February 2008

HVAC DESIGN MANUAL

For:

- New Hospitals
- Replacement Hospitals
- Ambulatory Care
- Clinical Additions
- Energy Centers
- Outpatient Clinics
- Animal Research Facilities
- Laboratory Buildings

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Veterans Affairs
Office of Construction & Facilities Management
Facilities Quality Service (00CFM1A)
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HVAC Design Manual

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CHAPTER 1: BASIC REQUIREMENTS

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1.1 INTRODUCTION

This HVAC Design Manual is revised to incorporate numerous changes due to:

- Energy Conservation (EPACT 2005 and DOE – Final Rule)
- Energy Conservation (Executive Order No. 13423 Dated January 24 2007: Strengthening Federal Environmental, Energy, and Transportation Management)
- Memorandum of Understanding (MOU): Federal Leadership In High Performance and Sustainable Buildings
- Physical Security Requirements
- Sustainable Design Considerations
- Commissioning

Use of this manual is meant for the Architect/Engineer (henceforth referred to as the A/E) and others engaged in the design and renovation of the VA facilities. These facilities are:

- New Hospitals
- Replacement Hospitals
- Ambulatory Care
- Clinical Additions
- Energy Centers
- Outpatient Clinics
- Animal Research Facilities
- Laboratory Buildings

It is expected that HVAC systems designed with the use of this manual will meet their primary objective of providing environmental comfort to the veterans, employees, and visitors. The HVAC system design package shall be complete, coordinated, and technically correct. In addition, the HVAC systems shall be safe, easily accessible for repairs and maintenance, energy efficient, and in compliance with the prescribed noise and vibration levels.

Deviations can be made from the stipulations of this manual to accommodate new concepts and design enhancements. However, such deviations shall be subject to review and approval by the VA Project Manager in consultation with the VA Facilities Quality Service (Office of Construction & Facilities Management) and shall not conflict with any Federal Regulations, Public Laws, Executive Orders, and the needs of the end-users.

Throughout this manual, the statement is made: to obtain approval from the “VA Authorities.”The “VA Authorities” is defined as the VA Project Manager. If approval is required by the local VA Medical Center, it is so noted in this manual.

1.2 ENERGY CONSERVATION

The need to conserve energy is mandated by the Federal Government by both Executive Order and Federal Law. In addition, 19 Federal Agencies have signed a Memorandum of Understanding (MOU) outlining specific goals and targets for energy conservation and sustainable design. The VA is one of the signatory agencies. In the following paragraphs, references and details of various requirements are given.

1.2.1 DOE FINAL RULE

In the Federal Register (Volume 72, No. 245), dated December 21, 2007, the Department of Energy (DOE) issued mandatory energy conservation guidelines as the final rule for implementing provisions in the Energy Policy Act (EPACT 2005). Provisions of the final rule are as follows:

1.2.1.1 ASHRAE Standard 90.1

(a) ASHRAE Standard 90.1 – 2004
ASHRAE Standard 90.1 – 2004 is a component of the DOE final rule. Provisions of this standard shall be used as a baseline for computing energy savings. By reference, DOE has incorporated Standard 90.1 – 2004 into 10 CFR Part 433. Also, the U.S. Congress has prescribed this standard in section 109 of the Energy Policy Act of 2005 (EPACT).

(b) ASHRAE Standard 90.1 – 2007
Recently, ASHRAE has published the revised Standard 90.1 – 2007. HVAC systems shall be designed to comply with the ANSI/ASHRAE/IESNA Standard 90.1 – 2004 for Buildings except Low-Rise Residential Buildings. The A/E is expected to fully comprehend and implement the practices dictated in ASHRAE 90.1 – 2004.

1.2.1.2 Additional Mandated Energy Conservation Measures

In addition to complying with the ASHRAE Standard, DOE has mandated that a new federal building must be designed to achieve an energy consumption level that is at least 30% below the level achieved under Standard 90.1-2004, ***if life-cycle cost-effective***. Use the Performance Rating Method – Appendix G of ASHRAE Standard 90.1 – 2004 to document the energy savings.

(a) Life-Cycle Cost (LCC) Analysis (Requirements): If the 30% reduction in energy consumption is not life-cycle cost-effective, the A/E must 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 will consider and evaluate readily available energy conservation measures with which the industry is generally familiar.

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

(b) Life-Cycle Cost Analysis (Methodology): To comply with the Public Law 95-619, an engineering economic analysis shall be performed in accordance with the procedure outlined by the Department of Energy (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:

- 20 year life-cycle period for system comparison
- Public domain programs such as TRACE, E-CUBE, and Carrier E20-II, etc.
- Other features are:
  - 7% discount factor
  - No taxes or insurance while computing cost

1.2.2 EXECUTIVE ORDER 13423 DATED JANUARY 26, 2007

Mandatory energy conservation requirements are also published in the above Executive Order. The MOU is mentioned in Section 2, paragraph f of the Executive Order. The MOU was signed under the Federal Leadership in High Performance and Sustainable Buildings.

The stated goals and objectives of the MOU are as follows:

1.2.2.1 New Construction

For new construction, reduce the energy cost budget by 30% compared to the baseline performance rating of ASHRAE Standard 90.1 - 2004. This requirement is identical to the DOE Final Rule published in the Federal Register.

1.2.2.2 Major Renovations

For major renovations, reduce the energy cost budget by 20% below pre-renovations 2003 baseline. In the event 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. It is assumed that the use of the facility shall remain similar before and after the renovation. 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.

1.2.2.3 VA Policy

Reduction in the energy cost budget shall be implemented as the reduction in energy consumption measured as BTU (British Thermal Units) or Joules (J).

1.2.2.4 Additional Measures (MOU)

MOU also addresses related issues such as commissioning, measurement, and verification, and protection and conservation of indoor and outdoor water. These issues are described below.

1.3 COMMISSIONING

While the VA guidelines for commissioning are under preparation to be issued soon, employ total building commissioning practices tailored to the size and complexity of the building and its system components in order to verify performance of building components and systems and help ensure that design requirements are met. This shall include a VA-designated commissioning authority to perform the following:

- Include commissioning requirements in construction documents
- Provide commissioning plan
- Verify the installation and performance of systems to be commissioned
- Provide commissioning report

1.4 MEASUREMENTS 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. 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, measure all new major installations using the ENERGY STAR® Benchmarking Tool for building and space types covered by ENERGY STAR® or FEMP designated equipment.

1.5 COMPLIANCE

See Section 1.9 for a list of abbreviations, applicable codes, and standards. These references are also given in the text of this manual where appropriate.

1.6 VA HOSPITAL BUILDING SYSTEM

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 (called the Redbook) and the 2006 Supplement. Additional details are included in Appendix 1-A.

1.6.1 DESIGN IMPLICATION

Due to the modular concept, the A/E will find that mechanical schematic/design development decisions occur much earlier in the overall planning/design process. Equipment selection and main distribution sizing should be evaluated as soon as the size and number of modules is determined.

1.7 PERTINENT STANDARDS

Note: The A/E shall submit to the VA a list of all applicable documents, posted in the TIL, listed below along with the datesthat were in effect on date of contract award.

Major standards are described in this section.

1.7.1 DESIGN MANUALS (PG-18-10)

Located in Technical Information Library (TIL)
http://www.va.gov/facmgt/standard/manuals_hosp.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.

1.7.2 DESIGN SUBMISSION REQUIREMENTS (PG-18-15)

Located in Architect/Engineer Information
http://www.va.gov/facmgt/ae/des_sub.asp

The submission requirements shall be implemented in conjunction with Appendix 1-C.

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

The instructions 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 assure a quality design product.
- Requiring life-cycle analysis of alternatives in order to optimize the design/cost tradeoff.
- Listing and detailing all the drawings, calculations, and specifications required for a complete design package.
- Indicating the final distribution of bid documents.

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

1.7.3 MASTER SPECIFICATIONS (PG-18-1)

Located in Technical Information Library (TIL)
http://www.va.gov/facmgt/standard/spec_idx.asp

Purpose
Defines a standardized method for the A/E to assure that the contractors provide 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.

1.7.4 ARCHITECT ENGINEER REVIEW CHECKLIST

Located in Technical Information Library (TIL)
http://www.va.gov/facmgt/standard/ae_checklist.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.

1.7.5 DESIGN ALERTS

Located in Technical Information Library (TIL)
http://www.va.gov/facmgt/standard/d_alert.asp

Purpose
Communicates current design issues and solutions.

The design alerts accomplish this by:

- Publishing periodic alert memos.
- Summarizing design solutions.

1.7.6 QUALITY ALERTS

Located in Technical Information Library (TIL)
http://www.va.gov/facmgt/standard/q_alerts.asp

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.

1.7.7 DESIGN GUIDES (PG-18-12)

Located in Technical Information Library (TIL)
http://www.va.gov/facmgt/standard/dg_idx.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.

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

Located in Technical Information Library (TIL)
http://www.va.gov/facmgt/standard/proc_idx.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.

1.7.9 NATIONAL CAD STANDARDS (NCS) AND DETAILS (PG-18-4) AND CAD DELIVERABLES GUIDELINES (PG-18-4)

Located in Technical Information Library (TIL)
http://www.va.gov/facmgt/standard/details.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 guidelines 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 the VA Authorities.

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

http://www.va.gov/facmgt/standard/physecurity.asp

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.

1.7.11 COST ESTIMATING MANUAL

Located in Cost Estimating
http://www.va.gov/facmgt/cost-estimating/

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.

1.7.12 SUSTAINABLE DESIGN FOR DESIGN AND CONSTRUCTION OF VHA FACILITIES, VBA FACILITIES, AND NCA FACILITIES

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.

1.7.13 SEISMIC DESIGN REQUIREMENTS (H-18-8)

Located in Technical Information Library (TIL)
http://www.VA.gov/facmgt/standard/etc/seismic.pdf

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.

1.7.14 FIRE PROTECTION DESIGN MANUAL

Located in Technical Information Library (TIL)
http://www.VA.gov/facmgt/standard/dmnual/dmfpfire.doc

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 COMPUTER AIDED FACILITIES MANAGEMENT REQUIREMENTS (CAFM)

The VA intends to implement Computer Aided Facility Management (CAFM) systems in all new and replacement hospital construction, and as feasible in all existing hospitals. The CAFM concept requires that all pertinent data regarding a facility be contained in a master digital database, accessible by facilities personnel at their workstations for use in operations, energy/cost management, and maintenance and for planning modifications in facility infrastructure due to space utilization changes.

In Appendix 1-B, additional information about format, utilization, and calculations is given.

1.9 ABBREVIATIONS AND REFERENCES

1.9.1 ABBREVIATIONS

Abbreviation	Description
A/E	Architects and Engineers
AB	Air Blender
AC	Air-Conditioning Section
AF	After-Filters
AFCV	Air Flow Control Valve
AHU	Air-Handling Units
BHP	Brake Horse Power
BMT	Bone Marrow Transplant
BSC	Biological Safety Cabinets
BTU	British Thermal Units
BTUH	British Thermal Units per Hour
CC	Cooling Coil
CD-1	Conceptual Design (Submission1)
CD-2	Conceptual Design (Submission2)
CFM	Cubic Feet Per Minute
CH	Chiller
CHW	Chilled Water
CT	Cooling Tower
CV	Constant Volume
D-1	Outdoor Air Damper
D-2	Return Air Damper
D-3	Relief Air Damper
DD-1	Design Development (Submission1)
DD-2	Design Development (Submission2)
DDC	Direct Digital Controls
DPA	Differential Pressure Assembly
DP	Diffuser Plate
DPS	Differential Pressure Switch
DX	Direct-Expansion
ECC	Engineering Control Center
EER	Energy Efficiency Ratio
ETO	Ethylene Oxide
FF	Final Filters
FM	Flowmeter
FPM	Feet Per Minute
FPS	Feet Per Second
GPM	Gallons Per Minute
H	Humidifier
HAC	Housekeeping Aide's Closet
HRD	Heat Recovery Device
HW	Hot Water
ICU	Intensive Care Unit
JC	Janitor's Closet
KPA	1000 Pascal
LAFW	Laminar Air Flow Workbench
MB	Mixing Box
MERV	Minimum Efficiency Reporting Valve

Abbreviation	Description
MRI	Magnetic Resonance Imaging
NC	Noise Level
OA	Outside Air
P	Pump
PF	Pre-Filter
PHC	Preheat Coil
PPM	Parts Per Million
PSI	Pounds per Square Inch
PSIG	Pounds per Square Gage
PSS	Primary Secondary System
RA	Return Air
RAF	Return Air Fan
RDS	Room Data Sheets
REA	Relief Air
RF	Radio-Frequency
RHC	Reheat Coil
SCI	Spinal Code Injury
SA	Supply Air
SAF	Supply Air Fan
SD	Smoke Detector
SD-1	SA Duct Smoke Damper
SD-2	RA Duct Smoke Damper
SDB	Branch Return Air Duct Detercor
SDR	Smoke Damper (Return)
SDS	Smoke Damper (Supply)
SP	Static Pressure
SPD	Supply Process and Distribution
TAB	Testing Adjusting and Balancing
VAV	Variable Air Volume
VHA	Veterans Health Administration
VPS	Variable Primary System
VSD	Variable Speed Drive
WG	Water Gage

1.9.2 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

APPENDIX 1-A :VA HOSPITAL BUILDING SYSTEM

1-A.1 DESCRIPTION OF MODULES

1-A.1.1 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 modulesare defined as one-story units of building volumes with a foot print of 10,000 Square Feet [3,048 Meters] to 20,000 Square Feet [6,096 Meters]. Each module is comprised 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.

1-A.1.2 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.

1-A.1.3 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.

1-A.1.4 THE FUNCTIONAL ZONE

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

1-A.1.5 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.

1-A.1.6 UTILITIES

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

1-A.2 ZONING OF AIR-HANDLING UNITS

1-A.2.1 ZONING CONSIDERATIONS

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 40,000 CFM [18,868 Liters/Second].

1-A.3 REFERENCES

1-A.3.1 DEVELOPMENT STUDY-VAHBS (REDBOOK – REVISED 1976)

1-A.3.2 SUPPLEMENT TO DEVELOPMENT STUDY (2006)

1-A.4 BASIC DESIGN OF A SERVICE ZONE

Figure 1-A shows a typical service zone.

Appendix 1-A

HVAC DESIGN MANUAL
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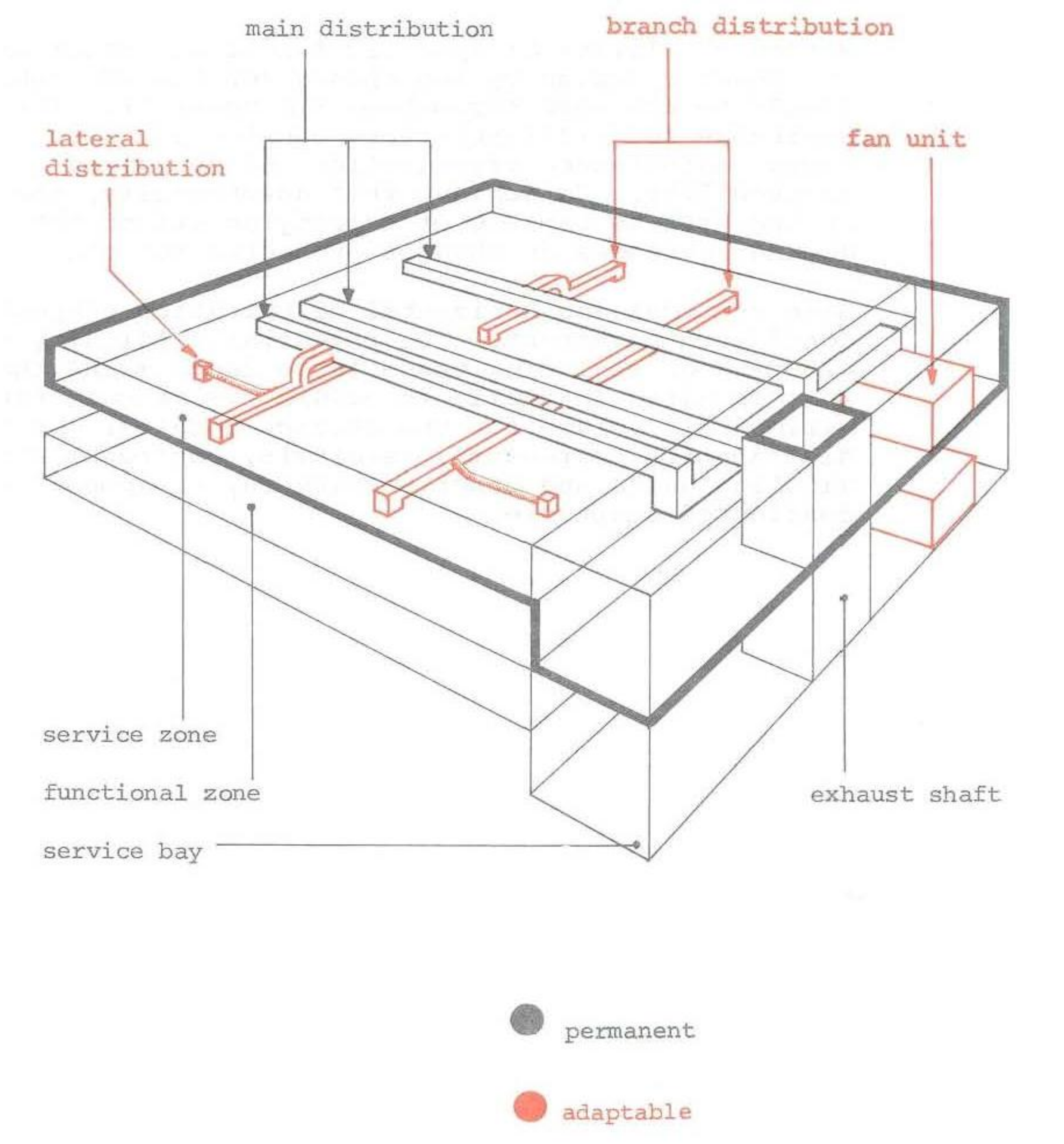


Basic Design of a Service Zone
Not to Scale

APPENDIX 1-B: COMPUTER AIDED FACILITIES MANAGEMENT

1-B.1 CAFM AND EQUIPMENT SCHEDULE UTILIZATION

1-B.1.1 INTRODUCTION

The requirement for access to a master digital database necessitates the compilation 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-B.1.2 SUBMISSION REQUIREMENTS

Although the VA is still finalizing software requirements for the ultimate CAFM configuration, the A/E shall begin the digital submission process now.

1-B.1.3 SCHEDULES

(a) The equipment and other schedules, which previously appeared in the VA TIL under the National CAD Standards as either .dwf or .dwg files, have been converted into Excel spreadsheet files (.xls), and are still located in the CAD section of the TIL. The schedules shall be downloaded for use.

(b) The schedules are similarly arranged to promote consistent data presentation. Notes for special requirements are listed below the schedules. Roll the cursor over column headings to display pop-up notes containing recommended methodologies for determining how to populate the columns. Several columns are intially hidden for use later in the design/construction and maintenance process.

(c) Use the schedules initially for equipment selection and listing. Completed schedules can then be inserted into project CAD drawings. Copies of the Excel files will be given to the successful contractor to fill in data from approved submittals, equipment suppliers, or bills of material. These modified schedules will then be inserted into the final as-built CAD drawings, to become part of the ultimate CAFM database. The facilities management group can then reveal the hidden columns for their purposes.

(d) The A/E Submission Requirements include full calculation sets for equipment selections. These calculations will also appear in the pop-up data boxes to provide easy access when used later in the CAFM system.

APPENDIX 1-C: A/E SUBMISSION REQUIREMENTS AND HVAC DESIGN MANUAL COORDINATION

1-C.1 GENERAL

1-C.1.1 INTRODUCTION

In this appendix, specific tasks outlined in the A/E Submission Requirements for Major New Facilities, Additions, and Renovations (Program Guide, PG-18-15, Volume B, May 2006) at various submittal stages of the design process are presented and related to the contents of this Design Manual. This effort substantiates and supplements the Submission Requirements, while providing in-depth insight into the submission needs.

1-C.1.2 COORDINATION

Coordination between the Submission Requirements and the Design Manual is mandatory. Variations and deviations from the prescribed submission task may be permitted on a case-by-case basis, if and where deemed necessary, to meet the project-specific scope of work. Such variations and deviations must be submitted in writing for the prior approval by the VA Authorities.

1-C.1.3 COMPLIANCE REQUIREMENTS

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

1-C.1.4 SPECIFIC DRAWING REQUIREMENTS

(a) The contract drawings shall include those listed below. For uniformity, drawings shall be arranged in the order listed. See NCS for more organizational detail:

- MH – 0xxx General Notes, Abbreviations, and Symbols (use only VA NCS).
- MD – 1xxx Demolition of existing HVAC work, floor plans, if applicable. Minor demolition may be shown on new construction drawings. Extensive demolition requires drawings for demolition only.
- MS – 1xxx Site Plan, Chilled Water. Heating Water as applicable, Steam Distribution.
- MH – 1xxx Floor Plans 1/8” = 1’-0” (1:100) for Equipment and Ductwork.
- MP – 1xxx Floor Plans 1/8” = 1’-0” (1:100) for Equipment and Piping.
- MH – 3xxx Sections shall be shown at large scale as required to clarify installation, especially through areas of possible conflict. At least 2 full building sections shall also be provided. Show all the equipment, including plumbing and electrical.
- MH – 4xxx Large Scale Floor Plans and Sections ¼” = 1’0” (1:50) for Mechanical Equipment Rooms (MERs). This includes central chillers and boiler plants.
- MH – 4xxx Large Scale Plans ¼” = 1’0” (1:5) for Mechanical Chases at each floor, showing all ducts, dampers, piping, and plumbing. All sizes shall be indicated at each level.
- MH – 5xxx VA Standard Details and all other necessary details.
- MH – 6xxx VA Standard Equipment Schedules. Include schedules for existing air-handling units, fans, pumps, etc. that will require alteration or rebalancing. See listing for the order of Equipment Schedules.
- MH – 6xxx Flow Diagrams for Chilled Water and Hot Water Systems. Flow diagrams shall show entire system on a single drawing.
- MH – 6xxx Flow and Control Diagrams for Steam and Condensate Piping Systems.
- MP – 7xxx Piping Riser Diagrams for chilled water, hot water, steam and condensate systems, where applicable. Piping Diagrams shall show all sizes, valves, gages, unions, vibration isolation, expansion devices, control devices, etc.
- MH – 8xxx Temperature Control Diagrams and Sequence of Operation for all HVAC Systems, including “Sequence of Operation” written on the drawings alongside the control diagrams.

(b) Walk-in refrigerators/freezers in dietetic areas and in laboratories shall be shown on “MH” drawings.

(c) Room numbers and names shall be shown on HVAC plans at every review stage including schematic submissions. Where there is insufficient room on the HVAC floor plans to show room names, room numbers only may be shown on the floor plan, with the room number and name tabulated on the drawing.

1-C.1.5 EQUIPMENT SCHEDULES

1-C.1.5.1 Order of Presentation

Equipment schedules shall be listed in the following order, vertically, from left to right, to facilitate checking and future reference. Refer to Appendix 1-B for equipment schedule utilization. For each item in a schedule, show the Basis of Design, including the manufacturer and model number selected.

(a) Air Conditioning Design Data (Outdoor and Indoor Design Conditions for the various occupancies)
(b) Air Flow Control Valves
(c) Air Flow Measuring Devices
(d) Air Handling Equipment
(e) Air Separators
(f) Chillers, Condensing Units, Air-Cooled Condensers
(g) Heat Exchangers
(h) Cooling Towers
(i) Engineering Control Center
(j) Expansion Tanks
(k) Fans
(l) Fan-Coil Units, Air Terminal Units (Boxes)
(m) Filters for Closed Loop Water Systems (chilled water and hot water)
(n) Finned Tube Radiation
(o) Heat Recovery Equipment
(p) Humidifiers
(q) Pre-Filters, After-Filters, Final-Filters, and Terminal-Filters
(r) Preheat Coils, Cooling Coils, Reheat Coils
(s) Pressure Reducing Valves, Safety Valves
(t) Pumps
(u) Radiant Heating Panels
(v) Room By Room Air Balance
(w) Sound Attenuators
(x) Supply, Return, and Exhaust Air Diffusers and Registers
(y) Unit Heaters
(z) Vibration Isolators
(aa) Water Flow Measuring Devices
(bb) Control Valves

1-C.1.5.2 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, but rather the data shall be in the range of available manufactured products.

1-C.1.5.3 Equipment Schedules – Glycol Data

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

1-C.2 SCHEMATICS 1 (S1)

Task Description (Item 9a – Page 8)
Provide estimated heating and cooling requirements of the existing and/or new buildings based on the gross square footage of area of each unique function space, such as patient bedrooms wing, animal research area, laboratories, offices, etc. Coordinate the estimated preliminary steam demand with the A/E submission requirements of the Steam Generation Section.

Design Manual Coordination
Provide basis for selecting the gross square footage for heating and cooling of each unique function.

Task Description (Item 9b – Page 9)
Investigate the condition and availability of the spare capacity of the existing systems such as chilled water, hot water, and steam, if any, and provide specific recommendations for meeting the needs of the project

Design Manual Coordination
Refer to Chapter 2 for the field survey requirements and the need to interview the technical personnel at the project site.

Task Description (Item 9c – Page 9)
Investigate the availability of utilities such as natural or propane gas, electricity, etc. for the HVAC equipment and provide their status.

Design Manual Coordination
Refer to Chapter 2 for the field survey requirements and the need to interview the technical personnel at the project site. Obtain the utility rate structure from the VA Facility and establish the division in the scope of work between the utility company and VA.

Task Description (Item 9d – Page 9)
Provide description of the tentative zoning of the spaces for proposing dedicated HVAC systems. State clearly the engineering criteria and rationale used for selecting three different types of systems for the life-cycle cost analysis for each functional space. State clearly all assumptions and parameters to be used in the analysis. If the analysis is scheduled to be performed on a computer, provide the name of the program.

Design Manual Coordination

(a) Zoning Requirements: HVAC zoning requirements are given in Chapter 6 and Appendix 6-A, where a list of the spaces that are grouped together with each dedicated air-handling unit is given. Depending upon the size and scope of the projects, the dedicated air-handling units may not be required, if approved by VA Authorities.

Refer to Chapter 2 for the systems generally not permitted in the VA facilities.

Examples:
Radiant ceiling panels for cooling
Fan coil units for new construction

(b) Life-Cycle Cost Analysis (System Comparison): Where an all-air system is mandated in the design manual, life-cycle cost analysis comparing three systems is not required on airside.

Task Description (Item e – Page 9) Provide a list of the energy conservation measures proposed to be used in the HVAC system design and the life-cycle cost analysis. State clearly the logic and criteria used in selecting each conservation measure.
Design Manual Coordination **(a)** In Chapter 1, Executive Order and MOU (Memorandum of Understanding) mandates 30% additional energy conservation over the ASHRAE Standard 90.1 – 2004 baseline. To meet this goal, wholly or partially, several measures are outlined in this manual. In Chapter 2, building thermal envelope study and energy recovery systems are described. In Chapter 4, a major study requiring optimization of the chilled water plant and piping/pumping arrangement is described. In Appendix 6-A and Appendix 6-B, numerous control sequences promoting energy conservation are mentioned. **(b)** The A/E should generate a list of the project-specific energy conservation measures to attain the goal of energy conservation and provide life-cycle cost analysis back-up data for each measure.

1-C.3 SCHEMATICS 2 (S2)

Task Description (Item 9a – Page 18) Provide a description of the heating, ventilating, and air-conditioning (HVAC) systems and equipment for each functional space.
Design Manual Coordination Chapter 2 and Chapter 3 describe the HVAC systems and their configurations.

Task Description (Item 9b – Page 18) Provide complete life-cycle cost analysis with specific recommendations and full back-up data. State the heating and cooling capacities of each functional area used in the life-cycle cost analysis. State the block cooling and heating loads for each new and/or existing building.
Design Manual Coordination The life-cycle cost analysis procedure and results for the central plant shall be in compliance with the methodology outlined in Chapter 1. While performing the life-cycle cost analysis, the A/E shall use block loads provided in 9a of S1.

Task Description (Item 9c – Page 18) Indicate tentative locations and sizes of all mechanical equipment rooms and principal vertical shafts. Show a block layout of major pieces of equipment in each mechanical equipment room. Show outside air, exhaust air, and relief air louvers. Resolve various items affecting louver location, while considering other factors such as visibility, historical considerations, wind direction, nuisance and health hazard odors caused by short circuiting of air from exhaust from emergency generators, truck waiting areas, etc. to intake.
Design Manual Coordination **(a)** Coordinate with the equipment and louver locations with the physical security requirements. Note the special considerations imposed by facilities that are in the vicinity of hurricanes and major storms. **(b)** Provide dedicated shafts for the contaminated exhaust per NFPA 90A.

1-C.4 DESIGN DEVELOPMENT 1 (DD1)

Task Description (Item 9a – Page 28) Provide the first version of the detailed zone heating and cooling load calculations. Accompany these calculations with the architectural drawings 1:200 (1/16 inch) scale showing correlation between each zone boundary and the floor area and abbreviated/coded room numbers used with computer input data sheets. Provide input manuals for the software programs with clear indications of the capabilities and limitations of the programs. Provide a level of detail of the calculations consistent with the development of the architectural drawings.
Design Manual Coordination **(a)** Chapter 2 requires computerized calculations and computerized psychrometric analysis. Specify the software program used for performing calculations and analyses. Provide an input manual and a matrix showing the co-relationship between the room numbers used and architectural drawings. **(b)** Submit first version of additional mandated energy conservation measures with calculations in accordance with Chapter 1.

Task Description (Item 9b – Page 28) For air handling units, heating and ventilating units, and exhaust air systems, estimate the capacities in cubic feet [cubic meters] per minute, static pressure, and required fan motor horse power.
Design Manual Coordination Express the supply air volume in the Inch-Pound (IP) units followed by SI (Metric Units) CFM (Cubic Feet per Minute) followed by Liters per Second (Liters/Second) in metric units. Provide an air balance for each air-handling unit with the level of detail consistent with the progress of project.

Task Description (Item 9c – Page 28) For the proposed chilled water plant, indicate the quantity and type of chillers, capacity in tons of refrigeration, and the electrical requirements. Provide pertinent data for the chilled water plant accessories, that is, the chilled water and condenser water pumps, and cooling tower. Coordinate the cooling tower location with other disciplines. Perform a sound/acoustic analysis to ensure that the noise generated by the chillers, condensers and condensing units, cooling tower, etc. is in compliance with the acceptable limits stipulated in the VA HVAC Design Manual.
Design Manual Coordination The A/E shall carefully study the two requirements outlined in Chapter 2 and include them in DD1 submission with specific recommendations. These requirements are: • Acoustic Analysis • Dispersion Analysis

Task Description (Item 9d – Page 28)
For the heating system, compile the total heating load based on the available information of the space heating requirements, domestic hot water load, humidification loads, and the equipment steam demand. Provide a written description of the proposed zoning of the heating system indicating such features as distribution of ventilation load, perimeter heat load, and reheat load associated with air terminal units.

Design Manual Coordination

(a) Coordination with the Steam Generation, Outside Utility Distribution, Architectural Service, and the Medical Center is essential before the preparation of the construction drawings.

(b) Submit dispersion analyses for the boilers.

Task Description (Item 9e – Page 28)
Assemble and provide available preliminary electrical power (normal and emergency) data to the electrical discipline.

Design Manual Coordination
Emergency power requirements are given throughout this manual. Mission critical facilities may require more emergency power than the minimum specified here.

Coordinate with the electrical discipline the extent of emergency power, generator room size, number of generators, and the type of generators (with integral radiators or remote radiators), fuel requirements, and fuel storage needs.

Task Description (Item 9f – Page 28)
Provide a description of the interaction between the existing HVAC systems (if any) and the new requirements. State clearly the impact on the existing HVAC systems.

Design Manual Coordination
The design team shall coordinate the hidden costs associated with the existing HVAC systems and correctly estimate the impact on the project cost. These costs are:

- Testing, Adjusting, and Balancing (TAB) of the existing systems
- Replacing components such as electric motors, starters, drives of the existing systems
- Impact on the architectural and interior design, such as demolition of the suspended ceiling and light fixtures, new suspended ceiling, fixtures, painting, shutdown, etc.

Task Description (Item 9g – Page 28)
Provide a written description of the seismic criteria (if applicable) on the HVAC systems.

Design Manual Coordination
See Chapter 2 for the seismic criteria and the reference of the applicable manuals and standards. Ensure coordination with these documents.

Task Description (Item 9h – Page 28)
Provide a list of edited VA standard symbols and abbreviations.

Design Manual Coordination
See TIL for the National CAD Standards.

Task Description (Item 9i – Page 28) Provide 1:100 (1/8 inch) scale HVAC floor plans for typical areas showing the proposed routing of the main air distribution and piping layouts. Ductwork and piping may be shown in single line.
Design Manual Coordination **(a)** Use of the single line ductwork is permitted only through DD1 submission. **(b)** Refer to Chapter 2 for the double line ductwork and piping for the DD2 documents. **(c)** Submit HVAC floor plan for each functional area such as a nursing unit, radiology, surgery, SPD, etc.

Task Description (Item 9j – Pages 28 and 29) Show fire and smoke partitions on HVAC floor plans. Show necessary smoke and fire dampers and smoke detectors, etc. on floor plans. For buildings that are not equipped with quick response sprinklers, describe each designated smoke zone interaction with the HVAC systems for the building.
Design Manual Coordination Ensure coordination with the VA Standard Detail for the duct crossing of the designated barrier for control sequence and division in the scope of work.

Task Description (Item 9k – Page 29) Provide equipment schedule for each major equipment.
Design Manual Coordination Provide all anticipated equipment schedule information in the VA standard format arranged as in section 1-C.1.5 Equipment Schedules, this appendix. Provide data for major equipment, leaving remaining schedules blank.

Task Description (Item 9l – Page 29) Submit 1:50 (¼ inch) scale floor plans of the typical mechanical equipment rooms (MERs) with at least two cross-sections showing all floor and ceiling mounted equipment, major ductwork, and piping. Show all ductwork and piping, 6 inches [150 mm] and larger, in double line. On the cross-sections, generally taken at right angles to each other, show actual elevations of each HVAC component, rise and drop as required to coexist with other interfering items of equipment and other building elements such as beams, lights, plumbing pipes, cable trays, etc. On the MERs, show all miscellaneous equipment and systems such as heating and ventilating systems for the MERs and locations of the temperature control panels. Clearly demonstrate clearances for access and maintenance with coil and tube pull spaces on the equipment layouts.
Design Manual Coordination Ensure that the equipment room includes space and related requirements of the sub-systems, such as: • Mechanical Room Ventilation and Heating • Emergency Exhaust System Refrigerant Spill Removal • Make-Up Air System • Cooling Tower Make-Up Water System

Task Description (Item 9m – Page 29)
Provide schematic flow and riser diagrams for each type of the typical air handling systems and all hydronic systems such as chilled water system, hot water system, steam system, glycol heat recovery system, etc. Provide existing capacities of these systems and new estimated loads with pumping arrangement, and control valves for complete understanding of existing systems to be utilized or interfaced with the new systems.

Design Manual Coordination

(a) Include general and special exhaust systems, dedicated exhaust shafts where required, floor isolating valves for the piping risers, flowmeters, automatic flow control and balancing devices, motorized dampers, fire dampers, smoke dampers, etc.

(b) Submit each type of the typical air handling system for each functional area, including nursing unit, surgery, radiology, SPD, etc.

Task Description (Item 9n – Page 29)
Develop schematic control diagrams for each type of typical air and hydronic systems. Show control devices such as thermostats, humidistats, flow control valves, dampers, freeze stats, operating and hi-limit sensors for all air systems and fluids, smoke dampers, duct detectors, etc.

Design Manual Coordination
Provide a DDC controls system architectural layout as specified in the design criteria. Show all DDC control points (analog and binary).

Task Description (Item 9o – Page 29)
Investigate the possibility of using the existing (if any) central Engineering Control Center (ECC) for the automatic temperature control requirements of the new project. Address the key issues of available spare capacity, compatibility, proprietary expansion, and any other information available from the medical center.

Design Manual Coordination
Coordinate with the requirements given in Chapter 5 of this manual.

1-C.5 DESIGN DEVELOPMENT 2 (DD2)

Task Description (Item 9a – Page 37)
Provide the first version of the room-by-room heating and cooling load calculations. These calculations shall be accompanied by the architectural drawings showing correlation between each HVAC zone boundary and the floor area, and a room schedule showing correlation between the architectural room numbers and abbreviated/coded room numbers used with computer input data sheets.

Provide input manuals (if not provided earlier during DD1) for the software programs with clear indications of the capabilities and limitations of the programs. Show the derivation of all "U" factors for building elements based on the actual building construction and published window data. The accuracy and the level of detail of the calculations shall be consistent with the development of the architectural drawings. Update these calculations during subsequent design phases to reflect all changes and availability of additional information. Include the following calculations:

(1) Peak zone-by-zone heating and cooling loads.

(2) Building block heating and cooling loads.

(3) Estimated steam consumption from all sources.

(4) Psychrometric chart for each air-handling unit showing cooling and heating coil conditions and computation of humidification loads. Show coil entering and leaving conditions and fan motor heat gains for supply and return air fans.

(5) Room-by-room air balance charts for each air handling unit showing supply, return, exhaust, make-up, and transfer air quantities with the intended pressure relationship with respect to adjoining spaces : positive, negative, or zero,.

Design Manual Coordination
In Chapter 2, the above requirements are substantiated.

- While calculating heat gain and loss, use the building thermal parameters selected and approved per the Building Thermal Envelope analysis.
- Submit an updated version of additional mandated energy conservation measures with calculations in accordance with Chapter 1. Provide life-cycle cost analysis data and identify the most energy-efficient design.
- Use a software program while performing the psychrometric analysis.
- Include the above room-by-room air balance schedule on the drawings, preferably on the applicable floor plans.

See VA Standard Details for room unit balance schedule.

