March 2011

HVAC Design Manual
for
New, Replacement, Addition, and Renovation of Existing VA Facilities

- ***Hospitals***
- ***Clinics (Outpatient and Inpatient)***
- ***Emergency Care***
- ***Ambulatory Care***
- ***Animal Research and Holding***
- ***Laboratories***
- ***Energy Centers***
- ***Warehouses***

Department of Veterans Affairs

Office of Construction & Facilities Management
Facilities Quality Service (00CFM1A)
811 Vermont Avenue, NW
Washington DC 20420

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The following individuals are those whose guidance, insight, advice and expertise made the update and revision of the HVAC Design Manual possible:

Lloyd H. Siegel, FIIA
Director, Strategic Management Office (00CFM1)
VA Office of Construction and Facilities Management
Washington DC

Kurt D. Knight, PE
Chief, Facilities Quality Service (00CFM1A)
Strategic Management Office
VA Office of Construction and Facilities Management
Washington DC

Mulraj (Manu) P. Dhokai, PE
Senior Mechanical Engineer (00CFM1A)
Facilities Quality Service
Strategic Management Office
VA Office of Construction and Facilities Management
Washington DC

Consultant
GLHN Architects and Engineers, Inc

William Nelson, PE
President - Project Principal
Tucson, AZ

Carol Larson, PE, CEM, LEED AP
Mechanical Department Manager - Project Executive
Tucson, AZ

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CHAPTER 1: HVAC DESIGN MANUAL

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1.1 INTRODUCTION

HVAC Design Manual (February 2008) is revised to incorporate changes resulting from the following:

- Applicable Codes and Standards
- ASHRAE Standard 170 – 2008 (Ventilation of Health Care Facilities)
- HVAC Design Criteria Revisions – Surgery Suite, SPD Suite, Animal Research, etc.
- Measurements and Verification
- Miscellaneous Corrections and Users' Input
- Reduced Number of Dedicated Air Handling Units
- Revisions to Room Data Sheets
- Third Party Certification – LEED (Silver) or Green Globe (Two Globes)
- VA Sustainable Design and Energy Reduction Manual
- Spinal Cord Injury – Rooms listed in the June 2008 Design Guide for the spinal cord Injury/Disorders Center (SCI) are reproduced in this manual under a dedicated air0handling unit serving the SCI. The HVAC design parameters for the rooms are undated to comply with ASHRAE Standard 170-2008 and 2010 Facility Guidelines Institute (FGI). The user should ignore the HVAC design parameters listed in the SCI and follow this manual.
- Isolation Rooms – Ante Rooms are clarified in this manual to comply with ASHRAE Standard 107-2008 and 2010 Facility Guidelines Institute (FGI).

This manual is intended for the Architect/Engineer (henceforth referred to as the A/E) and others engaged in the design and renovation of VA facilities. VA Medical Centers are encouraged to use these criteria for Non-Recurring Maintenance (NRM) and Minor Construction Projects to ensure quality control and uniformity in design and construction practices and procedures.

Use of this manual shall result in meeting the primary objective of providing environmental comfort to veterans, employees, and visitors. The HVAC system shall be:

- Technically correct, complete, and coordinated
- In compliance with all applicable safety standards
- Easily accessible for repairs and maintenance
- Energy efficient
- In compliance with prescribed noise and vibration levels

Deviations from this manual may be proposed to promote new concepts and design enhancements. Deviations shall not conflict with Federal Regulations, Public Laws, Executive Orders, or the needs of the end users. Any deviations are subject to review and written approval by the VA Project Manager in consultation with VA Consulting Support Service. For projects designed and contracted by the Office of Construction and Facilities Management, the VA Project Manager is the VA Authority. Interfacing with the VA Medical Center shall be through the VA Project Manager or his/her assigned individuals.

1.2 COMPLIANCE

- ASHRAE Standard 170-2008 (complete with amendments a through d).
- Facility Guidelines Institute (FGI) – 2010.

1.3 ENERGY CONSERVATION

Refer to the VA Sustainable Design and Energy Reduction Manual.

1.3.1 ASHRAE STANDARD 90.1 – 2007

ASHRAE Standard 90.1 – 2007 is a component of the Federal statutes. Provisions of this standard shall be used as a baseline for computing energy savings.

1.3.2 ASHRAE STANDARD 90.1 – 2010

The recently published ASHRAE Standard 90.1 – 2010 is not adopted by VA Facilities Quality Service. Elements of this standard, in whole or part, may be incorporated in future revisions and/or amendments of this manual.

1.4 MANDATED ENERGY CONSERVATION MEASURES

The Department of Energy (DOE) has mandated that new federal buildings shall be designed to achieve an energy consumption level at least 30% below that attained by the ASHRAE Standard 90.1 – 2007 baseline building, if life-cycle cost-effective. Use the Performance Rating Method, Appendix G of ASHRAE Standard 90.1 – 2002, to document energy savings.

1.4.1 LIFE-CYCLE COST ANALYSIS – REQUIREMENTS

If 30% reduction in energy consumption is not life-cycle cost-effective, the A/E shall evaluate alternate designs at successive decrements (for example, 25%, 20%, or lower) in order to identify the most energy-efficient design that is life-cycle cost-effective. To do so, the A/E shall consider and evaluate readily available energy conservation measures with which the industry is generally familiar and determine the most energy-efficient solution by using a life-cycle cost analysis approach. Refer to VA Sustainable Design and Energy Reduction Manual.

The DOE further stipulates that “agencies must estimate the life-cycle costs and energy consumption of the planned building as designed and an otherwise identical building just meeting the minimum criteria set forth in the applicable baseline ASHRAE or IECC standard.” This measure is meant to demonstrate and record the extent to which the mandated compliance is achieved.

1.4.2 LIFE-CYCLE COST ANALYSIS – METHODOLOGY

An engineering and economic analysis shall be performed in accordance with the procedure outlined by the DOE in the National Institute of Standards and Technology (NIST) Handbook 135 dated February 1996 (or the latest version) – Life-Cycle Costing Manual for the Federal Energy Management Program.

Use the following parameters when performing the analysis:

- Life-cycle study period: Expected system life not to exceed 40 years
- Building Life-Cycle Cost (BLCC) computational program (located on the NIST website)
- Discount factor as determined by DOE on Oct 1 of each year
- Include initial acquisition costs such as planning, design, purchase and construction and capital replacement costs. Include operating costs, such as energy used, water used,

and operating, maintenance, and repair costs. Taxes and insurance need not be included in the life-cycle cost analysis**.**

1.4.3 ENERGY REDUCTION REQUIREMENT - NEW CONSTRUCTION

Reduce the energy cost budget by 30% compared to the baseline performance rating of ASHRAE Standard 90.1 - 2007. This requirement is identical to the DOE Final Rule published in the Federal Register.

1.4.4 ENERGY REDUCTION REQUIREMENT - MAJOR RENOVATIONS

Reduce the energy cost budget by 20% below the pre-renovation 2003 baseline. If pre-renovation 2003 baseline data is not available, the A/E shall calculate the energy consumption before renovation, compare it with the energy consumption after renovation, and document the mandated savings. A project classified as “major renovation” shall meet the following two criteria:

(a) For a facility selected for renovation, the area of renovation is greater than 50% of the total area.

(b) A project is planned that significantly extends the building’s useful life through alterations or repairs and totals more than 30% of the replacement value of the facility.

1.4.5 VA POLICY

Reduction in the energy budget shall be expressed in Btu/gsf [kWh/gsm].

1.4.5.1 Certification

The VA is committed to obtaining a minimum of Silver certification from LEED or Two Globe certification from Green Globes for all new construction and major renovation projects.

1.5 MEASUREMENT AND VERIFICATION

Per DOE Guidelines issued under Section 103 of EPACT, install building-level utility meters in new major construction and renovation projects to track and continuously optimize performance. Memorandum of Understanding (MOU) mandates that the actual performance data from the first year of operation shall be compared with the energy design target. After one year of occupancy, the A/E shall measure all new major installations using the ENERGY STAR® Benchmarking Tool for building and space types covered by ENERGY STAR® or FEMP-designated equipment. The A/E shall submit a report of findings to the VA Authorities.

1.6 ABBREVIATIONS AND REFERENCES

See Chapter 8 for Abbreviations and References used in this manual.

1.7 COMMISSIONING

The scope of work shall include Total Building Commissioning in accordance with the Commissioning Process Manual and Specifications published by the Office of Construction and

Facilities Management and posted in the VA Technical Information Library (TIL)
http://www.cfm.va.gov/til/

1.8 VA STANDARDS

The A/E shall download applicable documents from the Technical Information Library (TIL) and submit a list of these documents with their effective dates to the VA Authorities. Descriptions of major standards follow:

1.8.1 DESIGN MANUALS (by discipline) (PG-18-10)

Located in Technical Information Library

http://www.cfm.va.gov/TIL/dManual.asp

Purpose

Conveys the general and specific VA design philosophy for medical and support facilities. The Manuals accomplish this by:

- Explaining specific design methodologies
- Listing acceptable system types
- Codifying certain code interpretations
- Listing values for design parameters
- Referencing certain sections of the Master Specification and Standard Details
- Containing examples of certain design elements

1.8.2 MINIMUM REQUIREMENTS FOR A/E SUBMISSIONS (PG-18-15)

Located in Architect/Engineer Information
http://www.cfm.va.gov/contract/aeDesSubReq.asp

Purpose

Provides a staged list of tasks in various design categories to define the A/E scope and ensure thorough and timely completion of the final design package and bid documents.

The Requirements accomplish this by:

- Progressively listing tasks at Schematic, Design Development, and Construction Documents stages
- Requiring task completion and submission for each stage according to a Critical Path Method (CPM) calendar
- Requiring implementation of a QA/QC process to ensure a quality design product
- Requiring life-cycle analysis of alternatives in order to optimize the design-to-cost tradeoff
- Listing and detailing all the drawings, calculations, and specifications required for a complete design package
- Indicating the final distribution of bid documents
- Indicating the interface between this Design Manual and Submission Requirements at each submission phase

1.8.3 MASTER CONSTRUCTION SPECIFICATIONS (PG-18-1)

Located in Technical Information Library

http://www.cfm.va.gov/TIL/spec.asp

Purpose

Defines a standardized method for the A/E to ensure that the contractor provides equipment and systems that meet the design intent in terms of performance, quality and cost.

The Specifications accomplish this by:

- Providing specific narrative descriptions of required equipment, salient elements, and system construction
- Listing applicable standards and codes and references
- Requiring individual submittal of equipment and systems for review and approval prior to contractor purchase
- Defining specific installation methods to be used

Note: The A/E shall include with the Construction Documents (CD1) submittal, an electronic version of the VA Master Specifications, with tracked changes or modifications displayed.

1.8.4 ARCHITECT ENGINEER REVIEW CHECKLIST

Located in Technical Information Library

http://www.cfm.va.gov/til/projReq.asp

Purpose

Provides the VA Peer Reviewer with a minimum list of critical items which must be included in each A/E submission.

The Checklist accomplishes this by:

- Referring to all VA design tools which pertain to the specific project
- Detailing certain life safety and coordination requirements

1.8.5 DESIGN ALERTS

Located in Technical Information Library

http://www.cfm.va.gov/TIL/alertDesign.asp

Purpose

Communicates current design issues and solutions.

The Design Alerts accomplish this by:

- Publishing periodic alert memos
- Summarizing design solutions

1.8.6 A/E QUALITY ALERTS

Located in Technical Information Library

http://www.cfm.va.gov/TIL/alert.asp#qalert

Purpose

Communicates quality deficiencies from recent A/E design submissions.

The Quality Alerts accomplish this by:

- Publishing checklists of design details often missed
- Including references to technical resources

1.8.7 DESIGN GUIDES (graphical, by function) (PG-18-12)

Located in Technical Information Library

http://www.cfm.va.gov/TIL/dGuide.asp

Purpose

Provides the designer with specific layout templates and medical equipment lists for all types of spaces/uses and specific design parameters for structural, electrical and mechanical service.

The Design Guides accomplish this by:

- Publishing design information
- Including functional diagrams and layout plates
- Listing standards

1.8.8 DESIGN AND CONSTRUCTION PROCEDURES (PG-18-3)

Located in Technical Information Library

http://www.cfm.va.gov/TIL/cPro.asp

Purpose

Establishes minimum consistent design/construction practices.

The Procedures section accomplishes this by:

- Referencing applicable codes and policies
- Describing standard drawing formats
- Listing security strategies
- Including miscellaneous design details

1.8.9 STANDARD DETAILS AND CAD STANDARDS (PG-18-4)

Located in Technical Information Library

http://www.cfm.va.gov/TIL/sDetail.asp

Purpose

Promotes standardization of CAD documents submitted to the VA Authorities.

The Standards section accomplishes this by:

- Providing downloadable equipment schedules
- Listing symbols and abbreviations
- Providing downloadable standard details in .dwg or .dwf format
- Providing requirements for preparing CAD drawings

Note: The A/E shall utilize the VA Standard Details to the fullest extent possible. A modification to a Standard Detail requires the approval of VA Authorities. A comprehensive list of symbols and abbreviations is included with the VA Standard Details. Use of the VA abbreviation list is mandatory. Edit the VA list to be project specific.

All mechanical drawings shall be numbered and arranged in strict accordance with VA CAD Standards.

1.8.10 PHYSICAL SECURITY DESIGN MANUAL FOR VA FACILITIES – MISSION CRITICAL FACILITIES AND LIFE SAFETY PROTECTED FACILITIES (FORMERLY CD-54)

Located in Technical Information Library

http://www.cfm.va.gov/til/spclRqmts.asp#PHS

Purpose

Sets physical security standards required for facilities to continue operation during a natural or man-made extreme event and for facilities that are required to protect the life safety of patients and staff in an emergency.

The Manuals accomplish this by:

- Setting objectives for physical security

- Providing strategies for use in design and construction to provide protection to VA facilities
- Providing cost-effective design criteria

1.8.11 COST ESTIMATING MANUAL

Located in Technical Information Library

http://www.cfm.va.gov/cost/

Purpose

Conveys the general and specific VA cost estimating philosophy for medical facilities.

The Manual accomplishes this by:

- Explaining specific estimating methodologies
- Providing examples of certain design elements

1.8.12 SUSTAINABLE DESIGN AND ENERGY REDUCTION MANUAL

Located in Technical Information Library

http://www.cfm.va.gov/til/sustain.asp

Purpose

Incorporates sustainable design practices to improve the building environment and to provide cost savings for long-term building operations and maintenance.

The Manual accomplishes this by:

- Prescribing the use of integrated design practices
- Providing strategies for optimization of energy performance
- Providing strategies for protection and conservation of water resources
- Providing strategies for enhancement of indoor environmental quality
- Providing strategies for reduction of environmental impact of materials

1.8.13 SEISMIC DESIGN REQUIREMENTS (STRUCTURAL) (H-18-18)

Located in Technical Information Library

http://www.va.gov/TIL/seismic.asp

Purpose

Sets the requirements for seismic design in new facilities and for rehabilitation of existing facilities.

The Manual accomplishes this by:

- Defining critical and essential facilities
- Prescribing code compliance with modifications
- Prescribing occupancy categories

1.8.14 FIRE PROTECTION DESIGN MANUAL

Located in Technical Information Library

http://www.cfm.va.gov/TIL/dManual.asp#Other

Purpose

Provides the fire protection engineering design criteria for all categories of VA construction and renovation projects.

The Manual accomplishes this by:

- Mandating code and standard compliance
- Defining water-supply requirements
- Defining fire extinguishing and fire alarm system requirements

1.8.15 BUILDING INFORMATION MODEL (BIM) GUIDE

Located in Technical Information Library

http://www.cfm.va.gov/til/projReg.asp

The VA has implemented the BIM system for all major construction and renovation projects per details given in VA BIM Guide.

1.9 VA HOSPITAL BUILDING SYSTEM

Located in Technical Information Library

http://www.cfm.va.gov/TIL/spclRqmts.asp#VAHBS

The VA Hospital Building System (VAHBS) is a methodology based on a modular concept for planning, designing, and constructing hospitals.

The methodology has been used nationwide successfully for capital and operating cost containment, shortened delivery schedules, and improved space utilization flexibility. All new and replacement VA hospital buildings shall use the VAHBS system. This system is also recommended for major additions to existing hospitals where future adaptability is an important factor.

See VHA Program Guide PG-18-3, Design and Construction Procedures, Topic 3, “VA Hospital Building System,” for further guidance. The complete reference for the VAHBS is contained in the 1976 Development Study (referred to as the Redbook) and the 2006 Supplement. Additional details are included in Appendix 1-A.

1.10 COMPUTER AIDED FACILITIES MANAGEMENT (CAFM)

1.10.1 CAFM AND EQUIPMENT SCHEDULE UTILIZATION

1.10.1.1 Introduction

The requirement for access to a master digital database necessitates the compilation of all architectural/engineering design data (plans, specifications, calculations, equipment selections, equipment submittal, commissioning/balance reports, and both hard copy and electronic job-related communications) in a digital, electronic format throughout the project. This need for digital data will affect the requirements for submission (see Design Submission Requirements).

1.11 HVAC DESIGN MANUAL AND A/E SUBMISSION REQUIREMENTS (PG-18-15)

1.11.1 COORDINATION

The documentation requirements outlined in PG-18-15 are the minimum contractual milestones and not the details and procedures described in this Manual. By supplementing each other, these two documents provide comprehensive guidelines to develop backup documentation for successful and state-of-the-art design.

1.11.2 COMPLIANCE REQUIREMENTS

For each submittal, the A/E shall forward to the VA a detailed list of the submissions required with a notation of full or partial compliance.

1.11.3 EQUIPMENT SCHEDULES

1.11.3.1 Order of Presentation

For each item in a schedule, show the Basis of Design, including the manufacturer and model number selected. These columns shall be hidden on the final design documents but available for VA use and for use later in the design/construction and maintenance process.

Equipment schedules shall be grouped on the design documents by system type, such as air side, water side, and steam.

1.11.3.2 Equipment Capacity and Performance Data Requirements

Equipment performance and capacity data shall correspond to that shown in the calculations, not a particular manufacturer's catalog data. The data shall be in the range of available manufactured products.

1.11.3.3 Equipment Schedules – Glycol Data

Heat exchangers, coils, pumps and chillers in glycol-water system shall be identified on the equipment schedule showing the percent glycol by volume of the circulating fluid for equipment derating purposes.

APPENDIX A: VA HOSPITAL BUILDING SYSTEM

1-A.1 DESCRIPTION OF MODULES

INTRODUCTION

The Redbook proposes a systematic or modular approach to the design of new hospital buildings. The building system approach requires integration of service modules starting with the initial stages of the design process. Service modules are defined as one-story units of building volumes with a footprint of 10,000 sf [930 m^2] to 20,000 sf [1,860 m^2]. Each module consists of structural bays, a service zone, and a functional zone (often subdivided into space modules). Each service module is completely contained in a fire compartment, either alone or with one or more other modules.

STRUCTURAL BAYS

The structural bay is the basic unit of which all other modules are composed. The dimensions of the structural bay are influenced by the functional layout, service zone clearances, and the type of structural system selected.

THE SERVICE ZONE

A service zone includes a full height service bay (with independent mechanical, electrical, and telecommunications rooms) and an independent service distribution network that includes an interstitial space above the functional zone.

THE FUNCTIONAL ZONE

The functional zone is the occupied floor area within a service module. Space modules are subdivisions of the functional zone.

FIRE COMPARTMENT

A fire compartment is a unit of area enclosed by a two-hour-rated fire resistive construction with at least two different exits.

UTILITIES

Individual HVAC, plumbing, electrical power, telecommunications, and fire protection (sprinkler systems) are all fully integrated into the service module.

ZONING OF AIR-HANDLING UNITS

As far as possible, selection of the air-handling unit shall follow the modular concept and match the boundary of the service zone. To achieve this, the space planners must ensure that only a single functional department is fitted in the space below the service zone.

During the conceptual design development, the following issues should be raised and resolved with the space planners:

(a) A single air-handling unit is meant to serve one medical function such as surgery, the patient wing, or a clinic. The same air-handling unit cannot service multiple functional areas due to their substantially differing HVAC needs.

(b) Should the boundary of the single air-handling unit extend beyond the service zone, the air-handling unit shall cross the service zone to serve the spaces located beyond the zone. Conversely, if two functional areas share the space below the same service zone, multiple air-handling units may be required for the same service zone. Multiple air-handling units may also be required if the capacity requirement of the functional space exceeds the limiting parameter of 50,000 cfm [23,600 L/s].

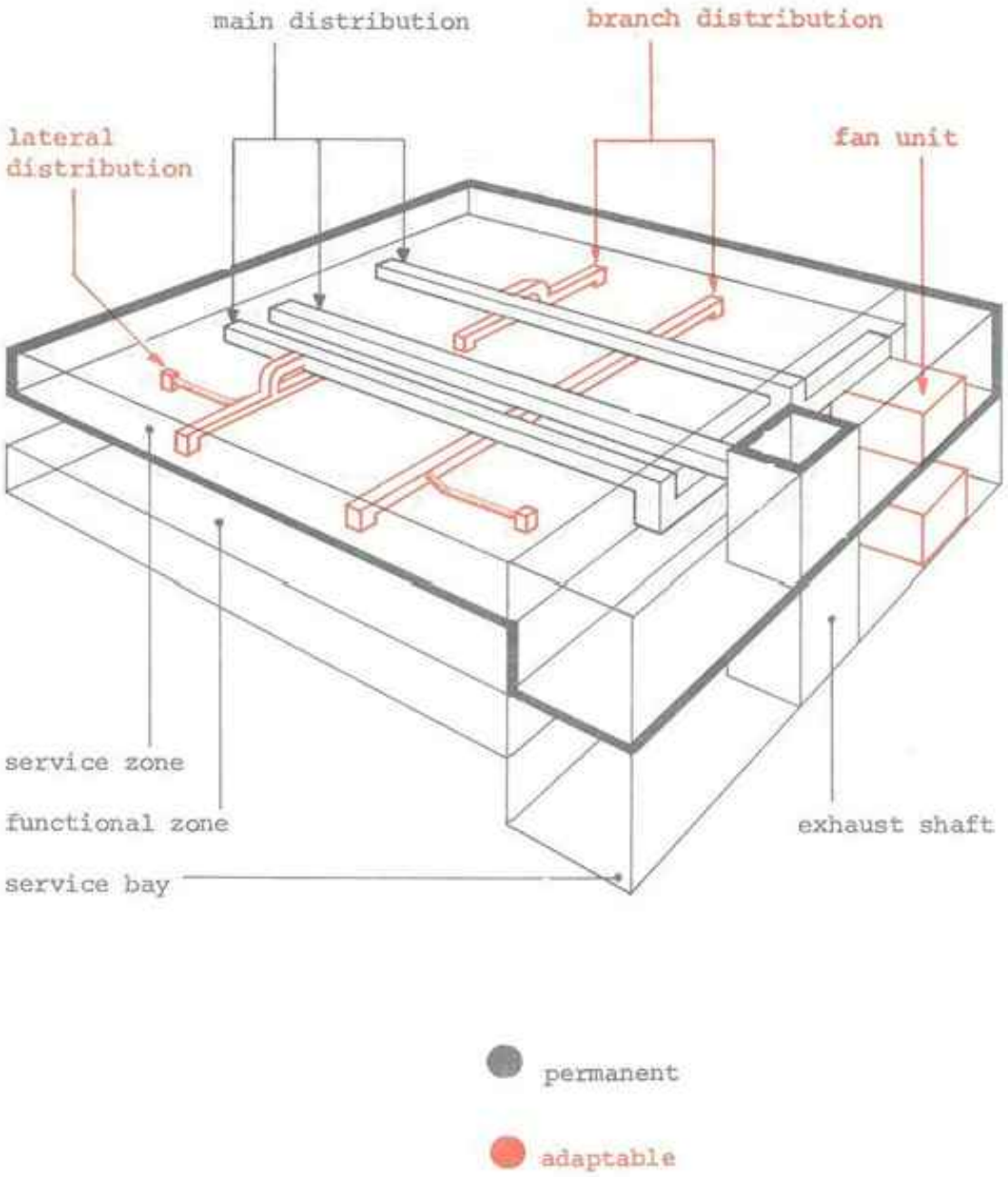
1-A.2 REFERENCES

DEVELOPMENT STUDY-VAHBS (REDBOOK – REVISED 1976)

SUPPLEMENT TO DEVELOPMENT STUDY (2006)

1-A.3 BASIC DESIGN OF A SERVICE ZONE

Figure 1-A shows a typical service zone.



BASIC DESIGN OF A SERVICE ZONE

Not to Scale

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CHAPTER 2: HVAC DESIGN PARAMETERS AND SELECTION CRITERIA

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2.1 INTRODUCTION

In this chapter, the basis of design and special studies requirements for the Heating, Ventilation, and Air-Conditioning (HVAC) systems for new and replacement hospitals, clinical additions, laboratories, research facilities, and energy centers are described. Information given below shall be used in conjunction with the VA Standard Details, Master Specifications, and associated documents, described in Chapter 1 and located on the TIL.

2.2 BASIS OF DESIGN

2.2.1 OUTDOOR DESIGN CONDITIONS

Weather conditions for VA facilities are given in Chapter 7. These conditions are based on the locations closest to the VA facilities and given in the 2009 ASHRAE Handbook of Fundamentals. The A/E can recommend and use (subject to prior approval by VA Authorities) more severe conditions, based on experience and knowledge of local weather conditions.

- High Humidity Locations: Chapter 7, for VA Facilities in High Humidity Locations.
- Low Humidity Locations: Chapter 7, for VA Facilities in Low Humidity Locations.
- Hurricane Locations: Physical Security Manual

2.2.1.1 Cooling and Heating Load Calculations

Use the following conditions for calculating the cooling and heating loads:

- Cooling (100% outdoor air unit) – 0.4% Dry-Bulb (Column 1a) and 0.4% Wet-Bulb Temperatures (Column 3)
- Cooling (minimum outdoor air unit) – 1.0% Dry-Bulb and Wet-Bulb Temperatures (Column 2a)
- Heating – 99.6 Percent Dry-Bulb Temperatures (Column 1b)

2.2.1.2 Cooling Tower Selection

Use the following conditions for selecting the cooling tower:

- 1 F [0.6 C] above 0.4 Percent Wet-Bulb Temperatures (Column 3)

2.2.1.3 Preheat Coil Selection

Use the following conditions for selecting the preheat coil:

- Annual Extreme Daily Mean Dry-Bulb Temperatures (Column Minimum)

2.2.1.4 Electrical Heating Devices Using Emergency Power

Use the following conditions for determining electrical heating devices:

- 99.6 Percent Dry-Bulb Temperatures (Column 1b)

2.2.2 INDOOR DESIGN CONDITIONS

See Chapter 6 and the Room Data Sheets

2.2.2.1 Indoor Minimum Relative Humidity

For all occupied spaces listed in ASHRAE Standard 170 – 2008 (Table 7-1), minimum indoor relative humidity shall be maintained at 20%. See Room Data Sheets for exceptions.

2.2.3 COOLING AND HEATING LOAD CALCULATIONS – PARAMETERS

2.2.3.1 Occupancy

Select design occupancy from the following:

- Applicable VA Design Guides
- Project Program Data
- Furniture Layout – Architectural Drawings
- ASHRAE Standard 62.1 – 2007 (Ventilation for Acceptable Indoor Air Quality)

2.2.3.2 Light and Power Loads

Estimate the heat gain due to lighting (overhead and task lights) and power (connected and plug-in equipment) loads, using the actual lighting layout and the manufacturer's published data. Use of assumed parameters (W/sf or Btuh/sf) is not acceptable in the final design.

It shall be clearly stated during design development if any diversity factors are used.

2.2.3.3 Building Thermal Envelope

The building thermal envelope shall be in compliance with the ASHRAE Standard 90.1 – 2007 and shall be based on the actual building construction.

2.2.3.4 Outdoor Air For Ventilation (Calculation Requirements)

Use the following parameters to estimate the highest value of the minimum outdoor air for ventilation:

- ASHRAE Standard 62.1 – 2007
- ASHRAE Handbook of Applications – 2007
- ASHRAE Standard 170 - 2008
- VA Requirement: Minimum 15% of the supply air
- Exhaust Air: See Chapter 6 (Room Data Sheets)

Typical spaces are:

- Housekeeping Aid Closet
- Patient Toilets
- Shower Rooms
- Soiled Utility or Storage Rooms
- Locker Rooms
- Kitchen range hoods
- Dishwashers (wet exhaust hoods)
- Kitchenette (50 cfm [24 L/s])
- Make-up air for negative air balance
- Space pressurization allowance (see note below)

Allow 5% (minimum) allowance for space pressurization in the overall air balance at the air-handling unit level. See Room Data Sheets for individual room air balance. Show all values used for air balance at the design development stage. The allowance can be as high as 10% based on such factors as the number of exit doors to outdoors, operable versus non-operable windows, presence or absence of vestibules, weather stripping of windows, etc.

2.2.4 COOLING AND HEATING LOAD CALCULATIONS

Using an ASHRAE-based, public domain (DOE) or commercially available software program (Trane, Carrier, and/or other approved), calculate the cooling and heating capacities using the parameters described in the following paragraphs.

2.2.4.1 Room Data Output

The calculated HVAC design parameters for each space shall be shown in an EXCEL type spread-sheet. A sample copy of the spread sheet is shown in Table 2-1. Provide a spread sheet for each air-handling unit as it is a vital tool to facilitate an in-depth review.

2.2.4.2 AHU Peak Cooling Load

AHU peak cooling load is the maximum load on the air-handling unit due to room sensible, room latent, and total outdoor air for ventilation cooling loads. Note that the AHU peak-cooling load is not the sum of the individual room peak cooling loads, which occurs at different times, in different months, and due to differing orientations. If a chiller serves a single air-handling unit, use the AHU peak load to select the chilled water system.

2.2.4.3 AHU Peak Supply Air Volume

AHU peak supply air volume is calculated from the peak space sensible cooling load without the sensible cooling load due to use of outdoor air for ventilation. Use AHU peak supply air volume for selecting the air-handling unit and air distribution ductwork upstream of the VAV box. For ductwork downstream of the VAV box, use the individual room peak supply air volumes. The return air duct shall be sized based on peak AHU supply air volume. The return air branch from the room shall be sized based on room peak supply air volume.

2.2.4.4 AHU Supply Air Volume and Duct Leakage Factor

Calculated AHU peak supply air volume shall be rounded off to the next 100 cfm or 10 L/s and increased by 5% to account for the air leakage due to ductwork and the system components. Increase the supply air volume by an additional 5% safety factor. Thus, the calculated supply air volume shall be increased by a total of 10.25%.

AHU Supply Air Volume:

Calculated Supply Air Volume x 1.05 (Leakage Allowance) x 1.05 (Safety Factor) = 1.1025, that is, 10.25% over the calculated rounded-off value.

Note: Show this value on the fan schedule.

2.2.4.5 Psychrometric Analysis

Provide psychrometric analysis for each air-handling unit by using software programs.

The calculated and graphic display of the system performance shall include the following:

- Outdoor and indoor design conditions
- Mixed air conditions
- Coil leaving air conditions
- Heat gain due to supply and return air fans
- Supply air volume
- Cooling, heating, and humidification loads

2.2.4.6 Building Peak Cooling Load

Building peak cooling load is the maximum cooling load due the space sensible and latent loads and the peak-cooling load due to the ventilation demand of the entire building, treated as one room. Building peak cooling load is not the sum of the peak cooling loads of the individual AHUs. Use building peak cooling load to select the cooling system.

2.2.5 ROOM TEMPERATURE CONTROLS

2.2.5.1 Definition

A space is defined as individually controlled only when a dedicated terminal unit (example: air terminal unit, fan coil unit, heat pump, or any other heating and/or cooling device) is used, with a dedicated room temperature sensor, to control the space temperature.

2.2.5.2 Individually Temperature Controlled Spaces

Listed below are examples of individually controlled spaces with dedicated temperature sensors. See Room Data Sheets, Chapter 6 for all individually controlled spaces.

- Animal Holding Areas
- Conference Room
- Kitchen
- Laboratory
- Operating Room
- Patient Bedroom

2.2.5.3 Group Temperature Control

(a) Perimeter Spaces

A single air terminal unit can serve as many as three offices or patient examination rooms located on the same exposure and with identical load characteristics. Do not combine spaces located on different zones to form a common temperature controlled zone.

Exception:

A perimeter corner space with at least two exposures shall be equipped with a dedicated room temperature control.

(b) Interior Spaces

A single terminal unit can serve as many as four interior office or patient examination rooms with identical load characteristics.

2.2.5.4 Open Spaces

Open spaces with an exposed perimeter shall not be combined with interior spaces to form a common temperature control zone. A perimeter zone is defined as an area enclosing an exposed length and 12 to 15 ft [4 to 5 m] width. An interior zone does not have exposed walls.

2.2.6 PERIMETER HEATING

2.2.6.1 General

Provide supplementary perimeter heating systems for:

(a) Patient Bedrooms: When the room heat loss exceeds 180 Btuh/lin ft [173 W/lin m] of exposed wall.

(b) All Other Occupied Spaces: When the room heat loss exceeds 210 Btuh/lin ft [202 W/lin m] of exposed wall.

(c) Energy Conservation: A building thermal envelope with enhanced energy efficiency can eliminate the need for perimeter heating systems.

2.2.6.2 Heating System Description

(a) All patient bedrooms and associated exposed bathrooms and all occupied spaces that qualify for supplementary heating shall use radiant ceiling panels only, unless approved otherwise by VA Authorities.

(b) During design development, provide coordinated details of the perimeter reflected ceiling plan, showing linear diffusers and radiant ceiling panels. Design shall optimize performance while maximizing aesthetics.

(c) For all other spaces such as non-patient bathrooms, exterior stairs, vestibules, and unoccupied spaces, thermostatically-controlled heat can be delivered by unit heaters, cabinet heaters, convectors or baseboard radiators.

2.2.6.3 Heating Medium

Heating hot water is the preferred choice for the heating medium. Use two-way modulating control valves to control the hot water flow. Minimum flow for each heating circuit shall not be less than 0.5 gpm [0.03 L/s]. For unoccupied miscellaneous spaces, steam or gas may be used. Use of electric resistance heaters shall be approved by VA Authorities and may be permitted where other heating mediums are not available.

2.3 SPECIAL STUDIES

The A/E shall perform the following special studies to ensure that the design intent is met. The studies, complete with estimated construction costs and the designer's specific recommendations, shall be submitted for review and approval.

2.3.1 ACOUSTIC ANALYSIS

2.3.1.1 General

Perform an acoustic analysis to demonstrate that the specified room noise levels are achieved in all octave bands for all air-handling units, heating and ventilating units, fans, chillers, boilers, generators, and outdoor noise producing equipment, such as cooling towers and chillers. See Room Data Sheets for the required Noise Criteria (NC) levels.

2.3.1.2 Acoustic Mitigation Measures – HVAC Systems (Not including Cooling Towers)

(a) Select equipment with lower sound power levels.

(b) Locate equipment away from noise-sensitive areas, such as conference rooms and patient bedrooms.

(c) Provide factory-fabricated sound attenuators in the main ducts, AHU casings, or downstream of air terminal units as needed to achieve the required noise levels.

(d) Provide acoustic sound lining in return or exhaust ducts under negative air pressure. Show the full extent of the acoustic lining on the floor plans and cross-sections. Specify expected attenuation in each octave band with the selected lining.

(e) Radiated or breakout noise in the low frequency range (humming noise) is often ignored and is hard to attenuate. Evaluate and include such measures as the use of thicker gage ducts and duct configurations shown in the 2007 ASHRAE Handbook of Applications.

(f) If recommended by the acoustic analysis, select duct velocities lower than those shown in the duct sizing criteria.

(g) Select louvers with sound baffles, where practical. Select transfer grilles with acoustic treatment.

2.3.1.3 Acoustic Mitigation Measures – Cooling Towers

Attenuation treatment of cooling towers depends upon factors such as local ordinance and functions of the surrounding spaces. The measures suggested below should be evaluated and included as deemed necessary.

(a) Locate cooling towers away from sensitive areas.

(b) Select cooling towers with low noise generating fans.

(c) Include acoustic screening (fencing) around cooling towers to contain the radiated noise. Coordinate this measure with the architects, VA Authorities, and local ordinances.

(d) Use acoustically-lined louvers, where required.

(e) Install sound attenuators on the intake and/or discharge sides.

(f) Include maximum permissible sound power levels measured at 5 ft [2 m] and 55 ft [17 m] from the cooling tower in the equipment schedule.

2.3.1.4 Unitary Equipment

Unitary Equipment – Space Mounted

When served by unitary equipment located within the conditioned space, the room noise levels are higher than remotely located equipment. For such spaces, an increase of 5 NC (in the room noise level) is permitted. Acoustic mitigation measures for the spaces served by unitary equipment are:

- Equipment selection at mid-speed for the required output
- Use of acoustic lining in the return air duct for the ducted installation
- Use of acoustic enclosure over the equipment, where feasible

2.3.2 DISPERSION ANALYSIS

2.3.2.1 General

(a) The A/E shall perform a computerized dispersion analysis to ensure that odors and hazardous exhaust do not enter into outdoor air intakes and open windows of VA facilities and adjoining properties. The analysis shall be self-certified with back-up data and itemized recommendations.

(b) Contamination is a serious safety and health issue. It is critical to evaluate and implement the recommendations of the analysis. All recommendations must be implemented even if OSHA and ASHRAE requirements are exceeded.

2.3.2.2 Scope of Work

The dispersion analyses shall evaluate the exhaust air discharged from the surrounding exhaust systems that are toxic and infectious. Examples of exhaust sources are:

- Emergency Generators
- Vehicular Exhaust
- Kitchen Exhaust
- Boiler Stacks
- Cooling Towers
- Incinerator
- Fume Hoods
- Biological Safety Cabinets
- TB Isolation Room Exhaust

2.4 BUILDING THERMAL ENVELOPE (EXISTING FACILITIES ONLY)

The mechanical designer and the project architect shall jointly examine the existing building thermal envelope and evaluate the possibility of making it energy-efficient. The recommended energy conservation measures shall be validated by life-cycle cost analysis.

2.5 BUILDING THERMAL ENVELOPE (NEW FACILITIES)

The latest edition of the Architectural Design Manual for New Hospitals refers to ASHRAE 189.1-2009, Standard for the Design of High-Performance Green Buildings. The complete standard has not been adopted by the VA, but the Architectural Design Manual requires compliance with the building envelope requirements. The prescriptive assembly maximum U-values and insulation minimum R-values stated in ASHRAE 189.1-2009 shall be incorporated into the opaque elements of the building envelope of new facilities.

2.6 VIBRATION CONTROL

Selection of vibration isolators shall be done from the matrix given in VA Master Specification 23 05 41 (Noise and Vibration Control for HVAC Piping and Equipment) and the equipment manufacturer's recommendations. Include applicable standard details. Indicate all vibration isolation types on the equipment schedules.

2.7 SEISMIC REQUIREMENTS

2.7.1 GENERAL

Earthquake-resistive design for the HVAC equipment and piping shall comply with H-18-8 (VA Seismic Design Handbook), ASCE-7, SMACNA Seismic Restraint Manual, and the International Building Code (IBC).

Structures assigned to Seismic Design Category C, D, E, or F, permanent non-structural components and their attachments, and the structure-supported attachments of permanent equipment shall be designed to resist total design forces prescribed in ASCE-7.

2.7.2 EXCEPTIONS

HVAC equipment, ductwork, and piping shall be braced in accordance with the most current edition of the Seismic Restraint Manual Guidelines for Mechanical Systems (SMACNA). There are conditions (see examples below) in SMACNA under which seismic bracing may be omitted. However, a design professional shall review and may revoke such omissions for the specific project.

- Piping in boiler and mechanical rooms less than 1.25 in [32 mm] in diameter
- HVAC equipment weighing less than 400 lb [181 kg] supported and attached directly to the floor
- HVAC equipment weighing less than 20 lb [9 kg] suspended from the roof or floor, or hung/supported from the wall

2.7.3 CONFORMANCE WITH SMACNA

SMACNA does not cover all conditions, such as providing bracing details for seismic restraints of equipment, details of flexible joints when crossing seismic or expansion joints, or bracing of in-line equipment, etc. Also, in locations of Very High Seismicity (as listed in H-18-8), SMACNA details should be used with care. Although SMACNA lists conditions under which seismic bracing may be omitted, the A/E may revoke these omissions on an individual project basis.

2.7.4 CALCULATIONS

Unless otherwise shown by SMACNA, provide detailed structural calculations for VA's review on the design of hangers, supports, anchor bolts, welds, and connections. Show sizes, spacing, and length for securing equipment, piping, and ductwork to structural members. The design calculations shall be prepared and certified by a registered structural engineer of record for the project.

2.7.5 DRAWINGS

2.7.5.1 General

Where SMACNA details are incomplete or not applicable, provide necessary seismic restraint details. Coordinate mechanical, architectural, and structural work.

2.7.5.2 Ductwork and Piping Plans and Sections

Show locations of required restraints with reference to SMACNA or special restraint details, whichever is applicable.

2.7.5.3 Equipment Restraints

Provide special details (not covered by SMACNA), where required. Provide special attention to the seismic provision for the suspended equipment.

2.8 FIRE AND SMOKE PROTECTION

2.8.1 COMPLIANCE

HVAC design and equipment shall be in compliance with NFPA 90A, NFPA 96, NFPA 99, NFPA 101 and other applicable codes with devices, such as, fire dampers, smoke dampers, and duct-mounted smoke detectors shown on the drawings where applicable.

While the local codes and ordinances are not binding to the VA, wherever possible, such provisions shall be reviewed with VA Authorities and implemented upon approval. See Figure 2-1 for typical smoke control for air-handling units.

2.8.2 EQUIPMENT AND CRITERIA

2.8.2.1 Smoke Dampers and Detectors

(a) Installation of smoke dampers and detectors shall be done in compliance with the manufacturer’s published recommendations for duct clearance distances and elbow locations.

(b) Provide electrical actuators.

(c) Smoke dampers and detectors shall be hard-wired.

(d) Provide an end switch with each smoke damper to ensure that the damper is proven open before the fan starts and closed after the fan is stopped.

(e) Provide local audible and visible alarms and a remote alarm at the ECC.

2.8.2.2 Fire Dampers

Show all fire dampers on floor plans.

2.8.2.3 Stair Pressurization

Stair pressurization is not used in VA facilities.

2.8.2.4 Engineered Smoke Control System

Engineered smoke control systems are not used in VA facilities.

2.8.2.5 Atrium Smoke Control System

See Chapter 6 for the Atrium smoke control system.

2.8.2.6 Elevator Shaft Venting

(a) Compliance

Rule 100.4 of ANSI.1, Elevator Safety Code.

(b) Hardware

Provide a normally closed, two-position, motorized damper in the hoist way for venting smoke. See VA Standard Detail for additional information. The damper shall open when activated by the space detector located at the top of each elevator hoist way. Status of the hoist way damper position shall be monitored at the ECC.

2.9 DESIGN CONSIDERATIONS FOR EXISTING BUILDINGS

2.9.1 SITE SURVEY

2.9.1.1 Site Visits

Coordinate site visits with VA Authorities to become familiar with entry, exit, security requirements, parking, and storage requirements. Perform an extensive site survey, record crucial measurements, and interview the maintenance and operating personnel to document actual field conditions, access requirements, and maintenance history of the existing equipment.

Do NOT rely solely on as-built drawings. Take photographs and actual measurements where tight conditions prevail and provide cross-sections of such locations.

2.9.1.2 Field Survey Report

Include the site survey report in the project submission and describe chronic problems and shortcomings that may impact the project scope of work.

2.9.1.3 Additional Work

Should the site survey result in changes in the scope of work, notify the VA Authorities, in writing, as soon as possible. Any additional work resulting from the site survey must be authorized in advance before it is included in the project scope.

2.9.2 MODIFICATIONS – EXISTING SYSTEMS

Work on the existing systems shall include the following measures:

2.9.2.1 Steam Radiators

Existing steam radiators shall be dismantled and replaced with hydronic hot water heat. If this measure is not feasible, the existing radiators shall be equipped with modulating control valves, controlled by the room thermostat responsible for cooling the space. A single thermostat shall prevent cooling and heating concurrently.

2.9.2.2 DDC Controls

All new control devices shall be equipped with electric actuators. For a major renovation of an existing facility, where an updated control system is being installed, replace pneumatic with electric actuators.

2.9.2.3 Existing Ductwork

Where connections are made between new and existing ductwork, the existing ductwork shall be pressure tested, thoroughly cleaned, and sanitized to avoid the possibility of contamination.

2.9.2.4 Refrigerant Removal

Refrigerant from existing equipment that is being dismantled and removed shall be handled and stored in containers per EPA guidelines, and disposed of in accordance with EPA guidelines. Consult local VA Authorities for logistical details and support.

2.10 PROJECT PLANNING

The HVAC system design and development shall consider the factors listed below:

2.10.1 PHASING

Coordinate the phasing requirements with facility personnel. Phasing will have significant impact on the need for swing space, schedule, and the system design. Testing, Adjusting, and Balancing and Commissioning costs are dependent on phasing. Duplication of efforts shall be minimized.

2.10.2 UTILITY CONNECTIONS AND OUTAGES

Coordinate outdoor utility routing, available capacity, and intended outages with facility personnel. Provide signs showing revised traffic patterns and revisions to parking.

2.11 DEMOLITION WORK

Demolition work shall be clearly documented with points of disconnections and connections clearly shown. The demolition drawings shall show the locations of new shutoff valves, end caps, and blind flanges.

2.12 LOCATIONS OF OUTDOOR AIR INTAKES AND EXHAUST AIR OUTLETS

2.12.1 COMPLIANCE – PHYSICAL SECURITY

Air intakes and exhausts shall be designed in accordance with the Physical Security Design Manual for VA Facilities – Mission Critical Facilities.

2.12.2 GENERAL

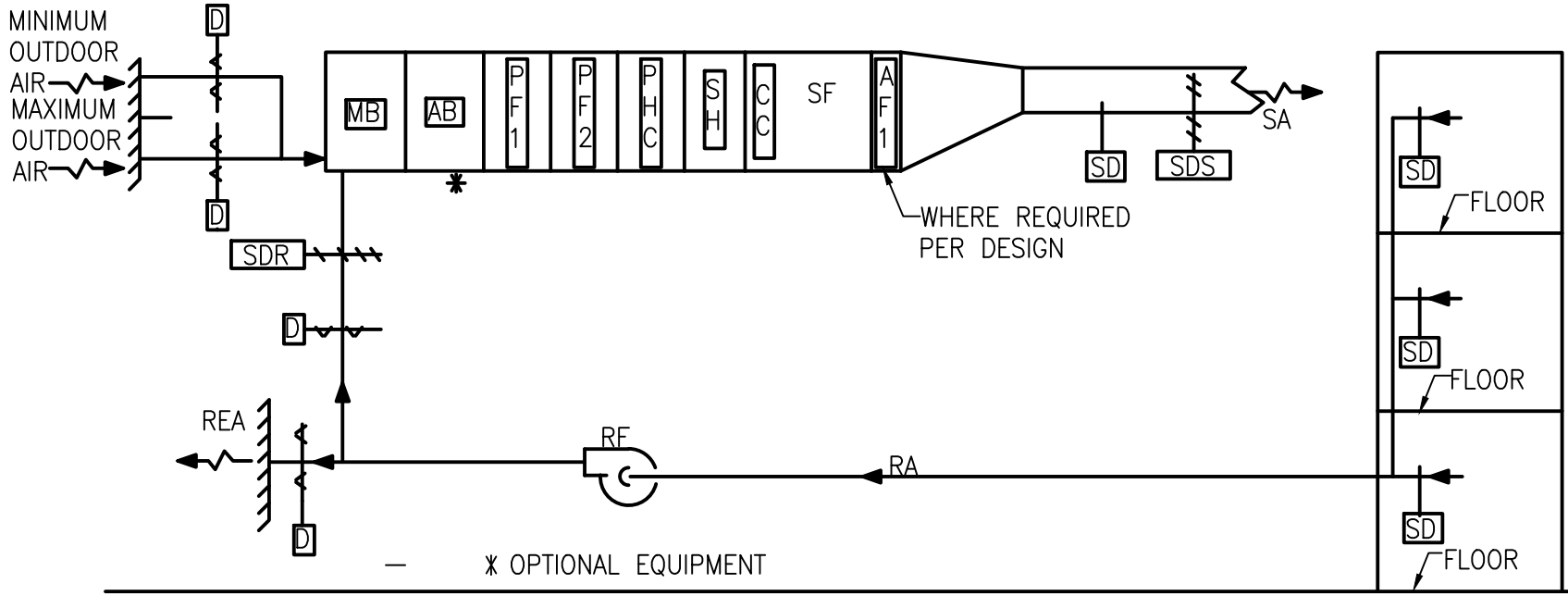
Outdoor air intake and exhaust air outlets shall be located to avoid health hazards, nuisance odors, reduction in capacity of HVAC equipment, and corrosion of equipment caused by re-entry of exhaust air from laboratories, transportation systems, cooling towers, and air-cooled condensers. See VA Master Specifications for the types of allowable louvers and their limiting velocities and pressure drops.

2.12.3 COMMON OUTDOOR AIR INTAKE

Common outdoor air intake can be used in conjunction with multiple air handling units, provided the outdoor air intake plenum is partitioned with a dedicated intake for each air handling unit.

2.13 BID PACKAGE COORDINATION

Ensure that the bid documents are coordinated within the mechanical discipline and across architectural and all other engineering disciplines to avoid delays and costly change orders/claims.



NOTES:
1. THIS DIAGRAM IS APPLICABLE TO SYSTEMS WITH A DESIGN CAPACITY GREATER THAN 15,000 CFM [7,075 L/S] AND SERVING MULTIPLE FLOORS.
2. SMOKE DAMPERS ARE NOT REQUIRED IF AHU IS LOCATED ON FLOORS SERVED AND SERVES ONLY THAT FLOOR OR LOCATED ON ROOF DIRECTLY ABOVE FLOOR SERVED. SEE NFPA 90A.
3. SEE STANDARD DETAILS AND CAD STANDARDS (PG–18–4) LOCATED ON THE TIL FOR A LIST OF ABBREVIATIONS.

SMOKE CONTROL FOR AIR HANDLING UNIT SYSTEMS

Not to Scale

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ROOM COOLING AND HEATING LOADS OUTPUT DATA SUMMARY SCHEDULE

AHU NO	ROOM NO	ROOM NAME	ROOM SIZE				AHU	PEAK ROOM COOLING LOAD				PEAK ROOM HEATING LOAD		CALCULATED ROOM AIRFLOW				REQUIRED ROOM AIRFLOW			SELECTED DESIGN ROOM AIRFLOW		ROOM AIR RETURN EXHAUST (G) EXHAUST (S)	ROOM STATUS	ROOM AIR BALANCE
			AREA		HEIGHT		SYSTEM TYPE	SENSIBLE		LATENT															
			SF	M^2	FT	M	VAV OR CV	BTUH	W	BTUH	W	BTUH	W	CFM	L/S	ACH	ΔT	CFM	L/S	ACH	CFM	L/S		VAV OR CV	(+) OR (-) OR (0)

NOTES:

1. THIS SCHEDULE IS REQUIRED FOR DESIGN SUBMISSION.
2. PROVIDE 11"x17" SPREADSHEETS TO VA FOR DESIGN SUBMISSIONS.
3. USE MINIMUM AIRFLOW (CFM [L/S]) FOR AIR CHANGE CALCULATIONS. IN MOST CASES, THIS IS THE HEATING AIR FLOW RATE.

ROOM DATA OUTPUT
Not to Scale

CHAPTER 3: AIRSIDE HVAC SYSTEMS AND EQUIPMENT

Table of Contents

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3.1 INTRODUCTION

This chapter addresses the airside of HVAC systems and associated equipment. Information given below shall be used in conjunction with the VA Standard Details, Master Specifications, and associated documents, described in Chapter 1 and located in the TIL.

The following HVAC systems are evaluated:

- Central air handling units (all-air systems)
- Terminal cooling and heating systems
- Minimum ventilation air handling units (100% outdoor air)
- Heating and ventilation units
- Heat recovery systems
- Exhaust systems
- Miscellaneous systems/components

Criteria for duct sizing and design are provided at the end of this chapter.

3.2 ALL-AIR SYSTEMS

3.2.1 SPECIAL REQUIREMENTS

3.2.1.1 System Selection

All-air systems shall be used for all new facilities and major renovations of existing facilities where above ceiling clearance is available to accommodate HVAC air distribution systems. Design of all-air systems shall be based on admitting minimum outdoor air, or 100% outdoor air, with variable air volume (VAV) or constant volume (CV) configuration.

Air handling unit system selection shall be based on a Life Cycle Cost Analysis (LCCA) comparing a minimum of three different system configurations. Systems requiring lower dew point temperatures, such as surgery, may involve additional systems for comparison. Further consideration will be given to whether the project is in a high or low humidity area.

For a conventional VAV system with a pre-heat coil, steam humidifier, and chilled water coil include an analysis of water side versus air side economizer. Analysis shall include impact of additional humidification energy required when using air side economizer in low humidity areas.

Analyze the effectiveness of a dedicated outdoor air system (DOAS) ducted to the outdoor air intake of multiple VAV or CV air handling units. Advantages of supply air reset shall be included in the analysis. For the DOAS, evaluate the effectiveness of a series desiccant wheel to produce lower dew point temperatures with 42-44 F [5-7 C] chilled water supply.

In lieu of a DOAS, evaluate the effectiveness of a dual-path air handling unit. The outdoor air and recirculated air paths each include a dedicated cooling coil.

Evaluate the life cycle cost of dual fan, dual duct VAV units. Address integral economizer cycle or DOAS. The dual fan system shall be arranged in a draw-through configuration. This system is advantageous in low humidity areas.

Separate analysis will be required for the Surgery Suite and any 100% outside air systems.

All air handling systems shall be proven cost effective based on a LCCA.

3.2.1.2 Maximum Capacity

The capacity of a single air-handling unit shall not exceed 50,000 cfm [23,600 L/s).

3.2.1.3 AHU Configuration

(a) Air handling units shall be AHRI certified (either independently or in-house, dependent on fan system selection), factory-fabricated, and the standard product of one manufacturer. All air-handling units shall be constructed in modular, vertical or horizontal, and draw-through configuration. Use of blow-through air-handling units is not permitted, as fully saturated air leaving the cooling coil causes damage to the downstream filters and sound attenuators. See Figure 3-1 for a typical air handling unit configuration.

(b) Each air-handling unit shall be installed as a standalone entity without any physical interface with another air-handling unit. Selection of stacked (one on the top of another) air handling units is not permitted. Use of a common return air fan for two or more air-handling units is also not permitted.

3.2.1.4 Rooftop Air-Handling Units

Rooftop air-handling units are NOT permitted in high humidity locations shown in Chapter 7. Rooftop air-handling units are also not permitted in hurricane areas identified in the Physical Security Manual for Mission Critical Facilities.

