Section 2
Narrative

Narrative

Assumptions:

The Research Laboratory Design Guide Narrative addresses new construction as well as renovation projects.

The discussion throughout the Design Guide focuses on biosciences labs "life sciences labs" as used by the Department of Veterans Affairs (VA).

Note: Dimensions are given in metric units with the English unit conversion in parentheses. For example: 1680 mm (5'-6").

Introduction:

It is imperative that laboratory planners are aware that the research facility must not be designed exclusively and permanently for any one pattern or type of research work. The focus of research is constantly changing. It should be expected that the direction of the facility's research program may change between design and activation. Therefore, the VA goal is to achieve a facility that is flexible enough to accommodate future programs while maintaining cost efficiency at the time of design.

The design of a laboratory is a response to four major challenges:

⇒ Flexibility: The nature of research can change in unpredictable ways. It is important to assess the kind and extent of flexibility that can be rationally planned while considering ADA guidelines.

⇒ Safety: High risk factors to researchers include possible contamination from specimens, explosion, and exposure to chemicals. Exits must be clearly marked and the location of fume hoods must eliminate the possibility of endangering the workers.

⇒ Quality of Environment: The presence of natural light, pleasing colors, and a quiet environment within the laboratory enhance productivity.

⇒ Cost Efficiency: Assuring quality facilities while maintaining cost efficiency is a strong VA goal.

Trends:

Present trends are toward research at the micro level (genes, cells, viruses, microorganisms). Trends toward micro level research are evidenced in the emergence of new research technologies such as mass spectroscopy and magnetic resonance imaging equipment. Design trends involve environmentally controlled atmospheres in the labs. Equipment is more automated with computer controlled processes combined with the need to frequently replace and update the equipment. Some of the new technology imposes stringent requirements on building utilities and environmental controls. It is imperative that labs be designed with mobile carts and shelving to allow for new equipment and a rearrangement of the work flow. To insure a successful project, planners must anticipate future trends of research study that will take place in the lab through contact with lab users.

Laboratory Space Planning:

There are two plan options: the open plan versus the closed plan. The open plan reduces construction costs (requiring fewer walls), improves square footage efficiency, and is oriented toward research teams. The closed plan allows tighter security and provides containment. Although large laboratory programs common in teaching institutions are not present at the VA, grouping of investigators by similar techniques (e.g.: molecular biology) is done frequently in the VA. VA investigator groups would benefit from the availability of open plan labs. As shown in Section 4 of this guide, the VA recommends the open plan concept for all future lab design.

With the adoption of the open plan concept, there is a need to consider flexible casework options. Modular casework can be arranged in many ways to suit the needs of the researchers. For example, fixed casework can be located along the perimeter walls, with mobile casework units or split benches in the center space.

The VA standard for aisles between benches or equipment is 1500 mm (5'-0”), to allow space in which two people may work back to back at apparatus and a third person may pass between them. Aisles should be aligned in the direction of egress.

Main corridors in lab neighborhoods need to be 1800 mm (6'-0”) wide to allow enough of a turning radius for equipment entering/exiting the labs. A corridor wider than 1800 mm (6'-0”) is likely to become a storage area.

Cost savings proposals must be investigated during the process of planning these facilities. For example, minimizing the number of laboratory partitions and barriers improves flexibility and saves on cost. If possible, avoid locating plumbing in walls that may be moved in the future. Partitions used within labs to hang casework may be replaced by free-standing cabinets and shelving. A decision to locate the research labs on the upper building levels saves on ductwork length from fume hoods and makes the addition of future fume hoods less costly.

<u>Disabled Persons Access</u>: If a disabled researcher works in a VA laboratory, then all parts of the laboratory and its emergency equipment must be designed or adapted to meet the user's needs. (See Guide Plate 4-2.)

Modular Design:

In order to achieve flexibility, the design must be planned in terms of a basic planning concept, "the lab module". The module establishes a dimensioned method by which building systems, partitions, and casework work well together within the new or existing building structural framework. Some factors that affect the establishment of the lab module are:

⇒ the number of people working in the lab

⇒ the required length of continuous lab work surfaces per investigator

⇒ the width of the aisles in between benches

⇒ the number of fume hoods per laboratory

Lab support, offices, and corridors, can be planned to adhere to a basic module so that a high degree of flexibility is achieved.