Task Description (Item 9b – Pages 37 and 38) Submit complete engineering calculations and selection criteria of major HVAC equipment such as chillers, cooling tower, air handling units, heating and ventilating units, return and exhaust fans, circulating pumps, and energy recovery equipment. Provide catalogue cuts for all selected equipment.
Design Manual Coordination See Chapter 2. In addition to the above, provide equipment schedules, selection calculations, product data information for heat exchangers, PRV stations, and humidification equipment. All equipment schedule engineering data shall be backed up by submitted calculation.

Task Description (Item 9c – Page 38) Ensure coordination with electrical, plumbing, and steam generation disciplines by compiling the pertinent information that they require. Distribute information, such as normal and emergency power requirements, steam consumption for all HVAC and kitchen/sterilizer equipment, and make-up water requirements, to the respective trades.
Design Manual Coordination Provide a checklist, or any other supporting documents, showing the details of the coordination effort.

Task Description (Item 9d – Page 38) Submit 1:100 (1/8 inch) scale HVAC floor plans for typical areas showing at least the main supply, return, and exhaust air ductwork with sizes based on the updated calculations. Illustrate duct and ceiling clearances, where ductwork cross, with 1:50 (¼ inch) scale local sections. Indicate ductwork, regardless of sizes and/or complexity of layout and show 6 inch [150 mm] and larger piping in double line. Indicate individual room air distribution and temperature control arrangement for a representative sample of typical spaces, such as patient bedrooms, operating suite, laboratory areas, conference rooms, etc., on duct and piping layouts. Provide separate floor plan drawings for layouts of air distribution and piping systems.
Design Manual Coordination Use the duct and piping criteria prescribed in this manual. Deviations, if any, shall be permitted only if backed by acoustic or economic analysis.

Task Description (item 9e – Page 38) Provide updated 1:50 (¼ inch) scale typical mechanical equipment room plans with resolution of review comments made during previous submission.
Design Manual Coordination Typical mechanical equipment rooms shall include an AHU room per each functional area, central plant, and heating room.

Task Description (Item 9f – Page 38) Update the typical schematic and riser diagrams for air-handling systems and hydronic systems by providing quantities and sizes to reflect the latest engineering calculations. Show locations of all exhaust fans. Also show the locations of all major components with respect to the building floor and each other.
Design Manual Coordination Refer to section 1-C.1.4 Specific Drawing Requirements, this appendix, for a list of diagrams and risers.

Task Description (Item 9g – Page 38) Perform a sound/acoustic analysis to ensure that the noise generated by the air-handling units and the fans is in compliance with the VA HVAC Design Manual.
Design Manual Coordination In Chapter 2, minimum requirements and suggested measures are described.

Task Description (Item 9h – Page 38) Provide demolition drawings indicating scope of work for demolition.
Design Manual Coordination None.

Task Description (Item 9i – Page 38) Show HVAC work associated with phasing plan.
Design Manual Coordination The phasing plan shall be coordinated with the medical center in consultation with the VA resident engineer and the required shutdown of the affected facilities and utilities. The phasing plan shall address such issues as swing space, parking interruptions, and re-routing of pedestrian/vehicular traffic.

Task Description (Item 9j – Page 38) Show the extent of the outside chilled water and condenser water piping. Clearly show how the piping shall be laid in the tunnels, trenches, or by direct burial.
Design Manual Coordination **(a)** Show piping profile with direct burial system. Provide manholes as required. Piping shall be laid below the frost line. Provide expansion loop and guides for the high-pressure steamlines. **(b)** Provide a cross-section of the trenches and tunnel layouts. Trench covers shall be removable. Provide lighting and ventilation with the tunnel installation. Show access to tunnels.

Task Description (Item 9k – Page 38) Update the schematic control diagrams for each type of typical air and hydronic system used for development in previous submission by providing a written description of the sequence of operation on the floor plans. Explain clearly the function and role of each control device and describe the safety/alarms and normal operating controls of each system. Provide a schedule showing electrical control interlock of each component.
Design Manual Coordination See Chapter 5 for additional details. Include DDC architecture on drawings.

Task Description (Item 9l – Pages 38 and 39) Detail the scope of work involved with the central Engineering Control Center (ECC). Indicate the planned capabilities including features of energy management and conservation. Provide a point schedule for analog/digital input and output to be included in ECC.
Design Manual Coordination **(a)** See Chapter 5 for the sample of the point schedule. **(b)** Ensure coordination with the disciplines other than mechanical.

Task Description (Item 9m – Pages 39) Specifications.
Design Manual Coordination Coordination with the actual scope of work and editing of the specifications is essential.

1-C.6 CONSTRUCTION DOCUMENTS 1 (CD1)

Task Description (Item 9a – Page 47) Provide complete and final engineering calculations of all systems. In addition to the updated room-by-room heating and cooling calculations, perform and submit the following calculations: **(1)** Final selection of all pumps with the pump head calculations based on the actual piping layout and takeoffs and pressure drop through the equipment selected for the systems. **(2)** Final selection of all fans with the fan static pressure calculations based on the actual duct layouts and takeoffs and static pressure drop through the equipment for the systems. **(3)** Sizing and selection of all expansion tanks based on the actual piping layout and volume computation.
Design Manual Coordination All selections shall be based on the actual takeoffs using a public domain software program. All engineering parameters indicated on equipment schedules shall be backed up by detailed engineering calculations, submitted in electronic format, and not based on "rule of thumb" and/or "office policies." Variable speed drives shall not be used as a justification for not providing detailed engineering calculations.

Task Description (Item 9a – Page 47) **(4)** Sizing and selection of all steam to hot water converters and heat exchangers based on the flow requirement of each terminal unit, that is, duct-mounted reheat coil, box (air terminal unit) mounted reheat coil, unit heaters, convectors, finned tube radiation, radiant ceiling panels, etc.
Design Manual Coordination **(a)** Do not assume water flow rate based on the block load or the fixed and assumed water temperature differential. Flow thus established is likely to fall short of meeting the needs of all terminal units, specifically the miscellaneous terminal units, which are generally not considered. **(b)** Submit final version of additional mandated energy conservation measures with calculations in accordance with Chapter 1. **(c)** Submit detailed calculations for each PRV station and safety relief valve.

Task Description (Item 9a – Page 47) **(5)** Sound analysis of various systems and steps shall be taken to ensure compliance with the specified noise levels.
Design Manual Coordination See Chapter 2. Acoustic analysis is required for ***all*** HVAC systems, not just for a few typical systems.

Task Description (Items 9b – 9c – 9d) Pages 47 and 48) **(b)** Provide complete selection data including catalogue cuts and calculations for all HVAC equipment and drawings showing all equipment schedules. **(c)** Complete the coordination requirements with electrical, plumbing, and steam generation by providing revised information (if any) developed since the last submission. In addition, complete coordination with the architectural drawings (louvers, ceiling access panels, reflected ceiling plans, etc.) and structural drawings (operating weights of ceiling and floor mounted equipment, concrete and steel supports, roof and floor openings, etc.). **(d)** Submit 100% complete HVAC floor plans for all areas showing all ductwork and piping at 1:100 (1/8 inch) scales. Indicate ductwork and piping on separate drawings unless this requirement is waived by VA. Show all duct/pipe sizes and air/fluid quantities. Show air quantities for each room and each air inlet/outlet, expressed in cubic meters (feet) per minute, and fluid quantity, where required, in liters per second (gallons per minute). Show all volume dampers, fire dampers, smoke dampers, automatic control dampers, and rise and drop in ductwork, air inlet/outlets, etc. on the air distribution floor plans. Show all piping specialties, such as expansion loops, anchors, valves, drip assemblies, balancing fittings, etc., on the piping floor plans. Indicate all architectural room names and numbers along with designated smoke and smoke/fire barriers.
Design Manual Coordination Express quantities first in IP (Inch-Pound) units followed by SI (Metric) units. • CFM (Liters/Second) • GPM (Liters/Second)

Task Description (Item 9e - 9f - 9g – 9h – 9i – 9j – 9k – Pages 48 and 49) **(e)** Submit 100% complete HVAC floor plans for all mechanical equipment rooms with at least two cross-sections taken at right angles to each other at 1:50 (1/4 inch) scale. Show all equipment located on roof and/or grade. **(f)** Update smoke and fire partitions in HVAC floor plans as described under DD1. **(g)** Provide 100% complete drawings of the outside chilled water and condenser water distribution showing pipe sizes and insulation with plans, profile, sections, details, and all accessories such as anchors, expansion loops/joints, valves, manholes, capped and flanged connections, and interfaces between the new and existing work (if any). Clearly indicate any interferences with the existing utilities and/or landscape elements on outside piping layout drawings. Show rerouting of any utilities, cutting of roads, pavements, trees, etc. and the extent of new and demolition work. Base outside utility drawings on the study of the latest site drawings, discussions with engineering personnel, and the actual site inspection of the existing utility. **(h)** Provide 100% complete automatic temperature control drawings. Clearly show all duct detectors, control valves/dampers, static pressure sensors, differential pressure control assemblies, etc. whose actual physical location is critical for the intended sequence of operation on floor plans. For projects involving a central Engineering Control Center (ECC), provide a point schedule with intended analog/digital input and output, graphics capabilities, and requirements of the other trades to be included in the ECC. Provide a riser diagram showing locations of all field data gathering panels and their interfaces with the ECC. Show the actual location of the ECC and peripherals on floor plans. **(i)** Submit 100% complete standard detail drawings. Edit VA details to suit the project. Include any special details deemed useful and necessary for the project. **(j)** Provide 100% complete HVAC demolition drawings showing clearly the extent of demolition work. Indicate sizes of ductwork and piping to be dismantled. Show capacities and sizes of the existing equipment to be removed. Clearly show points of connection, disconnection, blank-offs, and dead-end flanges with isolating valves. Coordinate demolition and restoration work with other disciplines. Clearly state the revised capacities of the existing systems affected by the demolition work together with additional efforts, if any, involved in testing, balancing, and adjusting them. **(k)** Submit HVAC specifications in the format provided in CD1, paragraph 16, SPECIFICATIONS.
Design Manual Coordination Ensure coordination and provide supporting documentation such as a checklist showing the extent of coordination. Provide 100% complete riser and air flow diagrams.

CHAPTER 2: HVAC DESIGN PARAMETERS AND SELECTION CRITERIA

Table Of Contents

2.1 INTRODUCTION

The HVAC systems shall be designed and selected in accordance with the parameters and criteria given in this chapter. Unless a change from these parameters is approved by VA Authorities, the logic and methodology outlined here shall govern. This chapter details the selection criteria for the air-handling units (AHU), as they are the prime HVAC delivery systems.

2.1.1 DEFINITION – HIGH HUMIDITY AREAS

High humidity areas are defined as locations where the dew-point is greater than or equal to 60 F [15.6 C] for 4,000 hours per year or more. See Chapter 7 for the VA Facilities that meet this requirement.

2.1.2 DEFINITION – LOW HUMIDITY AREA

Low humidity areas are defined as locations where the-dew point is less than 35 F [1.7 C] for 4,000 hours per year or more. See Chapter 7 for the VA Facilities that meet this requirement.

2.2 SPECIAL REQUIREMENTS

2.2.1 DX – TERMINAL UNITS

Through-the-wall air-conditioners, window air-conditioners, packaged terminal air-conditioners (PTAC), or heat pumps are ***not*** permitted, unless specifically approved by VA Authorities. See Chapter 4 for permitted applications.

2.2.2 ROOF-MOUNTED EQUIPMENT

Do not use roof-mounted air-handling equipment unless specifically approved by the VA Authorities.

Exceptions:

- Cooling Towers
- Exhaust Fans
- Air-Cooled Chillers
- Pre-Fabricated Air Intakes
- Relief Hoods

For ***all*** roof-mounted equipment, including the above exempted equipment, the A/E shall coordinate the structural integrity, access, screening needs, and walking pads with other disciplines and the facility personal. Structural integrity must be evaluated and certified by a registered professional structural engineer.

All AHUs shall be housed in adequately sized, enclosed spaces.

2.2.3 REFRIGERANT HCFC-22

Do not design air-conditioning or refrigeration equipment using HCFC-22 refrigerant. The design shall include only EPA-approved refrigerants.

2.2.4 ACOUSTIC LINING

2.2.4.1 Ducts – Positive Air Pressure

Use of the acoustic, sound lining is ***not*** permitted on the inside surface of the supply air ducts or other ducts under positive air pressure.

Exceptions:

- Supply air terminal units (CV/VAV boxes)
- Integral supply air plenums serving linear diffusers

2.2.4.2 Ducts – Negative Air Pressure

Acoustic lining may be used in the return and exhaust air ducts under negative air pressure.

2.2.4.3 Lining Characteristics

Acoustic lining shall be anti-microbial and non-friable. Thickness of the lining shall not be less than 1 inch [25 mm].

2.2.5 HUMIDIFIERS

Direct use of steam from the central boiler plant is not permitted for the unit-mounted and terminal humidifiers. Use boiler steam on the upstream side of the non-fired, steam-to-steam generator(s) to produce low or medium pressure steam on the downstream side for use in the humidification equipment.

2.2.6 GLYCOL

Use of ethylene glycol solution is not permitted as an anti-freeze agent for closed-loop hydronic systems. Use propylene glycol for its lower toxicity and higher heat transfer efficiency compared to ethylene glycol. See Chapter 4 for the VA position on the use of glycol for chiller and hot water systems and Appendix 4-A for further technical details.

2.2.7 AIR SYSTEMS

See Chapter 3 for the special requirements of the supply air systems (air-handling units and fan coil units) and distribution systems (ductwork and air terminal units).

2.3 SPECIAL STUDIES

Perform the following special studies and analyses to verify and substantiate the system design and its ability to meet design goals and objectives. The submittal for review and approval by the VA Authorities shall include a certified copy of each study and analysis, including recommendations and cost implications. See Appendix 1-C.

2.3.1 ACOUSTIC CONSIDERATIONS

2.3.1.1 General

Perform detailed 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 Chapter 6 (Room Data Sheets) for the maximum permissible room noise criteria (NC) levels. Follow ASHRAE recommendations for spaces not included in the Room Data Sheets.

Listed below are suggested acoustic measures to be evaluated and implemented, if feasible:

(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 on the downstream side of the 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 in the design measures such as the use of thicker gage ducts and recommended duct configurations (see 2007 ASHRAE Handbook of Applications).

(f) If recommended by the acoustic analysis, select duct velocities lower than those shown in the duct sizing criteria provided in Table 2-1.

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

2.3.1.2 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 included as necessary to meet the design requirements.

(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 authorities.

(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 Feet [1.5 Meters] and 55 Feet [17 Meters] from the cooling tower in the equipment schedule.

2.3.1.3 Fan Coil Units (Where Permitted)

It is recognized that spaces served by the unitary equipment (such as fan coil units) experience higher NC levels than those specified for similar spaces without fan coil units. Select fan coil units at mid-speed to deliver the required output. Provide acoustic lining in the return air ducts for ducted fan coil units.

2.3.2 DISPERSION ANALYSIS

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

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 they exceed OSHA and ASHRAE requirements.

The dispersion analyses that shall be conducted include, but not limited to, the following:

- Exhaust from laboratories
- ETO exhaust
- Infectious disease ward
- Animal research department
- Emergency generators
- Vehicular exhaust
- Kitchen exhaust
- Boiler stacks
- Cooling towers
- Incinerator

2.3.3 BUILDING THERMAL ENVELOPE

2.3.3.1 Minimum Compliance

The building thermal envelope shall comply with ASHRAE Standard 90.1 – 2007 for all new construction.

2.3.3.2 New Construction (Compliance in Excess of ASHRAE 90.1 – 2004)

To meet the mandated goal of energy conservation set in the federal mandates (see Chapter 1), the A/E shall perform a building thermal envelope study to evaluate the most cost-effective system to meet VA requirements.

Include thermal parameters of the building components (roof, wall, floor, and glass), associated costs, and recommendations. Design options may include elimination of perimeter heating system if a superior building thermal envelope results in related reduced first cost of HVAC systems. ***Based on the outcome of the study, VA Authorities may select an envelope more efficient than ASHRAE Standard 90.1 – 2007.***

2.3.3.3 Existing Construction

Evaluate each component of the building thermal envelope to achieve an energy-efficient design. For the existing spaces to be equipped with winter humidification, special attention shall be paid to vapor proofing to prevent moisture migration. Ensure coordination with the architectural discipline. Leakage of outdoor air can be a significant issue in existing construction. Minimize infiltration of cold outdoor air.

2.3.4 HEAT RECOVERY DEVICES

The A/E shall conduct a study and perform a life-cycle cost analysis of applicable heat recovery systems for each qualified HVAC system in the project. The study shall include estimates of the initial cost, maintenance cost, net energy savings, and impact on the space and other disciplines. Even though ASHRAE Standard 90.1 – 2007 mandates the use of a heat recovery system, VA has opted to evaluate the applicability and suitability of heat recovery systems before such systems are included in the HVAC design.

2.3.4.1 Sensible Heat Transfer

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

(a) Runaround System

- Simplest system utilizing a piping loop and circulator pump.
- The loop connects a finned-tube coil in the exhaust plenum with a finned tube coil in the makeup air plenum or AHU. 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 effects of glycol.

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

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

(c) Heat Pipes

- 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.

(d) Heat Wheel

- Rotary air-to-air heat exchange.
- Low-pressure drop of 0.4 – 0.7 inch WG [100 – 175 Pascal] of water.
- 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 the air-handling units serving the surgical suite and the SPD department.
- Ensure outside air is pressurized greater than exhaust air.

2.3.4.2 Sensible and Latent Heat Transfer

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

- Desiccant (Enthalpy) Heat Wheels
  - 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 the air-handling units serving the surgical suite or the SPD department.
  - Ensure outside air is pressurized greater than exhaust air.

2.3.4.3 Load Credit

(a) Savings in cooling and heating energies due to the heat recovery devices, shall ***not*** be taken when selecting air-handling units. Such savings can be projected into the energy analysis or life-cycle analysis, but actual equipment selection shall not “trim” the cooling and/or heating components.

(b) Include two sets of operating conditions in the equipment schedule, one with and one without heat recovery devices.

2.3.4.4 Exceptions

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

- All fume hood exhaust
- Kitchen exhaust (range hood and wet exhaust)
- Autopsy exhaust
- Isolation room exhaust
- Wet exhaust from cage and cart washers
- ETO – Ethylene Oxide Sterilizers exhaust

2.3.5 COMPREHENSIVE CHILLED WATER STUDY

See Chapter 4.

2.4 BASIS OF DESIGN

2.4.1 OUTDOOR DESIGN CONDITIONS

Weather conditions for the VA facilities are given in Chapter 7. These conditions are based on the locations closest to the VA facilities and given in 2005 ASHRAE Handbook of Fundamentals. The A/E can recommend and use (subject to prior approval of the VA Authorities) more severe conditions than those listed in the Handbook, based on experience and knowledge of local weather conditions.

2.4.1.1 Cooling and Heating Load Calculations

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

- Cooling – 0.4 Percent Dry-Bulb and Wet-Bulb Temperatures – Column 1a
- Heating – 99.6 Percent Dry-Bulb Temperatures – Column 1b

2.4.1.2 Cooling Tower Selection

- 1 F [0.56 C] above 0.4 Percent Wet-Bulb Temperatures – Column 3

2.4.1.3 Preheat Coil Selection

- Annual Extreme Daily Mean Dry-Bulb Temperatures – Minimum Column

2.4.1.4 Electrical Heating Devices Using Emergency Power

- 99.6 Percent Dry-Bulb Temperatures – Column 1b

2.4.2 INSIDE DESIGN CONDITIONS

Inside design conditions for all typical spaces are given in Appendix 6-A and Appendix 6-B. Provide humidification to maintain minimum 40 F [4.4 C] dew-point temperature of the supply air.

2.4.2.1 Commonly Used Inside Design Temperatures and Humidity Ranges

70 F to 75 F [21 C to 24 C] and 30% to 50% RH have different implications depending upon the application and system configuration, as shown below:

2.4.2.2 Year Around Conditions

70 F to 75 F [21 C to 24 C] and 30% to 50% RH
As defined in 2007 ASHRAE Handbook of Applications, the system shall be capable of maintaining temperatures within the range during normal working conditions. The cooling load for these spaces shall be calculated to maintain 70 F [20 C] at 50% RH and the heating load shall be calculated to maintain 75 F [24 C] at 30% RH. See Appendix 6-A and Appendix 6-B for the specific applications. The year around conditions can be used for variable air volume (VAV) or constant volume (CV) systems. Year around design conditions shall be used for all patient areas.

2.4.2.3 Variable Air Volume (VAV) with Dead-Band

70 F to 75 F [21 C to 24 C] and 30% to 50% RH
As defined in ASHRAE Standard 90.1 – 2007, the space thermostat shall be capable of providing the above range and a dead-band of 5 F [2.8 C] within which the supply of cooling and heating energy to the space is shut off or reduced to a minimum. The dead-band is mandated for the qualified spaces.

2.4.2.4 Constant Volume (CV) System

70 F to 75 F [21 C to 24 C] and 30% to 50% RH
For constant volume systems serving non-patient applications, the space temperature is allowed to drop to 70 F [21 C] before heating is activated. The difference is adjustable.

2.4.3 ROOM AIR BALANCE

2.4.3.1 Definition

(a) Maintain the specified volumetric air balance between the supply and exhaust or return air as stipulated in the Room Data Sheets. Locate the supply air outlets and return/exhaust air inlets to create a directional airflow required to maintain the intended air balance. Provide devices such as airflow control valve to measure and verify the design air balance.

(b) Positive or negative air balance is also required to create a difference in space pressure. Where pressure measurement and control are required, use a pressure differential sensor and matching control devices.

2.4.3.2 Neutral (0) Air Balance

Supply Air = Exhaust Air or Return Air or [Exhaust Air + Return Air]

2.4.3.3 Negative (-) Air Balance

Exhaust Air or Return Air = [Supply Air + 15%]

2.4.3.4 Double Negative (- -) Air Balance

Exhaust Air or Return Air = [Supply + 30%]
Some applications may not require supply air to maintain double negative air balance. The intended air balance is maintained by 100% make-up air, transferred by the door undercuts and transfer grilles.

2.4.3.5 Positive (+) Air Balance

Exhaust Air or Return Air = [Supply Air – 15%]

2.4.3.6 Double Positive (+ +) Air Balance

Exhaust Air or Return Air = [Supply Air – 30%]

2.4.4 OCCUPANCY

Refer to the VA Design Guides and/or project program for design occupancy.

2.4.5 LIGHT AND POWER LOAD

The designer shall estimate the light and power load based on actual lighting layout and equipment manufacturers' data. See VA Design Guides where applicable for preliminary estimate.

2.4.6 OUTSIDE AIR VOLUME

Minimum outside air for ventilation shall be the highest of the following:

- Compliance – ASHRAE Standard 62.1 – 2007
- VA Requirement – 15% of Supply Air Volume
- Exhaust Air – As calculated below and shown in the Room Data Sheets (Appendix 6-A and Appendix 6-B)
- Specified Minimum Air Changes per Hour – Table 3 (Chapter 7), ASHRAE 2007 Applications Handbook

2.4.7 TOTAL EXHAUST AIR VOLUME

Calculation of the total and room-by-room exhaust air volume shall be as follows:

2.4.7.1 Toilets and Housekeeping Aide's Closet

(a) Public Toilets – See Appendix 6-B
(b) Patient Toilets – See Appendix 6-B
(c) Housekeeping Aide Closet (HAC)/Janitor's Closet – See Appendix 6-B

2.4.7.2 Public Patient Areas

Conditioned air supplied to all designated patient registration and waiting areas shall be exhausted outdoors and not returned back to the serving air-handling unit.

2.4.7.3 Locker Rooms

- **Without Adjoining Toilets and/or Showers**

0.5 CFM/Square Foot [2.5 Liters/Second/Square Meter]

- **With Adjoining Toilets and/or Showers**

75 CFM [35.4 Liters/Second] per urinal and/or water closet

2.4.7.4 Soiled Storage Rooms

6 air changes per hour

2.4.7.5 Equipment Exhaust

Coordinate exhaust needs with the equipment manufacturers.

2.4.7.6 Hoods (Fume, Kitchen, or Canopy)

Coordinate exhaust needs with the hood manufacturers based on the mandated face velocity over the sash open area and the published exhaust data.

2.4.7.7 Space Pressurization Allowance

Minimum 5% of the calculated supply air volume shall be retained in the space for space pressurization and included as an allowance to curtail infiltration.

2.4.7.8 Make-Up Air for Volumetric Air Balance

Include make-up air for the negative air balance in the exhaust air tabulations.

2.5 COOLING AND HEATING LOAD CALCULATIONS

Using an ASHRAE-based, public domain (DOE) or commercially available software program (Trane, Carrier, and/or any other approved), the A/E shall calculate the following design parameters:

2.5.1 ROOM-BY-ROOM COOLING AND HEATING LOADS

2.5.1.1 Load Credit

While calculating the heating load, do not include occupancy, lighting load, or heat gain due to equipment.

2.5.1.2 Room Data Output

The computer printout shall include a unique output sheet for each space. The output shall include peak room sensible and latent loads and peak room supply air volume. The air terminal unit schedule shall indicate the peak supply air volume. See Appendix 1-C for detailed room-by-room listing.

2.5.2 BLOCK COOLING LOADS

Cooling load calculations shall establish:

- Peak (Block) Zone Cooling Load
- Peak (Block) Zone Supply Air Volume
- Peak (Block) Building Cooling Load

2.5.2.1 Peak (Block) Zone Cooling Load

- A zone is an air-handling unit, serving a group of rooms. Zone peak cooling load is the sum of the maximum cooling load due to the sensible and latent loads of the group of rooms treated as a single room, and the peak-cooling load due to ventilation air.
- Zone peak cooling load is not the sum of the peak cooling loads of the individual rooms, which may occur at different times, in different months, and due to differing orientations.
- If the chiller serves a single air-handling unit, use the zone peak cooling load for selecting the cooling coil, chilled water flow rate, and chiller capacity.

2.5.2.2 Peak (Block) Zone Supply Air Volume

- Zone peak supply air volume is the peak supply air volume demand due to the space sensible cooling loads of the group of rooms when treated as one room, but without the cooling load due to ventilation air.
- Zone peak supply air volume is not the sum of the peak supply air volumes of the individual rooms that may occur at different times, in different months, and due to differing orientations. Note that the zone peak cooling load and zone peak supply air volume may occur at different times.
- Use zone peak supply air volume for selecting the air-handling unit size and air distribution system.

2.5.2.3 Building Peak Cooling Load

- Building cooling load is the maximum cooling load due to the sensible and latent loads of the entire building, treated as a single room, and the peak cooling load due to the ventilation demand of the entire building.
- Building peak cooling load is not the sum of the peak cooling loads of the individual zones that may occur at different times, in different months, and due to differing orientations.
- Use building peak cooling load for selecting the refrigeration equipment and associated components.

2.5.3 SUPPLY AIR VOLUME (AHU CAPACITY)

Calculated supply air volume shall be rounded off to the next 100 CFM or Liters/Second and increased by 4% to account for the ductwork and the system component air leakage. Increase the supply air volume by an additional 5% safety factor. Thus, the calculated supply air volume shall be increased by calculated supply air x 1.04 x 1.05 = 1.092, that is, 9.2% more than the calculated air volume.

2.5.4 PSYCHROMETRIC ANALYSIS PROGRAM

The A/E shall perform software-based psychrometric analysis plotting for all air-handling unit systems, the parameters, processes, loads, and flow rates for each air-handling unit system. The analysis shall show system losses, including supply and return air fan motor heat gain. Psychrometric chart data shall be transferred to chilled cooling coil equipment schedule.

2.6 ECONOMIZER CYCLE

Evaluate and incorporate economizer cycle based on ASHRAE 90.1 – 2007.

2.6.1 AIRSIDE ECONOMIZER CYCLE

(a) Provide a dry-bulb temperature actuated or enthalpy-controlled, airside economizer where life-cycle cost-effective.
(b) When dry-bulb temperature actuated economizer cycle is used, the selection of the switchover temperature must not result in higher dehumidification or humidification loads.

2.6.2 WATERSIDE ECONOMIZER CYCLE

2.6.2.1 General

Evaluate and provide a waterside economizer, if proven cost-effective by the life-cycle analysis.

2.6.2.2 Description

The system shall consist of a hydronic circuit using cooling tower water in conjunction with a plate heat exchanger and a circulating pump. The system shall deliver cold water at +/- 45 F [7.2 C] into the distribution loop of the central chilled water plant to meet the winter cooling load and if possible postpone start-up of a central plant chiller at low-load conditions.

2.7 INDIVIDUAL ROOM TEMPERATURE CONTROL

2.7.1 GENERAL

A space is defined as individually controlled only when a dedicated air terminal unit and a room temperature sensor/controller serve it. Individual room temperature control is required for all patient bedrooms, patient treatment and examination rooms, and the healthcare functions and other spaces identified in Appendix 6-A and Appendix 6-B.

2.7.2 ROOM TEMPERATURE CONTROLS

Listed below are applications where group control can be provided in lieu of dedicated room temperature control:

2.7.2.1 Office Perimeter Spaces (Group)

A single terminal unit can serve as many as three perimeter office rooms located on the same exposure and with identical functions and load characteristics.

Exception: A corner office room with multiple exposures shall have its individual room temperature control.

2.7.2.2 Interior Spaces (Group)

A single terminal unit can serve as many as four interior office or patient examination rooms that have identical functions and load characteristics.

2.7.3 OPEN SPACES

Open spaces with exposed perimeter and interior areas shall be zoned such that one dedicated air terminal unit serves the perimeter and another serves interior zones. The perimeter zone is defined as an area enclosing exposed length and 12 to 15 Feet [3.7 to 4.6 Meters] width. An interior zone does not have exposed walls.

2.8 PERIMETER HEATING REQUIREMENTS

2.8.1 GENERAL

Provide supplementary perimeter-heating system for:

2.8.1.1 Patient Bedrooms

where heat loss exceeds 180 BTUH/Linear Foot [173 Watts/Linear Meter] of the exposed wall.

2.8.1.2 All Other Occupied Spaces

where heat loss exceeds 210 BTUH/Linear Foot [202 Watts/Linear Meter] of the exposed wall.

2.8.1.3 Exception

See Building Thermal Envelope Study (this chapter) for the possibility of eliminating the perimeter-heating system.

2.8.2 PERIMETER HEATING SYSTEM DESCRIPTION

2.8.2.1 System Configuration

(a) All patient bedrooms, associated toilets, and all occupied spaces that qualify for supplementary heating, shall use **only radiant ceiling panels**, unless approved by the VA Authorities. During design development, provide coordinated detail of perimeter reflected ceiling plan showing linear diffusers and radiant ceiling panels. Design shall optimize performance while maximizing aesthetics.

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

2.8.2.2 Heating Medium

Hot water available from the central heating plant shall be used as the heating medium. Use two-way modulating control valves to control the hot water flow. Minimum flow per each heating circuit shall not be less than 0.5 GPM [0.032 Liters/Second].

2.8.2.3 System Sizing and Control Criteria

It is essential to ensure that the terminal unit heating coil and the perimeter heating system are correctly sized to share the total heating load and that they operate in sequence. For example, if the terminal reheat coil is oversized, or not controlled to limit its share of heating duty, the perimeter heating system may not come online. See VA Standard Detail for the schematic control diagram and suggested sequence of operation.

2.9 DESIGN CRITERIA – AIR DISTRIBUTION SYSTEMS

2.9.1 DUCT DESIGN – GENERAL

2.9.1.1 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.

2.9.1.2 Duct Materials

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

2.9.1.3 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 airflow 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 1 inch [25 mm] thick glass fiber insulation between the two walls. Duct painting and finish requirements shall be coordinated with the VA Authorities.

2.9.1.4 Mandatory Requirement

All ductwork, without exception, shall be shown in double lines on all floor plans and cross-sections. See Appendix 1-C.

2.9.1.5 Duct Pressure Classification

Show duct pressure requirements for all ductwork on the floor plans. Required duct classification shall be shown as ½ inch, 1 inch, 2 inch, 3 inch, and 4 inch [20 mm, 25 mm, 50 mm, 75 mm, and 100 mm].

2.9.1.6 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 Feet [1.5 Meters].
(d) Do not penetrate firewalls and interstitial decks with flexible ducts.

2.9.1.7 Underground Duct

Use of underground and concrete ducts is not permitted.

2.9.1.8 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 Feet [2.0 Meters] high lead lining, lead shielding of the ductwork penetrating above the suspended ceiling is not required.

2.9.1.9 Minimum Duct Size

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

2.9.2 LIMITING DUCT SIZING PARAMETERS

Table 2-1: DUCT SIZING CRITERIA		
Duct Description	**Maximum Air Velocity**	**Maximum Static Pressure Drop**
Low Pressure Duct • Supply • Return • Relief • Exhaust	1,500 Feet/Minute [7.6 Meters/Second]	0.08 inch WG/100 Feet [0.66 Pascal/Meter]
Medium/High Pressure Duct • Supply	2,500 Feet/Minute [12.7 Meter/Second]	0.2 inch WG/100 Feet [1.64 Pascal/Meter]
Return Air Transfer Duct	750 Feet/Minute [3.8 Meter/Second]	0.04 inch WG/100 Feet [0.33 Pascal/Meter]

2.10 DESIGN CRITERIA – PIPING SYSTEMS

2.10.1 PIPE DESIGN – GENERAL

2.10.1.1 Pipe Selection Criteria

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

2.10.1.2 Minimum Pipe Size

For closed loop piping systems, the minimum size of the individual takeoff shall not be less than ¾ inch [20 mm].

2.10.1.3 Mandatory Requirements

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

2.10.1.4 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

2.10.2 LIMITING PIPE SIZING PARAMETERS

Table 2-2: Pipe Sizing Criteria		
Pipe Type and Size	**Maximum Fluid Velocity**	**Maximum Pressure Drop**
Chilled Water Hot Water Hot Glycol Water 2 inch [50 mm] and below	6.0 Feet/Second [1.8 Meters/Second]	2.0 Feet/100 Feet WG [0.2 KPA/Meter]
Chilled Water Hot Water Hot Glycol Water Above 2 inch [50 mm]	10.0 Feet/Second [3.0 Meters/Second]	2.0 Feet/100 Feet WG [0.2 KPA/Meter]
Condenser Water Any Size	10.0 Feet/Second [3.0 Meters/Second]	2.0 Feet/100 Feet WG [0.2 KPA/Meter]
High Pressure Steam Any Size	10,000 Feet/Minute [50.0 Meters/Second]	2.0 PSIG [13.8 KPA]
Low Pressure Steam Any Size	5,000 Feet/Minute [25.0 Meters/Second]	0.5 PSIG [3.5 KPA]
Pumped Condensate Any Size	10.0 Feet/Second [3.0 Meters/Second]	4.0 Feet/100 Feet WG [0.4 KPA/Meter]

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

2.11 VIBRATION CONTROL

Refer to Master Specification 23 05 41 (15200), Noise And Vibration Control For HVAC Piping And Equipment. Select vibration isolators in accordance with Appendix 2-A and with the equipment manufacturer's recommendations. Provide appropriate standard details. Indicate the type of isolation on the equipment schedule.

2.12 SEISMIC REQUIREMENTS (HVAC)

2.12.1 GENERAL

2.12.1.1 Compliance

Earthquake-resistive design shall comply with the requirements of latest edition of VA Handbook H-18-8, Seismic Design Requirements, and the International Building Code (IBC 2006).

2.12.1.2 Applications

Earthquake-resistive design for equipment, piping, and ductwork shall be as follows:

(a) New Buildings: For new buildings, apply seismic restraints for equipment as indicated in VA Handbook H-18-8.

(b) Existing Buildings: For existing buildings, apply seismic restraints for equipment in locations of Moderate High, High, and Very High Seismic activity, as indicated in VA Handbook H-18-8.

(c) New and Existing Buildings – Piping: For new and existing buildings, apply seismic restraints for piping and ductwork in locations of Moderate High, High, and Very High Seismic activity, as indicated in H-18-8.

(d) Local Codes: Where local Seismic Code is more stringent, comply with local code.

2.12.1.3 Omissions

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

2.12.2 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 Seismicities, SMACNA details should be used with special care.

2.12.3 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.

2.12.4 DRAWINGS

2.12.4.1 General

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

2.12.4.2 Ductwork and Piping Plans and Sections

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

2.12.4.3 Equipment Restraints

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

2.13 FIRE AND SMOKE PROTECTION

2.13.1 COMPLIANCE

(a) HVAC design and equipment shall be in compliance with NFPA 90A and shall be equipped with the devices such as fire dampers, smoke dampers, and duct-mounted smoke detectors. Compliance with the following codes is also mandatory:

- NFPA 45: Standard on Fire Protection for Laboratories
- NFPA 96: Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations
- NFPA 99: Standard for Health Care Facilities
- NFPA 101: Life Safety Code

(b) While the local codes and ordinances are not binding to the VA, wherever possible, such provisions shall be reviewed with the VA and implemented upon approval.

(c) See Figure 2-1 for typical smoke control for air-handling units.

2.13.2 ADDITIONAL REQUIREMENTS

2.13.2.1 Fire Dampers

Show all fire dampers on the floor plan.

2.13.2.2 Smoke Dampers

(a) Show all smoke dampers and smoke detectors on the floor plan and in the control schematic diagrams.

(b) Smoke dampers are ***not*** required at the designated smoke barriers for a fully sprinklered building that is equipped with quick response heads.

(c) Smoke dampers are also not required where penetrating the interstitial deck.

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

2.13.2.3 Wiring

Specify that the smoke detectors and dampers shall be hard-wired.

2.13.2.4 Alarms

Design the control sequence to initiate an alarm at the ECC (Engineering Control Center).

2.13.2.5 End-Switch

Provide an end-switch with the smoke dampers to ensure that the dampers are proven fully open before the fan starts.

2.13.3 STAIR PRESSURIZATION

For VA facilities, stair pressurization is not used.

2.13.4 ATRIUM SMOKE CONTROL

See Appendix 6-A for the smoke removal system design.

2.13.5 ELEVATOR SHAFT VENTING

2.13.5.1 Compliance

Rule 100.4 of ANSI.1, Elevator Safety Code.