Rooftop air-handling unit installation, where permitted, shall address and resolve coordination issues, including but not limited to:

- Structural integrity of the roof to bear the load
- Access for repairs, removal, and replacement of equipment
- Screening needs to meet local ordinances
- Walking pads to reach equipment
- Minimize exposed piping on the roof and install underneath the unit wherever possible

3.2.1.5 Supply Air Fan Selection

(a) Plenum Fans versus Centrifugal Fans: Use of a single or multiple (not more than four fans in an array) plenum fans is permitted over housed, air-foil centrifugal fans if proven as a superior choice based on the overall impact of the following parameters:

- BHP Absorbed
- Sound Power Ratings
- Overall Space Requirements
- Cost
- For VA Central Office Projects, the selection shall be reviewed and approved by VA Authorities.

The designer shall provide multiple fan selections comparing the plenum fans and housed centrifugal fans in a project specific configuration that addresses such issues as the status of the after-filters (ASHRAE 170) and required discharge air configuration. Note that the use of the plenum fans is approved within the fan casing only.

(b) Plenum Fans - Certification and Testing Requirements (AMCA and AHRI)

- **AMCA:** Each plenum fan shall be individually AMCA 210 certified for air performance and AMCA 300 certified for sound power. It is recognized that multiple fans in an array are not yet AMCA certified.
- **AHRI:** Air handling units equipped with a single plenum fan shall be AHRI 430 certified for airflow capacity and AHRI 260 certified for sound data. Air handling units equipped with multiple fans in an array shall be rated and factory tested in accordance with AHRI 430 for airflow capacity and AHRI 260 for sound data.

3.2.1.6 Air Distribution

All supply, return, exhaust, relief, and outdoor air duct systems shall be fully ducted between the fan intake/discharge and air outlets/inlets**. Use of the space between the structural ceiling and suspended ceiling is NOT permitted as an air plenum for air distribution and/or collection.**

3.2.1.7 Glycol

Use of an ethylene glycol solution is NOT permitted as an anti-freeze agent due to its toxicity level. Use propylene glycol for its lower toxicity and higher heat transfer efficiency compared to ethylene glycol. See Chapter 4 and Appendix 4-A for further technical details.

3.2.2 ALL-AIR SYSTEM COMPONENTS

3.2.2.1 Supply Air Fan(s)

(a) Fan Selection: See Supply Air Fan Selection in this chapter for fan selection.

(b) Fan Motor Selection: The fan motors shall be premium efficiency type per Federal Energy Management Program (FEMP) and VA Master Specifications. The fan motors shall be selected within the rated nameplate efficiency, without relying on the service factor. When used with VSDs (Variable Speed Drives), the fan motors shall be compatible with the motor controller duty.

3.2.2.2 Return Air Fan(s)

Where room air can be returned back to the system, provide a dedicated return or relief air fan for each air-handling unit to facilitate room-by-room air balance, economizer cycle, and intended volumetric air balance. Provide a direct digital control (DDC) interlock between the supply and return/relief air fans.

3.2.2.3 Exhaust Fan(s)

Provide general and special exhaust fan systems (as required) electronically interlocked with the AHU supply air fan. A single AHU may require interlocks with multiple exhaust fan systems, such as general exhaust, fume hood exhaust, and “wet exhaust”.

3.2.2.4 Motor Voltages

Motor Voltages shall conform to NEMA/ANSI standards as follows:

Table 3-1: MOTOR VOLTAGE SIZING CRITERIA

System Voltage (Transformers)		Utilization Voltage (Motors)
Nominal	With 4% Drop	Standard (For Schedule)
120	115.2	115
208	199.7	200
240	230.4	230
480	460.8	460
600	576.0	575
2400	--	2300
4160	--	4000

3.2.2.5 AHU Casing

The AHU casing shall be solid double-wall, without perforations. Provide thermal insulation between the inner and outer casings. Use of exposed interior insulation is not permitted.

The combination of the casing wall thickness and the insulation characteristics (insulation type, thickness, and density) shall:

- Provide stiffness to resist dents
- Limit vibration within the prescribed values

- Limit inlet, discharge, and casing-radiated noise
- Avoid condensation on the exterior surface of the air handling unit or its viewing windows when located in non-conditioned spaces, such as mechanical rooms, basements, and attic spaces

3.2.2.6 Access Sections and Mixing Box

Include access sections generally as shown in Figure 3-1. Show door swings on the floor plans. Include a factory-fabricated mixing box to mix the return and outdoor airstreams. Pre-filters shall not be located in the mixing box.

3.2.2.7 Blender Section

Provide a blender section, where warranted, to mix return and outside air and prevent stratification.

3.2.2.8 Drain Pan

Provide an insulated, stainless steel, double-wall, and double sloping drain pan for removing cooling coil condensate from the pan as soon as it forms. Where two coils are stacked, include an intermediate drain pan for draining condensate from the upper coil into the main drain pan. Raise all floor-mounted air-handling units above the finished floor level to obtain adequate static head for the installation of cooling coil condensate traps.

3.2.2.9 Cooling Coils

Provide chilled water or direct expansion (DX) (only where permitted) cooling coils constructed of copper tubes and aluminum fins. Select cooling coils to limit the face velocity to 500 fpm [3 m/s] or below and the fin spacing shall not exceed 132 fins/ft [433 fins/m]. Evaluate the possibility of lowering the cooling coil face velocity if life-cycle cost-effective.

3.2.2.10 Preheat Coils

Provide preheat coils for all AHUs where the winter design temperature (ASHRAE Annual Extreme Daily Mean Dry-Bulb Temperatures – Minimum Column) is 32 F [0 C] or below. Preheat coils are required when the mixed air temperature is lower than the supply air temperature. Select steam, hot water/glycol, hot water, or electric preheat coils, generally with the same face velocity as the cooling coils to avoid installation of blank off plates.

(a) Steam Coils: Select steam coils with integral face and bypass dampers and two-position on/off control valves. As an option, for non-100% outdoor air units, consider the use of a distributing type steam coil with a modulating control valve. Ensure that steam condensate is removed from the coil as soon as it is formed by selecting the correct steam trap size and type, adequate static leg for the gravity drain, and the recommended slope for the gravity return.

(b) Hot Water Coils – With Glycol: If the use of steam preheat coils is not feasible, use hot water/glycol preheat coils where the preheat coil surface comes in contact with 32 F [0 C], as defined above, or lower air temperature. Use propylene glycol solution with corrosion inhibitors specifically manufactured for HVAC applications. See Chapter 4 for glycol properties and design criteria.

(c) Hot Water Coils – Without Glycol: Glycol can be omitted where the heating design temperature is above 32 F [0 C]. The following freeze protection measures are recommended:

Provide a dedicated circulating pump in the coil circuit with hydronic separation between the coil circuit and the incoming hot water piping to maintain a constant water velocity of 3.0 fps [0.9 m/s] through the coil tubes. See VA Standard Detail - Hot Water Preheat Coil and Inline Pump.

Select coils with wider fin spacing at the rate of 6 fins/in or 8 fins/in [0.24 fins/mm or 0.31 fins/mm].

Provide coil connections to ensure that the coldest air faces the hottest fluid.

(d) Electric Coils: Electric preheat coils may be used where steam and/or heating hot water are not available. Select low-watt density electric coils complete with UL safety devices and Silicon Controlled Rectifier (SCR) controls for modulating operation.

3.2.2.11 Unit-Mounted Reheat Coils

Air-handling unit mounted reheat coils are used for single-zone application and elsewhere where required. Hot water or steam coils with modulating control valves are the preferred choice. Electric reheat coil may be used where hot water or steam is not available.

3.2.2.12 Corrosion Protection - Coils

(a) Surgical Suite Air-Handling Units: For ALL locations, air-handling unit-mounted coils shall be equipped with copper fins. Copper fins possess anti-microbial properties and for high-humidity locations offer corrosion protection. Select coil face velocities to compensate for the use of copper fins in lieu of aluminum fins.

(b) High Humidity Locations - All Air-Handling Units (Except Surgical Suite): All unit-mounted coils shall be equipped with multi-stage, electro-deposit coating (E-Coating) of 1-mil thick epoxy lining. Select coil face velocities and fin spacing per manufacturer's recommendations for coated coils.

3.2.2.13 Filtration

Each air handling unit shall be provided with two pre-filter sections. Pre-filters shall be located upstream of the coil sections. Filter face velocity shall not exceed 500 fpm [3 m/s]. After-filters and final-filters (terminal filter) shall be provided as shown in Chapter 6 and Room Data Sheets. Provide side-access filters for final filter applications.

(a) Filter Pressure Drops: Estimate the fan static pressure by using the manufacturer's published static pressure drop at the recommended changeover condition, and not at the clean condition.

The filter schedule shall show the static pressure drop through the filters at both conditions - clean and recommend changeover.

(b) Filter Efficiency: Filter efficiencies shall comply with ASHRAE Standard 52.2 – 2007, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size. All filter efficiencies are expressed as Minimum Efficiency Reporting Value (MERV) numbers.

Table 3-2: FILTER SCHEDULE

Designation	Location	MERV	Thickness
Pre-Filter (PF-1)	Upstream of All Coils and Supply Air Fan	7	2-inch Thick Throwaway
Pre-Filter (PF-2)	Downstream of PF-1	11	6-inch Thick Rigid Cartridge
Alternate Pre-Filter (PF-2)	Downstream of PF-1	13	6-inch Thick Rigid Cartridge
After-Filter (AF)	Downstream of Cooling Coil and Supply Air Fan	14	12-inch Thick Rigid Cartridge
Final-Filter	Downstream of Air Terminal Unit	17	99.97% @ 0.3 Microns (HEPA)

Notes:

(1) PF-1 and PF-2 shall be located back-to–back.
(2) All AHU mounted filters shall be nominal 24 in x 24 in [650 mm x 650 mm] size.

(c) Manual Pressure Gages: Provide a single dial-type differential pressure gauge with air sampling tubing and three isolation ball valves to measure static pressure across PF-1 and PF-2 and the total static pressure drop across both pre-filter sections.

Provide a single dial-type differential pressure gauge at each after-filter and final-filter.

(d) DDC Pressure Differential Switch: Provide a dedicated DDC pressure differential switch for each filter section. The DDC switch shall interface with the building ECC system to provide a remote maintenance alarm, when the pressure drop exceeds the switch alarm setting.

3.2.2.14 Humidifiers – Steam

Provide a unit-mounted steam humidifier to maintain the zone relative humidity at set point. The humidifier shall be jacketed type designed to attain full dispersion of steam in the airstream.

(a) Location: Preferred location of the humidifier is between the pre-heat and cooling coils. Duct-mounted steam humidifiers are permitted only for renovation projects in existing buildings, where space conditions are limited and after-filters are not required on the downstream side of the cooling coil and supply air fan. Provide drainable stainless steel duct sections on the upstream and downstream sides of duct-mounted humidifiers.

(b) Humidifier Controls: Provide a modulating steam control valve to control and maintain zone humidity. Locate the relative humidity sensor in the main return or exhaust air duct to control set point. Provide a high-limit humidity sensor in the supply air duct to disable humidification if the discharge humidity exceeds 80% (adjustable). Ensure full integration of the humidifier controls with the ECC, including remote alarm capability.

(c) Boiler Plant Steam: Steam from the central boiler plant may be used only if it is documented that the water treatment chemicals are FDA and OSHA approved.

(d) Dedicated Unfired Steam Generator: Where direct use of central plant steam is not feasible, an unfired steam-to-steam generator shall be used to produce “clean steam” at 15 psig [103 kPa]. Incoming water shall be de-ionized or reverse-osmosis treated as recommended by the generator manufacturer. Determine water quality based on the site sample and lower the incoming dissolved solids to 80 ppm (parts per million).

3.2.2.15 Humidifiers – Gas-Fired

Where central plant steam or “clean steam” is not available, evaluate the possibility of using a gas-fired steam generator. Determine water quality based on the site sample and lower the incoming dissolved solids to 80 ppm (parts per million).

3.2.3 ALL-AIR SYSTEM – TYPES

3.2.3.1 Variable Air Volume (VAV) Systems

VAV systems shall be used where feasible. The system shall be designed to vary the supply air volume in response to the prevailing cooling load while still maintaining the minimum outdoor air for ventilation at the air-handling unit level, under all operating conditions, from full load to part load. Each VAV system is generally equipped with:

- Variable speed drives for supply and return/relief fans
- Airflow measuring devices
- Static pressure sensors
- Pressure-independent air terminal units

(a) Automatic Control Sequence: Supply air fan speed shall be controlled by polling all air terminal units and/or by monitoring the duct static pressure. Airflow measuring devices shall facilitate a tracking sequence in which a constant differential between the supply and return/relief air volumes shall be maintained. Limit the tracking and speed reduction sequences to avoid return/relief air fan stalling.

(b) Airside Economizer Cycle: Incorporate economizer cycle as mandated by ASHRAE Standard 90.1 – 2007 and where found cost-effective by life-cycle cost analysis.

3.2.3.2 Constant Volume (CV) Systems

Constant volume systems, similar to variable air volume, shall be provided where the supply air volume is expected to remain constant or substantially constant.

3.2.3.3 Air Terminal Units

All terminal units shall be pressure-independent type and equipped with DDC controls.

All air terminal units (constant volume or variable air volume) serving perimeter or interior spaces shall be equipped with integral reheat coils. When terminal units serving interior spaces are not equipped with reheat coils and set at full shutdown condition, small but sustained leakage of supply air tends to overcool the space during prolonged no-load conditions. Heating hot water with modulating control is the preferred option.

(a) Capacity

- Capacity of a single air terminal unit shall not exceed 3,000 cfm (1,420 L/s).
- Minimum hot water flow shall not be lower than 0.5 gpm [0.03 L/s]

(b) Terminal Units Settings: The maximum and minimum air volume settings shall be factory set, but field adjustable. The minimum setting shall satisfy the following:

- Provide make-up air for exhaust
- Meet minimum ventilation air needs
- Limit the supply air temperature to 95 F [35 C] in heating mode. Increase the supply air airflow as required if more heat is required.

(c) Series Fan-Powered Air Terminal Units: For non-patient areas, evaluate the use of series fan-powered boxes. Provide a solid-state speed controller to adjust the fan speed. Provide a 1 in [25 mm] thick throwaway filter in the return air intake opening. Use of series fan-powered boxes offers the following advantages:

- Provides constant air circulation even at part load conditions and avoids stagnation
- Facilitates space heating during unoccupied hours without activating the air-handling unit.

(d) Acoustic Treatment: Provide terminal unit sound attenuators per acoustic analysis.

3.3 TERMINAL COOLING AND HEATING SYSTEMS

In this section, fan coil units are described with 100% outdoor air air-handling unit for minimum ventilation air. The use of water source and ground source heat pumps with auxiliary equipment is not addressed in this manual. Water source and ground source heat pumps are acceptable and shall be evaluated if the facility has significant spaces (example space is interior area) requiring year-around cooling.

3.3.1 SPECIAL REQUIREMENTS

3.3.1.1 Terminal Cooling Systems

The following terminal cooling systems were examined by Facilities Criteria Service:

- Radiant Panels
- Chilled Beams (Active and Passive)
- Valance Systems

Based on a LCCA and using a minimum of four air changes per hour (total) for a patient room (reference: ASHRAE standard 170-2008, Table 7-1, Note V) the above systems are not proven to be cost-effective and shall not be used.

3.3.1.2 DX Terminal Units

Through-the-wall air-conditioners, window air-conditioners, packaged terminal air-conditioners (PTAC), or terminal heat pumps are NOT permitted for all occupied spaces, unless approved by VA Authorities.

Where specifically approved by VA Authorities, spilt-systems or terminal DX units may be used only for non-patient spaces, where chilled water is not available. Examples spaces are:

- Pharmacy Storage within a Large Warehouse
- Remotely Located Security Office
- Guard Cabin

3.3.1.3 Fan Coil Units

Fan coil units are not permitted in new construction. Fan coil units are also not permitted in major renovation projects, where space is available to accommodate air distribution ductwork between the structural ceiling and the suspended ceiling. Use of 2-pipe seasonal changeover systems is not permitted.

Exception:

Fan coil units (two-pipe, cooling-only) may be used to serve miscellaneous spaces requiring year around cooling. Examples spaces are:

- Elevator Machine Rooms
- Communication Rooms

3.3.1.4 Minimum Ventilation Air

A dedicated, 100% outdoor air handling unit shall be provided to supply conditioned air to occupied spaces by fully ducted air distribution system. Admission and distribution of minimum ventilation air (conditioned or raw) is not permitted through fan coil units or any other terminal units.

3.3.1.5 Minimum Ventilation Air-Handling Units (100% Outdoor Air)

The central ventilation system shall be similar to the all-air system described above with MERV 7 and MERV 11 pre-filters installed back-to-back on the suction side of the supply air fan and equipped with a heat recovery device, pre-heat coil, and cooling coil. Remotely located central ventilation units shall distribute conditioned air directly into the conditioned space by supply air outlet and not into the fan coil unit intake.

(a) Ventilation Air Control: Do not deliver minimum ventilation air at "neutral" condition, by reheating the air up to the room air temperature after dehumidification. Provide dynamic control of the ventilation air temperature to take full advantage of its available cooling capacity in cooling mode and heating capacity in heating mode. Ensure that the variations in the ventilation air temperature do not compromise dehumidification.

(b) Ventilation Air Outlets: Minimum ventilation air outlets shall be designed to provide the required air throw to occupied areas. With smaller ventilation air volumes, 20 cfm [9 L/s], selection of suitable outlets is necessary. Use of the jet type of side outlets, generally used in aircraft, shall be evaluated to meet the design intent.

3.3.2 FAN COIL UNITS – SYSTEM DESCRIPTION

Where fan coil units are permitted, the system design shall be based on 4-pipe configuration, capable of providing on-demand heating or cooling. Fan coil units can be used in vertical, floor-mounted or in horizontal, ceiling-suspended (recessed or concealed) configuration with supply and return air ductwork as required. Vertical units are generally located under windows to control cold drafts and solar radiation.

3.3.2.1 System Applications

Generally, the use of 4-pipe fan coil systems shall be limited to serve perimeter spaces only. Use of fan coil units for interior spaces shall be carefully evaluated on a case-by-case basis. Isolated interior spaces can be conditioned using a 100% outdoor air unit. While this approach is not energy-efficient, it is significantly cost-effective. Use of heat recovery systems, generally provided with 100% outdoor air units, partially recover energy wasted when 100% outdoor air is used as total air. Provide a duct-mounted reheat coil for space temperature control.

3.3.2.2 Cooling Coil Condensate Piping

Design the cooling coil condensate piping to remove condensate without clogging the drain pan and drain lines. Minimize the extent of horizontal runs and provide cleanouts at each turn in the direction of flow. Pitch the drain line in the direction of flow to facilitate flow by gravity.

3.3.2.3 Filtration

Provide manufacturer's premium filters.

3.3.2.4 Acoustic Measures

Select fan coil units to deliver the required capacity at mid-speed. With ceiling-suspended fan coil units, provide acoustic lining in the return air duct (if required) and an acoustic enclosure to dampen the radiated noise.

3.3.2.5 Controls

4-pipe fan coil units shall be equipped with separate cooling and heating coils. Provide a two-way, modulating control valve for each coil to operate the cooling and heating modes in sequence. DDC controls shall be used, where proven cost-effective.

3.4 HEATING AND VENTILATION UNITS (HVU)

Provide central or split-function heating and ventilation systems, where mechanical cooling is not required. The system shall be able to operate from 100% outdoor air to minimum outdoor air to comply with ASHRAE Standard 62.1 – 2007 or exhaust air requirements, whichever is greater. Example spaces are:

- Large Warehouses
- Garages
- Storage Rooms
- Mechanical or Electrical Equipment Rooms

3.4.1 DESIGN PARAMETERS

3.4.1.1 Total Air Changes per Hour

Calculate the supply air volume based on the recommended air changes per hour by the applicable code or criteria and the project-specific parameters, such as, ceiling height and air distribution mode. The minimum supply air volume is generally maintained at 4 air changes per hour. To account for the internal heat gain due to lighting, equipment load, solar and other envelope heat gain, the supply air volume can also be estimated by assuming 10.0 F [5.6 C] difference between the space and ambient air temperatures.

3.4.1.2 Heating Mode

Occupied Mode – 65 F to 72 F [18 C to 22 C]

Unoccupied Mode – 50 F [10 C] During unoccupied mode, the system shall run in 100% re-circulatory mode, with the outdoor air damper fully closed, to maintain night setback temperature.

3.4.2 CENTRAL VENTILATION AND/OR HEATING SYSTEM

Generally, a central system is comprised of a fan, filter (MERV 8), and heating sections with a uniform air distribution system. The system shall be capable of delivering from 100% to minimum outdoor air on demand. Provide a central or multiple exhaust fans to modulate the exhaust air volume in unison with the outdoor air admitted into the space.

3.4.3 SPLIT-FUNCTION OR SEPARATE HEATING AND VENTILATION SYSTEM

Heating and ventilation functions are separated by dedicated equipment for heating and ventilation. Such systems can be designed in numerous configurations. As an example, single or multiple exhaust fans, as required, can be provided to ensure uniform coverage of the space with matching outdoor air intake(s) equipped with motorized dampers. The fans can be controlled manually and/or thermostatically. Ventilation may not be required in the heating season except to ensure minimum ventilation per ASHRAE Standard 62.1 – 2007.

Heating is provided by thermostatically controlled, ceiling-suspended unit heaters or cabinet heaters for uniform heat distribution. Heating medium can be hot water, steam or natural gas.

3.5 SUPPLY AIR OUTLETS

(a) Linear Diffusers:

- For all occupied spaces with exposed perimeter windows, the design shall be based on linear supply air diffusers. Minimum length of the supply air diffusers shall match the window width. The design shall include a factory-furnished, internally insulated supply-air plenum over the diffuser. Provide a single feed or multiple feeds to the plenum, as recommended by the manufacturer, to ensure uniform velocity distribution.

- For spaces such as lobbies and reception areas with high glass, include wall-to-wall linear diffusers in the design. Provide supply air plenums continuously or intermittently, as required, to ensure required throw and air diffusion. Include blank-off plates for the diffuser segments, where plenums are not required.
- Provide a manual volume control damper for each takeoff feeding linear diffusers

(b) Square/Rectangular Diffusers:

- For interior spaces and elsewhere, where required, include square 24 in x 24 in [600 mm x 600 mm] or 12 in x 12 in [300 mm x 300 mm] supply air diffusers with neck sizes as required to meet the duty conditions. Provide multiple supply air diffusers to achieve uniform air distribution without dead spots.
- Use rectangular supply air diffusers for uneven air distribution.
- For corridors, provide two-way blow diffusers to suit the space geometry.
- Limit the capacity of a single diffuser to 400 cfm [189 L/s].

(c) Round Diffusers: Use round diffusers for exposed occupied spaces.

(d) See HVAC schedules for supply/return and exhaust outlets.

3.6 HEAT RECOVERY SYSTEMS

The system design shall incorporate heat recovery systems to be in compliance with ASHRAE Standard 90.1-2007 and where found cost-effective based on life-cycle cost analysis. The applicability and suitability of heat recovery systems shall be evaluated by VA Authorities before heat recovery systems are included in the design.

3.6.1 SENSIBLE HEAT TRANSFER

The analysis shall include each of the following systems where applicable to sensible heat transfer only.

3.6.1.1 Runaround System

This system utilizes a piping loop and circulation pump. The loop connects a finned-tube coil in the exhaust plenum with a finned tube coil in the makeup air plenum or AHU. This system typically operates to preheat outdoor makeup air but also to pre-cool the make-up air when the exhaust air stream is cooler than the outdoor make-up air. Evaluate the impact of using propylene glycol.

3.6.1.2 Fixed-Plate System (Air-to-Air)

Plates augmented with fins separate air streams. No transfer media other than the plate-forming wall is used.

3.6.1.3 Heat Pipes

The salient features are:

- Heat source boils a heat transfer fluid and a heat sink condenses the fluid back to its liquid state, liberating the energy transferred from the fluid's phase change
- Transfer fluid is contained within a pipe
- Supply and exhaust streams must be in close proximity. Use sealed-tube thermosyphon.
- Corrosion resistance of the pipe must be ensured

3.6.1.4 Heat Wheel

The salient features are:

- Rotary air-to-air heat exchange
- Low-pressure drop of 0.4 – 0.7 in of water [100 – 175 Pa]
- Airstreams must be adjacent
- Airstreams must be filtered if particulate is present
- Fill medium requires periodic cleaning
- Since cross-contamination of airflows can occur, use of the heat recovery wheels is not permitted for air-handling units serving the SPD Department
- Ensure outside air is pressurized and greater than exhaust air

3.6.2 SENSIBLE AND LATENT HEAT TRANSFER

The analysis shall include each of the following systems where applicable to both sensible and latent energy transfer.

3.6.2.1 Desiccant (Enthalpy) Heat Wheels

The salient features are:

- Typical in laboratory facilities where more than half of the total HVAC load is latent
- The use of a three Angstrom molecular sieve provides sensible and latent energy recovery with a very low level of cross-contamination between the incoming outdoor air and exhaust system discharge
- Cross-contamination limit of less than 0.04% by particulate count
- Heat transfer efficiency of 75-90%
- No wet surfaces to support microbial growth or chemical byproducts associated with boiler steam humidification
- Since cross-contamination of airflows can occur, use of the heat recovery wheels is not permitted for air-handling units serving the SPD Department
- Ensure outside air is pressurized and greater than exhaust air

3.6.3 LOAD CREDIT

Do not include any credit due to the savings in cooling and heating energies while sizing and selecting the cooling, heating, and airside equipment. Such savings can be projected into the energy analysis or life-cycle analysis without reducing the primary equipment capacity. Include two sets of operating conditions in the equipment schedule, one with and one without heat recovery devices.

3.6.4 EXCEPTIONS – HEAT RECOVERY EQUIPMENT

In addition to the exceptions identified in ASHRAE Standard 90.1 - 2007, listed below are the applications for which heat recovery systems are not permitted:

- Exhaust from all fume hoods and biological safety cabinets
- Kitchen exhaust (range hood and wet exhaust)
- Autopsy exhaust
- Isolation room exhaust
- Wet exhaust from cage and cart washers
- ETO – Ethylene Oxide Sterilizers exhaust

3.7 EXHAUST SYSTEMS

See Chapter 6 and Room Data Sheets for additional information. Two types of exhaust systems are used in VA Facilities:

- General exhaust
- Special exhaust (including “Wet Exhaust”)

All exhaust systems generally consist of:

- Exhaust fan and motor
- Exhaust ductwork and inlets
- Controls and interlocks
- Discharge connections (louvers, stacks, or integral outlets)

Location and type of exhaust fans shall be project-specific. Install fans at the end of the exhaust ductwork and nearer to the outdoor discharge location to keep the exhaust ductwork under negative air pressure. With the exception of roof ventilators, exhaust fans shall be housed in adequately sized enclosed spaces.

3.7.1 GENERAL EXHAUST SYSTEM

3.7.1.1 Applications – Individual Spaces

See Chapter 6 and Room Data Sheets for additional information. Examples of the spaces served by general exhaust systems are:

- Attics
- Canopy Hoods

- Housekeeping Aid Closet (HAC)
- Locker Rooms
- Pipe Sub-Basement
- Soiled Storage Rooms
- Soiled Utility Rooms
- Toilets
- Toilets and Showers

3.7.1.2 Applications – Air-Handling Unit Systems

General exhaust systems are also required for spaces served by 100% outdoor air systems. Examples of these systems are:

- Supply Processing and Distribution (SPD)
- Laboratories
- Animal Holding and Research
- Autopsy Suite
- Kitchen (Food Preparation) without Grease Hoods and Wet Exhaust

3.7.2 SPECIAL EXHAUST SYSTEM - APPLICATIONS

See Chapter 6 and Room Data Sheets for additional information.

3.7.2.1 Dry Exhaust Systems

Special dry exhaust systems are generally dedicated systems serving specialized equipment or applications, such as:

- Biological Safety Cabinets (BSC)
- ETO (Ethylene Oxide Sterilizer) exhaust
- Fume hoods
- Kitchen range hood
- TB Isolation suite

3.7.2.2 Wet Exhaust Systems

Dedicated exhaust system used for ventilating rooms with heavy water/steam usage are designated as wet exhaust systems. Examples are:

- Automatic Cart Wash Equipment Room
- Manual Cart Wash Room
- Therapeutic Pool Room
- Kitchen Dishwashers

For all wet exhaust systems, provide welded stainless steel ductwork and corrosion resistant fan. Mount fan bearings out of the air stream.

3.8 FUME HOOD EXHAUST SYSTEMS

3.8.1 GENERAL

Provide exhaust systems for the hoods described below. Coordinate quantities, sizes, and types of fume hoods with the architectural drawings and project-specific program needs. In this section, the following three different types of hoods are covered:

- Radioisotope Hoods
- General Purpose and Chemical Hoods
- Perchloric Acid Hoods

3.8.2 SPECIAL REQUIREMENT

Use of auxiliary make-up air hoods is not permitted.

3.8.3 COMPLIANCE

- NFPA 45
- ANSI/ASHRAE Standard 110-1999 (Hood Testing)
- OSHA 29 CFR (Part 1910)

3.8.4 BASIS OF DESIGN (H3 AND H7 HOODS)

3.8.4.1 General

The basic premise of the fume hood exhaust system is to maintain constant, face velocity of 100 fpm [0.5 m/s] over the hood sash area, under varying sash positions. The sash is defined as the movable glass panel, which covers the face area of the hood. The sash position can vary from almost fully closed to fully open to a pre-determined intermediate stop with a fixed sash stop.

3.8.4.2 Specific Requirements

(a) Provide emergency power for the exhaust system and associated controls for all hood exhaust systems.

(b) Do not connect any exhaust from sources other than identical hoods to the fume hood exhaust system.

(c) Radioisotope hoods can be grouped together to form a combined exhaust system. General Purpose or Chemical hoods can be grouped together to form a combined exhaust system. Perchloric Acid hoods cannot be grouped together. Each Perchloric Acid hood must have its own dedicated exhaust system.

(d) Provide spark-proof construction fans and explosion-proof motors.

(e) Provide an airflow control valve with readout capability or a DDC CV/VAV terminal unit in each branch exhaust duct.

(f) Provide local and remote alarm capability at the ECC for each fume hood in the event of a system failure or the face velocity readout outside the high or low set-points.

(g) Provide round, stainless-steel welded ductwork for hood exhaust. Provide a stainless steel transition piece between the hood discharge connection and the exhaust duct.

(h) Keep entire exhaust ductwork under negative air balance.

(i) Discharge exhaust air from the highest level of the building. Provide a discharge stack at least 10 ft [3 m] tall. Increase the stack height, as required to meet the dispersion analysis recommendations. The discharge velocity at the nozzle shall be 3,500 fpm [18 m/s].

(j) Include the discharge air velocity pressure and the static pressure drop through the hood in the fan static pressure calculations.

(k) Include recommended acoustic analysis measures to contain the fan noise traveling back to the exhaust fan in the system design. Measures shall also examine such items as:

- Fan Selection
- Duct Velocity
- Sound Attenuators

(l) Do not attempt heat recovery from exhaust ducts of fume hoods.

(m) Do not install fume hood exhaust ducts in the same shafts that environmental ducts are housed. See NFPA 90A for additional information.

(n) Do not install fire dampers in fume hood exhaust ducts.

(o) The designer shall verify the project-specific filtration requirements for the Radioisotope hood exhaust air system in consultation with the end-users and the Radiation Safety Officer. The filtration requirements depend on the use/quantity and type of isotopes used and may require MERV 17 (HEPA) filter, or a combination of MERV 17 (HEPA) and a charcoal filter, or no filters at all.

3.8.5 H14 HOODS

In addition to the specific requirements listed for H3 and H7 hoods, the following additional requirements apply:

(a) Provide exhaust fan with polyurethane or similar inorganic coating or acid-resistant metallic material.

(b) Water Spray System: Design a water spray system to wash down the entire exhaust system at the end of each use, including the exhaust fan, ductwork, hood, and the baffles. Ensure coordination with the plumbing and electrical disciplines for make-up water connections and heat tracing (with emergency power) of the cold water line, where required. The wash down cycle shall be either automatic or manual. Provide a hose bibb within 30 ft [9 m] of the discharge stack to facilitate manual wash.

3.8.6 EXHAUST AIR VOLUME

(a) Hood exhaust air volume is the product of the nominal sash area multiplied by the design face velocity over the sash area. Nominal sash area is the product of the actual sash width multiplied by the operating sash height. Operating sash height is defined as the height at the working level, where all laboratory work is done. For hoods equipped with fixed sash stops, operating height is the sash height at the fixed sash stop.

(b) Exact exhaust air volume data shall be obtained from the hood manufacturers. In the absence of data, for the purpose of preliminary planning, use the average exhaust air volumes given below for each size and type of the fume hoods.

Table 3-3: Radioisotope Hoods Preliminary Exhaust Air Volumes

Hood Size in [mm]	Flow Rate cfm [L/s]	Pressure Drop in of water [Pa]
48 [1200]	875 [413]	0.38 [93]
60 [1500]	1125 [531]	0.38 [93]
72 [1800]	1375 [649]	0.38 [93]

Table 3-4: General Purpose or Chemical Hoods Preliminary Exhaust Air Volumes

Hood Size in [mm]	Flow Rate cfm [L/s]	Pressure Drop in of water [Pa]
36 [900]	625 [295]	0.36 [89]
48 [1200]	875 [413]	0.30 [75]
60 [1500]	1125 [531]	0.32 [89]
72 [1800]	1375 [649]	0.24 [60]
96 [2400]	1875 [884]	0.40 [100]

Table 3-5: Perchloric Acid Hood Preliminary Exhaust Air Volumes		
Hood Size in [mm]	**Flow Rate cfm [L/s]**	**Pressure Drop in of water [Pa]**
48 [1200]	1030 [486]	0.63 [156]
60 [1500]	1355 [639]	0.50 [125]
72 [1800]	1680 [792]	0.75 [187]
96 [2400]	2355 [1111]	0.75 [187]

3.8.7 EXHAUST SYSTEM DESIGN

3.8.7.1 Constant Volume (CV) Design

For a small project involving fewer than four hoods, the fume hood exhaust system design may be constant volume type. Two different configurations are described:

(a) Integral Bypass Hoods: Bypass hoods maintain constant exhaust air volume. Lowering of the hood sash exposes a bypass inlet located above the sash. The bypass inlet reduces the increase in the sash face velocity, which in turn reduces turbulence and loss of containment. Provide a dedicated exhaust fan with this arrangement.

(b) External Bypass Hoods: With the external bypass hood (see VA Standard Detail, External Bypass Hoods), exhaust air volume is either directed through the room connection or through the hood by on/off motorized dampers connected in parallel. With the use of modulating dampers, response to keeping the constant face velocity is enhanced.

3.8.7.2 Variable Air Volume (VAV) Hoods (General Purpose and Chemical Hoods and Radioisotope Hoods Only)

(a) For new construction and major renovations to be in compliance with mandated energy conservation directives, provide a variable air volume design for Radioisotope hoods and General Purpose and Chemical hoods. This system is accurate and sophisticated in maintaining constant face velocity with varying sash positions by varying the exhaust air volume. The system has substantial potential to reduce energy consumption since it mostly operates at part load conditions.

(b) System Configuration and Controls: The design shall consist of three separate systems:

- **Supply Air System:** The capacity of the variable air volume supply air system shall be selected to maintain inside design conditions and/or to meet the exhaust needs of the hoods. The complete system design shall include a variable speed drive for the supply air fan, an airflow measuring device, DDC-controlled VAV air terminal units, and a static pressure sensor.

- **Hood Exhaust Air System:** Design a dedicated, VAV system to serve all identical hoods (either General Purpose and Chemical hoods or Radioisotope hoods). The capacity of the exhaust system shall be selected to satisfy all hoods operating at their nominal capacities. Each duct connection from the hood shall be equipped with an airflow control valve that modulates to vary the exhaust air volume to maintain the constant face velocity. Each hood shall be equipped with controls which continually measure and monitor sash position, velocity, and the required exhaust air volume. The complete system design shall include a variable speed drive for the exhaust air fan, an airflow measuring device, a HEPA filter (Radioisotope hood only), and a static pressure sensor.
- **General Exhaust System:** Design a dedicated, VAV system which operates in parallel with the hood exhaust system. The capacity of the general exhaust system shall be sized to remove the room supply air when all hoods have assumed fully closed position. Note that even with the sash assuming a "fully-closed" position; the hood admits enough make-up air from the room to maintain negative air balance in the hood. The complete system design shall include a variable speed drive for the exhaust fan, an airflow measuring device, a DDC-controlled airflow control valves (generally one per laboratory), and a static pressure sensor.
- **Controls:** For each laboratory, in response to the room temperature sensor and/or the sash positions of the fume hoods, the DDC controls shall orchestrate a synchronized operation of the VAV supply air terminal, VAV fume hood exhaust, and VAV general exhaust system to maintain a constant offset per each door, that is, the make-up air from the corridors shall be used to maintain negative air balance. Assume an offset of 100 cfm [47 L/s] per each door. Each fan shall adjust its speed in response to a signal from its static pressure sensor to conform to the prevailing volumetric situation.

3.9 BIOLOGICAL SAFETY CABINETS (BSC)

3.9.1 COMPLIANCE

- National Sanitation Foundation (NSF), Standard 49-2002 or the latest edition
- ASHRAE – Handbook of Applications (2007 or the latest edition)

3.9.2 CABINET CLASSIFICATION

(a) BSC protects research personnel, products, and environment from exposure to the biohazards and cross contamination. Common sizes of the cabinet are 4 ft [1 m] and 6 ft [2 m].

(b) Cabinet and Safety Classification: BSC are classified into three classes, as shown in the following table:

Table 3-6: Biological Safety Cabinet Classification

Classification	Bio-Safety Level	Application
Class I	1,2,3	Low to moderate risk biological agents
Class II	1,2,3	Low to moderate risk biological agents
Class III	4	High risk biological agents

(c) Class I and Class III cabinets are rarely used. All Class II Cabinets require HEPA filters in the exhaust air system.

(d) VA does not utilize BSL 4 facilities.

3.9.2.1 Class I Cabinets

(a) General: These cabinets do not protect the product because the “dirty” room air passes over the work surface. Cabinets are identical to the chemical laboratory hoods.

(b) Design Criteria:

- Design face velocity is 75 fpm [0.4 m/s]
- Filtration – Cabinet air must be filtered (MERV 7 and MERV 17) before it is exhausted outdoors or re-circulated in the laboratory. Use a system configuration to suit the design intent. The available configurations are an integral exhaust fan or the building exhaust fan and hard duct connections or thimble.
- Airflow Control Valve – Provide a pressure-independent airflow control valve to ensure constant exhaust air volume
- Exhaust Ductwork – Provide welded stainless steel ductwork
- Emergency Power – Provide emergency power for the exhaust fan

3.9.2.2 Class II Cabinets

(a) Classification: Classification of BSC, Class II cabinets is based on NSF 2002. Classifications are shown in the following table:

Table 3-7: Classification of Class II Biological Safety Closets	
Classification	**General Description**
A1	● 70% intake air re-circulated back to cabinet and 30% air exhausted outdoors ● Provide a duct "thimble connection" for exhaust to outdoors ● Provide cabinet air intake at 75 cfm [35 L/s] capacity
A2	● 70% intake air re-circulated back to cabinet and 30% air exhausted outdoors ● Provide a duct "thimble connection" for exhaust to outdoors ● Provide cabinet air intake at 100 cfm [47 L/s] capacity
B1	● 40% intake air re-circulated back to cabinet and 60% air exhausted outdoors ● Provide a dedicated exhaust air duct (hard connection) to outdoors ● Provide cabinet air intake at 100 cfm [47 L/s] capacity
B2	● Provide a dedicated exhaust air duct (hard connection) to outdoors after passing over the unit-mounted HEPA filter ● Provide air intake at 100 cfm [47 L/s]

(b) Exhaust Air Volumes: The average exhaust air-quantities and pressure drops for type B1 and B2 and Class II cabinets are shown in the following tables:

Table 3-8: Cabinet Type B1 Exhaust Air Requirements		
Size in [mm]	**Exhaust Air cfm [L/s]**	**Pressure Drop in of water [Pa]**
48 [1200]	270 [127]	1 [249]
72 [1800]	410 [193]	1 [249]

Table 3-9: Cabinet Type B2 Exhaust Air Requirements		
Size in [mm]	**Exhaust Air cfm [L/s]**	**Pressure Drop in of water [Pa]**
48 [1200]	730 [345]	1 [249]
72 [1800]	1150 [543]	1 [249]

(c) Filtration: Class II, Type B1 and Type B2 safety cabinets come with two sets of HEPA filters, one for supply within the cabinet, and one for exhaust from the cabinet.

The pressure drops include friction loss through clean exhaust MERV 17 (HEPA) filters (the supply HEPA filter within the cabinet is not included as the internal blower takes care of this filter) and transition fitting on the exhaust side. With a Type B1 hood, the exhaust filter is within the hood casing; the mounting is external with Type B2 hood.

(d) Interlock: Interlock the internal blower and external blowers. For B2 safety cabinets, coordinate the filter height above the B2 hood with other disciplines.

(e) Pressure Drop Estimation: While estimating the static pressure of the exhaust fan, add an allowance for the dirty condition of the HEPA filter and the external ductwork.

(f) Airflow Control and Alarm: Provide a pressure-independent airflow control valve in the exhaust air stream to ensure constant airflow through the system. Provide an air monitoring device and provision for sound and visible alarm at the hood and at the central ECC in the event that the flow varies more than plus or minus 10% of the normal value. Provide an interface with the ECC control to initiate a remote alarm.

(g) Duct Damper: Provide an airtight damper on the exhaust side to isolate the hood for service and maintenance.

(h) Emergency Power: Provide emergency power for the exhaust fans and the associated motorized dampers.

3.9.3 BIOLOGICAL SAFETY LEVEL 3 (BSL3)

See Appendix 3-A.

3.10 DESIGN CRITERIA – AIR DISTRIBUTION SYSTEMS

3.10.1 DUCT DESIGN – GENERAL

3.10.1.1 Compliance

Air distribution system shall be designed in accordance with applicable ASHRAE and SMACNA Standards. Parameters listed below shall govern in the event of discrepancies from the ASHRAE or SMACNA Standards. Use applicable sections of the SMACNA Standard to select the air distribution ductwork pressure classification.

3.10.1.2 Duct Materials

Ductwork shall be fabricated from galvanized steel, aluminum, or stainless steel depending upon applications.

3.10.1.3 Duct Selection Criteria

(a) Sizing Parameters: Duct size selection must satisfy two limiting parameters: maximum air velocity and maximum static pressure drop. All supply air duct mains for all air-handling units shall be sized to carry 25% more air without exceeding the two limiting parameters. The fan static pressure shall be calculated based on actual air flow rate. The duct pressure classification shall be based on the increased (25%) flow rate.

(b) Sizing Criteria: Use equal friction method for sizing low-pressure ductwork. Use static-regain method for sizing medium pressure ductwork.

(c) Exposed Ductwork: All exposed (visible in space) ductwork in the occupied conditioned spaces shall be designed and fabricated from double-wall, flat, oval, or round ductwork with galvanized outer shell and non-perforated, galvanized, inner lining with a 1 in [25 mm] thick glass fiber insulation between the two walls. Duct painting and finish requirements shall be coordinated with the VA Authorities.

3.10.1.4 Mandatory Requirement

All ductwork, without exception, shall be shown in double lines on all floor plans and cross-sections.

3.10.1.5 Duct Pressure Classification

Show duct pressure requirements for all ductwork on the floor plans. Required duct classification shall be shown as ½ in, 1 in, 2 in, 3 in, and 4 in [125 Pa, 250 Pa, 500 Pa, 750 Pa, 1000 Pa].

3.10.1.6 Flexible Ducts

(a) Use of flexible duct shall be restricted to connections between the VAV/CV air terminal units and the medium or high pressure supply air duct and connections between the supply air diffusers and the low-pressure supply air ductwork.

(b) Do not use flexible duct on exposed ductwork in occupied areas.

(c) Maximum length of flexible ductwork shall not exceed 5 ft [2 m].

(d) Do not penetrate firewalls and interstitial decks with flexible ducts.

3.10.1.7 Underground Ducts

Use of underground and concrete ducts is not permitted.

3.10.1.8 Shielded Ducts

Coordinate locations of shielded rooms with the architectural drawings. Generally, lead lining in walls terminates at or below the ceiling level. However, in special instances where lead linings extend higher and ducts penetrate the lining, ducts shall be wrapped with lead sheet of the same thickness as the wall lining. Consult medical equipment vendor for specific recommendations.

Exceptions:

- In Super Voltage therapy rooms with thick concrete walls, lead shielding may not be required for ducts penetrating the room wall. A registered health physicist shall check adjacency uses and determine lead shielding requirements.
- Dark rooms require full height lead lining. For walls of dark rooms located adjacent to rooms with walls having 7 ft [2 m] high lead lining, lead shielding of the ductwork penetrating above the suspended ceiling is not required.

3.10.1.9 Minimum Duct Size

- Rectangular Ducts: 8 in x 6 in [200 mm x 150 mm]
- Round Ducts: 6 in [150 mm]

3.10.2 LIMITING DUCT SIZING PARAMETERS

Table 3-1: DUCT SIZING CRITERIA

Duct Description	Maximum Air Velocity	Maximum Static Pressure Drop
Low Pressure Duct Supply Return Relief Exhaust	1,500 fpm [8 m/s]	0.08 in of water/100 ft [0.66 Pa/m]
Medium/High Pressure Duct Supply	2,500 fpm [13 m/s]	0.20 in of water/100 ft [1.64 Pa/m]
Transfer Air Duct	750 fpm [4 m/s]	0.04 in of water/100 ft [0.33 Pa/m]

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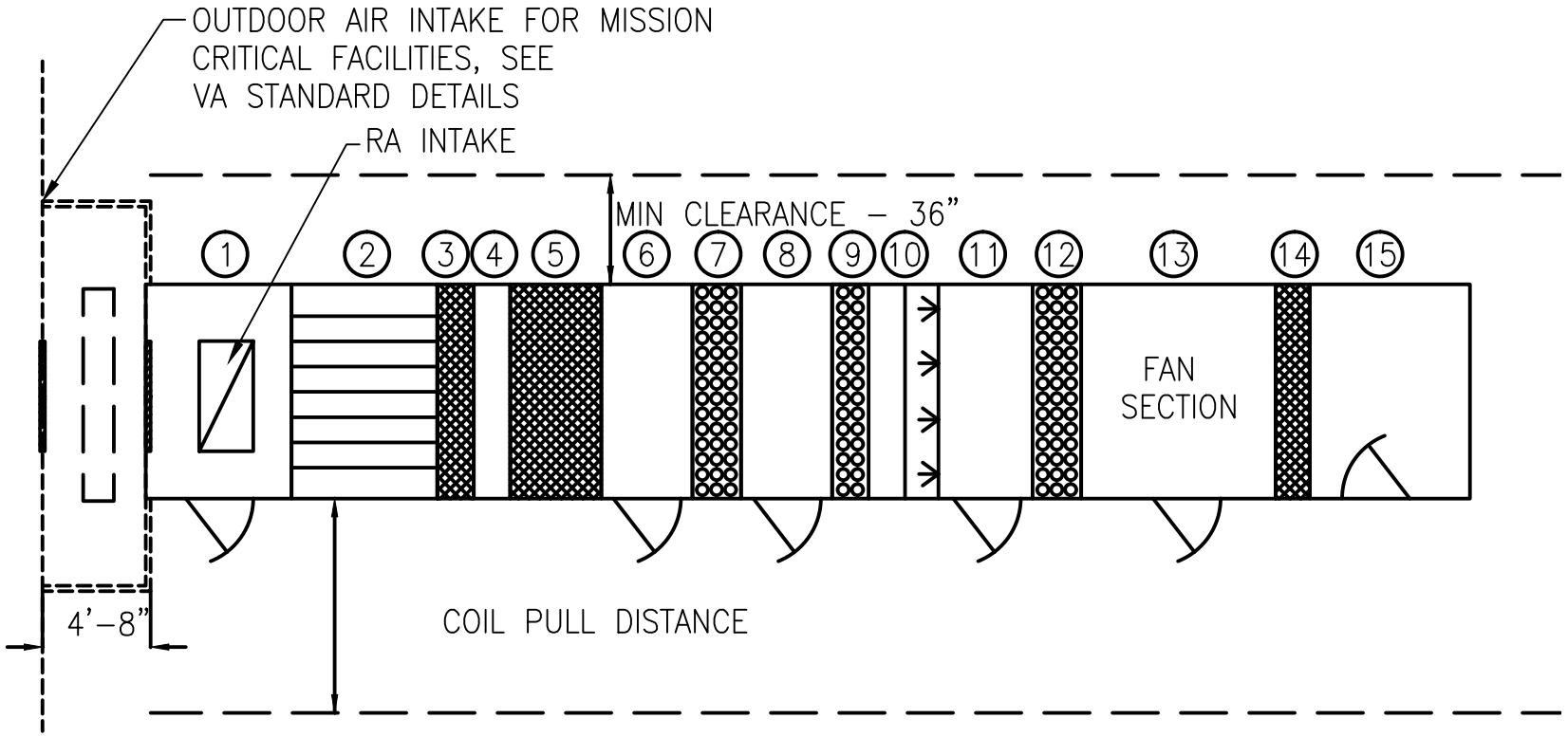

NOTE: SEE FIG. 3–1 CONTINUATION FOR GENERAL NOTES AND DIMENSIONS OF COMPONENTS

TYPICAL AIR HANDLING UNIT

Not to Scale

AIR HANDLING UNIT	Item #	MINIMUM OUTSIDE AIR PRE-FILTERS & AFTER-FILTER VAV	100% OUTSIDE AIR PRE-FILTERS & AFTER-FILTER CV	LENGTH IN [CM]			
* AS REQUIRED				20,000 CFM (9,450 L/S)	30,000 CFM (14,150 L/S)	40,000 CFM (18,900 L/S)	50,000 CFM (23,600 L/S)
Mixing Box *	1	Yes	No	48 [122]	48 [122]	49 [125]	54 [137]
Blender Section *	2	Yes	No	48 [122]	48 [122]	49 [125]	54 [137]
Pre-Filter (Side Access)	3	Yes	Yes	12 [30]	15 [38]	15 [38]	15 [38]
Inspection Section, small	4	Yes	Yes	12 [30]	15 [38]	15 [38]	15 [38]
Pre-Filter (Side Access)	5	Yes	Yes	30 [76]	30 [76]	30 [76]	30 [76]
Access Section, med-large	6	Yes	Yes	30 [76]	30 [76]	30 [76]	30 [76]
Heat Recovery Coil *	7	No	Yes	16 [41]	20 [51]	20 [51]	20 [51]
Access Section, med-large *	8	No	Yes	30 [76]	30 [76]	30 [76]	30 [76]
Pre-Heat Coil	9	Yes	Yes	12 [30]	15 [38]	15 [38]	15 [38]
Inspection Section, small	10	Yes	Yes	12 [30]	15 [38]	15 [38]	15 [38]
Humidifier *	11	Yes	Yes	32 [81]	40 [102]	40 [102]	40 [102]
Cooling Coil	12	Yes	Yes	16 [41]	20 [51]	20 [51]	20 [51]
Fan	13	Yes	Yes	64 [163]	69 [175]	84 [213]	92 [234]
After-Filter *	14	Yes	Yes	42 [107]	42 [107]	42 [107]	42 [107]
Discharge Plenum *	15	Yes	Yes	64 [163]	64 [163]	64 [163]	64 [163]

	20,000 CFM [9,435 L/S]	30,000 CFM [14,150 L/S]	40,000 CFM [18,870 L/S]	50,000 CFM [23,597 L/S]
Overall Width (IN [CM])	96 [244]	120 [305]	137 [348]	137 [348]
Overall Height (IN [CM])	64 [163]	75 [191]	92 [234]	107[272]

NOTES:

1. IF ITEMS 1 AND 2 ARE NOT INCLUDED, PROVIDE MED–LARGE ACCESS SECTION.
2. IF SPACE IS AVAILABLE, PROVIDE ACCESS DOORS ON BOTH SIDES OF AHU. IF SPACE IS NOT AVAILABLE, ENSURE EQUIPMENT IS SERVICEABLE FROM ONE SIDE OF THE AHU.
3. HUMIDIFIER LOCATION IS OPTIONAL AND MAY BE LOCATED IN THE AHU OR IN THE MAIN SUPPLY AIR DUCT.
4. SEE VA STANDARD DETAILS FOR OUTSIDE AIR PLENUM DETAIL. THE PLENUM LENGTH IS APPROXIMATELY 4 FT – 8 IN. [1.4 M]
5. THE INFORMATION GIVEN IN THE DETAIL IS FOR CONCEPTUAL DESIGN AND PLANNING. THE DESIGNER SHALL MAKE HIS OWN SELECTION BASED ON ENGINEERING CALCULATIONS AND UNIT BASIS OF DESIGN.
6. OVERALL LENGTH IS DEPENDENT ON COMPONENTS AND FAN SYSTEM SELECTED.
7. FAN SYSTEM IS EITHER FAN WITH DIFFUSER PLATE OR PLENUM FAN ARRAY.

TYPICAL AIR HANDLING UNIT

Not to Scale

APPENDIX 3-A: BIO-SAFETY LEVEL 3 (BSL3) FACILITIES

3-A.1 GENERAL

3-A.1.1 INTRODUCTION

VA Medical Centers use Bio-Safety Level 3 (BSL3) containment laboratories for animal research and general research applications. ***Containment control is an essential goal of facility design, operation, and maintenance. Primary and secondary barriers defined below are the mandatory provisions necessary to achieve the stated goal of containment.*** For new construction and existing construction with major renovation, the following design criteria shall be used.

3-A.1.2 CODE AND COMPLIANCE

The facility design shall comply with NFPA 45 and the Center for Disease Control (CDC) and the guidelines given in the National Institute of Health (NIH), Bio-Safety in Microbiological and Biomedical Laboratories (BMBL), 5th edition.

3-A.1.3 CERTIFICATION

Each facility shall be inspected and certified annually by the local safety officer and/or industrial safety hygienist in accordance with the procedure outlined by the National Institute of Health (NIH).

3-A.2 PRIMARY BARRIERS

3-A.2.1 BIOLOGICAL SAFETY CABINETS

(a) Perform all manipulations that may create aerosol or splatter inside a Biological Safety Cabinet (BSC) of appropriate size and classification (Class II or Class III). BSCs constitute ***primary barriers*** to protect the community, environment, and laboratory personnel. Access, ventilation, and other features described in the respective trades below are the ***secondary barriers*** to enhance the containment.

(b) Coordinate quantity and type of cabinets with the end users. Open vessels and open batches shall not be used to perform such activities.

3-A.3 SECONDARY BARRIERS

3-A.3.1 LABORATORY – LOCATIONS

Locate BSL3 laboratories away from high-traffic areas to minimize general public exposure.

3-A.3.2 LABORATORY – ACCESS

Entry in the laboratory shall be through a dedicated and enclosed passageway or an Ante Room, that is, through two sets of self-closing and self-locking doors. Provide interlocking mechanism to prevent both sets of doors being opened at the same time. The passageway or the Ante Room can be used for changing clothes. Movement of supply and waste can be through a separate double-door access or autoclave.