Upon discussing user needs and spatial functions with VA investigators, it was decided that 3200 mm (10'-6") on center is a comfortable laboratory module width. The depth of the laboratory module is strongly influenced by safety considerations and codes. It is recommended that VA labs will utilize a 9300 mm (30'-6") on center lab module depth to sufficiently allow for adequate Equivalent Linear Footage (ELF) of bench space per investigator and to provide a secondary means of egress and equipment space. These module dimensions are strictly guidelines and should be evaluated for each project.

In renovation projects, the 9300 mm (30'-6") module depth can be maintained by removing existing partitions and orienting benchwork parallel to the corridor. These two neighboring spaces combine to form the new larger lab.

Once a module is chosen for a project, it forms the floor plate for the entire facility. It is essential that all labs and support spaces follow the established module. A great advantage to implementing the module system is the ability to convert research space with minimal interruption to the neighboring areas.

In cases where the research facility is separate from the Medical Center, the idea of future expansion is an important consideration. When possible, anticipate a master plan that reasonably allows for future growth.

Space Relationships:
(See Section 3, Relationship and Generic Layout Diagrams)

Ideally, the research facility should be located near the Veterinary Medical Unit so that specimens may be transported easily. A dedicated elevator can be used to connect these two areas in a vertically planned facility.

When possible, lab facilities should be conceived with a central-core approach. The central-core contains spaces (cold rooms, common instrument rooms, glassware room, and ultralow freezer rooms) and utilities necessary to support individual labs. Laboratory support spaces may be located on either side of the central core, separated by the main corridor. Investigators' offices should be planned as close as possible to the labs without taking space from the lab zone. To foster staff interaction, the offices should be grouped in clusters.

The "laboratory neighborhood" diagrams in Section 3 represent a planning concept that brings together all of the resources that researchers use on a daily basis. Lab neighborhoods include labs, lab support spaces, offices, and all shared equipment. They are successful in biological science labs because there is no need to duplicate expensive support spaces. Due to this sharing effort, lab neighborhoods create a sense of community by encouraging interaction among the lab workers.

Appropriate relationships and adjacencies are essential to permit a smooth flow of personnel, supplies, and equipment. Traffic flow is predominantly from laboratories to the core and administrative areas and then back to the laboratories. It is important that the distance between laboratories and common instrument rooms be as short as possible since samples, chemicals, and flammable materials are transported between the two areas. Several small rooms are preferable to one larger room for core items such as gamma counters, high-speed centrifuges and ultra centrifuges. As a result, these spaces can be placed in various locations in the center area and thus shorten the traveling distance throughout the laboratory area. In a large facility (with multiple floors or wings), it is important that several flammable, acid, and gas cylinder storage areas be located along exterior walls throughout the facility (or floor) for safety reasons.

Specialized areas (PCR, NMR, electron microscope, confocal microscope, cell irradiator) have specific requirements because the equipment housed there is particularly sensitive to vibration, heat, light, or a combination of factors. These requirements involve isolating certain specialized areas from mechanical rooms, dumbwaiters, and elevators.

Materials handling zones adjacent to dedicated service elevators allow for ease of dispensing and disposing of lab materials and supplies. The administration area should be located in an area separate from the traffic generated by the laboratory and close to elevators. In a single story facility, locate the administration area at one end, or in the center core of a one-floor "cross" design.

Renovation:

A considerable number of future VA Research Laboratory Facilities will be renovation projects as opposed to new construction. This includes both complete renovation of an existing facility as well as adaptive re-use of a facility. In general, the cost for renovation is lower than for new construction.

The existing VA facility must first be evaluated for the building's ability to house a modern research laboratory. There are certain requirements which must be met to indicate if the building would be suitable for renovation: a floor to floor height of 4200 mm (14'-0”); a live load capability of 500 kg/m^2 (100 psf); and a structural grid based on a module of 6000 mm (20'-0”) to 7200 mm (24'-0”) that will readily accept the lab module.