2.13.5.2 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 shall be monitored by the DDC controls.

2.14 DESIGN CONSIDERATIONS FOR EXISTING BUILDINGS

While the scope of work and the conditions are project-specific, the following guidelines are derived based on past experience.

2.14.1 SITE SURVEY

2.14.1.1 As-Built Drawings

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

2.14.1.2 Site Visits

Coordinate site visits in advance with the VA facility personnel and become familiar with entry, exit, parking, storage, and security requirements.

2.14.1.3 Site Survey

Perform an extensive site survey, record crucial measurements, and interview the maintenance and operating personnel to visualize the actual field conditions, access requirements, and maintenance history of the existing equipment. Include the site interview report in the project submission and describe the chronic problems and shortcomings which may impact the project scope of work.

Should the site survey result in additional work affecting the scope of work, the Project Manager should be notified as soon as possible. Any additional work resulting from the site survey must be authorized in advance before it is included in the design.

2.14.2 PROJECT PLANNING

The HVAC system design and development shall be affected by the considerations listed below:

2.14.2.1 Phasing

Coordinate the phasing requirements with the facility personnel. Phasing will have significant impact on the need for the swing space, schedule, and the system design itself. Testing, Adjusting, and Balancing (TAB) cost and the commissioning cost are also dependent upon phasing, as some TAB work may have to be repeated.

2.14.2.2 Utility Connections and Outage

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

2.14.3 TECHNICAL CONSIDERATIONS

2.14.3.1 Demolition Work

Extent of demolition work shall be clearly documented with points of disconnections and connections clearly shown. The demolition drawings shall also show the locations where new shutoff valves, blank-offs, and dead-end flanges may be required.

2.14.3.2 Modifying Existing Systems

Work on the existing systems shall include the following measures:

(a) Steam Radiators: Existing steam radiators shall be dismantled and replaced by 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 in operation at the same time.

(b) DDC Controls: All new control devices shall be equipped with electric actuators. For a major renovation of the existing facilities, where an updated control system is being installed, replace pneumatic with electric actuators.

(c) Existing Ductwork: Where connections are made between the new and existing ductwork, the existing ductwork shall be pressure tested, thoroughly cleaned, and sanitized to avoid any possibility of contamination.

(d) Refrigerant Removal: Refrigerant from the existing equipment to be dismantled and removed shall be handled, stored in containers per EPA guidelines, and disposed of in accordance with the EPA guidelines. Consult local VA Authorities for logistic details and support.

(e) System Selection: Provide an all-air system unless space constraints dictate otherwise. The A/E shall fully document and demonstrate that the installation of an all-air system is not feasible. See Chapter 3 for the use of the fan coil units with central ventilation system for minimum air.

(f) Attic/Crawl Spaces: Affected attic and crawl spaces shall be ventilated, insulated (as required and feasible), and heated. See the Room Data Sheets (Chapter 6) for additional information.

(g) Roof-Mounted Air-Handling Equipment: See this chapter for the general policy statement.

2.15 LOCATIONS OF OUTSIDE AIR INTAKES AND EXHAUST AIR OUTLETS

2.15.1 GENERAL

Coordinate the requirements given below with the Physical Security Manual.

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

2.15.2 MINIMUM REQUIREMENTS

2.15.2.1 Louver Location

Coordinate the louver location with Physical Security Manual.

2.15.2.2 Operating Room Air Intake

Air intake for the AHU serving surgical suites shall be at least 30 Feet [9.1 Meters] above the ground. Provide more distance if required by the dispersion analysis.

2.15.2.3 Laboratory and Research Exhaust

Terminate exhaust from the fume hood and the laboratory general exhaust at the highest point of the building and in accordance with NFPA 99, Standard for Health Care Facilities.

2.15.2.4 Physical Security Compliance

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

2.15.2.5 Common Outside Air Intake

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

2.15.2.6 Hurricane and Natural Disaster Locations

For hurricane areas, HVAC systems for the mission-critical facilities shall be designed in accordance with the Physical Security Manual.

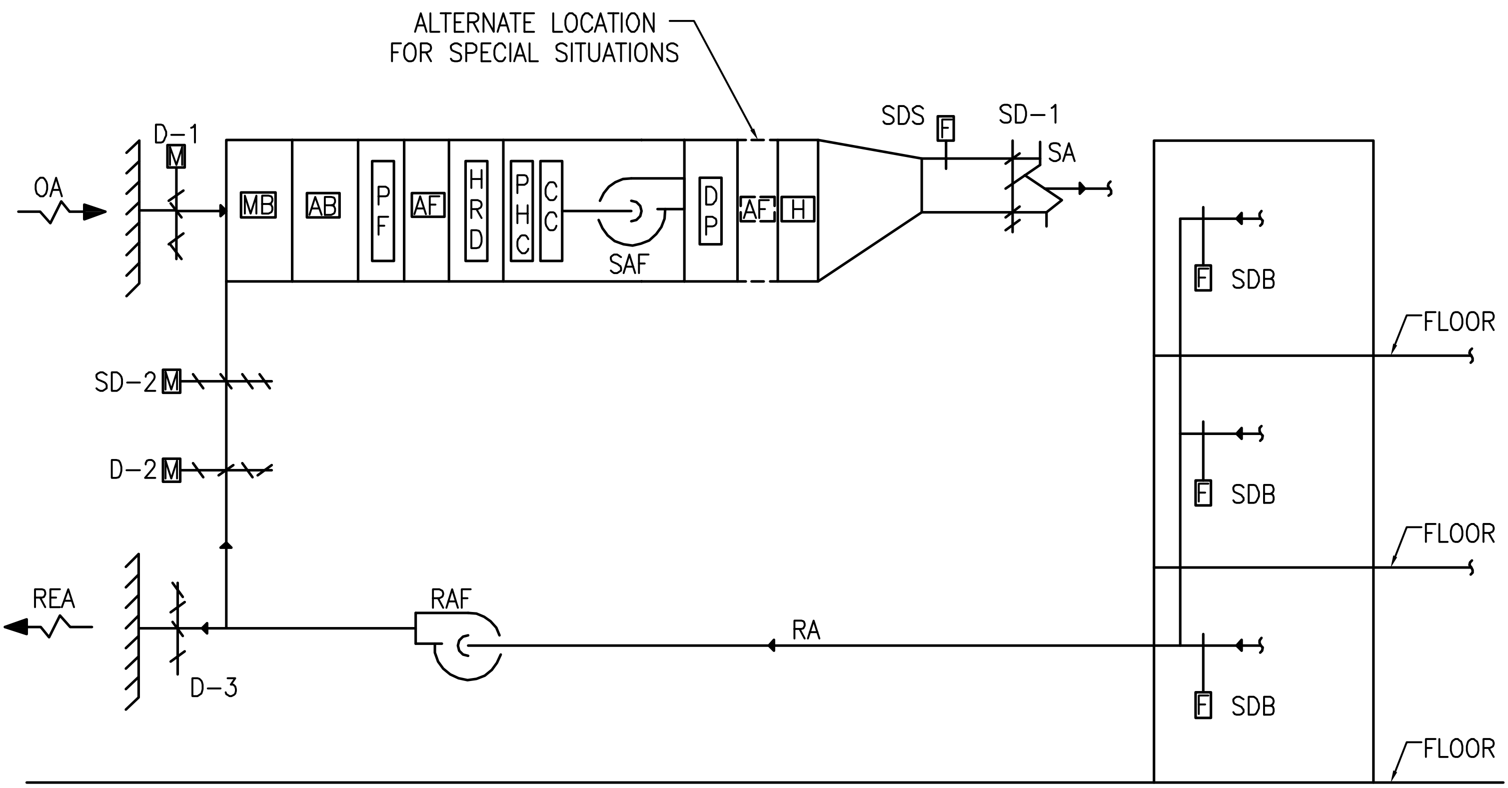
2.16 COORDINATION

2.16.1 GENERAL

It is vital to ensure that bid documents are coordinated within the discipline and across disciplines to avoid delays and costly change orders/claims.

2.16.2 CERTIFICATION

Before the construction documents are released for bid, the A/E shall issue a letter to the VA Authorities certifying that the design of the HVAC systems is fully coordinated within the HVAC discipline and among the disciplines. The letter shall be signed by the design firm’s principal.



NOTES:
1. THIS DIAGRAM IS APPLICABLE TO SYSTEMS WITH CAPACITY OF 15,000 CFM [7,075 LITER/SECOND] OR GREATER. SMOKE DAMPERS ARE NOT REQUIRED IF AHU IS LOCATED ON FLOOR SERVED AND SERVICES ONLY THAT FLOOR OR LOCATED ON ROOF DIRECTLY ABOVE FLOOR SERVED. SEE NFPA 90A.

SMOKE CONTROL FOR AIR HANDLING UNIT SYSTEMS

Not to Scale

APPENDIX 2-A: SELECTION GUIDE FOR VIBRATION ISOLATORS

EQUIPMENT		ON GRADE			20 FT FLOOR SPAN			30 FT FLOOR SPAN			40 FT FLOOR SPAN			50 FT FLOOR SPAN		
		BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL
REFRIGERATION MACHINES																
ABSORPTION		---	D	---	---	SP	1.0	---	SP	1.0	---	SP	1.7	---	SP	1.7
PACKAGED HERMETIC		---	D	---	---	SP	1.0	---	SP	1.7	---	SP	1.7	R	SP	2.5
OPEN CENTRIFUGAL		B	D	---	B	SP	1.0	---	SP	1.7	B	SP	1.7	B	SP	3.5
RECIPROCATING:																
500 - 750 RPM		---	D	---	---	SP	1.7	R	SP	1.7	R	SP	2.5	R	SP	3.5
751 RPM & OVER		---	D	---	---	SP	1.0	---	---	1.7	R	SP	2.5	R	SP	2.5
COMPRESSORS AND VACUUM PUMPS																
UP THROUGH 1-1/2 HP		---	D,L, W	---	----	D,L, W	---	---	D,L, W	---	---	D,L, W	---	---	D,L, W	---
2 HP AND OVER:																
500 - 750 RPM		---	D	---	---	S	1.7	---	S	2.5	---	S	2.5	---	S	2.5
750 RPM & OVER		---	D	---	---	S	1.0	---	S	1.7	---	S	2.5	---	S	2.5
PUMPS																
CLOSE COUPLED	UP TO 1-1/2 HP	---	---	---	---	D,L, W	---	---	D,L, W	---	---	D,L, W	---	---	D,L, W	---
	2 HP & OVER	---	---	---	I	S	1.0	I	S	1.0	I	S	1.7	I	S	1.7
BASE MOUNTED	UP TO 10 HP	---	---	---	---	D,L, W	---	---	D,L, W	---	---	D,L, W	---	---	D,L, W	---
	15 HP THRU 40 HP	I	S	1.0	I	S	1.0	I	S	1.7	I	S	1.7	I	S	1.7
	50 HP & OVER	I	S	1.0	I	S	1.0	I	S	1.7	I	S	2.5	I	S	2.5

EQUIPMENT	ON GRADE			20 FT FLOOR SPAN			30 FT FLOOR SPAN			40 FT FLOOR SPAN			50 FT FLOOR SPAN		
	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL
ROOF VENTILATORS															
ABOVE OCCUPIED AREAS:															
5 HP & OVER	---	---	---	CB	S	1.0	CB	S	1.0	CB	S	1.0	CB	S	1.0
CENTRIFUGAL BLOWERS															
UP TO 50 HP:															
UP TO 200 RPM	B	N	0.3	B	S	2.5	B	S	2.5	B	S	3.5	B	S	3.5
201 - 300 RPM	B	N	0.3	B	S	1.7	B	S	2.5	B	S	2.5	B	S	3.5
301 - 500 RPM	B	N	0.3	B	S	1.7	B	S	1.7	B	S	2.5	B	S	3.5
501 RPM & OVER	B	N	0.3	B	S	1.0	B	S	1.0	B	S	1.7	B	S	2.5
60 HP & OVER:															
UP TO 300 RPM	B	S	1.7	I	S	2.5	I	S	3.5	I	S	3.5	I	S	3.5
301 - 500 RPM	B	S	1.7	I	S	1.7	I	S	2.5	I	S	3.5	I	S	3.5
501 RPM & OVER	B	S	1.0	I	S	1.7	I	S	1.7	I	S	2.5	I	S	2.5
COOLING TOWERS															
UP TO 500 RPM	---	---	---	---	SP	1.0	---	SP	1.7	---	SP	2.5	---	SP	3.5
501 RPM & OVER	---	---	---	---	SP	1.0	---	SP	1.0	---	SP	1.7	---	SP	2.5
INTERNAL COMBUSTION ENGINES															
UP TO 25 HP	I	N	0.3	I	N	0.3	I	S	1.7	I	S	2.5	I	S	2.5
30 THRU 100 HP	I	N	0.3	I	N	1.7	I	S	2.5	I	S	3.5	I	S	3.5
125 HP & OVER	I	N	0.3	I	N	2.5	I	S	3.5	I	S	4.5	I	S	4.5

EQUIPMENT	ON GRADE			20 FT FLOOR SPAN			30 FT FLOOR SPAN			40 FT FLOOR SPAN			50 FT FLOOR SPAN		
	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL
AIR HANDLING UNIT PACKAGES															
SUSPENDED:															
UP THRU 5 HP	---	---	---	---	H	1.0	---	H	1.0	---	H	1.0	---	H	1.0
7-1/2 HP & OVER:															
UP TO 500 RPM	---	---	---	---	H, THR	1.7	---	H, THR	1.7	---	H, THR	1.7	---	H, THR	1.7
501 RPM & OVER	---	---	---	---	H, THR	1.0	---	H, THR	1.0	---	H,TH R	1.7	---	H,TH R	1.7
FLOOR MOUNTED:															
UP THRU 5 HP	---	D	---	---	S	1.0	---	S	1.0	---	S	1.0	---	S	1.0
7-1/2 HP & OVER:															
UP TO 500 RPM	---	D	---	R	S, THR	1.7	R	S, THR	1.7	R	S, THR	1.7	R	S, THR	1.7
501 RPM & OVER	---	D	---	---	S, THR	1.0	---	S, THR	1.0	R	S, THR	1.7	R	S, THR	1.7
IN-LINE CENTRIFUGAL AND VANE AXIAL FANS, FLOOR MOUNTED: (APR 9)															
UP THRU 50 HP:															
UP TO 300 RPM	---	D	---	R	S	2.5	R	S	2.5	R	S	2.5	R	S	3.5
301 - 500 RPM	---	D	---	R	S	1.7	R	S	1.7	R	S	2.5	R	S	2.5
501 - & OVER	---	D	---	---	S	1.0	---	S	1.0	R	S	1.7	R	S	2.5
60 HP AND OVER:															
301 - 500 RPM	R	S	1.0	R	S	1.7	R	S	1.7	R	S	2.5	R	S	3.5
501 RPM & OVER	R	S	1.0	R	S	1.7	R	S	1.7	R	S	1.7	R	S	2.5

NOTES:

(1) Refer to MASTER SPECIFICATION 23 05 41 (15200), NOISE AND VIBRATION CONTROL for isolators and symbols. Edit to show where isolators other than the ones shown are used, such as for seismic restraints and position limit stops.

(2) For suspended floors lighter than 4 inch [100 mm] thick concrete, select deflection requirements from next higher span.

(3) For separate chiller building on grade, pump isolators may be omitted.

(4) Direct bolt fire pumps to concrete base. Provide pads (D) for domestic water booster pump package.

(5) For projects in seismic areas, use only SS and DS type isolators and snubbers.

(6) Isolators are not required when cooling tower is located on grade or on the roof over the mechanical room.

(7) Floor mounted (APR 1): Use "B" type in lieu of "R" type base.

(8) Suspended: Use "H" isolators of same deflection as floor mounted.

CHAPTER 3: AIRSIDE HVAC SYSTEMS AND EQUIPMENT

Table of Contents

3.1 INTRODUCTION

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

Evaluated systems are:

- All-Air Systems
- Fan Coil Unit Systems
- Heating and Ventilation Systems
- Exhaust Systems
- Miscellaneous Systems/Components

3.2 ALL-AIR SYSTEMS

3.2.1 SPECIAL REQUIREMENTS

3.2.1.1 Mandatory Use

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

3.2.1.2 AHU Configuration

(a) Air-handling units shall be ARI-certified, factory-fabricated, and standard products of one manufacturer. All air-handling units shall be constructed in modular, vertical or horizontal, and draw-through configuration. ***Use of the blow-through air-handling units is not permitted, as fully saturated air leaving the cooling coil causes damage to the filters and sound attenuators on the downstream side*.** See Figure 3-1 for the 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.

3.2.1.3 AHU Capacity

The capacity of a single air-handling unit shall not exceed **40,000 CFM [18,688 Liters/Second].**

3.2.1.4 Air Distribution

(a) All supply, return, exhaust, relief, and outside air systems shall be fully ducted between the fans and air inlets/outlets. ***Use of the space between the structural ceiling and the suspended ceiling is not permitted as an air plenum.***

(b) Generally a single supply air duct shall run from the supply air fan discharge to the air outlets. ***Use of a dual-duct air distribution system is not permitted.***

3.2.1.5 Air Terminal Units

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 0 CFM [0 Liters/Second], small but sustained leakage of supply air tends to overcool the space during prolonged no-load conditions. Use heating hot water where available, with modulating control. See further details in this chapter.

3.2.1.6 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. See further details in this chapter.

Exception:
Fan coil units (two-pipe, cooling-only) can be used to serve miscellaneous spaces requiring year around cooling. See Appendix 6-B for specific applications.

3.2.2 VAV SYSTEMS

3.2.2.1 General

VAV systems shall be designed to vary the supply air volume in response to the prevailing cooling load while still maintaining minimum outside air for ventilation under all operating conditions, from full-load to part-load conditions at the air-handling unit level.

3.2.2.2 System Controls and Components

The system design shall include:

- Variable speed drives for supply and return/relief air fans
- Airflow measuring devices in supply, return, and minimum outside air ducts
- Supply air fan speed shall be controlled by polling all air terminal units

Airflow measuring devices shall facilitate a tracking sequence in which a constant difference between the supply and return/relief air fans shall be maintained. Limit the tracking and speed reduction sequences to avoid return/relief air fan stalling while still maintaining minimum outside air.

3.2.3 CONSTANT VOLUME ALL-AIR SYSTEMS

Constant volume AHUs shall be similar to the VAV all-air units with the exception that the supply and return air fans do not require variable speed drives unless the application calls for constant air volume delivery under varying filter static pressure drops.

3.2.4 SYSTEM COMPONENTS

3.2.4.1 Supply Air Fan

(a) General: Select statically and dynamically-balanced centrifugal fans in the configuration and design suited for the specific applications. Select the fan type and construction to deliver design air volume at the estimated static pressure without exceeding the required noise and vibration criteria. Limit fan speed to 1,600 RPM. ***Use of plug/plenum centrifugal fans is not permitted.***

(b) Selection Criteria: Select the supply air fan and motor for the calculated air volume and static pressure, adjusted for altitude, temperature, fan inlet/discharge conditions (system effect) as specified in AMCA 201-02. Fan selection shall be made within the stable range of operation at an optimum static efficiency.

The fan motor BHP [KW] at the operating point on the fan curves shall be increased by 10% to cover the drive losses and field conditions. The fan motor shall be selected within the rated nameplate capacity and without relying upon NEMA Standard Service Factor. Wherever the variable frequency drive is specified, the fan motor selection shall be compatible with variable frequency drive motor controller duty.

Additional information for energy efficient motors is given in the TIL

3.2.4.2 Return Air Fan

When room air is returned to the air-handling unit, provide a dedicated return or relief air fan for each air-handling unit to facilitate the room-by-room air balance. The fan system shall incorporate the use of an airside economizer cycle, as specified in Chapter 2. Provide an electronic interlock between the:

- Supply and return/relief air fans
- Supply and exhaust air fans associated with the air-handling unit

3.2.4.3 Exhaust Fan(s)

Provide general and special exhaust fans as required, electronically interlocked with the AHU supply air fan. A single AHU may be interlocked with multiple exhaust fans serving multiple applications such as fume hood exhaust, “wet exhaust,” and general exhaust systems.

3.2.4.4 Motor Voltages

Motor voltages shall conform to NEMA/ANSI standard 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

3.2.4.5 AHU Casing

The AHU casings shall be solid (without perforations) double-wall type, with thermal insulation between the inner and outer casings. Use of exposed interior insulation is not permitted. Combination of the casing gages and thermal insulation shall ensure the following:

(a) There is no condensation on the exterior surface of the AHU or viewing windows when located in the non-conditioned spaces such as mechanical rooms, basements, and attic spaces.

(b) Composite assembly comprising of casings and insulation shall provide adequate stiffness to limit vibrations and radiated noise.

(c) See AHU specifications for the construction details.

3.2.4.6 Access and Mixing Sections

The design shall include access sections, as shown in the Figure 3-1. The designer shall show access sections and door swings on the floor plans. Include factory-fabricated mixing boxes to mix the return and outside airstreams. Provide a bender section, where warranted, to mix return and supply air and prevent stratification.

3.2.4.7 Drain Pans

(a) Provide insulated, stainless steel, double-wall, and double sloping drain pans for removing cooling coil condensate from the pan as soon as it is formed. The drain pans shall be coated with factory-applied, anti-bacterial finish.

(b) Where two coils are stacked on top of each other, include an intermediate drain pan for draining condensate from the top coil into the main drain pan.

(c) Raise all floor-mounted air-handling units from the finished floor levels to gain adequate static head for the installation of the cooling coil condensate traps and steam traps, where steam pre-heat coils are used.

3.2.4.8 Cooling Coils

(a) Chilled water and DX cooling coils shall be copper tube and aluminum fin construction. Select cooling coils at face velocity of 500 Feet/Minute [2.5 Meters/Second], with the fin spacing not to exceed 132 Fins/Foot [433 Fins/Meter].

(b) Evaluate the option of lowering the cooling coil face velocity if life-cycle cost-effective.

(c) Equip cooling coils with copper fins in high humidity areas. See Chapter 7.

3.2.4.9 Preheat Coils

Provide preheat coils for ***all*** AHUs where winter design temperature is 30 F [-1.1 C] or less. Provide steam, hot water/glycol, hot water, or electric pre-heat coils. Provide face velocity identical to the cooling coils. Ensure freeze protection by evaluating and including one or more of the options below:

(a) Steam Heating Coils: Steam coils with integral face and bypass dampers and two-position on/off control valves. As an option, for non-100% outside air units, consider the use of distributing type of steam coil with a modulating control valve to ensure uniform heat distribution and to minimize air stratification. Ensure that the steam condensate is removed from the coil as soon as it is formed. Ensure correct sizing of steam trap, availability of the gravity drain leg (static height), and recommended slope for the gravity return. See VA Standard Detail.

(b) Hot Water/Glycol Coils: Evaluate the use of hot water/glycol preheat coils where the preheat coil surface comes in contact with ambient air below freezing temperatures. Use propylene glycol solution specifically manufactured for HVAC applications with inhibitors for corrosion resistance. See Appendix 4-A for the glycol properties and Chapter 4 for system description. Include additional freeze protection measures in the system design, as indicated by ASHRAE.

- Provide a dedicated circulating pump in the coil circuit with hydronic separation between the coil circuit and the incoming hot water piping. See VA Standard Detail, Hot Water Preheat heating Coil and Inline Pump.
- Maintain constant water velocity through the preheat coil tubes at 3.0 Feet/Second [0.9 Meters/Second].
- Select coils with wider fin spacing at the rate of 6 or 8 Fins/Inch.
- Provide coil connections to ensure that the coldest air faces the hottest fluid.

(c) Hot Water Coils: Glycol can be omitted for the locations where the outdoor design temperature is above 32 F [0 C].

(d) Electric Coils: Use of electric preheat is permitted only where steam and hot water are not available. Select low-watt density electric coils complete with safety and SCR (Silicon-Controlled-Rectifier) controls to ensure modulating operation.

3.2.4.10 Unit-Mounted Reheat Coils

Where application permits the use of an AHU-mounted reheat coil (example: for a single zone), use hot water reheat coils, with modulating temperature control. Freeze protection measures are not required. Use of electric reheat is permitted only where hot water is not available.

3.2.4.11 Heat Recovery Systems

See Chapter 2.

3.2.4.12 Economizer Cycle

See Chapter 2.

3.2.4.13 Filters

(a) General: For each air-handling unit, provide two filter sections: pre-filters and after-filters. Locate pre-filters and after-filters back-to-back, on the suction side of the fan. Provide adequate space between the two filter sections to locate sensors and tubing for measuring the pressure drops through both pre-filters and after-filters.

(b) Special Applications: For specialized applications in Appendix 6-A, three sets of filters shall be provided. Provide pre-filters and after-filters, as described above, on the upstream side of the supply air fans. Provide final-filters on the downstream side of the supply air fan, or multiple terminal filters on the downstream side of the individual air terminal units. Provide a diffuser section between the supply air fan and final-filters when the final-filters are located immediately the supply air fan. The diffuser section shall ensure uniform distribution air across the filter face area.

(c) Filter Efficiency: Filter efficiencies shall comply with ASHRAE Standard 52.2 – 1999 (Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size). All filter efficiencies shall be expressed as MERV (Minimum Efficiency Reporting Value).

Pre-Filters (VA Grade A)

MERV Rating = 8

Particle Sizes = 3 to 10 Microns

Average Dust-Spot Efficiency = 30 to 35%

Filter Size = 2 inch Thick Throwaway

After-Filters (VA Grade B)

MERV Rating = 11

Particle Sizes = 1 to 3 Microns

Average Dust-Spot Efficiency = 60 to 65%

Filter Size = 6 inch Thick Cartridge Throwaway

After-Filters (VA Grade C)

MERV Rating = 14

Particle Size = 0.3 to 1.0 Micron

Average Dust-Spot Efficiency = 90 to 95%

Filter Size = 12 inch Thick Cartridge Throwaway

After-Filters (VA Grade D)

MERV Rating = 15

Particle Size = 0.3 to 1.0 Micron

Average Dust-Spot Efficiency = Greater Than 95%

Filter Size = 12 inch Thick Cartridge Throwaway

After-Filters (VA Grade E, HEPA Filters)

MERV Rating = 17

Particle Size = 0.3 Micron or Smaller

Efficiency = 99.97% on 0.3 Micron-Sized Particles

IEST (Institute of Environmental Sciences and Technology) Type A

(d) **Applications:** See Appendix 6-A for specific applications.

(e) **Manual Pressure Gages:** Provide a single dial-type differential pressure gage with air sampling tubing and three isolation valves (ball valves) to measure static pressure drop through each filter section and/or the total static pressure drop through pre-filters and after-filters.

Provide a dedicated pressure gage for the final-filters.

(f) **Automatic DDC Sensors:** Provide a dedicated DDC pressure differential sensor for each filter section to register the actual pressure drop. The DDC sensors shall interface with the building ECC system to remotely provide a maintenance alarm capability.

(g) **Filter Pressure Drops:** Estimate the fan static pressure with filters in dirty condition at the manufacturer's published data for the recommended changeover conditions. Do not use filter static pressure drop at clean condition. In the equipment schedule show both static pressure drops for each filter section, that is, at the clean and replacement conditions.

3.2.4.14 Humidifiers

(a) **General:** Central or primary humidifiers shall be sized to maintain zone humidity as specified. Terminal humidifiers, when used, shall be used for additional humidification and room level control. See Appendix 6-A and Appendix 6-B for terminal humidification applications.

(b) **Type:** Humidifiers shall be steam manifold jacketed type, designed to attain full dispersion of steam into the airstream. Humidifiers shall be located in the air-handling unit or in the main supply air duct. When located in the supply air duct, design shall include pitched, welded duct section of stainless steel construction. Provide a drain connection at the bottom face of the duct at the lowest point. See VA Standard Details.

(c) **Steam-to-Steam Generator:** Provide a steam-to-steam, unfired steam generator to produce low-pressure "clean steam" at 15 PSIG [103.4 Kilo-Pascal]. Verify the actual pressure at which high-pressure steam is generated at the central boiler plant in the winter season. See VA Standard Detail, Steam-To-Steam Unfired Generator.

(d) Humidifier Controls: Provide a modulating steam control valve to control and maintain the space humidity. Provide a return air duct-mounted sensor to control the humidity set-point. Provide a high-limit humidity sensor in the supply air duct to stop humidification if the measured humidity exceeds 85% (adjustable). Ensure full integration of the humidifier controls with the ECC, including remote alarm capability.

(e) Water Quality: Provide incoming water on the low-pressure side steam generator in accordance with the manufacturer's recommendations. Use an actual sample of the available make-up water. Provide recommended water treatment and lower the incoming dissolved solids to 80 PPM (Parts Per Million).

3.2.4.15 Supply Air Terminals

(a) General: Provide pressure-independent, DDC-controlled air terminal units (also referred to as boxes), for the constant and/or variable air volume applications. Each box shall be equipped with integral, hot water reheat coil. Provide two-way, modulating control valves.

(b) Limiting Capacities:

- Maximum capacity of a single box shall not exceed 3,000 CFM [1,416 Liters/Second]
- Minimum hot water flow shall not be lower than 0.5 GPM [0.03 Liters/Second]

(c) Terminal Settings: Design maximum and minimum air volumes shall be factory-set, but field-adjustable. The minimum setting shall satisfy the following:

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

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

- Constant air circulation even at part-load conditions, avoiding the sense of stagnation
- Simplified control sequences for the night setback and morning warm-up cycles, avoiding the use of the primary air-handling units

(e) Acoustic Treatment: Provide terminal sound attenuators, as recommended by the acoustic analysis.

3.2.4.16 Supply Air Outlets

(a) Linear Diffusers:

- For all occupied spaces with exposed perimeter windows, the design shall be based on linear supply air diffusers. The 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 lobby and reception areas with high glass, include wall-to-wall linear diffusers in the design. Provide supply air plenum continuously or intermittently as required to ensure required throw and air diffusion. Include blank-offs for the diffuser segments, where plenums are not required.

- Provide a manual volume control damper for each takeoff feeding the linear diffuser.

(b) Square/Rectangular Diffusers:

- For interior spaces and elsewhere (where required), include square 24 inch [600 mm] x 24 inch [600 mm] or 12 inch [300 mm] x 12 inch [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 [187 Liters/Second].

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

3.3 FAN COIL UNITS SYSTEMS

3.3.1 SYSTEM DESCRIPTION

Where the use of fan coil units is permitted, design 4-pipe fan coil units systems to heat and cool the occupied spaces. For minimum ventilation, provide a dedicated, 100% outside air unit to cool and dehumidify or heat and humidify the ambient air. Provide a fully-ducted, distribution system to supply conditioned, minimum ventilation air directly into the space. Admission and distribution of minimum ventilation air (conditioned or raw) is ***not*** permitted through the fan coil units.

See Chapter 2 for the estimation of the minimum outside air requirements.

3.3.2 SYSTEM APPLICATIONS

3.3.2.1 Interior Spaces

(a) Generally the use of 4-pipe fan coil systems shall be limited to serve the perimeter spaces only.

(b) Fan coil units shall not be used to serve isolated interior spaces. Use minimum ventilation air to condition and ventilate such occupied spaces. Provide room temperature control.

3.3.2.2 Ventilation Air Control

Do not deliver minimum ventilation air at “neutral” condition, where air is reheated almost 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.

3.3.2.3 Ventilation Air Outlets

Minimum ventilation air outlets shall be designed to provide the required air throw to the occupied areas. With smaller ventilation air volumes, 20 CFM [9.5 Liters/Second], selection of suitable outlets is necessary. Use of the jet type of side outlets, generally used in aircrafts, shall be evaluated to meet the design intent.

3.3.3 SYSTEM COMPONENTS

3.3.3.1 Central Ventilation Unit (100% Outside Air)

(a) General: The system components shall be similar to the air-handling unit described under all-air systems in this chapter. Mixing boxes and blenders is not required with 100% outside air units. Use a low-velocity supply air system.

(b) Filtration:

Pre-Filters – Grade A

After-Filters – Grade B

Instrumentation and static pressure selection criteria shall be similar to the all-air systems.

(c) Humidification: Provide zone-controlled humidification where required to maintain +/- 30% space humidity with equipment similar to those described for the all-air systems.

Heat Recovery Systems: See Chapter 2.

3.3.3.2 Fan Coil Units

(a) General: Fan coil units can be used in vertical, floor-mounted or in horizontal, ceiling-suspended configurations. Vertical units are generally located under the windows to control cold drafts and solar radiation. Ceiling suspended units can be recessed or concealed with air distribution ductwork as needed.

(b) Cooling Coil Condensate Piping: Design shall ensure that the cooling coil condensate is removed without clogging the drain pan and drainlines. Minimize the extent of horizontal runs and provide cleanouts at each turn in the direction of flow. Pitch the drainline in the direction of flow to facilitate flow by gravity.

(c) Filtration: Provide manufacturer's standard filters.

(d) Acoustic Measures: See Chapter 2.

(e) 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.

3.4 HEATING AND VENTILATION SYSTEMS (HVU)

3.4.1 GENERAL

Heating and/or ventilation systems shall be provided where mechanical cooling is not required. See Appendix 6-B for applications.

3.4.2 SYSTEM CONFIGURATION

HVU systems can be designed in any viable configuration to suit the applications. HVU can be composite units, similar to the conventional air-handling units, capable of providing ventilation and heating. Alternately, providing the dedicated heating and ventilation sub-systems can separate heating and ventilation functions.

3.4.2.1 Composite System

(a) System Description: The system shall comprise of a fan, filters, and coil sections to deliver a minimum of six or more air changes per hour, as required. The system shall be complete with supply air distribution ductwork and outlets to ensure uniform air distribution. The system shall operate continuously during occupied hours.

(b) System Operation:

- The system shall be capable of admitting minimum outside air (ASHRAE 62.1 – 2007) during heating mode up to 100% outside air when outside air temperature is greater than 68 F [20 C], adjustable.
- The ventilation and heating shall be thermostatically-controlled. During night setback and unoccupied mode, the temperature shall be set at 50 F [10 C] and maintained by cycling the unit in 100% re-circulatory mode without admitting any outside air.

3.4.2.2 Separate Heating and Ventilation Systems

(a) System Description (Ventilation): The ventilation system shall comprise a single exhaust fan or multiple exhaust fans, as required to ensure uniform coverage of the space. The exhaust fans shall be controlled manually or thermostatically. Provide matching intake and exhaust louvers, equipped with motorized dampers.

- When ambient temperature is 68 F [20 C] and above, the system shall admit unfiltered, 100% outside air, to be discharged outdoors by the exhaust fans. During unoccupied hours, the system shall be inoperative.
- During heating mode, the system shall admit only minimum outside air to comply with ASHRAE 62.1 – 2007 by operating one fan out of the battery of multiple exhaust fans or using another means, such as two-speed fans.

(b) System Description (Heating): The heating system shall comprise multiple terminal heaters such as unit heaters or forced-flow heaters to distribute heat uniformly and re-circulate air in the space. Heaters shall be thermostatically-controlled.

- During occupied mode, the heaters shall maintain 68 F [20 C] with minimum ventilation supplied by the remote ventilation system.
- During unoccupied mode, the heaters shall maintain 50 F [10 C] with the remote ventilation system in inoperative mode.

3.5 GENERAL AND SPECIAL EXHAUST SYSTEMS

3.5.1 INTRODUCTION – GENERAL EXHAUST SYSTEM

Typically general exhaust systems are centralized with the following system components:

- Exhaust Fan
- Exhaust Air Ductwork
- Exhaust Air Inlets
- Exhaust Air Discharge Arrangement (example: louvers)
- Motorized Damper(s)

- Controls (Interlocks)

3.5.2 APPLICATIONS – GENERAL EXHAUST SYSTEM

(a) The general exhaust systems serve the following spaces:

- Toilets
- Showers
- Locker Rooms
- Janitor's Closets
- Canopy Hoods
- Dark Rooms
- General Storage Spaces
- Soiled Utility Rooms

(b) General exhaust systems shall be provided for the spaces requiring 100% exhaust of supply air. Such exhaust systems are interlocked with the respective supply air system to ensure required air balance. See Appendix 6-A for examples:

- Supply Processing and Distribution (SPD) exhaust, less ETO exhaust and "wet exhaust"
- Kitchen and dining exhaust, less range hood exhaust and "wet exhaust"
- Laboratories, less fume hoods exhaust and biological safety cabinets exhaust
- Animal research facilities, less fume hoods exhaust and biological safety cabinets exhaust
- Surgical suite, less cylinder storage exhaust
- Bone Marrow Transplant (BMT)
- Autopsy suite

(c) General exhaust system can serve multiple air-handling units with identical hours of operation. Duct lengths shall not be excessive.

3.5.3 SPECIAL EXHAUST SYSTEMS

Described below are the special exhaust systems for fume hoods and Biological Safety Cabinets (BSC). Additional special exhaust systems such as ETO exhaust, isolation room exhaust, and kitchen grease hood exhaust are described in Appendix 6-A and Appendix 6-B.

3.5.4 ADDITIONAL CONSIDERATIONS

3.5.4.1 Fan Location

Location and type of exhaust fans shall be project-specific. Install fans at the end of the exhaust ductwork and nearer to the discharge outdoors 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.

3.5.4.2 Heat Recovery System

See Chapter 2.

3.6 FUME HOOD EXHAUST SYSTEMS

3.6.1 GENERAL

Provide exhaust systems for the hoods mentioned 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 (VA Type H3)
- General Purpose and Chemical Hoods (VA Type H7)
- Perchloric Acid Hoods (VA Type H14)

3.6.2 SPECIAL REQUIREMENT

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

3.6.3 COMPLIANCE

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

3.6.4 BASIS OF DESIGN (H3 AND H7 HOODS)

3.6.4.1 General

The basic premise of the fume hood exhaust systems is to maintain constant, face velocity at 100 Feet/Minute [0.5 Meter/Second] 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.

3.6.4.2 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) H3 hoods can be grouped together to form a combined exhaust system. H7 hoods can be grouped together to form a combined exhaust system. H14 hoods cannot be grouped together. Each H14 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 Feet [3.0 Meters] tall. Increase the stack height, as required to meet the dispersion analysis recommendations. The discharge velocity at the nozzle shall be 3,500 Feet/Minute [17.8 Meters/Second].