3-A.3.3 ARCHITECTURAL CONSIDERATIONS

3-A.3.3.1 Windows

All windows in the laboratory shall be closed and sealed. Due to security concerns, provide high impact glass with wire mesh for the windows and doors. Coordinate the glass characteristics with the VA Master Specifications.

3-A.3.3.2 Penetrations

All floor, wall, and ceiling penetrations shall be sealed to prevent any aerosol movement. All duct and pipe openings shall also be sealed.

3-A.3.3.3 Walls, Ceilings, and Floors

(a) Provide smooth surfaces for the walls, ceilings, and floors. The surfaces shall be impermeable to liquids and resistant to the chemicals and disinfects used in the laboratories.

(b) Floors shall be monolithic with continuous cove moldings that extend at least 4 in [100 mm] up the wall.

(c) Use of the acoustic tile suspended ceiling is not permitted. The ceiling shall have a water-proof, hard surface for ease of cleaning.

3-A.3.3.4 Doors

(a) Provide galvanized, epoxy-painted hollow metal doors with smooth impervious surfaces.

(b) Use of the wooden doors is ***not*** permitted.

3-A.4 PLUMBING AND FIRE PROTECTION CONSIDERATIONS

(a) All laboratory valves, gas cylinder manifold stations, vacuum system filters, and other plumbing and fire protection equipment requiring service and maintenance shall be located in a secured location outside of the BSL-3 laboratory suite.

(b) Provide a dedicated hands-free (sensor) hand washing sink located near the exit of the laboratory. Do not locate the hand washing sink in the vestibule.

(c) The BSL-3 laboratory suite shall be on a separate sprinkler zone with a dedicated, supervised control valve.

(d) The sprinkler heads shall be concealed-type or provide a sprinkler design capable of being decontaminated on a regular basis.

(e) The suction side of the vacuum pump shall be piped to a 0.2 micron hydrophobic inline filter with valve bypass prior as close as possible to the laboratory. A mechanism for the decontamination of filters shall be incorporated into the design of the vacuum system.

(f) The vacuum pump discharge shall have a sampling port and shall be vented to atmosphere in a secured location at least 10 ft [3 m] above any accessible location.

(g) An emergency shower/eyewash station shall be within the same room as the chemical fume hood. The emergency shower/eyewash station shall not have a floor drain.

(h) An autoclave shall be made available inside the laboratory for decontamination purposes.

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CHAPTER 4: BUILDING COOLING AND HEATING SYSTEM

Table of Contents

4.1 INTRODUCTION

This chapter describes refrigeration and heating systems for building HVAC systems. Information given below shall be used in conjunction with the VA Standard Details, Master Specifications, and associated documents, described in Chapter 1 and located in the TIL.

The following systems are evaluated:

Cooling Systems

- Central Chilled Water Plants and Small Chilled Water Systems
- Chilled Water System Components
- Direct Expansion (DX) Systems

Heating Systems

- Steam Systems (Excluding Generation and Outside Distribution)
- Hydronic Hot Water Systems
- Glycol Systems
- Electrical Heating Systems
- Gas Heating Systems
- Miscellaneous Systems

Criteria for pipe sizing and design are provided at the end of this chapter.

4.2 COOLING SYSTEMS - CHILLED WATER

4.2.1 CENTRAL CHILLED WATER PLANTS and SMALL CHILLED WATER SYSTEMS

4.2.1.1 General

Select cost-effective and optimum central chilled water plants and/or small chilled water systems to meet the project-specific requirements. Each installation shall consist of multiple (minimum two) chillers. For central plants, water-cooled chillers shall be centrifugal (open or hermetically sealed) or rotary-screw compressors or absorption machines. Small chilled water systems are generally equipped with air-cooled or water-cooled rotary-screw or scroll compressors. Use of reciprocating compressors is not permitted.

4.2.1.2 Chilled Water Optimization Study - Central Plants and Small Systems

Conduct a comprehensive study to evaluate and define the lowest life-cycle cost performance of the chilled water system. The study shall address system components and parameters, such as, chilled water leaving temperature, inlet/outlet temperature differential, flow, pipe and pump sizes, etc. While optimizing the chilled water system parameters, special consideration shall be given to spaces requiring lower space temperature (65 F [18 C] to 68 F [20 C]) and winter time cooling requirements.

The study shall justify the choice of refrigerant. The refrigerant shall be EPA approved and compatible with all local, state, and federal regulations. Base the system selection on such refrigerants as HCFC 123, HFC 410a and HFC 134a. Follow ASHRAE Standard 15, Safety Code for Mechanical Refrigeration and ASHRAE Standard 34, Designation and Safety Classification of Refrigerants to ensure full compliance.

4.2.1.3 Central Chilled Water Plant Sizing

Do not include the cooling load requirements for special applications where mandated dedicated chillers may be required (example: Animal Research and Holding Areas).

For the cooling requirements of the Surgical Suite, see Chapter 6.

4.2.1.4 Maximum Chiller Capacity

Capacity of a single water-cooled chiller equipped with centrifugal or rotary-screw compressor(s) and absorption chiller(s) shall not exceed 1,250 tons of refrigeration capacity. Capacity of a single air-cooled chiller equipped with rotary-screw or scroll compressors shall not exceed 250 tons.

Chillers shall be rated and certified per AHRI conditions.

4.2.1.5 Standby Chiller Capacity

For new construction and major renovation projects, the central chilled water plant and small chilled water system shall comprise N+1 chillers, where N is the number of chillers in operation to meet the total cooling demand and 1 (one) is the installed standby chiller. Capacity of the standby chiller shall match the capacity of the largest installed chiller. All plant components, condenser and chilled water piping, and controls shall be sized and selected to match the N + 1 requirement.

4.2.1.6 Small Chilled Water Systems

Generally, air-cooled chillers are used for small chilled water systems with single or multiple chillers. Provide independent refrigeration circuits where feasible.

(a) Air-Cooled Chillers

For noise-sensitive locations, include chiller manufacturer's standard acoustic options in the design. Ensure compliance with the physical security guidelines.

(b) Corrosion Control - Air-Cooled Chiller

For corrosive environments and high-humidity locations, include factory-applied anti-corrosion treatment for condenser coil fins. Provide copper fins with or without corrosion treatment, where recommended by the manufacturer.

4.2.1.7 Minimum System Volume - Small Chilled Water Systems

Each small chilled water system must maintain minimum recommended water volume to avoid frequent cycling of the compressors. If the calculated, chilled-water system volume, as designed, is less than the published recommendations of the chiller manufacturer (recommendations vary with manufacturers), include an inline, pressurized, and insulated chilled water storage tank in the piping circuit to provide the required thermal inertia. Tank installation shall be complete with supports, isolating valves, drain connections, access for tank maintenance, and inlet/outlet nozzles.

4.2.1.8 Minimum Performance Compliance (ASHRAE Standard 90.1 – 2007)

Table 4-1: Water Chilling Packages – Minimum Efficiency
Water-Cooled, Electrically Operated
Based on FEMP Requirements

Equipment Type	Capacity Tons of Refrigeration	Minimum Efficiency Full Load (kW/ton)	Minimum Efficiency IPLV (kW/ton)	Test Procedure
Rotary Screw	150 - 299	.64	.49	AHRI 550/590
	300 and Larger	.64	.49	
Centrifugal	150 - 299	.59	.52	AHRI 550/590
	300 - 2000	.56	.45	

Table 4-2: Water Chilling Packages - Minimum Efficiency
Absorption Machines
Based on ASHRAE 90.1 - 2007 Requirements

Equipment Type	Capacity Tons of Refrigeration	Minimum Efficiency Full Load (COP)	Minimum Efficiency IPLV	Test Procedure
Single Effect	All Capacities	0.70	-----	AHRI 560
Indirect-Fired Double Effect	All Capacities	1.00	1.05	
Direct-Fired Double Effect	All Capacities	1.00	1.00	

Table 4-3: Water Chilling Packages – Minimum Efficiency
Air-Cooled, Electrically Operated
Based on FEMP Requirements

Equipment Type	Capacity Tons of Refrigeration	Minimum Efficiency Full Load (kW/ton)	Minimum Efficiency IPLV (kW/ton)	Test Procedure
Scroll	30 – 60	1.23	.86	AHRI 550/590
Screw	70 – 200	1.23	.98	AHRI 550/590

4.2.2 CHILLED WATER SYSTEM COMPONENTS

4.2.2.1 Chilled and Condenser Water Pumps

(a) General

Provide base-mounted, centrifugal (horizontal or vertical split-case or vertical turbine) pumps for chilled water and condenser water applications. In-line pumps can be used for small (5 hp [4 kW] and smaller) sizes. For condenser water pumps, available net positive suction head (NPSH) must exceed required NPSH to avoid pump cavitation.

(b) Selection Criteria

Select pumps to operate at 1750 rpm. Higher speeds are approved for use, if pumps are not available that operate at 1750 rpm. Select the operating point at or near the highest efficiency and to the left side of the maximum efficiency point but not more than 5% from the maximum efficiency curve. The pump motors shall be non-overloading over the entire range of their operation and compatible with variable speed drives, where such applications are used.

For flow rates in excess of 1,200 gpm [76 L/s], the pump selection shall be optimized, based on multiple types and sizes, including single suction or double suction pumps.

4.2.2.2 Cooling Towers

(a) General

Provide induced draft-type, gravity-flow, factory-fabricated, and factory-tested cooling towers. Use of forced-draft cooling towers shall be avoided except for special applications, such as, indoor locations. The cooling towers shall be certified by the Cooling Tower Institute (CTI) and shall meet OSHA safety requirements and comply with the VA Physical Security Manual. See Figure 4-4 for the piping and pumping arrangement.

(b) Selection Criteria

The cooling tower shall be selected to fit within the available footprint and height constraints. The cooling tower selection shall address corrosion resistance and noise criteria requirements. Design the cooling tower discharge in accordance with the recommendations of the dispersion analysis.

The cooling tower accessories shall be project-specific and include such items as:

- Walking Platform
- Stairs and Ladder Safety Cage
- Tower Loading and Supporting Structure
- Basin Heating System
- Variable Speed Drives – Fan Motors

(c) Cooling Tower - Roof Location

For cooling towers installed on the roof, address and resolve the following:

- Operating Weight with Structural Discipline
- Shading Requirement with Architectural Discipline
- Access below Roof (design the supporting steel to raise the cooling tower by at least 4 ft [1 m] above the roof surface to facilitate access underneath the tower for re-roofing)
- Walking Pads with Architectural Discipline

(d) Controls

Provide a dedicated controller for each cooling tower. During off-peak season, the control strategy shall allow the tower to lower the water temperature below the design, leaving water temperature and follow the ambient wet-bulb temperature.

4.2.2.3 Water Treatment - Chilled Water System

(a) Chemical Shot Feeder

Provide a chemical shot feeder in bypass position to treat the closed-loop chilled water system. Select the feeder size and chemicals based on the system volume and the water analysis, but not less than 5 gal [19 L]. Provide piping connections per VA Standard Detail.

(b) Water Filter

Provide a cartridge-type filter in bypass position to remove solid suspended particles from the chilled water system. Filter capacity shall be at least 3% of the maximum chilled water flow rate. Include the bypass flow in the pump duty. Provide piping connections per VA Standard Detail.

4.2.2.4 Water Treatment - Condenser Water System

(a) General

Design a water treatment system for treating cooling tower water based on make-up water samples. Use non-toxic chemicals approved by local and EPA requirements. The water treatment shall operate automatically with the chemical feed and blow down systems.

Use of cooling towers shall be evaluated with the use of plate-and-frame heat exchangers.

(b) System Description

Provide a chemical feed pump for each chemical feed tank, specifically, tower scale and corrosion inhibitor, acid and biocide. Each pumping system shall be equipped with a check valve, drain connections, and a safety relief arrangement. Monitor the pump status at the ECC. Provide a chemical feed controller, conductivity probe, and pH and oxidation reduction potential (ORP) systems.

(c) Water Meters

Provide a water meter in the condenser water make-up and blow down piping. Water meter shall be capable of reading the instantaneous flow and totalized flow locally and at the ECC.

(d) Floor Space

Provide floor space marked reserved on the floor plans for the water treatment system to include an eye wash and emergency shower. Coordinate with the plumbing discipline to provide a washbasin. Provide storage cabinets to house the chemical testing equipment for the water treatment system.

(e) Solid Separator

Include a solid separator in the condenser water circuit to eliminate the suspended solid particles from the system.

4.2.3 PIPING AND PUMPING ARRANGEMENT

4.2.3.1 Constant Volume System

Smaller systems (defined in ASHRAE 90.1-2007) and systems serving a single air-handling unit and chiller can be constant volume type using three-way control valve.

4.2.3.2 Variable Flow Systems - Chilled Water

(a) General

Select any one of the two generally used variable flow piping and pumping systems.

- PSS (Primary - Secondary System)
- VPS (Variable Primary System)

Both systems are designed to maintain constant chilled water temperature entering the terminal units during full load to part load conditions.

(b) Primary-Secondary System (PSS)

See Figure 4-1 for the piping and pumping arrangement.

(b.1) Primary Loop

Piping arrangement consists of constant volume primary loop. Chilled water header shall be piped to permit isolation of a chiller and a pump during part load condition and permit the use of any chiller with any pump. Provide a two-way modulating control-valve and a flow meter in each chiller circuit to isolate the idle chiller and keep constant flow through each evaporator with one chiller or all chillers in use.

(b.2) Secondary Loop

Chilled water flow is variable in the secondary loop serving the terminal units. The loop consists of multiple pumps equipped with variable speed drives. The terminal cooling units are equipped with two-way modulating control valves Provide a high-accuracy flow meter in the secondary circuit.

(b.3) De-Coupler Piping

Provide hydronic separation (de-coupler piping) between the primary and secondary loops to provide hydronic separation between the two circuits and enable chilled water to flow in either direction

(b.4) Control Strategy

Secondary loop chilled water flow varies as the field two-way valves modulate. The secondary loop pressure will be maintained at the set point by varying the secondary chilled water pump speed. The set point is measured and maintained by a differential pressure assembly (DPA) installed in the secondary loop. Coordinate the DPA set-point with the Testing, Adjusting, and Balancing (TAB) contractor. Indicate location of the DPA on the floor plans and riser diagrams. An alternate mode of controlling the secondary pump speed involves polling of all chilled water control valves.

(c) Variable Primary System (VPS)

See Figure 4-2 for the piping and pumping arrangement.

(c.1) General

VPS is less expensive in first cost and energy efficiency is higher when compared to a "traditional" primary/secondary system. However, VPS may not be suitable for all applications. While VA encourages the use of VPS, inherent complexities of the system controls, start-up, and loading/unloading of the chillers should be resolved during design development. It is also important to ensure that a minimum constant cooling load is always present for the VPS to be effective.

(c.2) System Operation

VPS consists of a single circulation/distribution loop that circulates the same water through the terminal cooling units and the chiller evaporators. The flow is permitted to vary throughout the loop, including through the evaporator tubes. Minimum velocity through the evaporator tubes must not be allowed to decrease below the manufacturer's recommended value. A bypass assembly, similar to the PSS system shall be included in the design as shown in the Figure 4-2.

(c.3) Control Strategy

Include a high-accuracy flow meter to monitor the evaporator water flow rate. A pressure-differential sensor across the evaporator can be utilized in lieu of a flow meter. Reduce the pump speed at part load conditions by using the same concept (DPA) used in the PSS systems. Avoid sudden variations of the connected load by resorting to sequencing to maintain the system stability. Start/stop of all air-handling units shall be programmed and software controlled. Accomplish loading, unloading, and sequencing of chillers and associated auxiliaries in response to the prevailing load and accumulated run time. Include devices such as a chiller control panel, chilled water temperature sensors in the supply and return pipes, and a flow meter.

4.2.4 CHILLED WATER FREEZE PROTECTION - PROPYLENE GLYCOL

4.2.4.1 VA Policy

For VA Central Office Projects, propylene glycol solutions are NOT permitted for freeze-protection of **ALL** central chilled water systems. See the example in Appendix 4-A for small, standalone chilled water systems requiring coil freeze protection. The VA Regions and Medical Centers are advised not to use glycol solutions in chilled water systems. Propylene glycol compromises the mandated energy conservation goal by **substantially** increasing the pumping horsepower consumption and reducing the heat transfer efficiency of the chillers and AHU cooling coils. The use of glycol results in higher first cost due to larger chilled water pumps, the need for storing and purchasing of the glycol solution, and the pumping or charging kit.

However, the use of propylene glycol for preheat coil freeze protection is acceptable. It is also permitted in thermal storage ice applications.

4.2.4.2 Freeze Protection Measures

To counteract the possibility of freezing, the designer shall evaluate and include project-specific measures.

(a) Insulation – Thickness

Increase the insulation thickness of exposed chilled water piping by at least 1-in [25 mm] over the recommended thickness for indoor piping. Provide aluminum jacket and select higher density insulation for exposed piping.

(b) Heat Tracing

Provide thermostatically-controlled heat tracing by selecting heating cable of appropriate density (W/lin ft [W/lin m]). Connect heat-tracing circuit to the emergency power circuit.

(c) Controls

Provide a control sequence to start the chilled water pumps and keep chilled water in circulation below 32 F [0 C] ambient temperature.

(d) Storage Tank

Evaluate the potential of draining the exposed chilled water volume into storage tank(s). Locate the storage tank(s) in a covered and heated space.

4.3 COOLING SYSTEMS - DIRECT EXPANSION (DX)

4.3.1 GENERAL

Where chilled water is not available year-round, non-patient spaces requiring mechanical cooling can be served by terminal DX units of suitable configuration. Use of DX cooling systems is not permitted in high humidity locations.

4.3.2 SELECTION CRITERIA

Equipment selection shall comply with the minimum EER requirements outlined in ASHRAE Standard 90.1 – 2007.

4.3.3 DX SYSTEM DESIGN CONSIDERATIONS

4.3.3.1 Refrigerant Piping

Refrigerant piping layout and design shall be reviewed and approved by the equipment manufacturer. Limit field-installed refrigerant piping lengths and minimize elbows and changes in elevations to avoid oil return problems and loss of efficiency.

4.3.3.2 Multiple Compressors

Select two compressors in parallel, where feasible, in place of a single compressor to facilitate part load operation and provide partial redundancy. With two compressors serving a single DX coil, provide intertwined coil circuiting to facilitate refrigerant flow through the entire coil even with one compressor in operation.

4.3.3.3 System Controls

Where the DX system is equipped with integral, local microprocessor-based controls, provide an interface with the ECC via open BACnet protocol.

4.4 HEATING SYSTEMS

4.4.1 STEAM HEATING SYSTEM

4.4.1.1 General

High-pressure steam generated at most VA facilities, by a central boiler plant, is used to serve a variety of applications, such as:

- Laundry Service
- Sterilizers
- Kitchen Equipment
- Building Heating Systems
- Domestic Hot Water

The system design shall be based on the actual steam generation pressure in summer and winter seasons. The average range is between 80 psig [552 kPa] and 125 psig [863 kPa].

4.4.1.2 Steam Pressure Classification

For VA facilities, the following steam pressure classifications are used:

- Low-Pressure Steam (LPS) – 15 psig [103 kPa] and below
- Medium-Pressure Steam (MPS) – 16 psig [110 kPa] through 59 psig [407 kPa]
- High-Pressure Steam (HPS) – 60 psig [414 kPa] and above

When sizing steam piping from the boiler plant to the mechanical equipment rooms, the steam pressure drop (line losses) is restricted to 10 psig [69 kPa].

4.4.1.3 Steam Pressure Requirements

Listed below are the suggested operating pressures:

Table 4-4: Suggested Steam Operating Pressures	
Equipment	**Operating Steam Pressure psig [kPa]**
Radiators	5 [34]
Convectors	5 [34]
Terminal Humidifiers; Duct Mounted	15 [103]
Heating Coils	30 [206]
Steam-to-Hot Water Converters	30 [206]
Unit Heaters	30 [206]
Domestic Water Heaters	30 [206]
AHU Mounted Steam Humidifiers	30 [206]
Sterilizers and Washers	Refer to Program Guide PG-18-6
Dietetic Equipment	Refer to Program Guide PG-18-6
Laundry Presses and Ironers	125 [862]

4.4.1.4 Pressure Reducing Valve (PRV) Stations – Selection Guidelines

(a) Provide dedicated PRV station(s) for each building and for each steam pressure setting.

(b) Do not provide two-stage PRV station to reduce high-pressure steam pressure.

(c) Provide two PRVs, in parallel, where significant (>2/3) variation in the steam demand is expected. For such applications, two PRV valves, of uneven sizes should be provided. The smaller valve (1/3 capacity) set at higher than the exit pressure shall open first and the larger valve (2/3 capacity) set at lower than the exit pressure shall open next but only when the smaller valve is unable to meet the increasing load demand and resulting higher pressure drop.

(d) While sizing the PRV station, assume diversity for the process load by assuming 100% load of the largest equipment and 25% load of the remaining steam-consuming equipment from the same department.

(e) Size PRV bypass valve and the safety relief valve according to the National Board Inspection Code of the National Board of Boiler and Pressure Vessel Inspectors (Columbus, Ohio). Size the safety valve to handle the maximum flow of the largest PRV or the bypass. Verify that the bypass valve capacity does not exceed the capacity of the safety valve.

4.4.1.5 Steam System Components and Procedures

(a) Shutoff Valve - HPS

Provide a shutoff valve and a pressure gage, 4.5 in [115 mm] dial for each incoming HPS service in the mechanical equipment room. For a shutoff valve, larger than 4 in [100 mm] size, include a factory-installed, integral warm-up valve of 0.75 in [20 mm] or 1 in [25 mm] size in bypass position.

(b) Steam Flow Meter

For each steam PRV station, include a steam-flow meter with interface to the EEC. Provide capability to read instantaneous and total steam flow. Where the facility is equipped with an Advanced Metering System, ensure coordination between the new steam flow meter and the existing metering system.

(c) Stress Analysis

Perform a computerized stress analysis on the actual steam piping layout and show anchors, guides, and expansion loops to avoid pipe deflection and contain expansion. All devices shall be shown in the floor plans at approximately the same location where they are intended. Submit calculations for review and approval.

(d) Flash Tank

The steam gravity return piping design shall not permit direct connections between the high-pressure gravity return and medium-pressure gravity return to the low-pressure gravity return lines to avoid flashing. Provide a flash tank, where all gravity returns will reduce pressure and temperature. From the flash tank, the low-pressure gravity return shall flow into the condensate receiver of the condensate return pump. Adjust the flash tank elevation to ensure gravity flow into the condensate receiver. **Gravity return must *not* be lifted.** The flash tanks shall be shown at all applicable locations on the floor plans and elevations.

(e) Steam Reheat Coils

Use of steam reheat coils shall be avoided to the greatest extent possible, particularly above occupied areas. Problems due to trap noise, pitched condensate return, trap maintenance, and ceiling height restriction are viable reasons for avoiding steam reheat coils above occupied areas. In addition, steam trap installation requires a minimum of 12 in [300 mm] for static lift and 6 in [150 mm] for the dirt leg.

(f) Vent Lines

Provide vent lines, as required, extending above the building roof. Vent lines from the condensate tank and flash tank can be combined into a single line. Vent line from safety valve(s) at the PRV station shall be independent of other vent lines and shall extend a minimum of 6 ft [2 m] above the roof.

To avoid long safety valve discharge piping, safety valves may be located close to the termination point, provided no shut-off valve is installed between the PRV and the safety valve.

(g) Condensate Return Pumps

Provide duplex condensate pumps, complete with a receiver, to return liquid condensate to boiler plant. Provide emergency power for the pumps. If the duplex condensate pump system is installed in a pit, the starter, disconnect switch, and alternator must be located outside the pump pit. Provide an alternator to facilitate switching the pump operation.

(h) Steam Traps – Selection Criteria and Limitations

(h.1) Float and Thermostatic Traps

Provide float and thermostatic (F&T) traps for all modulating loads such as heat exchangers, domestic hot water heaters, and modulating control valves (where used) for preheat coils and equipment with modulating loads. Provide minimum 12 in [300 mm] static head for the trap operation. Space permitting, provide 18 in [450 mm] head. Static head shall be shown in the steam trap installation detail and the floor plans must emphasize the need to provide maximum available static head. Non-compliance with this requirement has been a cause of operational problems in many installations. Size all F&T traps at 0.25 psig [1.7 kPa] pressure drop.

Size traps for heat exchangers and AHU preheat coils at 250% of the design load to meet the start-up needs. Capacity of a single trap shall not exceed 5,000 lb/h [2268 kg/h].

(h.2) Inverted Bucket Traps

Steam traps on the steam line drip points shall be inverted bucket type, with bi-metallic thermal element for air removal. Select the working pressure range suitable for the maximum line pressure. For steam lines in continuous operation with infrequent shut downs, drip traps shall be sized for the line radiation loss, in lb/h [kg/h] multiplied by three. The trap pressure differential shall be 80% of the line operating pressure.

(h.3) Installation and Documentation Needs

- Each coil shall be individually trapped.
- Provide a steam trap schedule by assigning a unique trap number and location. Indicate the type, capacity, and the pressure differential at which the trap is selected. The trap schedule shall be shown on the drawings.

(i) Steam Gun Sets

Provide a steam gun set consisting of steam, water, and detergent, at the following locations (see VA standard detail for more information):

- Trash or trash compaction rooms
- Dietetics - manual cart wash
- Supply, Processing & Distribution (SPD) - Manual Equipment Wash

4.4.2 HYDRONIC HOT WATER SYSTEMS

4.4.2.1 General

Hot water heating systems are commonly used due to ease of transportation of the heating medium, flexibility of piping layout, and versatility of the controls. For terminal heating devices, not in direct contact with freezing ambient air, use a hot water heating system.

4.4.2.2 Hot Water Source - Steam

For most VA facilities, steam is available from the central boiler plant via existing steam distribution loop to generate heating hot water. Each hot water generating system shall consist of two steam-to-hot water heat exchangers, circulating pumps, and associated system auxiliaries. One heat exchanger and circulating pump acts as 100% standby. See Figure 4-5 for the piping and pumping arrangement.

4.4.2.3 Hot Water Source - Hot Water Boilers

(a) General

Where steam is not available (example: Standalone Facilities), packaged, hot water heating boilers can be used to meet the heating and reheat demands. The boiler type, heating water temperatures, fuel type, and pumping/piping system configuration shall be based on the project requirements.

High-efficiency, condensing boilers are better suited to meet the mandated goal of 30% energy conservation. The boiler selection shall be optimized to obtain high efficiency at low return water temperature. At 120 F [49 C] return water temperature, the condensing boiler efficiency is as high as 91%.

(b) Condensing Boiler Selection Criteria

(b.1) Heating Load - 2,700,000 Btuh [790 kW] and Less

Provide two boilers, 100% capacity each, each complete with pump, piping, controls, etc., to make a complete working system.

(b.2) Heating Load - Higher than 2,700,000 Btuh [790 kW]

Provide three boilers, 50% capacity each, each complete with pumps, piping, controls, etc., to make a complete working system. Selection of multiple boilers shall be limited to four plus one (N + 1) boilers.

(c) High-Efficiency Non-Condensing Boilers

Use of non-condensing boilers shall be investigated only when the capacity requirements cannot be met by an array of five (N + 1) condensing boilers.

4.4.2.4 Hot Water Design Temperature

The supply water temperature entering the terminal units are generally selected in the range of 140 F [60 C] to 160 F [71 C]. The hot water temperature differential (supply temperature minus return temperature) shall be optimized to gain maximum energy advantage. The design water temperature differential is maintained between 20 F [11 C] to 30 F [17 C]. Higher water temperature difference will result in less water flow, smaller pipe sizes and reduced pumping power consumption.

4.4.2.5 Fuel Selection

When natural gas is used as the primary fuel, the design shall include stored fuel (propane gas or Number 2 oil) as back-up fuel.

With condensing boilers, during interruption of natural gas, propane gas is a preferred substitute for ease in automatic or manual changeover. Back-up fuel is not required where natural gas is not available.

4.4.2.6 Hot Water Piping and Pumping

The piping and pumping configuration shall be similar to the chilled water piping and pumping configurations described in this manual.

4.4.2.7 Freeze Protection – Hot Water

(a) General

For hot water preheat coils coming in contact with ambient air or mixed air below freezing temperatures, provide freeze protection by mixing propylene glycol in the heating hot water. Provide a glycol-hot water heating system with a heat exchanger, circulating pumps, and interconnecting piping.

(b) Glycol Properties

Select the smallest possible concentration of glycol to produce the desired antifreeze properties. Include an inhibitor in the glycol solution to prevent corrosion. Water used in conjunction with glycol shall be low in chloride and sulfate ions.

(c) HVAC Equipment Selection

Selection of equipment utilizing glycol shall take into account the loss of efficiency, impact on the flow and pressure drop, and increased pump BHP. See Appendix 4-A for corrections.

4.4.2.8 Terminal Units

The terminal units generally used with hot water heating systems are:

- Heating Coils – VAV/CV Air Terminal Units
- Unit Heaters

- Cabinet Unit Heaters
- Convectors
- Radiant Ceiling Panels
- Finned Tube Radiation
- Hot Water Curtains
- Fan Coil Units
- Hot Water Coils – Preheat and Reheat Coil mounted in AHU

4.4.3 ELECTRICAL HEATING SYSTEMS

4.4.3.1 General

Heating by resistance heaters are considered when fossil fuels are not available, and/or for applications where use of any other fuels could pose a safety hazard.

4.4.3.2 Applications

Use terminal heating units (unit heaters, finned-tube radiation, radiant panels) for locations such as:

- Emergency Generator Rooms
- Electrical Equipment Rooms
- Telecommunication Rooms
- Elevator Machine Rooms

4.4.3.3 Controls

The heating elements shall be controlled either in steps or by SCR (Silicon Controlled Rectifiers). Ensure safety compliance with heaters, such as high-temperature cutouts, as mandated by UL certification.

4.4.4 GAS HEATING SYSTEMS

4.4.4.1 General

Use gas heating where natural gas is readily available at the site. Alternately, liquid propane gas (LPG) can be used.

4.4.4.2 Applications

Gas-fired equipment is generally used for miscellaneous heating applications. These applications are:

- Mechanical Rooms
- Gymnasiums
- Storage Spaces

Ensure that combustion air and exhaust air needs are addressed and included in the design per the manufacturer's recommendations and NFPA 54, National Fuel Gas Code. Care shall be taken to avoid any possibility of exhaust air short-circuiting into an outdoor air intake or operable windows. Follow the recommendations of the dispersion analysis. Wherever available and feasible, use modulating burners to provide energy-efficient and smooth temperature control.

4.4.5 GEOTHERMAL HEATING

(a) General

Geothermal heating is the direct use of geothermal power for heating applications. Thermal efficiency is high because energy conversion is not needed, but capacity factors tend to be low (approximately 20%) since the heat is mostly needed in the winter. Geothermal energy originates from the heat retained within the Earth's core, from radioactive decay of minerals, and from solar energy absorbed at the surface. Most high temperature geothermal heat is harvested in regions close to tectonic plate boundaries where volcanic activity rises close to the surface of the Earth. In these areas, ground and groundwater can be found with temperatures higher than the target temperature of the application.

(b) References

The State of Idaho Website (*http://www.energy.idaho.gov/renewableenergy/district_heating.shtml)* has useful information for review

(c) Analysis

The designer shall analyze the potential of using geothermal heating. If other facilities in the area are using geothermal energy, the designer shall prepare a life-cycle analysis with geothermal heat as an option.

4.5 DESIGN CRITERIA – PIPING SYSTEMS

4.5.1 PIPE DESIGN – GENERAL

4.5.1.1 Pipe Selection Criteria

Pipe size selection must satisfy limiting parameters, maximum water velocity and maximum fluid pressure drop.

4.5.1.2 Minimum Pipe Size

For closed loop piping systems, minimum size of the individual takeoff shall not be less than 0.75 in [20 mm].

4.5.1.3 Mandatory Requirements

All piping 6 in [150 mm] and larger shall be shown in double lines on all floor plans in the final submission.

4.5.1.4 Miscellaneous Requirements

- Dielectric unions where connecting two dissimilar metals
- Drain connections at all low points in piping
- Manual air vents at all high points in piping

4.5.2 LIMITING PIPE SIZING PARAMETERS

Table 4-5: Pipe Sizing Criteria

Pipe Type and Size	Maximum Fluid Velocity	Maximum Pressure Drop
Chilled Water Hot Water Hot Glycol Water 2 in [50 mm] and below	6.0 fps [1.8 m/s]	2.0 ft WG/100 ft [0.2 kPa/m]
Chilled Water Hot Water Hot Glycol Water Above 2 in [50 mm]	10.0 fps [3.0 m/s]	2.0 ft WG/100 ft [0.2 kPa/m]
Condenser Water Any Size	10.0 fps [3.0 m/s]	2.0 ft WG/100 ft [0.2 kPa/m]
High Pressure Steam Any Size	10,000 fpm [50.0 m/s]	2.0 psig/100 ft [.5 kPa]
Low Pressure Steam Any Size	5,000 fpm [25.0 m/s]	0.5 psig/100 ft [.1 kPa]
Pumped Condensate Any Size	10.0 fps [3.0 m/s]	4.0 ft WG/100 ft [0.4 kPa/m]

Note: For closed-loop hydronic chilled water, heating hot water, and glycol/hot water systems, pipe sizing is based on "Cameron Hydraulic Data."

- C = 100 for open cooling tower systems
- C = 150 for closed systems

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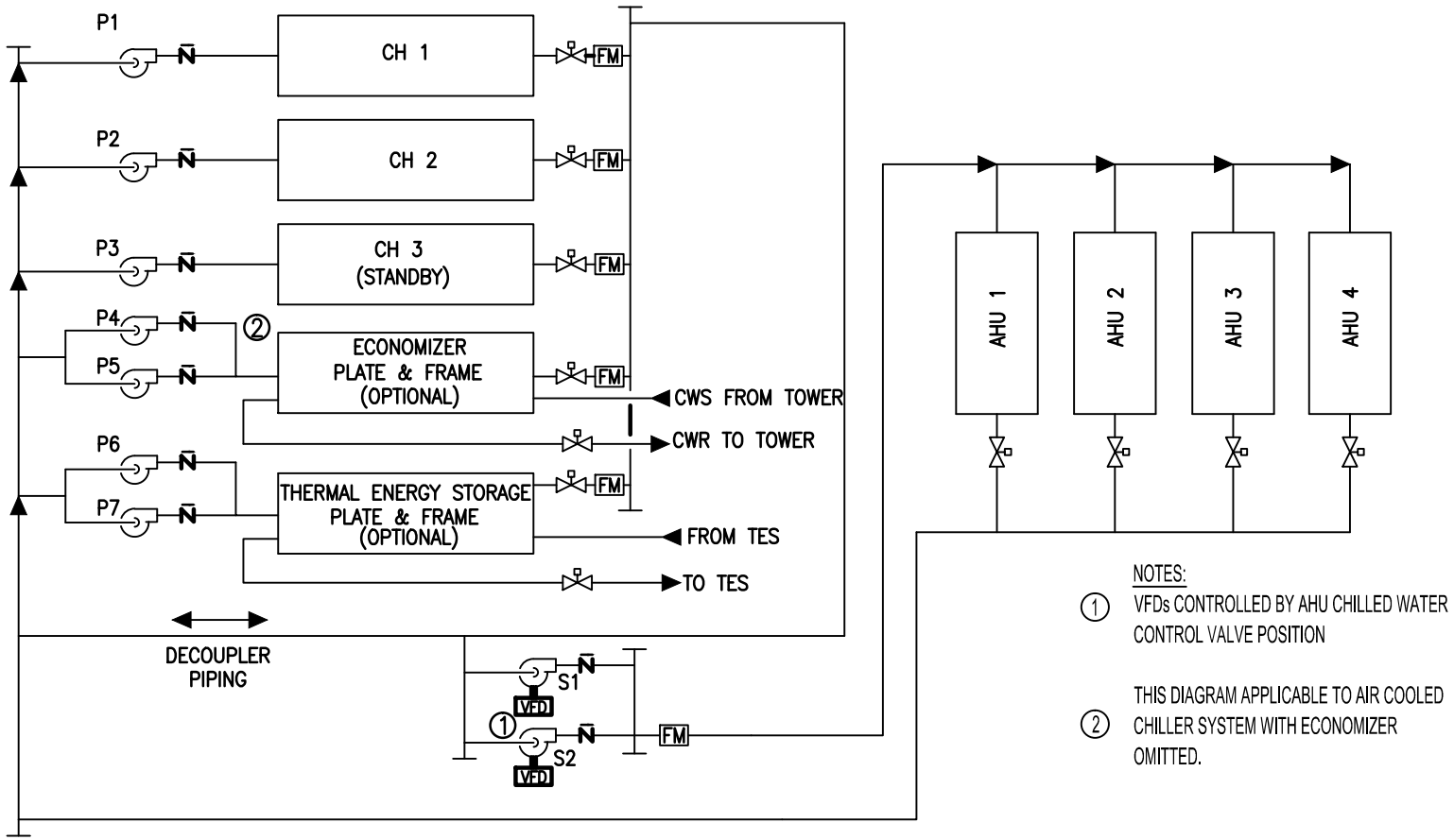

CHILLED WATER PRODUCTION AND DISTRIBUTION - PRIMARY- SECONDARY SYSTEM (PSS)

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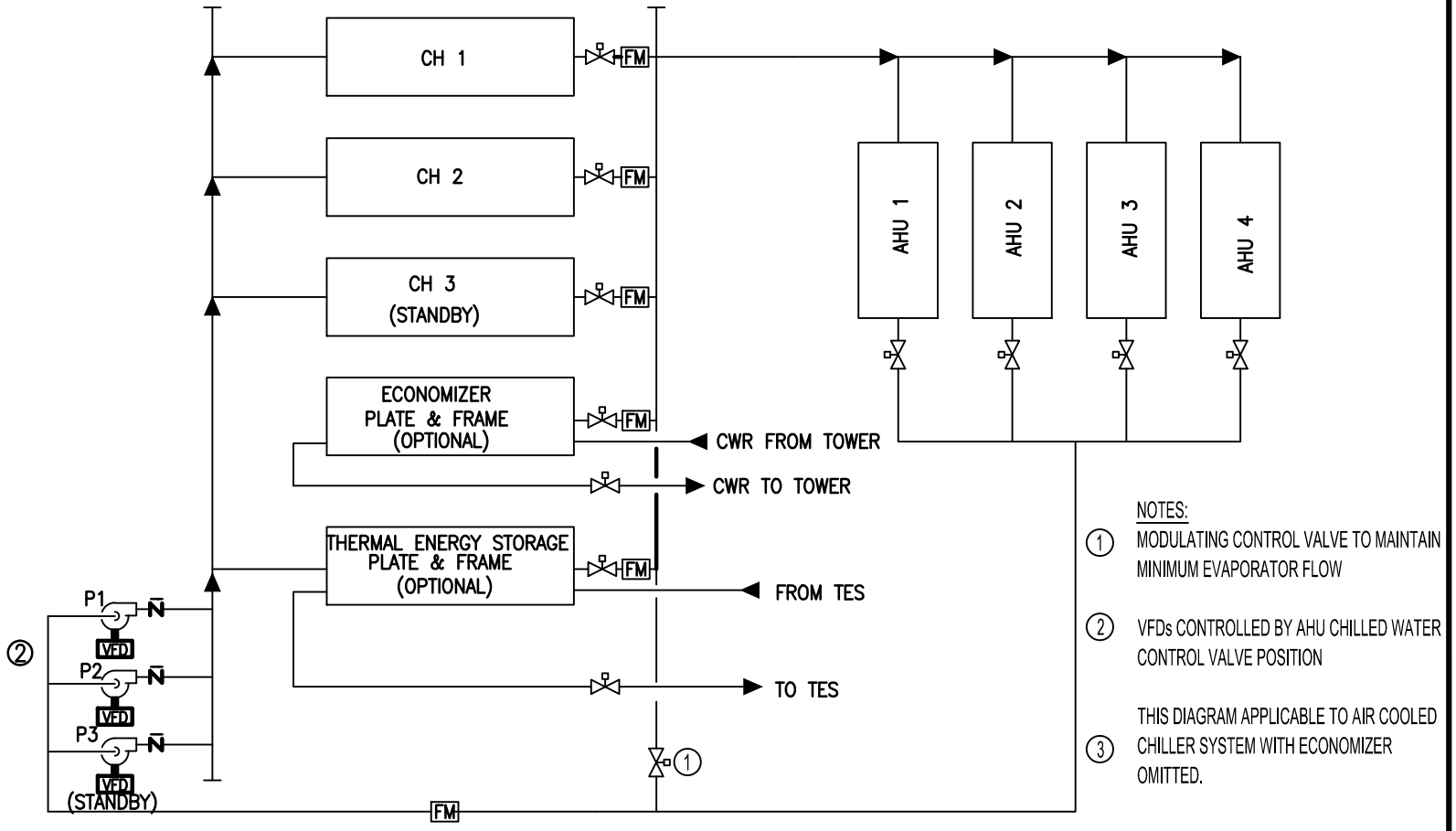

CHILLED WATER PRODUCTION AND DISTRIBUTION - VARIABLE PRIMARY SYSTEM (VPS)

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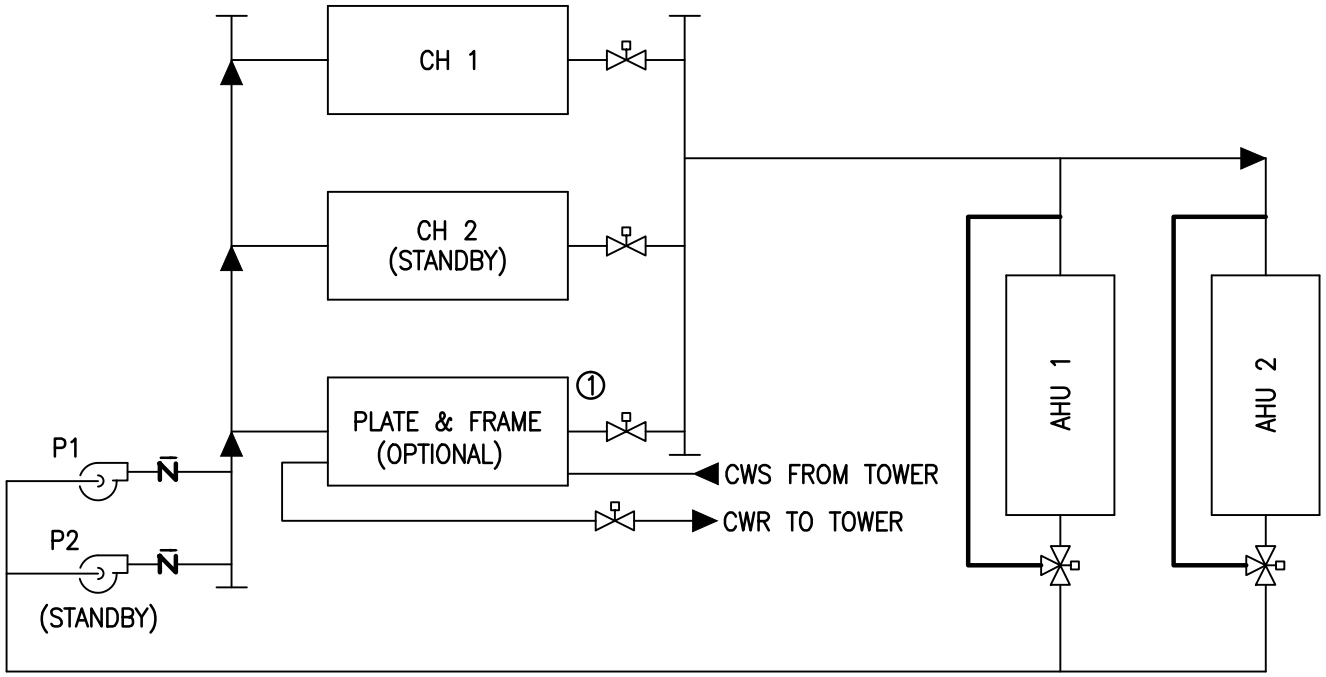

NOTES:
① THIS DIAGRAM APPLICABLE TO AIR COOLED CHILLER SYSTEM WITH ECONOMIZER OMITTED.

CHILLED WATER PRODUCTION AND DISTRIBUTION - SINGLE CHILLER SYSTEMS, CONSTANT VOLUME

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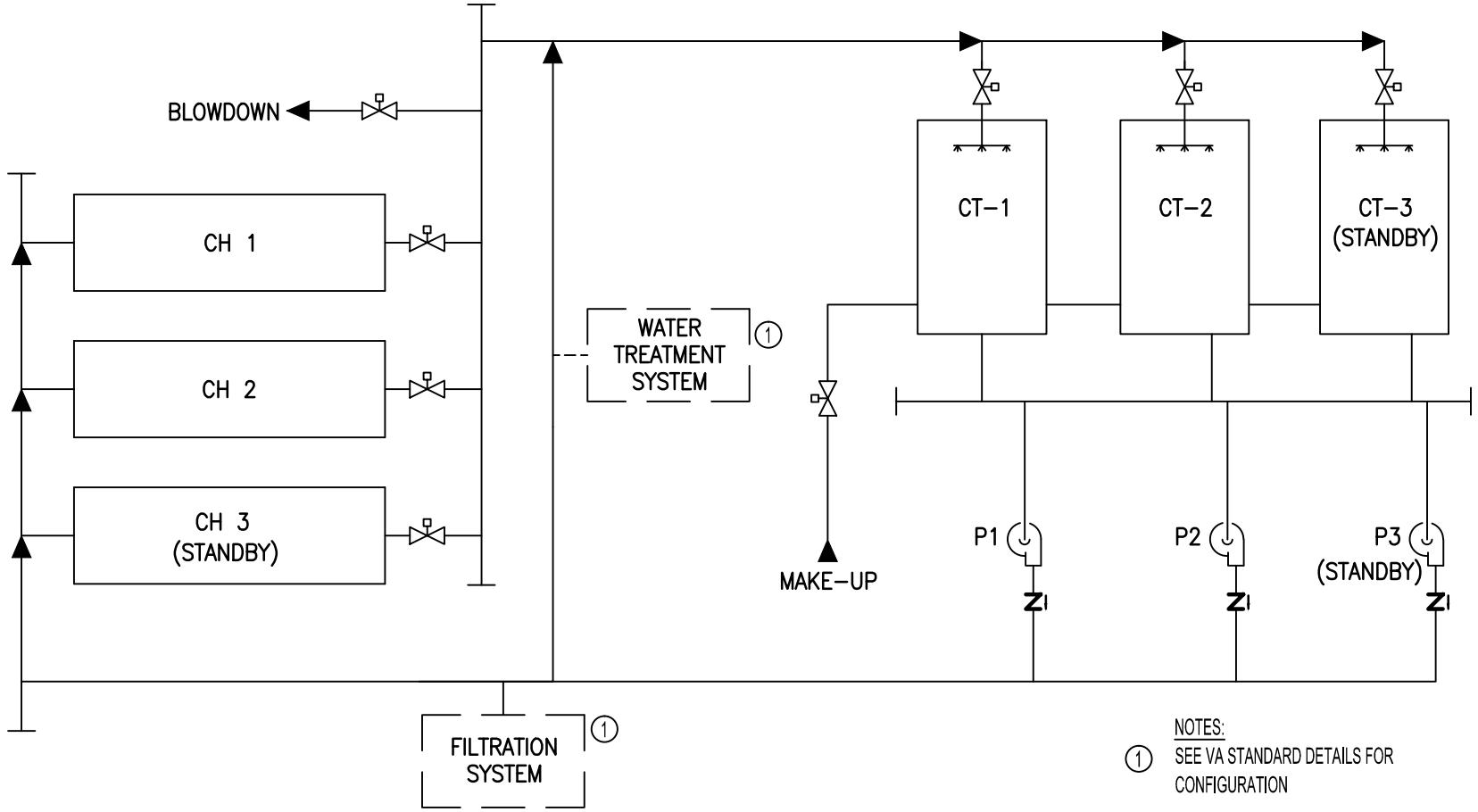

COOLING TOWER SYSTEM

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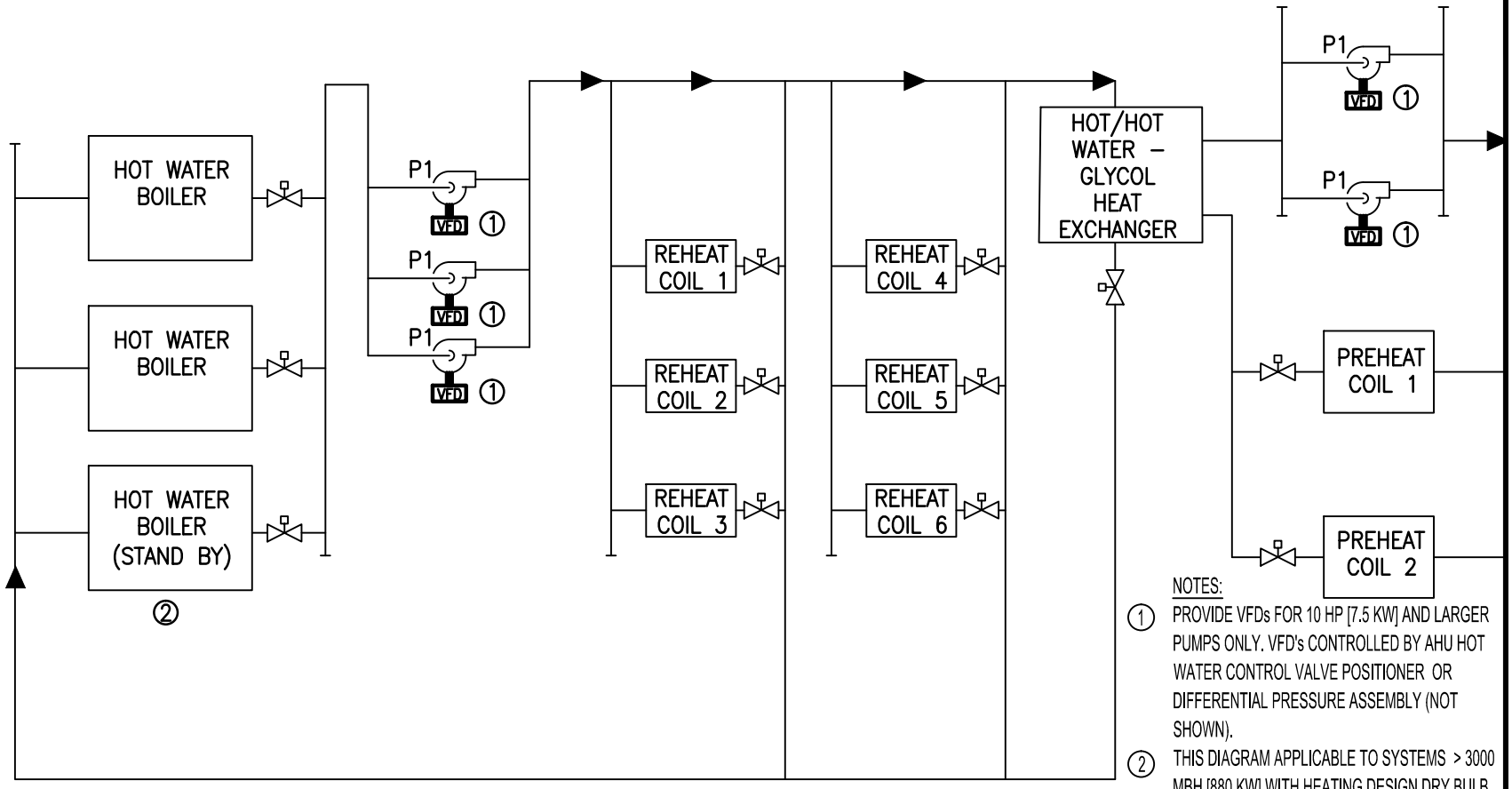

HYDRONIC HOT WATER DISTRIBUTION

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APPENDIX 4-A: PROPYLENE GLYCOL – WATER SOLUTION

4-A.1 GENERAL

All hydronic systems shall use propylene glycol solution where heat transfer applications require lower freezing temperature than water. The primary application for the addition of propylene glycol is for freeze protection.

Propylene glycol is less toxic than the commonly used ethylene glycol.

4-A.1.1 SELECTION CRITERIA

(a) Hot Water Freeze Protection: The freezing point of the glycol solution shall be at least 5 F [3 C] lower than the anticipated ambient temperature to prevent the formation of crystals. The anticipated ambient temperature shall be the minimum annual extreme daily temperature for the location. See Chapter 7 for this temperature.

(b) Chilled Water Freeze Protection: The freezing point of the glycol solution shall be at least 5 F [3 C] lower than the anticipated ambient temperature to prevent the formation of crystals. The anticipated ambient temperature shall be the minimum annual extreme daily temperature for the location. See Chapter 7 for this temperature.

(c) Thermal Energy Storage (Ice) Systems: Consult the tank and chiller manufacturer for glycol correction sizing information and direction.

(d) The glycol solution shall be inhibited for corrosion control.

(e) Verify the water quality based on a site water sample to ensure compliance with the following guidelines:

- Less than 500 ppm calcium and magnesium in chemicals (chloride and sulfate)
- Less than 25 ppm of chloride and sulfate
- Less than 100 ppm (5 grains) of total hardness
- Less than 100 ppm dissolved solids

Use of distilled or deionized water shall be blended with municipal water if required to meet the standards above.

4-A.1.2 COIL FREEZE PROTECTION

To determine the required concentration of propylene glycol, the designer shall compare the freezing temperature of the solution and the selection criteria above. The solution can be expressed by weight or volume, almost interchangeably, as the difference is negligible. The freeze point of propylene glycol is listed below:

Table 4-A1 – Propylene Glycol Properties (From ASHRAE Fundamentals – 2009)	
Percentage Concentration by Volume	**Freezing Temperature F [C]**
0%	32 [0.0]
10%	26 [-3.0]
20%	19 [-7.0]
30%	9 [-13.0]
40%	-6 [-21.0]
50%	-28 [-33.0]

4-A.1.3 PROPYLENE GLYCOL PROPERTIES

The properties of propylene glycol are shown in the following table:

Table 4-A2 – Properties of Propylene Glycol Solutions (From ASHRAE Fundamentals – 2009)				
Percentage Concentration by Volume	**Density* (lb/cf) [kg/m^3]**		**Thermal Conductivity (Btu-ft/h-sf-F) [W/m-C]**	
	25-45 F [-4-7 C]	120-160 F [49-71 C]	25-45 F [-4-7 C]	120-160 F [49-71 C]
10%	63.38 [1015]	62.28 [998]	0.293 [0.507]	0.334 [0.578]
20%	64.14 [1027]	62.85 [1007]	0.267 [0.462]	0.301 [0.521]
30%	64.79 [1038]	63.33 [1014]	0.243 [0.421]	0.270 [0.467]
40%	65.35 [1047]	63.74 [1021]	0.222 [0.384]	0.243 [0.421]
50%	65.82 [1054]	64.06 [1026]	0.201 [0.348]	0.217 [0.376]
Percentage Concentration by Volume	**Specific Heat (Btu/lb-F) [J/kg-C]**		**Viscosity (cP) [Pa-s]**	
	25-45 F [-4-7 C]	120-160 F [49-71 C]	25-45 F [-4-7 C]	120-160 F [49-71 C]
10%	0.966 [4042]	0.985 [4121]	2.80 [$2.80*10^{-3}$]	0.75 [$0.75*10^{-3}$]
20%	0.938 [3920]	0.965 [4038]	4.23 [$4.23*10^{-3}$]	0.97 [$0.97*10^{-3}$]
30%	0.906 [3782]	0.939 [3929]	7.47 [$7.47*10^{-3}$]	1.30 [$1.30*10^{-3}$]
40%	0.868 [3623]	0.908 [3799]	13.20 [$13.20*10^{-3}$]	1.71 [$1.71*10^{-3}$]
50%	0.825 [3443]	0.871 [3644]	19.66 [$19.66*10^{-3}$]	2.36 [$2.36*10^{-3}$]

*For pump power calculations, specific gravity is the density of propylene divided by density of water.

