoring and alarm communication.

Feedwater Requirements to the System	
Note: Local water conditions may dictate additional pretreatment to achieve specified performance.	
Flow rate	12 gpm @ 40 psi minimum
Temperature	77ºF (25ºC) ideal, 85ºF (30ºC) maximum.
	77ºF (25ºC) ideal, 85ºF (30ºC) maximum. Water temperature will affect permeate production rate. For a 1ºF drop in temperature a 2% drop in water production is expected
pH	5.8 - 11.0
Chlorine Concentration Tolerance	
Cellulose Acetate (CA) Membrane Polyamide (PA) Membrane	2.0 ppm max 0.0 ppm max
Total dissolved solids	1000 mg/One max
Turbidity	<5 SDI
Hardness	<15 grains per gallon
Maganese	<0.05 ppm
Organics	<1 ppm
Silicas	<1 ppm
Iron	<2 ppm in concentrate

Table 8-11

Products

1. Major system components will comply with the following:

- RO Unit - Pre-treat feedwater, process water through RO unit equipped with automated clean-in-place and flush systems, pH, conductivity and temperature monitoring, control panel with LCD graphics display and devices including pumps, piping, fittings, valves, sensors, and transmitters.

2. Pretreatment will have a pH Buffer System maintains feedwater at pH = 5.8-6.2 and comply according to Table 8-12.

Pretreatment Standards	
Solution Metering Pump	Positive displacement, diaphragm type with stroke length and frequency adjustments
Solution Tank (floor standing with recess for mounting solution pump)	1. Material: polyethylene 2. Capacity: 35 gallons 3. Low level detection switch: PVC
pH Sensor/Transmitter	1. Display: graphics display on controller 2. Automatic temperature compensation 3. Range: 0-14 pH 4. Accuracy: +/-0.2% depending on electrode calibration 5. Alarm set points for high and low pH
pH Probe	1. Glass electrode 2. PVDF housing with Viton seals

Table 8-12

3. Chlorination systems will maintains feedwater at 0.3-2.0 ppm chlorine concentration for chlorine tolerant (CA) membrane only and comply according to Table 8-13.

Chlorination System Standards	
Solution Metering Pump	Positive displacement, diaphragm type with stroke length and frequency adjustments.
Solution Tank (Floor standing with recess for mounting solution pump)	1. Material: polyethylene 2. Capacity: 35 gallons 3. Low level detection switch: PVC

Table 8-13

4. Pre-filters will comply as follows:

- Sized to application.
- Housing: polypropylene.
- Cartridge: 5 micron spun polypropylene.

5. RO Machines for cabinets and frame - floor standing will comply according to Table 8-14.

RO Machine Standards	
Overall Size	60 inches W x 38 inches D x 78 inches H max with membranes

RO Machine Standards	
Six Membrane Model	60 inches W x 38 inches D x 78 inches H max with membranes
Five or Less Membrane Model	60 inches W x 35 inches D x 78 inches H max with membranes
Material	300 series stainless steel
Optional Neutralization Tank	Separate floor standing assembly

Table 8-14

6. RO pumps and membranes will comply according to Table 8-15.

RO Pump and Membrane Standards	
Pump/ Motor	Type: multistage centrifugal Pump material: stainless steel Motor: 208-230/460 VAC, 60Hz, 3 phase, 3 HP Control: automatic with manual on/off inlet valve
Membranes	Type: spiral wound, 4 inches dia. x 40 inches length Material: cellulose acetate (CA) standard; polyamide (PA) optional Housing: 304 stainless steel; 4.5 inches dia x 49 inches high

Table 8-15

7. Sensors/transmitters and controls will comply according to Table 8-16.

Sensor/Transmitter and Control Standards	
Inlet Three-way Valve	Type: motorized valve Wetted material: PVC w/Viton seals
Temperature sensor monitors permeate water temperature	Wetted material: 316 stainless steel
Pressure sensors/transmitter monitoring parameters	1. Pre-filter/Supply Water pressure 2. Post-filter 3. RO pump outlet 4. Final pressure (Concentrate outlet pressure from membrane) 5. Permeate line pressure 6. Wetted material: 316 stainless steel
Flow sensor/transmitter measure flow rates	1. Concentrate to drain 2. Permeate 3. Wetted material: 316 stainless steel, PVDF, ceramic and Viton seals

Sensor/Transmitter and Control Standards	
Pressure sensor monitors permeate line pressure and system shuts down when over-pressure conditions occur	Wetted material: 316 Stainless Steel
Permeate purity valve directs permeate flow to storage tank or drain	1. Type: Three-way motorized valve 2. Wetted material: 316 Stainless Steel w/Teflon seats
Conductivity Sensor/ Transmitter (Monitors inlet water conductivity for use in program calculations)	
Display	Graphics display on controller
Mounting	Directly to inlet piping
Cell Constant	K=0.1
Range	5uS/cm-10 mS/cm
Accuracy	3% of measured value
Alarm Set Point	For high conductivity
Wetted Materials	PVDF with Viton seals & graphite electrode
Conductivity Sensor/ Transmitter Monitors permeate water to direct flow	
Display	Graphics display on controller
Mounting	Directly to inlet piping.
Cell Constant	K=0.1
Range	0.5uS/cm-200uS/cm
Accuracy	3% of measured value
Alarm Set Point	For high conductivity
Wetted Materials	PVDF with Viton seals & stainless steel electrode
Permeate Check valve: stops back flow into permeate side of membrane.	Wetted materials: 316 Stainless steel

Table 8-16

8. Control panels in RO with the cabinet operating the entire system will comply according to Table 8-17.

Control Panel Standards	
Controller	Microprocessor based
Display	64x240 character LCD graphics display
Alarm	Audible with disable mode.
Alarm Warning	Messages are displayed on control panel graphics display
Remote Alarm	Relay with dry contacts and V5 Watchdog connection for controller alarms; Second relay with dry contacts for loss of power alarm.
Input Power	24VAC, 60Hz, 1 phase isolated

Table 8-17

9. Maintenance equipment that provides automated operational processes for membrane maintenance will comply as follows and according to Table 8-18.

- Automatic flush system activates a bypass solenoid to increase water flow across the membrane automatically at preset time intervals.
- Automatic clean-in-place system cleans membrane with a cleaning solution automatically as required or a minimum of every 90 days.

Automatic Clean-in-place System Standards	
Note: Cleaning solution injection assembly proportionately injects solution into water supply line to fill clean-in-place tank.	
Tank	1. Material: polyethylene 2. Capacity: 18 gallons 3. Level detection switch: PVC
Process Control Valves	Fill solenoid: stainless steel
Recirculation valves	1. Motorized ball valve 2. Wetted material: PVC–inlet valve, 316 Stainless steel-CIP and permeate valve
Tank drain solenoid valve	316 Stainless Steel
Neutralization Tank Option (provides means to manually neutralize cleaning solution)	
Holding tank	Material: polyethylene Capacity: 30 gallons Drain Valve: PVC

Table 8-18

10. Piping, tubing, fittings, and connections will comply according to Table 8-19.

Piping, Tubing, Fittings and Connections Standards	
Wetted Materials	1. Feed Water: PVC/CPVC/Polyproplylene/ 316 stainless steel 2. Permeate water: 316 stainless steel
Sample Valves	1. Pre and post filters and concentrate flow (Ball type – PVC body) 2. Permeate flow (Needle type – 316 stainless steel)
Connections	1. Inlet: 1 inch FPT or 1 inch pipe solvent welded 2. Permeate outlet: 3/4 inches FPT 3. Drains: • Concentrate Drain: 3/4 inches FPT • CIP Drain: 3/4 inches FPT

Table 8-19

11. Storage and re-pressurization equipment will provide atmospheric tank storage and pump systems to accumulate the RO product water and re-pressurize for delivery through the supply header.