(j) Include the discharge air velocity pressure and the static pressure drop through 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 any heat recovery from the exhaust ducts of fume hoods.

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

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

(o) For H3 hoods, include VA Grade E (HEPA Filter – MERV 17) and VA Grade A (pre-filters) in the exhaust air duct, on the suction side of the exhaust fan.

3.6.5 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 washdown cycle shall be either automatic or manual. Provide a hose bibb within 30 Feet [9.1 Meters] of the discharge stack to facilitate manual wash.

3.6.6 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 the 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 3-2: Radioisotope Hoods (H3) Preliminary Exhaust Air Volumes		
Hood Size Inches [mm]	CFM [Liters/Second]	Pressure Drop Inch WG [Pascal]
48 [1200]	875 [413]	0.375 [93]
60 [1500]	1125 [531]	0.375 [93]
72 [1800]	1375 [649]	0.375 [93]

Table 3-3: General Purpose or Chemical Hoods (H7) Preliminary Exhaust Air Volumes		
Hood Size Inches [mm]	CFM [Liters/Second]	Pressure Drop Inch WG [Pascal]
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 3-4: Perchloric Acid Hood (H14) Preliminary Exhaust Air Volumes		
Hood Size Inches [mm]	CFM [Liters/Second]	Pressure Drop Inch WG [Pascal]
48 [1200]	1030 [486]	0.625 [156]
60 [1500]	1355 [639]	0.50 [125]
72 [1800]	1680 [792]	0.75 [187]
96 [2400]	2355 [1111]	0.75 [187]

3.6.7 EXHAUST SYSTEM DESIGN

3.6.7.1 Constant Volume (CV) Design

For a small project involving fewer than four hoods, the fume hood exhaust system design may be a 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.

3.6.7.2 Variable Air Volume (VAV) Hoods (H7 and H3 Hoods Only)

For new construction and major renovations to be in compliance with the mandated energy conservation directives, provide a variable air volume design for H3 and H7 fume 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.

(a) System Configuration and Controls: The design shall comprise 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, variable air volume system to serve all identical hoods (either H7 or H3). 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 (H3 hood only), and a static pressure sensor.

- **General Exhaust System:** Design a dedicated, variable air volume 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, 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 [47.2 Liters/Second] 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.

3.7 BIOLOGICAL SAFETY CABINETS (BSC) – VA TYPE H12

3.7.1 BIOLOGICAL SAFETY LEVEL 3 (BSL3)

See Appendix 3-A.

3.7.2 COMPLIANCE

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

3.7.3 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 Feet [12 Meters] and 6 Feet [18 Meters].

(b) Cabinet and Safety Classification: BSC are classified into three classes, as shown below:

Table 3-5: 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 have BSL 4 facilities.

3.7.3.1 Class I Cabinets

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

(b) Design Criteria:

- Design face velocity is 75 Feet/Minute [0.4 Meters/Second].
- Filtration – Cabinet air must be filtered (VA Grades A and E) before it is exhausted outdoors or re-circulated in the laboratory. Use 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 a 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.

3.7.3.2 Class II Cabinets

(a) Classification: Classification of BSC, Class II cabinet is based on NSF 2002.

Table 3-6: 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 [34.4 Liters/Second] 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 [45.9 Liters/Second] 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 [45.9 Liters/Second] 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 FPM [45.9 Liters/Second]

(b) Exhaust Air Volumes: The average exhaust air-quantities and pressure drops for type B1 and B2 and Class II cabinets are listed below:

Table 3-7: H12 Cabinet Type B1 Exhaust Air Requirements		
Size Inches [mm]	**Exhaust Air CFM [Liters/Second]**	**Pressure Drop Inch WG [Pascal]**
48 [1200]	270 [124]	1 [249]
72 [1800]	410 [188]	1 [249]

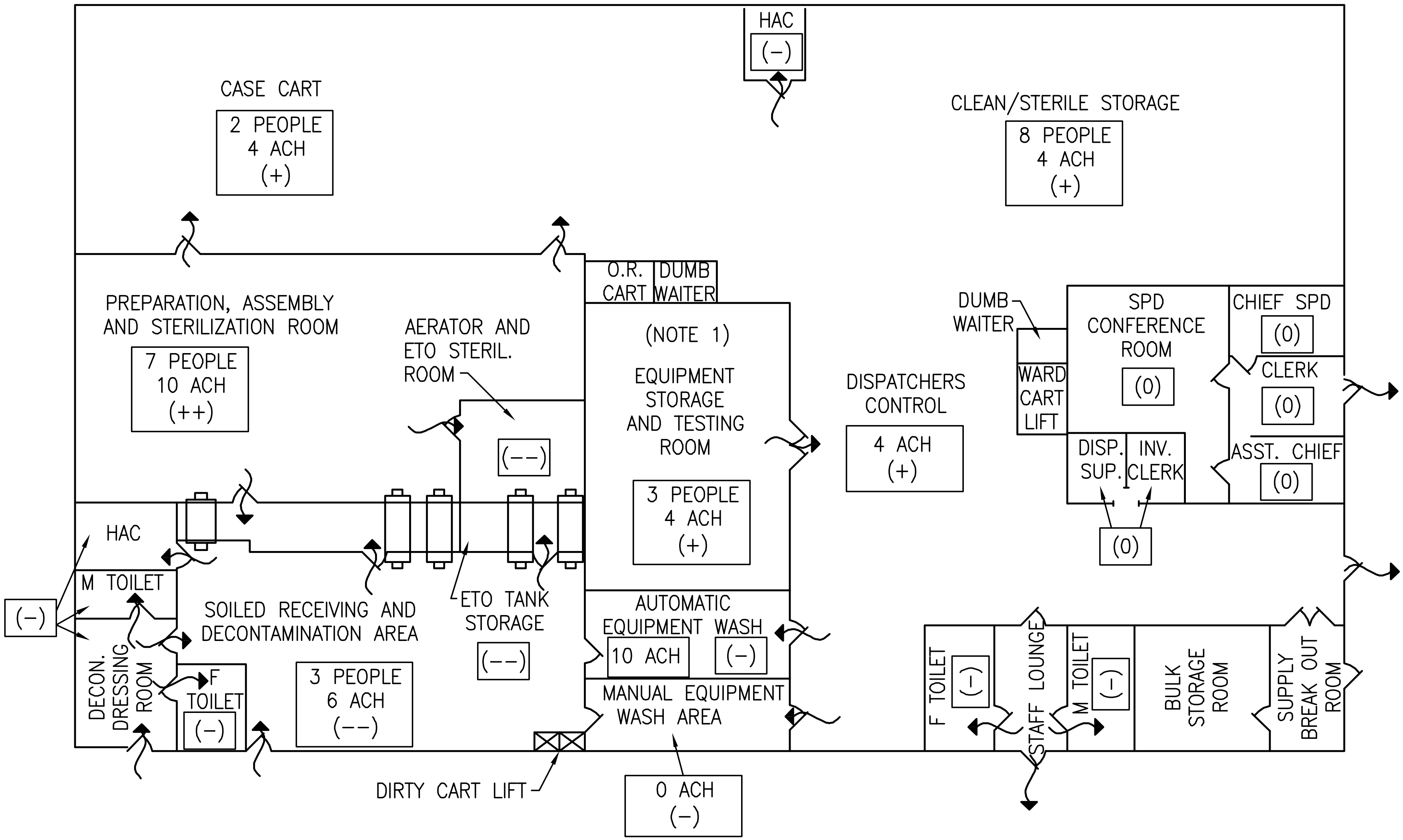
Table 3-8: H12 Cabinet Type B2 Exhaust Air Requirements		
Size Inches [mm]	**Exhaust Air CFM [Liters/Second]**	**Pressure Drop Inch WG [Pascal]**
48 [1200]	730 [325]	1 [249]
72 [1800]	1150 [527]	1 [249]

(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 VA Grade E HEPA filters (the fact that the supply HEPA filter within the cabinet is not included as the internal blower maintains 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.

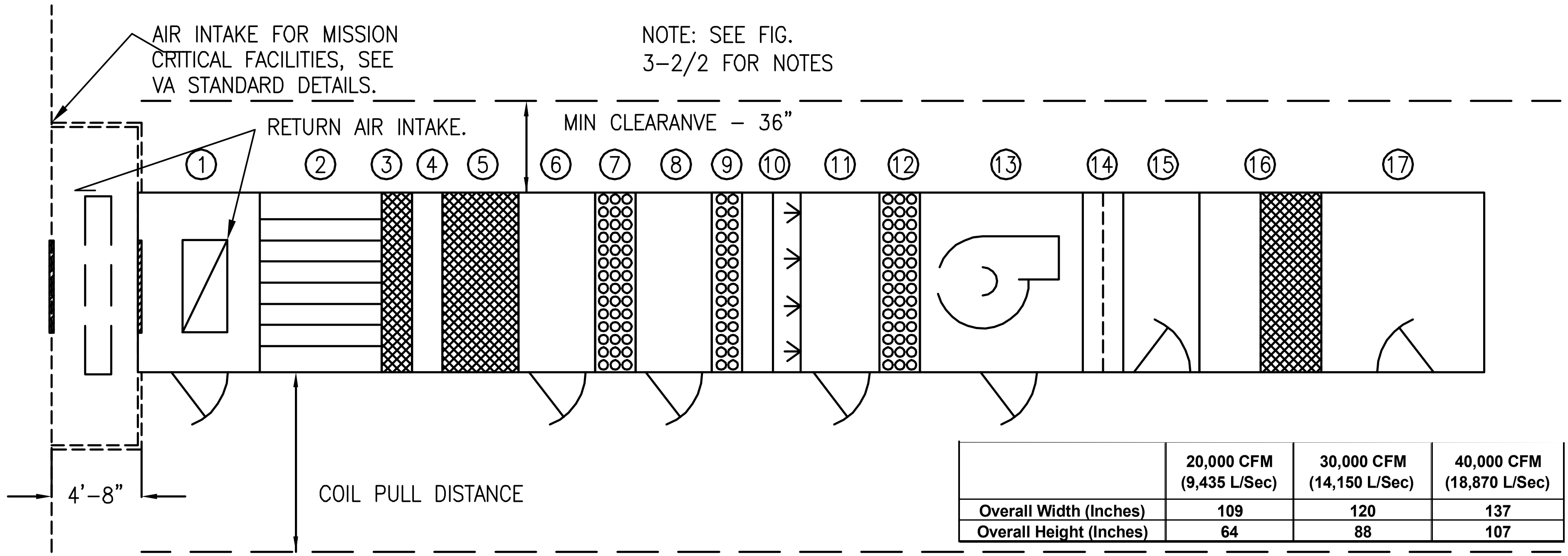
NOTE 1 : PARTITION WALLS ARE OPTIONAL
ACH : AIR CHANGES PER HOUR
: DIRECTION OF AIRFLOW

+ : POSITIVE AIR BALANCE
- : NEGATIVE AIR BALANCE
0 : NEUTRAL AIR BALANCE



SUPPLY PROCESSING AIR FLOW DIAGRAM

Not to Scale



	20,000 CFM (9,435 L/Sec)	30,000 CFM (14,150 L/Sec)	40,000 CFM (18,870 L/Sec)
Overall Width (Inches)	109	120	137
Overall Height (Inches)	64	88	107

	AIR HANDLING UNIT	Item #	MINIMUM OUTSIDE AIR TWO BEDS OF FILTERS VAV	MINIMUM OUTSIDE AIR THREE BEDS OF FILTERS CV	100% OUTSIDE AIR TWO BEDS OF FILTERS CV	100% OUTSIDE AIR THREE BEDS OF FILTERS CV	LENGTH INCHES		
	* AS REQUIRED						20,000 CFM (9,435 L/SEC)	30,000 CFM (14,150 L/SEC)	40,000 CFM (18,870 L/SEC)
*	Mixing Box	1	Yes	Yes	No	No	48	48	54
*	Blender Section	2	Yes	Yes	No	No	48	48	54
	Pre-Filters (Side Access)	3	Yes	Yes	Yes	Yes	12	15	15
	Inspection Section, small	4	Yes	Yes	Yes	Yes	12	15	15
	After-Filters (Side Access)	5	Yes	Yes	Yes	Yes	30	30	30
	Access Section, med-large	6	Yes	Yes	Yes	Yes	30	30	30
*	Heat Recovery Coil	7	No	No	Yes	Yes	16	20	20
*	Access Section, med-large	8	No	No	Yes	Yes	30	30	30
*	Pre-Heat Coil	9	Yes	Yes	Yes	Yes	12	15	15
*	Inspection Section, small	10	Yes	Yes	Yes	Yes	12	15	15
*	Humidifier	11	Yes	Yes	Yes	Yes	32	40	40
	Cooling Coil	12	Yes	Yes	Yes	Yes	16	20	20
	Fan	13	Yes	Yes	Yes	Yes	64	69	92
*	Diffuser	14	No	No	No	Yes	16	20	54
*	Access Section, med-large	15	No	No	Yes	Yes	30	30	30
*	HEPA Filter	16	No	No	No	Yes	42	42	54
*	Discharge Plenum (Vertical)	17	Yes	Yes	Yes	Yes	64	64	64

TYPICAL AIR HANDLING UNIT

Not to Scale

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. PROVIDE VAPOR TIGHT MARINE LIGHT IN EACH ACCESS SECTION, FACTORY WIRED TO A SINGLE WEATHERPROOF SWITCH LOCATED ON EXTERIOR OF CABINET.
4. INCLUDE A WIRE REINFORCED GLASS VIEW WINDOW IN EACH ACCESS AND FAN SECTION.
5. HUMIDIFIER LOCATION IS OPTIONAL AND MAY BE LOCATED IN THE AHU OR IN THE MAIN SUPPLY AIR DUCT.
6. SEE VA STANDARD DETAILS FOR OUTSIDE AIR PLENUM DETAIL. THE PLENUM LENGTH IS APPROXIMATELY 4 FEET – 8 INCHES.
7. THE INFORMATION GIVEN IN THE DETAIL IS MEANT FOR CONCEPTUAL DESIGN AND PLANNING. THE DESIGNER SHALL MAKE HIS OWN SELECTION BASED ON ENGINEERING CALCULATIONS AND UNIT BASIS OF DESIGN.

AIR HANDLING UNIT NOTES

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 the animal research and general research applications. ***Containment control is an essential goal of the 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 BSC (Biological Safety Cabinet) 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) See the VA Design Manual for the details on the biological safety cabinets. 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 exposure to the general public.

3-A.3.2 LABORATORY – ACCESS

Entry in the laboratory shall be through a dedicated and enclosed passageway or an anteroom, that is, through two sets of self-closing and self-locking doors. Provide interlocking mechanism to prevent the both sets of doors being open at the same time. The passageway or the anteroom 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. Provide high impact glass for the windows and doors with wire mesh inside for security concerns. 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 piping 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 disinfectants used in the laboratories.

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

(c) Use of the acoustic tile suspended ceiling is not permitted. Ceiling shall have a water-proof, hard surface for the 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 that requires 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 and not in the vestibule.

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

(d) The sprinkler heads shall be concealed-type or 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 Feet [3 Meters] above any accessible location.

(g) An emergency shower/eyewash station shall be within the same room as a 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.

CHAPTER 4: BUILDING COOLING AND HEATING SYSTEMS

Table of Contents

4.1 INTRODUCTION

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

(a) Refrigeration Systems

- Central chilled water plants
- Air-cooled chillers
- Chilled water system components
- Direct expansion (DX) systems

(b) Heating Systems

- Steam systems (excluding steam generation and outside distribution)
- Hydronic hot water systems
- Glycol systems
- Electrical heating systems
- Gas heating
- Miscellaneous systems

4.2 REFRIGERATION SYSTEMS

4.2.1 GENERAL

Selection of the refrigeration systems and equipment shall be based on applicability to the specific project and cost-effectiveness.

(a) Choice of Refrigerant: Evaluate and justify the choice of refrigerant for each project. The refrigerant shall be fully compatible with all local, state, and federal regulations. The refrigeration equipment selection shall be based on the new EPA-approved refrigerants such as HCFC 123, HFC 410a, and HFC 134a. The latest versions of ASHRAE Standards 15, Safety Code for Mechanical Refrigeration and ASHRAE Standard 34, Designation and Safety Classification of Refrigerants, shall be followed to ensure full compliance.

(b) Reciprocating Compressors: The use of reciprocating compressors is ***not*** permitted.

4.3 CENTRAL CHILLED WATER PLANTS

4.3.1 GENERAL

For new construction and major renovation projects, central chilled water plants shall comprise multiple (minimum two) water-cooled chillers, using centrifugal (open or hermetically sealed) or rotary-screw compressors or absorption machines.

4.3.2 SPECIAL REQUIREMENTS

4.3.2.1 Maximum Chiller Capacity

Capacity of a single chiller shall not exceed 1,250 tons of refrigeration when rated at ARI conditions. All chillers shall be the products of one manufacturer.

4.3.2.2 Standby Chiller Capacity

For new construction and major renovation projects, the central chilled water plant shall comprise N+1 chillers, where N = 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. Provide N+1 plant components.

- Chilled Water Pump
- Condenser Water Pump
- Cooling Tower
- Required Controls

Size chilled water and condenser water piping mains for total installed capacity.

4.3.2.3 Central Chilled Water Plant Sizing

Do not include cooling load requirements for special applications where mandated dedicated chillers are required.

Exception:

Surgical Suite – When selecting chillers, chilled water systems, and interfacing with the central, chilled-water plant, use the following criteria:

With Central Chilled Water Plant
Provide two banks of cooling coils arranged in series in the dedicated air-handling unit serving the surgical suite. Use chilled water from the central chilled water plant to perform the first stage of cooling with the water temperature at 44 F [7.0 C]. Use chilled water from the dedicated chiller serving the surgical suite to perform the second stage of cooling with a chilled water supply temperature at approximately 41 F [5 C].

With this arrangement, the dedicated surgical suite chiller size shall be reduced considerably and the central chilled water plant will not have to operate at 41 F [5 C]. Chilled water at a temperature of 41 F [5 C] is required to produce approximately 47 F [8.3 C] air leaving temperature, which is required to maintain inside design conditions of 62 F [16.7 C] and 60% relative humidity.

Without Central Chilled Water Plant
Where a central chilled water plant is not available, size the dedicated chiller to meet the following requirements:

- Total cooling demand of the surgical suite
- Inside design conditions with appropriate chilled water temperature and flow through a single bank of cooling coils

4.3.2.4 Minimum Performance Compliance, based on ASHRAE Standard 90.1 – 2007

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

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

Table 4-2: Water Chilling Packages – Minimum Efficiency
Air-Cooled, Electrically Operated
Based on FEMP Requirements

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

Table 4-3: Water Chilling Packages – Minimum Efficiency
Absorption Machines
Based on ASHRAE 90.1 - 2007 Requirements

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

4.3.2.5 Use of Glycol – Chilled Water Systems

(a) Use of glycol is not permitted in chilled water systems, as it counteracts the mandated goal of increased energy conservation and results in higher maintenance. Specific reasons are:

- Reduced heat transfer efficiency of the chillers and cooling coils
- Increased pumping horsepower and energy consumption due to increased viscosity
- Increased recurring maintenance due to loss of glycol concentration over time
- Increased initial cost, due to requirements for glycol, pumping kit, and larger chilled water pumps

(b) To counteract the possibility of freezing, the A/E shall include project-specific measures in the design documents. A few suggestions are:

- Increase the thickness of the chilled water piping insulation by 1 inch [25.4 mm] over the recommended thickness for indoor applications.
- Select higher density (minimum 3.0 lb/ft^3 [48.055 kg/m^3]) for the pipe insulation.
- Provide thermostatically-actuated heat tracing by selecting a cable of appropriate density (Watts/Linear Foot). Connect heat-tracing circuit to emergency power.
- Provide a control sequence to start the pumps and keep chilled water in circulation below 32 F [0.0 C] ambient temperature.
- Provide a storage tank to store the exposed chilled water volume below pre-set chilled water temperature. Locate tank in covered and heated space.

4.3.3 COMPREHENSIVE CHILLED WATER SYSTEM STUDY

Provide a major study, in accordance with the guidelines given in Chapter 1, which evaluates and defines the lowest life-cycle cost performance. The study shall evaluate chillers, piping/pumping configuration, condenser water systems (cooling towers, pumps and piping), waterside economizers, and thermal energy storage.

4.3.3.1 Optimization – Chiller Performance

The chilled water supply and the chilled water temperature differential (between entering and leaving temperatures) shall be optimized during the system selection process. Past studies and recommendations have demonstrated that selecting a chilled water supply temperature lower than 44 F [6.7 C] and a chilled water temperature differential higher than 10 F [5.6 C] results in an energy-efficient and optimum design.

Chillers can be of uneven size if the design is deemed efficient to meet the part-load and winter cooling demand.

4.3.3.2 Chilled Water Pumping/Piping Configuration

A comprehensive study shall evaluate a cost-effective and appropriate piping and pumping system. Two systems are described here – Primary/Secondary System (PSS) and Variable Primary System (VPS). Chillers, cooling towers, and pumps shall be headered together to ensure total interoperability.

4.3.3.3 Primary-Secondary System (PSS)

(a) General: See Figure 4-1 for piping and pumping arrangement. Arrange piping and pumping in order to isolate a chiller and its associated auxiliary equipment (chilled water and condenser water pumps and cooling tower) while ensuring that the leaving chilled water temperature remains unchanged.

(b) Primary Loop: Design a constant-volume, primary loop with a dedicated pump for each chiller. Chilled water supply and return headers shall enable the use of any pump with any chiller. Include a two-way modulating control-valve and a flowmeter in each chiller circuit to isolate the idle chiller when not in operation and keep constant flow through each evaporator when one chiller or all chillers are in use.

(c) De-Coupler Piping: Provide hydronic separation (de-coupler piping) between the primary and secondary loops to separate the two circuits and enable the chilled water flow to change direction.

(d) Secondary Loop: system Provide secondary pumping loop with multiple pumps. Provide two-way modulating control valves in the secondary circuit for the cooling terminal devices. Provide a high-accuracy flowmeter in the secondary circuit. Secondary pumps shall be equipped with variable speed drives. The secondary system is a variable flow system.

(e) Control Strategy:

(1) The secondary chilled water pump speeds shall vary in response to part-load conditions by maintaining the set pressure differential in the secondary loop. Include a chilled water differential pressure assembly (DPA) in the secondary chilled water piping across the hydronically farthest loop. Multiple DPAs may be required to sample patently different loops. Using multiple differential assemblies, the drive shall move only if all devices are polled and their specific set-points are not compromised. Calibrate the actual set-point of the assembly in conjunction with the manual reading given by the TAB (Testing, Adjusting, and Balancing) contractor. Show exact location of the DPA on the floor plans and riser diagrams.

(2) 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 primary supply and return and the secondary supply and return and flowmeter to develop a control strategy.

(3) Integrate the function of microprocessor-based chiller controls with the chilled water control system. All microprocessor-based control points should be accessible from the remote building DDC control system.

(4) Include hardware and software in the control sequence to prevent reduction in the secondary flow below a pre-determined limit. Such situations would occur with:

- 100% outside air AHU
- AHUs equipped with economizer cycles

(5) Include bypass piping assembly near the DPA. The assembly shall comprise a two-way modulating valve and a pair of shutoff valves on either side of the bypass control valve. The bypass assembly should be sized to carry the minimum flow recommended by the pumps and/or variable speed drive manufacturers.

4.3.3.4 Variable Primary System (VPS)

(a) General: See Figure 4-2 for the piping and pumping arrangement. A VPS system is less expensive in first cost and energy efficiency compared to a “traditional” primary/secondary system. However, VPS is not suitable for all applications. While VA certainly encourages the use of VPS, inherent complexities of the system controls, start-up, and loading/unloading of the chillers must be resolved during the design development process. It is also important to ensure that minimum constant cooling load is always present for the VPS to be effective. The intent of either system is to maintain constant leaving chilled water temperature from full-load to part-load conditions.

(b) System Operation: In a VPS system, chilled water flow is allowed to vary throughout the loop, including in the evaporator tubes. Provide a common chilled water circulation/distribution loop to circulate water through the terminal cooling units and the chiller evaporators. Minimum flow through the system must not be allowed to drop below the manufacturer's recommended water velocity through the evaporator tubes. A bypass assembly, similar to the PSS system shall be included in the design as shown in the Figure 4-2.

(c) Control Strategy:

(1) Include a high-accuracy flowmeter to monitor chilled water flow in the system design. In place of a flowmeter, the pressure differential across the evaporator can be measured and converted to flow based on the specific manufacturer's published flow-pressure data. The pump speed shall decrease in response to part-load conditions, using the same concept used for the PSS systems. A differential pressure assembly (DPA) shall control the pump speed.

(2) Control the sequencing of the connected load to avoid sudden variations and not compromise the system stability. Start-stop of all air-handling units shall be programmed and software controlled.

(3) 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 primary supply and return, and a flowmeter.

4.3.3.5 Single Chiller Systems, Constant Volume

See Figure 4-3 for the piping and pumping arrangement. For small chiller plants consisting of one chiller (and one standby chiller), provide a constant volume system with constant speed pumps and three-way valves at the air handling units.

4.3.3.6 Water Treatment (Chilled Water System)

(a) Chemical Shot Feeder: Provide a chemical shot feeder in bypass position to treat the closed-loop chilled water. Select the feeder size and chemicals based on the system volume and the water analysis, but not less than 3% of the chilled water flow rate.

(b) Water Filter: Provide a cartridge-type of filter in bypass position to remove solid suspended particles from the chilled water in circulation. Filter capacity shall be at least 3% of the chilled water flow rate. Include the bypass flow in the pump duty.

4.4 AIR-COOLED CHILLERS

4.4.1 GENERAL

The capacity of a single air-cooled chiller shall not exceed 250 tons.

4.4.2 CHILLER CONSTRUCTION

(a) Select chillers with rotary-screw or scroll compressors. Provide multiple compressors and independent refrigeration circuits.

(b) Select chillers with microprocessor-based controls that have the ability to interface with the building DDC system. All chiller points shall be viewable from the DDC system. Update specifications to ensure coordination between the chiller and controls requirements.

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

(d) For corrosive environments, include factory-applied anti-corrosion treatment for the condenser coil fins.

4.4.3 MINIMUM SYSTEM VOLUME

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

4.4.4 CONTROLS STRATEGY

(a) For a single chiller installation with chilled water pump horsepower 7.5 HP or less, provide a combination of three-way and two-way modulating chilled control valves to permit the pump to ride on its curve without dead-heading.

(b) Evaluate the use of VPS and include it in the design to meet the enhanced, energy conservation mandate.

(c) Accomplish loading and unloading of the chiller by maintaining the leaving water temperature through the microprocessor-based chiller capacity control.

4.5 CHILLED WATER SYSTEM COMPONENTS

4.5.1 PUMPS

4.5.1.1 General

Provide base-mounted, centrifugal (horizontal or vertical split-casing) or vertical turbine-type pumps for the chilled water and condenser water applications. For the condenser water system, available net positive suction head (NPSH) must exceed the required NPSH to avoid pump cavitation.

4.5.1.2 Selection Criteria

(a) Select pumps with an operating speed not in excess of 1,750 RPM, where feasible. A selection based on more than 1,750 RPM may be used if life-cycle cost-effective.

(b) Select pumps at or near the highest efficiency and to the left-hand side of the maximum efficiency point but not more than 5% from the maximum efficiency curve.

(c) Pump motors shall be non-overloading over the entire range of their operation and shall be compatible with variable speed drives, where used for such applications.

(d) In general, 5 HP and smaller pumps can be selected as inline pumps.

(e) For flow rates of 1,200 GPM [76 Liters/Second] and higher, make multiple pump selections, involving single suction or double suction pumps including horizontal split-case design. Optimum selection shall be based on efficiency, cost, and maintenance considerations.

(f) Selection of parallel pumps shall ensure that the pump curve is nearly flat to effectively operate in parallel configuration.

4.5.2 COOLING TOWERS

4.5.2.1 General

(a) Cooling towers shall be induced draft-type, gravity-flow, factory-fabricated, and factory-tested. Select the cooling towers that are certified by the applicable section of the CTI (Cooling Tower Institute), OSHA requirements for safety, and Physical Security Requirements. See Figure 4-4 for the piping and pumping arrangement.

(b) Corrosion resistance and noise levels shall be the prime selection criteria of the cooling towers, influencing the choice of design and materials. Depending upon the height restriction and available space, the cooling tower shall be single-cell or double-cell construction. See Chapter 2 for the noise and dispersion requirements.

4.5.2.2 Selection Options

Each cooling tower selection shall address and resolve such issues as:

- Cooling tower location
- Cross flow or counter flow towers
- Gear drive or belt-drive
- Concrete basin or steel basin
- Stainless steel basins are preferred, unless proven otherwise
- Tower accessories – fill, walking platform
- Stairs and ladder safety cage
- Tower loading and supporting structure
- Net positive suction head requirements
- Tower controls
- Basin heating

4.5.2.3 Additional Selection Criteria

(a) Provide a variable speed drive for the cooling tower fan motor. Keep the tower motor away from the water flow by a shaft extension.

(b) When the cooling tower is located on the roof, coordinate its operating weight with the structural discipline and design the supporting steel structure to support the tower on the roof. Design of the supporting steel shall permit elevating the cooling tower at least 4 Feet [1.2 Meters] (net) above the roof surface to facilitate access and re-roofing the surface underneath the cooling tower.

(c) 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.

(d) See Chapter 2 for acoustic treatment.

4.5.2.4 Water Treatment (Condenser Water System)

(a) General: Design a water treatment system for treating the cooling tower water based on the 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.

(b) System Description: Provide a chemical feed pump for each chemical feed tank, specifically, tower scale and corrosion inhibitor, acid and biocide inhibitor. 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) Watermeters: Provide a watermeter in the condenser water make-up line, and blow down line, capable of reading the actual 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, and coordinate with plumbing to provide a washbasin. Provide a desk with storage cabinets to house the chemicals 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.

4.6 DX SYSTEMS

4.6.1 GENERAL

Where chilled water is not available year around, non-patient spaces that require mechanical cooling can be treated using dedicated DX units, split-systems or complete factory-fabricated units.

Use of DX cooling systems is not permitted in patient wings, patient treatment and special procedures areas, or in high humidity locations.

4.6.2 SELECTION CRITERIA

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

4.6.3 EQUIPMENT LOCATION AND LAYOUT

(a) Location: Locations of the outdoor DX units shall be coordinated with the architectural discipline, Medical Center, and physical security requirements.

(b) Refrigerant Piping: Limit the lengths of the field-installed refrigerant piping and minimize bends and changes in elevations to avoid oil return problems and loss of efficiency. The refrigerant piping layout must meet prior approval of the equipment manufacturers.

(c) Multiple Compressors: Provide two compressors in parallel, where feasible, in place of a single compressor. With two compressors serving a single DX coil, design the coil circuiting to facilitate refrigerant flow through the entire coil even with one compressor in operation.

(d) System Controls:

- Provide local (non-DDC) thermostatic controls.
- Where the DX system is equipped with integral, local microprocessor-based controls, provide an interface with the ECC. If such an arrangement is not feasible, provide a DDC temperature sensor to sound a high and/or low limit alarm at the ECC.

4.7 HEATING SYSTEMS

4.7.1 STEAM HEATING SYSTEM

4.7.1.1 General

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

- Laundry service
- Sterilizers
- Kitchen equipment
- Building heating hot water
- Domestic hot water

(b) Obtain the actual steam generation pressure, as it varies with the facility. The average range is between 80 PSIG [552 KPA] and 125 PSIG [863 KPA].

4.7.1.2 Pressure Classification

For VA facilities, steam pressure is classified as shown below:

- 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

4.7.1.3 Available Steam Pressure – High Pressure Steam (HPS)

(a) Obtain actual winter steam generation pressure from facility personnel for sizing the pressure-reducing valve (PRV) station.

(b) Calculate steam pressure loss between the boiler plant and the equipment room, where the PRV station will be installed. Restrict this pressure loss to 10 PSIG [6.9 KPA]. If required, modify the steam pipe sizing criteria, stipulated in Chapter 2, to contain the pressure loss to 10 PSIG [6.9 KPA].

4.7.1.4 Steam Pressure Requirements

Listed below are the suggested operating pressures:

Table 4-4: Suggested Steam Operating Pressures

Equipment	Operating Steam Pressure PSIG [KPA]
Radiators	5.0 [34]
Convectors	5.0 [34]
Terminal Humidifiers; Duct Mounted	15.0 [105]
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 [860]

4.7.1.5 PRV Stations

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

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

(c) Provide two PRVs in parallel at the locations and applications where significant (> 2/3) variation in the steam demand is expected. Select two PRV valves of uneven sizes, the smaller valve of 1/3 and the larger valve of 2/3 capacities. Set the smaller valve at a higher exit pressure than the set exit pressure and the larger valve at a lower exit pressure than the set exit pressure so that the smaller valve shall open first, maintaining higher than the set-point pressure and delivering 1/3-steam flow rate. With the increase in load, the controlled pressure shall drop and the larger valve shall open, eventually admitting the remaining 2/3-steam flow rate. With the smaller valve already delivering 1/3 capacity, the total capacity shall be the full rated capacity.

(d) For sizing the steam 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 the PRV bypass valve and the safety valve according to 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.

4.7.1.6 Miscellaneous Design Requirements

(a) **Shutoff Valve – HPS:** Include a shutoff valve and a pressure gage, 4.5 inch [114.3 mm], for each incoming HPS service in the mechanical equipment room. For a shutoff valve, larger than 4 inch [100 mm] size, include a factory-installed, integral warm-up valve of .75 inch [20 mm] or 1 inch [25 mm] size in bypass position.

(b) **Steam Flowmeter:** For each steam PRV station, include a steam-flow measuring meter with interface to the EEC. Provide capability to read instantaneous and total steam flow.

(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 piping design shall not permit any 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 shall reduce pressure and temperature. From the flash tank, low-pressure gravity return shall flow into the condensate receiver of the condensate return pump. Adjust the elevation of the flash tank outlet to ensure gravity flow into the condensate receiver. Gravity return must ***not*** be lifted. The flash tank shall be shown at all applicable locations in drawings and specifications.

(e) **Steam Reheat Coils:** Do not locate steam reheat coils above suspended ceilings of the occupied areas. Problems due to trap noise, condensate return requiring pitch, trap maintenance, and ceiling height restriction are viable reasons for avoiding steam traps. Trap installation requires at least 12 inch [300 mm] for static lift and 6 inch [150 mm] for the dirt leg.

(f) Vent Line(s): Provide an atmospheric vent line to extend above the building roof. Vent lines from the condensate tank and flash tank can be combined into a single line. The vent line from the safety valve at the PRV station shall extend above the roof, to a height of 6 Feet [1.8 Meters], independent of the other vent line.

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

(g) Condensate Return Pump: Provide a duplex condensate pump, complete with a receiver, to return the liquid condensate up to boiler plant. Provide emergency power for the pumps. If the duplex condensate pump is installed in a pumppit, 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:

(1) 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 the preheat coils and the equipment with modulating load.

(2) Provide minimum 12 inch [300 mm] static lift for the trap operation. Space permitting, provide 18 inch [450 mm] lift. Static lift should not only be shown in the steam trap installation detail but the floor plans must emphasize the need to provide maximum available static lift. Non-compliance with this requirement has been a cause of operational problems in many installations.

(3) Size all F&T traps at ¼ PSIG [1.7 KPA] pressure drop.

(4) Size traps for heat exchangers and AHU preheat coils at 250% of the design load to meet the start-up needs. No single trap shall sized for more than 5,000 Pounds [2,358 KG] per hour.

(5) 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.

(6) For steam lines in continuous operation with infrequent shut downs, drip traps shall be sized for the line radiation loss, in Pounds [KG] per hour, multiplied by three. The trap pressure differential shall be about 80% of the line operating pressure.

(7) Each coil shall be individually trapped.

(8) 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.

4.7.1.7 Steam Gun Sets

Provide a steam gun set, comprising of steam, water, and detergent, at the following places. See VA Standard Detail for more information.

- Trash or trash compaction rooms
- Dietetics – manual cart wash
- Supply, Processing, and Distribution (SPD) – manual cart wash

4.7.2 HYDRONIC HOT WATER SYSTEMS

Note: Requirements for chilled water and condenser water pumps apply to hot water pumps.

4.7.2.1 Introduction

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. See Chapter 3 for information on AHU-mounted heating coils, VAV/CV air terminal units, and radiant ceiling panels.

4.7.2.2 System Description

(a) For most VA facilities, either steam is available from the central boiler plant or the existing steam distribution loop is used to generate hydronic hot water.

(b) Each hot water generating system shall comprise two steam-to-hot water heat exchangers, circulating pumps, and associated system auxiliaries. One heat exchanger and circulating pump shall act as 100% standby. See Figure 4-5 for the piping and pumping arrangement.

(c) Maximum limiting parameters of the hydronic hot water are:

- Supply Water Temperature – 180 F [82.2 C]
- Temperature Differential (Supply – Return) – 20 F [11.1 C]
- In general, maintaining lower supply water temperature with the control valve manufacturer’s recommended water flows has ensured stable system operation

(d) The following is a list of the terminal units using hydronic hot water:

- Hot water coils (VAV/CV) terminal units
- Unit heaters
- Cabinet unit heaters
- Radiant ceiling panels
- Duct-mounted reheat coils
- AHU-mounted preheat and reheat coils
- Fan coil units
- Convectors
- Base-board heaters
- Finned tube radiation
- Heating hot water curtains

(e) For large installations such as new and/or replacement hospitals or clinical additions, evaluate the feasibility of providing multiple heating systems to minimize the piping runs and ensure flexibility. Provide variable-speed drives for 10 horsepower and larger pumps.

(f) For hydronic preheat coils that come in contact with ambient or mixed air below freezing temperatures, provide freeze protection by mixing propylene glycol in the heating hot water. Provide a dedicated glycol-hot water heating system with a heat exchanger, circulating pumps, and interconnecting piping. The heating system shall be similar to the conventional hot water heating system serving the building reheat coils and other terminal heating units.

(1) Select the smallest possible concentration of the glycol to produce the desired antifreeze properties. Include an inhibitor in the glycol solution to prevent corrosion.