A general assumption must be made that the existing building's infrastructure will not fulfill the demands of a research program. The renovation must address increased needs for air supply, exhaust, chilled water supply, steam, and electrical power.

Communication:

The single most frequent source of user dissatisfaction during both the design and construction phases is the lack of clear communication and interaction among parties with an interest in and responsibility for the project. The Office of Construction Management selects the architecture/engineering firm (A/E) with VA Medical Center representation on the Selection Board. The A/E bases their design on established VA criteria. Costs are fixed at the end of design development, therefore extensive changes must be avoided beyond this point. Plans should be reviewed by a representative from the Research staff, the Administrative Officer, and the Associate Chief of Staff for Research at VA Central Office. At each phase, the reviewers must examine the plans thoroughly. Planning changes and design errors need to be addressed as early as possible to avoid costly change orders during construction.

The Office of Construction Management at VA Central Office assigns a Resident Engineer (RE) to a project prior to beginning construction. The RE is responsible for assuring that construction proceeds on schedule, stays within the budgeted cost and follows plans and specifications bid on by the contractor. Interaction between the RE and user representatives is crucial. The project coordinator, who may be either the Chief of the VA Medical Center Engineering Service, or another individual assigned by the VA Medical Center Director will have frequent contact with the RE. During construction, the Research staff representative and the VA Administrative Officer should be afforded the opportunity of touring the site at monthly intervals.

Engineering Considerations:

Electrical (Emergency power, power requirements, lighting):

Power needs for research laboratories far exceed those for typical commercial buildings. In recent developments of research laboratories there is less dependence on gases and water than there is on electricity. Research is no longer bench bound; there is more writing and use of plug-in electronic devices.

Critical information regarding equipment needs and operations is required for each laboratory unit early in the design phase of the project. In the past, new equipment purchased for a VA facility was considered in the electrical power calculations; however, equipment moved from a previous VA facility to the new lab needs to be anticipated also. One solution is to allow a 10% over-design for the number of outlets in labs.

In laboratories, the total building load for preliminary design purpose is 430 W/m² (40 W/ft²) connected load with 160 W/m² (15 W/ft²) demand load at the power panels. Electrical power panels are to be located along the corridor for access by maintenance workers. Where access to electrical panels is restricted, consideration should be given to providing spare conduits inside the labs.

An emergency power system (including provisions for alarms wired to a centrally monitored station) for the following should be given significant consideration: elevator exits for disabled people, freezers, refrigerators, incubators, controlled temperature rooms, fume hoods, tissue culture areas, and other equipment responsible for maintaining costly experiments. Approximately half of the 120 V outlets in common instrument rooms are to be on emergency power.

Outlets should be clearly marked (color coded) so users can readily identify the proper type of power. Particular attention should be directed to each work station area within the laboratory to provide duplex 120 V - 20 A commercial power, and 120 V - 20 A emergency power as required. Laboratories are designed with enough 120 V circuits for the known equipment plus 20% spare circuits for future loads. (In calculations, each circuit should be loaded with no more than 1200 W.) Each laboratory unit needs adequate 208 V single phase receptacles to accommodate large equipment such as high speed centrifuges. Critical equipment such as refrigerators, freezers and ultra-low temperature freezers may also require 208 V - 20 A emergency power receptacles. An automatic data processing (ADP) outlet should be appropriately located to provide access to local area networks. This will also provide access for environmental and equipment monitoring devices and alarm systems. Laboratories require duplex outlets along the benchtops at 610 mm (24") on center for bench equipment and computers. In areas designated for free standing equipment, duplex outlets shall be placed at 915 mm (36") on center.

Walk-in refrigerators (cold rooms) intended for procedures shall be provided with at least one outlet on each wall. Common instrument areas need to have dedicated 120 V strip outlets, in addition to occasional 208 V outlets. Determining the appropriate number of 120 V and 208 V outlets for common instrument rooms requires close collaboration between Research personnel and the A/E firm.

Hallways need outlets for maintenance purposes, but these outlets will not be on the same circuits as outlets located in labs, shared support areas, or offices.