12. The storage tank assembly (floor standing) will comply according to Table 8-20.

Floor Standing Storage Tank Assembly Standards	
Capacity	Sized to application (90-1100 gallons)
Material	1. Tank and Gasket: Polyethylene 2. Cover: Polypropylene 3. Hardware: 316 stainless steel
Seal	Bolt down cover with gasket
Level Control	Level sensing pressure sensor/transducer
Switches	Back-up overflow float switch
Air Vent Filter	0.2 micron

Table 8-20

13. The purified water distribution dual pump skid will comply according to Table 8-21.

Purified Water Distribution Dual Pump Skid Standards	
Type	Centrifugal
Wetted Material	1. Pump: 316 L stainless steel passivated 2. Piping/Fittings: 316 stainless steel; passivated & electro-polished
Motor	1. 208-230/460 VAC, 60 Hz, 3 phase (sized to application, 1.5 - 2.0 HP) 2. Maximum 1.5 HP output pressure: 55 psi @ 60 Hz; 40 psi @ 50 Hz 3. Maximum 2.0 HP output pressure: 62 psi @ 60 Hz, 44 psi @ 50 Hz 4. Transformer may be required for all other VAC applications 5. 200 VAC/60 Hz convert to 240 VAC 6. 380 VAC/60 Hz convert to 480 VAC
Motor Starter	Frame-mounted and pre-wired to motors
Floor Standing Frame	Stainless steel
Size	30 inches D x 36 inches W x 49.5 inches H

Table 8-21

14. The interconnect piping, fittings and valves will comply according to Table 8-22.

Interconnect Piping, Fittings and Valve Standards	
Piping Material	1. Feed Water: PVC/CPVC/Polyproplylene/ Brass/ Stainless steel 2. Permeate Water: 316 stainless steel

Interconnect Piping, Fittings and Valve Standards	
Valve Material	1. Inlet Valve: PVC with Viton seals CIP 2. Permeate Valve: 316 stainless steel with Teflon seats

Table 8-22

15. The pressure tank (floor standing) will provide pressurized storage of RO product water and comply according to Table 8-23.

Floor Standing Pressure Tank Standards	
Capacity (Size per application)	1. 86-gallon tank with 25.4 gallon working capacity at 40/55psi draw down 2. Optional 34-gallon tank with 10 gallon working capacity at 40/55psi
Wetted Material	Polypropylene, butyl - FDA approved with stainless steel fitting
Size	1. 26 inches D X 47.2 inches H - (86 gallon) or 2. 22 inches dia x 29-1/2 inches H – (optional - 34 gallon)

Table 8-23

16. The system maintenance kit will provide equipment and supplies to check for proper system operation and comply according to Table 8-24.

System Maintenance Kit Standards	
Conductivity Meter	Portable battery operated meter to measure water purity
Standard Solutions	Initial supply for calibrating pH and conductivity analyzers
Chlorine Test Kit	Measures chlorine concentration
Daily Log Sheets	Tabulated forms to record operational data if unit is not monitored by V5 Watchdog

Table 8-24

17. The capabilities and features will be automatic operation with a microprocessor controller to control the entire system and minimize personal attention requirements.

18. The system performance will comply with the following and according to Tables 8-25 and 8-26.

- Specifications are based on designated operating parameters.
- Reject feedwater contaminants to listed levels for each membrane type according to Table 8-25.

CA Membrane Reject Contaminant Percentages	
Salt Rejection	93-97%

CA Membrane Reject Contaminant Percentages	
Organic Rejection	>200 MW
Bacteria Rejection	>99%
Pyrogen Rejection	>99%
Particle Rejection	>99%

Table 8-25

- Assume typical water with a mixture of monovalent and polyvalent salts.
- Expect some performance variations based on water temperature and local water conditions.
- Provide feedwater within temperature range of 50-85ºF (10-30ºC) or membrane life may be shortened. Max temperature is 104ºF (40ºC).
- Produce permeate at designated rates based on 60ºF feed water temperature. For every 1ºF below 60ºF, expect a 2% reduction in the permeate production according to Table 8-26.

Permeate Production	
CA Membrane	0.4 - 2.4 GPM (585-3510 GPD)
PA Membrane	0.9 - 5.2 GPM (1242-7452 GPD)

Table 8-26

- Recover permeate at a 50% ratio of feedwater as a standard, but base actual recovery on analysis of supply water
- Membrane life may be reduced if temperature is outside of 50-85ºF (10-30ºC). Maximum temperature 104ºF (40ºC)

19. The automated system control will comply with the following:

- Activate RO machine when water level in storage tank reaches refill point
- Activate pH pump when RO operates and monitor pH level with pH sensor/ transmitter to automatically keep feedwater adjusted to pH=5.8-6.2
- Activate chlorine pump to maintain chlorine level in feedwater at pre-established set concentration of 0.3-2.0 ppm. Prevent microbial growth internally in RO with adequate chlorination (CA membrane only).
- Check inlet pressure to automatically shut down RO machine for pump protection if water pressure or flow is lost.
- Check temperature of water to automatically shutdown RO machine for internal component protection if permeate water temperature rises above 100ºF
- Check conductivity of product water with sensor/analyzer for product water diversion to drain if sensor detects water quality below set purity.
- Activate one distribution pump when pressure tank pressure reaches the cut-in set point and shut down at cut-out set point.
- Operate two distribution pumps alternatively during run cycles to prevent stagnation from occurring.
- Provide automatic back-up of pump operation by operating only the good pump if either pump fails
- Display operational status on message screen.
- Activate RO system and flush solenoid valve to automatically increase water flow across membrane at

preset daily/hourly time intervals to flush sediment from membrane surfaces
- Determine need for membrane cleaning and activate as required based on sensor readings.
- Activate automatic clean-in-place system to clean membranes with a special solution as required or a minimum of every 3 months as follows:

  - Inject cleaning solution concentrate proportionately into RO water as it fills clean-in-place tank.
  - Control flow into tank with level detection switch.
  - Circulate solution mixture through reverse osmosis unit for preset time period.
  - Soak solution for preset time.
  - Drain solution mixture from tank.
  - Flush cleaning solution out of RO unit and continue to operate until acceptable purity level is attained.

- Provide daily log reporting from sensor readings and store in controller memory.

20. The automated system monitoring will comply with the following:

- Display alarm conditions on controller graphics screen.
- Activate audible buzzer and alarm message when alarm occurs.
- Close dry contact relay for controller alarm remote transmission to another device.
- Close dry contact relay for power loss alarm transmission to another device.
- Allow 98 days of operational data to be stored in the controller memory as follows:

  - View daily log data on the controller display one day at a time. Scroll to other days.
  - Allow daily log data to be transferred to an attached PC for archiving or printouts.