4-A.2 PUMP SELECTION

4-A.2.1 STEP 1: EQUIPMENT FLOW RATE AND HEAD

Propylene glycol, more viscous and less thermally efficient than water, requires different considerations when using standard pump selection data. Furthermore, propylene and ethylene glycol have very different properties and cannot be interchanged.

The designer shall consult the manufacturers of coils, chillers and heat exchangers to determine flow and head requirements of the equipment at the specified glycol percentage and temperature. The equipment manufacturer shall select equipment to account for specific heat, thermal conductivity and viscosity effects of the glycol solution. The designer shall coordinate with the manufacture to optimize the equipment selection to maximize the water/glycol mixture temperature differential and minimize the increase in flow rate.

4-A.2.2 STEP 2: HEAD CORRECTION DUE TO VISCOSITY

A correction is applied to account for the increased viscosity of the propylene glycol solution. This correction factor is applied to pipe, valves and fitting pressure drop only and changes the required pump head. The manufacturer's flow rates at the specified glycol percentage are used when determining the initial pressure drop in the piping system. The designer shall use the correction factors from Table 4-A3 when calculating the viscosity correction. The designer shall indicate the corrected values (GPM, WPD, APD, EWT, LWT) on the HVAC Equipment schedules. Provide appropriate notes.

The head correction required due to flow increases provided by the manufacturer's equipment selection may be excessive and the designer shall evaluate increasing the pipe size to reduce the pressure drop. Maximum fluid velocity and maximum pressure drop criteria for pipe sizing shall conform to Chapter 4 requirements.

Note that operating temperatures above 160 F [71 C] does not require head correction due to the effects of viscosity.

Table 4-A3 – Effect of Propylene Glycol Solutions (From ASHRAE HVAC Systems and Equipment – 2008)

Percentage Concentration by Volume	Changes Due To Viscosity Head Increase Coefficient	
	25-45 F [-4-7 C]	120-160 F [49-71 C]
10%	1.08*	0.90
20%	1.14*	0.95
30%	1.27*	0.97
40%	1.45	1.00
50%	1.60	1.03

*Used for low temperature chilled water.

4-A.2.3 STEP 3: POWER CORRECTION DUE TO VISCOSITY

The final correction factor is applied to account for the change in pump power requirements. To find that correction, the designer shall refer to Hydraulic Institute Standard 9.6.7, *Effects of Liquid Viscosity on Rotodynamic (Centrifugal and Vertical) Pump Performance*. It is the Design Professional's responsibility to consult the standard to determine the correction factor for pump efficiency due to changes in viscosity.

4-A.3 SAMPLE PUMP SELECTION – WITH PROPYLENE GLYCOL SOLUTION

Application 1 – Chilled Water Freeze Protection

A simple, all-water example follows:

A chiller and an air handling unit chilled water coil are connected by pipe and a water-based pump operating under conditions of:

200 gpm [12.6 L/s]

70 ft [209 kPa] total head

40 ft [120 kPa] head due to pipe, valves and fittings

30 ft [90 kPa] head due to equipment

40 F [4 C] fluid temperature

5.0 bhp [3.7 kW] and 71% efficiency pump

Specific gravity = 1.0

The equipment is a chiller and an air handling unit chilled water coil.

Determine the operating values of the same system if the fluid is changed to a solution of 40% glycol by volume.

Step 1:

Manufacturers are consulted and the chilled water coil requires 300 gpm [18.9 L/s] and 22 ft [66 kPa] head and the chiller evaporator pressure drop at 300 gpm is 28 ft [84 kPa] when using 40% glycol.

Step 2:

Using the pump affinity laws, correct the pipe, valves and fittings head for the new flow rate. At 300 gpm, the new head is 90 ft [269 kPa]

Total Dynamic Head Correction (due to viscosity increase) = 90 x 1.45 = 131 ft of water [390 kPa].

Resultant Pumping Power Required:

$$P = \frac{\text{flow (gpm)} \times \text{head (ft of water)} \times \text{specific gravity (unitless)}}{3960 \times \text{pump efficiency (unitless)}}$$

$$P = \frac{300 \times (22+28+131) \times 1.046}{3960 \times 0.71} = 20.2 \text{ bhp [15.1 kW]}$$

Step 3:

Pump Efficiency Correction (due to viscosity increase from Table 4-A3) = 0.93* x 0.71 = 0.66

* Value found from Hydraulic Institute Standard 9.6.7.

Resultant Pumping Power Required:

$$P = \frac{300 \times 181 \times 1.046}{3960 \times 0.66} = 21.7 \text{ bhp [16.2 kW] for 40\% by volume glycol solution}$$

Table 4-A4 – Summary Results, Typical Example		
Items	**Water**	**Propylene Glycol – Water Solution 40% by Volume 40 F [4.4 C]**
Flow Rate	200 gpm [12.6 L/s]	300 gpm [18.9 L/s]
Head	70 ft of water [209 kPa]	181 ft of water [541 kPa]
Power	5.0 bhp [3.7 kW]	21.7 bhp [16.2 kW]

Application 2 – Heating Hot Water Freeze Protection

A simple, all-water example follows:

A steam to hot water heat exchanger and an air handling unit hot water coil are connected by pipe and a water-based pump operating under conditions of:

40 gpm [2.5 L/s]

30 ft [90 kPa] total head

20 ft [60 kPa] head due to pipe, valves and fittings

10 ft [30 kPa] head due to equipment

140 F [60 C] fluid temperature

0.75 bhp [0.56 kW] and 50% efficiency pump

Specific gravity = 1.0

The equipment is a steam to hot water heat exchanger and an air handling unit hot water coil.

Determine the operating values of the same system if the fluid is changed to a solution of 40% glycol by volume.

Step 1:

Manufacturers are consulted and the hot water water coil requires 50 gpm [3.2 L/s] and 4 ft [12 kPa] head and the heat exchanger pressure drop at 50 gpm is 10 ft [30 kPa] when using 40% glycol.

Step 2:

Using the pump affinity laws, correct the pipe, valves and fittings head for the new flow rate. At 50 gpm, the new head is 31 ft [93 kPa]

Total Dynamic Head Correction (due to viscosity increase) = 31 x 1.00 = 31 ft of water [93 kPa].

Resultant Pumping Power Required:

$$P = \frac{\text{flow (gpm)} \times \text{head (ft of water)} \times \text{specific gravity (unitless)}}{3960 \times \text{pump efficiency (unitless)}}$$

$$P = \frac{50 \times (4+10+31) \times 1.046}{3960 \times 0.50} = 1.19 \text{ bhp } [0.89 \text{ kW}]$$

Step 3:

Pump Efficiency Correction (due to viscosity increase from Table 4-A3) = 1.00* x 0.50 = 0.50

* Value found from Hydraulic Institute Standard 9.6.7.

For hot water applications, pump efficiency is not generally penalized due to viscosity. It is the designer's responsibility to confirm the correction factor Hydraulic Institute Standard 9.6.7, *Effects of Liquid Viscosity on Rotodynamic (Centrifugal and Vertical) Pump Performance*.

Table 4-A5 – Summary Results, Typical Example		
Items	**Water**	**Propylene Glycol – Water Solution 40% by Volume 140 F [60 C]**
Flow Rate	40 gpm [2.5 L/s]	50 gpm [3.2 L/s]
Head	30 ft of water [90 kPa]	45 ft of water [135 kPa]
Power	0.75 bhp [0.56 kW]	1.19 bhp [0.89 kW]

Application 3 – Thermal Storage System (Ice)

For thermal energy storage (ice) systems, consult the tank and chiller manufacturer for glycol correction sizing information and direction.

4-A.4 NOTES TO BE ADDED TO EQUIPMENT SCHEDULES

(a) Pumps

For pumps using an aqueous solution of water and glycol, the designer shall add a remark that "Pump corrections have been applied" after calculating the appropriate correction factors. This remark shall be located on the pump equipment schedule.

(b) Coils, Chillers, Heat Exchangers

For coils, chillers and heat exchangers using an aqueous solution of water and glycol, the manufacturer shall increase the heat transfer surfaces to account for the percentage of glycol. The GPM, EWT, LWT and WPD indicated on the schedule shall be shown for the solution indicated, and not pure water. A remark shall be added that "Coil corrections have been applied for GPM, WPD, APD, EWT and LWT for the solution shown" (substitute chiller or heat exchanger as required) on the schedule.

CHAPTER 5: AUTOMATIC TEMPERATURE CONTROLS

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5.1 GENERAL

(a) Provide a Direct Digital Control (DDC) system for new and replacement hospitals and major renovations of existing facilities. The DDC system will monitor and control the HVAC, plumbing and other systems. See specifications, VA Standard Details, and Chapter 6 (Applications) for additional information.

(b) The A/E shall determine the cost effectiveness of the following options:

Option 1 - Upgrade the ECC and existing DDC control system to a new BACnet compatible control system; provide new controllers as required for new scope of work.

Option 2 - Upgrade ECC; provide new controllers as required for new scope of work, utilize BACnet gateway for communication to existing DDC system.

Option 3 - Provide new BACnet compatible control system for new scope of work; existing DDC system to remain.

Option 4 - Install new BACnet software package to existing ECC; install BACnet controllers for new scope of work and existing DDC system is to remain.

Option 5 - Integrate new scope of work into existing DDC system (same manufacturer).

(c) The interface with the existing ECC shall be seamless. The system shall include a personal computer (PC), laptop computers, color printer, distributed DDC controllers, panels, sensors, switches, alarms, flowmeters, relays, control valves and dampers, wiring, system graphics, control sequences, and accessories to make a complete and workable system.

(d) Use of DDC controls shall result in energy efficient operation and help achieve the mandated goal of energy conservation, described in Chapter 1.

5.2 BASIC DESIGN

5.2.1 NEW FACILITY OR RENOVATION

5.2.1.1 Option 1

Replace existing ECC with new BACnet Engineering Control Center (B-AWS), replace all existing DDC controllers with new BACnet controllers, install new BACnet communication network, install new building (B-BC) and equipment controllers (B-AAC, B-ASC) as required for new scope of work. Provide new portable operators terminal.

5.2.1.2 Option 2

Replace existing ECC with new BACnet Engineering Control Center (B-AWS), install new BACnet gateway with full communication to existing controllers, install new BACnet communication network, install new building (B-BC) and equipment controllers (B-AAC, B-ASC) as required for new scope of work. Provide new portable operator’s terminal.

5.2.1.3 Option 3

Install new BACnet Engineering Control Center (B-AWS). Install new building (B-BC) and equipment controllers (B-AAC, B-ASC) as required for new scope of work. Provide new portable operator's terminal. Existing ECC, associated communication network and controllers to remain.

5.2.1.4 Option 4

Install new BACnet software on existing ECC which shall co-exist with current ECC operation software package, existing communication network to be re-used, install new building (B-BC) and equipment controller's (B-AAC, B-ASC) as required for new scope of work. Provide new portable operator's terminal.

5.2.1.5 Option 5

Integrate new scope of work into existing DDC system (same manufacturer).

5.3 BACNET CONTROLLER IDENTIFICATION

B-AWS	BACnet Advanced Workstation
B-BC	BACnet Building Controller
B-AAC	BACnet Advanced Application Controller
B-ASC	BACnet Application Specific Controller

5.4 SPECIFIC REQUIREMENTS

5.4.1 CONTROL ACTUATORS

Automatic control valves and dampers shall be equipped with electric actuators. Use of pneumatic actuators is not permitted unless specifically requested by the medical center for renovation of existing facilities.

5.4.2 CONTROL VALVES

Select control valves with equal percentage, or linear flow characteristics. Provide bubble tight shutoff against 1.5 times design pressure. Utilize two-way, modulating control valves to the greatest extent possible. Select control Cv and pressure drop per manufacturer's recommendations. The Design Engineer shall specify maximum pressure differential allowed to ensure proper pumping capacity is available.

5.4.3 CONTROL DAMPERS

Select airfoil-type control dampers with blade and edge seals to minimize air leakage while in the shutoff position. Show all damper sizes on the mechanical equipment floor plans and section drawings.

5.4.4 END-SWITCHES

Provide end-switches for 100% outdoor air dampers and duct-mounted smoke dampers, Dampers shall be fully open before the supply air fans are energized.

5.4.5 SAFETIES

Provide hard-wired interlocked connections for all safety devices, such as freeze stats, smoke detectors, smoke dampers, and refrigerant leak detection devices. All safety devices shall be provided with additional dry contacts and shall be connected to the DDC system for monitoring and sequencing.

5.4.6 CONTROL WIRING

Specify all UL-listed components and wiring installation in accordance with the National Electric Code. All control wiring shall be installed in electric metallic tubing or conduits, unless otherwise approved by VA Authorities.

5.4.7 AIR FLOW MEASURING STATIONS

Specify style of air flow measuring station (electronic, pitot tube, etc.) required. Provide air flow measuring station locations with sufficient upstream and downstream straight duct requirements per manufacturer's recommendations. Define minimum and maximum cfm values for each station.

5.4.8 PERSONAL COMPUTER (PC)

Provide a PC with the maximum available memory, hard-drive capacity, and processing speed at the time of design. Minimum PC configuration: Intel Core 2 Duo E8400 processor (3.0GHz, 6M, 1333MHz FSB), 8GB SDRAM, 1333MHz, 250GB 7,200 rpm SATA Hard Drive, Integrated Intel GMA 4500 Video, Windows 7 Professional with Windows Office Professional software package. Provide two (2) 24 in [610 mm] flat screen monitors, expanded keyboard, CD drive, and a mouse. Provide two printers: one for status and one for reports. The report printer shall be color ink jet type. Coordinate the selection and location of the computer and associated equipment with the end-users.

5.4.9 LAPTOP COMPUTER

The laptop computer shall be similar to the PC above with at least a 19 in [425 mm] color monitor.

5.4.10 SOFTWARE

Provide an operator-programmable, pro-active software system, based on project-specific applications. All controllers shall be connected through a dedicated communication network to share common data and reports with the workstation. Provide download, upload and all software configuration capabilities between the PC and the local controllers.

5.4.11 COLOR GRAPHICS

Provide a complete dynamic color graphics package on the PC and laptop computers. Provide a schematic diagram for each control system and sub-system with the design setpoints and actual conditions. Indicate the mode of operation and alarm status.

5.4.12 SPREADSHEETS

Provide Excel-type spreadsheet tables for each item of equipment to trend and log the data with setpoints, actual sensor readings, and status.

5.4.13 SECURITY

Provide three levels of password protection to restrict altering the device setpoints.

5.4.14 STATUS MONITORING

Provide current transducers (analog) for monitoring the status and energy of all fan (including cooling towers) and pump motors. Do not use differential pressure switches for status monitoring.

5.4.15 ROOM TEMPERATURE SENSORS

Use commercial grade room temperature sensors with programmable temperature adjustment limits and night setback push button override capabilities. Specific sensor tolerances should be noted in project specifications.

5.5 HUMIDITY SENSORS

Use commercial grade duct and room mounted humidity sensors, accuracy of +/- 2% (0-90%).

5.5.1 METERING REQUIREMENTS

Coordinate metering requirements, with similar ongoing efforts (if any) at the VA facilities, to ensure seamless integration and avoid duplication. Coordinate the efforts with the specification 25 10 10 - Advanced Utility Metering System.

5.6 SYSTEM APPLICATIONS

5.6.1 GENERAL

Listed below are generic control requirements for various HVAC systems. The list does not cover all control requirements and sub-sequences. Similarly, all control requirements may not be applicable to all situations. Using information given below, and other available resources, the A/E shall develop detailed control sequences for all systems.

5.6.2 AIRSIDE CONTROLS

Airside controls include operation of the air-handling units, exhaust systems, room level controls, and other miscellaneous controls.

5.6.2.1 Air-Handling Units

(a) System Start-Up

(b) Morning Warm-Up Mode

(c) Morning Cool-Down Mode

(d) Unoccupied Mode

(e) Supply Air Temperature Control (include all applicable modes)

- Heating Mode
- Mechanical Cooling Mode
- Economizer Cycle Mode
- Mechanical Cooling with Economizer Cycle Mode
- Supply Air Temperature Reset Control, where applicable

(f) Freeze Protection Control – Pre-Heat Coil

- Mixed Air Temperature Control
- Fan Operation Control
- Outside Air Damper Control

(g) Fan Speed Control – Supply Air Fan

Refer to ASHRAE Standard 90.1 - 2007 for mandated static pressure reset control.

(h) Fan Tracking Control – Supply and Return Air Fans

(i) Minimum Ventilation Air – Outdoor Air Control

Include demand control ventilation, where applicable.

(j) Smoke Detector/Smoke Damper Operation

(k) Filter Maintenance Alarm

- Pre-Filters
- After-Filters
- Final-Filters

(l) Volumetric Data

- Supply Air Volume – cfm [L/s]
- Return Air Volume – cfm [L/s]
- Minimum Ventilation Air (Outdoor Air) – cfm [L/s]

(m) Heat Recovery System Operation

- Applicable to 100% Outdoor Air Ventilation Systems
- Run Around Coil
- Heat Recovery Coil

(n) Humidity Control

- Humidification Mode with Operating and High-Limit Controls
- High-Humidity Controls – Mechanical Cooling Mode

(o) Special Exhaust Systems

- Fume Hoods
- Biological Safety Cabinets

5.6.2.2 Individual Room Temperature or Pressure Control

(a) Constant Volume Air Terminal Unit

- See Figure 5-1

(b) Variable Volume Air Terminal Unit

- With Dead-Band (see Figure 5-2)
- Without Dead-Band (see Figure 5-3)

(c) Room Pressure Differential Control

- Air Flow Control Valves

(c) Fan Coil Unit Control

- Four-Pipe System
- Two-Pipe System

(d) Ground Source Heat Pump (GSHP) Control

- Variable Speed Pump Control
- Seasonal Shutdown

5.6.3 HEATING SYSTEM CONTROLS

(a) Pumping System Controls

- Start-Up with Automatic Changeover (Emergency and Equal Runtime)
- Primary-Secondary Piping/Pumping Control
- Variable Primary Piping/Pumping Control, where applicable

(b) Heat Exchanger Controls

- Leaving Water Temperature Control
- Water Temperature Reset Control

(c) Boiler Controls

- Safety Controls
- Outdoor Air Reset
- Integration with the Central DDC (ECC) Controls

(d) Geothermal Heating Control

- Safety Controls
- Outdoor Air Reset

5.6.4 CHILLED WATER SYSTEM CONTROLS

(a) Standalone Chilled Water Plant

- System Start-Up
- Automatic Part-Load Operation
- Chiller Safety Controls and Interlock With Central DDC System

(b) Chilled Water Temperature Control

- Fixed Water Temperature Control (Leaving Chiller)
- Reset Water Temperature Control, where applicable

(c) Pumping System Control

- Start-Up with Automatic Changeover (Emergency and Equal Runtime)
- Primary-Secondary Piping/Pumping Control
- Variable-Primary Piping/Pumping Control, where applicable
- Minimum Pump Speed Control

(d) Cooling Tower Control

- Leaving Water Temperature Control
- Fan Speed Control
- Vibration Isolation Control
- Make-Up Water Control
- Basin Temperature Control
- Water Treatment Controls Including Integration with DDC Controls
- Plate Heat Exchanger Control (Economizer Mode, where applicable)

(e) Thermal Energy Storage Control – Water or Ice

- Storage Capacity
- Special Equipment Requirements
- Utility Rate Information
- Recharge/Discharge Control
- Cooling Tower Temp Control Requirements.

5.6.5 NON-DDC CONTROLS

For standalone closed-loop applications, DDC controls and connection to the central ECC system shall be eliminated if it is determined that remote monitoring, alarm, and start-up are not necessary. Such applications are generally non-critical and should be evaluated on a case-by-case basis. Specific applications may require DDC temperature sensors for high or low limit alarms.

Examples of closed-loop controls are:

- Elevator Machine Room (Using Standalone DX System)
- Vestibule Heater
- Exterior Stairs Heater
- Attic Heating and Exhaust Ventilation Systems
- Mechanical Room – Heating/Ventilation Control

5.7 DOCUMENTATION REQUIREMENTS

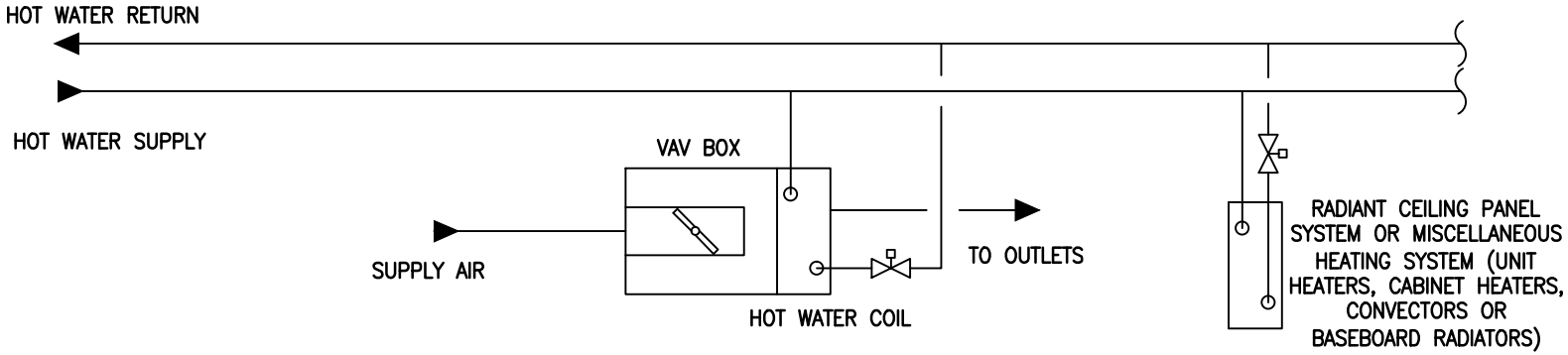
5.7.1 SCHEMATIC DIAGRAM AND CONTROL SEQUENCE

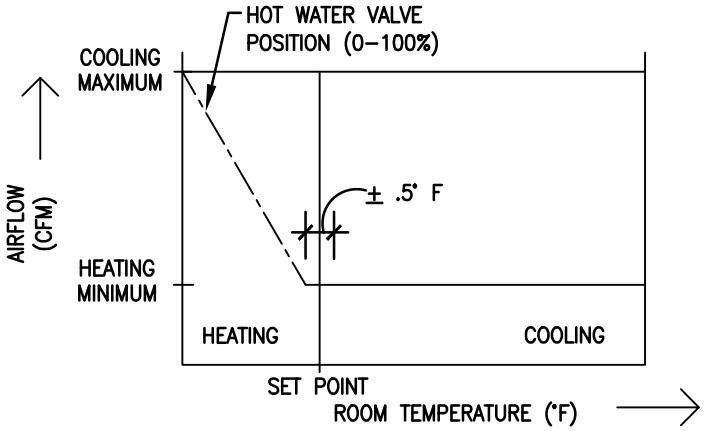
Provide a control diagram showing all controlled devices with unique designation numbers, such as valves V-1 and V-2, dampers D-3 and D-4, etc. Describe the role of each controlled device in the sequence of operation. Describe the sequence of operation in all modes, generally as outlined above.

The control schematic diagram and the written specific sequence of operation must be included in the contract drawings. Do NOT include the sequence of operation in the specifications.

5.7.2 POINT LIST

Provide a comprehensive DDC point schedule for each system. Provide a list of all analog and binary points, alarm requirements, and measurement needs. Sample point lists are shown in Figure 5-4, Figure 5-5, Figure 5-6, and Figure 5-7.





VAV BOX CONTROL SEQUENCE

CONTROL SEQUENCES

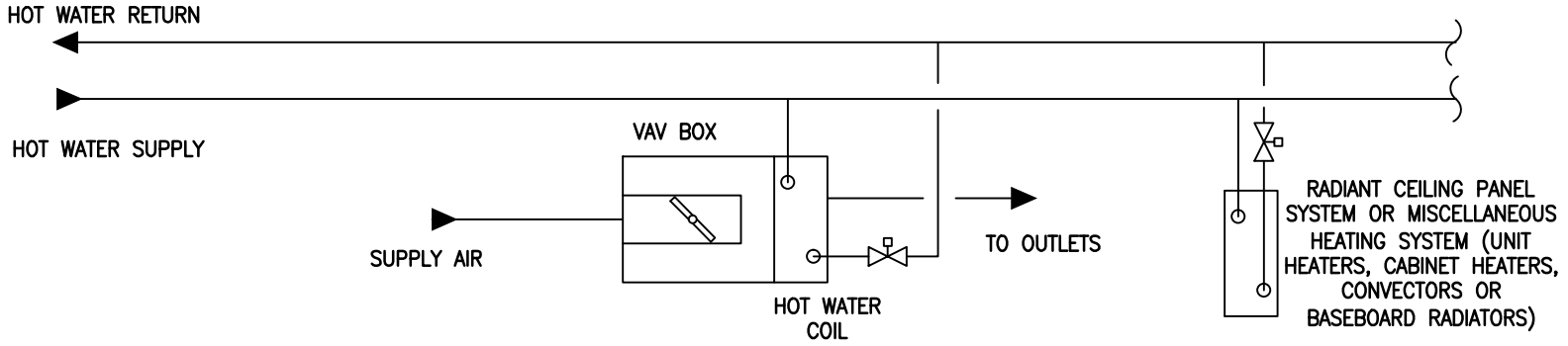
CASE 1: NO PERIMETER HEATING
- A. HOT WATER VALVE ENABLED AT ALL TIMES.
- B. HOT WATER VALVE OPENS IF ROOM TEMPERATURE IS LESS THAN SET POINT.

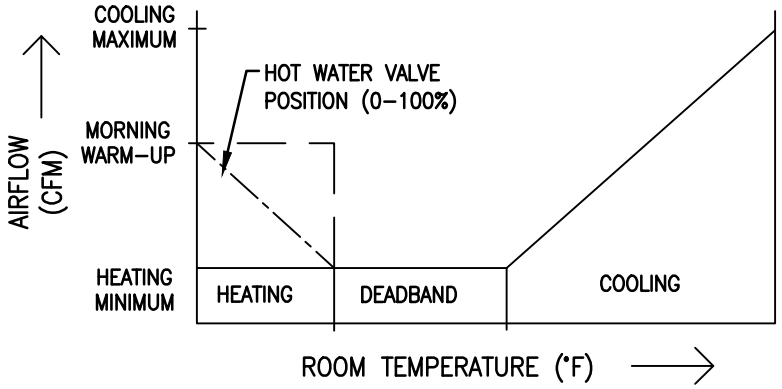
CASE 2: WITH RADIANT CEILING PANEL SYSTEM
- A. RADIANT PANEL CONTROL VALVE ENABLED BELOW A SPECIFIED OUTSIDE AIR TEMPERATURE.
- B. IF CV BOX HOT WATER VALVE IS 100% OPEN AND ROOM TEMPERATURE IS LESS THAN SETPOINT, RADIANT CEILING PANEL HOT WATER VALVE MODULATES OPEN TO MAINTAIN ROOM TEMPERATURE SET POINT.

CASE 3: WITH MISCELLANEOUS HEATING
- A. CONTROL VALVE FOR MISCELLANEOUS HEATING SYSTEM ENABLED BELOW A SPECIFIED OUTSIDE AIR TEMPERATURE.
- B. IF CV BOX HOT WATER VALVE IS 100% OPEN (AND RADIANT CEILING PANEL SYSTEM VALVE, IF INSTALLED) AND ROOM TEMPERATURE IS LESS THAN SETPOINT, MISCELLANEOUS HEATING HOT WATER VALVE MODULATES TO MAINTAIN ROOM TEMPERATURE.

CV TERMINAL UNIT WITH REHEAT AND PERIMETER HEATING

Not to Scale





VAV BOX CONTROL SEQUENCE

CONTROL SEQUENCES

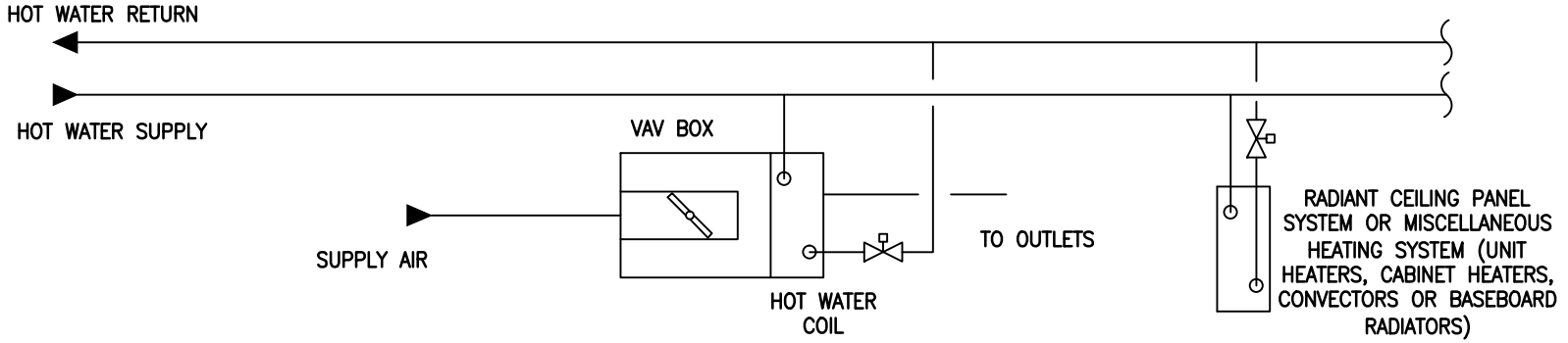
CASE 1: NO PERIMETER HEATING
- A. HOT WATER VALVE ENABLED AT ALL TIMES.
- B. HOT WATER VALVE OPENS IF ROOM TEMPERATURE IS LESS THAN LOWER LIMIT.

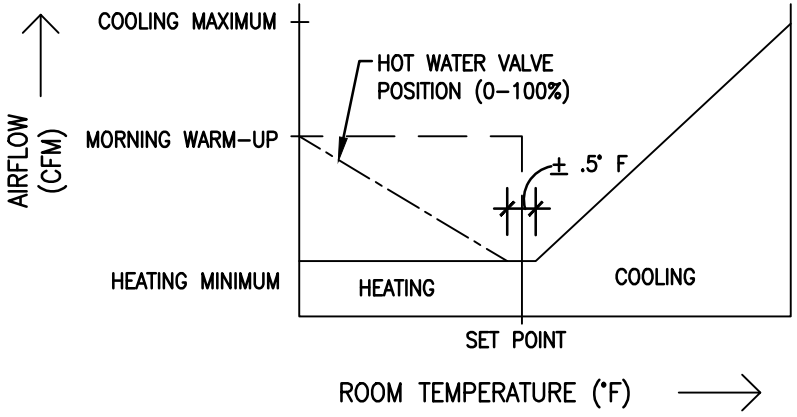
CASE 2: WITH RADIANT CEILING PANEL SYSTEM
- A. RADIANT PANEL CONTROL VALVE ENABLED BELOW A SPECIFIED OUTSIDE AIR TEMPERATURE.
- B. IF VAV BOX HOT WATER VALVE IS 100% OPEN AND ROOM TEMPERATURE IS LESS THAN SETPOINT, RADIANT CEILING PANEL HOT WATER VALVE MODULATES OPEN TO MAINTAIN ROOM TEMPERATURE SET POINT.

CASE 3: WITH MISCELLANEOUS HEATING
- A. CONTROL VALVE FOR MISCELLANEOUS HEATING SYSTEM ENABLED BELOW A SPECIFIED OUTSIDE AIR TEMPERATURE.
- B. IF VAV BOX HOT WATER VALVE IS 100% OPEN (AND RADIANT CEILING PANEL SYSTEM VALVE, IF INSTALLED) AND ROOM TEMPERATURE IS LESS THAN SETPOINT, MISCELLANEOUS HEATING HOT WATER VALVE MODULATES TO MAINTAIN ROOM TEMPERATURE.

VAV TERMINAL UNIT WITH REHEAT AND PERIMETER HEATING, WITH 5° DEADBAND

Not to Scale





VAV BOX CONTROL SEQUENCE

CONTROL SEQUENCES

CASE 1: NO PERIMETER HEATING
- A. HOT WATER VALVE ENABLED AT ALL TIMES.
- B. HOT WATER VALVE OPENS IF ROOM TEMPERATURE IS LESS THAN LOWER DEADBAND LIMIT.

CASE 2: WITH RADIANT CEILING PANEL SYSTEM
- A. RADIANT PANEL CONTROL VALVE ENABLED BELOW A SPECIFIED OUTSIDE AIR TEMPERATURE.
- B. IF VAV BOX HOT WATER VALVE IS 100% OPEN AND ROOM TEMPERATURE IS LESS THAN SETPOINT, RADIANT CEILING PANEL HOT WATER VALVE MODULATES OPEN TO MAINTAIN ROOM TEMPERATURE SET POINT.

CASE 3: WITH MISCELLANEOUS HEATING
- A. CONTROL VALVE FOR MISCELLANEOUS HEATING SYSTEM ENABLED BELOW A SPECIFIED OUTSIDE AIR TEMPERATURE.
- B. IF VAV BOX HOT WATER VALVE IS 100% OPEN (AND RADIANT CEILING PANEL SYSTEM VALVE, IF INSTALLED) AND ROOM TEMPERATURE IS LESS THAN SETPOINT, MISCELLANEOUS HEATING HOT WATER VALVE MODULATES TO MAINTAIN ROOM TEMPERATURE.

VAV TERMINAL UNIT WITH REHEAT AND PERIMETER HEATING - 0° DEADBAND

Not to Scale

		System Outputs		System Inputs										System Software/Control					
		Binary	Analog	Binary	Analog									Alarm Processing			Application/Function		
System Component	Point ID	Command	Position %	Status	Temperature	Pressure	Humidity	Flow	Current	Totalization	Conductivity	ORP	Percent	Data (Comm Line)	Equipment Status	Low Limit	High Limit	Lead/Lag	Start/Stop	
Supply Fan																				
On/Off									X						X					
Start/Stop		X																	X	
Status Auto				X																
Status Hand				X																
VFD Control Panel														X						
Return Fan																				
On/Off									X						X					
Start/Stop		X																	X	
Status Auto				X																
Status Hand				X																
VFD Control Panel														X						
Relief Fan																				
On/Off									X						X					
Start/Stop		X																	X	
Status Auto				X																
Status Hand				X																
VFD Control Panel														X						
Exhaust Fan																				
On/Off									X						X					
Start/Stop		X																	X	
Status Auto				X																
Status Hand				X																
VFD Control Panel														X						
Glycol Energy Recovery Pump																				
On/Off									X						X					
Start/Stop		X																	X	
Status Auto				X																
Status Hand				X																
Outside Air Temperature					X															
Outside Air Humidity							X													
Mixed Air Temperature					X											X	X			
Heat Recovery Coil Temperature					X											X	X			
Preheat Coil Temperature					X											X	X			
Chilled Water Coil Temperature					X											X	X			
Supply Air Temperature					X											X	X			
Supply Air Humidity							X									X	X			
Space Temperature					X											X	X			
Space Humidity							X									X	X			
Pre-Filter Status				X											X					
Freezestat Status				X											X					
Duct Mounted Smoke Detector Status				X											X					
Static Pressure Sensor						X										X	X			
Return Air Damper Position													X							
Outside Air Damper Position													X							
Mixed Air Damper Position													X							
VAV Box Flow								X												
VAV Box Supply Air Temperature					X											X	X			

AIR HANDLING SYSTEM OVERVIEW

		System Outputs		System Inputs											System Software/Control					
		Binary	Analog	Binary	Analog										Alarm Processing			Application/Function		
System Component	Point ID	Command	Position %	Status	Temperature	Pressure	Level	Flow	Current	Totalization	Conductivity	ORP	pH	Data (Com Line)	Equipment Status	Low Limit	High Limit	Lead/Lag	Start/Stop	
Chilled Water Pump																				
On/Off									X						X					
Start/Stop		X																X	X	
Status Auto				X																
Status Hand				X																
VFD Control Panel Data														X						
Chilled Water Supply Temperature					X											X	X			
Chilled Water Return Temperature					X											X	X			
Chilled Water Supply Flow								X												
Chiller Control Panel																				
Safeties/Failures				X												X	X			
On/Off									X						X					
Start/Stop		X																X	X	
Data														X						
Chilled Water Pump																				
On/Off									X						X					
Start/Stop		X																X	X	
Status Auto				X																
Status Hand				X																
VFD Control Panel Data														X						
Cooling Tower Make Up Flow								X		X										
Cooling Tower Blow Down Flow								X		X										
Cooling Tower Fan																				
On/Off									X						X					
Start/Stop		X																X	X	
Status Auto				X																
Status Hand				X																
VFD Control Panel Data														X						
Condenser Water Supply Temperature					X											X	X			
Condenser Water Return Temperature					X											X	X			
Cooling Tower Fan Vibration				X																
Condenser Water pH													X							
Condenser Water Conductivity											X									
Condenser Water ORP												X								
P&F Economizer																				
Chilled Water Supply Temperature					X											X	X			
Chilled Water Return Temperature					X											X	X			
Chiller kW									X											
Cooling Tower Fan kW									X											
Chilled Water Pump kW									X											
Condenser Water Pump kW									X											

CHILLED WATER SYSTEM OVERVIEW

		System Outputs		System Inputs											System Software/Control					
		Binary	Analog	Binary	Analog										Alarm Processing			Application/Function		
System Component	Point ID	Command	Position/90	Status	Temperature	Pressure	Differential Pressure	Level	Flow	Current	Totalization	Conductivity	ORP	Data (Com Line)	Equipment Status	Low Limit	High Limit	Lead/Lag	Start/Stop	
Hot Water Pump																				
On/Off										X					X		X			
Start/Stop		X																X	X	
Status Auto				X																
Status Hand				X																
VFD Control Panel Data														X						
Hot Water Supply Temperature					X											X	X			
Hot Water Return Temperature					X											X	X			
Hot Water Flow									X											
Boiler Control Panel																				
Safeties/Failures				X											X					
On/Off										X					X					
Start/Stop		X																X	X	
Data														X						

HEATING SYSTEM OVERVIEW

		System Outputs		System Inputs											System Software/Control					
		Binary	Analog	Binary	Analog										Alarm Processing			Application/Function		
System Component	Point ID	Command	Position/90	Status	Temperature	Pressure	Differential Pressure	Level	Flow	Current	Totalization	Conductivity	ORP	Data (Com Line)	Equipment Status	Low Limit	High Limit	Lead/Lag	Start/Stop	
Freezers and Refrigerators																				
Dietetics					X											X	X			
Compressed Air																				
On/Off				X																
Safeties/Failures				X											X					
Pressure				X												X				
Medical Gas																				
On/Off				X																
Safeties/Failures				X											X					
Pressure				X												X				
Vacuum System																				
On/Off				X																
Safeties/Failures				X											X					
Pressure				X													X			
Emergency Generators																				
Control Panel Data														X						
On/Off										X					X					
Domestic Hot Water Supply Temperature					X											X	X			
Domestic Hot Water Return Temperature					X											X	X			
Domestic Hot Water Pump																				
On/Off										X					X					
Start Stop		X																X	X	
Status Auto				X																
Status Hand				X																
Sewage Pumps																				
Elevator Machine Room Temperature					X												X			
Electrical Room Temperature					X												X			

MISCELLANEOUS SYSTEM OVERVIEW

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CHAPTER 6: APPLICATIONS

Table of Contents

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6.1 GENERAL

This chapter includes HVAC design criteria for the air-handling units (AHUs) and the individual rooms. Criteria for individual rooms are included in the **Room Data Sheets (RDS).** The AHUs are classified into two categories: **Dedicated Air-Handling Units** and **Common Air-Handling Units.**

6.2 DEDICATED AIR-HANDLING UNITS

These air-handling units are selected to serve the specific medical functions and/or departments to maintain their functional and operational integrity. The design criteria of each dedicated AHU are given in the **AHU System Data Sheet.** Each dedicated AHU has its own unique system configuration and needs that may or may not match with other dedicated AHUs and functions. For example, an AHU serving the Dining Area and Cafeteria has patently different criteria than the Nursing Wing. Specific examples of unique system configurations are:

- 100% Outdoor Air or Minimum Outdoor Air
- Quality of Filtration (MERV Values) and Locations of After-Filters
- Hours of Operation (24-Hours or Daytime Use only)

The number of dedicated air-handling units shall vary with the size and type of projects. For replacement and/or new hospitals and major renovations, where each medical function defined below is a full-fledged department, the following dedicated air-handling units shall be provided:

- Animal Research and Holding Areas
- Atrium
- Auditoriums and Theaters
- Autopsy Suite
- Dining Area (Cafeteria)
- Emergency Care Unit
- Gymnasium
- Imaging Series
- Kitchen
- Laboratories
- Main Computer Room
- Main Entrance Lobby
- Nursing Wing
- Pharmacy Service
- Spinal Cord Injury/Disorders Center
- Standalone Smoking Facility
- Supply Processing and Distribution (SPD)
- Surgical Suite

Following the description of each air-handling unit, the HVAC data of each unique room served by the dedicated air-handling unit is given in the Room Data Sheets (RDS). The RDS, however, does NOT include **Support Rooms,** generally present in almost all medical departments and functions. A few examples of these support rooms are:

- Conference Rooms
- Corridors
- Housekeeping Aid Closet (HAC)
- Locker Rooms
- Offices
- Toilets

6.3 COMMON (NON-DEDICATED) AIR-HANDLING UNITS

These air-handling units serve multiple functions consisting of patient care (clinics, treatment, and procedure rooms) and non-patient care common rooms (described in section 6.2). **For small projects, such as standalone clinics, where the scope of work is limited involving only a few rooms of a specific medical function, and not a full-fledged department, the common air-handling units can serve such rooms otherwise covered by the dedicated air-handling units in large projects.**

It is important to note that when the rooms of differing requirements are grouped together, the serving common air-handling unit shall be selected to meet the most stringent room requirements as outlined in ASHRAE Standard 170-2008. These requirements are:

- Filtration Requirements (this includes the status of after-filters)
- Indoor Design Conditions (this includes temperature and relative humidity)
- Hours of Operation

6.3.1 COMMON ROOMS

The common rooms are divided into three categories:

6.3.1.1 Patient Examination, Treatment, and Procedure Rooms

In this category all patient care rooms are described. The list includes clinics, treatment, and procedure rooms, including Class A Operating Rooms, Special Procedure Rooms, and Treatment Rooms.

Air handling units serving these rooms shall be provided with pre-filters (MERV 7 and MERV 11) and an after-filter (MERV 14).

6.3.1.2 Non Patient Rooms - Support Areas

Rooms from this category are general in nature, and are found in nearly all departments. These rooms include Conference Rooms, Corridors, HAC, Locker Rooms, Offices and Toilets.

6.3.1.3 Non Patient Rooms - Miscellaneous Areas

Rooms not directly involved with patient care but are an innate part of the building construction and require HVAC. A few examples of these rooms are:

- Attic Space
- Electrical Equipment Rooms
- Engineering Shops
- Exterior Stairs
- Mechanical Equipment Rooms
- Vestibules

6.4 GENERAL NOTES

The general notes described below are applicable to all AHUs and all rooms.

These notes are NOT repeated elsewhere.

In addition, there are specific notes applicable only to the air-handling units and/or rooms under which they are written.

6.4.1 INDOOR DESIGN CONDITIONS

The indoor design conditions used in this design manual are generally based on the ASHRAE Standard 170-2008 and the subsequent amendments “a” through “d”.

6.4.1.1 Common Design Conditions

Indoor Design Temperature

- Range: 70 F [21 C] to 75 F [24 C]
- Tolerance: +/- 1.0 F [+/- 0.6 C]
- Cooling Set Point: 75 F [24 C]
- Heating Set Point: 70 F [21 C]

Indoor Design Relative Humidity

(a) Range

20% RH to 60% RH

(b) Tolerance

+/- 2.5% RH in Humidification Mode

(c) Humidification Set Point

20% RH

Using an exhaust or return air duct-mounted relative humidity sensor, relative humidity shall be controlled at the set point by the steam control valve serving the humidifier.

(d) Dehumidification Design Set Point

55% RH with 60% RH as the maximum limiting set point.

Direct control of relative humidity in dehumidification mode is not required. The relative humidity is indirectly controlled to maintain approximately 55% RH by controlling the cooling coil leaving air temperature. Perform psychrometric analysis using 75 F [24 C] and 55% RH as the indoor design parameters to establish the cooling capacity, mixed air conditions, fan heat gain, and cooling coil leaving air conditions. The 5% difference between the limiting set point (60% RH) and the design set point (55% RH) is the permissible drift. The alarms and the corrective actions shall be initiated when the relative humidity exceeds 60%.

(e) Room Humidity Control

The system does not require individual room humidity control, unless mentioned specifically.

(f) Uncontrolled Humidity Range

The relative humidity is uncontrolled between the humidification and dehumidification modes.

(g) Dead-Band Room Temperature

5 F [3 C] – Adjustable for VAV applications for the qualified spaces described in ASHRAE Standard 170-2008.

6.4.2 AIR BALANCE

6.4.2.1 Definitions

In this Design Manual, volumetric air difference between the supply and return air volumes or supply and exhaust air volumes is characterized as positive air balance, negative air balance, or neutral air balance.

(a) Positive Air Balance

Positive air balance, designated as (+) in the Room Data Sheets, occurs when the supply air volume is 15% more than the return and/or exhaust air volumes. 15% supply air is used to pressurize the space.

(b) Double Positive Air Balance

Double positive air balance, designated as (+ +) in the Room Data Sheets, occurs when the supply air volume is 30% more than the return and/or exhaust air volumes. 30% supply air is used to pressurize the space. This arrangement is used to aid in the isolation of patients from the environment for applications such as Bone Marrow Transplant (BMT) or Orthopedic Patients or the Burn Unit.

(c) Negative Air Balance

Negative air balance, designated as (-) in the Room Data Sheets, occurs when the supply air volume is 15% less than the return and/or exhaust air volumes. 15% make-up air is introduced into the space from adjoining areas. This arrangement involves the introduction of supply air and removal of exhaust and/or return air for applications such as Locker Rooms, Dining Hall etc.

Make-up air to maintain negative air balance shall be admitted by door undercut, door grille, or transfer grille. For noise sensitive areas provide acoustic transfer grille with lined transfer duct.

(d) Double Negative Air Balance

Double negative air balance, designated as (- -) in the Room Data Sheets, occurs when the supply air volume is 30% less than the return and/or exhaust air volumes. 30% make-up air is introduced into the space from the adjoining areas. This arrangement may involve introduction of supply air and removal of exhaust and/or return air or it may involve 100% make-up air without any supply air. Spaces such as, HAC's, Soiled Utility Rooms, Private Toilets are examples of double negative spaces without supply air.

(e) Neutral Air Balance

Neutral air balance, designated as (o) in the Room Data Sheets, occurs when the air supplied to the space equals return and/or exhaust air volumes. Air is not exchanged between adjoining spaces.

6.4.2.2 Design Considerations

(a) Air Distribution

To create the intended air balance the direction of air flow must be established by judicious locations of the supply and return/exhaust air devices.

(b) Automatic Controls

To maintain verifiable air balance with trend logging capabilities, devices such as airflow control valves are required in the exhaust or return air ducts. Where the air balance is required to create verifiable differential air pressure, the complexity of the automatic control system shall be reviewed and upgraded as required.

(c) Building Construction

The creation of differential air pressure mandates that the room envelope is sealed to minimize leakage at the design differential pressure, generally set at 0.01 in [2.5 Pa].

(d) Air Changes

For design purposes, the minimum number of total air changes indicated shall be either supplied for positive (+) pressure rooms or exhausted for negative (-) pressure rooms.

6.4.3 INDIVIDUAL ROOM CONTROL

6.4.3.1 Individual Room Control

Refer to Chapter 2, Room Temperature Controls.

6.4.4 EXHAUST CLASSIFICATION AND DESIGNATION ON ROOM DATA SHEETS

- Exhaust (G) = General Exhaust System.
- Exhaust (S) = Special Exhaust System.

Note: See Room Data Sheets and Chapter 3 for exhaust systems.

AHU SYSTEM DATA SHEETS AND ROOM DATA SHEETS

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ANIMAL RESEARCH AND HOLDING AREAS - AIR HANDLING UNIT	
AHU System Data Sheet	
Air Handling Type	Constant Volume
Indoor Design Temperature	Room Data Sheets
Indoor Design Relative Humidity	Room Data Sheets
Minimum Total Air Changes per Hour	Room Data Sheets
Minimum Outdoor Air Changes per Hour	100%
Return Air Permitted	No
Exhaust Air Required	Yes
Air Economizer Cycle Required	Not Applicable
Heat Recovery System Required	ASHRAE Standard 90.1 - 2007
Filtration - Pre-Filters (PF-1 and PF-2)	PF-1 = MERV 7 and PF-2 = MERV 11
Filtration - After-Filter (AF)	AF = MERV 14
Cooling Source	Chilled Water
Heating Source	Steam and/or Hot Water
Humidification Source	Plant Steam or "Clean Steam"
General Exhaust System Required	Yes
Special Exhaust System Required	Yes
Emergency Power Required	Yes
Individual Room Temperature Control Required	Room Data Sheets
Room Air Balance	Room Data Sheets
Compliance	AAALAC
Note 1 - AAALAC AALAC = American Association for Accreditation of Laboratory Animal Care	
Note 2 - Number of Air-Handling Units **(a)** Provide two separate air-handling units, one to meet the lower indoor design temperature, 65 F [18 C], for the Animal Surgical Suite and Rabbit Holding Area and another unit to serve the Animal Holding Areas and Associated Spaces for which the indoor design temperature ranges from 72 F [22 C] to 77 C [25 C]. **(b)** For smaller facilities with few spaces requiring lower (65 F [18 C]) indoor temperature, dedicated, re-circulatory terminal cooling units can provide supplementary cooling in lieu of a dedicated air-handling unit.	
Note 3 - Special Acoustical Needs Animals are susceptible to low-frequency rambling noise. Implement the recommendations of the acoustic analysis in the HVAC and building design. Address the noise transmitted between the floors and the cage washing equipment and the animal holding areas by using acoustic blankets and/or tiles.	

ANIMAL RESEARCH AND HOLDING AREAS - AIR HANDLING UNIT
AHU System Data Sheet
Note 4 - High-Limit Temperature Controls **(a) Room Air Temperature Control - Animal Holding and Serving Areas** Each room temperature sensor shall be equipped with a high-limit sequence to disable the room air terminal unit when the temperature exceeds the design set point by 10 F [6 C] and initiate a visible local alarm and a remote alarm at the ECC. **(b) Supply Air Temperature Control - Air Handling Units** Each supply air temperature sensor shall be equipped with a high-limit sequence to disable the air-handling unit and initiate a visible alarm at the serving area and a remote alarm at the ECC, if the supply air temperature exceeds the set point by 10 F [6 C].
Note 5 - Relative Humidity Control (Dehumidification Mode) **(a) Operating Control** Relative humidity is not controlled, directly, in the dehumidification mode but is maintained within the range by the control of the cooling coil leaving dew-point temperature. The approximate dew-point temperatures for the Surgical Suite and Rabbit Holding Area is 46 F [8 C] and for the Animal Holding and Associated Areas is 53 F [12 C]. **(b) High-Limit Control** Provide a relative humidity sensor in each animal holding and treatment area to initiate corrective actions and alarms in the event any sensor registers a 5% increase above the set point.
Note 6 - Relative Humidity Control (Humidification Mode) **(a) Operating Control** Relative humidity is directly controlled by an air-handling unit mounted, central humidifier and a relative humidity sensor located in the main exhaust air duct to maintain and control the relative humidity at set point. The humidifier control valve shall close upon airflow interruption. **(b) High-Limit Control** Provide a high-limit sensor located in the main supply air duct to disable the humidifier and initiate alarms if the relative humidity exceeds 80%. In the event of drop or rise in the room relative humidity by 10% (below or above the set point), corrective actions and alarms shall be initiated.
Note 7 - Local Alarms All local alarms shall be visible type, such as, rotating red light, as audible alarms disturb animals and create panic situations. All remote alarms at the ECC shall initiate an audible device and a printed message.
Note 8 - Air Balancing Devices Provide a manual air volume damper in each individual branch duct leaving the animal holding and treatment areas including surgery and laboratories.
Note 9 - Chilled Water If uninterrupted supply of chilled water is not available on demand from the central chilled water plant, provide dedicated air-cooled chillers (N+1) connected to an emergency power supply. The air-cooled machines will facilitate easy start in mild weather. Dedicated chillers may also be required if the central chilled water plant cannot deliver chilled water at the lower temperature required to maintain 65 F [18 C] at 55% RH for the surgery and laboratory areas, etc.

ANIMAL RESEARCH AND HOLDING AREAS - ROOM DATA SHEET													
ROOM NAME	INDOOR TEMPERATURE				INDOOR RELATIVE HUMIDITY		MIN TOTAL ACH	MIN OA ACH	ROOM AIR RETURN EXHAUST (G) EXHAUST (S)	MAX NOISE LEVEL NC	ROOM AIR BALANCE	INDIVIDUAL ROOM CONTROL	
	COOLING		HEATING		% RH	% RH						TEMP	FLOW
	F	C	F	C	MAX	MIN							
General: The room names listed below are from the VA Design Guide - Veterinary Medical Unit Dated 26 February 1993. The actual room layouts, equipment disposition, and the HVAC parameters may vary with the project scope of work.													
Animal Receiving and Examination Room	72	22	72	22	55	45	10	10	Exhaust (G)	35	(-)	Yes	CV
Note 1 - Exhaust Air Pick-Up Collect room exhaust air at approximately 7 in [175 mm] above the floor level through 1 in [25 mm] thick, MERV 6 filter grille.													
Animal Room (Cubical Housing)	72	22	72	22	55	45	15	15	Exhaust (G)	35	(-)	Yes	CV
Note 1 - Exhaust Air Pick-Up Provide exhaust air inlets at base corners and center the ceiling supply outlet in each cubical to ensure uniform air distribution.													
Animal Room (Large Animal Room)	72	22	85	29	55	45	15	15	Exhaust (G)	35	(-)	Yes	CV
Note 1 - Exhaust Air Pick-Up Collect room exhaust air at approximately 7 in [175 mm] above the floor level through 1 in [25 mm] thick, MERV 6 filter grille.													
Animal Room (Small Animal Room)	72	22	85	29	55	45	15	15	Exhaust (G)	35	(-)	Yes	CV
Note 1 - Exhaust Air Pick-Up Collect room exhaust air at approximately 7 in [175 mm] above the floor level through 1 in [25 mm] thick, MERV 6 filter grille.													
Animal Treatment Room	72	22	72	22	55	40	8	8	Exhaust (G)	35	(-)	Yes	CV
Note 1 - Exhaust Air Pick-Up Collect room exhaust air at approximately 7 in [175 mm] above the floor level through 1 in [25 mm] thick, MERV 6 filter grille.													