(2) Selection of the affected equipment shall take into account the loss of efficiency, impact on the pressure drops, and pump BHP.

(3) Additional information is available in the Appendix 4-A Propylene Glycol and the latest edition of the 2007 ASHRAE Handbook of Systems and Equipment (Chapter: Hydronic Heating and Cooling System Design).

(4) Water used in conjunction with the glycol shall be low in chloride and sulfate ions.

4.7.2.3 Water Treatment (Hot Water)

(a) Chemical Shot Feeder: Provide a chemical shot feeder in bypass position to treat the closed-loop hot water system. Select the feeder size and chemicals based on the system volume and the water analysis, but not less than 3% of the hot water flow rate.

(b) Water Filter: Provide a cartridge-type filter in bypass position to remove solid suspended particles from the hot water in circulation. Filter capacity shall be at least 3% of the hot water flow rate. Include the bypass flow in the pump duty.

4.7.2.4 Controls Strategy

(a) Provide two-way modulating control valves for all terminal units. Use three-way valves at the end of each run only if the circulating hot water pump is scheduled to ride on its own curve. Prevent dead-heading of the pump by ensuring that at least 20% flow remains constant.

(b) For non-critical applications such as unit heaters installed in attic spaces, control valves need not be provided. Water can “run wild” with the space temperature controlled by cycling the heater fan.

(c) Provide a hot water reset control to inversely vary the supply water temperature with the ambient temperature. Reset shall be adjustable and limited. For many applications and situations, reheat load is approximately constant. Selection of the lowest water temperature, selected nominal water flow, and the terminal units shall be such that the required heating output is not compromised.

4.7.3 ELECTRICAL HEATING SYSTEMS

4.7.3.1 General

Use electrical heat only when heat generated by fossil fuel is not cost-effective.

4.7.3.2 Compliance

U.L. Rating

4.7.4 GAS HEATING SYSTEMS

4.7.4.1 General

Use gas heating where natural gas is readily available at the site. Alternately, Liquid Propane Gas (LPG) can also be used.

4.7.4.2 Applications

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

- Mechanical rooms
- Warehouses
- Large storage spaces
- Laundries
- Vehicle maintenance facilities
- Gymnasiums

4.7.4.3 Heating Equipment

- Unit heaters
- Roof-top HVAC units
- Heating and ventilation units

All devices shall be thermostatically-controlled.

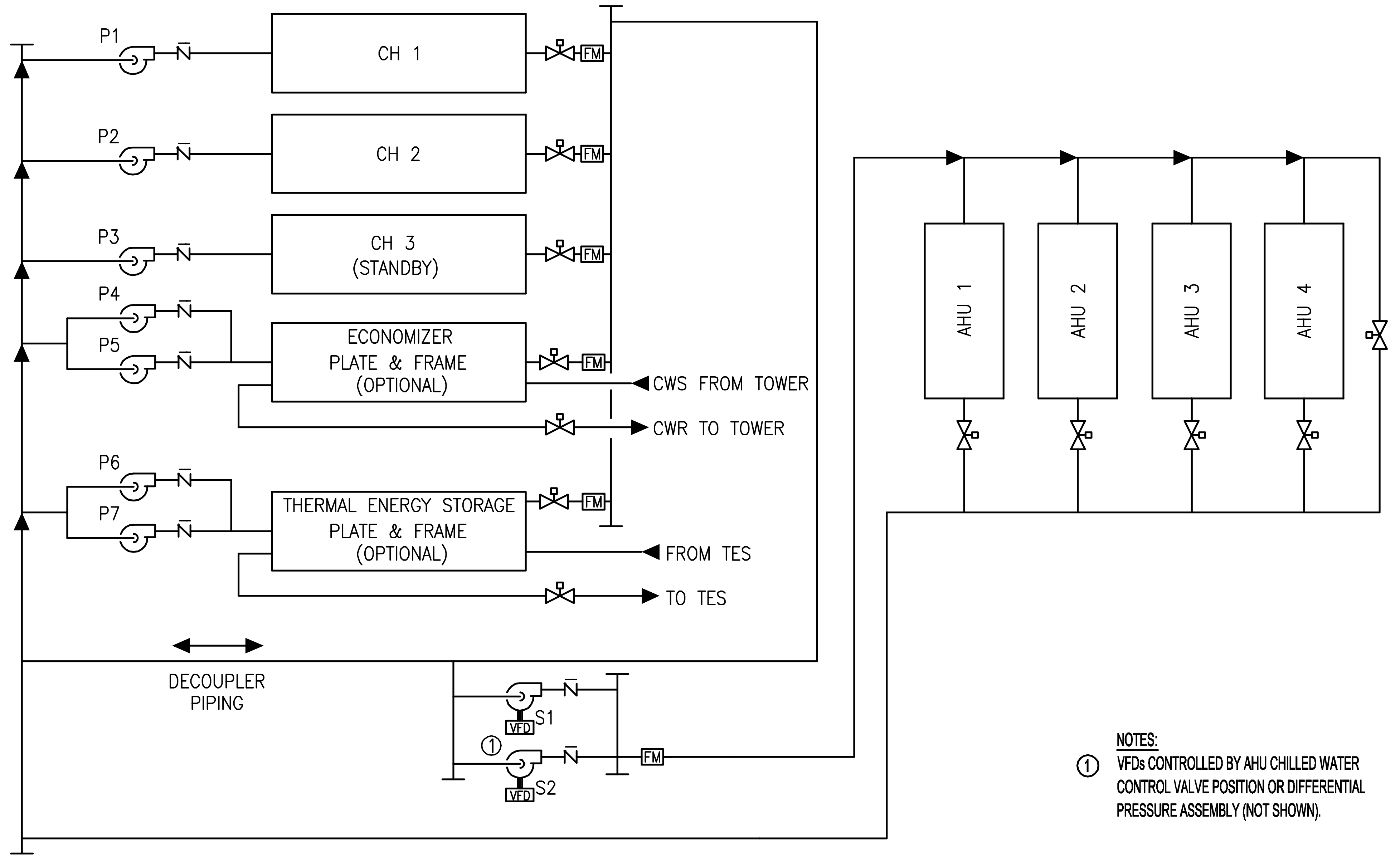
4.7.4.4 Miscellaneous Items

(a) Ensure that make-up air and exhaust needs are addressed and included in the design per the manufacturer’s recommendations and NFPA 54, National Fuel Gas Code.

(b) Care shall be taken to avoid any possibility of the exhaust vent short-circuiting into any intake or the operable windows of the occupied spaces. Follow the recommendations of the dispersion analysis.

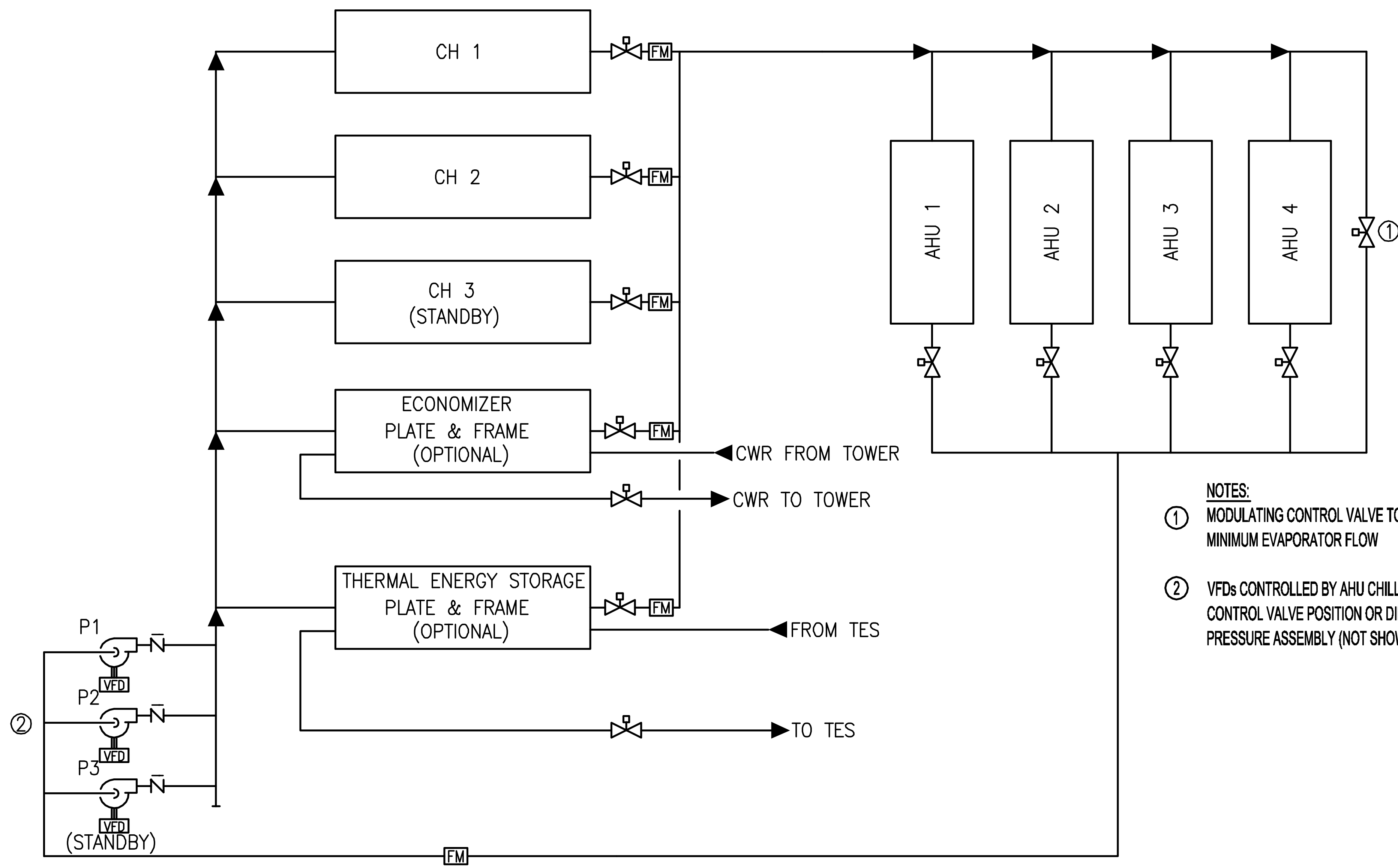
(c) Wherever available and feasible, use modulating or two-step burners to provide energy-efficient and smooth temperature control.

HVAC DESIGN MANUAL
CHAPTER 4
FIGURE 4-1
FEB 2008



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

Not to Scale



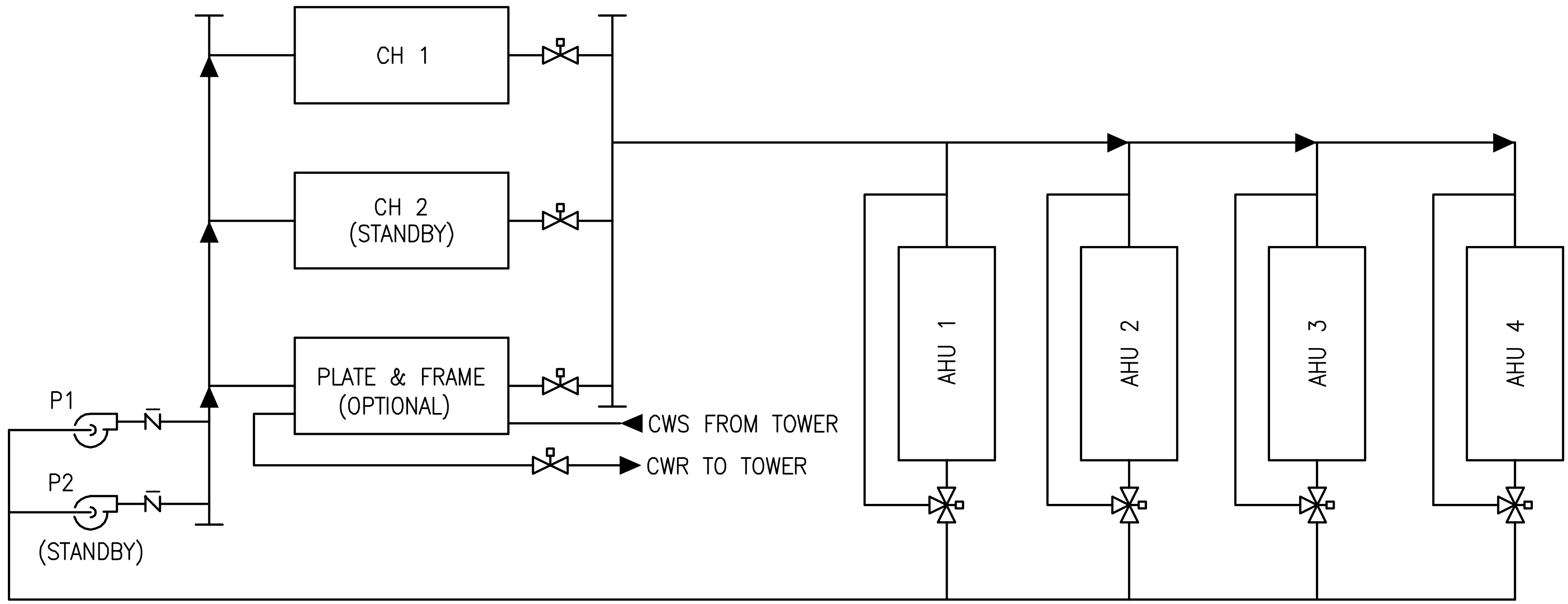
NOTES:

① MODULATING CONTROL VALVE TO MAINTAIN MINIMUM EVAPORATOR FLOW

② VFDs CONTROLLED BY AHU CHILLED WATER CONTROL VALVE POSITION OR DIFFERENTIAL PRESSURE ASSEMBLY (NOT SHOWN)

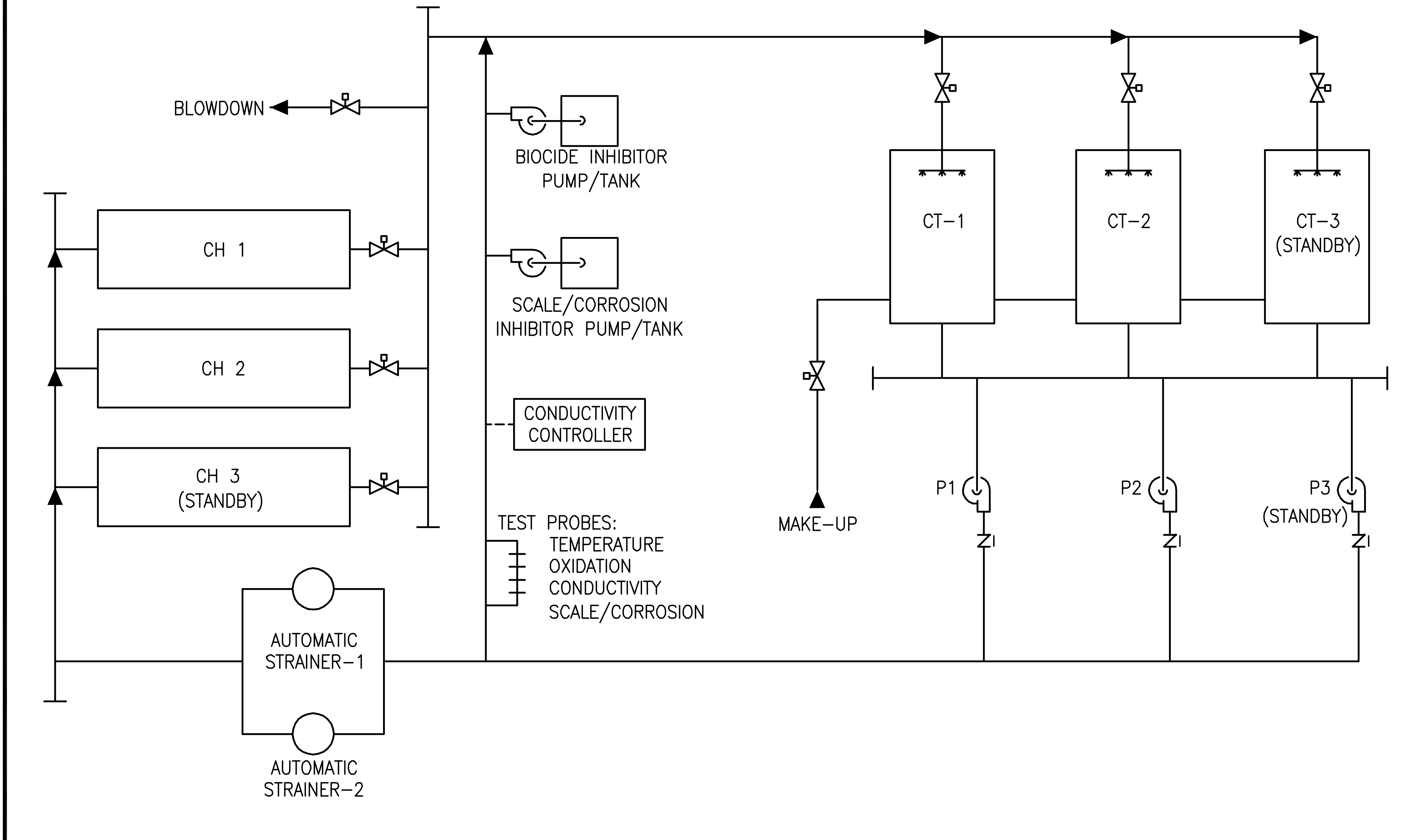
CHILLED WATER PRODUCTION AND DISTRIBUTION - VARIABLE PRIMARY SYSTEM (VPS)

Not to Scale



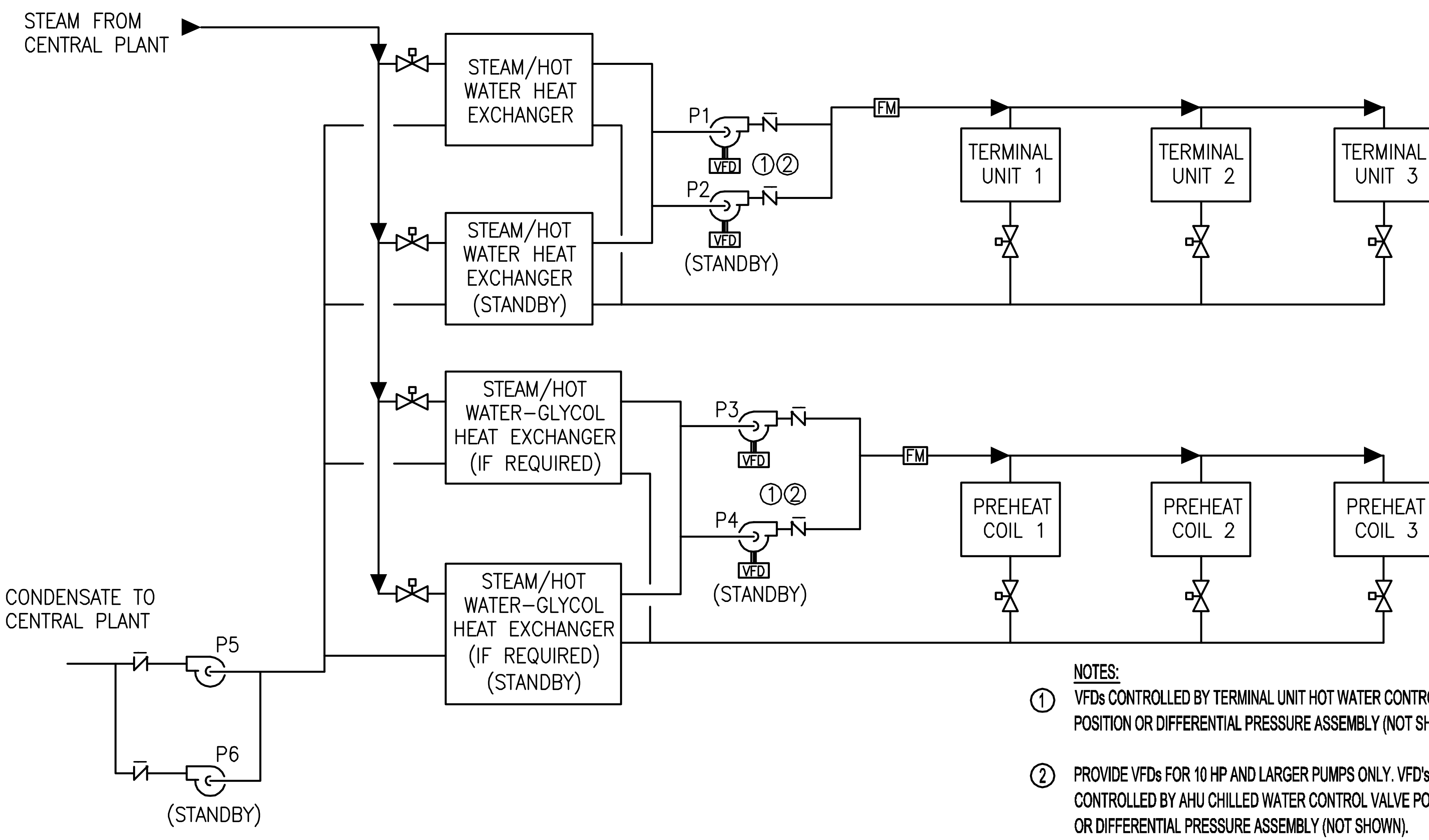
CHILLED WATER PRODUCTION AND DISTRIBUTION - SINGLE CHILLER SYSTEMS, CONSTANT VOLUME

Not to Scale



COOLING TOWER SYSTEM

Not to Scale



NOTES:

1. VFDs CONTROLLED BY TERMINAL UNIT HOT WATER CONTROL VALVE POSITION OR DIFFERENTIAL PRESSURE ASSEMBLY (NOT SHOWN).
2. PROVIDE VFDs FOR 10 HP AND LARGER PUMPS ONLY. VFD's CONTROLLED BY AHU CHILLED WATER CONTROL VALVE POSITIONER OR DIFFERENTIAL PRESSURE ASSEMBLY (NOT SHOWN).

HYDRONIC HOT WATER DISTRIBUTION

Not to Scale

APPENDIX 4-A: PROPYLENE GLYCOL

4-A.1 PROPYLENE GLYCOL – WATER SYSTEMS

4-A.1.1 INTRODUCTION

For freeze protection of the hot water preheat coils and heat recovery coils (used in runaround systems), use propylene glycol solution with hot water.

4-A.1.2 GLYCOL CONCENTRATION

Concentration of glycol shall be determined using the following criteria.

(a) Propylene glycol freezes and forms slush at 30% concentration by volume. Viscosity of the glycol solution rises dramatically as the fluid temperature drops.

Glycol Temperature	Viscosity, Centipoises
68 F [20.0 C]	60.5
32 F [0.0 C]	243

To address this phenomenon, the A/E shall avoid situations where freeze protection is required to prevent damage to the equipment during idle periods in winter season. It is important to ensure that while designing the glycol system, the flow rate and glycol concentration are optimized to control the adverse effect of higher viscosity.

(b) For applications that require the fluid to remain a liquid, select a concentration with a freezing point 5 degrees F [2.8 C] below the expected operating temperature of the equipment/piping system.

(c) Excessive concentrations of glycol shall be avoided.

(d) Refer to the ASHRAE Fundamentals Handbook for physical properties of propylene glycol solutions.

4-A.1.3 CORRECTION FACTORS

4-A.1.3.1 Flow Correction Calculation

Use the correction factors shown in Table 4-A1 to determine the flow rate due to glycol concentration. The glycol concentration corrected flow value shall be used in the equipment schedules.

Table 4-A1: Propylene Glycol Solution Flow Correction Factors – Increased Viscosity

Solution by Volume (Percent)→	20	30	40	50
30 - 40 F [1.1 - 4.4 C]	1.04	1.06	1.10	1.15
180 - 190 F [82.8 – 87.8 C]	1.03	1.05	1.07	1.11

Example:
200 GPM water at 40 foot head and a 30% solution by volume at 30 F using a pump with 69% efficiency.

$$FlowRate = 200 \times 1.06 = 212 GPM$$

4-A.1.3.2 Pressure Drop Correction Calculation

Use the correction factors shown in Table 4-A2 and Table 4-A3 to determine the pump head due to glycol concentration. The glycol concentration corrected pump head value shall be used in the equipment schedules. Note that two correction factors must be applied, one due to increased flow and one due to increased viscosity.

(a) The following correction factors applied to the head calculated for the water flow will give the increased head due to the increase in solution flow.

Table 4-A2: Propylene Glycol Solution Pump Head Correction Factors – Increased Flow				
Solution by Volume (Percent)→	20	30	40	50
30 - 40 F [1.1 – 4.4 C]	1.08	1.12	1.21	1.32
180-190 F [82.2 – 87.8 C]	1.06	1.10	1.14	1.23

Example:

Using the above example, the calculated pressure drop due to increased flow is:

$$\mathrm{Pr}\,essureDrop = 40 \times 1.12 = 45\,Feet$$

(b) The following correction factors applied to the head calculated for the increased flow will give the total head for the solution.

Table 4-A3: Propylene Glycol Solution Pump Head Correction Factors – Increased Viscosity				
Solution by Volume (Percent)→	20	30	40	50
30 F [1.1 C]	1.14	1.34	**	**
40 F [4.4 C]	1.12	1.28	1.4	1.6
180 F [82.2 C]	No correction is needed for solutions above 160 F [71.1 C]			
190 degrees F [87.8 C]				

**The viscosity of this mixture/temperature combination is too great and pumping will not occur.

Example:

Using the above example, the calculated pressure drop from increased viscosity is:

$$Total\ \mathrm{Pr}\,essureDrop = 45 \times 1.34 = 60\,Feet$$

4-A.1.3.3 Power Correction Calculation

Propylene glycol solutions affect pump performance. A power correction factor is required due to the higher specific gravity of the propylene glycol mixture. Use the following formula to determine the pump horsepower required due to glycol concentration. The specific gravity of the solution mixture shall be used in the equation. The glycol concentration corrected horsepower value shall be used in the equipment schedules.

$$BHP = GPM \times Head \times SpGravity \Big/ 3960 \times PumpEfficiency$$

Example:
Using the above example, the calculated horsepower from increased flow and head is:

$$BHP = 212 \times 60 \times 1.04 \Big/ 3960 \times .69 = 4.84 Hp$$

CHAPTER 5: AUTOMATIC TEMPERATURE CONTROLS

Table of Contents

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 Detail, and Chapter 6 (Applications) for additional information.

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

- Integrate the new DDC system into the existing system (use the same manufacturer).
- Integrate all existing and new DDC points and functions into one new system. The control system shall be open protocol.
- Provide a standalone system for all new DDC points and functions if approved by the VA Authorities. The control system shall be open protocol.

(c) The interface with the existing ECC shall be seamless. The system shall include PC (personal computer), 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. See Chapter 1 for details.

5.2 SYSTEM REQUIREMENTS

Include, at a minimum, the following features in the DDC system.

5.2.1 CONTROL ACTUATORS

Automatic control valves and dampers shall have electric control actuators.

5.2.2 CONTROL VALVES

Select control valves with equal percentage, or linear flow characteristics. Provide bubble tight shutoff against 1.5 times design pressure. Select control values at 3 PSIG [20.7 KPascal] maximum pressure drop at design flow rate.

5.2.3 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 Room (MER) plan and section drawings. End-switches are also required for 100% outside air units to ensure that the outside air damper is fully open before the supply air fan is energized.

5.2.4 FIRE AND SMOKE DAMPERS

See Chapter 2 for requirements. End-switches are also required for 100% outside air units to ensure that the outside air damper is fully open before the supply air fan is energized.

5.2.5 SAFETIES

Indicate hard-wired connections for all safety alarms, including freeze stats, smoke detectors, smoke dampers, refrigerant leak detection, and any other critical alarms. Include this information in the controls schematic diagram and written sequence of operation.

5.2.6 STATUS MONITORING

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

5.2.7 WIRING

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

5.2.8 ROOM TEMPERATURE SENSORS

Use commercial grade room temperature sensors with limited temperature adjustment and night setback push button override capabilities.

5.2.9 PERSONAL COMPUTER (PC)

Provide a PC with sufficient memory, hard-drive capacity, and processing speed, and at least a 21 inch [533.4 mm] color monitor. Provide expanded keyboard, CD drive, and a mouse. Ensure coordination with the specifications to include up-to-date PC features. Provide two printers: one for status and one for reports. Report printer shall be color ink jet type.

5.2.10 LAPTOP COMPUTER

Provide a laptop computer with up-to-date features and a 19 inch [425 mm] color monitor.

5.2.11 SOFTWARE

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

5.2.12 COLOR GRAPHICS

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

5.2.13 SPREADSHEETS

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

5.2.14 SECURITY

Provide three levels of password protection to restrict altering the device set-points.

5.2.15 REMOTE METERING REQUIREMENT

(a) Use the ECC system to track and optimize the performance of the metering system. Metering is required for each building for the following utilities and applications:

- Steam
- Chilled Water
- Hot Water
- Gas
- Cooling Tower Make-Up Water and Blowdown
- Total Building Domestic Water
- Building and Sub-System KW and KWH

(b) Coordinate the final metering system with ongoing VA metering project.

5.3 SYSTEM APPLICATIONS

5.3.1 GENERAL

(a) Listed below are generic control sequences for various HVAC systems. The list does not cover all sequences and sub-sequences. Similarly, all sequences are ***not*** applicable to all situations, as their inclusion or deletion would depend upon the project-specific requirements.

(b) Using the information given below, and other available resources, the A/E shall develop a detailed sequence of control and operations, in which all modes of the system are described.

5.3.2 AIRSIDE CONTROLS

Airside controls include operation of the air-handling units, exhaust systems, room level controls, and other miscellaneous controls. See Chapter 6 for specific applications and details of sequences.

5.3.2.1 Air-Handling Units

- System Start-Up
- Morning Warm-Up
- Morning Cool-Down
- Supply Air Temperature Control (include all applicable modes):
  - Heating
  - Mechanical Cooling
  - Economizer
  - Mechanical Cooling with Economizer Cycle Mode
- Freeze Protection (Pre-Heat Coil)
- Fan Speed Control (Supply Air Fan)
- Fan Speed Control (Return/Relief Air Fan)
- Fan Tracking (Supply and Return Air Fans)
- Minimum Ventilation (Outside Air) Control
- Freeze Stat Operation
- Smoke Detector/Smoke Damper Operation
- Filter Maintenance Alarm
  - Pre Filters
  - After Filters
  - HEPA Filters
- Volumetric Data
  - Supply – CFM

- Return – CFM
- Minimum Ventilation Air – CFM

- Heat Recovery System Operation
- **Supply Air Temperature Reset Control:** Use of this subroutine is viable during heating mode only. Care must be taken to ensure that the de-humidification is not compromised while attempting the supply air temperature reset.
- **Operating Static Pressure Reset Control:** See ASHRAE Standard 90.1 – 2007 for the mandated subroutine.
- Interlocked Exhaust Fan(s) Operation
- Winter Humidification Mode
- Demand Ventilation Control
- Summer High-Humidity Override Control
- Unoccupied Mode

5.3.2.2 Room Controls

- **Room Air Terminal Unit Control:** Minimum supply air volume setting for the VAV air terminal unit shall be based on the following considerations:
  - Direct exhaust requirement from the space
  - Make-up air for the communicating exhaust system
  - Limiting supply air temperature in heating mode to 95 F [35.0 C]
  - Minimum air for positive space pressurization, where applicable
- Dead-Band Control
- Sequential Heating Mode

See Figure 5-1 for control sequence for constant volume terminal reheat with perimeter heating and dead-band.

See Figure 5-2 for the control sequence for variable air volume terminal reheat with perimeter heating and dead-band.

See Figure 5-3 for the control sequence for year around variable air volume terminal reheat with perimeter heating and 0° dead-band.

See Figure 5-4 for the control sequence for year around constant volume terminal reheat with perimeter heating and 0° dead-band.

5.3.2.3 Exhaust Systems (Laboratories):

See Chapter 3 and Chapter 6 for further details regarding:

- Laboratory part-load volumetric ontrols
- With or without hoods
- Perchloric acid wash-down control
- Laboratory fume hood sash control
- Laboratory HEPA filter control

5.3.2.4 Isolation Rooms Exhaust:

See Chapter 6.

5.3.3 HEATING SYSTEMS

- System Start-Up
- Leaving (from converter) Hot Water Temperature Control
- Hot Water Temperature Reset Control
- Pump Speed Control (where applicable)
- Minimum Pump Speed Control
- Pump Start-Stop and Sequencing Control – Based on Equal Runtime

5.3.4 CHILLED WATER PLANT CONTROLS

- System Start-Up (cold start procedure)
- Leaving (from chiller) Chilled Water Temperature Set Point Control
- Chilled Water Temperature Reset Control (generally used with constant volume system)
- Chiller Start-Stop and Sequencing Control
- Variable Speed Drive Control – Primary only or Primary-Secondary Chilled Water Pump
- Cooling Tower Temperature Control
- Cooling Tower Fan Speed Control
- Cooling Tower Vibration Isolation Control
- Cooling Tower Make-Up Water Control
- Cooling Tower Basin Temperature Control
- Plate Heat Exchanger Control – Economizer Mode Operation
- Chilled Water Pump – Minimum Speed Control
- Secondary Loop – Variable Set Point Control/ Pressure Differential Assembly Control
- Thermal Energy Storage (water or ice) Control

5.3.5 NON-DDC CONTROLS

For standalone applications, DDC controls and connection to the central ECC system can be eliminated if it is determined that remote monitoring, alarm, and start-up are not necessary. Such applications are generally non-critical. Examples of such controls are:

- Light Switch Operated Toilet Exhaust (Remote Location)
- Vestibule Heater
- Exterior Stairs Heater
- Attic Heating and Exhaust
- Mechanical Room – Heating/Ventilation Control

See the Room Data Sheets for room alarm parameters.

5.4 DOCUMENTATION REQUIREMENTS

5.4.1 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 and control. Describe the sequence of operation in all modes, generally as outlined above. Control schematic diagram and the sequence of operation must be included on the drawings. Do ***not*** include the sequence of operation in the specifications.

5.4.2 POINT LIST

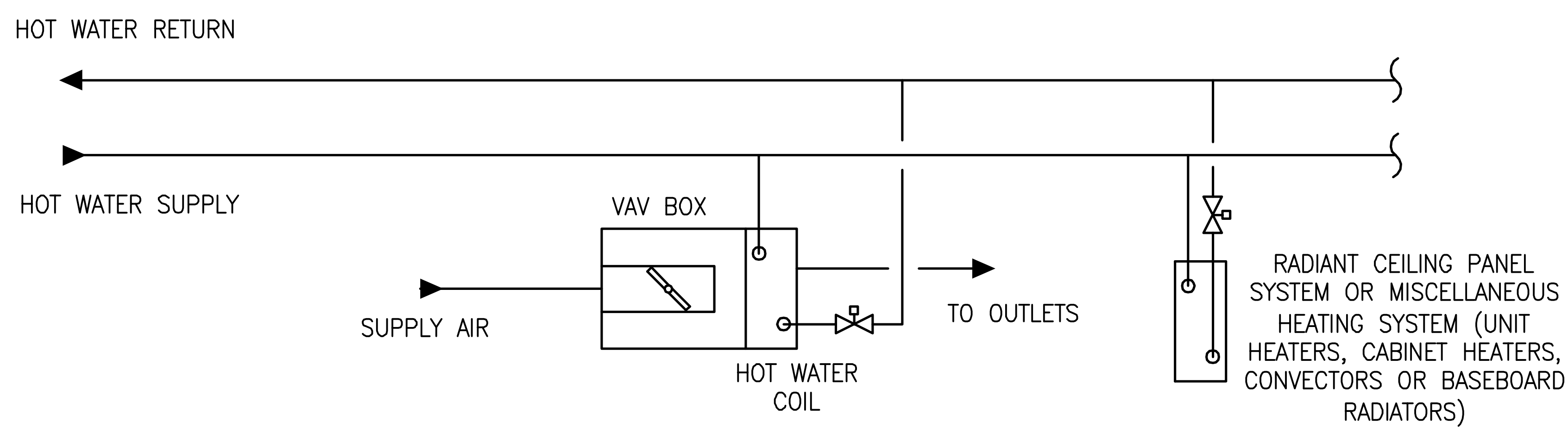
Provide a comprehensive point schedule for each system listing all analog and binary points, alarm requirements, and measurement needs.

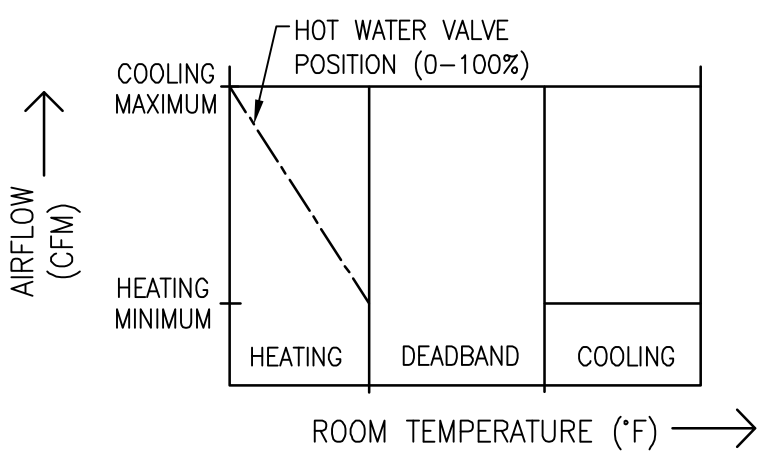
Examples:

- CFM
- GPM
- Static Pressure
- Pressure Differential

5.4.2.1 Sample List of Points

Sample lists of points for air handling units, chilled water and condenser water systems, heating and boiler systems, and miscellaneous systems are shown in Figures 5-5 through 5-8. The point lists are not all inclusive and do not include items such as software features describing the programming needs and capabilities. This list is meant to show the general format. The A/E shall include all features and project specific details, as required. All items shown in the point lists may not be applicable to each situation.