- Provide data transmission to send RO operational data and alarm messages to a remote message display of a V5 Watchdog computer.
- Provide alarm messages for abnormal conditions as follows:

  - High, low and empty product water storage tank levels.
  - Low solution levels in pH buffer and chlorine solution tanks.
  - Low inlet pressure.
  - High feed-water temperature.
  - Low flow from RO pump.
  - High/Low pH of feedwater.
  - High conductivity of product water.
  - Distribution pump failure

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Appendix E: Recoil Hose Flush Station

Standard

General

The recoil hose flush station will be a panel assembled, self-contained unit designed for wall-mounting. It shall provide a method to internally flush up to six detachable recoil hoses at one time. The flushing procedure involves connecting up to six recoil hoses to the flushing station and automatically flushing them with water and then evacuating the hoses with compressed air. Periodic flushing may control bacterial growth in the recoil hoses. For more effective bacterial control, the recoil hoses can be chlorine sanitized by installing a separate chlorine injector station in the feedwater line to the recoil hose flush station.

Description of Operation

The recoil hose flush station is designed to flush up to six recoil hoses with water or a sanitizing solution (with separate chlorine injector station) and then evacuate the hoses with compressed air. The manual flush station has ball valves that are turned manually to introduce water or air. The automated flush station is equipped with a controller with user adjustable times that controls two solenoid valves. This permits the flush sequence to be completed by just pushing one button. The controller has two- and four-cycle operation. Two-cycle operation has the capabilities to control the length of a plain water flush and air evacuation. Four-cycle operation is selected when the water supply is chlorinated to sequence through four timed steps:

1. Initial flush.
2. Soak period.
3. Second flush.
4. Air evacuation.

The recoil hose flush station operating parameters will comply according to Table 8-27.

Recoil Hose Flush Station Operating Parameters	
Water Supply Pressure	40-60 psi/75 psi maximum
Water Supply Flow	4 gpm minimum
Compressed Air	Clean, oil free
Compressed Air Pressure	15-60 psi/75 psi maximum
Compressed Air Flow	10 cfm (cubic feet per minute)

Table 8-27

Equipment, Components and Standards

Recoil Hose Flush Station Equipment and Component Standards	
Panel Size	Approximately 35 inches H x 25 inches W
Material	300 series 18 gauge stainless steel with pre-punched holes for mounting screws
Wetted Components	Piping: 1/2 inches OD Tubing - 316SS Fittings: Thread/Compression Type 316SS Check Valves - air & water inlet - Stainless Steel
Quick Disconnects	Material: 316 Stainless steel (wetted parts only) Style: Universal with ball check in quick disconnect QD plug
Valves	Solenoid operated Stainless Steel 115 VAC 50/60 Hz normally-closed pilot-operated type.
Plumbing Connections	Water/Air Inlet: Flange with swivel nut for 1/2 inches Male Pipe Thread (MPT) adaptor Drain: 1/2 inches OD 316 Stainless Steel Compression fitting with 15 feet of drain piping

Table 8-28

Recoil Hose Flush Station Control Panel Specifications (Model 5480 Only)	
Enclosure	NEMA 12, Size 10-1/2 inches H x 8-1/2 inches W x 5 inches D 304 Stainless Steel
Electrical Requirements	115 volts alternating current (VAC), 50/60 Hz, single phase, 1 amp with ground fault interrupter (GFI circuit) required (must be hard wired)
GP Controller Features	1. Start and Reset Buttons 2. 32-character LCD 3. Power and Alarm indicator lights 4. Audible Alarm with Silence Button 5. Keypad with dome switches 6. Selectable two- and four-cycle flush modes 7. Cycle settings: • Flush 1: Preset to 2 minutes; range is 1-9 minutes • Soak (four-cycle only): Preset to 30 minutes; range is 1-99 minutes • Flush 2 (four-cycle only): Preset to 2 minutes; range is 1-9 minutes • Air Evacuate: Preset to 15 seconds; range is 1-99 seconds

Table 8-29

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Appendix F: Chlorine Injection Station

Standard

General

The chlorine injector station will be a panel assembled self-contained unit designed for wall mounting. It will provide chlorinated water for the recoil hose flush station and other applications where the water flow rate is constant. Both units are UL LISTED.

The chlorine injection station is for use only with auto recoil hose flush station with a controller to provide control functions. The unit will include a metering pump, 4-gallon tank, flow switch, mixing chamber, electrical controls and wall mounting hardware. All components will be compatible with tap water or purified water supply. The approximate dimensions are 38 inches H x 35 inches W x 10 inches D.

Description of Operation

The chlorine injector station is designed to mix a sodium hypochlorite solution into the water flow. When water flow is detected by the flow switch, the metering pump will start injecting the chlorine solution. The pump will keep operating until water flow stops. The sodium hypochlorite solution is stored in a 4 gallon polyethylene tank.

Operating Parameters

Chlorine Injection Station Operating Parameters	
Water Supply Pressure	1. 75 psi maximum 2. Recoil Hose Flushing - 40-60 psi
Water Supply Flow	1. 0.25 gpm minimum 2. Recoil Hose Flushing - 4 gpm minimum 3. Water Supply Temperature: 40-120°F
Chlorine Concentration	0-20 ppm, adjustable ranges
Treatment Capacity Per Tank	Half full tank will treat approximately 1350 gallons of water at 20 ppm

Table 8-30

Equipment, Components, and Standards

Chlorine Injection Station Equipment and Component Standards	
Panel	Size: Approximately 23.5 inches H x 35 inches W Material: 300 series 18 gauge stainless steel with pre-punched holes for mounting screws
Piping, Fittings, Valves, etc.	
Piping	1/2 inches OD Tubing - 316SS
Fittings	Thread/Compression Type - 316SS
Ball Valve	3/8 inches FPT - 316SS
Inlet Connection	Flange with swivel nut for 1/2 MPT adaptor
Outlet Connection	1/2 OD compression fitting
Flow Switch	
Activation Flow Rate	.25 gallons/minute minimum
Construction	PVC with hermetically sealed switch
Electrical Rating	120 Volts AC, 50/60 Hz, (.5 amps maximum), normally closed.
Mixing Chamber	
Construction	Polypropylene; 3/8 NPT ports
Mixing Tube	PVC Pipe
Chlorine Injection Pump/ Tank Standards	
Construction	Glass fiber reinforced thermoplastic. All exposed fasteners are stainless steel
Flow Rate	Maximum capacity 26 ml/minute, maximum pressure 140 psi
Electrical Rating	1. 120 volts AC, 50/60 Hz 2. Average input power is 168 watts @ maximum speed
Suction and Injection	1. A foot valve with integral strainer is provided for the suction line 2. The injection point has an anti-siphon check valve with 1/2 inches NPT male connection
Solution Tank	1. Capacity: 4 gallon, size 12 inches x 6 inches x 12 inches 2. Material: Polyethylene
Control Panel (Model 301 Only)	
Enclosure	NEMA 12, Size 10 inches x 8 inches x 6 inches; 304 Stainless Steel
Electrical Requirements	120 Volts AC, 50/60 Hz, single phase, 1 amp with ground fault interrupter (GFI circuit) required (must be hard wired)
Controls	Selector switch for chlorinated water or plain water

Chlorine Injection Station Equipment and Component Standards	
Junction Box	
Enclosure	Weatherproof, aluminum two-gang switch box
Electrical Requirements	Must be powered from GP Controller on auto Recoil Hose Flush Station
Controls	Must be controlled by GP Controller on auto Recoil Hose Flush Station

Table 8-31

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Appendix G: Rack Manifold Flush Station

Standard

General

The automatic rack manifold flush station will be a panel assembled self-contained unit designed for wall mounting. It will provide chlorinated water at an operating pressure of approximately 17 psi for flushing and sanitizing mobile rack manifolds.