ANIMAL RESEARCH AND HOLDING AREAS - ROOM DATA SHEET													
ROOM NAME	INDOOR TEMPERATURE				INDOOR RELATIVE HUMIDITY		MIN TOTAL ACH	MIN OA ACH	ROOM AIR RETURN EXHAUST (G) EXHAUST (S)	MAX NOISE LEVEL NC	ROOM AIR BALANCE	INDIVIDUAL ROOM CONTROL	
	COOLING		HEATING		% RH MAX	% RH MIN						TEMP	FLOW
	F	C	F	C									
Cage Wash Room	72	22	72	22	55	40	20	20	Exhaust (S)	40	(-)/(+)	Yes	CV
Note 1 - Wet Exhaust System Provide a dedicated wet exhaust system to serve the Cage Washer Room and Cage Wash Room (with Tunnel Washer Room).													
Cage Wash Room (with Tunnel Washer)	77	25	77	25	55	40	15	15	Exhaust (S)	40	(-)/(+)	Yes	CV
Note 1 - Wet Exhaust System See Cage Wash Room.													
Carcass and Waste Storage	NA	NA	NA	NA	NA	NA	10	NA	Exhaust (G)	40	(- -)	No	CV
Note 1 - Room Exhaust Maintain double negative air balance by drawing all transfer air from the adjoining space.													
Clean Cage Storage Room	77	25	70	21	55	40	6	6	Exhaust (G)	40	(+)	Yes	CV
Note 1 - Room Exhaust Collect exhaust through the hood over the sterilizer.													
Cold Room	36	2.2	36	2.2	NA	NA	NA	NA	Exhaust (G)	40	(-)	Yes	CV
Note 1 - Room Exhaust Draw 50 cfm [24 L/s] exhaust from the cold room. Provide transfer air through ducted ceiling connection. Provide a dedicated refrigeration unit.													
Diagnostic Laboratory	72	22	72	22	55	40	15	15	Exhaust (G)	40	(-)	Yes	CV
Note 1 - Room Exhaust Coordinate exhaust with equipment, such as, fume hoods and/or Biological Safety Cabinets.													

ANIMAL RESEARCH AND HOLDING AREAS - ROOM DATA SHEET

ROOM NAME	INDOOR TEMPERATURE				INDOOR RELATIVE HUMIDITY		MIN TOTAL ACH	MIN OA ACH	ROOM AIR RETURN EXHAUST (G) EXHAUST (S)	MAX NOISE LEVEL NC	ROOM AIR BALANCE	INDIVIDUAL ROOM CONTROL	
	COOLING		HEATING		% RH	% RH						TEMP	FLOW
	F	C	F	C	MAX	MIN							
Diet Kitchen	NA	NA	NA	NA	NA	NA	4	4	Exhaust (G)	45	(--)	No	CV
Note 1 - Room Exhaust Transfer air from the adjoining space for exhaust. Do not provide supply air.													
Dry Feed and Bed Storage	NA	NA	NA	NA	NA	NA	4	4	Exhaust (G)	40	(o)	No	CV
Note 1 - Room Supply Air Provide a ducted, supply air takeoff from an adjoining air terminal unit.													
Environmental Laboratory	72	22	72	22	55	40	4	4	Exhaust (G)	40	(o)	Yes	CV
Note 1 - Room HVAC HVAC is required for the work area only.													
Equipment Storage	NA	NA	NA	NA	NA	NA	4	4	Exhaust (G)	40	(o)	No	CV
Note 1 - Room Supply Air Provide a ducted, supply air takeoff from an adjoining air terminal unit.													
Hazardous Waste Disposal Room	NA	NA	NA	NA	NA	NA	10	10	Exhaust (S)	40	(- -)	No	CV
Note 1 - Exhaust System Provide a dedicated exhaust system. Terminate exhaust at least 10 ft [3 m] above the highest roof level. Discharge exhaust at 3,500 fpm [18 m/s] and/or according to the dispersion analysis recommendations. Evaluate the need for filtration in the exhaust air duct before discharging outdoors. Consult with the end users and local safety officer for exhaust air filtration requirements.													
Incinerator Room	NA	NA	50	10	NA	NA	50	50	Exhaust (S)	45	(-)	Yes	CV
Note 1 - Exhaust System Provide a thermostatically controlled terminal heater. Provide a dedicated exhaust fan with motorized intake and discharge dampers. Coordinate intake (transfer) air volume for exhaust with the combustion air requirement of the incinerator.													
Necropsy	72	22	72	22	55	40	15	15	Exhaust (S)	40	(-)	Yes	CV
Note 1 - Exhaust Coordination Coordinate exhaust over the trimming and necropsy tables.													

ANIMAL RESEARCH AND HOLDING AREAS - ROOM DATA SHEET													
ROOM NAME	INDOOR TEMPERATURE				INDOOR RELATIVE HUMIDITY		MIN TOTAL ACH	MIN OA ACH	ROOM AIR RETURN EXHAUST (G) EXHAUST (S)	MAX NOISE LEVEL NC	ROOM AIR BALANCE	INDIVIDUAL ROOM CONTROL	
	COOLING		HEATING		% RH	% RH						TEMP	FLOW
	F	C	F	C	MAX	MIN							
Procedural Laboratory (Barrier Suite)	72	22	72	22	55	40	15	15	Exhaust (S)	40	(-)	Yes	CV
Note 1 - Fume Hood Exhaust Provide a dedicated exhaust system for the fume hood.													
Procedural Laboratory (Chemical/Radioisotope)	72	22	72	22	55	40	15	15	Exhaust (S)	40	(-)	Yes	CV
Note 1 - Fume Hood Exhaust Provide a dedicated exhaust system for the fume hood.													
Procedural Laboratory (Infectious Disease)	72	22	72	22	55	40	15	15	Exhaust (S)	40	(- -)	Yes	CV
Note 1 - Fume Hood Exhaust Provide a dedicated exhaust system for the fume hood.													
Procedural Laboratory (Standard)	72	22	72	22	55	40	15	15	Exhaust (S)	40	(-)	Yes	CV
Note 1 - Fume Hood Exhaust Provide a dedicated exhaust system for the fume hood.													
Quarantine Room	72	22	72	22	55	45	15	15	Exhaust (G)	35	(-)	Yes	CV
Note 1 - Room Air Distribution Coordinate supply and exhaust air distribution with the Quarantine Room layout. Provide multiple exhaust air grilles over each quarantine area.													

ANIMAL SURGICAL SUITE AND RABBIT HOLDING AREAS - ROOM DATA SHEET

ROOM NAME	INDOOR TEMPERATURE				INDOOR RELATIVE HUMIDITY		MIN TOTAL ACH	MIN OA ACH	ROOM AIR RETURN EXHAUST (G) EXHAUST (S)	MAX NOISE LEVEL NC	ROOM AIR BALANCE	INDIVIDUAL ROOM CONTROL	
	COOLING		HEATING		% RH	% RH						TEMP	FLOW
	F	C	F	C	MAX	MIN							
General: The room names listed below are from the VA Design Guide - Veterinary Medical Unit dated 26 February 1993. The actual room layouts, equipment disposition, and the HVAC parameters may vary with the project scope of work.													
Animal Operating Room (Survival)	65	18	65	18	60	45	15	15	Exhaust (G)	35	(+)	Yes	CV
Note - None													
Animal Operating Room (Terminal)	65	18	65	18	60	45	15	15	Exhaust (G)	35	(+)	Yes	CV
Note - None													
Animal Surgical Preparation Room	65	18	65	18	60	45	4	4	Exhaust (G)	35	(-)	Yes	CV
Note 1 - Room Air Balance While maintaining negative air balance with respect to the adjoining operating rooms, adjust exhaust air volume as required.													
Control Booth	72	22	72	22	60	45	8	8	Exhaust (G)	40	(o)	Yes	CV
Note - None													
Corridors	72	22	72	22	60	45	4	4	Exhaust (G)	40	(+)	Yes	CV
Note 1 - Room Air Balance Adjust supply and exhaust air volumes, as required, to meet the air balance requirements of the adjoining spaces.													
Dark Room	72	22	72	22	60	45	6	6	Exhaust (G)	40	(-)	Yes	CV
Note 1 - Exhaust Duct Provide acid-resistant exhaust duct if chemicals are used for film processing. **Note 2 - Plumbing** Evaluate the use of silver recovery plumbing, if required.													

ANIMAL SURGICAL SUITE AND RABBIT HOLDING AREAS - ROOM DATA SHEET													
ROOM NAME	INDOOR TEMPERATURE				INDOOR RELATIVE HUMIDITY		MIN TOTAL ACH	MIN OA ACH	ROOM AIR RETURN EXHAUST (G) EXHAUST (S)	MAX NOISE LEVEL NC	ROOM AIR BALANCE	INDIVIDUAL ROOM CONTROL	
	COOLING		HEATING		% RH	% RH						TEMP	FLOW
	F	C	F	C	MAX	MIN							
Holding Area - Rabbits	65	18	65	18	60	45	15	15	Exhaust (G)	35	(-)	Yes	CV
Note 1 - Exhaust Air Pick-Up Collect room exhaust air at approximately 7 in [175 mm] above the floor level through 1 in [25 mm] thick, MERV 6 filter grille.													
Post Operative Intensive Care	65	18	80	27	60	45	10	10	Exhaust (G)	40	(+ +)	Yes	CV
Note 1 - Room Temperature Adjustment Size the reheat coil to maintain higher space temperature on demand.													
Radiographic Room	72	22	72	22	60	45	8	8	Exhaust (G)	40	(-)	Yes	CV
Note - None													
Scrub and Gown	72	22	72	22	60	45	4	4	Exhaust (G)	35	(+)	Yes	CV
Note - None													
Surgical Work and Supply	72	22	72	22	60	45	4	4	Exhaust (G)	35	(o)	Yes	CV
Note 1 - Room Exhaust Draw exhaust air over the sterilizer hood. Adjust supply air volume to meet the exhaust needs.													

ATRIUM - AIR HANDLING UNIT	
AHU System Data Sheet	
Air Handling Type	Constant or Variable Air Volume
Indoor Design Temperature - Cooling	75 F [24 C]
Indoor Design Temperature - Heating	70 F [21 C]
Indoor Design Relative Humidity - Dehumidification	60%
Indoor Design Relative Humidity - Humidification	20%
Minimum Total Air Changes Per Hour	4
Minimum Outdoor Air Changes Per Hour	2
Return Air Permitted	Yes (Normal Mode)
Exhaust Air Required	Yes (Smoke Evacuation Mode)
Air Economizer Cycle Required	Yes
Heat Recovery System Required	ASHRAE Standard 90.1 - 2007
Filtration - Pre-Filters (PF-1 and PF-2)	PF-1 = MERV 7 and PF-2 = MERV 11
Cooling Source	Chilled Water
Heating Source	Steam and/or Hot Water
Humidification Source	Plant or "Clean" Steam
General Exhaust System Required	No
Special Exhaust System Required	Yes (Smoke Evacuation Mode)
Emergency Power Required	Yes (Smoke Evacuation System)
Individual Room Temperature Control Required	Yes
Room Air Balance	Positive (+) (Normal Mode) Negative (-) (Smoke Evacuation)

Note 1 - HVAC System

Based on Atrium configuration and air distribution arrangement, evaluate using a variable air volume HVAC system in lieu of a constant volume system.

Note 2 - Smoke Evacuation System

Design the smoke evacuation system per NFPA 101 and its associated documents. VA has opted to follow NFPA 101 with the understanding that the provisions of NFPA 101 may be at variance with the IBC. The design calculations shall be performed by a fire protection professional engineer and reviewed by an independent fire protection professional engineer. The VA fire protection engineer may serve as the independent reviewer.

Note 3 - Design Details

(a) Upon activation of the smoke evacuation system, the Atrium AHU shall operate in 100% outdoor air mode. Provide an additional make-up air system if the required smoke removal volume is greater than the Atrium AHU supply air volume. The make-up air system shall be complete with fan, MERV 7 filter, and a heating coil.

(b) Size the heating capacity to maintain 50 F [10 C] minimum space temperature in the smoke evacuation mode. For 32 F [0 C] and lower ambient temperatures, design the heating system with freeze protection measures.

AUDITORIUMS AND THEATERS - AIR HANDLING UNIT	
AHU System Data Sheet	
Air Handling Type	Constant or Variable Air Volume
Indoor Design Temperature - Cooling	75 F [24 C]
Indoor Design Temperature - Heating	70 F [21 C]
Indoor Design Relative Humidity - Dehumidification	60%
Indoor Design Relative Humidity - Humidification	Optional
Minimum Total Air Changes Per Hour	4
Minimum Outdoor Air Changes Per Hour	Chapter 2
Return Air Permitted	Yes
Exhaust Air Required	No
Air Economizer Cycle Required	Yes
Heat Recovery System Required	ASHRAE Standard 90.1 - 2007
Filtration - Pre-Filters (PF-1 and PF-2)	PF-1 = MERV 7 and PF-2 = MERV 11
Cooling Source	Chilled Water
Heating Source	Steam and/or Hot Water
Humidification Source	Plant or "Clean" Steam
General Exhaust System Required	Yes
Special Exhaust System Required	No
Emergency Power Required	No
Individual Room Temperature Control Required	Yes
Room Air Balance	Positive (+)
Note 1 - HVAC System Based on Auditorium and Theater air distribution arrangement and extent of conditioned air volume, evaluate using a variable air volume HVAC system in lieu of a constant volume system.	
Note 2 - Demand Control Ventilation Incorporate demand-controlled ventilation sequence, if feasible, to control outdoor air based on carbon-dioxide concentration.	
Note 3 - High-Humidity Control Incorporate high-humidity limiting control sequence to monitor and control the space relative humidity to 60% maximum. See Chapter 5 for project-specific suggested sequences.	
Note 4 - General Exhaust System Exhaust the spaces associated with the Auditorium and Theater either by a dedicated or a common exhaust system (examples: toilets, HAC, etc.).	

AUTOPSY SUITE - AIR HANDLING UNIT	
AHU System Data Sheet	
Air Handling Type	Constant Volume
Indoor Design Temperature	Room Data Sheets
Indoor Design Relative Humidity	Room Data Sheets
Minimum Total Air Changes Per Hour	Room Data Sheets
Minimum Outdoor Air Changes Per Hour	100%
Return Air Permitted	No
Exhaust Air Required	Yes
Air Economizer Cycle Required	Not Applicable
Heat Recovery System Required	ASHRAE Standard 90.1 - 2007
Filtration - Pre-Filters (PF-1 and PF-2)	PF-1 = MERV 7 and PF-2 = MERV 13
Cooling Source	Chilled Water
Heating Source	Steam and/or Hot Water
Humidification Source	Plant or "Clean" Steam
General Exhaust System Required	Yes
Special Exhaust System Required	Yes
Emergency Power Required	Yes (Exhaust System Only)
Individual Room Temperature Control Required	Room Data Sheets
Room Air Balance	Room Data Sheets

Note 1 - Dedicated Air-Handling Unit

A dedicated air-handling unit for the Autopsy Suite is NOT required if an air-handling unit in the vicinity can meet the requirements of the hours of operation and filtration. When served by such a common air-handling unit, the supply air need not be 100% outdoor air.

Note 2 - Dedicated General Exhaust System

(a) Exhaust System and Discharge Requirement

Provide a dedicated exhaust system to serve the Autopsy Suite. Locate the exhaust fan on the roof with the fan discharging above the highest point of the building. Provide a stack of sufficient height (minimum 10 ft [3 m]) to discharge air at 3,500 fpm [18 m/s]. Follow the recommendations of the dispersion analysis to ensure that exhaust air does not enter outside air intakes, operable windows and other openings. Mount the fan bearings outside the airstream and monitor the fan status at the ECC.

(b) Exhaust Ductwork

Maintain exhaust ductwork under negative pressure. Provide an airflow control valve to ensure accurate exhaust air volumetric flow. Provide an alarm locally and at the ECC to report air flow disruption.

Note 3 - Special Exhaust System

Provide a special exhaust system(s) to serve fume hoods and/or biological safety cabinets included in the project-scope.

AUTOPSY SUITE - ROOM DATA SHEET

ROOM NAME	INDOOR TEMPERATURE				INDOOR RELATIVE HUMIDITY		MIN TOTAL ACH	MIN OA ACH	ROOM AIR RETURN EXHAUST (G) EXHAUST (S)	MAX NOISE LEVEL NC	ROOM AIR BALANCE	INDIVIDUAL ROOM CONTROL	
	COOLING		HEATING		% RH	% RH						TEMP	FLOW
	F	C	F	C	MAX	MIN							
Autopsy Room	75	24	68	20	60	20	12	2	Exhaust (S)	35	(-)	Yes	CV
Note 1 - Air Distribution Locate exhaust air intakes at the ceiling and floor level. Locate the floor level inlets approximately 7 in [175 mm] above the floor. **Note 2 - Canopy Hood** A canopy hood may be required over the dissecting tables to capture exhaust at the maximum rate of 100 fpm [0.5 m/s] through the hood face area. Coordinate the exhaust air volume and exhaust location with the manufacturer of the dissecting tables. **Note 3 - Room Noise Level** Noise level lower than NC 35 may be required where audio/video recording is performed. **Note 4 - Occupied and Unoccupied Modes** Evaluate the feasibility of providing occupied/unoccupied modes based on anticipated usage of these spaces.													
Gross Specimen Storage Room	75	24	68	20	60	20	6	**2**	Exhaust (S)	40	(-)	Yes	CV
Note 1 - Air Distribution Coordinate location of the exhaust air inlet over the sink and counter area to capture the exhaust air fumes.													
Non-Refrigerated Body-Holding Room	75	24	68	20	60	20	10	2	Exhaust (S)	40	(-)	Yes	CV
Note 1 - General This room is provided in facilities where autopsies are not performed. This is a temporary holding area.													

DINING AREA (CAFETERIA) - AIR HANDLING UNIT	
AHU System Data Sheet	
Air Handling Type	Variable Air Volume
Indoor Design Temperature - Cooling	75 F [24 C]
Indoor Design Temperature - Heating	70 F [21 C]
Indoor Design Relative Humidity - Dehumidification	60%
Indoor Design Relative Humidity - Humidification	Optional
Minimum Total Air Changes Per Hour	6
Minimum Outdoor Air Changes per Hour	Chapter 2
Return Air Permitted	Yes
Exhaust Air Required	Yes
Air Economizer Cycle Required	Yes
Heat Recovery System Required	ASHRAE Standard 90.1 - 2007
Filtration - Pre-Filters (PF-1 and PF-2)	PF-1 = MERV 7 and PF-2 = MERV 11
Cooling Source	Chilled Water
Heating Source	Steam and/or Hot Water
Humidification Source	Plant Steam or "Clean Steam"
General Exhaust System Required	Yes
Special Exhaust System Required	Yes
Emergency Power Required	No
Individual Room Temperature Control Required	Yes
Room Air Balance	Negative (-)
Note 1 - Kitchen Make-Up Air Estimate the make-up air requirement for the adjoining kitchen (if any) and transfer room air to the kitchen. Maintain the dining or cafeteria under positive air balance with respect to the kitchen.	
Note 2 - Exhaust System Provide a general or special exhaust system (NFPA 96) when the Dining Area (Cafeteria) is a standalone facility using a canopy and/or a range hood. Coordinate the exhaust air requirement with the kitchen consultant, drawings, and equipment catalogue cuts.	
Note 3 - Air Balance Maintain the Dining Area (Cafeteria) under negative air balance with respect to the adjoining spaces.	

EMERGENCY CARE UNIT - AIR HANDLING UNIT	
AHU System Data Sheet	
Air Handling Type	Variable Air Volume
Indoor Design Temperature	Room Data Sheets
Indoor Design Relative Humidity	Room Data Sheets
Minimum Total Air Changes Per Hour	Room Data Sheets
Minimum Outdoor Air Changes Per Hour	Chapter 2
Return Air Permitted	Yes (Normal Mode)
Exhaust Air Required	Yes (Emergency Mode)
Air Economizer Cycle Required	Yes
Heat Recovery System Required	ASHRAE Standard 90.1 - 2007
Filtration - Pre-Filters (PF-1 and PF-2)	PF-1 = MERV 7 and PF-2 = MERV 11
Filtration - After-Filter (AF)	AF = MERV 14
Cooling Source	Chilled Water
Heating Source	Steam and/or Hot Water
Humidification Source	Plant Steam or "Clean Steam"
General Exhaust System Required	Yes
Special Exhaust System Required	Yes (Emergency Mode)
Emergency Power Required	Yes
Individual Room Temperature Control Required	Room Data Sheets
Room Air Balance	Room Data Sheets
Note 1 - Emergency Mode Design the AHU system to operate in 100% outdoor air mode during a medical emergency created by an epidemic of contagious diseases. The 100% outdoor air mode shall be activated manually. Size the utilities (chilled water, hot water, and steam) and controls to be compatible with the normal and emergency modes.	
Note 2 - General Exhaust System Exhaust the spaces associated with the Emergency Care Unit either by a dedicated or a common exhaust system (examples: toilets, locker rooms, HAC, etc.).	
Note 3 - Special Exhaust System Provide a special exhaust system for activation during the medical emergency mode. Alternately, the return air system can operate as a special exhaust system.	

EMERGENCY CARE UNIT - ROOM DATA SHEET

ROOM NAME	INDOOR TEMPERATURE				INDOOR RELATIVE HUMIDITY		MIN TOTAL ACH	MIN OA ACH	ROOM AIR RETURN EXHAUST (G) EXHAUST (S)	MAX NOISE LEVEL NC	ROOM AIR BALANCE	INDIVIDUAL ROOM CONTROL	
	COOLING		HEATING		% RH	% RH						TEMP	FLOW
	F	C	F	C	MAX	MIN							
Emergency Waiting Room	75	24	70	21	60	20	12	2	Exhaust (G)	40	(-)	Yes	CV
Note 1 - Room Air Distribution Design the air distribution system to draw room air over the waiting and admitting patients. Provide transfer air to maintain the waiting area under negative air balance. Provide a stack of sufficient height (minimum 10 ft [3 m]) to discharge air at 3,500 fpm [18 m/s]. Follow the recommendations of the dispersion analysis to ensure that exhaust air does not enter outside air intakes, operable windows and other openings.													
Examination Room	75	24	70	21	60	20	6	2	Return	40	(-)	Yes	VAV
Note 1 - Room Air Distribution Coordinate with the end-users to designate a few selected rooms for examination of patients with infectious diseases. Design the air distribution system to maintain negative air balance and exhaust all air outdoors.													
Life Support Unit	75	24	70	21	60	20	6	2	Return	35	(o)	Yes	VAV
Note - None													
Nurses Station	NA	NA	NA	NA	NA	NA	6	NA	Return	40	(o)	No	VAV
Note - None													
Observation/Treatment	75	24	70	21	60	20	6	2	Return	40	(-)	Yes	VAV
Note 1 - Room Air Distribution Coordinate with the end-users to designate a few selected rooms for observation and treatment of patients with infectious diseases. Design the air distribution system to maintain negative air balance and exhaust all air outdoors.													

GYMNASIUM - AIR HANDLING UNIT	
AHU System Data Sheet	
Air Handling Type	Constant Volume
Indoor Design Temperature - Cooling	75 F [24 C]
Indoor Design Temperature - Heating	70 F [21 C]
Indoor Design Relative Humidity - Dehumidification	60%
Indoor Design Relative Humidity - Humidification	Optional
Minimum Total Air Changes Per Hour	6
Minimum Outdoor Air Changes Per Hour	Chapter 2
Return Air Permitted	Yes
Exhaust Air Required	No
Air Economizer Cycle Required	Yes
Heat Recovery System Required	ASHRAE Standard 90.1 - 2008
Filtration - Pre-Filters (PF-1 and PF-2)	PF-1 = MERV 7 and PF-2 = MERV 11
Cooling Source	Chilled Water or DX
Heating Source	Steam and/or Hot Water
Humidification Source	Plant or "Clean" Steam
General Exhaust System Required	Yes
Special Exhaust System Required	No
Emergency Power Required	No
Individual Room Temperature Control Required	Yes
Room Air Balance	Neutral (o)
Note 1 - Demand-Controlled Ventilation Incorporate demand-controlled ventilation sequence, if feasible, to control outdoor air based on carbon-dioxide concentration.	
Note 2 - General Exhaust System Provide a general exhaust system to serve adjoining support spaces (examples: toilets, locker rooms, HAC, etc.).	

IMAGING SERIES - AIR HANDLING UNIT	
AHU System Data Sheet	
Air Handling Type	Variable Air Volume
Indoor Design Temperature	Room Data Sheets
Indoor Design Relative Humidity	Room Data Sheets
Minimum Total Air Changes Per Hour	Room Data Sheets
Minimum Outdoor Air Changes Per Hour	Room Data Sheets
Return Air Permitted	Room Data Sheets
Exhaust Air Required	Room Data Sheets
Air Economizer Cycle Required	Yes
Heat Recovery System Required	ASHRAE Standard 90.1 - 2007
Filtration - Pre-Filters (PF-1 and PF-2)	PF-1 = MERV 7 and PF-2 = MERV 11
Filtration - After-Filter (AF)	AF = MERV 14
Cooling Source	Chilled Water
Heating Source	Steam and/or Hot Water
Humidification Source	Plant Steam or "Clean Steam"
General Exhaust System Required	Yes
Special Exhaust System Required	Yes
Emergency Power Required	MRI Unit Emergency Exhaust Fan Associated Controls
Individual Room Temperature Control Required	Room Data Sheets
Room Air Balance	Room Data Sheets

Note 1 - MRI (Magnetic Resonance Imaging) Unit

(a) Reference Document

MRI Design Guide published by the VA Office of Construction and Facilities Management: This Publication contains valuable information about the space layout , equipment list, exhaust system and utility requirements. A design guide plate for each room shows tentative room dimensions and equipment layout.

(b) Coordination

Capacity and configuration of the MRI Unit varies by manufacturer. Coordination with the project specific MRI vendor is mandatory. Coordinate vibration isolation requirement of AHU(s) sited in proximity to the MRI scanner.

(c) RF Shielding

For HVAC ducts and pipes penetrating RF shielding of the MRI Scanning Room, coordinate penetration requirements with MRI system manufacturer, RF shield vendor, and architectural discipline.

IMAGING SERIES - AIR HANDLING UNIT
AHU System Data Sheet
Note 2 - Radiology Service **(a) Reference Document** Radiology Service Design Guide published by the VA Office of Construction and Facility Management: This publication contains valuable information about the space layout, equipment list, and utilities requirements. A design guide plate for each room shows tentative room dimensions and the equipment layout. **(b) Shielded Walls and Ceilings** For HVAC ducts and pipes penetrating shielded walls and ceilings, ensure coordination with the architectural discipline and provide treatment as specified by the equipment manufacturer and medical physicist.
Note 3 - Nuclear Medicine **(a) Reference Document** Nuclear Medicine Design Guide published by the VA Office of Construction and Facilities Management: This publication contains valuable information about the space layout, equipment list, and utilities requirements. A design guide plate for each room shows tentative room dimensions and the equipment layout. **(b) Exhaust Systems** Provide a special exhaust system(s) for fume hoods and biological safety cabinets. Coordinate hood locations and sizes with the architectural discipline. For radioisotope hoods, coordinate the need for HEPA filters or Carbon Filters or both or no filters with the VA Safety Officer. **(c) Shielded Walls and Ceilings** For HVAC ducts and pipes penetrating shielded walls and ceilings, ensure coordination with the architectural discipline and provide treatment as specified by the equipment manufacturer and medical physicist.
NOTE 4 - Radiation Therapy Service **(a) Reference Document** Radiation Therapy Service Design Guide published by the VA Office of Construction and Facilities Management: This publication contains valuable information about the space layout, equipment list, and utilities requirements. A design guide plate for each room shows tentative room dimensions and the equipment layout. **(b) Shielded Walls and Ceilings** For HVAC ducts and pipes penetrating shielded walls and ceilings, ensure coordination with the architectural discipline and provide treatment as specified by the equipment manufacturer and medical physicist.
NOTE 5 - Indoor Design Conditions Indoor design conditions may vary from Room Data Sheets to meet the requirements of the selected equipment.
NOTE 6 - Design Documents The Room Data Sheets indicate generic requirements of various equipment in the Imagining Series. If the details of the selected equipment are not known when design documents are issued, provide a design based on information in the Room Data Sheets and based on an agreed vendor. The purpose is to provide a reasonable level of documentation for construction pricing and bidding.

IMAGING SERIES (MRI UNIT) - ROOM DATA SHEET

ROOM NAME	INDOOR TEMPERATURE				INDOOR RELATIVE HUMIDITY		MIN TOTAL ACH	MIN OA ACH	ROOM AIR RETURN EXHAUST (G) EXHAUST (S)	MAX NOISE LEVEL NC	ROOM AIR BALANCE	INDIVIDUAL ROOM CONTROL	
	COOLING		HEATING		% RH	% RH						TEMP	FLOW
	F	C	F	C	MAX	MIN							
MRI Control Room	75	24	70	21	50	40	6	2	Return Exhaust (G)	40	(+)	Yes	VAV
Note - None													
MRI Scanning Room	68	20	70	21	50	40	12	2	Return Exhaust (S)	35	(+)	Yes	VAV

Note 1- MRI Scanning Room Temperature

MRI scanners' image quality can be degraded by environmental conditions outside of the equipment manufacturer's specifications. MRI Scanning Room temperature shall be maintained between 68 F - 70 F [20 C - 21 C] under both heating and cooling conditions.

Note 2 - Emergency Exhaust Fan

(a) Provide a special automatic/manual emergency exhaust system to exhaust the scanning room in the event cryogen spills in the room. Provide directly ducted connection between the exhaust air inlet and the fan, as shown in the sketch in the MRI Design Guide.

(b) Automatic operation of the exhaust system shall be interlocked to the MRI equipment vendor automatic alarm system (if provided) by an electric relay. Provide two manual switches (one located in the scanning room and the other in the control room) under the custody of the designated operating personnel.

(c) Exhaust fan can discharge from the walls or roof if there are no operable windows or outside air intakes, or if regular or scheduled human traffic is not within a 25 ft [7.6 m] radius. Provide a motorized damper in the return air duct to stop return air pick up.

(d) Provide a laser optical oxygen sensor, located 18 in [450 mm] below the suspended architectural ceiling, to sound an audible and visible local alarm and an alarm at the ECC in the event the oxygen level drops. Alternatively, if saturatable sensor oxygen monitor systems are used, these shall be located outside the MRI Scanning Room with a sampling tube entering the MRI Scanning Room at 18 in [450 mm] below the suspended architectural ceiling. Coordinate any and all penetrations of the required RF shield assembly with the RF shield vendor. Alarm shall automatically activate the emergency exhaust fan operation sequence.

Note 3 - Cryogen (Quench) Vent Pipe

(a) Provide a vent pipe (size, location, and material to be coordinated with the MRI equipment supplier) from the RF shield to outdoors.

(b) Divide the scope of work such that the MRI vendor is responsible for the supply and installation of the vent pipe, including RF Shield fitting, from the magnet to the RF Shield Barrier.

(c) Helium gas vent can discharge horizontally, through exterior walls, or vertically, though the roof. For both discharge conditions, there shall be no operable windows or outside air intakes, and no regular or scheduled human traffic within 25 ft [7.6 m] radius in all directions. Terminate the vent pipe with a turndown weather head. Horizontal chamfered terminations are not permitted. Termination shall be protected from horizontal wind driven rain entry. Insulate the quench piping from the MRI connection to termination. Insulation shall be calcium silicate type.

(d) Provide two manual quench activation switches (one located in the control room and the other in the scanning room).

IMAGING SERIES (MRI UNIT) - ROOM DATA SHEET														
ROOM NAME	INDOOR TEMPERATURE				INDOOR RELATIVE HUMIDITY		MIN TOTAL ACH	MIN OA ACH	ROOM AIR	MAX NOISE LEVEL NC	ROOM AIR BALANCE	INDIVIDUAL ROOM CONTROL	
	COOLING		HEATING		% RH	% RH			RETURN EXHAUST (G) EXHAUST (S)			TEMP	FLOW
	F	C	F	C	MAX	MIN							

Note 4 - Overpressure Relief

(a) Hatch in RF Shield Enclosure: MRI equipment vendor shall be responsible for the supply, installation, and testing of the pressure relief hatch (gravity-operated). The hatch shall be similar to a back draft damper. Upon sensing a difference in pressure between the occupied space and the void between the suspended ceiling and the RF Shield enclosure, the hatch shall open to permit the cryogen gas to escape into the void between the RF Shield and the floor or roof above.

(b) Hatch in the Roof or Wall: Install an "explosion" hatch in the roof or wall, whichever is the closest, to relieve gas under pressure to the outdoors. The explosion hatch is pressure-actuated and can be connected to the quench alarm system. Coordinate the location, size and design or the hatch with the MRI equipment vendor. Provide snow/ice melt systems in hatch cover as indicated by position and local climate.

Note 5 - Optional MRI Equipment Circulating Fan (Room Air Distribution)

(a) At the MRI vendor's option, room air can be circulated through the MRI equipment by a dedicated circulating fan and returned back to the system by an indirect (thimble) connection. Coordinate the division in the scope of work between the MRI vendor and the general contractor.

(b) Arrange room air distribution to allow the conditioned air to flow over/through the MRI scanner with return and/or exhaust inlets located at the rear of the equipment back to facilitate MRI equipment cooling.

Note 6 - Ductwork and Devices

(a) It is strongly recommended that all active devices (VAVs, fan coil units, dampers, humidifiers, sensors or detectors) be located outside the MRI Scanning Room.

(b) Ductwork, hangers, fasteners and appurtenances used within the MRI Scanning Room plenum should be of non-magnetic materials and construction (e.g. aluminum).

(c) MRI manufacturer may recommend supply and return duct penetrations both enter the MRI Scanning Room from the MRI System Component Room. Coordinate locations/routes.

(d) All piping and ductwork penetrations of MRI Scanning Room RF shield must be carefully coordinated with MRI manufacturer's and RF shield vendor's siting requirements.

IMAGING SERIES (MRI UNIT) - ROOM DATA SHEET

ROOM NAME	INDOOR TEMPERATURE				INDOOR RELATIVE HUMIDITY		MIN TOTAL ACH	MIN OA ACH	ROOM AIR RETURN EXHAUST (G) EXHAUST (S)	MAX NOISE LEVEL NC	ROOM AIR BALANCE	INDIVIDUAL ROOM CONTROL	
	COOLING		HEATING		% RH	% RH						TEMP	FLOW
	F	C	F	C	MAX	MIN							
MRI Systems Component Room	70	21	70	21	60	40	6	2	Return	40	(+)	Yes	CV
Note 1 - HVAC System **(a)** Provided a dedicated air conditioning unit to serve the System Component Room. Coordinate size and configuration with the equipment manufacturer. Coordinate air distribution with the raised floor. Provide water sensor alarm (local and at the ECC) in the event of water leakage below the raised floor. **(b)** Provide a closed loop, dedicated, water chiller to cool the MRI equipment. Chiller shall be air cooled and remotely located. Provide cross connections with the central chilled water plant. Additional considerations are: Ensure that the water quality (pH value, hardness, and solid suspended contents) are in accordance with the equipment manufacturer's specifications. All piping from the System Component Room entering the MRI Scanning Room shall meet "Radio Frequency Requirements." Provide clearly marked and identified access for the piping located in walls and chases. Coordinate chilled water flow requirement, chilled water temperature, and division in scope of work (connection detail) at each chilled water connection.												
MRI Visiting Area	75	24	70	21	50	40	12	2	Exhaust (G)	40	(-)	Yes	CV
Note 1 - Air Balance Provide exhaust through the general exhaust system.													

IMAGING SERIES (NUCLEAR MEDICINE SERVICES) - ROOM DATA SHEET

ROOM NAME	INDOOR TEMPERATURE				INDOOR RELATIVE HUMIDITY		MIN TOTAL ACH	MIN OA ACH	ROOM AIR RETURN EXHAUST (G) EXHAUST (S)	MAX NOISE LEVEL NC	ROOM AIR BALANCE	INDIVIDUAL ROOM CONTROL	
	COOLING		HEATING		% RH	% RH						TEMP	FLOW
	F	C	F	C	MAX	MIN							
Bone Densitometry Room	70	21	70	21	50	20	6	2	Return	35	(o)	Yes	CV
Note - None													
Nuclear Medicine Scanning Room (Patient Examination Room)	75	24	70	21	50	20	10	2	Exhaust (G)	35	(-)	Yes	CV
Note 1 - Air Balance Provide volumetric controls to demonstrate negative air balance. **Note 2 - Air Distribution** Locate supply and exhaust air outlets to create a directional airflow and transfer air from the adjoining area. Locate 50% of exhaust air outlets at ceiling level and 50% of exhaust air outlets at 7 in [175 mm] above finished floor. **Note 3 - Xenon Gas** If xenon gas is used in this room, coordinate with the local radiation safety officer for any additional measures.													
Nuclear Pharmacy Laboratory (Hot Laboratory) Storage and Preparation Area	75	24	70	21	60	20	6	2	Exhaust (G)	35	(-)	Yes	CV
Note 1 - Fume Hoods This room is also known as the Radiopharmacy Room. Coordinate quantity and type of fume hoods and/or biological safety cabinets and provide an appropriate, dedicated exhaust system(s) to serve the hoods. See Chapter 3. If radioactive xenon gas and/or radioactive iodine are used in this space, coordinate with the local radiation safety officer for additional measures necessary, if any. Provide a supplementary general exhaust system, if required per the room air balance. **Note 2 - Air Balance** Provide volumetric controls to demonstrate negative air balance. **Note 3 - Air Distribution** Locate supply and exhaust air outlets to create a directional airflow and transfer air from the adjoining area.													
Patient Dose Administration	75	24	70	21	50	20	6	2	Exhaust (G)	35	(-)	Yes	CV
Note 1 - Air Balance Provide volumetric controls to demonstrate negative air balance. **Note 2 - Air Distribution** Locate supply and exhaust air outlets to create a directional airflow and transfer air from the adjoining area.													

IMAGING SERIES (NUCLEAR MEDICINE SERVICES) - ROOM DATA SHEET

ROOM NAME	INDOOR TEMPERATURE				INDOOR RELATIVE HUMIDITY		MIN TOTAL ACH	MIN OA ACH	ROOM AIR RETURN EXHAUST (G) EXHAUST (S)	MAX NOISE LEVEL NC	ROOM AIR BALANCE	INDIVIDUAL ROOM CONTROL	
	COOLING		HEATING		% RH	% RH						TEMP	FLOW
	F	C	F	C	MAX	MIN							
PET/CT Control	70	21	70	21	55	40	6	2	Exhaust (G)	35	(+)	Yes	VAV
Note - None													
PET/CT Scanning Room	70	21	70	21	55	40	12	2	Exhaust (G)	35	(-)	Yes	VAV
Note 1 - Air Balance Provide volumetric controls to demonstrate negative air balance. **Note 2 - Air Distribution** Locate supply and exhaust air outlets to create a directional airflow and atransfer air from the adjoining area. Locate 50% of exhaust air outlets at ceiling level and 50% of exhaust air outlets at 7 in [175 mm] above finished floor.													
PET/CT System Component Room	70	21	70	21	50	40	6	2	Exhaust (G)	40	(+)	Yes	VAV
Note 1 - HVAC System Provide a dedicated air conditioning unit to serve the System Component Room. Coordinate size and configuration with the equipment manufacturer. Coordinate air distribution with the raised floor. Provide water sensor alarm (local and at the ECC) in the event of water leakage below the raised floor.													

IMAGING SERIES (RADIATION THERAPY SERVICES) - ROOM DATA SHEET													
ROOM NAME	INDOOR TEMPERATURE				INDOOR RELATIVE HUMIDITY		MIN TOTAL ACH	MIN OA ACH	ROOM AIR RETURN EXHAUST (G) EXHAUST (S)	MAX NOISE LEVEL NC	ROOM AIR BALANCE	INDIVIDUAL ROOM CONTROL	
	COOLING		HEATING		% RH MAX	% RH MIN						TEMP	FLOW
	F	C	F	C									
CT Simulator Control Area	75	24	70	21	60	20	6	2	Return	35	(+)	Yes	CV
Note - None													
CT Simulator Unit Room	75	24	70	21	60	20	12	2	Return	35	(+)	Yes	CV
Note - None													
Linear Accelerator Room/ Control Area	75	24	70	21	60	20	8	2	Return	35	(o)/(+)	Yes	CV
Note - None													
Treatment Planning Computer Room - Dosimetry Room	75	24	70	21	60	20	6	2	Return	35	(+)	Yes	CV
Note - None													
Ultrasound Planning Unit Room	75	24	70	21	60	20	6	2	Return	35	(+)	Yes	CV
Note 1 - Air Balance Maintain negative room air balance in adjoining toilet.													

IMAGING SERIES (RADIOLOGY SERVICES) - ROOM DATA SHEET													
ROOM NAME	INDOOR TEMPERATURE				INDOOR RELATIVE HUMIDITY		MIN TOTAL ACH	MIN OA ACH	ROOM AIR RETURN EXHAUST (G) EXHAUST (S)	MAX NOISE LEVEL NC	ROOM AIR BALANCE	INDIVIDUAL ROOM CONTROL	
	COOLING		HEATING		% RH MAX	% RH MIN						TEMP	FLOW
	F	C	F	C									
CT Area - Control Room	75	24	70	21	60	20	12	2	Return	35	(+)	Yes	CV
Note - None													
CT Area - Scanning Room	75	24	70	21	60	20	12	2	Return	35	(+)	Yes	CV
Note - None													
IR Area - Special Procedure (SP) Control Room	75	24	70	21	60	20	15	2	Return	35	(+)	Yes	CV
Note - None													
IR Area - SP Room	75	24	70	21	60	20	15	2	Return	35	(+)	Yes	CV
Note - None													
IR Area - SP System Component Room	70	21	70	21	60	20	15	2	Return	35	(+)	Yes	CV
Note - None													
Patient Area - Chest Room	75	24	70	21	60	20	6	2	Return	35	(+)	Yes	CV
Note - None													
Patient Area - General Purpose Radiology Room	75	24	70	21	60	20	6	2	Return	35	(+)	Yes	CV
Note - None													
Patient Area - Mammography Room	75	24	70	21	60	20	6	2	Return	35	(+)	Yes	CV
Note - None													

IMAGING SERIES (RADIOLOGY SERVICES) - ROOM DATA SHEET													
ROOM NAME	INDOOR TEMPERATURE				INDOOR RELATIVE HUMIDITY		MIN TOTAL ACH	MIN OA ACH	ROOM AIR RETURN EXHAUST (G) EXHAUST (S)	MAX NOISE LEVEL NC	ROOM AIR BALANCE	INDIVIDUAL ROOM CONTROL	
	COOLING		HEATING		% RH MAX	% RH MIN						TEMP	FLOW
	F	C	F	C									
Patient Area - Radiographic/Fluoroscopic Room	75	24	70	21	60	20	6	2	Exhaust (G)	35	(-)	Yes	CV
Note 1 - Air Balance Maintain negative room air balance in adjoining toilet.													
Patient Area - Ultrasound Room	75	24	70	21	60	20	6	2	Return	35	(+)	Yes	CV
Note 1 - Air Balance Maintain negative room air balance in adjoining toilet.													
Radiology Waiting Room	75	24	70	21	60	20	12	2	Exhaust (G)	40	(-)	Yes	CV
Note 1 - Air Distribution Design air distribution system to move air towards the waiting patients.													

KITCHEN (FOOD PRODUCTION) - AIR HANDLING UNIT	
AHU System Data Sheet	
Air Handling Type	Constant Volume
Indoor Design Temperature - Cooling	78 F [26 C]
Indoor Design Temperature - Heating	70 F [21 C]
Indoor Design Relative Humidity - Dehumidification	60%
Indoor Design Relative Humidity - Humidification	Not Required
Minimum Total Air Changes Per Hour	10
Minimum Outdoor Air Changes Per Hour	Chapter 2
Return Air Permitted	Yes
Exhaust Air Required	Yes
Air Economizer Cycle Required	Yes
Heat Recovery System Required	ASHRAE Standard 90.1 - 2007
Filtration - Pre-Filters (PF-1 and PF-2)	PF-1 = MERV 7 and PF-2 = MERV 11
Cooling Source	Chilled Water
Heating Source	Steam and/or Hot Water
Humidification Source	Not Required
General Exhaust System Required	Yes
Special Exhaust System Required	Yes
Emergency Power Required	No
Individual Room Temperature Control Required	Yes
Room Air Balance	Negative (-)
Compliance	NFPA 96

Note 1 - Space Air Balance

Minimum room air changes can be increased to meet the exhaust requirements of the range hood and canopy hoods. Conversely, room air can be returned back to the air-handling unit if the system air balance shows surplus air after accounting for the hood exhaust requirement and the use of the return air is economically viable. Transfer air from the exit corridor may be used to maintain negative air balance in the space.

Note 2 - Grease Hood Exhaust System

Provide a dedicated exhaust system to remove grease-laden air in accordance with NFPA 96. The design shall also follow the following code requirements:

(a) Discharge exhaust per dispersion analysis recommendations.

(b) Maintain at least 40 in [1000 mm] between the roof surface and exhaust air outlet.

(c) Do not install fire dampers, volume dampers, and turning vanes in the exhaust duct. Avoid excessive horizontal runs and install access doors at each turn for grease removal.

(d) Do not install exhaust duct in the shaft carrying environmental ducts (NFPA 90A).

Note 3 - Make-Up Air Hood (Grease Hood Exhaust)

Make-up air hood is permitted if proven economically viable. Past experience has shown that the initial and recurring costs associated with the make-up air system and the discomfort experienced by the kitchen staff due to the proximity of marginally tempered make-up air makes the make-up air hood system as a less desirable alternate.

Note 4 - General Exhaust System (Optional)

Provide a dedicated exhaust system to capture heat over refrigeration condensing units, plate warmer, mixer, etc. Factory or field-installed installed canopy hoods may be required.

KITCHEN (FOOD PRODUCTION) - AIR HANDLING UNIT
AHU System Data Sheet
Note 5 - Wet Exhaust System Provide a dedicated exhaust system to capture and remove moisture over pot/pan washing areas, dishwashers, steam kettles, steamers and high-pressure cookers. Use field-installed or integral hoods furnished by the equipment manufacturer.
Note 6 - Heat Recovery System or Return Air Based on the actual air balance and the life-cycle cost analysis, either return the "clean air" to the system or exhaust outdoors after passing through a heat recovery system. Note that the use of a heat recovery system is not permitted with grease laden and wet air exhausts.

LABORATORIES - AIR HANDLING UNIT	
AHU System Data Sheet	
Air Handling Type	Constant or Variable Air Volume
Indoor Design Temperature	Room Data Sheets
Indoor Design Relative Humidity	Room Data Sheets
Minimum Total Air Changes Per Hour	Room Data Sheets
Minimum Outdoor Air Changes per Hour	100%
Return Air Permitted	No
Exhaust Air Required	Yes
Air Economizer Cycle Required	Yes
Heat Recovery System Required	ASHRAE Standard 90.1 - 2007
Filtration - Pre-Filters (PF-1 and PF-2)	PF-1 = MERV 7 and PF-2 = MERV 13
Cooling Source	Chilled Water
Heating Source	Steam and/or Hot Water
Humidification Source	Plant Steam or "Clean Steam"
General Exhaust System Required	Yes
Special Exhaust System Required	Yes
Emergency Power Required	Yes
Individual Room Temperature Control Required	Room Data Sheets
Room Air Balance	Room Data Sheets
Compliance	NFPA 45 and 99

Note 1 - Air-Handling Unit

A dedicated air-handling unit with 100% outdoor air is required when a group of laboratories, forming a full-fledged department is in the project scope. One or two laboratories, in the outpatient clinic or similar facilities, can be served by an air-handling unit with minimum outdoor air shown in the Room Data Sheets (Reference: ASHRAE Standard 170 -2008) and meeting the filtration requirements.

Note 2 - Fume Hoods and Biological Safety Cabinets

Coordinate exhaust needs with the laboratory equipment (fume hoods and biological safety cabinets). Room Noise Levels can be increased by NC 5 for laboratories equipped with fume hoods and/or biological safety cabinets.

Note 3 - AHU System Configuration

(a) The system configuration (CV or VAV) shall be project specific. Applications involving multiple hoods, selected to maintain fixed face velocity at varying sash positions, are ideally suited for a variable air volume system. Such VAV systems are designed to meet the simultaneous, but at times differing, needs of the room cooling load and equipment exhaust. The control system shall be designed to provide dynamic interaction between the equipment exhaust and general exhaust systems while still maintaining a constant "offset" (make-up air) from the adjoining corridor for negative air balance.

(b) Use of low flow fume hoods shall be evaluated and compared to the VAV system.

Note 4 - General Laboratory

General Laboratory or "Dry Laboratory" is defined as a space without hoods or biological safety cabinets and chemicals are not used wihtin the space. Generally used for research activities, these laboratories contain electronic equipment. Room air can be returned back to the unit, but the cost-effectiveness of doing so when using 100% outdoor air units shall be evaluated before doing so.

Note 5 - Nuclear Laboratory

Nuclear Medicine Laboratory is included in the dedicated air-handling system for the Imaging Series.

LABORATORIES - ROOM DATA SHEET

ROOM NAME	INDOOR TEMPERATURE				INDOOR RELATIVE HUMIDITY		MIN TOTAL ACH	MIN OA ACH	ROOM AIR RETURN EXHAUST (G) EXHAUST (S)	MAX NOISE LEVEL NC	ROOM AIR BALANCE	INDIVIDUAL ROOM CONTROL	
	COOLING		HEATING		% RH	% RH						TEMP	FLOW
	F	C	F	C	MAX	MIN							
General: Coordinate supply and exhaust air volumes with the fume hoods and biological safety cabinets. A general exhaust system shall be provided where spaces are not equipped with fume hoods and/or biological safety cabinets.													
Bacteriology	75	24	70	21	60	20	6	2	Exhaust (S)	40	(-)	Yes	CV
Note - None													
Biochemistry	75	24	70	21	60	20	6	2	Exhaust (S)	40	(-)	Yes	CV
Note - None													
Cytology	75	24	70	21	60	20	6	2	Exhaust (S)	40	(-)	Yes	CV
Note - None													
Dry Laboratories	75	24	70	21	60	20	6	2	Return	40	(o)	Yes	CV
Note - None													
Glass Washing	NA	NA	NA	NA	NA	NA	10	2	Exhaust (S)	40	(-)	No	CV
Note 1 - Wet Exhaust System Provide a wet exhaust system.													
Histology	75	24	70	21	60	20	6	2	Exhaust (S)	40	(-)	Yes	CV
Note - None													
Media Transfer	75	24	70	21	60	20	4	2	Exhaust (S)	45	(+)	Yes	CV
Note 1 - Room Air Return Room air can be returned if chemicals are not used in the room.													

LABORATORIES - ROOM DATA SHEET													
ROOM NAME	INDOOR TEMPERATURE				INDOOR RELATIVE HUMIDITY		MIN TOTAL ACH	MIN OA ACH	ROOM AIR RETURN EXHAUST (G) EXHAUST (S)	MAX NOISE LEVEL NC	ROOM AIR BALANCE	INDIVIDUAL ROOM CONTROL	
	COOLING		HEATING		% RH	% RH						TEMP	FLOW
	F	C	F	C	MAX	MIN							
Microbiology	75	24	70	21	60	20	6	2	Exhaust (S)	40	(-)	Yes	CV
Note - None													
Pathology	75	24	70	21	60	20	6	2	Exhaust (S)	40	(-)	Yes	CV
Note - None													
Serology	75	24	70	21	60	20	6	2	Exhaust (S)	40	(-)	Yes	CV
Note - None													
Sterilizing	75	24	70	21	60	20	10	2	Exhaust (S)	40	(-)	Yes	CV
Note 1 - Wet Exhaust System Provide a wet exhaust system.													

MAIN COMPUTER ROOM - AIR CONDITIONING UNIT (CRAC Units)	
AHU System Data Sheet	
Air-Handling Type	Constant Volume
Indoor Design Temperature	64 F [18 C] - 75 F [24 C]
Indoor Design Relative Humidity	30% - 55%
Minimum Total Air Changes per Hour	Based on Unit Capacity
Minimum Outdoor Air Changes per Hour	ASHRAE Standard 62.1 - 2007
Return Air Permitted	Yes
Exhaust Air Required	No
Air Economizer Cycle Required	No
Heat Recovery System Required	ASHRAE Standard 90.1 - 2007
Filtration	Manufacturer's Standard
Cooling Source	Chilled Water or DX
Heating Source	Hot Water
Humidification Source	Plant Steam or "Clean Steam"
General Exhaust System Required	No
Special Exhaust System Required	No
Emergency Power Required	Yes
Individual Room Temperature Control Required	Yes
Room Air Balance	Positive (+)
Note 1 - Standby Capacity Provide N+1 computer room air-conditioning units. N = Number of units in operation and 1 is the standby unit.	
Note 2 - Unit Location and Type Locate all units in a dedicated mechanical room adjacent to the computer room. All units shall be floor-mounted. For new installations and major renovations, do not locate units in the computer room. Units shall be designed for data processing applications. See VA specification 23 81 23, Computer Room Air Conditioners, for additional information.	
Note 3 - Telephone Equipment Room and Facility Management Service Provide similar air-conditioning systems for the Telephone Equipment Room and the Facility Maintenance Service (FMS). Standby units can be shared between IT (Information Technology), FMS, and Telephone Equipment Room if a common mechanical room is provided. Ensure coordination with the office of Information and Technology (OIT) Design Guide for additional information and design criteria.	
Note 4 - Raised Floor Protection Provide an under floor, water leak detection system and a smoke detector to detect smoke and initiate corrective actions with alarms.	
Note 5 - Air Distribution System Coordinate the location and type of supply and return air distribution systems with the building design as numerous configurations outlined in the OIT Design Guide are considered as acceptable configurations.	
Note 6 - Automatic Controls Provide a local control panel in the Main Computer Room displaying temperature, RH and unit status for each AHU. Provide an open-protocol, BACnet interface between the control panel furnished with the AHU unit and the central ECC system.	
Note 7 - Space Pressurization Provide environmental air from a dedicated or a common adjoining air-handling unit to pressurize the space. Do not return air to the adjoining air handling unit.	