In general, the more detailed a task, the higher the illumination required to perform it with accuracy. VA laboratories require 1080 lx (100 fc) for benchtop level lighting. A minimum of 810 lx (75 fc) is acceptable with minimum glare and maximum efficiency. Where the correct identification of color is important, special color-corrected lamps may be necessary. Energy efficient light fixtures with individual room switches should be considered as an aid in conserving energy.

<u>Note</u>: Electrical design information is located on the Design Standards accompanying the guide plates. See the VA Electrical Design Manual for further information.

Mechanical (Heating, Ventilating, and Air Conditioning):

GENERAL:

The HVAC designer shall coordinate with the VAMC Research Service Staff, Architect, Equipment Designers, and others as required, to satisfy the mechanical needs of the laboratory facility specified for the project. Equipment selection and location should be finalized early in the design stage to avoid redesign and schedule delays. Heat producing equipment for present and future use must be identified, quantified and satisfied.

The following represents the highlights of the HVAC system design for VA Research Laboratory facilities.

HVAC SYSTEM:

<u>Laboratory, Specialized, and Support Areas</u>: Lab areas should have a dedicated air handling unit, 100% outdoor air, a minimum of 12 air changes per hour of room supply air, a negative room pressure created by exhausting 15% more air than is supplied, a room noise level not to exceed NC-45, and room conditions of 24°C (76°F), 50% RH in summer, and 22°C (72°F), 30% RH in winter. See individual guide plates under Sections 4, 5, and 6 for these areas.

<u>Fume Hood Exhaust</u>: The ventilation system for the fume hood exhaust should conform to OSHA Regulation 29 CFR, Part 1910. The VA HVAC Design Manual shows exhaust air quantities for hoods based on sash openings of 710 mm (28 in.). Fume hoods with 450 mm (18 in.) sash stops may be specified to reduce the required fume hood exhaust and result in energy savings and noise reduction. This should be coordinated with the users.

Auxiliary make-up air hoods should be avoided due to energy cost for tempering air in winter, the discomfort caused by unconditioned air in summer, and drafts discharging directly onto the operator's head. This is discouraged by ANSI/AIHA Z9.5-1992, Laboratory Ventilation.

Polyvinyl chloride (PVC) coated galvanized ducts may be used for fume hood exhaust in lieu of stainless steel, except for perchloric hoods, which still require welded stainless steel ducts. As required by OSHA, the exhaust air from fume hoods should be terminated 3000 mm (10 ft.) above the roof level with a minimum discharge velocity of 15 m/s (3000 fpm). (More information on fume hoods is contained later in narrative discussion.)

System Type: The system may be either constant volume or variable air volume (VAV) based on life cycle cost analysis. Use of room by-pass is generally preferred by users in lieu of the integral hood by-pass. The use of room by-pass versus integral hood by-pass should be verified with the user, and requirements in PG-08-1 also should be verified and adjusted accordingly to ensure the project specifications reflect the user's requirements.

The constant volume system is less complicated and more easily balanced to maintain the necessary room negative pressure. VAV systems should be designed for a minimum 12 air changes per hour with a reduction to 6 air changes per hour for reduced loads. The reduction to 6 air changes per hour should also be verified to match the hood exhaust requirements. Controls for sash position and air flow control valves should be of industrial grade quality. The designer should note the following ASHRAE statement, "The decision to select a variable volume exhaust system should not be made without the understanding and approval of the research staff and local safety officials. The level of sophistication and ability of the maintenance staff to maintain such a complex system is also an important consideration."

Future Capacity: Refer to equipment sizing criteria in the HVAC Design Manual.

Shafts: Exhaust air from fume hoods, ducts carrying flammable vapors, and piping shall not be installed in the same shaft used for movement of environmental air as per NFPA 90-A.

Noise: Excessive noise and inadequate testing and balancing of the air system, especially the fume hoods, are common problems that must be addressed. The designer must comply with the VA HVAC Design Manual requirements for sound calculations. Sound attenuation in the ductwork should be provided, as required, to achieve desired sound levels. Maintain air velocity through the exhaust ducts within the ASHRAE recommended range of 5 to 6 m/s (1000 to 1200 fpm). Lower range of velocity is preferred to achieve desired sound levels. Specifications shall reference compliance with the Associated Air Balance Council or National Environmental Balancing Bureau testing and balancing procedure for fume hoods.