The flush station will consist of a metering pump, a 4 gallon tank, a flow switch, an inlet water filter/mixing tube, pressure regulator, wall mount hardware, a poly recoil hose with quick disconnect on the outlet side for connection to the mobile rack watering manifold and a solenoid valve and Controller for one- or three-cycle operation. The approximate dimensions are: 40 inches H x 37 inches W x 10 inches D.

The automated flush station will have stainless steel solenoid valve and controller for tap water or purified water supply.

Description of Operation

The rack manifold flush station is designed to mix a sodium hypochlorite solution into the water flow. When a rack manifold is connected to the rack manifold flush station and water flow is detected by the flow switch, the metering pump will start injecting the chlorine solution. The pump will keep operating until the preset time has elapsed (automatic units) or water flow stops. The sodium hypochlorite solution is held in a 4-gallon polyethylene tank.

The automated rack manifold flush station uses the GP Controller to control and monitor one- or three-cycle operation. One-cycle operation controls the length of flush time only. Three-cycle operation sequences through 3 timed steps: initial flush, soak period, and final flush.

Operating Parameters

Rack Manifold Flush Station Operating Standards	
Water Supply Pressure	25 psi minimum/75 psi maximum
Water Supply Flow	2 gpm minimum
Water Supply Temperature	40-120ºF (4 - 49ºC)
Flush Station Output Pressure	15-17 psi
Flush Station Output Flow	0.25 gpm minimum, 1.0 gpm typical
Chlorine Concentration	20 ppm recommended, adjustable

Rack Manifold Flush Station Operating Standards	
Flush Cycles per Tank (This is 180-480 manifold flush cycles depending on flush time and flow rate.)	One full tank will treat approximately 720 gallons of water at 20 ppm or 1300 gallons at 10 ppm.

Table 8-32

Equipment, Components, and Standards

Rack Manifold Flush Station Equipment and Component Standard	
Panel	1. Size: Approximately 23.5 inches H x 35 inches W 2. Material: 300 series 18 gauge stainless steel with pre-punched holes for mounting screws
Piping, Fittings, Valves, etc.	
Piping	1/2 inches OD Tubing-316SS
Fittings	Thread/Compression Type-316SS
Valves	1. Solenoid operated Stainless Steel 115 VAC 50/60 Hz; normally closed pilot-operated type and stainless steel ball type 2. Check Valves: 316 Stainless Steel 3. Inlet Connection: Flange with swivel nut for 1/2 MPT adaptor
Flow Switch	
Activation Flow Rate	.25 gallons/minute minimum
Construction	PVC with hermetically sealed switches
Electrical Rating	115 Volts AC, 50/60 Hz (.50 amps maximum), normally closed
Mixing Chamber	
Construction	Polypropylene with 3/8 NPT ports
Mixing Tube	PCV pipe
Chlorine Injection Pump/ Tank	
Construction	1. Glass fiber reinforced thermoplastic 2. All exposed fasteners are stainless steel
Flow Rate	1. Maximum capacity 31 ml/ minute 2. Maximum pressure 100 psi
Electrical Rating	1. 115 volts AC, 50/60 Hz 2. Average input power is 130 watts at maximum speed
Suction and Injection	1. A foot valve with integral strainer is provided for the suction line 2. The injection point has an anti-siphon check valve with 1/2 inches NPT male connection

Rack Manifold Flush Station Equipment and Component Standard	
Solution Tank	1. Capacity: 4 gallon, Size 12 inches x 6 inches x 12 inches 2. Material: Polyethylene
Pressure Regulator	
Construction	3. 316 Stainless steel wetted parts
Ports	4. 1/2 inches MPT inlet, 3/8 inches MPT outlet
Pressure Capacity	5. 75 psi maximum inlet, 17 psi outlet
Flow	6. 17 psi - 13 gpm
Recoil Hose Assembly	
Hose Material	7. Polyurethane - 3/8 inches OD by 1/4 inches ID, black, FDA Grade
Hose Reach	8. 10 feet
Quick Disconnect	9. Universal Style stainless steel socket
Control Panel	
Enclosure	NEMA 12, Size 10 inches H x 8 inches W x 6 inches D 304 Stainless Steel Construction
Electrical Requirements	115 volts AC, 50/60 Hz, single phase, 1 amp with ground fault interrupter (GFI circuit) required (must be hard wired)
Controls	Manual: Selector Switch for Chlorinated Water or Plain Water Automatic: GP Controller features 1. Start and Reset Buttons 2. 32-Character LCD 3. Power and Alarm indicator lights 4. Audible Alarm with Silence Button 5. Keypad with dome switches 6. Selectable one- and three-cycle flush modes 7. Cycle settings: • Flush 1: preset to 2 minutes; range is 1 - 9 minutes • Soak (three-cycle only): Preset to 30 minutes; range is 1 - 99 minutes • Flush 2 (three-cycle only): Preset to 2 minutes; range is 1 - 9 minutes

Table 8-33

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Appendix H: Fire Alarm Strobes in Animal Housing Areas

TEXAS DEPARTMENT OF LICENSING AND REGULATION
Code Review and Inspections Division
ARCHITECTURAL BARRIERS
P.O. Box 12157 • Austin, Texas 78711 • (512)463-3211 • (877)278-0999 • FAX (512)475-2886
www.license.state.tx.us • Architectural.Barriers@license.state.tx.us

VARIANCE APPLICATION

In accordance with Rule 68.31, I hereby apply for variance or waiver of a standard or specification required for compliance with the Architectural Barriers Act, Article 9102, Texas Civil Statutes as they apply to the facility described on the **attached Project Registration Form** on the grounds that literal compliance with the Department's regulations is impractical in this case. **NOTE:** A completed Project Registration Form must accompany variance application or the application will be returned as incomplete.

FORM MUST BE COMPLETED IN FULL — PLEASE PRINT OR TYPE

Project Name: Basic Sciences Research Building		AB Project Number: EABPRJA2805807 (*Required field if project is registered)
Building/Facility Name: M.D. Anderson Cancer Center		
Street Address: 1515 Holcombe Blvd.	City/Zip: Houston, TX 77030	Telephone: (713)792-7792
Owner: The University of Texas System		
Mailing Address: 6900 Fannin-Mezzanine Level	City/Zip: Houston, TX 77030	Telephone: (713)794-4360

Is building/facility being considered for state lease? ☐ Yes XX No
Has bidding or award of contract occurred? ☐ Yes XX No

If yes to either, identify the state agency and provide a state agency contact name: — Telephone:

Is a state agency **currently** located in this building/facility? XX Yes ☐ No
If yes, identify state agency, provide location (i.e. floor, suite), and the state lease number if applicable:
U.T./M.D. Anderson Cancer Center occupies entire building

Total square footage of building/facility: 505,000 Per floor: approximately 30,000 gsf

Check the work performed: XXX New Construction ☐ Addition ☐ Renovation/ Modification/ Alteration ☐ Change in Occupancy

State the section of the Texas Accessibility Standards for which a variance is being requested. Separate applications must be submitted for each standard or specification to be considered.