MAIN ENTRANCE LOBBY - AIR HANDLING UNIT	
AHU System Data Sheet	
Air Handling Type	Variable Air Volume
Indoor Design Temperature - Cooling	75 F [24 C]
Indoor Design Temperature - Heating	70 F [21 C]
Indoor Design Relative Humidity - Dehumidification	60%
Indoor Design Relative Humidity - Humidification	Optional
Minimum Total Air Changes Per Hour	6
Minimum Outdoor Air Changes Per Hour	Chapter 2
Return Air Permitted	Yes
Exhaust Air Required	Yes (From Selected Spaces)
Air Economizer Cycle Required	Yes
Heat Recovery System Required	ASHRAE Standard 90.1 - 2007
Filtration - Pre-Filters (PF-1 and PF-2)	PF-1 = MERV 7 and PF-2 = MERV 11
Cooling Source	Chilled Water
Heating Source	Steam and/or Hot Water
Humidification Source	Plant Steam or "Clean Steam"
General Exhaust System Required	Yes
Special Exhaust System Required	No
Emergency Power Required	No
Individual Room Temperature Control Required	Yes
Room Air Balance	Positive (+)
Note 1 - Areas Served The air-handling unit may serve adjoining spaces, such as, Gift Shop, Barber's Shop, Chapel, Public Toilets, and Waiting and Admitting. See Chapter 6, Non Patient Room Data Sheets, for additional information on these spaces.	
Note 2 - Air Balance Maintain lobby at positive air balance with respect to the vestibule.	

NURSING WING - AIR HANDLING UNIT	
AHU System Data Sheet	
Air Handling Type	Variable Air Volume
Indoor Design Temperature	Room Data Sheets
Indoor Design Relative Humidity	Room Data Sheets
Minimum Total Air Changes Per Hour	Room Data Sheets
Minimum Outdoor Air Changes Per Hour	Chapter 2
Return Air Permitted	Yes (Normal Mode)
Exhaust Air Required	Yes (Emergency Mode)
Air Economizer Cycle Required	Yes
Heat Recovery System Required	ASHRAE Standard 90.1 - 2007
Filtration - Pre-Filters (PF-1 and PF-2)	PF-1 = MERV 7 and PF-2 = MERV 11
Filtration - After-Filter (AF)	AF = MERV 14
Cooling Source	Chilled Water
Heating Source	Steam and/or Hot Water
Humidification Source	Plant Steam or "Clean Steam"
General Exhaust System Required	Yes
Special Exhaust System Required	Yes (Emergency Mode)
Emergency Power Required	Yes
Individual Room Temperature Control Required	Room Data Sheets
Room Air Balance	Room Data Sheets

Note 1 - Designated Emergency Epidemic Air-Handling Unit

(a) Design at least one air-handling unit for each patient wing (or as required) to operate in 100% outdoor air mode, on demand, during an emergency epidemic situation, such as pandemic flu. Location of the 100% outdoor air-handling unit shall be determined by VA Authorities. Top floor location is preferred to avoid traffic and facilitate discharge of contaminated exhaust.

(b) Provide a set of double doors as the designated entry into the designated Emergency Ward. An entry vestibule is recommended but is not mandatory.

(c) During emergency mode, the air handling unit shall operate at constant volume and the room air shall be exhausted outdoors from the highest point above the roof, through a single or multiple stacks at least 10 ft [3 m] high at a discharge velocity of 3,500 fpm [18 m/s]. Dispersion analysis recommendations may require higher stack heights.

(d) Design the utilities (chilled water, hot water, and steam) and air-handling unit system components to meet the peak cooling, heating, and humidification demands, while operating in 100% outdoor air mode. Select the controls hardware and software to ensure stable operation in normal and emergency modes.

NURSING WING - ROOM DATA SHEET

ROOM NAME	INDOOR TEMPERATURE				INDOOR RELATIVE HUMIDITY		MIN TOTAL ACH	MIN OA ACH	ROOM AIR RETURN EXHAUST (G) EXHAUST (S)	MAX NOISE LEVEL NC	ROOM AIR BALANCE	INDIVIDUAL ROOM CONTROL	
	COOLING		HEATING		% RH	% RH						TEMP	FLOW
	F	C	F	C	MAX	MIN							
Intensive Care Units (ICU)	75	24	70	21	60	20	6	2	Return	35	(+)	Yes	VAV
Note 1 - Filtration Requirements For ICUs served by the Surgical Suite AHU, provide terminal HEPA filters on the downstream side of each air terminal unit.													
Litter Bath	82	28	70	21	60	20	15	2	Exhaust (G)	45	(-)	Yes	VAV
Note - None													
Nurses Station	75	24	70	21	60	20	6	2	Return	40	(o)	Yes	VAV
Note - None													
Patient Bedrooms	75	24	70	21	60	20	6	2	Return	35	(o)	Yes	VAV
Note 1 - Minimum Air Changes per Hour For Patient Bedrooms, a minimum of 4 ACH (in lieu of 6 ACH) are permitted when supplemental heating and/or cooling systems are used.													
Patient Bedrooms (Acute Respiratory)	75	24	70	21	60	20	6	2	Exhaust (G)	35	(-)	Yes	CV
Note 1 - Minimum Air Changes per Hour For Patient Bedrooms, a minimum of 4 ACH (in lieu of 6 ACH) are permitted when supplemental heating and/or cooling systems are used.													
Patient Bedrooms (Psychiatric Ward)	75	24	70	21	60	20	6	2	Return	35	(o)	Yes	VAV
Note 1 - Safety Requirements - Exposed Equipment Use of exposed and accessible HVAC equipment is not permitted (examples: Room-mounted fan coil units and convectors, air outlets/inlets, temperature sensors, etc.). **Note 2 - Safety Requirements - Suspended Ceiling** Do not use lay-in tile acoustical ceiling. Use hard ceiling or concealed snap in arrangement. Keep ceiling height as high as possible. Use security clips to retain radiant ceiling panels in place. Ensure coordination with the architectural discipline. **Note 3 - Safety Requirements - Suspended Air Outlets/Inlets** Provide security diffusers, grilles, and registers. **Note - 4 Minimum Air Changes per Hour** For Patient Bedrooms, only a minimum of 4 ACH (in lieu of 6 ACH) are permitted when supplemental heating and/or cooling systems are used.													

NURSING WING - ROOM DATA SHEET

ROOM NAME	INDOOR TEMPERATURE				INDOOR RELATIVE HUMIDITY		MIN TOTAL ACH	MIN OA ACH	ROOM AIR RETURN EXHAUST (G) EXHAUST (S)	MAX NOISE LEVEL NC	ROOM AIR BALANCE	INDIVIDUAL ROOM CONTROL	
	COOLING		HEATING		% RH	% RH						TEMP	FLOW
	F	C	F	C	MAX	MIN							
Toilets - Patients (Interior)	NA	NA	NA	NA	NA	NA	10	NA	Exhaust (G)	35	(--)	No	CV
Note 1 - Air Balance Air exhausted from the toilet is transferred from the Patient Bedroom. Do not supply air to the toilet under positive air pressure.													
Toilets - Patients (Perimeter)	NA	NA	68	20	NA	NA	10	NA	Exhaust (G)	35	(--)	No	CV
Note 1 - Air Balance Air exhausted from the toilet is transferred from the Patient Bedroom. Do not supply air to the toilet under positive air pressure. **Note 2 - Perimeter Heating** For toilets with an exterior wall subject to heat loss, provide thermostatically-controlled (closed-loop local control loop) radiant panels to maintain temperature set point.													

PHARMACY SERVICE - AIR HANDLING UNIT	
AHU System Data Sheet	
Air Handling Type	Variable Air Volume
Indoor Design Temperature	Room Data Sheets
Indoor Design Relative Humidity	Room Data Sheets
Minimum Total Air Changes Per Hour	Room Data Sheets
Minimum Outdoor Air Changes Per Hour	Chapter 2
Return Air Permitted	Yes
Exhaust Air Required	Yes
Air Economizer Cycle Required	Yes
Heat Recovery System Required	ASHRAE Standard 90.1 -2007
Filtration - Pre-Filters (PF-1 and PF-2)	PF-1 = MERV 7 and PF-2 = MERV 13
Filtration - Final Filter (FF)	FF = MERV 17 (HEPA)
Cooling Source	Chilled Water
Heating Source	Steam and/or Hot Water
Humidification Source	Plant Steam or "Clean Steam"
General Exhaust System Required	Yes
Special Exhaust System Required	Yes
Emergency Power Required	Yes
Individual Room Temperature Control Required	Room Data Sheets
Room Air Balance	Room Data Sheets
Compliance	USP <797>

Note 1 - USP <797> Pharmaceutical Compounding - Sterile Preparations (CSP)

Per USP <797>, compounding of sterile products (hazardous or non-hazardous) shall be accomplished in a clean room environment. The designer shall be familiar with the environmental requirements specified in USP <797> to ensure compliance. In the Room Data Sheets for hazardous and non-hazardous clean rooms, terminology is defined.

Note 2 - Air-Handling Unit

Pharmacy areas, other than clean rooms, can be served by an air-handling unit equipped with MERV 13 pre-filters. However, an air-handling unit serving clean rooms must address the special HVAC needs of providing Final MERV 17 (HEPA) filters, extended hours of operations, and lower space temperature (68 F [20 C] compared to 75 F [24 C] for all other spaces). Evaluate the use of packaged air moving equipment with a HEPA filter, in lieu of a terminal HEPA filter, to isolate the high-static branch circuit and avoid penalizing the entire air handling unit.

Note 3 - Chilled Water

Chilled water shall be available uninterrupted and on demand. A dedicated chiller connected to emergency power shall be considered if the central plant is not equipped with emergency power.

PHARMACY SERVICE - ROOM DATA SHEET

ROOM NAME	INDOOR TEMPERATURE				INDOOR RELATIVE HUMIDITY		MIN TOTAL ACH	MIN OA ACH	ROOM AIR RETURN EXHAUST (G) EXHAUST (S)	MAX NOISE LEVEL NC	ROOM AIR BALANCE	INDIVIDUAL ROOM CONTROL	
	COOLING		HEATING		% RH	% RH						TEMP	FLOW
	F	C	F	C	MAX	MIN							
Ante Room (Hazardous Clean Room)	68	20	68	20	60	35	30	30	Exhaust (S)	35	(+)	Yes	CV
Note 1 - Ante Room Per USP <797> the Ante Room shall have at least an ISO 8 classification for a standalone Buffer Room and shall be maintained at a positive air balance with respect to the Clean Room and adjoining areas.													
Ante Room (Non-Hazardous Clean Room)	68	20	68	20	60	35	30	3	Return	35	(-)	Yes	CV
Note 1 - Ante Room Per USP <797>, the Ante Room shall have an ISO Class 8 classification and shall be maintained at negative air pressure with respect to the Clean Room and positive air pressure with respect to adjoining areas.													
Clean Room (Hazardous Applications)	68	20	68	20	60	35	30	30	Exhaust (S)	35	(-)	Yes	CV
Note 1 - Definition The device used for performing the sterile compounding is located in the Buffer Room. The Buffer Room is an ISO Class 7 Clean Room. The device is known as the Primary Engineering Control (PEC). For Hazardous Clean Room, the PEC is a Biological Safety Cabinet (BSC) or any other device recommended by USP <797>. PEC is a Class 5 device. All air supplied to the BSC shall pass through HEPA filtration then exhaust to outdoors. **Note 2 - Minimum Total Air Changes per Hour** Per USP <797>, "If the area has an ISO 5 HEPA-filtered recirculating device, a minimum of 15 ACHs through the area supply HEPA filters is adequate." The 30 ACH listed above are total air changes as "the PEC is a good augmentation to generating air changes in the air supply of an area but cannot be the sole source of HEPA-filtered air". **Note 3 - Positive Air Pressure** Design the system to maintain -0.01 in [-2.5 Pa] negative air pressure differential between the Buffer Room and the Ante Room. USP <797> permits the use of a velocity meter in place of differential pressure measurement. Adjust the outdoor air volume, as required, to attain the design air pressure differential. Provide a local, visible alarm and remote alarm at the central ECC, after allowing for nuisance alarms created by door openings, etc. **Note 4 - Terminal HEPA Filter** Provide a terminal MERV 17 (HEPA) filter with 99.97% efficiency at 0.3 microns downstream of the dedicated air terminal unit serving the Buffer Room. This terminal unit shall be equipped with a booster fan to allow the terminal unit to compensate for the increased pressure drop of the HEPA filter and therefore not penalize the entire system.													

PHARMACY SERVICE - ROOM DATA SHEET

ROOM NAME	INDOOR TEMPERATURE				INDOOR RELATIVE HUMIDITY		MIN TOTAL ACH	MIN OA ACH	ROOM AIR	MAX NOISE LEVEL NC	ROOM AIR BALANCE	INDIVIDUAL ROOM CONTROL	
	COOLING		HEATING		% RH	% RH			RETURN EXHAUST (G) EXHAUST (S)			TEMP	FLOW
	F	C	F	C	MAX	MIN							
Note 5 - Air Distribution Provide unidirectional air distribution with overhead supply and bottom return air collection. Locate return air inlet(s) in the wall at 7 in [175 mm] above the floor. **Note 6 - Coordination** Coordinate USP <797> requirements for ceiling fixtures, floor, wall, ceiling surfaces, and caulking/sealing with other disciplines.													
Clean Room (Non-Hazardous Applications)	68	20	68	20	60	35	30	3	Return	40	(+)	Yes	CV
Note 1 - Definition The device used for performing sterile compounding is located in the Buffer Room. The Buffer Room is an ISO Class 7 Clean Room. The device is known as the Primary Engineering Control (PEC). For Non-Hazardous Clean Room, the PEC is a Linear Airflow Workstation (LAFW) or any other device recommended by USP <797>. A LAFW re-circulates HEPA filtered air and is an ISO Class 5 device. **Note 2 - Minimum Total Air Changes per Hour** Per USP <797>, "If the area has an ISO 5 HEPA-filtered recirculating device, a minimum of 15 ACHs through the area supply HEPA filters is adequate." The 30 ACH listed above are total air changes as "the PEC is a good augmentation to generating air changes in the air supply of an area but cannot be the sole source of HEPA-filtered air". **Note 3 - Positive Air Pressure** Design the system to maintain +0.01 in [+2.5 Pa] positive air pressure differential between the Buffer Room and the Ante Room. USP <797> permits the use of a velocity meter in place of differential pressure measurement. Adjust the outdoor air volume, as required, to attain the design air pressure differential. Provide a local, visible alarm and remote alarm at the central ECC, after allowing for nuisance alarms created by door opening etc. **Note 4 - Terminal HEPA Filter** Provide a terminal MERV 17 (HEPA) filter with 99.97% efficiency at 0.3 microns downstream of the dedicated air terminal unit serving the Buffer Room. This terminal unit shall be equipped with a booster fan to allow the terminal unit to compensate for the increased pressure drop of the HEPA filter and therefore not penalize the entire system. **Note 5 - Air Distribution** Provide unidirectional air distribution with overhead supply and bottom return air collection. Locate return air inlet(s) in the wall at 7 in [175 mm] above the floor. **Note 6 - Coordination** Coordinate USP <797> requirements for ceiling fixtures, floor, wall, ceiling surfaces, and caulking/sealing with other disciplines.												

PHARMACY SERVICE - ROOM DATA SHEET													
ROOM NAME	INDOOR TEMPERATURE				INDOOR RELATIVE HUMIDITY		MIN TOTAL ACH	MIN OA ACH	ROOM AIR RETURN EXHAUST (G) EXHAUST (S)	MAX NOISE LEVEL NC	ROOM AIR BALANCE	INDIVIDUAL ROOM CONTROL	
	COOLING		HEATING		% RH MAX	% RH MIN						TEMP	FLOW
	F	C	F	C									
Controlled Substance Vault and Secured Dispensing/Receiving Area	75	24	70	21	60	30	4	2	Return	40	(+)	Yes	VAV
Note - None													
Dispensing, Pre-Packing, and EXTEMP	75	24	70	21	60	30	4	2	Return	40	(+)	Yes	VAV
Note - None													
Drug Information Service	75	24	70	21	60	30	4	2	Return	40	(o)	Yes	VAV
Note - None													
EXTEMP Repacking and Compounding	75	24	70	21	60	30	4	2	Return	40	(+)	Yes	VAV
Note - None													
Medicine Assignment and Stat Counter	75	24	70	21	60	30	4	2	Return	40	(+)	Yes	VAV
Note - None													
Prescription Receiving, Filling Assembly	75	24	70	21	60	30	4	2	Return	40	(+)	Yes	VAV
Note - None													
Production Area - CMOP	75	24	70	21	60	30	4	2	Return	45	(+)	Yes	CV
Note - None													
Unit Dose and Ward Stock	75	24	70	21	60	30	4	2	Return	40	(+)	Yes	VAV
Note - None													

SPINAL CORD INJURY/DISORDERS CENTER - AIR HANDLING UNIT	
AHU System Data Sheet	
Air Handling Type	Variable Air Volume
Indoor Design Temperature	Room Data Sheets
Indoor Design Relative Humidity	Room Data Sheets
Minimum Total Air Changes Per Hour	Room Data Sheets
Minimum Outdoor Air Changes Per Hour	Chapter 2
Return Air Permitted	Yes
Exhaust Air Required	No
Air Economizer Cycle Required	Yes
Heat Recovery System Required	ASHRAE Standard 90.1 - 2007
Filtration - Pre-Filters (PF-1 and PF-2)	PF-1 = MERV 7 and PF-2 = MERV 11
Filtration - After-Filter (AF)	AF = MERV 14
Cooling Source	Chilled Water
Heating Source	Steam and/or Hot Water
Humidification Source	Plant Steam or "Clean Steam"
General Exhaust System Required	Yes
Special Exhaust System Required	No
Emergency Power Required	Yes
Individual Room Temperature Control Required	Room Data Sheets
Room Air Balance	Room Data Sheets
Note 1 - Dedicated Air-Handling Unit Provide a dedicated air-handling unit where the Spinal Cord Injury/Disorders Center (SCI) is constructed as a standalone entity or full-fledged department. The air-handling unit can also serve the SCI Long Term Care unit if located in the same building.	
Note 2 - Listed Rooms and Their Names Room names shown in the attached Room Data Sheets are based on the Design Guide dated June 2008 for the Spinal Cord Injury/Disorders Center. All rooms from the June 2008 Design Guide are NOT listed in the Room Data Sheets as the HVAC parameters are being revised to comply with ASHRAE Standard 170. See Chapter 6 for the miscellaneous and support rooms, such as, Housekeeping Aide's Closet (HAC), Attic Space, Crawl Space (Pipe Basement), Exterior Stairs, Mechanical/Electrical Rooms, etc.	
Note 3 - HVAC Design Parameters The HVAC design parameters listed in this doucment differs from the VA June 2008 Design Guide to comply with ASHRAE Standard 170 - 2008 and its four amendments (a) - (d) . ASHRAE Standard 170 has revised its position on many issues, compared to the 2007 ASHRAE Handbook of Applications, which was the basis of 2008 Design Guide.	
Note 4 - Indoor Design Conditions (Temperatures - Bedrooms and Isolation Rooms) Temperature tolerance for heating and cooling modes is +/- 1.0 F [0.6 C]	

Note 5 - Indoor Design Conditions (Relative Humidity - Bedrooms and Isolation Rooms)

(a) Dehumidification Mode

The relative humidity is not directly controlled but maintained within the range by controlling the dew-point temperature between 47 F to 48 F [8 C to 9 C], based on the psychometric analysis at 66 F [19 C] and 55% RH with 60% RH as the high limit. Upon rise in relative humidity above 60%, initiate alarms (local visible and remote at the ECC) and project-specific corrective actions.

(b) Humidification Mode

Upon drop in space relative humidity below 20%, measured by any space relative humidity sensor, the central humidifier shall be activated to maintain the set point.

(c) General Note

Individual room humidity control is not required. Relative humidity shall remain uncontrolled between 20% and 60%

SPINAL CORD INJURY/DISORDERS CENTER - ROOM DATA SHEET

ROOM NAME	INDOOR TEMPERATURE				INDOOR RELATIVE HUMIDITY		MIN TOTAL ACH	MIN OA ACH	ROOM AIR RETURN EXHAUST (G) EXHAUST (S)	MAX NOISE LEVEL NC	ROOM AIR BALANCE	INDIVIDUAL ROOM CONTROL	
	COOLING		HEATING		% RH	% RH						TEMP	FLOW
	F	C	F	C	MAX	MIN							
General Note: The HVAC Design parameters and system capabilities may be different, if systems other than all-air systems are used.													
Activities of Daily Living	72	22	82	28	60	20	6	2	Exhaust (G)	40	(-)	Yes	CV
Note 1 - General The data given above is for the Living Room only. See Activities of Daily Living - Toilet for the adjoining toilet. Transfer air from the adjoining area to maintain negative air balance.													
Activities of Daily Living - Toilet	NA	NA	NA	NA	NA	NA	10	NA	Exhaust (G)	40	(-)	No	CV
Note 1 - Room Temperature Control Room temperature control is not required. Provide supply air from the dedicated air terminal unit serving the Activities of Daily Living. Transfer air from the adjoining area to maintain negative air balance. **Note 2 - Terminal Heater** For toilet subject to heat loss, provide thermostatically-controlled (closed-loop, local control) terminal heater to maintain up to 82 F [28 C].													
Acute Care Ante Room	NA	NA	NA	NA	NA	NA	10	NA	Exhaust (S)	40	NA	No	CV
Note 1 - Ante Room Application and Exhaust See Note 1 of the Acute Care Isolation rooms for the mandated use of an Ante Room. Air supplied or transferred into this room shall be exhausted outdoors by a special exhaust system described for Acute Care Isolation - Negative Air Balance.													
Acute Care Isolation - Negative Air Balance	72	22	82	28	60	20	12	2	Exhaust (S)	35	(-)	Yes	CV
Note 1 - Airborne Infection Isolation (AII) Room This isolation room is for a patient requiring AII. For this application, the use of an Ante Room is not mandated by ASHRAE and Facility Guidelines Institute (FGI). **Note 2 - Special Exhaust System** Provide a dedicated exhaust system to serve the room. Maintain entire ductwork under negative air pressure and discharge exhaust air at 10 ft [3 m] above the highest roof level at 3500 fpm [18 m/s] discharge velocity. Provide an airflow control valve in the exhaust air duct. A HEPA filter in the exhaust air duct is not mandated by ASHRAE or FGI.													

SPINAL CORD INJURY/DISORDERS CENTER - ROOM DATA SHEET

ROOM NAME	INDOOR TEMPERATURE				INDOOR RELATIVE HUMIDITY		MIN TOTAL ACH	MIN OA ACH	ROOM AIR RETURN EXHAUST (G) EXHAUST (S)	MAX NOISE LEVEL NC	ROOM AIR BALANCE	INDIVIDUAL ROOM CONTROL	
	COOLING		HEATING		% RH	% RH						TEMP	FLOW
	F	C	F	C	MAX	MIN							
Acute Care Isolation - Positive Air Balance	72	22	82	28	60	20	12	2	Return	35	(+)	Yes	CV
Note 1 - Protective Environment (PE) Room This isolation room is for a patient requiring a PE. For this application, the use of an Ante Room is not mandated by ASHRAE and FGI unless the patient also requires AII. **Note 2 - Terminal HEPA Filter** Provide a terminal HEPA filter (MERV 17) on the downstream side of the dedicated air terminal unit serving the PE room.													
Acute Care One Bedroom	72	22	82	28	60	20	6	2	Return	35	(o)	Yes	VAV
Note - None													
Acute Care Two Bedroom	72	22	82	28	60	20	6	2	Return	35	(o)	Yes	VAV
Note - None													
Acute Respiratory One Bedroom	72	22	82	28	60	20	6	2	Return	35	(o)	Yes	VAV
Note - None													
Corridor	72	22	82	28	60	20	6	2	Exhaust (G)	40	(o)	Yes	CV
Note 1 - Supply Air Volume Adjust supply air volume, as required, to meet the exhaust requirements of the adjoining spaces, such as, toilets and/or HAC. **Note 2 - Air Balance** Maintain neutral air balance with respect to the occupied spaces except those requiring negative air balances.													
Day Room/Lounge	72	22	82	28	60	20	6	2	Return	35	(o)	Yes	VAV
Note 1 - Smoking Provide a dedicated 100% exhaust system if smoking is permitted in the lounge.													

SPINAL CORD INJURY/DISORDERS CENTER - ROOM DATA SHEET

ROOM NAME	INDOOR TEMPERATURE				INDOOR RELATIVE HUMIDITY		MIN TOTAL ACH	MIN OA ACH	ROOM AIR RETURN EXHAUST (G) EXHAUST (S)	MAX NOISE LEVEL NC	ROOM AIR BALANCE	INDIVIDUAL ROOM CONTROL	
	COOLING		HEATING		% RH	% RH						TEMP	FLOW
	F	C	F	C	MAX	MIN							
Home Environment Learning													
Bathroom	NA	NA	NA	NA	NA	NA	10	NA	Exhaust (G)	40	(-)	No	CV
Bedroom	72	22	82	28	60	20	4	2	Return	35	(o)	Yes	VAV
Kitchen	NA	NA	NA	NA	NA	NA	10	NA	Exhaust (G)	40	(-)	No	CV
Living/Dining	72	22	82	28	60	20	4	2	Return	35	(o)	Yes	VAV
Note 1 - Bedroom and Living/Dining Bedroom and Living/Dining can be served by a common terminal unit if the rooms are located on the same exposure as shown in the SCI Design Guide dated June 2008. **Note 2 - Kitchen** Exhaust room air outdoors if the kitchen equipment or room exhaust has an outdoor air connection.													
Hydrotherapy/Tubroom	78	26	82	28	NA	NA	10	NA	Exhaust (S)	40	(-)	Yes	CV
Note 1 - Exhaust System Provide a dedicated or a common wet exhaust system with welded stainless steel ductwork.													
Internet Cafe	72	22	82	28	60	20	6	2	Return	35	(o)	Yes	VAV
Note - None													
Litter Storage	78	26	70	21	NA	NA	6	NA	Exhaust (G)	40	(-)	Yes	CV
Note 1 - Exhaust System Transfer air from the adjoining spaces to maintain negative air balance. **Note 2 - Room Temperature Control** Individual room temperature control is optional. The room can be served by a common air terminal unit with similar load characteristics.													
Main Entrance and Canopy Section	78	26	72	22	60	20	6	2	Exhaust (G)	45	(+)	Yes	CV
Note 1 - Ex-filtration Allow Main Entrance air to ex-filtrate to Canopy Section when the entry door is open.													

SPINAL CORD INJURY/DISORDERS CENTER - ROOM DATA SHEET													
ROOM NAME	INDOOR TEMPERATURE				INDOOR RELATIVE HUMIDITY		MIN TOTAL ACH	MIN OA ACH	ROOM AIR RETURN EXHAUST (G) EXHAUST (S)	MAX NOISE LEVEL NC	ROOM AIR BALANCE	INDIVIDUAL ROOM CONTROL	
	COOLING		HEATING		% RH	% RH						TEMP	FLOW
	F	C	F	C	MAX	MIN							
Multipurpose Room	78	26	72	22	60	20	6	2	Exhaust (G)	40	(o)	Yes	VAV
Note 1 - Room Temperature Control Where the room is equipped with folding partitions, provide individual room temperature control on either side of the partition. **Note 2 - Energy Conservation Initiative** Evaluate the feasibility of using a carbon-dioxide (CO_2) and/or occupancy sensor to conserve energy during part load conditions. The control sequence shall be project-specific.													
Nourishment Kitchen	NA	NA	NA	NA	NA	NA	6	NA	Exhaust (G)	40	(-)	No	CV
Note 1 - Exhaust System Connect exhaust to a common general exhaust system. Provide 100% transfer air for the exhaust from the adjoining space.													
Nurse Station/Ward Clerk	72	22	82	28	60	20	6	2	Return	40	(o)	Yes	VAV
Note - None													
Outpatient Urodynamics Clinic Clean Utility Room	NA	NA	NA	NA	NA	NA	4	NA	Return	35	(+)	No	CV
Note 1 - Room Air Balance Provide supply air from adjoining air terminal unit.													
Patient (Litter) Bathroom	78	26	70	21	NA	NA	10	NA	Exhaust (G)	40	(-)	Yes	CV
Note 1 - Exhaust System Connect the room exhaust to a common general exhaust system. Transfer air from adjoining spaces to maintain negative air balance.													
Resident Dining/Serving	72	22	82	28	60	20	6	2	Return	40	(-)	Yes	VAV
Note - None													
Resident Storage	72	22	82	28	60	20	4	NA	Exhaust (G)	40	(-)	Yes	CV
Note 1 - Room Temperature Control and Air Balance Room temperature control is optional; can be served by a common terminal unit. Transfer air from adjoining space for negative balance.													

SPINAL CORD INJURY/DISORDERS CENTER - ROOM DATA SHEET

ROOM NAME	INDOOR TEMPERATURE				INDOOR RELATIVE HUMIDITY		MIN TOTAL ACH	MIN OA ACH	ROOM AIR	MAX NOISE LEVEL NC	ROOM AIR BALANCE	INDIVIDUAL ROOM CONTROL	
	COOLING		HEATING		% RH	% RH			RETURN EXHAUST (G)			TEMP	FLOW
	F	C	F	C	MAX	MIN			EXHAUST (S)				
Spinal Cord Injury/Disorders - Long Term Care													
Computer Lab	72	22	82	28	60	20	6	2	Return	40	(o)	Yes	VAV
(On Unit) Resident Dining Serving	72	22	82	28	60	20	6	2	Return	40	(-)	Yes	VAV
One-Bed Room	72	22	82	28	60	20	6	2	Return	35	(o)	Yes	VAV
PET/KT/OT Clinic	72	22	82	28	60	20	6	2	Return	40	(o)	Yes	VAV
Recreation Therapy	72	22	82	28	60	20	6	2	Return	40	(o)	Yes	VAV
Special Care Room	72	22	82	28	60	20	6	2	Return	40	(o)	Yes	VAV
Two-Bed Room	72	22	82	28	60	20	6	2	Return	35	(o)	Yes	VAV
Visitor Lounge	72	22	82	28	60	20	6	2	Return	40	(o)	Yes	VAV
Therapeutic Pool	80	27	85	29	NA	NA	10	2	Exhaust (S)	40	(-)	Yes	CV

Note 1 - (On Unit) Resident Dining Serving

Transfer air for rooms with negative air balances from adjoining areas.

Note 2 - Recreation Therapy

Provide individual room temperature control on either side of the partition.

Note 1 - Exhaust System

Provide a dedicated or common wet exhaust system with welded stainless steel ductwork. Provide two-position supply and exhaust air terminal units to reduce air volumes to 50% during unoccupied mode.

Note 2 - Supply Air Distribution

Direct supply air towards interior surfaces prone to condensation and towards water surface to move contaminated air towards exhaust. Locate exhaust air inlets to maximize capture effectiveness and minimize short-circuiting of the supply air.

Note 3 - Pool Water Temperature

Coordinate required water temperatures for the SCI and MS patients as shown in the SCI Design Guide dated June 2008.

SPINAL CORD INJURY/DISORDERS CENTER - ROOM DATA SHEET

ROOM NAME	INDOOR TEMPERATURE				INDOOR RELATIVE HUMIDITY		MIN TOTAL ACH	MIN OA ACH	ROOM AIR RETURN EXHAUST (G) EXHAUST (S)	MAX NOISE LEVEL NC	ROOM AIR BALANCE	INDIVIDUAL ROOM CONTROL	
	COOLING		HEATING		% RH	% RH						TEMP	FLOW
	F	C	F	C	MAX	MIN							
Therapeutic Pool - Female Dressing Room	78	26	70	21	NA	NA	6	2	Exhaust (G)	40	(-)	Yes	CV
Note 1 - Supply Air Volume Adjust supply and transfer air volumes as required to meet the exhaust requirements of the shower, toilet, and lockers.													
Therapeutic Pool - Male Dressing Room	78	26	70	21	NA	NA	6	2	Exhaust (G)	40	(-)	Yes	CV
Note 1 - Supply Air Volume Adjust supply and transfer air volumes as required to meet the exhaust requirements of the shower, toilet, and lockers.													
Therapy Rooms													
Kinesiotherapy Treatment Clinic	72	22	82	28	60	20	6	2	Return	40	(o)	Yes	VAV
Occupational Therapy	72	22	82	28	60	20	6	2	Return	40	(o)	Yes	VAV
Physical/Kinesiology Therapy 30 Beds	72	22	82	28	62	20	6	2	Return	40	(o)	Yes	VAV
Physical/Kinesiology Therapy 60 Beds	72	22	82	28	62	20	6	2	Return	40	(o)	Yes	VAV
Physical Therapy Treatment Clinic	72	22	82	28	60	20	6	2	Return	40	(o)	Yes	VAV
Note - None													
Transfer Equipment Storage	78	26	70	21	NA	NA	4	NA	Exhaust (G)	40	(-)	Yes	CV
Note 1 - Exhaust System Connect exhaust to a general exhaust system serving other spaces. Transfer air from the adjoining spaces to maintain negative air balance. **Note 2 - Room Temperature Control** Individual room temperature control is optional. The room can be served by a common air terminal unit with similar load characteristics.													

SPINAL CORD INJURY/DISORDERS CENTER - ROOM DATA SHEET

ROOM NAME	INDOOR TEMPERATURE				INDOOR RELATIVE HUMIDITY		MIN TOTAL ACH	MIN OA ACH	ROOM AIR RETURN EXHAUST (G) EXHAUST (S)	MAX NOISE LEVEL NC	ROOM AIR BALANCE	INDIVIDUAL ROOM CONTROL	
	COOLING		HEATING		% RH	% RH						TEMP	FLOW
	F	C	F	C	MAX	MIN							
Urodynamic Rooms													
Cystoscopy/Lithotripsy	66	19	66	19	60	20	15	3	Return	35	(+)	Yes	VAV
Note 1 - Unoccupied Mode Provide a two-position air terminal unit to deliver 50% supply air during unoccupied mode while maintaining positive air balance. **Note 2 - Air Distribution** Provide unidirectional air distribution with overhead supply and floor level return. Locate return air registers at opposite ends at 8 in [200 mm] above the floor. **Note 3 - Instrumentation** Provide temperature and relative humidity sensors for trending of indoor design conditions.													
Dressing Room/Cubicle	72	22	82	28	60	20	6	2	Return	40	(o)	Yes	VAV
Note - None													
Exam/Treatment Room	72	22	82	28	60	20	6	2	Return	35	(o)	Yes	VAV
Note - None													
Instrument Cleaning Room	72	22	82	28	60	20	10	NA	Exhaust (G)	40	(- -)	Yes	CV
Note 1 - Exhaust System Connect the room exhaust to a dedicated or a common general exhaust system and transfer air from the Storage Room and Corridor.													
Nurse Station	72	22	82	28	60	20	6	2	Return	40	(o)	Yes	VAV
Note - None													
Recovery Room	72	22	82	28	60	20	6	2	Return	35	(o)	Yes	VAV
Note - None													
Storage Room	72	22	82	28	60	20	6	2	Return	40	(+)	Yes	CV
Note 1 - Air Balance Maintain storage space at positive air balance with respect to the Instrument Cleaning Room and neutral air balance with respect to Corridor.													
Urologist Office	72	22	82	28	60	20	4	2	Return	40	(o)	Yes	VAV
Note - None													

STANDALONE SMOKING FACILITY - AIR HANDLING UNIT	
AHU System Data Sheet	
Air HandlingType	Constant Volume
Indoor Design Temperature - Cooling	77 F [25 C]
Indoor Design Temperature - Heating	70 F [21 C]
Indoor Design Relative Humidity - Dehumidification	60%
Indoor Design Relative Humidity - Humidification	Not Required
Minimum Total Air Changes Per Hour	6
Minimum Outdoor Air Changes Per Hour	Chapter 2
Return Air Permitted	Yes
Exhaust Air Required	Yes (Intermittently)
Air Economizer Cycle Required	Yes
Heat Recovery System Required	ASHRAE Standard 90.1 - 2007
Filtration - Pre-Filter (PF-1)	PF 1 = MERV 7
Cooling Source	Chilled Water or DX
Heating Source	Steam and/or Hot Water, Electric
Humidification Source	Not Required
General Exhaust System Required	Yes
Special Exhaust System Required	No
Emergency Power Required	No
Individual Room Temperature Control Required	Yes
Room Air Balance	Negative (-)
Note 1 - VHA Directive Per VHA Directive (2003-035 dated July 1, 2003), smoking is permitted for long term care patients and mental health patients. Indoor smoking must not interfere with the safety of non-smokers.	
Note 2 - HVAC System Details and Controls The HVAC system selection shall be project specific - either a chilled water or direct-expansion (DX) system. **(a) Chilled Water System** Provide a modulating chilled water control valve. **(b) DX System** Provide at least two independent refrigeration circuits, if available for the required capacity.	
Note 3 - Suggested Control Sequences **(a) Unoccupied Mode** The system shall cycle (on/off) with the outdoor air damper closed to maintain a night-setback temperature at 60 F [16 C]. **(b) Purge Cycle** A dedicated exhaust fan shall operate intermittently during occupied mode to flush smoke-laden air outdoors.	

SUPPLY PROCESSING AND DISTRIBUTION (SPD) - AIR HANDLING UNIT	
AHU System Data Sheet	
Air Handling Type	Constant Volume
Indoor Design Temperature	Room Data Sheets
Indoor Design Relative Humidity	Room Data Sheets
Minimum Total Air Changes Per Hour	Room Data Sheets
Minimum Outdoor Air Changes Per Hour	100%
Return Air Permitted	No
Exhaust Air Required	Yes
Air Economizer Cycle Required	No
Heat Recovery System Required	ASHRAE Standard 90.1 - 2007
Filtration - Pre-Filters (PF-1 and PF-2)	PF 1 = MERV 7 and PF 2 = MERV 11
Filtration - After-Filter (AF)	AF = MERV 14
Cooling Source	Chilled Water
Heating Source	Steam and/or Hot Water
Humidification Source	Plant Steam or "Clean Steam"
General Exhaust System Required	Yes
Special Exhaust System Required	Yes
Emergency Power Required	Yes
Individual Room Temperature Control Required	Room Data Sheets
Room Air Balance	Room Data Sheets
Note 1 - General Coordination Coordinate equipment heat gain and utility requirements with the selected equipment. The abator is supplied with the ETO Sterilizer. Mechanical drawings shall indicate duct, pipe and utility connections.	
Note 2 - General Exhaust System Provide a dedicated, general exhaust system for the spaces identified in the Room Data Sheets.	
Note 3 - Wet Exhaust System Provide a dedicated (space) exhaust system for the Manual Equipment Wash and Automatic Cart Washer Rooms.	
Note 4 - Wet Exhaust System (Automatic Cart Wash Equipment) Provide a dedicated (equipment) exhaust system for the Automatic Cart Wash Equipment. The system capacity shall be based on the actual selected equipment.	

Note 5 - Ethylene Oxide (ETO) Exhaust System

(a) General - New Construction and Major Renovations of the SPD Department

Per VHA (Veterans Health Administration) Directive, under processing and concurrence, the following measures shall be implemented:

For all new construction and major renovations, provide an Abator for each Ethylene Oxide (ETO) sterilizer to convert the ETO exhaust into water vapor and carbon-dioxide. Per Directive in all existing ETO sterilizer installations, abators shall be installed by 2015. No ETO sterilizers shall be used without abators after 2015.

(b) Abator

Abator is a pollution control device. Vent line from each ETO sterilizer is connected to its own abator to split ethylene oxide into water vapor and carbon-oxide by an exothermic reaction. Per VHA direction, each sterilizer shall be equipped with its own abator to avoid a single point of failure and facilitate on-line maintenance.

(c) Exhaust System

The dedicated exhaust system serving the ethylene oxide sterilizer installation shall include exhaust through the sterilizer room, abator, and the flammable storage cabinet required to house the ETO canisters.

(d) ETO Sterilizer Room Exhaust

Exhaust through or over the sterilizer by an integral plenum is not required, as the VA Standard Operating Procedure permits opening of the sterilizer door only after the specified time limit has expired at the end of each operating cycle. Provide ceiling-mounted exhaust register over the sterilizer door to exhaust the room at 10 air changes per hour.

(e) Exhaust through the Abator

Each abator admits 50 cfm [24 L/s] room air through its intake nozzle and discharges it through its exhaust nozzle at very high temperature, approximately at 480 F [250 C]. Room air is mixed at the rate of 150 cfm [71 L/s] with the hot air discharge discharged by the abator to dilute the hot air. This is accomplished by a three-way mixing nozzle supplied by the equipment manufacturer.

(f) Exhaust through the Flammable Storage Cabinet

Admit room air into the cabinet through the cabinet doors and connect the cabinet exhaust nozzle to the exhaust system. Ensure that enough air is exhausted to create -0.06 in [-15 Pa] negative air pressure. The approximate nozzle size is 4 in [100 mm] and the exhaust air volume is 40 to 50 cfm [19 to 24 L/s].

(g) Abator Vent Pipe

Each abator is equipped with its own vent pipe, operative during emergency only when the intended chemical reaction to break the ETO into water and CO2 does not materialize. Coordinate vent pipe size, material, fittings, and equivalent length limitations with the ETO manufacturer. Coordinate vent termination details with the equipment manufacture.

(h) Exhaust Fan and Ductwork

Provide a non-ferrous, spark-proof construction centrifugal fan with a backward inclined wheel. The fan motor shall be mounted outside the exhaust air stream. Maintain complete exhaust air ductwork under negative air balance. Provide an airflow control valve to ensure accurate air balance. Locate the fan and abator vent exhaust pipe at least 25 ft [8 m] from any outdoor air intake, unsealed doors and windows, driveways, and walkways. Modify the discharge requirements if so recommended by the dispersion analysis.

SUPPLY PROCESSING AND DISTRIBUTION (SPD) - AIR HANDLING UNIT
AHU System Data Sheet
Note 6 - Air Distribution Requirements **(a)** Air distribution system design is vital to ensure contamination control. The design should demonstrate the directions and magnitude of the supply, exhaust, make-up, and relief air flows. Provide automatic airflow control valves, as required, to accomplish the design objective. It is vital to ensure that the supply air inlets and exhaust air outlets are judiciously located. **(b)** See Figure 6-1, SPD Airflow, for further information.
Note 7 - Automatic Controls **(a) Room Temperature Control** Provide individual room temperature control as shown in the Room Data Sheets. **(b) Room Relative Humidity Control** Not Required. **(c) Supply Air Temperature Control** Select and control the supply air temperature to maintain 72 F [22 C] at 55% RH. While 60% RH is the maximum permissible relative humidity, base the psychometric analysis on 55% RH. Direct control of the overall space relative humidity is not required in the dehumidification mode. **(d) Relative Humidity Control - Humidification Mode** Provide a unit-mounted, central steam humidifier to control and maintain the overall space relative humidity at 30% RH by a relative humidity sensor located in the main general exhaust duct. **(e) High-Limit Relative Humidity Control - Humidification Mode** Activate high-limit relative humidity control when the overall space relative humidity exceeds 60%. Provide project-specific measures to lower the relative humidity below 60% RH. **(f) High-Low Limit Controls and Alarms** Provide high and low limit local and remote alarms and initiate the corrective actions to control high and low limit alarms. Integrate ETO sterilizer controls with the building controls using a BACNET open protocol system.

SPD CLEAN - ROOM DATA SHEET

ROOM NAME	INDOOR TEMPERATURE				INDOOR RELATIVE HUMIDITY		MIN TOTAL ACH	MIN OA ACH	ROOM AIR	MAX NOISE LEVEL NC	ROOM AIR BALANCE	INDIVIDUAL ROOM CONTROL	
	COOLING		HEATING		% RH	% RH			RETURN EXHAUST (G) EXHAUST (S)			TEMP	FLOW
	F	C	F	C	MAX	MIN							
General: The rooms and their relative locations with adjoining spaces are based on information given in the VA Design Guide for the SPD Service dated February 2010.													
Ante Room	NA	NA	NA	NA	NA	NA	10	10	Exhaust (G)	40	(+)	No	CV
Note 1 - Room Air Balance Provide supply air from an adjoining air terminal unit, as individual room temperature control is not required. Direct air flow towards exterior doors. Do not exhaust air from this room.													
Assistant Chief	75	24	70	21	60	20	4	4	Exhaust (G)	35	(o)	Yes	CV
Note - None													
Bulk Storage	73	23	73	23	55	20	4	4	Exhaust (G)	40	(o)	Yes	CV
Note 1 - None													
Case Cart Holding	72	22	72	22	60	20	4	4	Exhaust (G)	40	(+)	Yes	CV
Note 1 - None													
Chief	75	24	70	21	60	20	4	4	Exhaust (G)	35	(o)	Yes	CV
Note - None													
Clean HAC	NA	NA	NA	NA	NA	NA	10	10	Exhaust (G)	40	(- -)	No	CV
Note 1 - Room Air Exhaust Use 100% transfer air from the clean areas to exhaust the HAC.													
Clean Lockers - Men	NA	NA	NA	NA	NA	NA	6	6	Exhaust (G)	40	(-)	No	CV
Note 1 - Room Air Balance Maintain locker rooms under negative air balance with respect to PPE and positive air balance with respect to the connecting Clean Toilet/Showers - Men.													

SPD CLEAN - ROOM DATA SHEET

ROOM NAME	INDOOR TEMPERATURE				INDOOR RELATIVE HUMIDITY		MIN TOTAL ACH	MIN OA ACH	ROOM AIR RETURN EXHAUST (G) EXHAUST (S)	MAX NOISE LEVEL NC	ROOM AIR BALANCE	INDIVIDUAL ROOM CONTROL	
	COOLING		HEATING		% RH	% RH						TEMP	FLOW
	F	C	F	C	MAX	MIN							
Clean Lockers - Women	NA	NA	NA	NA	NA	NA	6	6	Exhaust (G)	40	(-)	No	CV
Note 1- Room Air Balance Maintain locker rooms under negative air balance with respect to PPE and positive air balance with respect to the connecting Clean Toilet/Showers - Women.													
Clean Toilet/Showers - Men	NA	NA	NA	NA	NA	NA	10	10	Exhaust (G)	40	(--)	No	CV
Note 1- Room Air Balance Do not provide supply air to the toilet. Exhaust this space using 100% transfer air from the adjoining Clean Lockers - Men.													
Clean Toilet/Showers - Women	NA	NA	NA	NA	NA	NA	10	10	Exhaust (G)	40	(--)	No	CV
Note 1- Room Air Balance Do not provide supply air to the toilet. Exhaust this space using 100% transfer air from the adjoining Clean Lockers - Women.													
Dispatch Area	75	24	70	21	60	20	4	4	Exhaust (G)	40	(o)	Yes	CV
Note - None													
ETO Sterilizer/Aerator Room	72	22	72	22	60	20	10	10	Exhaust (S)	40	(-)	Yes	CV
Note 1 - General Provide a dedicated exhaust system to serve the ETO Sterilizer Room and abator. See AHU System Data Sheet for details. Provide transfer air from the Preparation, Assembly, and Sterilization Area to maintain negative air balance. **Note 2 - Flammable Storage Cabinet** Provide exhaust ventilation through the flammable storage cabinet. The cabinet exhaust shall be connected to the ETO exhaust system. Ensure compliance with NFPA 30 and applicable OSHA Regulations. **Note 3 - Alarms and Controls** Provide an alarm panel outside the ETO Sterilizer Room to sound a local alarm and remote alarm at the ECC in the event of loss or interruption of exhaust airflow. Integrate ETO gas leakage alarm with the exhaust system alarm.													
First Clerk Office	NA	NA	NA	NA	NA	NA	4	4	Exhaust (G)	40	(o)	No	CV
Note 1 - Room Air Balance Provide supply air from an adjoining air terminal unit.													

SPD CLEAN - ROOM DATA SHEET

ROOM NAME	INDOOR TEMPERATURE				INDOOR RELATIVE HUMIDITY		MIN TOTAL ACH	MIN OA ACH	ROOM AIR RETURN EXHAUST (G) EXHAUST (S)	MAX NOISE LEVEL NC	ROOM AIR BALANCE	INDIVIDUAL ROOM CONTROL	
	COOLING		HEATING		% RH	% RH						TEMP	FLOW
	F	C	F	C	MAX	MIN							
Non Sterile Storage	72	22	72	22	60	20	4	4	Exhaust (G)	40	(+)	Yes	CV
Note 1 - None													
PPE	72	22	72	22	60	20	10	10	Exhaust (G)	40	(+)	Yes	CV
Note 1- Room Air Balance Provide a dedicated terminal unit to serve Clean Lockers - Men and Women. Provide transfer air, as required, from Sterile/Non Sterile Storage. The space air shall infiltrate to the Clean Toilet/Showers - Men and Women.													
Preparation, Assembly, and Sterilization Area	72	22	72	22	60	20	4	4	Exhaust (G)	40	(+ +)	Yes	CV
Note 1 - Room Air Changes per Hour Minimum (total and outdoor) air changes specified for this room are based on ASHRAE Standard 170 - 2008. Actual air changes may vary based on the transfers air requirements of the adjoining spaces (ETO Sterilizer Room and Decontamination Area), cooling load to meet the space temperature, and transfer air to the clean storage spaces to maintain positive air balance. **Note 2 - Room Air Balance** Provide simple devices, such as, ball-in-tube or flutter strips to show the airflow direction. Device shall be installed between Preparation, Assembly, and Sterilization Area and the Sterile/Non Sterile Storage Area. Provide airflow control valves in the exhaust air ducts to measure and monitor the design air balance.												
Receiving & Breakout	72	22	72	22	60	20	6	6	Exhaust (G)	40	(+)	Yes	CV
Note 1 - None													

SPD CLEAN - ROOM DATA SHEET

ROOM NAME	INDOOR TEMPERATURE				INDOOR RELATIVE HUMIDITY		MIN TOTAL ACH	MIN OA ACH	ROOM AIR RETURN EXHAUST (G) EXHAUST (S)	MAX NOISE LEVEL NC	ROOM AIR BALANCE	INDIVIDUAL ROOM CONTROL	
	COOLING		HEATING		% RH	% RH						TEMP	FLOW
	F	C	F	C	MAX	MIN							
Satellite SPD Storage	NA	NA	NA	NA	NA	NA	4	2	Return	40	(+)	No	CV
Note 1- Ventilation Air Requirement Do not provide 100% outdoor air to, or 100% exhaust from, the SPD Storage Room and Warehouses remotely located from the Central SPD Department. **Note 2 - Individual Room Temperature Control** Not required for rooms of 80 to 100 sf [8 to 10 m^2]. Required for larger rooms with intermittent occupancy. **Note 3 - Return Air Pick-Up** Return air from rooms under 100 sf [10 m^2] is optional. **Note 4 - Room Air Balance** Provide supply air from an adjoining air terminal unit.													
Scope Storage Room	NA	NA	NA	NA	NA	NA	4	4	NA	40	(+)	No	CV
Note 1 - Room Air Balance Allow room air to ex-filtrate into the Endoscope Processing/High Level Decontamination Room. Maintain Endoscope Processing/High Level Decontamination Room under negative air balance and the Scope Storage Room under positive air balance.													
Staff Breakroom/Conference	75	24	70	21	60	20	6	4	Exhaust (G)	35	(o)	Yes	CV
Note - None													
Sterile Storage	72	22	72	22	60	20	4	4	Exhaust (G)	40	(+)	Yes	CV
Note 1 - None													

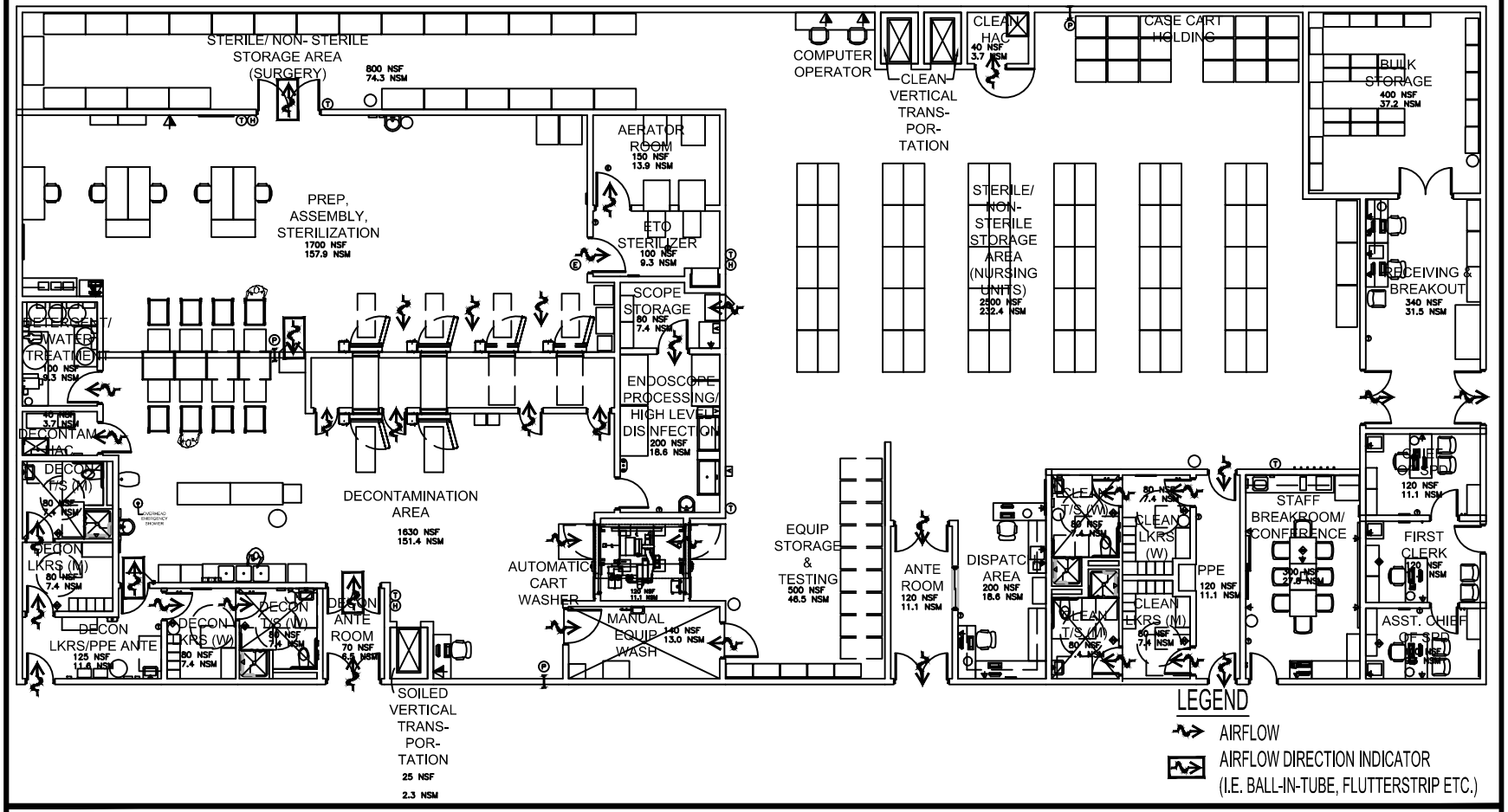
SPD SOILED (DIRTY) - ROOM DATA SHEET

ROOM NAME	INDOOR TEMPERATURE				INDOOR RELATIVE HUMIDITY		MIN TOTAL ACH	MIN OA ACH	ROOM AIR RETURN EXHAUST (G) EXHAUST (S)	MAX NOISE LEVEL NC	ROOM AIR BALANCE	INDIVIDUAL ROOM CONTROL	
	COOLING		HEATING		% RH	% RH						TEMP	FLOW
	F	C	F	C	MAX	MIN							
General: The rooms and their relative locations with adjoining spaces are based on information given in the VA Design Guide for the SPD Service dated February 2010.													
Automatic Cart Washer	NA	NA	NA	NA	NA	NA	10	10	Exhaust (S)	45	(-)	No	CV
Note 1 - Special Exhaust System See Manual Equipment Wash.													
Decontamination Ante Room	NA	NA	NA	NA	NA	NA	10	10	No	40	(+)	No	CV
Note 1 - Room Air Balance Provide supply air from an adjoining air terminal unit, as individual room temperature control is not required. Direct air flow towards interior doors. Do not exhaust air from this room.													
Decontamination Area	72	22	72	22	60	20	6	6	Exhaust (G)	40	(--)	Yes	CV
Note 1 - Room Air Changes per Hour Minimum (total and outdoor) air changes specified for this room are based on ASHRAE Standard 170 - 2008. Actual air changes may vary based on the transfer air requirements of the adjoining spaces, cooling load to meet the space temperature, and transfer air from the adjoining spaces to maintain negative air balance. **Note 2 - Room Air Balance** Provide simple devices, such as, ball-in-tube or flutter strips to show airflow direction. Devices shall be installed between the Decontamination Area and the following rooms: Decontamination Ante Room, Preparation, Assembly, and Sterilization Area, and Decontamination/Ante Room/PPE. Provide airflow control valves in the exhaust air ducts to measure and monitor the design air balance.													
Decontamination HAC	NA	NA	NA	NA	NA	NA	10	10	Exhaust (G)	40	(- -)	No	CV
Note 1 - Room Air Balance Use 100% transfer air from the Decontamination Area to exhaust this room.													
Decontamination Lockers/PPE Ante Room	75	24	70	21	60	20	10	10	Exhaust (G)	40	(-)	Yes	CV
Note 1 - Room Air Balance Provide a dedicated air terminal unit to serve Ante Room, Locker Rooms - Men and Women. Provide transfer air, as required, from the adjoining corridor. Exhaust room air by a ducted connection. The space air shall infiltrate into the Decontamination Lockers - Male and Female and Decontamination Area.													