VAV BOX CONTROL SEQUENCE

CONTROL SEQUENCES

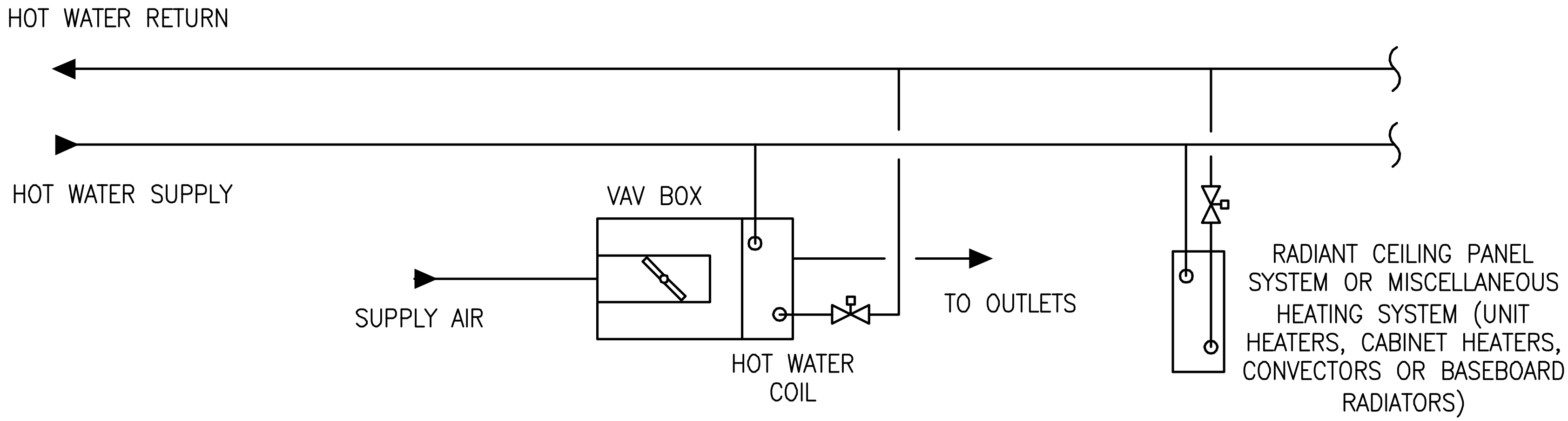
CASE 1: NO PERIMETER HEATING
A. HOT WATER VALVE ENABLED AT ALL TIMES.
B. HOT WATER VALVE OPENS IF ROOM TEMPERATURE IS LESS THAN SET POINT.

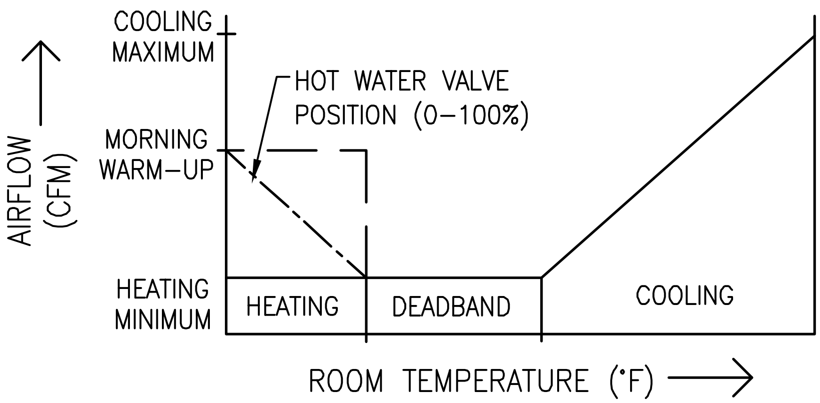
CASE 2: WITH RADIANT CEILING PANEL SYSTEM
A. RADIANT PANEL CONTROL VALVE ENABLED BELOW A SPECIFIED OUTSIDE AIR TEMPERATURE.
B. IF CV BOX HOT WATER VALVE IS 100% OPEN AND ROOM TEMPERATURE IS LESS THAN SETPOINT, RADIANT CEILING PANEL HOT WATER VALVE MODULATES OPEN TO MAINTAIN ROOM TEMPERATURE SET POINT.

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, WITH 5° DEADBAND

Not to Scale





VAV BOX CONTROL SEQUENCE

CONTROL SEQUENCES

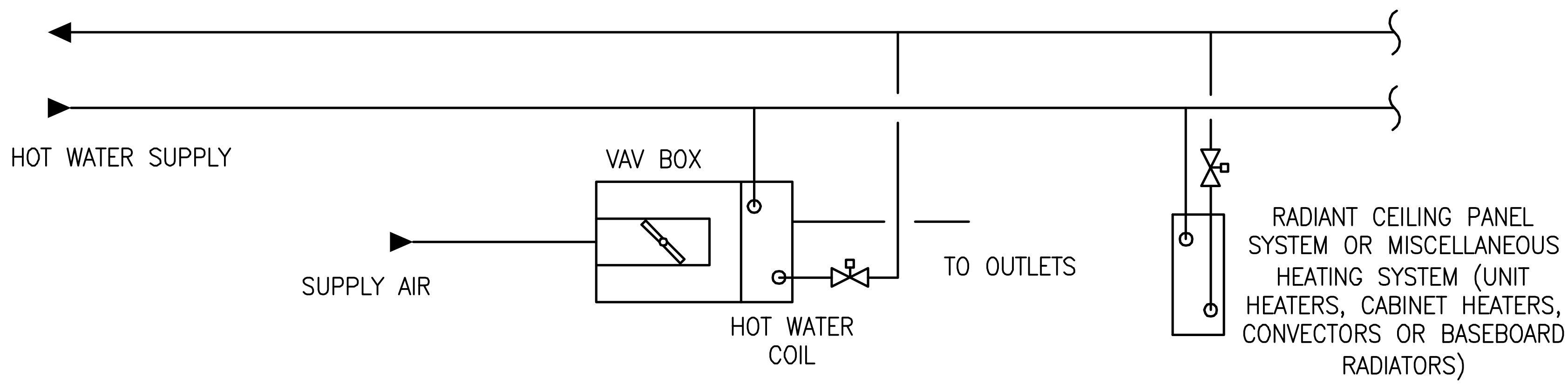
CASE 1: NO PERIMETER HEATING
- A. HOT WATER VALVE ENABLED AT ALL TIMES.
- B. HOT WATER VALVE OPENS IF ROOM TEMPERATURE IS LESS THAN LOWER DEADBAND LIMIT.

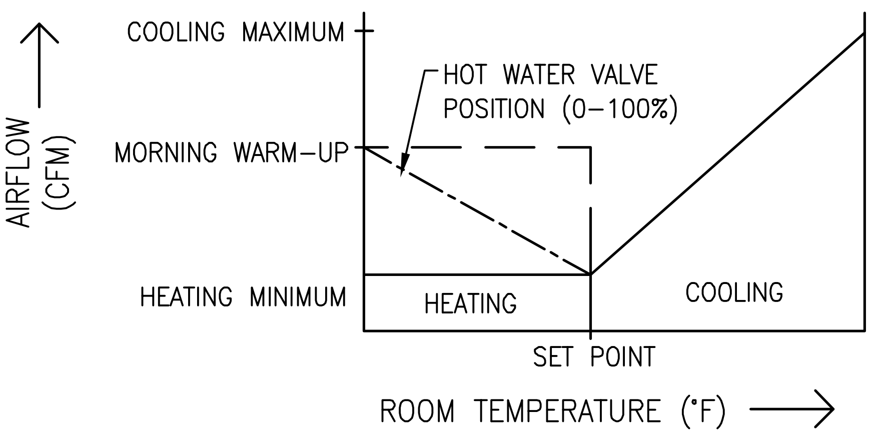
CASE 2: WITH RADIANT CEILING PANEL SYSTEM
- A. RADIANT PANEL CONTROL VALVE ENABLED BELOW A SPECIFIED OUTSIDE AIR TEMPERATURE.
- B. IF VAV BOX HOT WATER VALVE IS 100% OPEN AND ROOM TEMPERATURE IS LESS THAN SETPOINT, RADIANT CEILING PANEL HOT WATER VALVE MODULATES OPEN TO MAINTAIN ROOM TEMPERATURE SET 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, WITH 5° DEADBAND

Not to Scale





VAV BOX CONTROL SEQUENCE

CONTROL SEQUENCES

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- A. HOT WATER VALVE ENABLED AT ALL TIMES.
- B. HOT WATER VALVE OPENS IF ROOM TEMPERATURE IS LESS THAN LOWER DEADBAND LIMIT.

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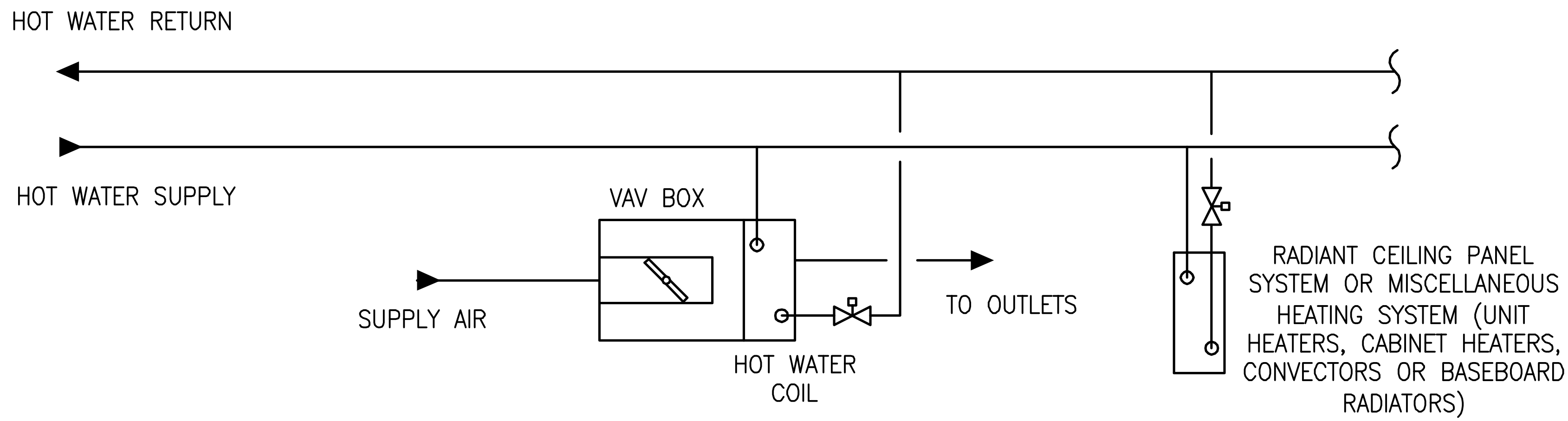
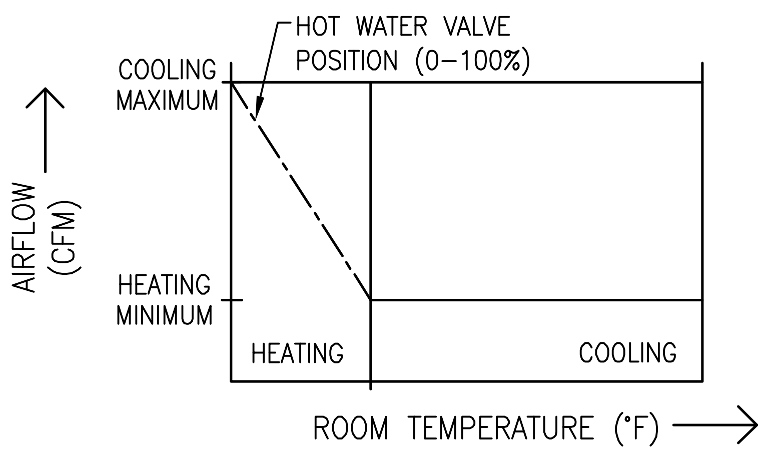
- B. IF VAV BOX HOT WATER VALVE IS 100% OPEN (AND RADIANT CEILING PANEL SYSTEM VALVE, IF INSTALLED) AND ROOM TEMPERATURE IS LESS THAN SETPOINT, MISCELLANEOUS HEATING HOT WATER VALVE MODULATES TO MAINTAIN ROOM TEMPERATURE.

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

Not to Scale





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.

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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, WITH 0° DEADBAND

Not to Scale

		System Outputs				System Inputs									System Software/Control					
		Binary		Analog		Binary		Analog							Alarm Processing			Application/Function		
System Component	Point ID	Electric	Pneumatic	Electric	Pneumatic	Status		Temperature	Pressure	Humidity	Flow	Current	Percent	Data	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 Temperature Humidity										X						X	X			
Space Temperature								X								X	X			
Space Humidity										X						X	X			
Pre-Filter Status						X									X					
After-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			Function	
System Component	Point ID	Electric	Pneumatic	Electric	Pneumatic	Status		Temperature	Pressure	Level	Flow	Current	pH	Data	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								
Cooling Tower Blow Down Flow											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														
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	Electric	Pneumatic	Electric	Pneumatic	Status		Temperature	Pressure	Differential Pressure	Level	Flow	Current	Data	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				
Start/Stop		X																X	X
Data														X					

HEATING SYSTEM OVERVIEW

		System Outputs				System Inputs									System Software/Control				
		Binary		Analog		Binary		Analog							Alarm Processing			Function	
System Component	Point ID	Electric	Pneumatic	Electric	Pneumatic	Status		Temperature	Pressure	Differential Pressure	Level	Flow	Current	Data	Equipment Status	Low Limit	High Limit	Lead/Lag	Start/Stop
Freezers and Refrigerators																			
Dietetics								X								X	X		
Laboratories								X								X	X		
Blood Bank								X								X	X		
Mortuary								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

CHAPTER 6: APPLICATIONS

Table of Contents

6.1 GENERAL

This chapter includes the HVAC design criteria for the air-handling units (AHU) and the design data for the individual rooms, henceforth referred to as the Room Data Sheets (RDS) in Appendices 6-A and 6-B. Appendix 6-A contains the dedicated AHUs and associated Room Data Sheets. Appendix 6-B contains the common room and associated Room Data Sheets.

6.2 AHU CLASSIFICATION

The air-handling units are classified as dedicated air-handling units and common (or non-dedicated) air-handling units.

6.2.1 DEDICATED AIR-HANDLING UNITS

6.2.1.1 General

Based on VA experience, dedicated AHUs are provided to serve each unique functional area. The dedicated air-handling units serve only that specific medical functions and/or departments to maintain their functional and operational integrity. Zoning of the occupied spaces should be such that two patently different functions cannot be combined together. For example, an air-handling unit cannot serve both the surgical suite and the nursing wing, due to their different needs. Each dedicated air-handling unit has design and operating characteristics that may or may not match those of other dedicated air-handling units. A specific design project may or may not include any or all dedicated air-handling units.

6.2.1.2 List of Dedicated Air-Handling Units

For the new and/or replacement hospitals and major renovations where each medical function or department is a full-fledged unit with all support spaces, the design shall include dedicated air-handling units to serve the following:

- Animal Research and Holding Areas
- Atrium
- Auditoriums and Theaters
- Autopsy Suite
- BMT (Bone Marrow Transplant) Suite
- Computer Room Air Conditioning Unit
- Dental Clinic
- Dining (Dietetics)
- Emergency Care Unit
- Gymnasium
- Intensive Care Units and Recovery Rooms
- Kitchen (Dietetics)
- Laboratories
- Laundry (Central)
- Imaging Series – MRI Unit
- Medical Media Service
- MRI Unit
- Nuclear Medicine Service
- Nursing Wing (Primary Unit)
- Pharmacy Service
- Radiology Suite
- Spinal Cord Injury Unit
- Standalone Smoking Facility

- Supply Process Distribution (SPD)
- Surgical Suite
- Telephone Equipment Room
- Waiting and Patient Admitting Areas

6.2.1.3 Appendix 6-A

In the attached Appendix 6-A, HVAC design characteristics and criteria for all dedicated air-handling units are given as the AHU Data Sheets followed by the Room Data Sheets (RDS) of the core functional areas associated with the respective air-handling units. Each room data sheet includes the HVAC design criteria and requirements at the room level.

6.2.1.4 Appendix 6-B

Appendix 6-A does not include common rooms (corridors, offices, storage spaces, etc.) and support rooms (toilets, locker rooms, janitor's closets, etc.) generally associated with many health care and patient support activities. While the room-level HVAC characteristics of the common rooms and support rooms will remain the same regardless of their AHU affiliations, the minimum outside air and exhaust air requirements shall be based on the serving AHU.

Appendix 6-B includes the room data sheets of all such rooms and miscellaneous facility support rooms (elevator machine rooms, electrical rooms, mechanical rooms, etc.). All spaces in Appendix 6-B are arranged alphabetically.

6.2.2 COMMON (NON-DEDICATED) AIR-HANDLING UNITS

6.2.2.1 General

(a) The common or non-dedicated air-handling units are selected to serve the patient care spaces and functions not covered by the dedicated air-handling units. Such areas are generally found in the clinical additions, ambulatory care units, satellite or community based clinics, and special procedure and/or treatment rooms.

(b) The common or non-dedicated air-handling units can also serve the specialty rooms included in Appendix 6-A, provided the project-specific scope of work includes only a few such rooms and not the full-fledged functional department.

(c) While zoning the common or non-dedicated air-handling units, care must be taken to ensure that the functional integrity of the spaces is not compromised.

6.2.2.2 AHU Selection Criteria

Selection and design of a single air-handling unit or multiple common (non-dedicated) air-handling units shall be based on the following criteria:

(a) Project scope and size

(b) Space layout

(c) Capacity limitations of a single AHU (see Chapter 2)

(d) Matching (or differing) selection requirements, such as:

- Hours of Operation (24-hours or daytime only)
- Ventilation Air Volume - Outside Air (100% or minimum)
- Filtration Arrangement and Selection Criteria (MERV values)
- Supply Air Volume (Constant or Variable)
- Interlocked Exhaust (General or Special System)
- Inside Design Conditions (Temperature and Relative Humidity)
- Heat Recovery (Yes or No)

APPENDIX 6-A: DEDICATED AIR HANDLING UNITS

ANIMAL RESEARCH AND HOLDING AREAS – AIR HANDLING UNIT

AHU Data Sheet	
Air Handling Unit Type	● CV ● **Note 1** ● **Note 2**
Inside Design Conditions	Room Data Sheets
Minimum Outside Air	100%
Minimum Supply Air Changes per Hour	Room Data Sheets
Return Air	Not Permitted
Economizer Cycle	Not Applicable
Room Noise Level	Room Data Sheet
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade D
Cooling Source	● Provide a dedicated chiller to serve the Animal Research and Holding Facility. ● Provide cross-connections with the central chilled water plant for emergency backup.
Heating Source	● Use high pressure steam from the central boiler plant as the primary source for generating heating hot water and producing “clean steam” for winter humidification. ● Use medium pressure steam from the central boiler plant for unit mounted pre-heat coils.
General Exhaust System(s)	Provide a general exhaust system for the spaces not covered by the special exhaust systems.
Special Exhaust System(s)	For fume hoods and Biological Safety Cabinets (BSC), provide special exhaust systems as outlined in Chapter 3.
Heat Recovery System	Per ASHRAE Standard 90.1 – 2007, evaluate the use of a heat recovery system to transfer energy between the exhaust and incoming outside air streams.
Emergency Power	Required for the complete HVAC system serving the Animal Research Facility, including DDC controls
Additional Energy Conservation Measures	To meet the mandated goal of 30% additional energy conservation above ASHRAE 90.1 – 2004, evaluate the use of a desiccant dehumidification system to reduce the dew-point temperature of the incoming outside air.

ANIMAL RESEARCH AND HOLDING AREAS – AIR HANDLING UNIT

Note 1: Provide central humidifier at the unit to maintain 50 F [10 C] dew-point. Provide terminal humidifiers where indicated in the Room Data Sheets.

Note 2: Incorporate the following special features in the design of the HVAC systems:

(a) Automatic Control Valves: Ensure that the automatic control valves serving the unit-mounted preheat and reheat coils and the terminal reheat coils are selected to close in fail-safe position, that is, assume normally closed position. This vital safety issue must be incorporated in the design. Past experience has shown that the inadequacy of the control system has created serious consequences to the well-being of the animals due to the possibility of overheating. With normally closed control valves, ways and means shall be included in the design to prevent the possibility of the coil(s) freezing. Additionally, provisions shall be made to prevent hot, humid air from entering the space. Chiller valve shall fail open. Provide high and low limits for the supply air fan to de-energize when the supply air temperature is above 65 F [18.3 C] and below 45 F [7.2 C].

(b) Acoustics: Animals are susceptible to low-frequency rambling noise. HVAC design shall address this sensitivity issue and include necessary measures, including the use of acoustic blankets or tiles to prevent noise transmission through floors or between cage washing and animal housing areas.

(c) Alarms: Provide a temperature and humidity sensor in each animal holding room, surgery room, laboratory, and any additional areas identified by the VA Authorities. Provide local alarm and remote alarm at ECC in the event space temperature and/or relative humidity exceeds high and low set points. One centrally located visible type (rotating red light) alarm shall be provided. ***Local alarm shall be visible type only since audible alarms disturb the animals.***

Provide a redundant temperature sensing system to shut down supply air in case the primary temperature alarm system fails. Primary alarm failures have been the cause of multiple overheating tragedies in animal facilities.

ANIMAL RESEARCH AND HOLDING AREAS – ROOM DATA SHEETS

Animal Holding Areas – Room Data Sheet	
Inside Design Conditions	● Cooling 65 F [18.3 C] Dry-Bulb Temperature 50% Relative Humidity ● Heating 85 F [29.4 C] Dry-Bulb Temperature 50% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	15
Return Air	Not Permitted
Exhaust Air	● 100% ● **Note 2** ● **Note 3**
Room Noise Level	NC 35
Individual Room Temperature Control	Required
Room Air Balance	Negative (-)

Note 1: Provide terminal humidifier.

Note 2: Provide a special exhaust system for the animal holding areas. Discharge air at the highest level above the roof.

Note 3: Collect exhaust air 7 inches [175 mm] above the floor level. Exhaust grilles shall be equipped with 2 inch [50 mm] thick VA Grade A filters, and allow easy replacement of filters without the need to unscrew the grille from the duct assembly.

ANIMAL RESEARCH AND HOLDING AREAS – ROOM DATA SHEETS

Animal Operating Room – Room Data Sheet	
Inside Design Conditions	● Cooling 65 F [18.3 C] Dry-Bulb Temperature 50% Relative Humidity ● Heating 85 F [29.4 C] Dry-Bulb Temperature 50% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	15
Return Air	Not Permitted
Exhaust Air	● 100% ● **Note 2**
Room Noise Level	NC 35
Individual Room Temperature Control	Required
Room Air Balance	Positive (+)

Note 1: Provide terminal humidifier.

Note 2: Provide a special exhaust system for the surgical suite and associated treatment areas. Incorporate the following in the exhaust system design:

(a) Provide welded stainless steel ductwork.

(b) Maintain entire ductwork under negative air pressure.

(c) Exhaust air shall pass through a set of pre-filters – VA Grade A and after-filters HEPA filter – VA Grade E. Locate filters closest to the fan intake connection.

(d) Provide an airflow control valve (AFCV) to measure and set air volume under varying static pressure drop through the filters. Locate AFCV downstream of filters.

(e) Discharge exhaust air 10 Feet [3.0 Meters] above the highest building point at 3,500 Feet/Minute [17.8 Meters/Second] discharge velocity.

(f) Provide local (visible) and remote alarm at the ECC control system to indicate system and air balance disruption.

ANIMAL RESEARCH AND HOLDING AREAS – ROOM DATA SHEETS

Animal Receiving – Room Data Sheet	
Inside Design Conditions	● Cooling 65 F [18.3 C] Dry-Bulb Temperature 50% Relative Humidity ● Heating 85 F [29.4 C] Dry-Bulb Temperature 50% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	15
Return Air	Not Permitted
Exhaust Air	● 100% ● **Note 2**
Room Noise Level	NC 40
Individual Room Temperature Control	Required
Room Air Balance	Negative (-)
Note 1: Provide terminal humidifier. **Note 2:** Connect room exhaust to the general exhaust system.	

Animal Room With Ventilated Caging Exhausting Directly Out of the Room – Room Data Sheet	
Inside Design Conditions	● Cooling 65 F [18.3 C] Dry-Bulb Temperature 50% Relative Humidity ● Heating 85 F [29.4 C] Dry-Bulb Temperature 50% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	15
Return Air	Not Permitted
Exhaust Air	● 100% ● **Note 2**
Room Noise Level	NC 35
Individual Room Temperature Control	Required
Room Air Balance	Positive (+)
Note 1: Provide terminal humidifier. **Note 2:** Connect exhaust lines from ventilated racks to (a) independent exhaust system to allow consistent differential pressure in concert with room exhaust, or (b) room exhaust and provide controls to automatically maintain negative relative pressure to hallway. If ventilated caging includes its own exhaust fans, this may be considered in the room change calculations. ***Some racks rely completely upon the exhaust ducting and do not have their own exhaust fans.***	

ANIMAL RESEARCH AND HOLDING AREAS – ROOM DATA SHEETS

Carcass and Wastage – Room Data Sheet	
Inside Design Conditions	● Cooling 65 F [18.3 C] Dry-Bulb Temperature 50% Relative Humidity ● Heating 70 F [21 C] Dry-Bulb Temperature 50% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	10
Return Air	Not Permitted
Exhaust Air	● 100% ● **Note 2**
Room Noise Level	NC 40
Individual Room Temperature Control	Required
Room Air Balance	● Double Negative (- -) ● **Note 3**
Note 1: Provide terminal humidifier. **Note 2:** Connect room exhaust to the general exhaust system. **Note 3:** Admit at least three air changes per hour as make-up air from the adjoining spaces.	

Clean Cage Storage – Room Data Sheet	
Inside Design Conditions	● Cooling 65 F [18.3 C] Dry-Bulb Temperature 50% Relative Humidity ● Heating 70 F [21 C] Dry-Bulb Temperature 50% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	10
Return Air	Not Permitted
Exhaust Air	● 100% ● **Note 2**
Room Noise Level	NC 40
Individual Room Temperature Control	Required
Room Air Balance	Positive (+)
Note 1: Provide terminal humidifier. **Note 2:** Connect exhaust to the general exhaust system.	

ANIMAL RESEARCH AND HOLDING AREAS – ROOM DATA SHEETS

Containment Spaces – Room Data Sheet	
Inside Design Conditions	● Cooling 65 F [18.3 C] Dry-Bulb Temperature 50% Relative Humidity ● Heating 75 F [24 C] Dry-Bulb Temperature 50% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	15
Return Air	Not Permitted
Exhaust Air	● 100% ● **Note 2**
Room Noise Level	NC 40
Individual Room Temperature Control	Required
Room Air Balance	Negative (-)

Note 1: Provide terminal humidifier.

Note 2: Connect exhaust to the special exhaust system, for the surgical suite, described in the Animal Operating Room Data Sheet.

Corridors – Room Data Sheet	
Inside Design Conditions	● Cooling 65 F [18.3 C] Dry-Bulb Temperature 50% Relative Humidity ● Heating 70 F [21 C] Dry-Bulb Temperature 45% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	6
Return Air	Not Permitted
Exhaust Air	● 100% ● **Note 2**
Room Noise Level	NC 40
Individual Room Temperature Control	Required
Room Air Balance	Positive (+)

Note 1: Provide terminal humidifier.

Note 2: Air supplied to the corridors is generally used as make-up air to maintain the intended air balance. Adjust supply air volume as required to meet this objective. Where not used as make-up air, connect corridor air to the general exhaust system.

ANIMAL RESEARCH AND HOLDING AREAS – ROOM DATA SHEETS

Dirty Cage Washer – Room Data Sheet	
Inside Design Conditions	● Cooling 65 F [18.3 C] Dry-Bulb Temperature 50% Relative Humidity ● Heating 70 F [21 C] Dry-Bulb Temperature 50% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	15
Return Air	Not Permitted
Exhaust Air	● 100% ● **Note 2**
Room Noise Level	NC 40
Individual Room Temperature Control	Required
Room Air Balance	Double Negative (- -)

Note 1: Provide terminal humidifier.

Note 2:

(a) Provide a special, wet exhaust system for the dirty cage-washer. Provide welded stainless steel ductwork, pitch the horizontal ducts, and provide drain at the low points to prevent condensate backwash into the washer.

(b) Wet exhaust can be collected through the Type A canopy hood or through the cage washer when the cage washer is in operation. Collect wet exhaust through the cage washer by installing a motorized damper in each duct. Coordinate exhaust air volume and air pressure drop through the washer with the equipment manufacturer. Provide airflow control valves to maintain exhaust airflows through each path.

(c) Provide several hookups to exhaust ductwork for attachment of dirty bedding dump stations. This is a safety feature to reduce exposure of personnel to gaseous pollutants and allergens in the room.

ANIMAL RESEARCH AND HOLDING AREAS – ROOM DATA SHEETS

Feed and Bed Storage – Room Data Sheet	
Inside Design Conditions	● Cooling 65 F [18.3 C] Dry-Bulb Temperature 50% Relative Humidity ● Heating 70 F [21 C] Dry-Bulb Temperature 50% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	10
Return Air	Not Permitted
Exhaust Air	● 100% ● **Note 2**
Room Noise Level	NC 40
Individual Room Temperature Control	Required
Room Air Balance	Positive (+)
Note 1: Provide terminal humidifier. **Note 2:** Connect room exhaust to the general exhaust system.	

Laboratories – Room Data Sheet	
Inside Design Conditions	● Cooling 65 F [18.3 C] Dry-Bulb Temperature 55% Relative Humidity ● Heating 85 F [29.4 C] Dry-Bulb Temperature 50% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	15
Return Air	Not Permitted
Exhaust Air	● 100% ● **Note 2**
Room Noise Level	NC 40
Individual Room Temperature Control	Required
Room Air Balance	Negative (-)
Note 1: Provide terminal humidifier. **Note 2:** Connect exhaust to the special exhaust system, for the surgical suite, described in the Animal Operating Room Data Sheet.	

ANIMAL RESEARCH AND HOLDING AREAS – ROOM DATA SHEETS

Necropsy – Room Data Sheet	
Inside Design Conditions	● Cooling 65 F [18.3 C] Dry-Bulb Temperature 55% Relative Humidity ● Heating 85 F [29.4 C] Dry-Bulb Temperature 50% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	15
Return Air	Not Permitted
Exhaust Air	● 100% ● **Note 2**
Room Noise Level	NC 40
Individual Room Temperature Control	Required
Room Air Balance	Negative (-)
Note 1: Provide terminal humidifier. **Note 2:** Connect exhaust to the special exhaust system for the surgical suite, as described in the Animal Operating Room Data Sheet.	

Recovery Room – Room Data Sheet	
Inside Design Conditions	● Cooling 65 F [18.3 C] Dry-Bulb Temperature 55% Relative Humidity ● Heating 85 F [29.4 C] Dry-Bulb Temperature 50% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	15
Return Air	Not Permitted
Exhaust Air	● 100% ● **Note 2**
Room Noise Level	NC 35
Individual Room Temperature Control	Required
Room Air Balance	Positive (+)
Note 1: Provide terminal humidifier. **Note 2:** Connect exhaust to the special exhaust system for the surgical suite, as described in the Animal Operating Room Data Sheet.	

ATRIUM – AIR HANDLING UNIT

AHU Data Sheet and Room Data Sheet	
Air Handling Unit Type	● CV or VAV ● **Note 1**
Inside Design Conditions	● Cooling 75 F [24 C] Dry-Bulb Temperature 50% Relative Humidity ● Heating 70 F [21 C] Dry-Bulb Temperature 30% Relative Humidity
Minimum Outside Air	● Normal Mode – Chapter 2 ● Smoke Evacuation Mode – 100%
Minimum Supply Air Changes per Hour	4 – in the occupied zone
Return Air	● Normal Mode – Permitted ● Smoke Evacuation Mode – 100% Exhaust
Economizer Cycle	● Normal Mode – ASHRAE Standard 90.1 – 2007 ● Smoke Evacuation Mode – 100% Outside Air
Room Noise Level	NC 40
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade B
Cooling Source	Chilled water from the central chilled water plant
Heating Source	● Use high pressure steam from the central boiler plant as the primary source for generating heating hot water and producing “clean steam” for winter humidification. ● Use medium pressure steam from the central boiler plant for unit mounted pre-heat coils.
General Exhaust System(s)	● Provide an engineered smoke-evacuation exhaust system. ● **Note 2**
Special Exhaust System(s)	Not Required
Heat Recovery System	Not Required
Emergency Power	Required
Individual Room Temperature Control	Required
Room Air Balance	● Normal Mode – Neutral (0) ● Smoke Evacuation Mode – Negative (-)

ATRIUM – AIR HANDLING UNIT

AHU Data Sheet and Room Data Sheet
Note 1: Closed atriums are used for dining/cafeteria and multipurpose applications that require a conventional, dedicated air-handling unit with minimum outside air and comfort conditions. **Note 2:** **(a) Emergency Smoke Evacuation Mode:** Estimate required exhaust air volume to remove smoke from the atrium space. Ensure compliance with the applicable section of the NFPA and/or UBC. A registered fire protection engineer shall affix seal to the calculations to be reviewed and approved by VA Authorities. **(b)** Provide a make-up air unit with fan, filters, and coil sections in the event that the required exhaust air volume is greater than the capacity of the dedicated air-handling unit. Use of make-up air from the adjoining HVAC systems shall be avoided to prevent any possibility of contamination. Heating section, required for locations with winter ambient air temperature below 41 F [5 C], shall be sized to deliver air at 55 F [12.8 C]. **(c)** Coordinate automatic activation of the smoke evacuation system with the fire protection design. Provide capability for manual activation as well. **(d)** During smoke evacuation mode, the dedicated air-handling unit shall operate in 100% outside air mode with appropriate damper actions. Ensure freeze protection for the heating coil. Size the coil to deliver air at 55 F [12.8 C]. Cooling coil need not be sized to handle 100% outside air.

AUDITORIUMS AND THEATERS – AIR HANDLING UNIT

AHU Data Sheet and Room Data Sheet	
Air Handling Unit Type	● CV or VAV ● **Note 1**
Inside Design Conditions	● Cooling 75 F [24 C] Dry-Bulb Temperature 50% Relative Humidity ● Heating 70 F [21 C] Dry-Bulb Temperature 30% Relative Humidity
Minimum Outside Air	Chapter 2
Minimum Supply Air Changes per Hour	6
Return Air	Required
Economizer Cycle	ASHRAE 90.1 – 2007
Room Noise Level	NC 35
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade C
Cooling Source	Chilled water from the central chilled water plant
Heating Source	● Use high-pressure steam from the central boiler plant as the primary source for generating heating hot water and producing “clean steam” for winter humidification. ● Use medium pressure steam from the central boiler plant for the unit-mounted preheat coils.
General Exhaust System(s)	Optional, required if connected with spaces requiring exhaust
Special Exhaust System(s)	Not Required
Heat Recovery System	Not Required
Emergency Power	Not Required
Individual Room Temperature Control	Required
Room Air Balance	Positive (+)

Note 1: Evaluate and incorporate as feasible, the following features in the system design:

(a) Provide CO_2-actuated, demand-controlled ventilation. During start-up, admit only 7.5% outside air. Modulate minimum outside air damper to the design value when auditoriums are occupied and the CO_2 concentration rises above 400 PPM. Provide an airflow-measuring device with the minimum outside air damper and CO_2 sensor in the return air duct. Ensure accuracy of the airflow-measuring device at low air volumes.

(b) Provide high-humidity control for the summer cooling mode to limit the relative humidity to 60%.

(c) Provide individual room temperature control for spaces such as the stage, projector room, and entrance lobby.

(d) Maintain positive air balance with respect to the adjoining lobby and support areas.

AUTOPSY SUITE – AIR HANDLING UNIT

AHU Data Sheet	
Air Handling Unit Type	● CV ● **Note 1**
Inside Design Conditions	Room Data Sheets
Minimum Outside Air	100%
Minimum Supply Air Changes per Hour	Room Data Sheets
Return Air	Not Permitted
Economizer Cycle	Not Applicable
Room Noise Level	● NC 35 ● **Note 2**
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade C
Cooling Source	Chilled water from the central chilled water plant
Heating Source	● Use high pressure steam from the central boiler plant as the primary source for generating heating hot water and producing “clean steam” for winter humidification. ● Use medium pressure steam from the central boiler plant for unit mounted pre-heat coils.
General Exhaust System(s)	Room Data Sheets
Special Exhaust System(s)	Room Data Sheet
Heat Recovery System	Not permitted from the exhaust air stream
Emergency Power	Required for the entire HVAC system serving the Autopsy Suite, including DDC controls
Additional Energy Conservation Measures	To meet the mandated goal of 30% additional energy conservation above ASHRAE 90.1 – 2004, evaluate the use of desiccant dehumidification system to reduce the dew-point temperature of the incoming outside air.

Note 1: Autopsy Suite may not require a dedicated air-handling unit, if located close to laboratories also served by 100% outside air. Autopsy Suite requires 100% exhaust air to ensure odor control. Autopsy suite may remain in operation beyond normal working hours.

Note 2: Noise level lower than NC 35 is required, when audio/video recording is performed in the autopsy room.

AUTOPSY SUITE – ROOM DATA SHEETS

Main Autopsy Room – Room Data Sheet	
Inside Design Conditions	● Cooling 65 F [18.3 C] Dry-Bulb Temperature 60% Relative Humidity ● Heating 65 F [18.3 C] 40% Relative Humidity
Minimum Supply Air Changes per Hour	15
Return Air	Not Permitted
Exhaust Air	● 100% ● **Notes 1 and 2**
Room Noise Level	NC 40
Individual Room Temperature Control	Required
Room Air Balance	Double Negative (- -)

Note 1: Provide a special exhaust system for the autopsy suite with the following features:

(a) Provide welded stainless steel ductwork.

(b) Maintain entire ductwork under negative air pressure.

(c) Allow exhaust air to pass through a set of pre-filters – VA Grade A and after-filters HEPA – VA Grade E. Locate filters closest to the fan intake connection.

(d) Provide an airflow control valve (AFCV) to measure and set air volume under varying static pressure drop through the filters. Locate AFCV downstream of filters.