Section #	Location and Description of Nonconforming Condition
4.28.1	Animal rooms in vivarium

If the building/facility is a qualified historic building or facility, identify the historical designation and indicate date of designation, if applicable. no

NOTE: If this is a qualified historic building or facility, you must provide a determination of effect letter from the Texas Historical Commission.

State **in detail** the reason why compliance with the standard or specification is impractical. Include the cost necessary to achieve compliance and any scaled drawings, photos, or other documentation that would assist in our determination. Use additional sheets if necessary. See attached.

TDLR FORM a013AB 09-04-01 OVER

State the estimated cost of construction relating to this project: $126,141,000

Was a building permit required for this work? ☐ Yes XX No   Date Issued:

Have any other building permits been issued for this building/facility within the past 24 months? ☐ Yes XX No

If yes, state the date that permits were issued and the cost of construction for each permit:

Has a certificate of occupancy been issued for the building/facility? ☐ Yes ☐ No   Date Issued:

What is the original date of construction of this building/facility? Completed 3/31/2005

To the best of your knowledge, has a complaint ever been filed on this building/facility relative to accessibility?

☐ Yes XX No   If yes, what were the circumstances?

Was the complaint resolved? ☐ Yes ☐ No   Explanation:

State the phase of design or construction of the facility as of the date of this application:

Construction is completed.

PLEASE NOTE: The Department shall decide your application based on information submitted. You should therefore include all relevant information with your application. Drawings and photographs may be extremely beneficial.

September 6, 2005
Date

Luis Vivar, AIA
Name

FKP Architects, Inc.
Company/Firm

8 Greenway Plaza, Suite 300
Address

☐ Owner

[XX] Agent

Houston, TX 77030
City / State / Zip Code

Signature

(713)621-2100
Telephone

A $175.00 **NON-REFUNDABLE** PAYMENT MUST ACCOMPANY EACH APPLICATION . MAKE CHECK PAYABLE TO THE TEXAS DEPARTMENT OF LICENSING AND REGULATION AND MAIL TO TDLR, P. O. BOX 12157, AUSTIN, TEXAS 78711. APPLICATIONS RECEIVED WITHOUT PAYMENT WILL NOT BE PROCESSED. INCOMPLETE APPLICATIONS WILL BE RETURNED

Texas Department of Licensing and Regulation
Architectural Barriers Project Registration Confirmation Page
Thursday , October 11, 2001
EABPRJA2805807

PERSON FILING FORM
Name: Luis D. Vivar, AIA **Email:** **Phone:** 713-621-2100

Project Name: Basic Sciences Research Building
Project Address: M D Anderson Cancer Center
1515 Holcombe Blvd
Houston, TX 77030 **County:** Harris

TENANT Name: M D Anderson Cancer Center **Phone:** 713-792-7792
Tenant Address: 1515 Holcombe Blvd, Houston, TX 77030
Contact Name: Tommy Thomas/Capital Planning & Management **Phone:** 713-792-6667
Contact Address: 6900 Fannin - Suite1010, Houston, TX 77030-4095

BUILDING/FACILITY Name: M D Anderson Cancer Center
FACILITY Owner: The University of Texas System **Phone:** 713-794-4333
Owner Address: 6900 Fannin - Mezzanine Level, Houston, TX 77030
Contact Name: Ed Westland/Resident Construction Manager **Phone:** 713-794-4356
Contact Address: 6900 Fannin - Mezzanine Level, Houston, TX 77030

DESIGN FIRM Name: FKP Architects, Inc. **Phone:** 713-621-2100
Firm Address: 8 Greenway Plaza - Suite 300, Houston, TX 77046-0801
Designer Name: John Crane, AIA **Email:** jcrane@fkp.com

Type of License: Architect **License Number:** 4686

PROJECT DESCRIPTION
Date Construction Documents Issued: 09/28/2001
Start Date: 04/2001 **Completion date:** 10/2003 **Estimated Cost:** $126,141,000.00
Type of Work: New Construction
Does this building(s) have more than one level?
Are there any elevators, escalators, or platform lifts in this building?
Type of Funds: This project involves public funds, public land, tax abatement or is a state lease.
State Lease No. :
Scope of Work: Research building consisting of 17 levels that can be occupied, including 1 basement. The building gross square feet is 505,000. There will be 3 major functions in the building: a vivarium located on Level 1 and the Basement, an educational component located on Level 3, and research laboratories located on Level 5 and above.

I will submit this AB Confirmation Page with a complete set of construction documents and applicable fees totaling **Please contact TDLR for negotiated fee.** (Total includes plan review and filing fee) to: TDLR P.O. Box 12157 Austin, Texas 78711.

I hereby notify the Texas Department of Licensing and Regulation of the described project and of my intent to perform, or cause to be performed, all services necessary to design said project in accordance with the provisions of Texas Government Code, Chapter 469. I certify that I am the registered design professional with overall responsibility for the design of the project and whose seal is affixed to the construction documents.

Signature of Design Professional | **Date** | **Email Address**

OR

I hereby notify the Texas Department of Licensing and Regulation of my intent to comply with the provision of Texas Government Code, Chapter 469.

Signature of Building Owner or Designated Agent | **Date** | **Email Address**

Enter Another Project | Print This Page

Top of Page| TDLR Home Page|AB Home Page |AB Project Registration Page| Feedback

Click BACK to go to Previous Page

THE UNIVERSITY OF TEXAS
MD ANDERSON
CANCER CENTER

Linda D. Lee, Dr.P.H., R.E.M.
Executive Director, Environmental Health and Safety

Texas Department of Licensing and Regulation

Re: Request for Variance to Require White/Clear Fire Alarm Strobes in Animal Housing Areas

To Whom It May Concern:

This letter is to document, as the official local Authority Having Jurisdiction (AHJ) that I accept the alternative fire alarm compliance plan for animal housing areas at M. D. Anderson Cancer Center. This alternative consists of installing red strobes in the place of the clear/nominal white ones specified by the 2003 edition of the NFPA 72, National Fire Alarm Code. The justification for this substitution is that white or clear strobes will have a significant negative affect on the animals housed in the areas to the point that the intended operations (animal husbandry) would probably be made untenable when the alarms go off. These alarms will occur at least twice per year for fire drills and testing/inspections; false alarms not withstanding.

The installation proposed meets the requirements of the AHJ, as is required under the Fire Alarm Code.

Some pertinent background information includes the fact that the Texas Sate Fire Marshal's Office has designated state campus Environmental Health and Safety departments as the local AHJ. This reflects the fact that frequently these campuses have highly qualified Life Safety and Fire Alarm experts on staff as M. D. Anderson Cancer Center does. At M. D. Anderson Cancer Center, the Executive Director of Environmental Health and Safety was specifically given signature authority in this regard.

Enclosed is an e-mail from the Fire Marshal documenting the designation of authority which has been in place for a couple of years now, cut sheets of the U.L. listed device to be installed and a typical installation.