SPD SOILED (DIRTY) - ROOM DATA SHEET													
ROOM NAME	INDOOR TEMPERATURE				INDOOR RELATIVE HUMIDITY		MIN TOTAL ACH	MIN OA ACH	ROOM AIR RETURN EXHAUST (G) EXHAUST (S)	MAX NOISE LEVEL NC	ROOM AIR BALANCE	INDIVIDUAL ROOM CONTROL	
	COOLING		HEATING		% RH MAX	% RH MIN						TEMP	FLOW
	F	C	F	C									
Decontamination Lockers - Men	NA	NA	NA	NA	NA	NA	6	6	Exhaust (G)	40	(-)	No	CV
Note 1 - Room Air Balance Maintain locker rooms under negative air balance with respect to the Decontamination Lockers/PPE Ante Room and positive air balance with respect to the Decontamination Toilet/Shower - Men.													
Decontamination Lockers - Women	NA	NA	NA	NA	NA	NA	6	6	Exhaust (G)	40	(-)	No	CV
Note 1 - Room Air Balance Maintain locker rooms under negative air balance with respect to the Decontamination Lockers/PPE Ante Room and positive air balance with respect to the Decontamination Toilet/Shower - Women.													
Decontamination Toilet/Shower - Men	NA	NA	NA	NA	NA	NA	10	10	Exhaust (G)	40	(- -)	No	CV
Note 1 - Room Air Balance Do not provide supply air to the toilet. Exhaust this space using 100% transfer from the adjoining locker room.													
Decontamination Toilet/Shower - Women	NA	NA	NA	NA	NA	NA	10	10	Exhaust (G)	40	(- -)	No	CV
Note 1 - Room Air Balance Do not provide supply air to the toilet. Exhaust this space using 100% transfer air from the adjoining locker room.													
Detergent and Water Treatment	NA	NA	NA	NA	NA	NA	10	10	Exhaust (G)	40	(- -)	No	CV
Note 1 - Room Air Balance Use 100% transfer air from the Decontamination Area to exhaust this room. **Note 2 - Individual Room Temperature Control** Individual room temperature control with supply air is required if the space is occupied.													
Endoscope Processing/High Level Disinfection	72	22	72	22	60	20	10	10	Exhaust (G)	40	(-)	Yes	CV
Note 1 - Air Balance Provide transfer air for negative air balance from the Scope Storage Room and Decontamination Area.													

SPD SOILED (DIRTY) - ROOM DATA SHEET

ROOM NAME	INDOOR TEMPERATURE				INDOOR RELATIVE HUMIDITY		MIN TOTAL ACH	MIN OA ACH	ROOM AIR RETURN EXHAUST (G) EXHAUST (S)	MAX NOISE LEVEL NC	ROOM AIR BALANCE	INDIVIDUAL ROOM CONTROL	
	COOLING		HEATING		% RH	% RH						TEMP	FLOW
	F	C	F	C	MAX	MIN							
Manual Equipment Wash	75	24	70	21	NA	NA	10	10	Exhaust (S)	40	(-)	Yes	CV
Note 1 - Air Terminal Unit Provide a dedicated air terminal unit to serve the Manual Equipment Wash and Automatic Cart Washer rooms. **Note 2 - Special Exhaust Systems** Provide a dedicated wet exhaust system to serve this space and the Automatic Cart Washer room. Provide a dedicated wet exhaust system to serve the Automatic Cart Washer equipment. **Note 3- Air Balance** Provide transfer air for negative air balance from the clean side and/or Decontamination Area.													
Sterilizer Equipment Room	NA	NA	NA	NA	NA	NA	10	10	Exhaust (G)	45	(-)	No	CV
Note 1 - Ventilation Ventilate this space by supplying air from an adjoining terminal unit (individual room temperature control is not required) and transfer air from the Clean and Soiled sides. Coordinate the canopy hood (generally provided for the capture of vapor) design with the architectural and equipment drawings.													



SPD AIR FLOW

Not to Scale

SURGICAL SUITE - AIR HANDLING UNIT	
AHU System Data Sheet	
Air Handling Type	Variable Air Volume (Two Position)
Indoor Design Temperature	Room Data Sheets
Indoor Design Relative Humidity	Room Data Sheets
Minimum Total Air Changes per Hour	Room Data Sheets
Minimum Outdoor Air Changes per Hour	Chapter 2
Return Air Permitted	Yes
Exhaust Air Required	No
Air Economizer Cycle Required	Yes
Heat Recovery System Required	ASHRAE Standard 90.1 - 2007
Filtration - Pre-Filters (PF-1 and PF-2)	PF-1 = MERV 7 and PF-2 = MERV 11
Filtration - After-Filter (AF)	AF = MERV 14
Filtration - Final-Filter (FF)	FF = MERV 17 (HEPA)
Cooling Source	Chilled Water
Heating Source	Steam and/or Hot Water
Humidification Source	Plant Steam or "Clean Steam"
General Exhaust System Required	Yes
Special Exhaust System Required	No
Emergency Power Required	Yes
Individual Room Temperature Control Required	Room Data Sheets
Room Air Balance	Room Data Sheets
Compliance	NFPA 99

Note 1 - Air Handling Unit System Features

(a) Occupied/Unoccupied Modes

Provide two-position (occupied/unoccupied), pressure-independent, supply air terminal units and matching return air terminal units. During unoccupied mode, the supply air volume shall reduce 50% and the return air terminal units shall track the supply air terminal units to maintain the design pressure differential. Changeover from occupied to unoccupied modes and vice-versa shall be automatic and/or manual. Coordinate the location of the manual changeover switch with the users.

(b) Variable Speed Drives

Provide variable speed drives for the supply and return air fans to adjust the fan speeds in unison during all modes of operation while still maintaining the design minimum outside air volume.

(c) Coil Fins

Provide copper fins for ALL coils (pre-heat, cooling, and terminal reheat coils) at ALL locations. Copper fins possess anti-microbial property and anti-corrosive property that is useful in resisting corrosion in high-humidity locations and locations with industrial pollution.

Note 2 - Humidifier

Provide a unit-mounted, central steam humidifier to maintain the space relative humidity at 20%. Preferred location of the steam humidifier is between the pre-heat and cooling coils. Individual room humidity control and terminal humidifiers are NOT required. Provide spare capacity (to maintain space RH at 50%) in the humidifier to enable the user to select higher than 20% RH capacity .

SURGICAL SUITE - AIR HANDLING UNIT
AHU System Data Sheet
Note 3 - Ductwork **(a) Flexible Duct** Use of flexible duct is NOT permitted in the air distribution system. **(b) Acoustic Sound Lining and Sound Attenuators** Use of the acoustic duct lining and duct-mounted or terminal sound attenuators is not permitted in the supply air ductwork. Sound attenuators may be used in the return and exhaust air ductwork. The attenuators shall be "hospital grade" with polyester film lining over the acoustical fill. **(c) Duct Pressure Classification** Calculate the duct pressure classification for the supply air ductwork from the air-handling unit to the air terminal units. With terminal HEPA filters on the downstream side of each air terminal unit, the expected pressure classification may range from 3 in [747 Pa] to 4 in [996 Pa]. **(d) Duct Velocity** ALL ductwork shall be low-velocity type with maximum duct velocity not exceeding 1,500 fpm [8 m/s]. Provide lower velocity if recommended by the acoustic analysis. **(e) Duct Fabrication** ALL ductwork shall be fabricated from galvanized steel with the following exception: For Operating Rooms, Cystoscopy Rooms and Clean Core, supply air ductwork and distribution system shall be fabricated of stainless steel downstream of the final filters.
Note 4 -Final Filters Final filters shall be provided for ALL air terminal units, served by the Surgical Suite AHU. For spaces other than Operating and Cystoscopy Rooms, the use of a final HEPA filter ensures a balanced pressure drop at all air terminal units.
Note 5 - Air Distribution (Operating Rooms and Cystoscopy Rooms) **(a) Supply Air** Supply air distribution outlets shall consist of stainless steel multiple slot panel diffusers positioned around the operating tables to discharge 60% of the air in a vertical airstream inclined at a 15 degrees outward angle. Percentage distribution may vary by manufacturer. The remaining 40% air shall be delivered downward over the operating area using perforated face outlets. **(b) Return Air** Provide at least two return air inlets, fabricated from aluminum, to pick-up return air at approximately 7 in [175 mm] above the floor level. The inlets shall be located diagonally across from one another. **(c) Supply Air Terminal Units** All supply air terminal units shall be fabricated from galvanized steel but WITHOUT integral acoustic lining. **(d) Return Air Terminal Units** All return air terminal units can be conventional variable air volume boxes or airflow control valves (AFCV).
Note 6 - Air Distribution (All Other Spaces) **(a) Supply, Return, and Exhaust Air** Provide conventional overhead supply, return, and exhaust air ductwork with painted steel or aluminum air outlets and inlets. **(b) Supply and Return Air Terminal Units** All supply air terminal units shall be fabricated from galvanized steel and shall be the standard products of the manufacturers. The return air terminal units can be conventional variable air volume boxes or airflow control valves (AFCV).

SURGICAL SUITE - AIR HANDLING UNIT
AHU System Data Sheet
Note 7 - Temperature and Relative Humidity Controls **(a) Room Temperature Control** Provide individual room temperature control for Operating Rooms, Cystoscopy Rooms, and other spaces identified in the Room Data Sheets. Provide trend logging capability at the ECC in EXCEL type spreadsheet format. **(b) Room Humidity Sensors** Provide room humidity sensors for each Operating and Cystoscopy Room to measure and record the space relative humidity. While the space relative humidity is controlled by the cooling coil leaving dew-point temperature in the dehumidification mode and by the central humidifier in the humidification mode, the DDC control system shall poll the space relative humidity sensors to initiate the corrective actions: **(b.1) Dehumidification Mode** The relative humidity is not directly controlled but maintained within the range by controlling the dew-point temperature between 47 F to 48 F [8 C to 9 C], based on the psychometric analysis at 66 F [19 C] and 55% RH with 60% RH as the high limit. Upon rise in relative humidity above 60%, initiate alarms (local visible and remote at the ECC) and project-specific corrective actions. **(b.2) Humidification Mode** Upon drop in space relative humidity below 20%, measured by any space relative humidity sensor, the central humidifier shall be activated to maintain the set point. **(c) Space Pressure Differential Control** Provide a space pressure differential sensor (set point: + 0.01 in [+ 2.5 Pa]) monitoring and controlling device at each Operating and Cystoscopy room with respect to the Semi-Restricted Corridor. Provide a control sequence to maintain the set point. Coordinate with the architectural discipline to keep the space air tight. Also, provide a simple, manual device, such as, ball-in-tube or flutter strip to verify the airflow direction. Install devices between the Operating and Cystoscopy Rooms and the following rooms: Semi-Restricted Corridor and Clean Corridor.
Note 8 - Special Chilled Water Requirement Uninterrupted supply of chilled water (at the design chilled water supply temperature) shall be available on demand. In the event the central chilled water plant can not meet this requirement, provide a dedicated chiller (N+1) on emergency power. Provide cross connections between the central chilled water plant and the dedicated chiller(s) to ensure flexibility in operation.

SURGICAL SUITE - ROOM DATA SHEET

ROOM NAME	INDOOR TEMPERATURE				INDOOR RELATIVE HUMIDITY		MIN TOTAL ACH	MIN OA ACH	ROOM AIR RETURN EXHAUST (G) EXHAUST (S)	MAX NOISE LEVEL NC	ROOM AIR BALANCE	INDIVIDUAL ROOM CONTROL		UNOCCUPIED ACH
	COOLING		HEATING		% RH	% RH						TEMP	FLOW	
	F	C	F	C	MAX	MIN								
General: The rooms and their relative locations with adjoining spaces are based on information given in the VA Design Guide for the Surgical Service dated August 2005.														
Anesthesia Workroom & Equipment	75	24	70	21	60	20	6	2	Return	40	(o)	Yes	CV	6
Note - None														
Clean Core	75	24	70	21	60	20	8	2	Return	40	(++)	Yes	VAV	4
Note 1 - Air Balance Positive with respect to the Operating and Cystoscopic Rooms during occupied and unoccupied modes of operation.														
Controls & Communication Center	75	24	70	21	60	20	8	2	Return	40	(o)	Yes	VAV	4
Note - None														
Cystoscopic Rooms	66	19	75	24	60	20	20	4	Return	40	(+)	Yes	VAV	10
Note 1 - Air Balance Positive with respect to the Semi-Restricted Corridor during occupied and unoccupied modes of operation.														
Frozen Section Laboratories	75	24	70	21	60	20	6	2	Exhaust (G)	40	(-)	Yes	CV	6
Note - None														
Gas Cylinder Storage Room	NA	NA	NA	NA	NA	NA	6	NA	Exhaust (G)	40	(- -)	No	CV	6
Note 1 - Room Exhaust Transfer air from adjoining spaces for exhaust. Do not supply air under positive air pressure.														
Heart Lung Machine Preparation	75	24	70	21	60	20	6	2	Return	35	(o)	Yes	VAV	3
Note - None														

SURGICAL SUITE - ROOM DATA SHEET

ROOM NAME	INDOOR TEMPERATURE				INDOOR RELATIVE HUMIDITY		MIN TOTAL ACH	MIN OA ACH	ROOM AIR	MAX NOISE LEVEL NC	ROOM AIR BALANCE	INDIVIDUAL ROOM CONTROL		UNOCCUPIED ACH
	COOLING		HEATING		% RH	% RH			RETURN EXHAUST (G)			TEMP	FLOW	
	F	C	F	C	MAX	MIN			EXHAUST (S)					
Instrument Preparation and Storage	75	24	70	21	60	20	6	2	Return	40	(+)	Yes	VAV	3
Note 1 - Room Air Balance Positive during occupied and unoccupied modes of operation.														
Nerve Block Induction Room	75	24	70	21	60	20	10	2	Return	40	(+)	Yes	VAV	5
Note 1 - Room Air Balance Positive during occupied and unoccupied modes of operation.														
Operating Rooms	66	19	75	24	60	20	20	4	Return	40	(+)	Yes	VAV	10
Note 1 - Room Air Balance Positive during occupied and unoccupied modes of operation.														
Plaster Splint Storage	NA	NA	NA	NA	NA	NA	6	NA	Exhaust (G)	40	(-)	No	CV	6
Note - None														
Post Anesthesia Care Unit (PACU)	75	24	70	21	60	20	6	2	Return	35	(+)	Yes	CV	6
Note 1 - Room Temperature Control Size the terminal reheat coil to maintain 86 F [30 C] room temperature on demand. **Note 2 - Filtration Requirements** For PACUs served by the Surgical Suite AHU, provide terminal HEPA filters on the downstream side of each air terminal unit.														
Radiographic Film Processing Room	75	24	70	21	60	20	8	2	Exhaust (G)	40	(-)	Yes	CV	8
Note 1 - Room Air Return Return air is not permitted if chemicals are used in film processing.														

SURGICAL SUITE - ROOM DATA SHEET

ROOM NAME	INDOOR TEMPERATURE				INDOOR RELATIVE HUMIDITY		MIN TOTAL ACH	MIN OA ACH	ROOM AIR	MAX NOISE LEVEL NC	ROOM AIR BALANCE	INDIVIDUAL ROOM CONTROL		UNOCCUPIED ACH
	COOLING		HEATING		% RH	% RH			RETURN EXHAUST (G) EXHAUST (S)			TEMP	FLOW	
	F	C	F	C	MAX	MIN								
Semi-Restricted Corridor	75	24	70	21	60	20	8	2	Return	40	(o)	Yes	VAV	4
Note 1 - Room Air Balance Maintain negative air balance with respect to the Operating and Cystoscopy Rooms and positive to other adjoining spaces.														
Soiled Holding/Disposal Room	NA	NA	NA	NA	NA	NA	12	NA	Exhaust (G)	45	(- -)	No	CV	12
Note 1 - Room Exhaust Transfer air from the adjoining spaces for exhaust.														
Sub-Sterile Room	75	24	70	21	60	20	6	2	Exhaust (G)	40	(- -)	Yes	CV	6
Note 1 - Room Exhaust Transfer room air to the Sterilizer Equipment Room and connect to the general exhaust system. This room is positive with respect to the equipment room.														

Common (Non-Dedicated AHU) Room Data Sheets

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PATIENT EXAMINATION, TREATMENT, AND PROCEDURE ROOMS - ROOM DATA SHEET													
ROOM NAME	INDOOR TEMPERATURE				INDOOR RELATIVE HUMIDITY		MIN TOTAL ACH	MIN OA ACH	ROOM AIR	MAX NOISE LEVEL NC	ROOM AIR BALANCE	INDIVIDUAL ROOM CONTROL	
	COOLING		HEATING		% RH	% RH			RETURN EXHAUST (G) EXHAUST (S)			TEMP	FLOW
	F	C	F	C	MAX	MIN							
Audiology Office/Therapy Room	75	24	70	21	60	20	6	2	Return	35	(o)	Yes	VAV
Note - None													
Audiometric	75	24	70	21	60	20	6	2	Return	25	(o)	Yes	VAV
Note 1 - Acoustic Booth Coordinate the installation of the acoustic booth (if any) and its integral HVAC system with the architectural layout and building utilities. **Note 2 - Room Noise Level** Provide acoustic measures to maintain the design NC level.													
Blood Draw Room	75	24	70	21	60	20	6	2	Return	35	(o)	Yes	VAV
Note - None													
Bone Marrow Transplant (BMT) Suite													
Donors Room	75	24	70	21	60	20	6	2	Return	35	(+ +)	Yes	CV
Medication Preparation Room	75	24	70	21	60	20	6	2	Return	35	(+ +)	Yes	CV
Patient Rooms	75	24	70	21	60	20	6	2	Return	35	(+ +)	Yes	CV
Recovery Rooms	75	24	70	21	60	20	6	2	Return	35	(+ +)	Yes	CV
Note - None													

PATIENT EXAMINATION, TREATMENT, AND PROCEDURE ROOMS - ROOM DATA SHEET

ROOM NAME	INDOOR TEMPERATURE				INDOOR RELATIVE HUMIDITY		MIN TOTAL ACH	MIN OA ACH	ROOM AIR RETURN EXHAUST (G) EXHAUST (S)	MAX NOISE LEVEL NC	ROOM AIR BALANCE	INDIVIDUAL ROOM CONTROL	
	COOLING		HEATING		% RH	% RH						TEMP	FLOW
	F	C	F	C	MAX	MIN							
Dental Suite													
Ceramic Room	75	24	70	21	60	20	6	2	Exhaust (G)	40	(-)	Yes	CV
Note 1 - Heat Gain Coordinate equipment heat gain with the manufacturer. **Note 2 - Exhaust Air Intakes** Locate exhaust air registers at or near the technician's workbench. Ensure coordination with the architectural drawings.													
Oral Surgery Recovery Room	75	24	70	21	60	20	6	2	Return	35	(+)	Yes	CV
Note - None													
Oral Surgery Room	75	24	70	21	60	20	15	3	Return	35	(+)	Yes	CV
Note 1 - Space Classification The design criteria are based on the assumption that the Oral Surgery Room is classified as Class A Surgery/Procedure Room (ASHRAE Standard 170 - 2008). The designer shall verify the requirements with the end-users and modify the classification, if necessary. **Note 2 - Nitrous Oxide Gas** Where nitrous oxide gas is used, the design shall implement the recommendation of National Institute for Occupational Safety and Health (NIOSH) to limit the occupational exposure within the prescribed limits by installing a local scavenging system. Compliance is also required to NFPA 99 for other safety requirements.												
Prosthetic Laboratory	75	24	70	21	60	20	6	2	Exhaust (G)	40	(-)	Yes	CV
Note 1 - Exhaust from Prosthetic Dental Workstation Provide exhaust from the prosthetic dental workstation either by wall registers, installed at the table height, or by a canopy hood. Exhaust can be connected to the general exhaust system. Estimate the exhaust air volume based on the geometry of the work area. **Note 2 - Heat Gain** Coordinate equipment heat gain with the manufacturer. **Note 3 - Boil-Out Sink and Casing Soldering Areas** Provide exhaust over the boil-out sink and case-soldering area using a canopy hood, connected to a general exhaust system, and sized at 100 fpm [0.5 m/s] face velocity. Coordinate the hood size and location with the architectural drawings.												
Treatment Operatory	75	24	70	21	60	20	6	2	Return	40	(+)	Yes	CV
Note - None													

PATIENT EXAMINATION, TREATMENT, AND PROCEDURE ROOMS - ROOM DATA SHEET													
ROOM NAME	INDOOR TEMPERATURE				INDOOR RELATIVE HUMIDITY		MIN TOTAL ACH	MIN OA ACH	ROOM AIR	MAX NOISE LEVEL NC	ROOM AIR BALANCE	INDIVIDUAL ROOM CONTROL	
	COOLING		HEATING		% RH	% RH			RETURN EXHAUST (G) EXHAUST (S)			TEMP	FLOW
	F	C	F	C	MAX	MIN							
Examination Rooms	75	24	70	21	60	20	6	2	Return	35	(o)	Yes	VAV

Note 1 - General

The design parameters are applicable to all examination rooms not involving treatment and/or procedures.

Note 2 - Individual Room Temperature Control

Refer to Chapter 2 for the guidelines on the individual room temperature control.

Isolation Rooms

Note 1 - General

Isolation Rooms are classified into three categories: Airborne Infection Isolation (AII), Protective Environment (PE), and Combination AII/PE Rooms.

Note 2 - Ante Room

Per ASHRAE Standard 170 and the Facility Guidelines Institue (FGI), use of an Ante Room is mandated only for Combination AII/PE, where the patient requires a protective environment and also has an airborne infectious disease. However, this manual highly recommends that ALL isolation rooms are equipped with Ante Rooms.

(a) Ante Rooms facilitate intended design air balance.

(b) Ante Rooms provide better protection by isolating PE patients from the adjoining environment and the adjoining environment from the AII patient.

(c) Ante Rooms provide the space required to don protective equipment before entering the isolation room.

(d) Ante Rooms can be used for hand hygiene and storage of personal protective equipment and clean equipment.

PATIENT EXAMINATION, TREATMENT, AND PROCEDURE ROOMS - ROOM DATA SHEET

ROOM NAME	INDOOR TEMPERATURE				INDOOR RELATIVE HUMIDITY		MIN TOTAL ACH	MIN OA ACH	ROOM AIR	MAX NOISE LEVEL NC	ROOM AIR BALANCE	INDIVIDUAL ROOM CONTROL	
	COOLING		HEATING		% RH	% RH			RETURN EXHAUST (G) EXHAUST (S)			TEMP	FLOW
	F	C	F	C	MAX	MIN							
Airborne Infection Isolation (AII) (Negative Air Pressure)													
AII Ante Room (Optional)	NA	NA	NA	NA	NA	NA	10	NA	Exhaust (S)	35	Note 2	No	CV
AII Isolation Room	75	24	70	21	60	20	12	2	Exhaust (S)	35	(-)	Yes	CV

Note 1 - Special Exhaust System

Provide a dedicated, special exhaust system for the Patient Bedroom, Ante Room and Patient Toilet (where present). Do not connect other rooms to the dedicated exhaust system. Discharge exhaust air above the highest roof level through a stack at least 10 ft [3 m] tall at 3,500 fpm [18 m/s] discharge velocity. The discharge air outlet shall be located at least 25 ft [8 m] from outdoor air intakes and operable windows. Follow the recommendations of the dispersion analysis for higher than minimum requirements. Provide emergency power for the exhaust fan and associated controls.

Note 2 - Instrumentation

Provide a local, visual alarm and remote alarm at the ECC to show non-compliance in maintaining negative air pressure difference. Provide an automatic (DDC) airflow control valve in the exhaust air duct to measure and modulate the airflow as required.

Note 3 - Air Distribution Layout

(a) Patiend Bedroom

Locate the exhaust air inlet over or near the patient bed to ensure that air flows into the room and away from the patient room door. Preferred location of the exhaust air inlet is in the wall, 7 in [175 mm] above the floor, and near the patient head rest.

(b) Ante Room

When an Ante Room is used, transfer air is required to maintain 0.01 in [2.5 Pa] negative air pressure. Air shall transfer from the Corridor into the Ante Room and then to the Isolation Room. The Ante Room is positive with respect to the Isolation Room and negative with respect to the Corridor.

Combination Airborne Infection Isolation/Protective Environment (AII/PE)													
AII/PE Ante Room	NA	NA	NA	NA	NA	NA	10	NA	Exhaust (S)	35	Note 3	No	CV
AII/PE Isolation Room	75	24	70	21	60	20	12	2	Exhaust (S)	35	Note 3	Yes	CV

Note 1 - Terminal HEPA Filter

Same as PE Isolation Room.

Note 2 - Exhaust Air for Isolation Room and Ante Room

Same as AII Isolation Room.

Note 3 - Ante Room Airflow

(a) Supply air from the Ante Room to the Isolation Room and the Corridor; OR

(b) Exhaust air from the Ante Room by transferring air from the Isolation Room and the Corridor.

Note 4 - Instrumentation

Provide a local, visual alarm and remote alarm at the ECC to show non-compliance in maintaining negative air pressure difference. Provide an automatic (DDC) airflow control valve in the exhaust air duct to measure and modulate the airflow as required.

PATIENT EXAMINATION, TREATMENT, AND PROCEDURE ROOMS - ROOM DATA SHEET

ROOM NAME	INDOOR TEMPERATURE				INDOOR RELATIVE HUMIDITY		MIN TOTAL ACH	MIN OA ACH	ROOM AIR	MAX NOISE LEVEL NC	ROOM AIR BALANCE	INDIVIDUAL ROOM CONTROL	
	COOLING		HEATING		% RH	% RH			RETURN EXHAUST (G)			TEMP	FLOW
	F	C	F	C	MAX	MIN			EXHAUST (S)				
Protective Environment (PE) (Positive Air Pressure)													
PE Ante Room (Optional)	NA	NA	NA	NA	NA	NA	10	NA	Return	35	(-)	No	CV
PE Isolation Room	75	24	70	21	60	20	12	2	Return	35	(+)	Yes	CV
Note 1 - Terminal HEPA Filter Provide duct-mounted, terminal MERV 17 (HEPA) filter downstream of the dedicated air terminal units serving the Isolation Rooms. Ensure access for filter replacement and instrumentation. Provide a differential pressure gage and a differential pressure switch with a remote alarm to the ECC when the pressure drop exceeds the recommended pressure drop. **Note 2 - Positive Air Balance** Monitor and maintain the patient bedroom at + 0.01 in [+ 2.5 Pa] positive air pressure with respect to the adjoining spaces not associated with the Isolation Suite. Provide a local visual alarm and remote alarm at the ECC to show non-compliance in maintaining positive air pressure difference. Provide an automatic (DDC) airflow control valve in the branch return air duct to measure and modulate the airflow as required. **Note 3 - Air Distribution Layout** **(a) Patiend Bedroom** Locate the exhaust air inlet over or near the entry door to ensure that air flows into the room and away from the patient bed. **(b) Ante Room** When an Ante Room is used, airflow is required to maintain 0.01 in [2.5 Pa] positive air pressure between the patient bedroom and the corridor. Air shall transfer from the Isolation Room into the Ante Room and then to the Corridor. The Ante Room is negative with respect to the Isolation Room and positive with respect to the Corridor.													
Orthopedic Clinic (Cast Room)	75	24	70	21	60	20	6	2	Return	40	(-)	Yes	VAV
Note - None													

PATIENT EXAMINATION, TREATMENT, AND PROCEDURE ROOMS - ROOM DATA SHEET													
ROOM NAME	INDOOR TEMPERATURE				INDOOR RELATIVE HUMIDITY		MIN TOTAL ACH	MIN OA ACH	ROOM AIR RETURN EXHAUST (G) EXHAUST (S)	MAX NOISE LEVEL NC	ROOM AIR BALANCE	INDIVIDUAL ROOM CONTROL	
	COOLING		HEATING		% RH	% RH						TEMP	FLOW
	F	C	F	C	MAX	MIN							
Procedure Room/Class A Operating	75	24	70	21	60	20	15	3	Return	35	(+)	Yes	CV
Note 1 - Air Distribution Provide overhead supply and return air distribution. **Note 2 - Room Air Balance** Provide negative air balance where required by the application. **Note 3 - Minimum Filter Requirement** Provide MERV 7 and MERV 11 pre-filter and MERV 14 after-filter.													
Pulmonary Exercise Room	75	24	70	21	60	20	10	2	Exhaust (G)	40	(-)	Yes	VAV
Note - None													
Special Procedure Rooms													
Aerosolized Pentamidine	75	24	70	21	60	20	12	2	Exhaust (G)	35	(-)	Yes	CV
Bronchoscopy	75	24	70	21	60	20	12	2	Exhaust (G)	35	(-)	Yes	CV
Cardiac Catheterization	75	24	70	21	60	20	15	3	Return	35	(+)	Yes	CV
Colonoscopy/EGD	75	24	70	21	60	20	8	2	Exhaust (G)	35	(-)	Yes	CV
Cystoscopy	75	24	70	21	60	20	15	3	Return	35	(+)	Yes	CV
Endoscopy	75	24	70	21	60	20	6	2	Return	35	(+)	Yes	CV
Fluoroscopy	75	24	70	21	60	20	8	2	Exhaust (G)	35	(-)	Yes	CV
Gastrointestinal	75	24	70	21	60	20	10	2	Exhaust (G)	35	(-)	Yes	CV
Proctoscopy	75	24	70	21	60	20	6	2	Exhaust (G)	35	(-)	Yes	CV
Sigmoidoscopy	75	24	70	21	60	20	8	2	Exhaust (G)	35	(-)	Yes	CV
Sputum Collection	75	24	70	21	60	20	12	2	Exhaust (G)	35	(-)	Yes	CV
Note - None													

PATIENT EXAMINATION, TREATMENT, AND PROCEDURE ROOMS - ROOM DATA SHEET													
ROOM NAME	INDOOR TEMPERATURE				INDOOR RELATIVE HUMIDITY		MIN TOTAL ACH	MIN OA ACH	ROOM AIR	MAX NOISE LEVEL NC	ROOM AIR BALANCE	INDIVIDUAL ROOM CONTROL	
	COOLING		HEATING		% RH	% RH			RETURN EXHAUST (G) EXHAUST (S)			TEMP	FLOW
	F	C	F	C	MAX	MIN							
Therapy Rooms													
Hydrotherapy/Therapeutic Pool	75	24	70	21	60	20	12	2	Exhaust (G)	45	(-)	Yes	CV
Kinesiotherapy	75	24	70	21	60	20	6	2	Return	40	(o)	Yes	VAV
Occupational Therapy	75	24	70	21	60	20	6	2	Return	35	(o)	Yes	VAV
Physical Therapy	75	24	70	21	60	20	6	2	Return	35	(-)	Yes	VAV
Note 1 - Kinesiotherapy and Hydrotherapy/Therapeutic Pool Rooms													
The reheat coil capacity shall be sized to maintain up to 82 F [28 C] space temperature for the two rooms.													
Note 2 - Hydrotherapy/Therapeutic Pool													
Provide a dedicated wet exhaust system.													
Treatment Rooms													
Chemotherapy	75	24	70	21	60	20	6	2	Exhaust (G)	35	(-)	Yes	CV
Dermatology	75	24	70	21	60	20	6	2	Return	35	(-)	Yes	VAV
Phototherapy/Shower Room	75	24	70	21	60	20	6	2	Exhaust (G)	35	(o)/(-)	Yes	VAV
Note 1 - Phototherapy/Shower Room													
Maintain negative air balance in the Shower Room and neutral air balance in the Phototherapy Room.													
Tub Room	75	24	70	21	60	20	10	2	Exhaust (G)	40	(-)	Yes	CV
Note 1 - Reheat Coil Capacity													
The reheat coil capacity shall be sized to maintain 86 F [30 C] space temperature.													
Ventilatory Test Room	75	24	70	21	60	20	12	2	Exhaust (G)	35	(-)	Yes	CV
Note 1 - Exhaust Grilles													
Provide low level exhaust grilles 7 in [175 mm] above the finished floor.													
Visual Field/Photography Room	75	24	70	21	60	20	4	2	Return	35	(o)	Yes	VAV
Note - None													
Vital Signs Station	NA	NA	NA	NA	NA	NA	4	NA	Return	35	(o)	No	VAV
Note - None													

NON PATIENT ROOMS - SUPPORT AREAS - ROOM DATA SHEET

ROOM NAME	INDOOR TEMPERATURE				INDOOR RELATIVE HUMIDITY		MIN TOTAL ACH	MIN OA ACH	ROOM AIR RETURN EXHAUST (G) EXHAUST (S)	MAX NOISE LEVEL NC	ROOM AIR BALANCE	INDIVIDUAL ROOM CONTROL	
	COOLING		HEATING		% RH	% RH						TEMP	FLOW
	F	C	F	C	MAX	MIN							
Admission and Main Waiting	75	24	70	21	60	20	6	2	Exhaust (G)	40	(-)	Yes	CV
Note 1 - Waiting Area Exhaust Exhaust the designated waiting area by drawing supply and transfer air towards the space. Provide a dedicated exhaust air system, if feasible. ASHRAE recommends a dedicated air-handling unit, where the admission and waiting areas can be physically separated from the space, such as, entrance lobby. The dedicated air-handling unit shall be designed to operate from 100% outdoor air to minimum outdoor air on demand.													
Barber Shop	75	24	70	21	60	20	4	2	Return	40	(-)	Yes	VAV
Note 1 - Exhaust Requirements Per ASHRAE 62.1 - 2007, the barber shop should be exhausted at the rate of 0.5 cfm/sf [2.5 L/s/m^2], while returning the remaining air, if any.													
Chapel	75	24	70	21	60	20	4	2	Return	35	(o)	Yes	VAV
Note 1 - Dedicated Air-Handling Unit For chapels requiring 5,000 cfm [2,360 L/s] and higher supply air volume, provide a dedicated air-handling unit to facilitate energy conservation initiatives.													
Class Room	75	24	70	21	60	20	6	2	Return	35	(o)	Yes	VAV
Note 1 - Energy Conservation Initiative Evaluate the feasibility of using a carbon-dioxide (CO_2) and/or occupancy sensors to conserve energy during part load conditions. The control sequence shall be project-specific.													
Conference Room	75	24	70	21	60	20	4	2	Return	35	(o)	Yes	VAV
Note 1 - Energy Conservation Initiative Evaluate the feasibility of using a carbon-dioxide (CO_2) and/or occupancy sensors to conserve energy during part load conditions. The control sequence shall be project-specific.													
Corridors	75	24	70	21	60	20	4	2	Return	40	(+)	Yes	CV
Note 1 - Supply Air Volume Increase the supply air volume, as required, to meet the transfer air demands of the adjoining spaces, such as, toilets, janitor closets, soiled utility rooms, laboratories, spaces requiring negative air balance, and exterior doors requiring ex-filtration.													

NON PATIENT ROOMS - SUPPORT AREAS - ROOM DATA SHEET													
ROOM NAME	INDOOR TEMPERATURE				INDOOR RELATIVE HUMIDITY		MIN TOTAL ACH	MIN OA ACH	ROOM AIR RETURN EXHAUST (G) EXHAUST (S)	MAX NOISE LEVEL NC	ROOM AIR BALANCE	INDIVIDUAL ROOM CONTROL	
	COOLING		HEATING		% RH	% RH						TEMP	FLOW
	F	C	F	C	MAX	MIN							
Dressing Room	NA	NA	NA	NA	NA	NA	4	NA	Return	35	(o)	No	VAV
Note 1 - Room Supply Supply air from an adjoining air terminal unit with similar load characteristics.													
Gift Shop (Retail Store)	75	24	70	21	60	20	4	2	Return	40	(o)	Yes	VAV
Note - None													
Library	75	24	70	21	60	20	4	2	Return	35	(O)	Yes	VAV
Note - None													
Locker Room (with Toilets)	75	24	70	21	60	20	10	NA	Exhaust (G)	40	(-)	Yes	CV
Note 1 - Room Air Balance Transfer supply air to the toilets and showers. Maintain locker rooms under negative air balance with respect to the adjoining spaces.													
Locker Room (without Toilets)	75	24	70	21	60	20	6	NA	Exhaust (G)	40	(-)	Yes	CV
Note 1 - Room Air Balance Maintain locker rooms under negative air balance with respect to the adjoining spaces.													
Lounge	75	24	70	21	60	20	4	2	Exhaust (G)	40	(-)	Yes	CV
Note 1 - Room Air Return air is permitted if the lounge is not equipped with vending machines, microwave, refrigerator, etc.													

NON PATIENT ROOMS - SUPPORT AREAS - ROOM DATA SHEET

ROOM NAME	INDOOR TEMPERATURE				INDOOR RELATIVE HUMIDITY		MIN TOTAL ACH	MIN OA ACH	ROOM AIR	MAX NOISE LEVEL NC	ROOM AIR BALANCE	INDIVIDUAL ROOM CONTROL	
	COOLING		HEATING		% RH	% RH			RETURN EXHAUST (G) EXHAUST (S)			TEMP	FLOW
	F	C	F	C	MAX	MIN							
Medical Media Service (MMS)													
Audio Visual Storage/Checkout	75	24	70	21	60	20	4	2	Return	40	(o)	Yes	VAV
Camera Copy	75	24	70	21	60	20	6	2	Return	35	(o)	Yes	VAV
Client Review Room	75	24	70	21	60	20	4	2	Return	35	(o)	Yes	VAV
Computer Imaging System Network	75	24	70	21	60	20	6	2	Return	40	(o)	Yes	VAV
Darkroom (Printing/Enlarging)	75	24	70	21	60	20	6	2	Exhaust (G)	35	(-)	Yes	VAV
Expanded Core - Illustration Room	75	24	70	21	60	20	6	2	Return	35	(o)	Yes	VAV
Expanded Core - Stat Camera	75	24	70	21	60	20	6	2	Return	35	(o)	Yes	VAV
Photo Finishing	75	24	70	21	60	20	6	2	Exhaust (G)	35	(-)	Yes	VAV
Photo Studio/Audio Visual Recording	75	24	70	21	60	20	6	2	Return	30	(o)	Yes	VAV
Photomicrography	75	24	70	21	60	20	6	2	Return	35	(o)	Yes	VAV
Video Editing CCTV Control Room	75	24	70	21	60	20	6	2	Return	35	(o)	Yes	VAV
Note 1 - Darkroom (Printing/Enlarging) and Photo Finishing Exhaust room air if chemicals are used for film processing.													
Medical Records	75	24	70	21	60	20	4	2	Return	40	(o)	Yes	VAV
Note - None													
Medication Room	75	24	70	21	60	20	4	2	Return	40	(+)	Yes	VAV
Note - None													
Multipurpose Room	75	24	70	21	60	20	4	2	Return	40	(o)	Yes	VAV
Note 1 - Energy Conservation Initiative Evaluate the feasibility of using a carbon-dioxide (CO_2) and/or occupancy sensors to conserve energy during part load conditions. The control sequence shall be project-specific. **Note 2 - Folding Partitions** Where the room is equipped with folding partitions, provide individual room temperature control for either side of the partition.													

NON PATIENT ROOMS - SUPPORT AREAS - ROOM DATA SHEET													
ROOM NAME	INDOOR TEMPERATURE				INDOOR RELATIVE HUMIDITY		MIN TOTAL ACH	MIN OA ACH	ROOM AIR RETURN EXHAUST (G) EXHAUST (S)	MAX NOISE LEVEL NC	ROOM AIR BALANCE	INDIVIDUAL ROOM CONTROL	
	COOLING		HEATING		% RH	% RH						TEMP	FLOW
	F	C	F	C	MAX	MIN							
Offices	75	24	70	21	60	20	4	2	Return	40	(o)	Yes	VAV
Note 1 - Room Temperature Control See Chapter 2 for individual room temperature control requirements.													
Pool Dressing/Toilet/Shower - Male/Female	75	24	70	21	60	20	4	NA	Exhaust (G)	45	(-)	Yes	CV
Note - None													
Toilets - Public (Interior)	NA	NA	NA	NA	NA	NA	10	NA	Exhaust (G)	40	(- -)	No	CV
Note - None													
Toilets - Public (Perimeter)	NA	NA	68	20	NA	NA	10	NA	Exhaust (G)	40	(- -)	Yes	CV
Note 1 - Perimeter Heating For toilets with an exterior wall subject to heat loss, provide thermostatically-controlled (closed-loop, local control) terminal heater(s) to maintain set point.													

NON PATIENT ROOMS - MISCELLANEOUS AREAS - ROOM DATA SHEET

ROOM NAME	INDOOR TEMPERATURE				INDOOR RELATIVE HUMIDITY		MIN TOTAL ACH	MIN OA ACH	ROOM AIR RETURN EXHAUST (G) EXHAUST (S)	MAX NOISE LEVEL NC	ROOM AIR BALANCE	INDIVIDUAL ROOM CONTROL	
	COOLING		HEATING		% RH	% RH						TEMP	FLOW
	F	C	F	C	MAX	MIN							
Attic Space	NA	NA	50	10	NA	NA	10	10	Exhaust (G)	45	(o)	Yes	CV
Note 1 - Heating System Provide a thermostatically controlled (closed-loop, local control) heating system utilizing terminal unit heaters or a central heating system. Ensure uniform heat distribution. Minimum outdoor ACH is not required in heating mode. The ventilation system shall be inoperative when the heating system is enabled. **Note 2 - Ventilation System** Provide an exhaust ventilation system (closed-loop, local control either thermostatically or manually operated) to prevent excessive heat build up. The exhaust ventilation system shall consist of exhaust fan(s) and exhaust/intake air louvers with motorized dampers. Provide direct-drive fan(s) to reduce maintenance. If a central, supply air heating system (Note 1) is the selected option, exhaust (relief) arrangement shall be compatible with the central heating system. **Note 3 - Access** Coordinate access to the mechanical equipment with the architectural discipline.												
Audiology Instrument Calibration and Repair Shop	75	24	70	21	60	20	4	2	Return	40	(+)	Yes	VAV
Note - None													
Battery Charging Room	75	24	70	21	60	20	8	2	Exhaust (S)	40	(-)	Yes	CV
Note 1 - Special Exhaust System Provide a dedicated, special exhaust system where lead batteries (Automatic Transport System and Wheel Chairs Charging Areas) are charged. Exhaust system is not required where Ni-Cad batteries are charged. Provide a spark-proof construction exhaust fan, explosion-proof motor, and welded stainless steel ductwork. Provide emergency power for the fan motor. Provide local and remote (at ECC) alarm capabilities for fan status and airflow interruption.													
Biomedical Instrument Repair Shop	75	24	70	21	60	20	6	2	Exhaust (S)	40	(-)	Yes	CV
Note 1 - Dedicated Exhaust System **(a)** Provide a dedicated exhaust system where chemicals, such as, xylene and iodine are used. Evaluate the use of a canopy hood or a general purpose fume hood. The system start can be manually operated by a fan switch or automatically operated by remote DDC controls. **(b)** Provide a spark-proof construction exhaust fan with bearings mounted outside the exhaust air stream and an explosion-proof motor on emergency power. **(c)** Provide local and remote alarms in the event of fan failure or exhaust airflow interruption. **(d)** Provide an airflow control valve in the exhaust air duct to ensure constant exhaust airflow. **Note 2 - Alternate Return Air Pick-Up** Provide an alternate return air connection with a motorized damper when the exhaust fan is not in use.												

NON PATIENT ROOMS - MISCELLANEOUS AREAS - ROOM DATA SHEET													
ROOM NAME	INDOOR TEMPERATURE				INDOOR RELATIVE HUMIDITY		MIN TOTAL ACH	MIN OA ACH	ROOM AIR RETURN EXHAUST (G) EXHAUST (S)	MAX NOISE LEVEL NC	ROOM AIR BALANCE	INDIVIDUAL ROOM CONTROL	
	COOLING		HEATING		% RH MAX	% RH MIN						TEMP	FLOW
	F	C	F	C									
Clean Utility/Storage Room	NA	NA	NA	NA	NA	NA	4	NA	Return	40	(+)	No	CV
Note 1 - HVAC Treatment **(a)** For a small, 100 sf [9 m^2] and smaller, unoccupied room, individual room temperature control is not required. Room can be supplied from any adjoining constant-volume air terminal unit serving similar interior or perimeter space. Ducted return air pick-up is also not required, as the room air can ex-filtrate into adjoining spaces, such as, a non-exit corridor (NFPA 90A). **(b)** Individual room temperature control is required for a large, more than 100 sf [9 m^2], occupied room. Provide a minimum of 2 ACH outdoor air. **Note 2 - Remote SPD Clean (or Sterile) Rooms or Warehouses** For a clean or sterile SPD storage room or a warehouse located remotely from the SPD Department, 100% exhaust and/or 100% outdoor air is not required.												
Computer Lab Room	75	24	70	21	60	20	4	2	Return	40	(o)	Yes	VAV
Note - None													
Copy/Printing Room (Large)	75	24	70	21	NA	NA	6	2	Return	40	(o)	Yes	CV
Note - None													
Copy/Printing Room (Small)	NA	NA	NA	NA	NA	NA	6	NA	Exhaust (G)	40	(-)	No	CV
Note 1 - Usage Copy/Printing Room (Small) is a local room serving a single department only, with no more than 2 machines. **Note 2 - Conditioning** Conditioned air is drawn from other areas to ventilate the room and reduce the heat load.													

NON PATIENT ROOMS - MISCELLANEOUS AREAS - ROOM DATA SHEET

ROOM NAME	INDOOR TEMPERATURE				INDOOR RELATIVE HUMIDITY		MIN TOTAL ACH	MIN OA ACH	ROOM AIR RETURN EXHAUST (G) EXHAUST (S)	MAX NOISE LEVEL NC	ROOM AIR BALANCE	INDIVIDUAL ROOM CONTROL	
	COOLING		HEATING		% RH	% RH						TEMP	FLOW
	F	C	F	C	MAX	MIN							
Crawl Space (Pipe Basement)	NA	NA	50	10	NA	NA	6	6	Exhaust (G)	45	NA	Yes	CV

Note 1 - Compliance
This space shall comply with PG-18-3 (Design and Construction Procedures), Topic 5 - Pipe Basements April 2001, available in the VA Technical Information Library.
Note 2 - Exhaust Ventilation System
Provide a thermostatically-controlled (closed-loop, local control), or manually-operated, exhaust system to minimize excessive heat build-up. The system shall consist of an exhaust fan(s), exhaust air louver, intake louver, and motorized intake and exhaust air dampers (two-position, open/close type). Select a direct-drive exhaust fan to minimize maintenance.
Note 3 - Heating System
Provide thermostatically-controlled (closed-loop, local control) terminal heaters to ensure uniform heat distribution. The ventilation system shall be inoperative when the heating system is enabled.

Electrical Equipment Rooms (EER)													
Electrical Equipment Closets without Internal Heat Gain	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Note 1 - HVAC
Electrical closets without internal heat gain do not require HVAC.

Satellite and Main Electrical Rooms with Internal Heat Gain	86	30	40	5	NA	NA	NA	Note 2	Return	45	(o)	Yes	CV

Note 1 - Equipment Heat Gain
Estimate transformer heat dissipation at the rate of 3% of the anticipated actual peak demand. Do not use the rated nameplate capacity for equipment heat gain.
Note 2 - Mechanical Cooling
(a) Provide a dedicated mechanical cooling unit using chilled water or refrigerant direct expansion (DX) as the cooling medium. Cooling shall be available on demand.
(b) Use economizer cycle (ASHRAE Standard 90.1 - 2007) or exhaust ventilation in mild weather.
(c) Provide minimum outdoor air (ASHRAE Standard 62.1 - 2007) in the mechanical cooling mode.
(d) Avoid installing mechanical cooling units within the electrical room to prevent possible damage due to water leakage and/or overflow of condensate drain pans.
Note 3 - Heating
Provide thermostatically-controlled heating system only if the space heat gain cannot offset the design heat loss.
Note 4 - Controls
Provide a DDC sensor to monitor the space temperature and initiate local and remote alarms in the event space temperature exceeds 95 F [35 C]. Provide a DDC sensor for monitoring and alarm with local control loop.

NON PATIENT ROOMS - MISCELLANEOUS AREAS - ROOM DATA SHEET

ROOM NAME	INDOOR TEMPERATURE				INDOOR RELATIVE HUMIDITY		MIN TOTAL ACH	MIN OA ACH	ROOM AIR RETURN EXHAUST (G) EXHAUST (S)	MAX NOISE LEVEL NC	ROOM AIR BALANCE	INDIVIDUAL ROOM CONTROL	
	COOLING		HEATING		% RH	% RH						TEMP	FLOW
	F	C	F	C	MAX	MIN							
Elevator Machine Room	77	25	NA	NA	NA	NA	NA	NA	Return	45	(o)	Yes	CV

Note 1 - Equipment Heat Gain

Coordinate equipment heat dissipation with the elevator equipment manufacturer.

Note 2 - Mechanical Cooling Unit

(a) Provide dedicated, thermostatically-controlled mechanical cooling. Use chilled water or direct-expansion (DX) or a dedicated air terminal unit from a nearby air-handling unit in use year-round.

(b) Avoid installation of the chilled-water or DX mechanical cooling units within the elevator machine room to prevent possible damage due to water leakage and/or overflowing of the condensate drain pans.

Note 3 - Controls

Provide a DDC sensor to monitor the space temperature and initiate local and remote alarms in the event the space temperature exceeds 95 F [35 C]. DDC sensor for monitoring and alarm is required with local control loop.

Engineering Control Center Room	75	24	70	21	60	20	4	2	Return	40	(o)	Yes	CV

Note 1 - HVAC Unit

Provide a dedicated HVAC unit to provide cooling and heating as required using available sources, such as, chilled water, steam or hot water, or a DX cooling unit.

Engineering Shops (Maintenance)	80	27	68	20	NA	NA	6	2	Return Exhaust (G)	45	(-)	Yes	CV

Note 1 - General

The engineering shops include Carpentry Shop, Electrical Shop, Machine Shop, Paint Shop, Plumbing Shop, and Welding Shop. HVAC requirements and design approach for the shops differ based on the site location (high-humidity or low-humidity) and the specific program requirements.

Note 2 - Room Temperature Control

Provide individual room temperature control for the shops served by mechanical cooling and/or heating systems. Provide mechanical cooling for high-humidity locations and evaluate the use of 100% outdoor air for ventilation for low-humidity locations.

Note 3 - Welding Shop

Provide a dedicated exhaust system for the welding shop.

Note 4 - Paint Shop

For the paint shop, a dedicated exhaust ventilation system may be required to dilute the paint shop fumes. Coordinate with the paint booth supplier if a packaged, dedicated ventilation system is furnished by the paint booth supplier.

NON PATIENT ROOMS - MISCELLANEOUS AREAS - ROOM DATA SHEET

ROOM NAME	INDOOR TEMPERATURE				INDOOR RELATIVE HUMIDITY		MIN TOTAL ACH	MIN OA ACH	ROOM AIR	MAX NOISE LEVEL NC	ROOM AIR BALANCE	INDIVIDUAL ROOM CONTROL	
	COOLING		HEATING		% RH	% RH			RETURN EXHAUST (G) EXHAUST (S)			TEMP	FLOW
	F	C	F	C	MAX	MIN							
Exterior Stairs	NA	NA	50	10	NA	NA	NA	NA	NA	NA	NA	Yes	NA
Note 1 - Heating Provide a dedicated, thermostatically-controlled terminal heater with closed-loop, non-DDC temperature control.													
Housekeeping Aid Closet (HAC)	NA	NA	NA	NA	NA	NA	10	NA	Exhaust (G)	40	(- -)	No	CV
Note - None													
Kitchenette	NA	NA	NA	NA	NA	NA	6	NA	Exhaust (G)	40	(- -)	No	CV
Note - None													
Litter Storage	NA	NA	NA	NA	NA	NA	6	NA	Exhaust (G)	40	(- -)	No	CV
Note - None													
Loading Dock	NA	NA	60	15	NA	NA	NA	NA	Return	45	(o)	Yes	CV
Note 1 - Heating System Provide an air curtain with a heating element. Interlock the air curtain start with the loading dock door operating mechanism. Activate heating when the ambient temperature drops below 45 F [7 C] temperature.													
Maintenance Garages	NA	NA	60	15	NA	NA	-	100%	Exhaust (S)	50	(-)	Yes	CV
Note 1 - Ventilation (100% Outdoor Air) Provide a ventilation system complete with fan(s), exhaust and/or supply, and air inlet and outlet connections equipped with motorized dampers. Size and select the system to move air at the rate of 1.5 cfm/sf [7.6 L/s/m^2]. **Note 2 - Heating** Provide thermostatically-controlled heat delivered either by the supply air system or individual air terminal units. During heating mode, reduce the outdoor air to minimum as mandated by ASHRAE Standard 62.1-2007 and other applicable documents. **Note 3 - Compliance and Reference** The HVAC system shall be in compliance with the American Council of Government Industrial Hygienists (ACCIH) and NFPA 88B. Refer to the ASHRAE Handbook of Applications for further information.													