(e) Discharge exhaust air 10 Feet [3.0 Meters] above the highest building point at 3,500 Feet/Minute [17.8 Meters/Second] discharge velocity.

(f) Provide local (audible and visible) alarms and remote alarm at ECC to indicate system and air balance disruptions.

Note 2:

(a) Air distribution layout shall create directional airflow required to maintain negative air balance. Provide exhaust air collection at the ceiling and floor levels.

(b) Coordinate any additional exhaust needs with the autopsy table manufacturer.

(c) Collect exhaust over the sink counter area from the Gross Specimen Storage Room Mortuary Refrigerator. Exhaust 50 CFM [24 Liters/Second] from the mortuary refrigerator when the light is on. Provide a motorized damper (on/off type) in the exhaust air intake duct with an interlock to the room light.

AUTOPSY SUITE – ROOM DATA SHEETS

Support Areas (Circulation, Etc.) – Room Data Sheet	
Inside Design Conditions	● Cooling 75 F [24 C] Dry-Bulb Temperature 50% Relative Humidity ● Heating 70 F [21 C] Dry-Bulb Temperature 35% Relative Humidity
Minimum Supply Air Changes per Hour	8
Return Air	Not Permitted
Exhaust Air	● 100% ● **Note 1**
Room Noise Level	NC 40
Individual Room Temperature Control	Required
Room Air Balance	Double Negative (- -)
Note 1: Connect exhaust to the general exhaust system.	

BMT (BONE MARROW TRANSPLANT) SUITE – AIR HANDLING UNIT

AHU Data Sheet	
Air Handling Unit Type	● CV ● **Note 1**
Inside Design Conditions	Room Data Sheets
Minimum Outside Air	100%
Minimum Supply Air Changes per Hour	Room Data Sheets
Return Air	Not Permitted
Economizer Cycle	Not Applicable
Room Noise Level	Room Data Sheets
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade C ● Final-Filters – VA Grade E ● **Note 2**
Cooling Source	Chilled water from the central chilled water plant
Heating Source	● Use high-pressure steam from the central boiler plant as the primary source for generating heating hot water and producing “clean steam” for winter humidification. ● Use medium pressure steam from the central boiler plant for the unit-mounted preheat coils.
General Exhaust System(s)	100%
Special Exhaust System(s)	Not Required
Heat Recovery System	Per ASHRAE Standard 90.1 – 2007, evaluate the use of a heat recovery system to transfer energy between the exhaust and incoming outside air streams.
Emergency Power	Required for HVAC equipment and controls
Additional Energy Conservation Measures	To meet the mandated goal of 30% additional energy conservation above ASHRAE 90.1 – 2004, evaluate the use of a desiccant dehumidification system to reduce the dew-point temperature of the incoming outside air.

BMT (BONE MARROW TRANSPLANT) SUITE – AIR HANDLING UNIT

AHU Data Sheet

Note 1: A dedicated air-handling unit is required only when all BMT spaces are grouped together as a full-fledged department. BMT functions can also be found in special clinics or in an ambulatory department or clinical addition. BMT with limited size and scope can be grouped together with other similar functions and served by an air-handling unit other than a dedicated unit, provided that all innate HVAC requirements are not compromised.

Note 2:

(a) Locate the final filters (third bed) on the downstream side of the individual air terminal units serving the following rooms:

- Patient Areas
- Donor Rooms
- Recovery Rooms
- Medicine Preparation Rooms

(b) Terminal filters are not required for the support functions (Lounge, Nurse's Station, Circulation Spaces, and Conference Rooms, etc.).

(c) Oversize the terminal HEPA filters to reduce the system static pressure drop.

(d) Provide a variable speed drive for the supply air fan to ensure constant air delivery under varying resistance due to filter loading. Provide appropriate DDC control devices to operate the variable speed drive.

BMT (BONE MARROW TRANSPLANT) SUITE – ROOM DATA SHEETS

Room Data Sheets

- **Patient Rooms**
- **Donors Room**
- **Recovery Rooms**
- **Medication Preparation Room**

Inside Design Conditions	● Year Around Conditions: 70 F to 75 F [21 C to 24 C] 30% to 50% (Uncontrolled) ● **Note 1**
Minimum Supply Air Changes per Hour	8
Return Air	Not Permitted
Exhaust Air	100%
Room Noise Level	NC 35
Individual Room Temperature Control	Required
Room Air Balance	● Double Positive (+ +) ● **Note 2**

Note 1: The HVAC system shall be sized and selected to maintain any room temperature within the specified range. Cooling load calculations shall be based on 70 F [21 C] and 50% relative humidity. Heating load calculations shall be based on 75 F [24 C] and 30% relative humidity.

Note 2: Design air distribution system to maintain positive air pressure. Coordinate provision of anteroom with architectural discipline. Provide volumetric controls to demonstrate the air volume difference.

COMPUTER ROOM AIR-CONDITIONING UNITS (EQUIPMENT COOLING ONLY)

AHU Data Sheet and Room Data Sheet	
Air Handling Unit Type	● CV ● **Note 1**
Inside Design Conditions	● 64 F [17.8 C] to 75 F [24 C] Dry-Bulb Temperature ● 30 to 55% Relative Humidity
Minimum Outside Air	Not Required
Minimum Supply Air Changes per Hour	Coordinate unit capacity with the equipment load
Return Air	100%
Economizer Cycle	Not Applicable
Filtration	As furnished with the computer room air conditioning units
Cooling Source	Chilled water from the central chilled water plant or dedicated chiller or DX units
Heating Source	Hot water using steam from the central boiler plant
General Exhaust System(s)	Not Required
Special Exhaust System(s)	Not Required
Heat Recovery System	Not Applicable
Emergency Power	Required
Individual Room Temperature Control	Required
Room Air Balance	Positive (+)

Note 1:

(a) Provide multiple freestanding air conditioning units, also designated as CRACs (Computer Room Air Conditioning Units), specifically designed for the computer room. Provide N+1 units, where N = Number of units in operation and 1 unit is standby.

(b) Coordinate air distribution system with the raised floor.

(c) Provide reheat and humidification for each computer room air conditioning unit.

(d) Coordinate make-up water for humidification and cooling coil condensate drain line and trap with the plumbing discipline.

(e) Provide an automatic leak detection system for the under-floor space. Provide a local audible and remote alarm at the ECC in the event the under floor humidity rises above 65%. Provide interface between the CRAC units and the central DDC system.

(f) Admit conditioned air from the adjoining environmental AHU as the minimum outside air. For large installations, a dedicated make-up air unit may be required.

DENTAL CLINIC – AIR HANDLING UNIT

AHU Data Sheet	
Air Handling Unit Type	CV
Inside Design Conditions	Room Data Sheets
Minimum Outside Air	Chapter 2
Minimum Supply Air Changes per Hour	Room Data Sheets
Return Air	Required
Economizer Cycle	ASHRAE 90.1 – 2007
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade C
Cooling Source	Chilled water from the central chilled water plant
Heating Source	● Use high pressure steam from the central boiler plant as the primary source for generating heating hot water and producing “clean steam” for winter humidification. ● Use medium pressure steam from the central boiler plant for unit mounted pre-heat coils.
General Exhaust System(s)	Required
Special Exhaust System(s)	Not Required
Heat Recovery System	Not Required
Emergency Power	Not Required

DENTAL CLINIC – ROOM DATA SHEETS

Ceramic Room – Room Data Sheet	
Inside Design Conditions	● Cooling 75 F [24 C] Dry-Bulb Temperature 50% Relative Humidity ● Heating 70 F [21 C] Dry-Bulb Temperature 30% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	6
Return Air	● Not Permitted ● **Note 2**
Exhaust Air	Required
Room Noise Level	NC 40
Individual Room Temperature Control	Required
Room Air Balance	Negative (-)
Note 1: Coordinate internal heat gain with the equipment supplier. **Note 2:** Locate exhaust air registers at or near the technicians' workbenches. Coordinate locations with the architectural discipline.	

Dental Treatment Operatory	
Inside Design Conditions	● Year Around Conditions: 70 F [21 C] to 75 F [24 C] Dry-Bulb Temperature 30% to 50% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	6
Return Air	Not Permitted
Exhaust Air	100%
Room Noise Level	NC 40
Individual Room Temperature Control	Required
Room Air Balance	Positive (+)
Note 1: The HVAC system shall be sized and selected to maintain any room temperature within the specified range. Cooling load calculations shall be based on 70 F [21 C] and 50% relative humidity. Heating load calculations shall be based on 75 F [24 C] and 30% relative humidity.	

DENTAL CLINIC – ROOM DATA SHEETS

General Laboratory	
Inside Design Conditions	● Cooling 75 F [24 C] Dry-Bulb Temperature 50% Relative Humidity ● Heating 70 F [21 C] Dry-Bulb Temperature 30% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	12
Return Air	Not Permitted
Exhaust Air	● 100% ● **Note 2**
Room Noise Level	NC 40
Individual Room Temperature Control	Required
Room Air Balance	Negative (-)

Note 1: Coordinate internal heat gain with the equipment supplier.

Note 2: Coordinate the exhaust requirements for the prosthetic dental laboratories with the locations of the wall registers and canopy hood – if any.

Oral Surgery Recovery Room	
Inside Design Conditions	● Year Around Conditions 70 F [21 C] to 75 F [24 C] Dry-Bulb Temperature 30% to 50% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	8
Return Air	Not Permitted
Exhaust Air	100%
Room Noise Level	35
Individual Room Temperature Control	Required
Room Air Balance	Positive (+)

Note 1: The HVAC system shall be sized and selected to maintain any room temperature within the specified range. Cooling load calculations shall be based on 70 F [21 C] and 50% relative humidity. Heating load calculations shall be based on 75 F [24 C] and 30% relative humidity.

DENTAL CLINIC – ROOM DATA SHEETS

Oral Surgery Room	
Inside Design Conditions	● Year Around Conditions 70 F [21 C] to 75 F [24 C] Dry-Bulb Temperature 30% to 50% Relative Humidity ● **Notes 1 and 2**
Minimum Supply Air Changes per Hour	8
Return Air	Not Permitted
Exhaust Air	100%
Room Noise Level	35
Individual Room Temperature Control	Required
Room Air Balance	Positive (+)
Note 1: The HVAC system shall be sized and selected to maintain any room temperature within the specified range. Cooling load calculations shall be based on 70 F [21 C] and 50% relative humidity. Heating load calculations shall be based on 75 F [24 C] and 30% relative humidity. **Note 2:** Coordinate internal heat gain with the equipment supplier.	

DINING AREAS (DIETETICS) – AIR HANDLING UNIT

AHU Data Sheet and Room Data Sheet	
Air Handling Unit Type	VAV
Inside Design Conditions	● Cooling 75 F [24 C] Dry-Bulb Temperature 55% Relative Humidity Heating ● 70 F [21 C] Dry-Bulb Temperature 30% Relative Humidity ● 5 F [2.8 C] Dead-Band
Minimum Outside Air	● Chapter 2 ● **Note 1**
Minimum Supply Air Changes per Hour	6
Return Air	Permitted
Economizer Cycle	ASHRAE Standard 90.1-2007
Room Noise Level	NC 40
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade C
Cooling Source	Chilled water from the central chilled water plant
Heating Source	● Use high-pressure steam from the central boiler plant as the primary source for generating heating hot water and producing “clean steam” for winter humidification. ● Use medium pressure steam from the central boiler plant for the unit-mounted preheat coils.
General Exhaust System(s)	**Note 2**
Special Exhaust System(s)	**Note 2**
Heat Recovery System	Not Required
Emergency Power	Not Required
Individual Room Temperature Control	Required
Room Air Balance	● Negative (-) with respect to adjoining spaces ● Positive (+) with respect to the kitchen

Note 1: Estimate the make-up air requirement of the adjoining kitchen (if any) and adjust the minimum outside air volume accordingly.

Note 2: If a Dining Hall or Cafeteria is located next to the kitchen, a special exhaust system may not be required, as the room air can be transferred to the kitchen as make-up air for exhaust. With a standalone dining or cafeteria facility, provide a general exhaust system for the dining room. Collect exhaust air over a warmer located in the dining or kitchen through an integral or field-fabricated hood. Coordinate with the kitchen drawings, consultant, and equipment vendor to determine if there is a need for any additional exhaust within the dining hall or cafeteria, such as a range hood for a grill requiring a special exhaust system per NFPA 96.

EMERGENCY CARE UNIT (AMBULATORY CARE UNIT) – AIR HANDLING UNIT

AHU Data Sheet	
Air Handling Unit Type	● VAV ● **Notes 1 and 2**
Inside Design Conditions	Room Data Sheets
Minimum Outside Air	● Normal Operation – Chapter 2 ● Emergency Operations – 100%
Minimum Supply Air Changes per Hour	6
Return Air	● Normal Operation – Required ● Emergency Mode – Not Permitted
Economizer Cycle	ASHRAE Standard 90.1 – 2004
Room Noise Levels	Room Data Sheets
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade D
Cooling Source	● Chilled water from the central chilled water plant
Heating Source	● Use high pressure steam from the central boiler plant as the primary source for generating heating hot water and producing “clean steam” for winter humidification. ● Use medium pressure steam from the central boiler plant for unit mounted pre-heat coils.
General Exhaust System(s)	Required
Special Exhaust System(s)	Not Required
Heat Recovery System	Not Required
Emergency Power	Not Required

Note 1:

(a) Provide capability to operate this air-handling unit at 100% outside air during the emergency mode. Activate the emergency mode operation either by a manual selector switch or by DDC controls from a local control panel or remote ECC. Coordinate the location of the manual selector switch with VA Authorities.

(b) During emergency mode, return air fan shall operate as the exhaust air fan to relieve room air outdoors by automatic dampers, VAV air terminal units shall assume constant volume position to deliver the scheduled design air volume, and general exhaust (toilet etc.) system shall continue to operate. Do not assume any diversity while calculating supply air volume.

Note 2: Select cooling and heating capacities based on 100% outside air. Provide two control valves (1/3 and 2/3 capacities) for the cooling and preheat coils to operate in sequence to meet large load variation.

EMERGENCY CARE UNIT (AMBULATORY CARE UNIT) – ROOM DATA SHEETS

Emergency Waiting Room – Room Data Sheet	
Inside Design Conditions	● Year Around Conditions 70 F [21 C] to 75 F [24 C] Dry-Bulb Temperature 30% to 50% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	12 – CV Required
Return Air	Not Permitted
Exhaust Air	100%
Room Noise Level	NC 40
Individual Room Temperature Control	Required
Room Air Balance	Negative (-)
Note 1: The HVAC system shall be sized and selected to maintain any room temperature within the specified range. Cooling load calculations shall be based on 70 F [21 C] and 50% relative humidity. Heating load calculations shall be based on 75 F [24 C] and 30% relative humidity.	

Life Support Unit – Room Data Sheet	
Inside Design Conditions	● Year Around Conditions 70 F [21 C] to 75 F [24 C] Dry-Bulb Temperature 30% to 50% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	4 – VAV Permitted
Return Air	Permitted
Exhaust Air	Not Required
Room Noise Level	NC 35
Individual Room Temperature Control	Required
Room Air Balance	Neutral (0)
Note 1: The HVAC system shall be sized and selected to maintain any room temperature within the specified range. Cooling load calculations shall be based on 70 F [21 C] and 50% relative humidity. Heating load calculations shall be based on 75 F [24 C] and 30% relative humidity.	

EMERGENCY CARE UNIT (AMBULATORY CARE UNIT) – ROOM DATA SHEETS

Observation and Treatment Room – Room Data Sheet	
Inside Design Conditions	● Year Around Conditions 70 F [21 C] to 75 F [24 C] Dry-Bulb Temperature 30% to 50% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	6 – VAV Permitted
Return Air	Permitted
Exhaust Air	Not Required
Room Noise Level	NC 35
Individual Room Temperature Control	Required
Room Air Balance	Neutral (0)
Note 1: The HVAC system shall be sized and selected to maintain any room temperature within the specified range. Cooling load calculations shall be based on 70 F [21 C] and 50% relative humidity. Heating load calculations shall be based on 75 F [24 C] and 30% relative humidity.	

Security - Exam Room - Toilet – Room Data Sheet	
Inside Design Conditions	● Year Around Conditions 70 F [21 C] to 75 F [24 C] Dry-Bulb Temperature 30% to 50% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	6 – VAV Permitted
Return Air	Permitted
Exhaust Air	Toilet Only
Room Noise Level	NC 35
Individual Room Temperature Control	Required
Room Air Balance	Neutral (0) – Exam Room Negative (-) – Toilet
Note 1: The HVAC system shall be sized and selected to maintain any room temperature within the specified range. Cooling load calculations shall be based on 70 F [21 C] and 50% relative humidity. Heating load calculations shall be based on 75 F [24 C] and 30% relative humidity	

GYMNASIUM – AIR HANDLING UNIT

AHU Data Sheet and Room Data Sheet	
Air Handling Unit Type	CV
Inside Design Conditions	● Cooling 77 F [25 C] Dry-Bulb Temperature 55% Relative Humidity ● Heating 70 F [21 C] Dry-Bulb Temperature 30% Relative Humidity ● **Notes 1 and 2**
Minimum Outside Air	● Chapter 2 ● **Note 3**
Minimum Supply Air Changes per Hour	6
Return Air	Required
Economizer Cycle	ASHRAE 90.1 – 2007
Room Noise Level	NC 45
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade B
Cooling Source	Chilled water from the central chilled water plant
Heating Source	● Use high-pressure steam from the central boiler plant as the primary source for generating heating hot water and producing “clean steam” for winter humidification. ● Use medium pressure steam from the central boiler plant for the unit-mounted preheat coils.
General Exhaust System(s)	Optional, required if connected with spaces requiring exhaust
Special Exhaust System(s)	Not Required
Heat Recovery System	Not Required
Emergency Power	Not Required
Individual Room Temperature Control	Required
Room Air Balance	Positive (+)

Note 1: Provide high-humidity control for the summer cooling mode to limit the space relative humidity to 60%.

Note 2: Where feasible, evaluate the use of a heating and ventilation unit without mechanical cooling.

Note 3: Provide a CO_2-actuated, demand-controlled ventilation control sequence to admit minimum design outside air only when the CO_2 concentration starts rising above 400 PPM. Provide an airflow-measuring device with the minimum outside air damper and CO_2 sensor in the return air duct. Ensure accuracy of the airflow-measuring device at low air volumes.

IMAGING SERIES – MRI UNIT – AIR HANDLING UNIT

AHU Data Sheet	
Air Handling Unit Type	● CV ● **Note 1**
Inside Design Conditions	Room Data Sheets
Minimum Outside Air	Chapter 2
Minimum Supply Air Changes per Hour	Room Data Sheets
Return Air	Permitted
Economizer Cycle	ASHRAE Standard 90.1 – 2007
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade D
Cooling Source	● Chilled water from the central chilled water plant ● Room Data Sheets for the closed-loop dedicated chiller for the MRI System Component Room
Heating Source	● Use high pressure steam from the central boiler plant as the primary source for generating heating hot water and producing "clean steam" for winter humidification ● Use medium pressure steam from the central boiler plant for unit mounted pre-heat coils
General Exhaust System(s)	Room Data Sheets
Special Exhaust System(s)	Room Data Sheets
Heat Recovery System	Not Required
Emergency Power	Required for: ● Components of the MRI Unit (coordinate with the MRI vendor) ● Emergency exhaust fan ● Associated controls

Note 1:

(a) The design A/E shall become familiar with the MRI Design Guide published by the Office of Construction & 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) The capacity and configuration of the MRI (Magnetic Resonance Imaging) Unit varies from manufacturer to manufacturer. ***Coordination with the project-specific MRI vendor is critical.***

(c) The MRI Unit, a component of the Imaging Series, can be connected to any other dedicated air-handing unit such as the Radiology Unit, provided the HVAC design parameters are not compromised.

IMAGING SERIES – MRI UNIT – ROOM DATA SHEETS

MRI Control Room – Room Data Sheet	
Inside Design Conditions	● Year Around Conditions 70 F [21 C] to 75 F [24 C] Dry-Bulb Temperature 40% to 50% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	6
Return Air	Permitted
Exhaust Air	Permitted
Room Noise Level	NC 40
Individual Room Temperature Control	Required
Room Air Balance	Positive (+)
Note 1: The HVAC system shall be sized and selected to maintain any room temperature within the specified range. Cooling load calculations shall be based on 70 F [21 C] and 50% relative humidity. Heating load calculations shall be based on 75 F [24 C] and 40% relative humidity. Coordinate relative humidity requirement with the MRI equipment vendor.	

MRI Scanning Room – Room Data Sheet	
Inside Design Conditions	● Year Around Conditions 70 F [21 C] to 75 F [24 C] Dry-Bulb Temperature 40% to 50% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	12
Return Air	Permitted during normal operation
Exhaust Air	**Notes 2 - 5**
Room Noise Level	NC 35
Emergency Power	AHU Data Sheet
Individual Room Temperature Control	● Required ● Locate room temperature sensor in the return air duct and outside the RF Shielding. ● Provide low and high temperature alarms (local and at the ECC).
Room Air Balance	Positive (+)
Note 1: The HVAC system shall be sized and selected to maintain any room temperature within the specified range. Cooling load calculations shall be based on 70 F [21 C] and 50% relative humidity. Heating load calculations shall be based on 75 F [24 C] and 40% relative humidity. Coordinate the relative humidity requirement with the MRI equipment vendor. **Note 2: Emergency Exhaust Fan** **(a)** Provide a special automatic/manual emergency exhaust system to exhaust the scanning room in the event cryogen liquid 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 tied to the vendor's automatic alarm	

IMAGING SERIES – MRI UNIT – ROOM DATA SHEETS

system by an electric relay. Provide two manual switches (one located in the scanning room and 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/scheduled human traffic is within a 25 Foot [7.6 Meter] 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 inches [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 drop.

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) Spill can discharge from the walls or roof if there are no operable windows or outside air intakes, and no regular or scheduled human traffic within a 25 foot [7.60 Meter] radius. Terminate the vent pipe with a turndown weather head.

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: The General Contractor (GC) shall supply and install an “explosion” hatch in the roof or wall, whichever is the closet, to relieve gas under pressure outdoors. The explosion hatch is pressure-actuated and can be connected to the quench alarm system. Coordinate the location, size, and design of the hatch with the MRI equipment vendor.

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 the MRI equipment with return and/or exhaust inlets located on the equipment back to facilitate MRI equipment cooling.

IMAGING SERIES – MRI UNIT – ROOM DATA SHEETS

MRI System Component Room – Room Data Sheet	
Inside Design Conditions	70 F [21.1 C] Dry-Bulb Temperature 40% to 60% Relative Humidity
Minimum Supply Air Changes per Hour	● 6 ● **Note 1**
Return Air	Permitted
Exhaust Air	Not Applicable
Room Noise Level	NC 40
Individual Room Temperature Control	Required
Room Air Balance	Positive (+)

Note 1:

(a) Provide a dedicated AC unit to serve the System Component Room. Coordinate size and configuration with the equipment manufacturer.

- Coordinate AC unit air distribution with the raised floor.
- Provide water sensor alarm (local and at the ECC) in the event of any 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.
- Piping 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 the scope of work (connection detail) at each chilled water connection.

IMAGING SERIES – MRI UNIT – ROOM DATA SHEETS

MRI Visiting Area – Room Data Sheet	
Inside Design Conditions	● Year Around Conditions 70 F [21 C] to 75 F [24 C] Dry-Bulb Temperature 40% to 50% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	12
Return Air	Not Permitted
Exhaust Air	100% **Note 2**
Room Noise Level	NC 40
Individual Room Temperature Control	Required
Room Air Balance	Negative (-)
Note 1: The HVAC system shall be sized and selected to maintain any room temperature within the specified range. Cooling load calculations shall be based on 70 F [21 C] and 50% relative humidity. Heating load calculations shall be based on 75 F [24 C] and 40% relative humidity. Coordinate relative humidity requirement with the MRI equipment vendor. **Note 2**: Provide exhaust through the general exhaust system.	

INTENSIVE CARE UNITS AND RECOVERY ROOMS – AIR HANDLING UNIT

AHU Data Sheet	
Air Handling Unit Type	● CV ● **Note 1**
Inside Design Conditions	Room Data Sheets
Minimum Outside Air	● Chapter 2 ● **Note 2**
Minimum Supply Air Changes per Hour	Room Data Sheets
Return Air	Permitted
Economizer Cycle	ASHRAE Standard 90.1 – 2007
Inside Design Conditions	Room Data Sheets
Filtration	● Pre-Filters – VA Grade A ● After Filters – VA Grade C ● Final-Filters – VA Grade E ● **Note 3**
Cooling Source	● Dedicated chiller serving the surgical suite shall be the prime source of mechanical cooling for the ICU and recovery AHU. ● Provide cross-connections with the central chilled water plant for emergency backup.
Heating Source	● Use high-pressure steam from the central boiler plant as the primary source for generating heating hot water and producing "clean steam" for winter humidification. ● Use medium pressure steam from the central boiler plant for the unit-mounted preheat coils.
General Exhaust System(s)	Required
Special Exhaust System(s)	Not Required
Heat Recovery System	Not Required
Emergency Power	Required

Note 1:

(a) ICU and recovery rooms can be grouped together to form a dedicated unit if these spaces are situated in close proximity of each other and are not adjacent to the surgical suite.

(b) Provide a variable speed drive for the supply air fan to ensure constant air delivery under varying resistance due to filter loading. Provide the appropriate control sequence to operate the variable speed drive.

Note 2: Exhaust all supply air outdoors when the spaces are served by the surgical suite AHU.

Note 3: Locate final filters (third bed) on the downstream side of the supply air fan with a diffusion plate section between the filters and fan to ensure uniform air velocity and distribution.

INTENSIVE CARE UNITS AND RECOVERY ROOMS – ROOM DATA SHEETS

Intensive Care Unit – Room Data Sheet	
Inside Design Conditions	● Year Around Conditions 70 F [21 C] to 75 F [24 C] Dry-Bulb Temperature 30% to 50% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	6
Return Air	Permitted
Exhaust Air	**Note 2**
Room Noise Level	NC 35
Individual Room Temperature Control	Required
Room Air Balance	Positive (+)
Note 1: The HVAC system shall be sized and selected to maintain any room temperature within the specified range. Cooling load calculations shall be based on 70 F [21 C] and 50% relative humidity. Heating load calculations shall be based on 75 F [24 C] and 30% relative humidity. **Note 2**: Provide exhaust through the adjoining toilet, if any.	

Recovery Room – Room Data Sheet	
Inside Design Conditions	● Year Around Conditions 73 F [22.8 C] to 77 F [25 C] Dry-Bulb Temperature 30% to 55% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	6
Return Air	Permitted
Exhaust Air	**Note 2**
Room Noise Level	NC 35
Individual Room Temperature Control	Required
Room Air Balance	Positive (+)
Note 1: The HVAC system shall be sized and selected to maintain any room temperature within the specified range. Cooling load calculations shall be based on 73 F [22.8 C] and 50% relative humidity. Heating load calculations shall be based on 77 F [25 C] and 30% relative humidity. **Note 2**: Provide exhaust through the adjoining toilet, if any. **Note 3:** Provide terminal HEPA filter if Recovery Room is served by surgical suite AHU.	

KITCHEN (DIETETICS) – AIR HANDLING UNIT

AHU Data Sheet and Room Data Sheet	
Air Handling Unit Type	CV
Inside Design Conditions	● Cooling 82 F [27.8 C] Dry-Bulb Temperature 55% Relative Humidity ● Heating 70 F [21 C] Dry-Bulb Temperature ● **Note 1**
Minimum Outside Air	100%
Minimum Supply Air Changes per Hour	● 10 ● **Notes 2 and 3**
Return Air	Not Permitted
Economizer Cycle	Not Applicable
Room Noise Level	NC 45
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade C
Cooling Source	Chilled water from the central chilled water plant
Heating Source	● Use high pressure steam from the central boiler plant as the primary source for generating heating hot water and producing “clean steam” for winter humidification. ● Use medium pressure steam from the central boiler plant for unit mounted pre-heat coils.
General Exhaust System(s)	**Note 4**
Special Exhaust System(s)	**Note 5**
Heat Recovery System	Not Permitted
Emergency Power	Not Required
Individual Room Temperature Control	Required
Room Air Balance	Negative (-)

Note 1: Provision of winter humidification (30% RH) is project specific.

Note 2: Compile and coordinate the kitchen equipment heat gain with the equipment supplier and consultants.

Note 3: Make-Up Air System

Perform a cost-benefit analysis to justify the need for a dedicated, filtered, and tampered air unit to meet the make-up air need of the grease hood exhaust system(s). Provide specific recommendations to enable the VA Authorities to decide the status of the make-up air system.

Note 4: General Exhaust System

(a) Occupied Mode: Provide a general exhaust system to exhaust the space and capture heat over the equipment such as refrigeration compressors, plate warmer, mixers, etc. Locate exhaust air inlets as far above the equipment as possible.

KITCHEN (DIETETICS) – AIR HANDLING UNIT

(b) Unoccupied Mode: Provide a two-speed fan to operate the system at half-speed during unoccupied hours and maintain negative air balance with respect to the adjoining spaces.

Note 5: Grease Hood Exhaust System

The requirements listed below are not applicable to the small kitchenettes or warm-up kitchens.

(a) Provide a special exhaust system for the grease producing equipment such as griddles, ovens, broilers, and deep fat fryers. The design and construction of the exhaust system shall be in compliance with NFPA 96. Do not install turning vanes in the exhaust duct.

(b) Do not install fire and volume dampers in the exhaust air ductwork.

(c) Avoid horizontal duct runs as much as possible. Provide access doors in the exhaust ducts to remove grease at each turn in direction. Do not install turning vanes in the exhaust duct.

(d) Do not locate the grease exhaust duct in the same shaft carrying the environmental ducts. See NFPA 90A.

(e) Exhaust air discharge shall be in accordance with the outcome of the dispersion analysis. Maintain at least 40 inches [1000 mm] between the roof and the exhaust air outlet of the up-blast exhaust fan.

(f) Provide automatic and manual wash-down cycle and fire protection features operable from the hood control panel.

(g) Do not attempt any heat recovery from the grease laden air.

Note 6: Hot Vapor Producing Equipment

Coordinate the supply and installation of the high velocity type hoods with the kitchen drawings and consultants. Provide a dedicated exhaust system to serve hot vapor producing equipment such as steam kettles, vegetable steamers, and high-pressure cookers. Provide welded stainless steel ductwork.

Note 7: Wet Exhaust

Provide a dedicated wet exhaust system to capture moist air over the pot/pan and dishwasher. Either provide canopy-type hoods or use the integral hoods furnished by the equipment manufacturers. Provide welded stainless steel ductwork. Do not attempt any heat recovery from the moist air.

LABORATORIES – AIR HANDLING UNIT

AHU Data Sheet and Room Data Sheet	
Air Handling Unit Type	● CV or VAV ● **Note 1**
Inside Design Conditions	● Year Around Conditions 70 F [21 C] to 75 F [24 C] Dry-Bulb Temperature 30% to 50% Relative Humidity ● **Note 2**
Minimum Outside Air	100%
Minimum Supply Air Changes per Hour	**Note 3**
Return Air	Not Permitted
Economizer Cycle	Not Applicable
Room Noise Level	● NC 40 – Without Hoods ● NC 45 – With Hoods)
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade C
Cooling Source	Chilled water from the central chilled water plant
Heating Source	● Use high pressure steam from the central boiler plant as the primary source for generating heating hot water and producing "clean steam" for winter humidification. ● Use medium pressure steam from the central boiler plant for unit mounted pre-heat coils. ● Hot water using steam from the central boiler plant.
General Exhaust System(s)	● Required – Chapter 3 ● **Note 4** (Dry Laboratories)
Special Exhaust System(s)	Required – Chapter 3
Heat Recovery System	Do not attempt any heat recovery from the laboratory exhaust systems.
Emergency Power	Required for all exhaust systems serving fume hoods and biological safety cabinets, including DDC controls
Individual Room Temperature Control	Required
Room Air Balance	● Negative (-) ● **Note 5**

Note 1:

(a) The AHU system configuration shall be project-specific.

(b) For a small system involving a few laboratories and minimum (fewer than 4) fume hoods, provide a CV system.

(c) For large new and renovation projects, the system configuration shall be based on the dynamic interaction between the hoods' operation, general exhaust system, and maintaining constant offset with the corridor and adjoining spaces. A VAV system is provided to meet this objective.

LABORATORIES – AIR HANDLING UNIT

Note 2: The HVAC system shall be sized and selected to maintain any room temperature within the specified range. Cooling load calculations shall be based on 70 F [21 C] and 50% relative humidity. Heating load calculations shall be based on 75 F [24 C] and 30% relative humidity.

Note 3:

(a) Listed below are laboratories with minimum 6 air changes per hour:

- Laboratory Bacteriology
- Laboratory Biochemistry
- Laboratory Cytology
- Laboratory Histology
- Laboratory Microbiology
- Laboratory Nuclear Medicine
- Laboratory Pathology
- Laboratory Serology
- Laboratory, Media Transfer

(b) Listed below are applications with minimum 10 air changes per hour:

- Laboratory Glass Washing
- Laboratory Sterilizing

(c) Coordinate the quantity and types of hoods with the project requirements and provide special exhaust systems accordingly.

Note 4: “Dry Laboratories” are laboratories without any fume hoods, biological safety cabinets, and use of chemicals or water. Generally used for the research activities, the dry laboratories contain electronic equipment. The HVAC design criteria shall be similar to the office spaces. While the room air can be returned back to the system, evaluate the cost-effectiveness of an additional return air system.

Note 5: Estimate the corridor supply air volume to provide make-up for spaces under negative air balance. Provide a dedicated air terminal unit.

LAUNDRY (CENTRAL) AIR HANDLING UNIT

AHU Data Sheet and Room Data Sheet	
Air Handling Unit Type	● CV ● **Note 1**
Inside Design Conditions	● Cooling 84 F [28.0 C] Dry-Bulb Temperature 60% Relative Humidity ● Heating 68 F [20.0 C] Dry-Bulb Temperature Uncontrolled Relative Humidity ● **Note 2**
Minimum Outside Air	100%
Minimum Supply Air Changes per Hour	● 10 ● **Note 3**
Return Air	● Not Permitted ● **Note 4**
Economizer Cycle	Not Applicable
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade B
Cooling Source	Chilled water from the central chilled water plant
Heating Source	● Use high pressure steam from the central boiler plant as the primary source for generating heating hot water. ● Use medium pressure steam from the central boiler plant for unit mounted pre-heat coils.
General Exhaust System(s)	Required
Special Exhaust System(s)	Not Required
Heat Recovery System	Per ASHRAE Standard 90.1 – 2007, evaluate the use of a heat recovery system to transfer energy between the exhaust and incoming outside air streams
Additional Energy Conservation Measure	To meet the mandated goal of 30% additional energy conservation above ASHRAE 90.1 – 2004, evaluate the use of desiccant dehumidification system to reduce the dew-point temperature of the incoming outside air.
Emergency Power	Not Required
Individual Room Temperature Control	Required for each section (soiled and clean)
Room Air Balance	● Negative (-) – Soiled Area ● Positive (+) – Clean Linen Area

LAUNDRY (CENTRAL) AIR HANDLING UNIT

Note 1: Provide a dedicated air-handling unit to serve the soiled area and clean linen area. Evaluate the use of evaporative cooling and/or ventilation only for the locations, where mechanical cooling can be avoided.

Note 2: Provide a night set back cycle control sequence.

Note 3: Coordinate the laundry utilities needs and heat dissipation with the equipment manufacturers.

Note 4: Provide a line collector to clean and re-circulate the dryer exhaust air utilizing the dryer blower.

MAIN TELEPHONE EQUIPMENT ROOM AIR-CONDITIONING UNITS

AHU Data Sheet and Room Data Sheet	
Air Handling Unit Type	● CV ● **Note 1**
Inside Design Conditions	● 64 F [17.8 C] to 75 F [24 C] Dry-Bulb Temperature ● 30 to 55% Relative Humidity
Minimum Outside Air	Not Required
Minimum Supply Air Changes per Hour	Coordinate unit capacity with the equipment load
Return Air	100%
Economizer Cycle	Not Applicable
Filtration	As furnished with the computer room air conditioning units
Cooling Source	Chilled water from the central chilled water plant or dedicated chiller or DX units
Heating Source	Hot water using steam from the central boiler plant
General Exhaust System(s)	Not Required
Special Exhaust System(s)	Not Required
Heat Recovery System	Not Applicable
Emergency Power	Required
Individual Room Temperature Control	Required
Room Air Balance	Positive (+)

Note 1:

(a) Provide multiple freestanding air conditioning units, also designated as CRACs (Computer Room Air Conditioning Units), specifically designed for the computer room. Provide N+1 units, where N = Number of units in operation and 1 unit is standby.

(b) Coordinate air distribution system with the raised floor.

(c) Provide reheat and humidification for each computer room air conditioning unit.

(d) Coordinate make-up water for humidification and cooling coil condensate drain line and trap with the plumbing discipline.

(e) Provide an automatic leak detection system for the under-floor space. Provide a local audible and remote alarm at the ECC in the event the under floor humidity rises above 65%. Provide interface between the CRAC units and the central DDC system.

(f) Admit conditioned air from the adjoining environmental AHU as the minimum outside air. For large installations, a dedicated make-up air unit may be required.

MEDICAL MEDIA SERVICE (MMS) – AIR HANDLING UNIT

AHU Data Sheet	
Air Handling Unit Type	● VAV ● **Note 1**
Inside Design Conditions	Room Data Sheets
Minimum Outside Air	Chapter 2
Minimum Supply Air Changes per Hour	Room Data Sheets
Return Air	Permitted
Economizer Cycle	ASHRAE Standard 90.1 – 2007
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade C
Cooling Source	Chilled water from the central chilled water plant
Heating Source	● Use high pressure steam from the central boiler plant as the primary source for generating heating hot water and producing “clean steam” for winter humidification. ● Use medium pressure steam from the central boiler plant for unit mounted pre-heat coils.
General Exhaust System(s)	Required
Special Exhaust System(s)	Not Required
Heat Recovery System	Not Required
Emergency Power	Not Required

Note 1:

(a) With the advent of the digital technology, equipment for the Medical Media Service has changed and the use of the chemicals for the film processing has been eliminated or minimized.