Sincerely,

Linda D. Lee

Linda D. Lee, Dr.P.H., R.E.M.
Executive Director, Environmental Health and Safety
(713) 792-2888

CARING • INTEGRITY • DISCOVERY

1515 HOLCOMBE BOULEVARD • HOUSTON, TEXAS 77030-4009 • 713-792-2121 • www.mdanderson.org
A Comprehensive Cancer Center designated by the National Cancer Institute
located in the Texas Medical Center

1 September 2006

THE UNIVERSITY OF TEXAS
MD ANDERSON
CANCER CENTER

Department of Veterinary Medicine
and Surgery – 063
713-792-2780
FAX 713-794-4546

To: Charles H. Carlisle
Program Manager, Safety
Environmental Health & Safety, Physical Safety

From: Kenneth N. Gray, DVM, MS
Chairman, DVMS

Re: Need for Red Lens Strobe Visual Fire Alarm Devices in Animal Housing Rooms

Because of the high number of researchers who produce transgenic animals, requiring large scale breeding programs, it is imperative that the animals' not be exposed to light pulses that would affect pineal activity. The pineal gland produces melatonin, which controls an animal's biological rhythm and reproductive functions. It is crucial that the animal housing and procedure rooms in the Mitchell Basic Sciences Research Building be equipped visual fire alarm devices with red lens strobe lights that will not be perceptible to the rodents during the dark cycle. Below are references with excerpts that support this requirement. The *Guide for the Care and Use of Laboratory Animals* is the main resource used by the Association for Assessment and Accreditation of Laboratory Animal Care (AAALAC, International).

National Research Council. 1996. *Guide for the Care and Use of Laboratory Animals*. 7th Edition. National Academy Press, Washington DC.
"Photoperiod is a critical regulator of reproductive behavior in many species of animals and can also alter body-weight gain and feed intake. Inadvertent light exposure during the dark cycle should be minimized or avoided." (page 35)

McLennan, IS, Taylor-Jeffs, J. 2004. The use of sodium lamps to brightly illuminate mouse houses during their dark phases. *Laboratory Animals*. 38(4):384-92.
"A brief light pulse (200 lx/15min), 2h before lights on, suppressed both plasma and pineal melatonin to near basal levels within 30min. Exposure to light pulses 4h after lights off or 2h before lights on resulted in delays and advances, respectively, in the early morning decline of plasma and pineal melatonin on the next cycle."

Jarmak, A, Zawilska, JB, and JZ Nowak. 1998. The effect of various wave lengths of light and various duration of impulse times on suppression of n-acetyltransferase activity in the rat pineal gland. *Klinika Oczna*. 100(2):77-80.
"Exposure of rats to white, green, and blue lights for 1min decreased NAT pineal activity by 56%, 46%, and 21%, respectively, while the 1min pulse of red light did not significantly alter the enzyme activity."

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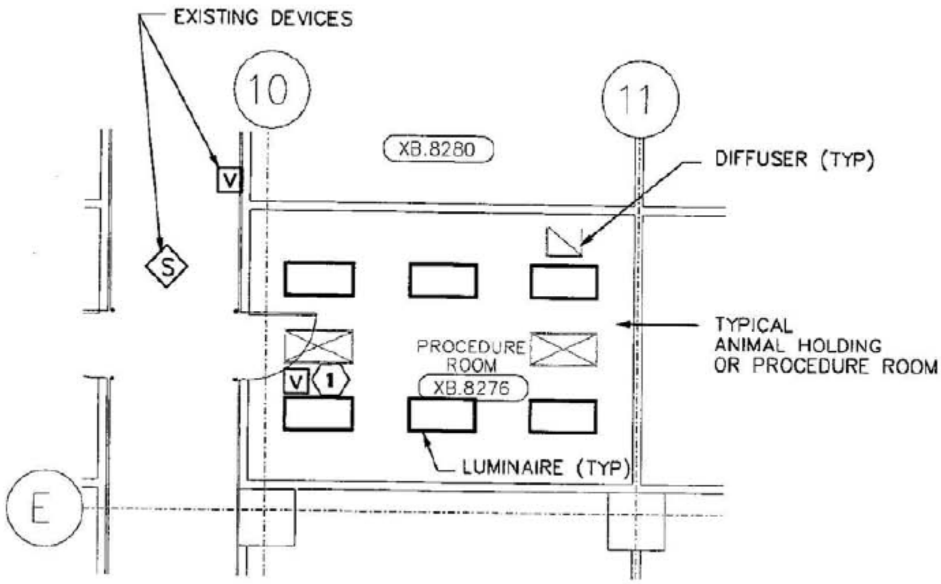
1515 HOLCOMBE BOULEVARD • HOUSTON, TEXAS 77030-4009 • 713-792-2121 • www.mdanderson.org
A Comprehensive Cancer Center designated by the National Cancer Institute located in the Texas Medical Center



KEYED NOTES

⟨1⟩ CELING MOUNTED RED STROBE, UL-1638; PLACE ADJACENT TO RECESSED LUMINAIRE FOR ACCESS THROUGH 2X4 OPENING.
MFR: WHEELOCK #RSSR-2475C-NW

INTERIM REVIEW ONLY
Document Incomplete.
Not Intended for permit, bidding or construction.
Engineer:
DOUGLAS G. GARRISON
P.E. Serial No: 53582
Date: 08/29/2005

FKP FKP Architects, Inc.	Architecture Interior Architecture Planning Equipment Planning	8 Greenway Plaza, Suite 300 Houston, Tx 77046-0801 Telephone: 713/621-2100 Facsimile: 713/621-2178	Project No.: 55014.00
			Sheet: NA — Sk# 01
	Project Name: BASIC SCIENCE RESEARCH BUILDING		Date: 08/26/08 — Scale: 1/8"=1'-0"

TEXAS DEPARTMENT OF LICENSING AND REGULATION
Compliance Division/ARCHITECTURAL BARRIERS
P.O. Box 12157 Austin, Texas 78711 (512)463-3211 (877)278-0999 FAX (512)475-2886
Email Address: architectural.barriers@license.state.tx.us Internet Address: www.license.state.tx.us

October 19, 2005

Mr. Luis Vivar, AIA
FKP Architects, Inc.
8 Greenway Plaza, Suite 300
Houston, TX 77030

Re: Variance Request dated: 09/06/05 EABPRJA2805807
Basic Sciences Research Bldg
MD Anderson Cancer Center
Houston, TX 77030

Dear Mr. Vivar:

The post-inspection variance request to waive the requirement to provide white xenon strobes in the typical animal holding rooms has been reviewed. The information submitted supports that the nature, use and function of these spaces are unique to animals and the variance is not required. The alarm system meets the requirements of TM 02-3.

This variance applies only to this project and is not intended to imply that a same or similar situation will have the same result.

If you wish to appeal this decision, you may do so by contacting the Director of Compliance Division, George Ferrie. Your written response must be received within twenty-one days of receipt of this letter and be accompanied by a $200.00 fee. Any additional information you wish to submit to support your position will be considered at that time.

Please be aware that this decision is based solely on the Government Code, Chapter 469 for the Elimination of Architectural Barriers and the Texas Accessibility Standards (TAS). It does not address compliance with the Americans with Disabilities Act (ADA) or any other local, state, or federal requirements. For information on the ADA, call the regional ADA Hotline at (800) 949-4232, or the U.S. Department of Justice at (202) 514-0301.

Please reference the EABPRJ number in all future correspondence pertaining to this project. If you have any questions or if we can be of assistance in assuring compliance with state law, please call us at (512) 463-3211.