The 5 dB room attenuation credit should not be taken in hard surfaced rooms, as is the case in many laboratories. Noise levels of NC-50 to NC-55 are not uncommon in laboratories. Biohazard safety cabinets with their internal HEPA filters and fans may have sound ratings of 63 to 67 dB (approximately NC-60) and are inherently noisy. Sound ratings for fume hoods are not published but are believed to be in the range of NC-40 to NC-50. Where it can be shown that the design noise level (NC-45) cannot be achieved, the designer may specify a higher value subject to VA approval.

Local and Remote Alarms: Coordinate with research personnel and engineering staff to identify critical points to be monitored with readouts and alarms at the Engineering Control Center (ECC) and/or local panels. For example, the temperature in controlled temperature rooms and the status of air flow for fume hoods should be continuously monitored, and a local audible and visible alarm, and alarm at the ECC for each fume hood and biological safety cabinet should be provided. See individual guide plates under Sections 4, 5, and 6 for other requirements that must be met.

Cooling Loads: Common instrument rooms and ultralow freezer areas contain numerous heat producing items which must be reflected in the cooling loads.

Air Distribution: The Microtome/Cutting Room air distribution system must be designed so that there are no drafts at the cutting tables.

Intale Louvers: Ensure that intake louvers are located to prevent entry of contaminated air. See recommendations listed in the HVAC Design Manual.

Location of Exhaust Fans: Exhaust fans for fume hoods and biological safety cabinets should be located at the end of exhaust ducts to maintain negative pressure in the exhaust ductwork inside the building.

Emergency Power: Emergency power shall be provided to equipment such as exhaust fans serving fume hoods, Flammable Storage Rooms, and Reagent Grade Water Treatment Rooms, and to other equipment listed in the HVAC Design Manual.

Note: Refer to the VA HVAC Design Manual for further design recommendations. Pertinent design information is shown on the Design Standards page accompanying the guide plates.

Plumbing:

Use chemical resistant waste and vent pipe for all laboratory sinks and equipment intended to receive acids and chemicals. Route the waste through a chemical neutralizing device prior to connecting to the drainage system. Extend the acid system vents through the roof separately.

Provide a reagent grade water piping system, without dead ends exceeding 300 mm (12"), to all required locations within the building. Piping for reagent grade water systems must be arranged in a loop and/or continuously recirculating configuration to eliminate stagnant water conditions. Size the piping for a minimum velocity of 8 minutes per second. Provide floor space, with valved and capped hot and cold water and a chemical resistant combination floor/funnel drain, for a central reagent treatment system. The reagent water treatment equipment will be selected to produce the degree of treatment required and furnished by the VA Medical Center.

Air compressors and vacuum pumps shall be multiplexed with single receivers. The units shall be sized so that 100 percent of the design load will be available with any one unit out of service.

Provide a minimum of 240 kPa (35 psi) water pressure at the highest fixture. Coordinate this pressure with other equipment requirements; some special washers require pressures above 275 kPa (40 psi).

Lab facilities need a recirculating domestic hot water system with 50°C (120°F) water available at the tap.

Design a wet pipe fire sprinkler system with quick response sprinklers throughout the building in accordance with NFPA 13. In multi-storied buildings, provide fire protection standpipes in accordance with NFPA 14.

Note: Refer to the VA Plumbing Design Manual for additional information. All plumbing systems shall be designed in accordance with the latest National Standard Plumbing Code. Plumbing information is located on the Design Standards accompanying the guide plates.

Energy Conservation:

Energy conservation begins at the macro level with building siting and envelope, and it continues to the micro level inside the energy-intensive Research Facility. For example, freezer rooms and cold rooms may be located back-to-back or side-by-side to save energy. Where economically feasible, ultralow freezers should be grouped together in one location and heat recovery systems for non-fume hood exhaust should be considered, if found cost effective through life cycle cost analysis.

Zoning of spaces, and separate air handling units for the administrative areas do result in energy conservation. Turning energy systems off will save the largest amount of energy. If it is feasible, heating, ventilating, and air conditioning systems should be on only during the hours of lab operation. If the ventilation system cannot be turned off, the next best approach is to reduce the airflow to the minimum required at all times. This practice may be done in each lab independently by turning down or off a chemical fume hood when it is not in use. However, minimum air changes and negative room pressure must be maintained in occupied labs. Refer to the VA HVAC Design Manual, section "Energy Conservation."