NON PATIENT ROOMS - MISCELLANEOUS AREAS - ROOM DATA SHEET

ROOM NAME	INDOOR TEMPERATURE				INDOOR RELATIVE HUMIDITY		MIN TOTAL ACH	MIN OA ACH	ROOM AIR RETURN EXHAUST (G) EXHAUST (S)	MAX NOISE LEVEL NC	ROOM AIR BALANCE	INDIVIDUAL ROOM CONTROL	
	COOLING		HEATING		% RH	% RH						TEMP	FLOW
	F	C	F	C	MAX	MIN							
Mechanical Equipment Rooms (MER)													
Air Handling Equipment Rooms	84	29	50	10	NA	NA	6	2	Return	45	(o)	Yes	CV
Heating Rooms	86	30	40	5	NA	NA	6	2	Return	45	(o)	Yes	CV

Note 1 - HVAC (All Locations)

Provide a dedicated supply air takeoff (from the air-handling unit located in the MER) to circulate conditioned air at 0.5 cfm/sf [2.5 L/s/m^2]. Circulated air can be returned back to the unit. Thermostatically-controlled terminal heater may be required to maintain the winter set point, where the AHU is not in operation round-the-clock.

Note 1 - Heating Rooms

Heating Rooms are the designated mechanical equipment rooms where steam enters the building for space heating, domestic hot water production, process heating, etc. The Heating Room is equipped with heat exchangers, PRV stations, circulating pumps, and other steam and hot water specialties.

Note 2 - High Humidity Locations

(a) HVAC Systems

Provide mechanical cooling, during peak summer season, by a thermostatically-controlled, dedicated chilled water or direct-expansion (DX) unit. The room can also be served by a thermostatically-controlled, air terminal unit from a nearby air-handling unit in operation round-the-clock.

(b) Heating Requirement

Verify the need for heating. Generally heating is not required as the heat produced within the space is sufficient enough to maintain above freezing temperatures.

Note 3 - All Other Locations

(a) Ventilation Option

For low-humidity (dry) locations, in mild weather, exhaust and/or supply air ventilation system can be used to keep the space temperature below 86 F [30 C]. The system shall consist of fans, inlet and outlet connections with motorized dampers, ductwork, and thermostatic controls. If using this option, increase minimum total ACH to 10.

(b) Mechanical Cooling

Provide mechanical cooling, during peak summer season, by a thermostatically-controlled, dedicated chilled water or DX unit. The room can also be served by a thermostatically-controlled, air terminal unit from a nearby air-handling unit in operation round-the-clock.

(c) Heating

Verify the need for heating. Generally heating is not required as the heat produced within the space is sufficient enough to maintain above freezing temperatures.

NON PATIENT ROOMS - MISCELLANEOUS AREAS - ROOM DATA SHEET

ROOM NAME	INDOOR TEMPERATURE				INDOOR RELATIVE HUMIDITY		MIN TOTAL ACH	MIN OA ACH	ROOM AIR RETURN EXHAUST (G) EXHAUST (S)	MAX NOISE LEVEL NC	ROOM AIR BALANCE	INDIVIDUAL ROOM CONTROL	
	COOLING		HEATING		% RH	% RH						TEMP	FLOW
	F	C	F	C	MAX	MIN							
Refrigeration Equipment Rooms	86	30	40	5	NA	NA	6	NA	Return	45	(o)	Yes	CV

Note 1 - High Humidity Locations

(a) General

Provide a dedicated mechanical cooling unit, complete chilled water or direct-expansion (DX) coil and minimum MERV 7 filters. Provide minimum outdoor air per ASHRAE Standard 15 (latest version) and capability to operate at 100% outdoor air during emergency refrigerant evacuation mode. Provide a variable speed drive to facilitate system operation in the normal and emergency modes.

(b) Capacity - Mechanical Cooling Unit

Base the capacity on the maximum of:

Internal heat gain (note that the heat dissipated by open chillers is much higher than hermetic chillers)

Exhaust air volume required to dilute the refrigerant spill - see ASHRAE Standard 15.

Note 2 - All Other Locations

Provide an exhaust ventilation system or a dedicated air-handling system, generally as described above under Note 1, and equipped with an economizer cycle, if feasible. Evaporative cooling can be used, in lieu of mechanical cooling, for low humidity locations.

Note 3 - Emergency Refrigerant Leak Evacuation System

Provide a refrigerant leak detection system complete with field-installed refrigerant detection sensors, wiring and local control panel per ASHRAE Standard 15. Provide an open protocol BACnet interface with the building ECC system. Provide local alarms per ASHRAE Standard 15 requirements. Provide remote alarms at the ECC.

Note 4 - Emergency Exhaust System

Upon activation by the leak detection system, the room air shall be exhausted outdoors by an emergency exhaust system and supply air system shall operate in 100% outdoor air mode. Provide exhaust air inlets in accordance with the recommendations of ASHRAE Standard 15 and chiller manufacturer. Activation of the leak detection system shall also trigger local and remote alarms. Provide emergency power for the emergency exhaust and supply fans and associated controls.

Reagent Grade Water Treatment Room	75	24	70	21	60	20	8	2	Exhaust (G)	40	(-)	Yes	CV
Note - None													
Soiled Utility and Storage Room	NA	NA	NA	NA	NA	NA	6	NA	Exhaust (G)	40	(- -)	No	CV
Note - None													

NON PATIENT ROOMS - MISCELLANEOUS AREAS - ROOM DATA SHEET

ROOM NAME	INDOOR TEMPERATURE				INDOOR RELATIVE HUMIDITY		MIN TOTAL ACH	MIN OA ACH	ROOM AIR	MAX NOISE LEVEL NC	ROOM AIR BALANCE	INDIVIDUAL ROOM CONTROL	
	COOLING		HEATING		% RH	% RH			RETURN EXHAUST (G) EXHAUST (S)			TEMP	FLOW
	F	C	F	C	MAX	MIN							
Standby Generator Room	80	29	40	18	NA	NA	4	NA	Return	NA	(o)	Yes	CV

Note 1 - Design Requirements

Design requirements listed above are for when the engine is not operating. During engine operation, exhaust air is required and room air balance is negative. During operation, room temperature shall not exceed maximum ambient temperature recommended by engine manufacturer.

Note 2 - Damper Requirements

Provide motorized dampers for all louvers. Dampers shall fail-open on loss of power.

Note 3 - Analysis Requirement

(a) Submit a detailed analysis showing all options and systems selected to provide proper ventilation and cooling of the standby generator space.

(b) Numerous design considerations must be included in the analysis. Once the size of the generator plant has been determined and the number of units selected then various manufacturers shall be consulted to ascertain the range of heat rejection from the various components. See Figure 6-2, Standby Generator Room, for the average heat rejection values. Assuming the prime movers are reciprocating diesel engines, consideration shall be given to the required radiator flow rates when the unit is naturally aspirated, turbocharged or is a lean burn unit. Airflow rates required for unit mounted radiators can vary substantially from one type to another and manufacturer to manufacturer.

Note 4 - Configuration Options

(a) The electrical equipment including the generator and onboard or nearby electrical equipment can be specified for wet locations, or remote radiators can be used thereby drastically reducing the louver area requirement.

(b) A system with a mix of unit mounted radiators and remote units can be proposed.

(c) The analysis shall compare unit mounted radiators to remote radiators. The analysis shall include cost of louvers and control devices. Louvers in areas prone to hurricanes or wind-debris hazards shall be meet the following Florida Building Code tests: Uniform Static Air Pressure Test, Cyclic Wind Pressure Test, Large Missile Impact Test, and Wind Driven Rain Resistance Test for Dry Areas, Enclosed.

(d) A separate detailed acoustic analysis shall be submitted for the final design of the standby generator facility.

Note 5 - Design Considerations

(a) The switchgear and control rooms shall be fully air-conditioned. If remote radiators are used and only minimal louvers are required for combustion air ventilation, consideration should be given to air conditioning the engine bay. The louvers are fitted with electrically controlled actuators to open as needed. Do not provide air conditioning during operation of the generator.

(b) If remote radiators are used, consideration of glycol addition to the system is required in freezing areas.

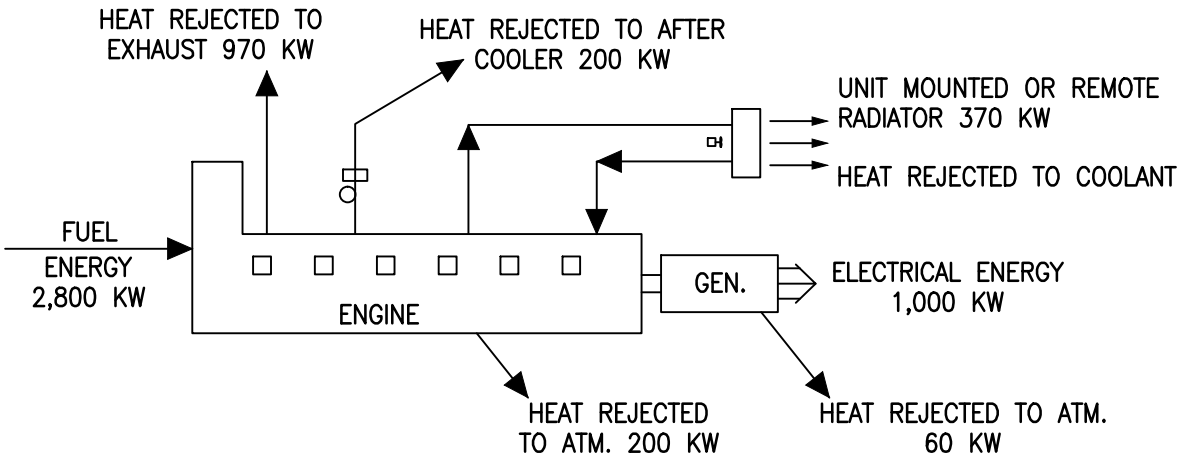
(c) Engine exhaust must be safely conveyed from the engine through the piping and any auxiliary equipment to the atmosphere within allowable pressure drops.

(d) Maintain separate exhaust for each engine. Provide individual silencers or mufflers for each exhaust system.

(e) Exhaust systems shall use welded tube turns with radius of 4 pipe minimum diameters.

(f) See VA Master Specification 26 32 13 ENGINE GENERATORS for additional information.

ENERGY BALANCE COMPRESSION IGNITION ENGINE



DIESEL – STAND BY GENERATOR CAPACITY DATA

1	60 HZ 1800 RPM 480 VOLTS	300 KW	500 KW	750 KW	1000 KW	1500 KW	2000 KW
2	FUEL CONSUMPTION FULL LOAD DIESEL GAL/HR	23	34	53	72	108	142
2.1	FUEL ENERGY INPUT, KW	880	1,320	2,020	2,700	4,080	5,400
3	AIR FLOW ACROSS RADIATOR, CFM	25,000	30,000	42,000	55,000	75,000	100,000
4	COMBUSTION AIR FULL LOAD, CFM	900	1,300	1,900	2,900	4,400	5,800
5	EXHAUST GAS FLOW RATE, FULL LOAD, CFM @ 950°F	2,500	3,700	5,400	7,900	12,100	16,100
6	HEAT REJECTION TO COOLANT, KW	200	200	340	370	700	820
7	HEAT REJECTION TO EXHAUST, KW	320	450	700	970	1,550	2,100
8	HEAT REJECTION TO AFTER COOLER, KW	N/A	N/A	110	230	350	420
9	HEAT REJECTION TO ATMOSPHERE FROM ENGINE, KW	70	100	160	200	240	280
10	HEAT REJECTION TO ATMOSPHERE FROM GENERATOR, KW	22	30	35	60	80	90
11	DELTA T ACROSS RADIATOR, °F (#6x3413)/(#3x1.08)	25	21	26	21	29	26
12	ROOM VENT RATE @ 15° F ROOM RISE, CFM (#10+#9)x3413)/(15x1.08)	19,382	27,388	41,082	54,777	67,417	77,951
AVERAGE, MID RANGE VALUES, VERIFY ALL QUANTITIES WITH AT LEAST (3) MANUFACTURERS							

STANDBY GENERATOR ROOM

Not to Scale

NON PATIENT ROOMS - MISCELLANEOUS AREAS - ROOM DATA SHEET

ROOM NAME	INDOOR TEMPERATURE				INDOOR RELATIVE HUMIDITY		MIN TOTAL ACH	MIN OA ACH	ROOM AIR RETURN EXHAUST (G) EXHAUST (S)	MAX NOISE LEVEL NC	ROOM AIR BALANCE	INDIVIDUAL ROOM CONTROL	
	COOLING		HEATING		% RH	% RH						TEMP	FLOW
	F	C	F	C	MAX	MIN							
Trash Collection Room	NA	NA	50	10	NA	NA	10	NA	Exhaust (G)	40	(- -)	Yes	CV
Note 1 - Exhaust System Provide a dedicated general exhaust system, if a common general exhaust system is not available in the vicinity. Exhaust system shall be manually operated and shall run continuously. **Note 2 - Heating** Provide a thermostatically-controlled heating system if wet sprinkler piping and/or any other building service piping passes through the room.													
Vestibules	NA	NA	50	10	NA	NA	NA	NA	NA	40	(+)	Yes	CV
Note 1 - Heating Provide a thermostatically-controlled terminal heater. Coordinate heater type and location with the architectural discipline. Floor-mounted cabinet unit heaters with bottom horizontal supply and top return have proven effective in counter-acting cold air settling at the floor level. **Note 2 - Space Pressurization** Supply 1.0 cfm/sf [5.1 L/s/m^2] air under positive pressure from an adjoining air terminal unit serving the lobby to maintain positive air pressure by allowing air to ex-filtrate outdoors.													

NON PATIENT ROOMS - MISCELLANEOUS AREAS - ROOM DATA SHEET

ROOM NAME	INDOOR TEMPERATURE				INDOOR RELATIVE HUMIDITY		MIN TOTAL ACH	MIN OA ACH	ROOM AIR RETURN EXHAUST (G) EXHAUST (S)	MAX NOISE LEVEL NC	ROOM AIR BALANCE	INDIVIDUAL ROOM CONTROL	
	COOLING		HEATING		% RH	% RH						TEMP	FLOW
	F	C	F	C	MAX	MIN							
Walk-in Refrigerator and Freezers	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Note 1 - Specifications

Coordinate equipment installation and design with the VA Master Specifications and Standard Details. Revised specifications are:
Walk-In Coolers and Freezers - Section 11 41 21
Laboratory Refrigerators - Section 11 53 23
Mortuary Refrigerators - Section 11 78 13

Note 2 - Constant Temperature Rooms

Rooms covered under VA Master Specification Section 13 21 29 are used for laboratories and research facilities. Generally, the mechanical contractor does not furnish these items. Provide DDC temperature sensors for these rooms to sound local and remote alarms at the ECC. Provide ventilation air requirements per ASHRAE 62.1 - 2007 only if building is pursuing LEED certification.

Note 3 - Frost Prevention

Include provisions to prevent frost formation and subsequent floor heating for equipment mounted on grade or above grade with fill. Provide heating cables in coordination with the electrical discipline to prevent freezing below grade or concrete sub-floor. Evaluate the possibility of using waste heat for anti-frost system, to conserve energy.

Note 4 - Emergency Power

Provide emergency power for the equipment and controls serving refrigerators and freezers.

Note 5 - Heat Gain Factors

Use ASHRAE recommendations for heat gain factors, load calculations and compressor running time while selecting equipment to maintain the temperatures listed below:
Dairy Freezers: -20 F [-29 C]
Ice Cream Freezers: -20 F [-29 C]
Meat Freezers: -12 F [-24 C]
Fresh Meat Refrigeration: 32 F [0 C]
Walk-In Refrigerators: 36 F [2 C]
Autopsy (Mortuary) Cold Room: 36 F [2 C]
Subsistence Storage (Supply Service): 36 F [2 C]

NON PATIENT ROOMS - MISCELLANEOUS AREAS - ROOM DATA SHEET													
ROOM NAME	INDOOR TEMPERATURE				INDOOR RELATIVE HUMIDITY		MIN TOTAL ACH	MIN OA ACH	ROOM AIR RETURN EXHAUST (G) EXHAUST (S)	MAX NOISE LEVEL NC	ROOM AIR BALANCE	INDIVIDUAL ROOM CONTROL	
	COOLING		HEATING		% RH	% RH						TEMP	FLOW
	F	C	F	C	MAX	MIN							
Warehouse (Central) with Pharmacy	80	27	68	20	60	NA	4	2	Return	45	(o)	Yes	VAV

Note 1 - HVAC Systems - Warehouse

Provide mechanical cooling and heating for high-humidity locations. Provide ventilation and heating for all other locations. Base the system selection on the warehouse size and availability of the utilities. With the mechanical cooling option, provide two sets of pre-filters (MERV 7 and 11). With the ventilation option, MERV 7 pre-filter can be used.

Note 2 - HVAC Systems - Pharmacy

Provide a thermostatically-controlled mechanical cooling unit to maintain 75 F [24 C] with 60% RH in cooling mode and 70 F [21 C] with 30% RH in heating mode.

CHAPTER 7: CLIMATIC DATA

Table of Contents

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CLIMATIC CONDITIONS

Table 7-1 CLIMATIC CONDITIONS

Location	Weather Station	North Latitude	MSL Elevation	Col. 1a 0.4%		Col. 1b 99.6%	Col. 2a 1%		Col. 2b 99%	Col. 3 Wet Bulb		Annual Extreme Daily-Mean Db	
				Temperatures									
				Summer		Winter	Summer		Winter	0.4%	1%	Maximum	Minimum
				Db	Wb	Db	Db	Wb	Db				
ALABAMA													
Birmingham	Birmingham Municipal AP	33.56	630	95.0	75.1	19.6	92.6	74.9	24.0	78.5	77.6	97.5	10.7
Montgomery	Montgomery Dannelly Fld	32.30	203	96.2	76.5	23.7	94.0	76.1	27.3	79.7	78.5	99.2	15.2
Tuscaloosa	Tuscaloosa Municipal AP	33.21	187	95.7	76.5	20.6	93.4	76.3	25.0	79.8	78.7	98.9	12.0
Tuskegee*	Tuskegee AP	32	195	96	79	22	95	79	22	-	-	-	-
ALASKA													
Anchorage	Anchorage Intl AP	61.18	131	71.4	58.7	-8.9	68.3	57.3	-4.4	60.3	58.8	76.4	-14.1
ARIZONA													
Phoenix	Phoenix Sky Harbor Intl AP	33.44	1106	110.2	70.0	38.6	108.1	69.8	41.3	76.1	75.2	114.5	34.4
Prescott	Prescott Love Fld	34.65	5052	94.3	61.2	17.5	91.4	60.6	20.7	67.1	65.7	98.6	9.9
Tucson	Tucson Intl AP	32.13	2556	105.9	66.2	31.7	103.6	66.0	34.4	72.5	71.7	109.9	26.4
ARKANSAS													
Fayetteville	Fayetteville Drake Fld	36.01	1260	95.2	75.2	8.0	92.7	74.8	14.6	78.0	77.0	98.8	1.1
Little Rock	Little Rock AFB	34.92	338	99.3	77.3	15.3	96.3	77.5	20.4	81.1	80.0	101.7	7.9
N. Little Rock	North Little Rock/Adams Fld	34.83	1152	95.2	76.4	16.4	92.8	76.1	21.9	78.9	77.8	98.3	10.9

Table 7-1 CLIMATIC CONDITIONS

Location	Weather Station	North Latitude	MSL Elevation	Col. 1a 0.4%		Col. 1b 99.6%	Col. 2a 1%		Col. 2b 99%	Col. 3 Wet Bulb		Annual Extreme Daily-Mean Db	
				Temperatures									
				Summer		Winter	Summer		Winter	0.4%	1%	Maximum	Minimum
				Db	Wb	Db	Db	Wb	Db				
CALIFORNIA													
Fresno	Fresno Yosemite Intl AP	36.78	328	103.6	71.2	31.5	101.1	70.0	33.7	73.7	72.2	107.9	28.6
Livermore*	Livermore Municipal AP	37.69	397	98.8	69.2	30.3	94.7	67.2	32.9	70.8	68.7	105.9	26.9
Loma Linda	March AFB/Riverside	33.88	1516	100.6	67.8	34.2	98.6	67.2	36.6	72.4	71	107.3	28.8
Long Beach	Long Beach Daugherty Fld	33.83	39	91.2	67.9	41.2	87.6	67.3	43.5	72.5	71.0	101.1	36.2
Los Angeles	Los Angeles Intl AP	33.94	325	83.7	64.3	44.4	80.4	64.7	46.5	70.2	69.0	93.8	40.0
Martinez*	Concord	38	195	100	7	24	97	70	24	-	-	-	-
Palo Alto	San Jose Intl AP	37.36	49	92.3	66.9	35.7	88.6	66.2	37.8	69.5	68.1	100.0	31.9
Menlo Park	San Jose Intl AP	37.36	49	92.3	66.9	35.7	88.6	66.2	37.8	69.5	68.1	100.0	31.9
San Diego	San Diego Lindbergh Fld	32.74	30	84.1	67.7	44.8	81.1	67.5	46.8	72.9	71.3	92.3	41.0
San Francisco	San Francisco Intl AP	37.62	20	83.0	63.0	38.8	78.3	62.1	40.8	65.4	64.0	94.3	35.3
Sepulveda	Burbank-Glendale-Pasadena AP	34.20	732	98.3	68.8	39.0	94.6	68.3	41.5	73.4	71.7	105.6	33.7
COLORADO													
Denver	Denver Stapleton Intl AP	39.77	5285	93.5	60.6	-4.0	90.8	60.1	3.3	64.6	63.5	98.9	-12.2
Ft. Lyon*	La Junta Municipal AP	38.05	4216	99.8	64.5	0.0	97.3	64.0	7.1	68.5	67.6	104.7	-5.9
Grand Junction	Grand Junction	39.13	4839	97.4	61.9	6.0	94.8	60.9	11.7	65.5	64.4	101.3	1.1

Table 7-1 CLIMATIC CONDITIONS

Location	Weather Station	North Latitude	MSL Elevation	Col. 1a 0.4%		Col. 1b 99.6%	Col. 2a 1%		Col. 2b 99%	Col. 3 Wet Bulb		Annual Extreme Daily-Mean Db	
				Temperatures									
				Summer		Winter	Summer		Winter	0.4%	1%	Maximum	Minimum
				Db	Wb	Db	Db	Wb	Db				
CONNECTICUT													
Newington	Hartford/ Brainard Fld	41.74	20	90.5	73.4	6.4	87.8	72.7	10.6	77.2	75.4	N/A	N/A
West Haven*	West Haven AP	41	6	88	76	3	84	76	3	-	-	-	-
DELAWARE													
Wilmington	Wilmington New Castle Co AP	39.67	79	91.9	75.1	11.7	88.9	74.1	16.1	78.0	76.8	96.4	4.5
DISTRICT OF COLUMBIA													
Washington DC	Washington DC Reagan AP	38.87	66	94.3	76.0	16.3	91.7	75.2	20.3	78.6	77.5	98.1	9.9
FLORIDA													
Bay Pines	St. Petersburg Clearwater AP	27.92	10	93.2	78.8	42.6	91.6	78.2	45.8	82.1	81.2	95.4	33.9
Coral Gables	Miami/Kendall-Tamia	25.65	10	92.4	77.8	45.4	91.2	77.6	49.0	80.3	79.5	96.2	39.3
Gainesville	Gainesville Regional AP	29.69	164	93.5	76.5	29.7	92.0	76.3	33.4	79.7	78.7	97.4	22.6
Lake City	Gainesville Regional AP	29.69	164	93.5	76.5	29.7	92.0	76.3	33.4	79.7	78.7	97.4	22.6
Miami	Miami Intl AP	25.82	30	91.8	77.6	47.7	90.7	77.5	51.7	80.2	79.5	95.1	41.1
Orlando	Orlando Executive AP	28.55	112	93.6	76.0	40.0	91.1	75.8	44.2	79.7	78.8	96.6	33.5
Tampa	Tampa Intl AP	27.96	10	92.4	77.4	38.4	91.3	77.3	42.5	80.5	79.9	95.0	30.8

Table 7-1 CLIMATIC CONDITIONS

Location	Weather Station	North Latitude	MSL Elevation	Col. 1a 0.4%		Col. 1b 99.6%	Col. 2a 1%		Col. 2b 99%	Col. 3 Wet Bulb		Annual Extreme Daily-Mean Db	
				Temperatures									
				Summer		Winter	Summer		Winter	0.4%	1%	Maximum	Minimum
				Db	Wb	Db	Db	Wb	Db				
GEORGIA													
Atlanta	Atlanta Hartsfield Intl AP	33.64	1027	93.8	74.3	20.7	91.5	74.0	25.8	77.2	76.2	96.5	11.8
Augusta	Augusta Bush Fld	33.37	148	97.1	76.2	22.2	94.7	76.0	25.8	79.4	78.3	100.7	14.8
Dublin*	Dublin AP	32	215	96	79	21	93	78	21	-	-	-	-
Decatur	Atlanta Hartsfield Intl AP	33.64	1027	93.8	74.3	20.7	91.5	74.0	25.8	77.2	76.2	96.5	11.8
HAWAII													
Honolulu	Honolulu Intl AP	21.33	16	89.9	74.0	61.2	89.1	73.6	63.3	77.2	76.3	91.6	57.5
IDAHO													
Boise	Boise Air Terminal	43.57	2867	98.1	64.2	2.7	95.0	63.1	10.5	66.3	65.0	103.7	1.0
ILLINOIS													
Chicago W. Side	Chicago Ohare Intl AP	41.99	673	91.9	74.6	-4.0	89.0	73.4	2.2	77.9	76.1	96.7	-10.7
Chicago Lakeside	Chicago Ohare Intl AP	41.99	673	91.9	74.6	-4.0	89.0	73.4	2.2	77.9	76.1	96.7	-10.7
Danville*	Danville	40	558	93	78	-3	90	77	-4	-	-	-	-
Downey*	Waukegan	42	680	92	78	-6	89	76	-6	-	-	-	-
Hines	Chicago Midway AP	41.79	617	92.1	74.9	-1.6	89.6	73.3	-6	78	76.2	97.3	-8.2
Marion*	Mt. Vernon (AWOS)	38.32	479	93.3	76.5	4.6	91.1	76.1	10.9	80.6	78.4	97.2	-6.6

Table 7-1 CLIMATIC CONDITIONS

Location	Weather Station	North Latitude	MSL Elevation	Col. 1a 0.4%		Col. 1b 99.6%	Col. 2a 1%		Col. 2b 99%	Col. 3 Wet Bulb		Annual Extreme Daily-Mean Db	
				Temperatures									
				Summer		Winter	Summer		Winter	0.4%	1%	Maximum	Minimum
				Db	Wb	Db	Db	Wb	Db				
INDIANA													
Ft Wayne	Ft. Wayne Intl AP	41.01	827	91.1	74.4	-2.6	88.4	73.1	3.8	77.6	75.9	94.7	-8.6
Indianapolis	Indianapolis Intl AP	39.71	807	91.1	75.3	-0.5	88.6	74.4	6.4	78.2	76.9	94.2	-7.7
Marion*	Marion	40	791	91	77	-4	90	75	-4	-	-	-	-
IOWA													
Des Moines	Des Moines Intl AP	41.54	965	93.4	76.2	-6.9	90.2	75.0	-1.6	78.4	77.1	97.6	-12.3
Iowa City*	Iowa City	41	645	92	80	-11	89	78	-11	-	-	-	-
Knoxville	Des Moines Intl AP	41.54	965	93.4	76.2	-6.9	90.2	75.0	-1.6	78.4	77.1	97.6	-12.3
KANSAS													
Leavenworth	Kansas City Intl AP, MO	39.30	1024	96.2	76.3	-.1	92.7	75.8	-3.4	79.5	78	100.2	-6.2
Topeka	Topeka Municipal AP	39.07	886	97.1	75.8	0.6	94.1	75.8	6.7	78.9	77.7	101.4	-5.7
Wichita	Wichita Mid-Continent AP	37.65	1339	100.4	73.3	4.0	97.2	73.4	10.5	77.4	76.3	104.9	-0.8
KENTUCKY													
Lexington	Lexington Bluegrass AP	38.04	988	91.7	73.9	6.0	89.3	73.7	12.7	77.3	76.0	95.2	-1.9
Louisville	Louisville	38.18	489	93.4	75.7	8.0	91.2	75.3	14.5	78.7	77.5	96.7	0.9
LOUISIANA													
Alexandria	Alexandra Intl AP	31.33	89	96.6	77.5	26.7	93.6	77.2	29.7	80.8	79.8	99.0	20.1
New Orleans	New Orleans Lakefront AP	30.04	10	93.4	78.7	35.6	92.0	78.3	38.8	81.4	80.5	96.8	29.6

Table 7-1 CLIMATIC CONDITIONS

Location	Weather Station	North Latitude	MSL Elevation	Col. 1a 0.4%		Col. 1b 99.6%	Col. 2a 1%		Col. 2b 99%	Col. 3 Wet Bulb		Annual Extreme Daily-Mean Db	
				Temperatures									
				Summer		Winter	Summer		Winter	0.4%	1%	Maximum	Minimum
				Db	Wb	Db	Db	Wb	Db				
Shreveport	Shreveport Regional AP	32.45	259	97.8	76.3	23.8	95.4	76.4	27.7	79.4	78.7	100.8	17.7
MAINE													
Togus	Augusta AP	44.32	361	87.0	70.6	-3.9	83.7	107.7	0.8	73.5	71.6	93.0	-10.1
MARYLAND													
Baltimore	Baltimore-Washington Intl AP	39.17	154	93.9	74.9	12.9	91.2	74.2	17.3	78.1	76.8	98.0	5.1
Perry Point	Baltimore-Washington Intl AP	39.17	154	93.9	74.9	12.9	91.2	74.2	17.3	78.1	76.8	98.0	5.1
MASSACHUSETTS													
Bedford	Boston Logan Intl AP	42.36	30	90.8	73.3	7.4	87.6	71.9	12.4	76.2	74.6	95.6	2.3
Boston	Boston Logan Intl AP	42.36	30	90.8	73.3	7.4	87.6	71.9	12.4	76.2	74.6	95.6	2.3
Brockton*	Taunton	41	20	89	75	5	86	74	5	-	-	-	-
North Hampton*	Springfield/Westover AFB	42	247	90	75	-5	87	73	-5	-	-	-	-
West Roxbury	Boston Logan Intl AP	42.36	30	90.8	73.3	7.4	87.6	71.9	12.4	76.2	74.6	95.6	2.3
MICHIGAN													
Ann Arbor*	Ypsilanti	42	777	92	75	1	89	74	1	-	-	-	-
Allen Park	Detroit Metro AP	42.22	663	90.3	73.8	1.4	87.4	72.5	6.7	76.9	75.0	94.9	-4.5
Battle Creek*	Battle Creek AP	42	939	92	76	1	88	74	1	-	-	-	-
Detroit	Detroit Metro AP	42.22	663	90.3	73.8	1.4	87.4	72.5	6.7	76.9	75.0	94.9	-4.5

Table 7-1 CLIMATIC CONDITIONS

Location	Weather Station	North Latitude	MSL Elevation	Col. 1a 0.4%		Col. 1b 99.6%	Col. 2a 1%		Col. 2b 99%	Col. 3 Wet Bulb		Annual Extreme Daily-Mean Db	
				Temperatures									
				Summer		Winter	Summer		Winter	0.4%	1%	Maximum	Minimum
				Db	Wb	Db	Db	Wb	Db				
Iron Mountain*	Iron Mountain/Ford	45.82	1181	88.2	72.2	-10.7	84.1	70.0	-6.2	74.7	72.3	92.8	-20.2
Saginaw	Saginaw Tri City Intl AP	43.53	669	88.9	73.6	0.0	86.5	71.8	3.6	76.4	74.5	95.2	-6.3
MINNESOTA													
Minneapolis	Minneapolis/St. Paul Intl AP	44.88	837	91.0	73.5	-13.4	87.9	72.3	-7.6	76.9	74.9	96.3	-18.6
St. Cloud	St. Cloud Regional AP	45.55	1024	90.0	72.9	-19.3	86.5	71.2	-12.9	76.5	74.5	95.6	-25.6
MISSISSIPPI													
Jackson	Jackson Intl AP	32.32	331	95.6	76.7	22.0	93.6	76.3	25.8	79.8	78.8	98.6	15.2
Biloxi	Keesler AFB/Biloxi	30.42	26	93.5	80.2	30.3	91.5	79.4	34.9	83.5	82.2	97.0	21.6
Gulfport	Keesler AFB/Biloxi	30.42	26	93.5	80.2	30.3	91.5	79.4	34.9	83.5	82.2	97.0	21.6
MISSOURI													
Columbia	Columbia Regional AP	38.82	899	94.7	76.1	1.3	91.6	75.9	7.1	79.1	77.7	99.3	-5.8
Kansas City	Kansas City	39.30	1024	96.2	76.3	-0.1	92.7	75.8	5.4	79.5	78.0	100.2	-6.2
Poplar Bluff	Poplar Bluff (AMOS)	36.77	479	93.8	77.1	9.5	91.5	76.4	15.5	80.2	78.8	98.3	2.9
St. Louis (JBO)	St. Louis Lambert Intl AP	38.75	709	95.6	76.8	4.1	93.1	76.1	10.2	79.4	78.2	99.9	-1.8
MONTANA													
Ft. Harrison	Helena Regional AP	46.61	2868	92.7	61.5	-15.4	89.3	60.7	-8.2	64.5	62.9	98.3	-21.6
Miles City	Miles City Municipal AP	46.43	2635	98.5	65.9	-18.1	94.7	64.9	-11.5	69.7	68.0	103.6	-24.0

Table 7-1 CLIMATIC CONDITIONS

Location	Weather Station	North Latitude	MSL Elevation	Col. 1a 0.4%		Col. 1b 99.6%	Col. 2a 1%		Col. 2b 99%	Col. 3 Wet Bulb		Annual Extreme Daily-Mean Db	
				Temperatures									
				Summer		Winter	Summer		Winter	0.4%	1%	Maximum	Minimum
				Db	Wb	Db	Db	Wb	Db				
NEBRASKA													
Grand Island	Grand Island Central NE Region	40.96	1857	96.2	73.8	-6.1	93.0	73.0	-0.1	77.3	75.6	102.1	-12.4
Lincoln	Lincoln Co	40.83	1188	97.2	75.1	-5.4	93.7	74.3	0.3	78.2	76.9	102.2	-11.4
Omaha	Omaha Eppley Airfield	41.31	981	95.0	76.1	-6.3	91.8	75.0	-0.7	79.0	77.3	99.8	-11.8
NEVADA													
Las Vegas	Nellis AFB	36.23	1880	109.2	67.6	28.2	107.3	67.1	31.5	72.5	71.2	21.9	113.8
Reno	Reno Tahoe Intl AP	39.48	4400	95.7	61.9	11.9	93.1	60.7	17.0	64.0	62.4	100.4	5.5
NEW HAMPSHIRE													
Manchester*	Manchester AP	42.93	233	91.2	72.1	1.0	88.6	70.8	6.7	75.8	74.1	96.9	-5.8
NEW JERSEY													
East Orange	Newark	40.72	30	94.0	74.9	11.0	91.0	73.5	15.5	77.7	76.3	98.9	5.6
Lyons*	New Brunswick	40	86	92	77	6	89	76	6	-	-	-	-
NEW MEXICO													
Albuquerque	Albuquerque	35.04	5315	95.2	60.3	17.7	92.9	60.1	21.2	65.3	64.5	99.4	10.4

Table 7-1 CLIMATIC CONDITIONS

Location	Weather Station	North Latitude	MSL Elevation	Col. 1a 0.4%		Col. 1b 99.6%	Col. 2a 1%		Col. 2b 99%	Col. 3 Wet Bulb		Annual Extreme Daily-Mean Db	
				Temperatures									
				Summer		Winter	Summer		Winter	0.4%	1%	Maximum	Minimum
				Db	Wb	Db	Db	Wb	Db				
NEW YORK													
Albany	Albany Co AP	42.75	292	89.0	73.0	-1.9	86.1	71.4	2.9	75.8	74.2	93.8	-9.1
Batavia*	Batavia	43	900	90	75	1	87	73	1	-	-	-	-
Bath*	Hornell	42	1325	88	74	-4	85	73	-4	-	-	-	-
Bronx	NYC/John F. Kennedy Intl AP	40.66	23	89.7	73.5	12.8	86.5	72.2	17.2	77.0	75.8	96.1	7.3
Brooklyn	NYC/John F. Kennedy Intl AP	40.66	23	89.7	73.5	12.8	86.5	72.2	17.2	77.0	75.8	96.1	7.3
Buffalo	Buffalo Niagara Intl AP	42.94	705	86.5	71.2	2.7	84.0	70.0	6.7	74.8	73.2	90.8	-3.1
Canandaigua*	Geneva	42	590	90	75	-3	87	73	-3	-	-	-	-
Castle Point	Poughkeepsie Dutchess Co AP	41.63	161	91.4	74.0	0.5	88.5	72.7	6.0	76.8	75.1	96.2	-8.1
Montrose*	Newberg-Stewart AFB	41.50	581	89.8	72.5	3.5	86.3	71.7	9.0	76.0	74.3	93.9	-4.1
New York City	NYC/John F. Kennedy Intl AP	40.66	23	89.7	73.5	12.8	86.5	72.2	17.2	77.0	75.8	96.1	7.3
Northport*	Suffolk Co AFB	40	57	86	76	7	83	74	7	-	-	-	-
Syracuse	Syracuse Hancock Intl AP	43.11	417	88.9	73.0	-2.7	86.0	71.2	2.9	75.4	73.7	92.8	-10.5
St. Albans	Syracuse Hancock Intl AP	43.11	417	88.9	73.0	-2.7	86.0	71.2	2.9	75.4	73.7	92.8	-10.5

Table 7-1 CLIMATIC CONDITIONS													
Location	Weather Station	North Latitude	MSL Elevation	Col. 1a 0.4%		Col. 1b 99.6%	Col. 2a 1%		Col. 2b 99%	Col. 3 Wet Bulb		Annual Extreme Daily-Mean Db	
				Temperatures									
				Summer		Winter	Summer		Winter	0.4%	1%	Maximum	Minimum
				Db	Wb	Db	Db	Wb	Db				
NORTH CAROLINA													
Durham	Raleigh Durham Intl AP	35.87	436	94.1	75.9	18.8	91.7	75.6	23.1	78.3	77.3	97.8	10.6
Fayetteville	Fort Bragg Simmons AAF	35.13	305	96.6	76.2	21.7	94.0	75.7	26.0	79.2	78.1	100.3	13.3
Asheville (Oteen)	Asheville Regional AP	35.43	2169	88.2	71.6	13.6	85.8	70.9	18.6	74.2	73.1	91.6	4.6
Salisbury	Winston-Salem Reynolds AP	36.13	971	92.4	74.5	18.2	90.3	73.9	22.8	40.9	39.8	96.3	9.5
NORTH DAKOTA													
Fargo	Fargo Hector Intl AP	46.93	899	91.0	72.1	-20.4	87.7	70.3	-15.2	75.4	73.4	96.9	-24.7
OHIO													
Brecksville	Cleveland Hopkins Intl AP	41.41	804	89.4	73.9	2.5	86.7	72.5	8.2	76.3	74.7	93.4	-4.0
Chillicothe*	Chillicothe	39	638	95	78	0	92	76	0	-	-	-	-
Cincinnati	Cincinnati Municipal AP Lunki	39.10	499	92.8	74.9	6.3	90.2	74.4	12.4	77.9	76.7	96.2	-1.8
Cleveland	Cleveland Hopkins Intl AP	41.41	804	89.4	73.9	2.5	86.7	72.5	8.5	76.3	74.7	93.4	-4.0
Dayton	Dayton Intl AP	39.91	1004	90.3	73.6	0.6	87.9	72.8	6.9	76.5	75.1	93.7	-6.5
OKLAHOMA													
Muskogee*	Muskogee	35	610	101	79	10	98	78	10	-	-	-	-

Table 7-1 CLIMATIC CONDITIONS

Location	Weather Station	North Latitude	MSL Elevation	Col. 1a 0.4%		Col. 1b 99.6%	Col. 2a 1%		Col. 2b 99%	Col. 3 Wet Bulb		Annual Extreme Daily-Mean Db	
				Temperatures									
				Summer		Winter	Summer		Winter	0.4%	1%	Maximum	Minimum
				Db	Wb	Db	Db	Wb	Db				
Oklahoma City	Oklahoma City Will Rogers World AP	35.39	1306	99.5	74.1	11.4	96.8	74.1	17.4	77.7	76.7	102.7	6.1
OREGON													
Portland	Portland Intl AP	45.59	108	91.2	67.5	23.9	87.1	66.5	28.6	69.4	67.8	99.0	20.5
Roseburg*	Roseburg AP	43	505	93	69	18	90	67	18	-	-	-	-
White City	Medford Rogue Valley Intl AP	42.39	1329	98.6	67.2	22.9	95.3	65.9	25.7	69.0	67.5	104.2	18.1
PENNSYLVANIA													
Altoona	Altoona Blair Co AP	40.30	1470	88.5	72.0	4.7	85.7	70.7	9.6	74.7	73.2	92.5	-2.6
Butler*	Butler Co (AWOS)	40.78	1247	88.0	72.4	3.1	84.4	70.6	8.9	74.6	73.0	91.1	-2.3
Coatesville*	New Castle	41	825	91	75	2	88	74	2	-	-	-	-
Erie	Erie Intl AP	42.08	738	86.4	72.9	5.2	84.0	71.6	9.7	75.3	73.8	91.5	-0.5
Lebanon	Harrisburg Capital City AP	40.22	348	92.4	73.8	8.7	89.6	72.5	13.3	76.5	75.2	96.3	1.6
Philadelphia	Philadelphia Intl AP	39.87	30	93.2	75.4	12.6	90.6	74.5	16.9	78.3	77.0	97.0	6.6
Pittsburgh	Pittsburgh Intl AP	40.50	1204	89.5	72.5	3.7	86.6	71.1	9.4	75.2	73.7	92.4	-3.0
Wilkes-Barre	Wilkes-Barre Scranton Intl AP	41.34	961	88.9	72.1	3.5	86.0	70.6	8.3	75.0	73.3	93.0	-2.7
PUERTO RICO													
San Juan	San Juan Intl AP	18.42	62	91.4	77.4	69.1	89.6	77.8	70.2	80.6	79.9	93.9	66.8

Table 7-1 CLIMATIC CONDITIONS													
Location	Weather Station	North Latitude	MSL Elevation	Col. 1a 0.4%		Col. 1b 99.6%	Col. 2a 1%		Col. 2b 99%	Col. 3 Wet Bulb		Annual Extreme Daily-Mean Db	
				Temperatures									
				Summer		Winter	Summer		Winter	0.4%	1%	Maximum	Minimum
				Db	Wb	Db	Db	Wb	Db				
RHODE ISLAND													
Providence	Providence/TF Green State	41.72	62	90.1	73.3	7.2	86.7	71.7	11.9	76.5	74.9	95.5	1.4
SOUTH CAROLINA													
Charleston	Charleston Intl AP	32.90	49	94.3	78.2	26.9	92.1	77.6	30.4	80.5	79.7	98.5	19.4
Columbia	Columbia Metro AP	33.94	226	97.0	75.4	22.0	94.5	75.1	25.9	78.4	76.8	100.6	15.0
SOUTH DAKOTA													
Ft. Meade	Rapid City Regional AP	44.05	3169	96.9	65.9	-10.5	92.8	65.6	-4.6	71.0	69.3	102.9	-17.3
Hot Springs	Rapid City Regional AP	44.05	3169	96.9	65.9	-10.5	92.8	65.6	-4.6	71.0	69.3	102.9	-17.3
Sioux Falls	Sioux Falls Foss Fld	43.58	1427	92.8	74.0	-13.7	89.4	73.3	-8.4	77.4	75.5	98.4	-19.4
TENNESSEE													
Memphis	Memphis Intl AP	35.06	331	96.0	77.3	17.0	93.9	76.9	21.7	80.2	79.2	98.6	10.7
Mountain Home	Bristol-Tri-City AP	36.48	1526	89.8	72.2	11.4	87.5	71.7	16.9	75.0	74.0	92.7	2.3
Murfreesboro*	Murfreesboro AP	35	608	97	78	9	94	77	9	-	-	-	-
Nashville	Nashville Intl AP	36.12	604	94.4	75.0	12.9	92.1	74.8	18.2	78.2	77.2	97.4	4.6

Table 7-1 CLIMATIC CONDITIONS

Location	Weather Station	North Latitude	MSL Elevation	Col. 1a 0.4%		Col. 1b 99.6%	Col. 2a 1%		Col. 2b 99%	Col. 3 Wet Bulb		Annual Extreme Daily-Mean Db	
				Temperatures									
				Summer		Winter	Summer		Winter	0.4%	1%	Maximum	Minimum
				Db	Wb	Db	Db	Wb	Db				
TEXAS													
Amarillo	Amarillo Intl AP	35.22	3606	97.3	66.2	7.2	94.8	66.2	13.7	71.1	70.0	101.2	0.9
Big Spring*	Big Spring AP	32	2537	100	74	16	97	73	16	-	-	-	-
Bonham*	Sherman-Perrin AFB	33	763	100	78	15	98	77	15	-	-	-	-
Dallas	Dallas-Fort Worth Intl AP	32.90	597	100.4	74.5	20.3	98.4	74.6	25.8	78.6	77.8	103.5	15.7
Houston	Houston Bush InterContinental AP	29.99	105	96.8	76.6	29.1	95.0	76.6	32.9	80.1	88.2	100.2	24.0
Kerrville	San Antonio Intl AP	29.53	810	98.5	73.5	27.4	96.9	73.6	31.6	78.0	77.3	102.2	21.5
Marlin	Waco Regional AP	31.61	509	100.8	75.1	22.9	98.9	75.3	27.5	78.7	78.1	104.3	17.6
San Antonio	San Antonio Intl AP	29.53	810	98.5	73.5	27.4	96.9	73.6	31.6	78.0	77.3	102.2	21.5
Temple*	Temple	31	675	100	78	22	99	77	22	-	-	-	-
Waco	Waco Regional AP	31.61	509	100.8	75.1	22.9	98.9	75.3	27.5	78.7	78.1	104.3	17.6
UTAH													
Salt Lake City	Salt Lake City Intl AP	40.79	4226	97.4	63.5	9.3	94.8	62.6	14.1	67.0	95.7	101.2	2.6
VERMONT													
White River Junction	Montpelier AP	44.20	1122	85.1	69.9	-10.7	82.3	68.2	-6	72.6	70.7	89.8	-18.3
VIRGINIA													
Hampton	Norfolk Intl AP	36.90	30	93.7	76.7	21.7	91.3	76.0	25.6	79.0	78.0	98.0	15.6
Richmond	Dinwiddie Co	37.18	197	97.4	77.8	15.9	94.7	76.7	19.2	80.9	79.4	100.5	6.2
Salem	Roanoke Regional AP	37.32	1175	92.1	72.9	14.2	89.8	72.4	19.0	75.4	74.5	96.0	6.3

Table 7-1 CLIMATIC CONDITIONS

Location	Weather Station	North Latitude	MSL Elevation	Col. 1a 0.4%		Col. 1b 99.6%	Col. 2a 1%		Col. 2b 99%	Col. 3 Wet Bulb		Annual Extreme Daily-Mean Db	
				Temperatures									
				Summer		Winter	Summer		Winter	0.4%	1%	Maximum	Minimum
				Db	Wb	Db	Db	Wb	Db				
WASHINGTON													
American Lake	Olympia AP	46.97	200	87.3	66.0	20.1	83.3	64.8	24.1	67.8	65.9	95.2	12.5
Seattle	Seattle-Tacoma Intl AP	47.46	433	84.9	65.0	24.5	81.3	63.6	29.1	66.5	64.8	92.4	20.7
Spokane	Fairchild AFB	47.62	2438	91.4	62.2	4.6	88.5	61.5	10.6	64.9	63.3	96.8	-1.7
Vancouver	Portland Intl AP	45.59	108	91.2	67.5	23.9	87.1	66.5	28.6	69.4	67.8	99	20.5
Walla Walla	Walla Walla City Co AP	46.10	1204	98.9	66.8	8.1	94.9	65.5	16.2	68.8	67.0	105.0	6.3
WEST VIRGINIA													
Beckley*	Beckley Raleigh Co MEM AP	37.80	2513	84.6	69.8	5.5	82.4	69.1	11.4	72.5	71.3	87.8	-3.4
Clarksburg*	Clarksburg	39	977	92	76	6	90	75	6	-	-	-	-
Huntington	Huntington Tri-State AP	38.38	837	91.9	73.8	8.4	89.4	73.5	14.6	77.3	76.0	95.0	-0.4
Martinsburg	Martinsburg Eastern WV Regional AP	39.40	535	93.3	73.9	9.7	90.4	73.1	14.6	77.0	75.6	97.6	-0.3
WISCONSIN													
Madison	Madison Dane Co Regional AP	43.14	866	89.8	74.4	-9.1	86.8	72.8	-2.9	77.1	75.0	94.2	-15.3
Tomah	La Crosse Municipal AP	43.75	656	92.1	75.1	-12.3	89.0	73.5	-5.8	78.0	75.9	98.0	-16.8
Wood	Milwaukee Mitchell Intl AP	42.95	692	90.3	74.6	-4.0	86.8	72.6	1.8	77.0	75.0	95.9	-10.3

Table 7-1 CLIMATIC CONDITIONS

Location	Weather Station	North Latitude	MSL Elevation	Col. 1a 0.4%		Col. 1b 99.6%	Col. 2a 1%		Col. 2b 99%	Col. 3 Wet Bulb		Annual Extreme Daily-Mean Db	
				Temperatures									
				Summer		Winter	Summer		Winter	0.4%	1%	Maximum	Minimum
				Db	Wb	Db	Db	Wb	Db				
WYOMING													
Cheyenne	Cheyenne Municipal AP	41.16	6142	89.2	58.6	-6.4	86.3	58.0	1.7	63.0	31.8	93.7	-14.8
Sheridan	Sheridan Co AP	44.77	3967	95.5	63.8	-12.7	92.1	63.0	-6.1	67.5	65.7	100.8	-20.3

NOTES:

- The climatic conditions table data is based on the 2009 ASHRAE Handbook of Fundamentals and the 1978 Department of Defense Engineering Weather Data (denoted by asterisk). Use column 1a and 1b for design.

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HIGH AND LOW HUMIDITY LOCATIONS

Table 7-2: HIGH HUMIDITY LOCATIONS Dew-Point Temperature > 60 F [15.6 C] For a Minimum of 4000 hours/year Data Based on 5-Year Averages	
Locations	**Annual Dew-Point Hours**
Bay Pines	5406
Biloxi	4114
Charleston	4368
Gainesville	4774
Honolulu	7951
Houston	5152
Lake City	4774
Miami	7020
New Orleans	5104
Orlando	5703
Panama City	5037
Pensacola	4838
San Juan	8474
Tampa	5788
Viera	6025
West Palm Beach	6606

Table 7-3: LOW HUMIDITY LOCATIONS	
Dew-Point Temperature < 35 F [1.7 C] For a Minimum of 3500 hours/year Data Based on 5-Year Averages	
Locations	**Annual Dew-Point Hours**
Albuquerque	5211
Anchorage	4947
Cheyenne	5556
Denver	5115
Fargo	4099
Las Vegas	5083
Phoenix	3674
Minneapolis	3893
Tucson	4063

Note: Calculate and compare humidification loads in the cooling and heating modes of the system operation. Size and select the humidification equipment based on the higher value.

CHAPTER 8: ABBREVIATIONS AND REFERENCES

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8.1 ABBREVIATIONS

Abbreviation	Description
AF	After-Filter
AB	Air Blender
AFCV	Air Flow Control Valve
AII	Airborne Infection Isolation
ACU	Air-Conditioning Unit
AHU	Air-Handling Unit
A/E	Architect/Engineer
BSC	Biological Safety Cabinet
BMT	Bone Marrow Transplant
bhp	Brake Horsepower
Btu	British Thermal Unit
Btuh	British Thermal Unit per Hour
CHW	Chilled Water
CH	Chiller
CCTV	Closed Circuit Television
CMOP	Consolidated Mail Outpatient Pharmacy
CV	Constant Volume
CD-1	Construction Documents (Submission1)
CD-2	Construction Documents (Submission2)
CC	Cooling Coil
CT	Cooling Tower
cfm	Cubic Feet Per Minute
DD-1	Design Development (Submission1)
DD-2	Design Development (Submission2)
DPA	Differential Pressure Assembly
DPS	Differential Pressure Sensor
DP	Diffuser Plate
DDC	Direct Digital Controls
DX	Direct Expansion
EER	Energy Efficiency Ratio
ECC	Engineering Control Center
ETO	Ethylene Oxide
EXTEMP	Extemporacous
fpm	Feet Per Minute
fps	Feet Per Second
FF	Final Filters
FM	Flowmeter
gpm	Gallons Per Minute
HRD	Heat Recovery Device
HW	Hot Water
HAC	Housekeeping Aid Closet
H	Humidifier
ICU	Intensive Care Unit

Abbreviation	Description
kPa	KiloPascal
LAFW	Laminar Air Flow Workbench
MRI	Magnetic Resonance Imaging
MERV	Minimum Efficiency Reporting Valve
MB	Mixing Box
NC	Noise Criteria
OA	Outdoor Air
D-1	Outdoor Air Damper
ppm	Parts Per Million
PPE	Personal Protective Equipment
psi	Pounds per Square Inch
psig	Pounds per Square Inch-Gage
PF	Pre-Filter
PHC	Preheat Coil
PRV	Pressure Reducing Valve
PSS	Primary Secondary System
PE	Protective Environment
P	Pump
RHC	Reheat Coil
REA	Relief Air
D-3	Relief Air Damper
RA	Return Air
D-2	Return Air Damper
RF	Return Fan
RDS	Room Data Sheets
SDR	Smoke Damper (Return)
SDS	Smoke Damper (Supply)
SD	Smoke Detector
SCI	Spinal Cord Injury
SP	Static Pressure
SH	Steam Humidifier
SA	Supply Air
SF	Supply Fan
SPD	Supply, Processing and Distribution
TAB	Testing, Adjusting and Balancing
VAV	Variable Air Volume
VPS	Variable Primary System
VSD	Variable Speed Drive
VHA	Veterans Health Administration
WG	Water Gage

8.2 REFERENCES

Abbreviation	Full Description of Reference
AMCA	Air Movement and Control Association International
ANSI	American National Standards Institute
ARI	Air-Conditioning and Refrigeration Institute
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
DOE	Department of Energy
IMC	International Mechanical Code
IPC	International Plumbing Code
ISO	International Organization for Standardization
NEC	National Electric Code
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NSF	National Science Foundation
OSHA	Operational Safety and Health Administration
SMACNA	Sheet Metal and Air-Conditioning Contractors' National Association
UBC	Uniform Building Code
UL	Underwriters Laboratories

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