Sincerely,

Linda L. Stewart

Linda L. Stewart, Program Specialist II
Architectural Barriers

Austin Headquarters: E.O. Thompson State Office Building · 920 Colorado · Austin, Texas 78701

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ARSAC Design Standards for Small Animals (Rodents) Vivarium

Glossary of Terms

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Glossary of Terms

A

A/E: Architecture and Engineering team

AAALAC, International: Association for Assessment and Accreditation of Laboratory Animal Care, International

AHRs: Animal Housing Rooms

AHU: Air Handling Unit

ARSAC: Animal Research Strategic Advisory Committee

ASC: Application Specific Controllers

ASHRAE: American Society for Heating, Refrigeration and Air Conditioning Engineers

ASME: American Society of Mechanical Engineers

ASTM International: American Society for Testing and Materials

B

BAS: Building Automation System

BCuP5: A metal alloy used in welding copper pipe.

BOD: Basis of Design

BREB: Basic Research and Education Building (Bastrop Campus)

BSC: Biological Safety Cabinet

BSC IIA2: Biological safety cabinet that provides personnel, product and environmental protection. Self-exhausts approximately 30% back into the room and re-circulates the rest.

BSC IIB1: Biological safety cabinet that provides personnel, product and environmental protection. Exhausts more than 50% via a remote ventilated system (i.e., building exhaust) and re-circulates the rest. Also known as 70% exhaust.

BSC IIB2: Biological safety cabinet that provides personnel, product and environmental protection. Exhausts 100% via a remote ventilated system (i.e., building exhaust). No recirculation.

BSL1: Biosafety Level 1, basic level of protection appropriate for well-characterized agents not known to cause disease in healthy humans.

BSL2: Biosafety Level 2, moderate risk agents that cause human disease by ingestion or through percutaneous or mucous membrane exposure. Emphasis on precautions with needles and sharp instruments.

BSL3: Biosafety Level 3, high, possibly lethal, risk agents that cause human disease by inhalation exposure. Emphasis on control of aerosols.

BSL4: Biosafety Level 4, high individual risk of life-threatening disease by the aerosol route and no treatment is available

BSRB: George and Cynthia Mitchell Basic Sciences Research Building

C

°C: The universal symbol for degrees Celsius.

CABIR: Center for Advanced Biomedical Imaging Research Building

CAP type II: College of American Pathologists, laboratory reagent grade water that maintains 1,000 colonies of bacterial per ml of water maximum, and the electrical resistance of the water may not drop below 2 Megohms at the outlet.

CCTV: Closed Circuit Television

CFM: Cubic Feet Per Minute, a measure of air flow.

CFR: Code of Federal Regulations

CMU: Concrete Masonry Units

CO2: Periodic table symbols for carbon dioxide.

CPVC: Chlorinated Polyvinyl Chloride, a type of plastic commonly used for water distribution.

CTT: Center for Targeted Therapy

CUH2A: An A/E firm

D

dB: "Decibel," which is used in reference to a unit or quantitative measurement for sound.

DDC: Direct Digital Control

DVMS: Department of Veterinary Medicine and Surgery

E

EH&S: Environmental Health and Safety

EPDM gaskets: Gaskets made of Ethylene Propylene Diene Monomer.

F

°F: The universal symbol for degrees Fahrenheit.

FPM: Feet Per Minute

fps: Feet Per Second

FRP: Fiberglass Reinforced Plastic

feet: An abbreviation for the measurement feet, which equals 12 inches.

FTE: Full Time Equivalent, the measure of one full time employee's work time.

G

GHz: International System of Units abbreviation for "gigahertz," which means "one billion cycles per second."

GLP: Good Laboratory Practices

GMP: Guaranteed Maximum Price or Good Manufacturing Practice

GPM: Gallons Per Minute

H

HEPA: High Efficiency Particulate Air Filter

HIPAA: Health Insurance Portability and Accountability Act enacted by the U.S. Congress in 1996.

HVAC: Heating, Ventilation and Air Conditioning

Hz: International System of Units abbreviation for "hertz," which means "one cycle per second."

I

in: An abbreviation for the measurement of inches.

I.R.I.: Industrial Research Institute

IDF: Intermediate Distribution Frame is a cable rack that interconnects and manages the telecommunications wiring between a main distribution frame and workstation devices.

IEEE: Institute of Electrical and Electronics Engineers, Inc.

IS: Information Security team on a project.

K

kV: Kilovolt, which equals 1000 volts.

L

LN2: Liquid Nitrogen

M

mA: Milliampere (1/1000 of an Ampere) is a unit electrical current measure produced in a circuit by 1 volt acting through a resistance of 1 Ohm.

MBC: Master Building Controllers

Mbps: Megabytes Per Second

MCC: Motor Control Centers

MEC: Modular Equipment Controllers

MEP: Mechanical, Electrical and Plumbing, usually used as a noun to refer to the company or contractor providing the engineering of those services.

micron: A unit of measure equaling 1,000,000th of a meter or approximately 0.00003937 inches.

N

NEC: National Electric Code

NFPA: National Fire Protection Association

NIH: National Institute of Health

NIST: National Institute of Standards and Technology

Nm: Newton meter, a compound unit of torque corresponding to the torque from a force of one Newton applied over a distance of one meter; dimensionally equivalent to a joule

NRC: National Research Council

O

O2: Periodic table symbol for Oxygen.

P

PC/DOS: Operating system for IBM type computers

pH: A symbol used to represent the measurement scale that determines the acidity or basicity of hydrogen ions in a solution.

PIR: Passive Infrared sensor is an electronic device that measures infrared light radiating from objects in a field of view

PM: Project Manger

PRS: Pressure Reducing Station

PRV: Pressure Reducing Valve

psi: Pounds Per Square Inch

psig: Pounds Per Square Inch Gauge

PVC: Polyvinyl Chloride is a material used in constructing a variety of materials from plumbing fixtures to vinyl siding.

R

REF: Research and Education Facilities

RH: Relative Humidity

RO System: Reverse Osmosis water generating equipment and distribution piping.

RTD: Resistance Temperature Detector is a wire-wound and thin film device that measures temperature through the physical principle of the positive temperature coefficient of electrical resistance of metals.

S

SCFM: Standard Cubic Feet Per Minute is the volumetric flow rate of gas corrected to "standardized" conditions of temperature, pressure and relative humidity.

SCV: South Campus Vivarium

SMACNA: Sheet Metal and Air Conditioning Contractors National Association

SRB: R. E. "Bob" Smith Research Building

STC: Society for Technical Communication

T

TDLR: Texas Department of Licensing and Regulation

TECO: Thermal Energy Cooperative, a business that provides steam and chilled water to TMC

TMC: Texas Medical Center

U

UL: Underwriters Laboratory

UPS: Uninterrupted Power Systems

UTPD: University of Texas Police Department (at Houston)

V

VMS: Vivarium Management System

VSD: Variable Speed Drives

W

Wi-Fi: Wireless Fidelity is a method radio waves transmit signals.