Concerns Specific To Research Facilities:

Finishes:

Interior finishes selected must allow for ease of cleaning and provide a pleasing work environment for Research staff. Early communication between Research staff, Interior Designer, and Architect is necessary to achieve successfully the desired finish.

The finishes in labs must be impervious to contaminants and able to withstand washing with detergents. Lab floors should be of a non-slip finish. Common instrument rooms have latex mastic floors and coved bases to allow for ease of maintenance. Since common instrument rooms and specialized equipment rooms (NMR) often house equipment of considerable weight, floor loading capacity should be determined early in the project design phase.

Laboratory ceilings should be set at a minimum of 2700 mm (9'-0") from floor to ceiling, with 600x1200 mm (2'x4') acoustical tile. If a 2700 mm (9'-0") ceiling height is planned, call for a fume hood sash that will open fully within the space. Ceilings in glassware washing rooms and biohazard containment labs are required to be gypsum board or plaster to tolerate the treatment of water and detergents.

Walk-in refrigerator and freezer rooms consist of prefabricated units designed for field assembly. The inside facing of walls and ceilings are stainless steel metal finishes. Metal casework and shelving must be rust-resistant. Lighting fixtures should be of watertight design.

Note: Finishes are noted on the Design Standards pages accompanying the guide plates.

Doors and Hardware:

Doors should swing out from laboratories as a means of safe egress; however they can create hazardous conditions by blocking the corridor traffic if not recessed into an alcove. VA labs typically have doors that swing into the lab; however, when corridors are wide enough, the doors should swing out. In new construction with 1830 mm (6') wide corridors, 1120 mm (3'-8") door widths are appropriate permitting larger equipment to be moved into the lab.

Doors to laboratories and offices should be of a metal or metal clad type, with sound deadening material applied to the inside and a viewing window of shatter-proof glass. Doors to laboratory units should be self-closing and lockable. Doors to offices shall be lockable but not self-closing. Cylinder handles rather than knobs are preferable in laboratories to facilitate ease of opening. All doors shall be provided a full width kick-mop plate to a minimum height of 250 mm (10") from the bottom of the door. All doors will conform to current NFPA fire rating codes. Floor mounted door stops should be provided when wall mounted bumpers will not provide an effective stop mechanism. Floor mounted stops need to be positioned so as to provide unobstructed movement of equipment and pedestrian traffic.

Furniture:

Furniture may include laboratory equipment or casework.

Laboratory equipment is usually metal with a chemical resistant coating to resist corrosion. It includes but is not limited to tables, cabinets, shelves, sinks, etc., and is utually installed by the General Contractor. It is generally specified for technical areas.

Casework may include laboratory equipment, but is more likely to be used in administrative areas. It has more general use and is likely to have more combinations of colors and textures than laboratory equipment. It can be plastic, metal, or wood. It is often installed by the manufacturer under a separate contract.

Casework and laboratory equipment should be addressed early in the facility design phase. Consideration will be given to functionality without sacrificing safety and comfort. As the design is developed, attention should be directed to utility and equipment configurations as well as to the type and number of fume hoods required and their placement in the laboratory. When feasible, modular or adjustable systems should be employed in common core areas as an alternative to fixed casework thus offering maximum flexibility for future needs.

With the increased use of electronic equipment, more work is done by researchers sitting in a U-shaped array of instruments. The modern researcher less often stands at a bench; he or she sits at equipment. The traditional fixed work top does not allow for flexibility, so free standing benches are advantageous. To provide ultimate flexibility, sinks are built into the benches where required, but are connected to the main drainage system by plastic pipes with screwed connections. The spines behind the benches are two levels; the low level for gases and water, and the upper level with nearly continuous electrical outlets.

Self-supporting casework systems allow great flexibility as they exist independent of a partition. The piping and electrical systems become an integral part of the casework as in traditional systems. The components are interchangeable and have flexible features built-in. The drawback to these systems is that they require substantial storage space when not in use.

Placement of dry-erase boards along the corridor walls and in gathering areas encourages investigators to discuss their work with other researchers.

Glassware Washers And Dryers:

Washers and dryers are used to wash, dry, and sanitize; they do not sterilize. This equipment can be heated by steam or electrical power with steam heating having a lower operating cost. In planning glassware rooms, the following should be kept in mind: floor drains must be large enough to accommodate the vast quantities of water disposed by the washers (a large floor sink with a minimum 100 mm (4") outlet); vapors produced by the machines need to be vented; and, the walls between the glassware area and adjoining rooms should be acoustically treated due to the high noise factor. There is also an increasing need for high temperature dryers for glassware used in RNA work. Highly contaminated areas also need their own sterilization and glassware washing equipment.

The location of washers and dryers needs to allow maintenance crews access to the equipment for repairs. The space behind the washers should have a floor drain to accommodate any leakage by the equipment. An exhaust canopy over the chamber opening to both the washers and dryers vents steam vapors.

Note: Operation and maintenance manuals for all equipment should be secured in the administration area to insure proper equipment care.

Reagent Grade Water Systems:

Reagent grade water systems are important for performing contaminant-free experiments in the lab, and for the final rinse in the glassware and sterilization room. The four basic methods of producing pure water are: distillation, deionization, reverse osmosis, and filtration. Depending on the contaminants in the water supply, and the Reagent Grade Type (purity level) of water needed, one or more of these methods will be indicated.

A raw water analysis must be done before a purification method can be selected. Equipment sizes vary greatly depending on the method selected, and the flow rate required. Where use is limited, or purity requirements stringent, point-of-use cartridge-type polishing stations can be provided. Where there is a strong need in all laboratories, a central system should be considered from the onset of design.

Security:

VA laboratory facilities are utilized 24 hours a day, thus requiring tight security. The location and layout of laboratories and specialized areas must be planned so as to restrict visitors as much as possible. The laboratory/core area should be located on a level other than the main entry floor of the building with access from keyed elevators which do not open into the receiving area on the main level. Access to the individual laboratories can be by a standard key system. Electronic perimeter security to the lab area is necessary if labs are adjacent to clinic and/or public areas.

Life Safety:

In order to achieve the desired quality of life in laboratories, a safe and secure work environment for investigators must be provided. Laboratories conducting procedures involving pathogens or carcinogens must be designed to eliminate cross-contamination. A safe environment can be maintained by: providing positive pressure for clean rooms; negative pressure and prohibition of recirculation of air from contaminated areas; adequate ventilation; and proper air filters. Air locks at entries to these areas and decontamination areas (shower and clothes changing rooms) may be needed for personnel.

In addition, emergency showers are located in the hallways with a contrasting spot painted on the floor to indicate the shower location, with the number of showers per area to be based on Occupational Health and Safety Agency (OSHA) requirements. There are no drains below emergency showers in corridors because of their infrequent use. Lastly, the emergency shower water should be tempered for a person to endure the full 15 minute wash. To permit privacy, selected showers should have curtains so that contaminated clothing may be removed. Eye and face wash units should be installed on the gooseneck faucets of sinks in each lab and in lab support areas where chemicals are used.

Materials Management:

Materials management involves storing lab materials and supplies as well as storing and disposing of chemical and biohazardous waste.

Hazardous chemicals in one area should be compatible (not cause dangerous chemical reactions), use storage space well, and be convenient to store and retrieve in addition to being near the loading dock.

Flammable liquid storage cabinets in the laboratories are intended to protect the contents from the heat and flames from outside the cabinet. These OSHA approved cabinets should be located remotely from operations in the lab which could lead to fire. The cabinets are not required by NFPA 30 to be ventilated. In addition to the provision for a few days' chemical supply in each lab, there should be a central chemical storage room for bulk supplies. Chemical storage rooms need open shelves with edge lips, cabinets for toxic materials, and exhaust hoods over unsealed toxins. Chemical storage rooms typically utilize a water fire sprinkler system.