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ARSAC Design Standards for Small Animals (Rodents) Vivarium

References

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References

1.0 Introduction

Several industry and governmental standards and publications were used as reference material and input for the establishment of minimum design requirements for facilities to be used for the housing, care and use of animals in biomedical research at MD Anderson. The primary sources for knowledge and information were:

- National Research Council, Guide for the Care and Use of Laboratory Animals.
- National Institute of Health, Design Policy and Guidelines, Animal Research Facilities.
- Association for Assessment and Accreditation of Laboratory Animal Care, Handbook of Facilities Planning, Vol. 2, Laboratory Animal Facilities.
- Centers for Disease Control, Bio-Safety in Microbiological and Biomedical Laboratories.
- M. D. Anderson Noise, Vibration, and Ultrasound Design Guide.

2.0 Piping Systems

General

- National Research Council, Institute of Laboratory Animal Resources. 1996. The Guide for the Care and Use of Laboratory Animals. Chapters 2 and 4.
- National Institute of Health. 2003. NIH Design Policy and Guidelines, Animal Research Facilities. Design Criteria D-16, 17 and 18.
- Affiliated Engineers Inc. January, 2002. Mitchell BSRB Updated Basis of Design Document. Various Sections, Section 8, Design Parameters.

2.1 Piping Systems: System Descriptions

Domestic Hot, Hot Water Return and Cold Water

National Research Council, Institute of Laboratory Animal Resources. 1996. The Guide for the Care and Use of Laboratory Animals. Chapters 2 and 4.

National Institute of Health. 2003. NIH Design Policy and Guidelines, Animal Research Facilities. Design Criteria D-16, 17 and 18.

Affiliated Engineers Inc. January, 2002. Mitchell BSRB Updated Basis of Design Document. Various Sections, Section 8, Design Parameters.

Reverse Osmosis (RO) Water

National Research Council, Institute of Laboratory Animal Resources. 1996. The Guide for the Care and Use of Laboratory Animals. Chapters 2, page 40.

Affiliated Engineers Inc. January, 2002. Mitchell BSRB Updated Basis of Design Document. Various Sections, Section 8, Design Parameters.

MD Anderson Capital Planning & Management. April 11, 2005. Physical Plant Building Redevelopment, Design Guidelines. Sections D2000, Plumbing General Guidelines and D2020, Domestic Water Distribution.

MD Anderson CP&M Master Specifications, March, 2010.

Compressed Air

Affiliated Engineers Inc. January, 2002. Mitchell BSRB Updated Basis of Design Document. Various Sections, Section 8, Design Parameters.

Special Gases, O2 and CO2

Affiliated Engineers Inc. January, 2002. Mitchell BSRB Updated Basis of Design Document. Various Sections, Section 8, Design Parameters.

CUH2A, I. 7.0 MD Anderson Plumbing Requirements. (2006).

NFPA 99

ASTM

Laboratory Vacuum

Affiliated Engineers Inc. January, 2002. Mitchell BSRB Updated Basis of Design Document. Various Sections, Section 8, Design Parameters.

UT MD Anderson Design Guidelines. South Campus Vivarium Project 04-0032. April 11, 2005.

Natural Gas

Affiliated Engineers Inc. January, 2002. Mitchell BSRB Updated Basis of Design Document. Various Sections, Section 8, Design Parameters.

NFPA 45, Fuel Gas Code.

Liquid Nitrogen (LN2)

Affiliated Engineers Inc. January, 2002. Mitchell BSRB Updated Basis of Design Document. Various Sections, Design Parameters.

CUH2A, I. 7.0 MD Anderson Mechanical Design Requirements. (2006).

Guide for the Care and use of Laboratory Animals, revised 1996. NIH Pub. No. 85-23. Washington, DC Public Health Service.

Chart Industries Design Guide for Liquid Nitrogen Piping, 2004

Fire Protection

Affiliated Engineers Inc. January, 2002. Mitchell BSRB Updated Basis of Design Document. Various Sections, Section 8, Design Parameters.

CUH2A, I. 7.0 MD Anderson Fire Protection Design Requirements. (2006).

NFPA 13.

Sanitary Waste and Vent

MD Anderson Design Guidelines & Specifications, March, 2010.

National Institute of Health. 10/14/2009 NIH Design Policies & Guidelines, Drainage Systems, Section 8-6.

Affiliated Engineers Inc. January, 2002. Mitchell BSRB Updated Basis of Design Document. Various Sections, Section 8, Design Parameters.

MD Anderson Design Guidelines. South Campus Vivarium Project 04-0032. April 11, 2005.

Storm Sewer

Affiliated Engineers Inc. January, 2002. Mitchell BSRB Updated Basis of Design Document. Various Sections, Section 8, Design Parameters.

MD Anderson Design Guidelines. South Campus Vivarium Project 04-0032. April 11, 2005.

MD Anderson Design Guidelines & Specifications , March, 2010.

Site Utilities

Affiliated Engineers Inc. January, 2002. Mitchell BSRB Updated Basis of Design Document. Various Sections, Section 8, Design Parameters.

CUH2A, I. 7.0 MD Anderson Mechanical Design Requirements. (2006).

City of Houston Codes and Standards. Latest Edition.

NFPA (as applies to Natural Gas Piping.)

3.0 Mechanical Systems: Temperature and Humidity Design Conditions

General

National Research Council, Institute of Laboratory Animal Resources. 1996. The Guide for the Care and Use of Laboratory Animals. Chapter 2.

National Institute of Health. 2003. NIH Design Policy and Guidelines, Animal Research Facilities. Design Criteria D-17 to D-19.

Canadian Council on Animal Care, Guide to the Care and Use of Experimental Animals Section III.A.2 and A.3

ASHRAE Standard 52-76, Filtration Testing parameters.

Building HVAC Loads

ASHRAE Handbook –Fundamentals. 2005.

Noise and Vibration

National Research Council, Institute of Laboratory Animal Resources. 1996. The Guide for the Care and Use of Laboratory Animals. Chapters 2 and 4.

National Institute of Health. 2003. NIH Design Policy and Guidelines, Animal Research Facilities.

CSTI Acoustics, 2010. Noise, Vibration and Ultrasound Design Guide for M. D. Anderson. CSTI Report 640 Rev A, July 15, 2010.

Building Pressure Relationships

National Research Council, Institute of Laboratory Animal Resources. 1996. The Guide for the Care and Use of Laboratory Animals. Chapter 2.

National Institute of Health. 2003. NIH Design Policy and Guidelines, Animal Research Facilities. Design Criteria D-17 to D-19.

Canadian Council on Animal Care, Guide to the Care and Use of Experimental Animals Section III.A.2 and A.3

Pipe Sizing

Spirex Sarco Design of Fluid Systems – Hook Ups -1992.

Ductwork Sizing SSMACNA (Sheet Metal and Air Conditioning Contractors National Association, Inc) – HVAC Duct Construction Standards, Metal and Flexible, Second Edition 1995.

3.1 Mechanical Systems: System Descriptions

Plant Steam and Condensate

Existing Systems.

Cleaver-Brooks Engineering Manual.

Clean Steam

NIH Design Policy and Guidelines-Animal Research Facilities, Spring 2003.

Chilled Water

National Research Council, Institute of Laboratory Animal Resources. 1996. The Guide for the Care and Use of Laboratory Animals. Chapters 2 and 4.

National Institute of Health. 2003. NIH Design Policy and Guidelines, Animal Research Facilities. Design Criteria D-16, 17 and 18.

Affiliated Engineers Inc. January, 2002. Mitchell BSRB Updated Basis of Design Document. Various Sections, Section 8, Design Parameters.

Supply Air and Filtration

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