Compressed gas cylinders, as well, need dedicated storage with local exhaust hoods to remove possible gas leakage. This room should be located along an exterior wall with a blow-out panel for each 1.1 to 1.7 m^3 (40 to 60 ft^3) of volume as outlined in NFPA-68 and more specifically in NFPA 55. Gas cylinders should be secured in supports designed to provide flexibility.

Disposal Of Waste:

VA laboratory facilities designate an area or areas for collecting and storing hazardous chemical, biological, and radioactive wastes before disposal. The disposal area should be located with reasonable proximity to the elevators which connect to the loading dock area for convenience of waste disposal. The disposal of waste depends in large part on local Medical Center policy and OSHA regulations. General waste consisting of paper and glass should be stored in a separate area of the facility not associated with hazardous waste.

Fume Hoods:

The main purpose of a fume hood is to contain and dispose of the effluent generated by work performed inside the hood. It is a safety device to protect the users from hazardous chemicals as outlined in ANSI Z 9.5. Fume hoods should not be located closer than 3000 mm (10'-0") to the primary exit door for two reasons: the traffic past the hood may cause a backdraft into the laboratory, and fume hoods may be the location of an explosion or fire thereby blocking the path of exit. Strict attention must be paid to fume hood safety; including color-coding utilities, installing automatic dry fire extinguishing systems, prohibiting the presence of spark producing devices (outlets) inside the hood, and proper signage for use and warnings.

Biological and chemical stand-alone hoods (ductless) with HEPA filters are more flexible than fixed hoods which must be connected to dedicated exhaust ducts. They allow for flexibility as to location, and lower first cost due to the elimination of ductwork and exhaust fans. However, their use is limited because they are not compatible with certain chemicals used in laboratories. The air purification system in the fume hood must be evaluated for each chemical used.

A fume hood exhaust system may serve up to four chemical hoods. This combined system may be used because vapors drawn through the hood are diluted to such low levels that chemical reactions yielding significant energy levels are highly unlikely. Consider aligning hoods back-to-back to save on ductwork. Separate dedicated exhaust systems are required for biosafety lab cabinets, radioisotope hoods, and perchloric-acid hoods. The combination vertical and horizontal sash in 1800 mm (6'-0") fume hoods should be considered, as they better control the amount of air through the hood. Fume hoods with larger exhaust discharge collar sizes tend to reduce noise.

Fume hood noise is a common complaint among laboratory users. (See "Mechanical Considerations" in narrative discussion.)

Any provisions for the addition of future fume hoods must be provided in the initial planning stages, including supply and exhaust air, plumbing, and electrical. However, caution should be exercised to ensure that any extra initial cost for future provisions is not wasted. Interstitial floors above Research Laboratories would better provide for additions and relocation of fume hoods. The VA Building System (interstitial space) lends itself to future design of the mechanical and electrical systems with less disruption to occupied space.

Bibliography

Weeks, John. "Laboratories for Medical Research." World Hospitals, Vol. XVII, No. 2, May 1981.

Braybrooke, Susan, ed. Design for Research. New York: John Wiley & Sons, 1986.

Ruys, Theodorus. Handbook of Facilities Planning, Volume 1. New York: Van Nostrand Reinhold, 1990.

Lees, R., and A. F. Smith, ed. Design, Construction, and Refurbishment of Laboratories. Chichester, England: Ellis Horwood Limited, 1984.

Diberardinis, Louis J., et al. Guidelines for Laboratory Design: Health and Safety Considerations, 2nd ed. New York: John Wiley & Sons, 1993.

Arcidi, Philip. "Inquiry: Laboratories." Progressive Architecture, August 1990.

Sennewald, Bea. "Flexibility by Design." Architecture, April 1987.

Cattan, Simon V., P.E., Salvatore X. Debono, P.E., and William W. White, P.E. "Modular Design for High-Tech Laboratories." Consulting-Specifying Engineer, September 1992.

von Kanel, Hans K. "Standardisation and Rationalisation of Research Buildings and

Laboratories." World Hospitals, Volume XVII, No. 2, May 1981.

Zeidler, Eberhard H. "Life Cycle Use of Medical Research Buildings." World Hospitals, Vol. XVII, No. 2, May 1981.

Planning Academic Research Facilities: A Guidebook. National Science Foundation, March 1992.