(b) A dedicated air-handling is required only if the Medical Media Service constitutes a full-fledged department with all or many spaces listed in the Room Data Sheets included in the scope of work.

MEDICAL MEDIA SERVICE (MMS) – ROOM DATA SHEETS

Audio Visual Equipment Storage/Checkout – Room Data Sheet	
Inside Design Conditions	● Cooling 75 F [24 C] Dry-Bulb Temperature 55% Relative Humidity ● Heating 70 F [21 C] Dry-Bulb Temperature 30% Relative Humidity ● 5 F [2.8 C] Dead-Band
Minimum Supply Air Changes per Hour	4 – VAV Permitted
Return Air	Permitted
Exhaust Air	Not Required
Room Noise Level	NC 40
Individual Room Temperature Control	Required
Room Air Balance	Neutral (0)

Camera Copy – Room Data Sheet	
Inside Design Conditions	● Cooling 75 F [24 C] Dry-Bulb Temperature 55% Relative Humidity ● Heating 70 F [21 C] Dry-Bulb Temperature 30% Relative Humidity ● 5 F [2.8 C] Dead-Band
Minimum Supply Air Changes per Hour	6 – VAV Permitted
Return Air	Permitted
Exhaust Air	Not Required
Room Noise Level	NC 35
Individual Room Temperature Control	Required
Room Air Balance	Neutral (0)

Client Review Room – Room Data Sheet	
Inside Design Conditions	● Cooling 75 F [24 C] Dry-Bulb Temperature 55% Relative Humidity ● Heating 70 F [21 C] Dry-Bulb Temperature 30% Relative Humidity ● 5 F [2.8 C] Dead-Band
Minimum Supply Air Changes per Hour	4 – VAV Permitted
Return Air	Permitted
Exhaust Air	Not Required
Room Noise Level	NC 35
Individual Room Temperature Control	Required
Room Air Balance	Neutral (0)

MEDICAL MEDIA SERVICE (MMS) – ROOM DATA SHEETS

Computer Imaging System Network (CISN) – Room Data Sheet	
Inside Design Conditions	● Cooling 75 F [24 C] Dry-Bulb Temperature 55% Relative Humidity ● Heating 70 F [21 C] Dry-Bulb Temperature 30% Relative Humidity ● 5 F [2.8 C] Dead-Band
Minimum Supply Air Changes per Hour	6 – VAV Permitted
Return Air	Permitted
Exhaust Air	Not Required
Room Noise Level	NC 40
Individual Room Temperature Control	Required
Room Air Balance	Negative (-)

Darkroom and Darkroom (Printing and Enlarging) – Room Data Sheet	
Inside Design Conditions	● Cooling 75 F [24 C] Dry-Bulb Temperature 50% Relative Humidity ● Heating 70 F [21 C] Dry-Bulb Temperature 30% Relative Humidity
Minimum Supply Air Changes per Hour	8 – CV Required
Return Air	Not Permitted
Exhaust Air	● 100% ● **Note 1**
Room Noise Level	NC 35
Individual Room Temperature Control	Required
Room Air Balance	Negative (-)
Note 1: Design parameters are based on the assumption that the darkroom procedures involve the use of the chemicals.	

Expanded Core – Illustration Room – Room Data Sheet	
Inside Design Conditions	● Cooling 75 F [24 C] Dry-Bulb Temperature 55% Relative Humidity ● Heating 70 F [21 C] Dry-Bulb Temperature 30% Relative Humidity ● 5 F [2.8 C] Dead-Band
Minimum Supply Air Changes per Hour	6 – VAV Permitted
Return Air	Permitted
Exhaust Air	Not Required
Room Noise Level	NC 35
Individual Room Temperature Control	Required
Room Air Balance	Neutral (0)

MEDICAL MEDIA SERVICE (MMS) – ROOM DATA SHEETS

Expanded Core – Stat Camera – Room Data Sheet	
Inside Design Conditions	● Cooling 75 F [24 C] Dry-Bulb Temperature 55% Relative Humidity ● Heating 70 F [21 C] Dry-Bulb Temperature 30% Relative Humidity ● 5 F [2.8 C] Dead-Band
Minimum Supply Air Changes per Hour	6 – VAV Permitted
Return Air	Permitted
Exhaust Air	Not Required
Room Noise Level	NC 35
Individual Room Temperature Control	Required
Room Air Balance	Neutral (0)

Photo Finishing – Room Data Sheet	
Inside Design Conditions	● Cooling 75 F [24 C] Dry-Bulb Temperature 50% Relative Humidity ● Heating 70 F [21 C] Dry-Bulb Temperature 30% Relative Humidity
Minimum Supply Air Changes per Hour	6 – CV Required
Return Air	Permitted
Exhaust Air	● 100% ● **Note 1**
Room Noise Level	NC 35
Individual Room Temperature Control	Required
Room Air Balance	Negative (-)
Note 1: Design parameters are based on the assumption that the photo finishing procedures involve use of the chemicals.	

Photo Studio/A.V. Recording – Room Data Sheet	
Inside Design Conditions	● Cooling 75 F [24 C] Dry-Bulb Temperature 55% Relative Humidity ● Heating 70 F [21 C] Dry-Bulb Temperature 30% Relative Humidity ● 5 F [2.8 C] Dead-Band
Minimum Supply Air Changes per Hour	6 – VAV Permitted
Return Air	Permitted
Exhaust Air	Not Required
Room Noise Level	NC 30
Individual Room Temperature Control	Required
Room Air Balance	Neutral (0)

MEDICAL MEDIA SERVICE (MMS) – ROOM DATA SHEETS

Photomicrography – Room Data Sheet	
Inside Design Conditions	● Cooling 75 F [24 C] Dry-Bulb Temperature 55% Relative Humidity ● Heating 70 F [21 C] Dry-Bulb Temperature 30% Relative Humidity ● 5 F [2.8 C] Dead-Band
Minimum Supply Air Changes per Hour	6 – VAV Permitted
Return Air	Permitted
Exhaust Air	Not Required
Room Noise Level	NC 35
Individual Room Temperature Control	Required
Room Air Balance	Neutral (0)
Note 1: The above room data is based on the assumption that chemicals shall not be used in the space. If chemicals are used for the process, the VAV system shall be changed to a CV system and return shall be changed to exhaust.	

Video Editing CCTB Control Room – Room Data Sheet	
Inside Design Conditions	● Cooling 75 F [24 C] Dry-Bulb Temperature 55% Relative Humidity ● Heating 70 F [21 C] Dry-Bulb Temperature 30% Relative Humidity ● 5 F [2.8 C] Dead-Band
Minimum Supply Air Changes per Hour	6 – VAV Permitted
Return Air	Permitted
Exhaust Air	Not Required
Room Noise Level	NC 35
Individual Room Temperature Control	Required
Room Air Balance	Neutral (0)

NUCLEAR MEDICINE SERVICE – AIR HANDLING UNIT

AHU Data Sheet	
Air Handling Unit Type	● CV ● **Note 1**
Inside Design Conditions	Room Data Sheets
Minimum Outside Air	Room Data Sheets
Minimum Supply Air Changes per Hour	Room Data Sheets
Return Air	● Room Data Sheets ● **Note 2**
Economizer Cycle	ASHRAE 90.1 – 2007
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade D
Cooling Source	Chilled water from the central chilled water plant
Heating Source	● Use high pressure steam from the central boiler plant as the primary source for generating heating hot water and producing “clean steam” for winter humidification. ● Use medium pressure steam from the central boiler plant for unit mounted pre-heat coils.
General Exhaust System(s)	**Note 3**
Special Exhaust System(s)	**Note 4**
Heat Recovery System	Not Required
Emergency Power	Not Required

Note 1: The A/E shall become familiar with the Nuclear Medicine Design Guide and related design guides of the Imaging Series. See TIL.

Note 2: Return air is permitted from the support functions such as circulation spaces such as the Nurse’s Station, Lounge, and Conference Rooms, if cost-effective.

Note 3: Provide a general exhaust system interlocked with the Nuclear Medicine AHU.

Note 4: Provide special exhaust system(s) for the fume hoods and biological safety cabinets. Coordinate hood locations and sizes with the architectural discipline.

NUCLEAR MEDICINE SERVICE – ROOM DATA SHEETS

Bone Densitometry Room – Room Data Sheet	
Inside Design Conditions	● Year Around Conditions 70 F [21 C] Dry-Bulb Temperature 30% to 50% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	6
Return Air	Not Permitted
Exhaust Air	Not Required
Room Noise Level	NC 35
Individual Room Temperature Control	Required
Room Air Balance	Neutral (0)
Note 1: The HVAC system shall be sized and selected to maintain any room temperature within the specified range. Cooling load calculations shall be based on 70 F [21 C] and 50% relative humidity. Heating load calculations shall be based on 75 F [24 C] and 30% relative humidity.	

Nuclear Medicine Scanning Room (Patient Examination Room) – Room Data Sheet	
Inside Design Conditions	● Year Around Conditions 70 F [21 C] to 75 F [24 C] Dry-Bulb Temperature 30% to 50% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	6
Return Air	Not Permitted
Exhaust Air	100%
Room Noise Level	NC 35
Individual Room Temperature Control	Required
Room Air Balance	● Negative (-) ● **Note 2**
Note 1: The HVAC system shall be sized and selected to maintain any room temperature within the specified range. Cooling load calculations shall be based on 70 F [21 C] and 50% relative humidity. Heating load calculations shall be based on 75 F [24 C] and 30% relative humidity. **Note 2:** **(a)** Provide volumetric controls to demonstrate negative air balance. **(b)** Locate supply and exhaust air outlets to create a directional airflow and admit make-up air from the adjoining area. **(c)** If Xenon gas is used in this room, coordinate with the local radiation safety officer for any additional measures.	

NUCLEAR MEDICINE SERVICE – ROOM DATA SHEETS

Nuclear Pharmacy Laboratory (Hot Laboratory) – Room Data Sheet Storage and Preparation Area – Room Data Sheet	
Inside Design Conditions	● Year Around Conditions 70 F [21 C] to 75 F [24 C] Dry-Bulb Temperature 30% to 50% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	12
Return Air	Not Permitted
Exhaust Air	● 100% ● **Note 2**
Room Noise Level	NC 35
Individual Room Temperature Control	Required
Room Air Balance	Negative (-)

Note 1: The HVAC system shall be sized and selected to maintain any room temperature within the specified range. Cooling load calculations shall be based on 70 F [21 C] and 50% relative humidity. Heating load calculations shall be based on 75 F [24 C] and 30% relative humidity.

Note 2:

(a) This room is also known as Radiopharmacy Room. Coordinate quantity and type of fume hoods and/or biological safety cabinets and provide 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 safety officer for additional measures necessary, if any. Provide a supplementary general exhaust system, if required per the room air balance.

(b) Provide volumetric controls to demonstrate negative air balance.

(c) Locate supply and exhaust air outlets to create a directional airflow and admit make-up air from the adjoining area.

NUCLEAR MEDICINE SERVICE – ROOM DATA SHEETS

Patient Dose Administration – Room Data Sheet	
Inside Design Conditions	● Year Around Conditions 70 F [21 C] to 75 F [24 C] Dry-Bulb Temperature 30% to 50% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	6
Return Air	Not Permitted
Exhaust Air	100%
Room Noise Level	NC 35
Individual Room Temperature Control	Required
Room Air Balance	● Negative (-) ● **Note 2**

Note 1: The HVAC system shall be sized and selected to maintain any room temperature within the specified range. Cooling load calculations shall be based on 70 F [21 C] and 50% relative humidity. Heating load calculations shall be based on 75 F [24 C] and 30% relative humidity.

Note 2:

(a) Provide volumetric controls to demonstrate negative air balance.

(b) Locate supply and exhaust air outlets to create a directional airflow and admit make-up air from the adjoining area.

PET/CT System Component Room – Room Data Sheet	
Inside Design Conditions	● Year Around Conditions 70 F [21 C] Dry-Bulb Temperature 40% to 50% Relative Humidity ● **Notes 1 and 2**
Minimum Supply Air Changes per Hour	As required to meet the cooling demand
Return Air	Permitted
Exhaust Air	Not Required
Room Noise Level	NC 40
Individual Room Temperature Control	Required
Room Air Balance	Positive (+)

Note 1: The HVAC system shall be sized and selected to maintain any room temperature within the specified range. Cooling load calculations shall be based on 70 F [21 C] and 50% relative humidity. Heating load calculations shall be based on 70 F [21 C] and 40% relative humidity.

Note 2: Provide a dedicated AC unit to serve the System Component Room. Coordinate size and configuration with the equipment manufacturer.

- Coordinate AC unit air distribution with the raised floor.
- Provide water sensor alarm (local and at the ECC) in the event of any water leakage below the raised floor.

NUCLEAR MEDICINE SERVICE – ROOM DATA SHEETS

PT/CT Control – Room Data Sheet	
Inside Design Conditions	● Year Around Conditions 70 F [21 C] Dry-Bulb Temperature 40% to 50% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	6
Return Air	Permitted
Exhaust Air	Not Required
Room Noise Level	NC 35
Individual Room Temperature Control	Required
Room Air Balance	Positive (+)
Note 1: The HVAC system shall be sized and selected to maintain any room temperature within the specified range. Cooling load calculations shall be based on 70 F [21 C] and 50% relative humidity. Heating load calculations shall be based on 70 F [21 C]and 40% relative humidity.	

PT/CT Scanning Room – Room Data Sheet	
Inside Design Conditions	● Year Around Conditions 70 F [21 C] Dry-Bulb Temperature 40% to 50% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	6
Return Air	Not Permitted
Exhaust Air	100%
Room Noise Level	NC 35
Individual Room Temperature Control	Required
Room Air Balance	● Negative (-) ● **Note 2**
Note 1: The HVAC system shall be sized and selected to maintain any room temperature within the specified range. Cooling load calculations shall be based on 70 F [21 C] and 50% relative humidity. Heating load calculations shall be based on 70 F [21 C] and 40% relative humidity. **Note 2:** **(a)** Provide volumetric controls to demonstrate negative air balance. **(b)** Locate supply and exhaust air outlets to create a directional airflow and admit make-up air from the adjoining area.	

NURSING WING – AIR HANDLING UNIT

AHU Data Sheet	
Air Handling Unit Type	VAV
Inside Design Conditions	Room Data Sheets
Minimum Outside Air	Chapter 2
Minimum Supply Air Changes per Hour	Room Data Sheets
Return Air	Permitted
Economizer Cycle	ASHRAE 90.1-2007
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade D
Cooling Source	Chilled water from the central chilled water plant
Heating Source	● Use high pressure steam from the central boiler plant as the primary source for generating heating hot water and producing “clean steam” for winter humidification. ● Use medium pressure steam from the central boiler plant for unit mounted pre-heat coils.
General Exhaust System(s)	Required
Special Exhaust System(s)	Not Required
Heat Recovery System	Not Required
Emergency Power	Not Required

NURSING WING – ROOM DATA SHEETS

Nurses Station – Room Data Sheet	
Inside Design Conditions	● Year Around Conditions 70 F [21 C] to 75 F [24 C] Dry-Bulb Temperature 30% to 50% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	6 – VAV Permitted
Return Air	Permitted
Exhaust Air	Not Required
Room Noise Level	NC 40
Individual Room Temperature Control	Required
Room Air Balance	Neutral (0)
Note 1: The HVAC system shall be sized and selected to maintain any room temperature within the specified range. Cooling load calculations shall be based on 70 F [21 C] and 50% relative humidity. Heating load calculations shall be based on 75 F [24 C] and 30% relative humidity.	

Patient Bedrooms – Room Data Sheet	
Inside Design Conditions	● Year Around Conditions 70 F [21 C] to 75 F [24 C] Dry-Bulb Temperature 30% to 50% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	● 6 – VAV Permitted ● **Note 2**
Return Air	Permitted
Exhaust Air	Through the connecting toilet
Room Noise Level	NC 35
Individual Room Temperature Control	Required
Room Air Balance	● Positive (+) with respect to the Toilet ● Neutral (0) with respect to the Corridor
Note 1: The HVAC system shall be sized and selected to maintain any room temperature within the specified range. Cooling load calculations shall be based on 70 F [21 C] and 50% relative humidity. Heating load calculations shall be based on 75 F [24 C] and 30% relative humidity. **Note 2:** Per 2007 ASHRAE Handbook of Applications, minimum air changes per hour can be reduced to 4 when supplemental heating system is included in design.	

NURSING WING – ROOM DATA SHEETS

Patient Bedrooms (Psychiatric Ward) – Room Data Sheet	
Inside Design Conditions	● Year Around Conditions 70 F [21 C] to 75 F [24 C] Dry-Bulb Temperature 30% to 50% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	● 6 – VAV Permitted ● **Note 2**
Return Air	Permitted
Exhaust Air	Through the connecting toilet
Room Noise Level	NC 35
Individual Room Temperature Control	Required
Room Air Balance	● Positive (+) with respect to the Toilet ● Neutral (0) with respect to the Corridor
Special Design Considerations	**Note 3**

Note 1: The HVAC system shall be sized and selected to maintain any room temperature within the specified range. Cooling load calculations shall be based on 70 F [21 C] and 50% relative humidity. Heating load calculations shall be based on 75 F [24 C] and 30% relative humidity.

Note 2: Per 2007 ASHRAE Handbook of Applications, minimum air changes per hour can be reduced to 4 when supplemental heating system is included in design.

Note 3:

(a) Use of exposed and accessible HVAC equipment is prohibited in the psychiatric wing. Examples:

- Radiators
- Fan Coil Units
- Exposed Piping and Ductwork
- Accessible Room Temperature Sensor
- Convectors

(b) 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.

(c) Radiant Ceiling: Use security clips to retain the radiant ceiling panels in place.

(d) Air Outlets/Inlets: Do not use conventional air inlets and outlets. Use security type, preferably, wall-mounted and recessed air outlets and inlets.

NURSING WING (Emergency Mode Unit) – AIR HANDLING UNIT

AHU Data Sheet and Room Data Sheet	
Air Handling Unit Type	● Normal Mode – VAV ● Emergency Mode – CV ● **Notes 1 and 2**
Inside Design Conditions	● Year Around Conditions 70 F [21 C] to 75 F [24 C] Dry-Bulb Temperature 30% to 50% Relative Humidity ● **Note 3**
Minimum Outside Air	● Chapter 2 – Normal Mode ● 100% – Emergency Mode
Minimum Supply Air Changes per Hour	8
Return Air	● Permitted – Normal Mode ● Not Permitted – Emergency Mode
Economizer Cycle	ASHRAE 90.1-2007
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade D
Cooling Source	Chilled water from the central chilled water plant
Heating Source	● Use high pressure steam from the central boiler plant as the primary source for generating heating hot water and producing “clean steam” for winter humidification. ● Use medium pressure steam from the central boiler plant for unit mounted pre-heat coils.
General Exhaust System(s)	**Note 4**
Special Exhaust System(s)	**Note 5**
Heat Recovery System	Not Required
Emergency Power	Provide emergency electric power for the HVAC system and the controls serving the emergency wing.
Individual Room Temperature Control	Required
Room Air Balance	● Neutral (0) – Normal Mode ● Negative (-) – Emergency Mode
Additional Considerations	**Note 6**

Note 1:

(a) Design at least one air-handling unit from one patient wing to serve during an emergency epidemic situation requiring strict isolation and ventilation control, such as a breakout of pandemic flu. During normal mode of operation, the designated air-handling unit shall operate in a variable air volume (VAV) mode with minimum outside air.

(b) During emergency mode of operation the system shall operate in a constant volume mode with 100% outside air. Switchover from normal to emergency mode shall be accomplished manually by giving a command to the DDC system. Coordinate the location(s) and number of designated wings with VA Authorities and the architectural discipline. Top floor location, away from the general traffic, is preferred to reduce the risk of contamination. With the top floor location, contaminated exhaust can be exhausted outdoors through the roof without requiring a dedicated shaft.

NURSING WING (Emergency Mode Unit) – AIR HANDLING UNIT

(c) Provide a set of double doors for entry into the designated emergency ward. An entry vestibule is recommended but not mandatory.

Note 2:

(a) During emergency mode, each air terminal unit shall be programmed to deliver the design air volume in a constant volume mode. Capacity of the air-handling unit shall therefore be the sum of all individual peaks; that is, without the diversity inherent to the variable air volume system.

(b) Size the cooling and heating capacities to accommodate the larger air flow and outside air requirements.

Note 3: The HVAC system shall be sized and selected to maintain any room temperature within the specified range. Cooling load calculations shall be based on 70 F [21 C] and 50% relative humidity. Heating load calculations shall be based on 75 F [24 C] and 30% relative humidity.

Note 4:

(a) Provide a general exhaust system to ventilate the patient toilets, soiled utility room, housekeeping aide's closets, etc.

(b) During normal and emergency modes of operation, exhaust shall be discharged outdoors over the roof at 3,500 Feet/Minute [18.0 Meters/Second] through a stack at least 10 Feet [3.0 Meters] high. A taller stack may be required, if recommended per dispersion analysis.

(c) Create alternate exhaust paths, with a pair of automatic, on/off motorized dampers, to pass exhaust over the pre-filters – VA Grade A and HEPA filters – VA Grade E during the emergency mode and without the filters during the normal mode of operation. Provide a variable speed drive for the exhaust fan motor and an airflow-measuring device without a variable speed drive to ensure constant air volume in both modes of operation.

Note 5:

(a) During emergency mode, all room air shall be exhausted outdoors and 100% outdoor air shall be admitted. During emergency mode, return air fan shall act as an exhaust fan and all automatic dampers shall be programmed to assume their revised positions. Exhaust air shall be discharged outdoors over the roof at 3,500 Feet/Minute [18.0 Meters/Second] through a stack at least 10 Feet [3.0 Meters] high. A taller stack may be required, if recommended per dispersion analysis.

(b) Provide air exhaust fan motor and an airflow-measuring device without a variable speed drive to ensure constant air volume in both modes of operation.

Note 6:

(a) Provide two, automatic control valves (1/3 and 2/3 capacity) for each coil to ensure stable operation between the two modes.

NURSING WING (Emergency Mode Unit) – AIR HANDLING UNIT

(b) Design air distribution system to collect return (or exhaust) air over the patient without short-circuiting the supply air, facilitating inwards airflow in each patient room.

PHARMACY SERVICE – AIR HANDLING UNIT

AHU Data Sheet	
Air Handling Unit Type	● VAV ● **Note 1**
Inside Design Conditions	Room Data Sheets
Minimum Outside Air	Chapter 2
Minimum Supply Air Changes per Hour	Room Data Sheets
Return Air	Room Data Sheets
Economizer Cycle	ASHRAE 90.1 – 2007
Filtration	● Pre-Filters – VA Grade A ● After Filters – VA Grade C ● Final-Filters – VA Grade E ● **Note 2**
Cooling Source	● Use chilled water from the central chiller plant ● **Note 3**
Heating Source	● Use high pressure steam from the central boiler plant as the primary source for generating heating hot water and producing “clean steam” for winter humidification. ● Use medium pressure steam from the central boiler plant for unit mounted pre-heat coils.
General Exhaust System(s)	Required
Special Exhaust System(s)	Room Data Sheets
Heat Recovery System	ASHRAE 90.1 – 2007
Emergency Power	Required
Additional Energy Conservation Measures	To meet the mandated goal of 30% additional energy conservation above ASHRAE 90.1 – 2004, evaluate the use of desiccant dehumidification system to reduce the dew-point temperature of the incoming outside air.

Note 1: The HVAC system design criteria are based on the latest (December 3, 2007) publication of the USP (The United States Pharmacopeial Convention) Revised Bulletin <797> Pharmaceutical Sterile Preparations. A dedicated air-handling unit is not required to serve only the hazardous and/or non-hazardous clean rooms as long as any air-handling unit serving these rooms can meet all requirements outlined in the AHU Data Sheet and the Room Data Sheets.

Note 2: Locate the final filters (third bed) on the downstream side of the individual air terminal units serving hazardous and non-hazardous clean rooms. Oversize the final filters to minimize the pressure drop. For remaining rooms, terminal HEPA filters are not required.

Note 3: Dedicated chiller is required if chilled water is not available year around.

PHARMACY SERVICE – ROOM DATA SHEETS

Non-Hazardous Clean Room – Room Data Sheet
Description: The following introductory information is provided for the non-hazardous clean rooms. The room comprises three segments: **1.** PEC (Primary Engineering Control) is a device or a space that provides an ISO Class 5 environment for compounding of drugs. ***Selection of the PEC shall be done by the VA Pharmacy Department.*** Generally a laminar airflow work bench (LAFW) is used as the PEC device. The room air need not be exhausted outdoors. Note that USP <797> General Chapter allows the use of a CAI (Compounding Aseptic Isolator) or CACI (Compounding Aseptic Containment Isolator) for Low-Risk Level CSPs (Compounded Sterile Preparations) even without the use of Class 7 Clean Room, provided "non-hazardous and radiopharmaceutical CSPs pursuant to a physician's order for a specific patient may be prepared, and administration of such CSPs shall commence within 12 hours of preparation or as recommended by in the manufacturer's package insert whichever is less." See USP <797> for the Low-Risk Conditions. **2.** Buffer area is the space in which the PEC is physically located. This is the clean room where activities such as preparation and staging of components used for drug preparation take place. Buffer area is maintained at ISO Class 7 by supplying HEPA filtered air unidirectionally from the suspended ceiling. **3.** Anteroom is an ISO Class 8 or better area, which serves as a transient place to maintain the integrity of buffer area. This space also handles personnel hygiene and garbing of the personnel. Physical separation between the anteroom and the buffer area is a wall with doors. Only one set of doors can be opened at any given time to avoid disruption of the air pressure gradient. **4.** See USP <797> for additional requirements for lighting and ceiling surfaces, caulking, etc. **5.** See Figures 6A-1 and 6A-2 for air balance and air flow diagrams.

PHARMACY SERVICE – ROOM DATA SHEETS

PEC and Buffer Room (Non Hazardous Clean Room) – Room Data Sheet	
Inside Design Conditions	● Cooling 68 F [20 C] Dry-Bulb Temperature (maximum) 55% Relative Humidity ● Heating 68 F [20 C] Dry-Bulb Temperature (minimum) 40% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	● 30 – CV Required ● **Note 2**
Return Air	Permitted
Exhaust Air	Not required with 100% re-circulatory ISO Class 5
Room Noise Level	NC 40
Individual Room Temperature Control	Required
Room Air Balance	● Positive (+) with respect to the anteroom ● **Note 3**
Note 1: Room level humidity control is not required. **Note 2:** Air changes listed above must be able to limit the concentration of airborne particles. Provide more air changer per hour, if required to maintain ISO Class 7 particulate count. **Note 3:** Provide outside air as required to maintain the specified pressure differential.	

Anteroom (Non Hazardous Clean Room) – Room Data Sheet	
Inside Design Conditions	● Cooling 68 F [20 C] Dry-Bulb Temperature (maximum) 55% Relative Humidity ● Heating 68 F [20 C] Dry-Bulb Temperature (minimum) 40% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	● 20 – CV Required ● **Note 2**
Return Air	Permitted
Exhaust Air	Not Required
Room Noise Level	NC 40
Individual Room Temperature Control	Required
Room Air Balance	● Positive (+) with respect to circulation space ● Negative (-) with respect to buffer room
Note 1: Room level humidity control is not required. **Note 2:** Air changes listed above must be able to limit the concentration of airborne particles. Provide more air changer per hour, if required, to maintain ISO Class 8 particulate count.	

PHARMACY SERVICE – ROOM DATA SHEETS

Hazardous Clean Room – Room Data Sheet
Description: The following introductory information is provided for the hazardous clean rooms. The room comprises three segments: **1.** PEC (Primary Engineering Control) is a device or a space that provides an ISO Class 5 environment for compounding of drugs. ***Selection of the PEC shall be done by the VA Pharmacy Department.*** Generally, a Biological Safety Cabinet (BSC) Class II B2 is used as the PEC device through which the air is exhausted outdoors after passing over the duct-mounted HEPA filter. See Chapter 3. **2.** Buffer area is the space in which the PEC is physically located. This is the clean room where activities such as preparation and staging of components used for drug preparation take place. Buffer area is maintained at ISO Class 7 by supplying HEPA filtered air and establishing unidirectional flow. **3.** This room can also be used to store hazardous substances, provided that adequate storage space is available. Otherwise, a separate room is required to store hazardous substances. This room should be ventilated at 12 air changes per hour. Exhaust from this room should be connected to the special exhaust system serving the buffer room and anteroom. **4.** Anteroom is an ISO Class 7 or better area, which serves as a transient place to maintain the integrity of buffer area. This space also handles personnel hygiene and garbing of the personnel. Physical separation between the anteroom and buffer area is a wall with doors. Only one set of doors can be opened at any given time to avoid disruption of the air pressure gradient. **5.** See USP <797> for additional requirements for lighting and ceiling surfaces, caulking, etc. **6.** See Figures 6A-1 and 6A-2 for air balance and air flow diagrams.

PEC and Buffer Room (Hazardous Clean Room) – Room Data Sheet	
Inside Design Conditions	● Cooling 68 F [20 C] Dry-Bulb Temperature (maximum) 55% Relative Humidity ● Heating 68 F [20 C] Dry-Bulb Temperature (minimum) 40% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	● 30 – CV Required
Return Air	Not Permitted
Exhaust Air	100%
Room Noise Level	NC 40
Individual Room Temperature Control	Required
Room Air Balance	Negative (-) with respect to the anteroom
Note 1: Room level humidity control is not required.	

PHARMACY SERVICE – ROOM DATA SHEETS

Anteroom (Hazardous Clean Room) – Room Data Sheet	
Inside Design Conditions	● Cooling 68 F [20 C] Dry-Bulb Temperature (maximum) 55% Relative Humidity ● Heating 68 F [20 C] Dry-Bulb Temperature (minimum) 40% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	● 30 – CV Required
Return Air	Not Permitted
Exhaust Air	● 100% ● See Buffer Room above
Room Noise Level	NC 40
Individual Room Temperature Control	Required
Room Air Balance	● Positive (+) with respect to Hazardous Clean Room ● Positive (+) with respect to circulation space whose room pressure is assumed to be neutral (0)
Note 1: Room level humidity control is not required.	

Controlled Substance Vault and Secured Dispensing Receiving Area – Room Data Sheet	
Inside Design Conditions	● Cooling 70 F [21 C] Dry-Bulb Temperature (maximum) 50% Relative Humidity ● Heating 75 F [24 C] Dry-Bulb Temperature (minimum) 35% Relative Humidity ● 5 F [2.8 C] Dead-Band ● **Notes 1 and 2**
Minimum Supply Air Changes per Hour	6 – VAV Permitted
Return Air	Permitted
Exhaust Air	Not Required
Room Noise Level	NC 40
Individual Room Temperature Control	Required
Room Air Balance	Neutral (0)
Note 1: Room level humidity control is not required. **Note 2:** Room humidity shall be 40% if this room is served by the same AHU serving the clean rooms above.	

PHARMACY SERVICE – ROOM DATA SHEETS

Dispensing, Pre-Packing, and EXTEMP – Room Data Sheet	
Inside Design Conditions	● Cooling 70 F [21 C] Dry-Bulb Temperature (maximum) 50% Relative Humidity ● Heating 75 F [24 C] Dry-Bulb Temperature (minimum) 40% Relative Humidity ● 5 F [2.8 C] Dead-Band ● **Notes 1 and 2**
Minimum Supply Air Changes per Hour	6 – VAV Permitted
Return Air	Permitted
Exhaust Air	Not Required
Room Noise Level	NC 40
Individual Room Temperature Control	Required
Room Air Balance	Neutral (0)
Note 1: Room level humidity control is not required. **Note 2:** Room humidity shall be 40% if this room is served by the same AHU serving the clean rooms above.	

Drug Information Service – Room Data Sheet	
Inside Design Conditions	● Cooling 70 F [21 C] Dry-Bulb Temperature (maximum) 50% Relative Humidity ● Heating 75 F [24 C] Dry-Bulb Temperature (minimum) 35% Relative Humidity ● 5 F [2.8 C] Dead-Band ● **Notes 1 and 2**
Minimum Supply Air Changes per Hour	4 – VAV Permitted
Return Air	Permitted
Exhaust Air	Not Required
Room Noise Level	NC 40
Individual Room Temperature Control	Required
Room Air Balance	Neutral (0)
Note 1: Room level humidity control is not required. **Note 2:** Room humidity shall be 40% if this room is served by the same AHU serving the clean rooms above.	

PHARMACY SERVICE – ROOM DATA SHEETS

EXTEMP Repacking and Compounding – Room Data Sheet	
Inside Design Conditions	● Cooling 70 F [21 C] Dry-Bulb Temperature (maximum) 50% Relative Humidity ● Heating 75 F [24 C] Dry-Bulb Temperature (minimum) 35% Relative Humidity ● 5 F [2.8 C] Dead-Band ● **Notes 1 and 2**
Minimum Supply Air Changes per Hour	6 – VAV Permitted
Return Air	Permitted
Exhaust Air	Not Required
Room Noise Level	NC 40
Individual Room Temperature Control	Required
Room Air Balance	Neutral (0)
Note 1: Room level humidity control is not required. **Note 2:** Room humidity shall be 40% if this room is served by the same AHU serving the clean rooms above.	

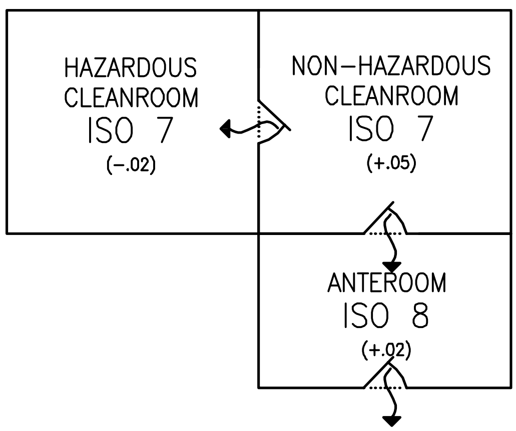
Medicine Assignment and Stat Counter – Room Data Sheet	
Inside Design Conditions	● Cooling 70 F [21 C] Dry-Bulb Temperature (maximum) 50% Relative Humidity ● Heating 75 F [24 C] Dry-Bulb Temperature (minimum) 35% Relative Humidity ● 5 F [2.8 C] Dead-Band ● **Notes 1 and 2**
Minimum Supply Air Changes per Hour	6 – VAV Permitted
Return Air	Permitted
Exhaust Air	Not Required
Room Noise Level	NC 40
Individual Room Temperature Control	Required
Room Air Balance	Neutral (0)
Note 1: Room level humidity control is not required. **Note 2:** Room humidity shall be 40% if this room is served by the same AHU serving the clean rooms above.	

PHARMACY SERVICE – ROOM DATA SHEETS

Prescription Receiving, Filling/Assembly – Room Data Sheet	
Inside Design Conditions	● Cooling 70 F [21 C] Dry-Bulb Temperature (maximum) 50% Relative Humidity ● Heating 75 F [24 C] Dry-Bulb Temperature (minimum) 35% Relative Humidity ● 5 F [2.8 C] Dead-Band ● **Notes 1 and 2**
Minimum Supply Air Changes per Hour	6 – VAV Permitted
Return Air	Permitted
Exhaust Air	Not Required
Room Noise Level	NC 40
Individual Room Temperature Control	Required
Room Air Balance	Neutral (0)
Note 1: Room level humidity control is not required. **Note 2:** Room humidity shall be 40% if this room is served by the same AHU serving the clean rooms above.	

Unit Dose and Ward Stock – Room Data Sheet	
Inside Design Conditions	● Cooling 70 F [21 C] Dry-Bulb Temperature (maximum) 50% Relative Humidity ● Heating 75 F [24 C] Dry-Bulb Temperature (minimum) 35% Relative Humidity ● 5 F [2.8 C] Dead-Band ● **Notes 1 and 2**
Minimum Supply Air Changes per Hour	6 – VAV Permitted
Return Air	Permitted
Exhaust Air	Not Required
Room Noise Level	NC 40
Individual Room Temperature Control	Required
Room Air Balance	Neutral (0)
Note 1: Room level humidity control is not required. **Note 2:** Room humidity shall be 40% if this room is served by the same AHU serving the clean rooms above.	

SKETCH A



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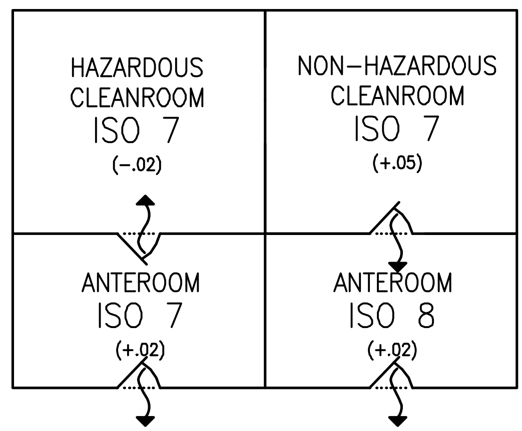

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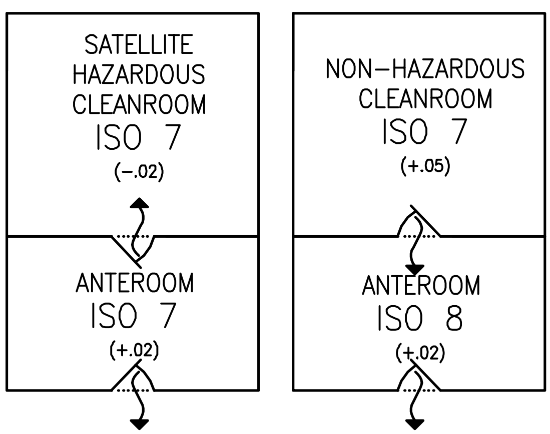


SWING DOORS SHOULD BE GASKETED AND HINGED TO OPEN AGAINST POSITIVE PRESSURE FOR PERSONEL SAFETY AND MAINTAINING PROPER PRESSURE RELATIONSHIPS.

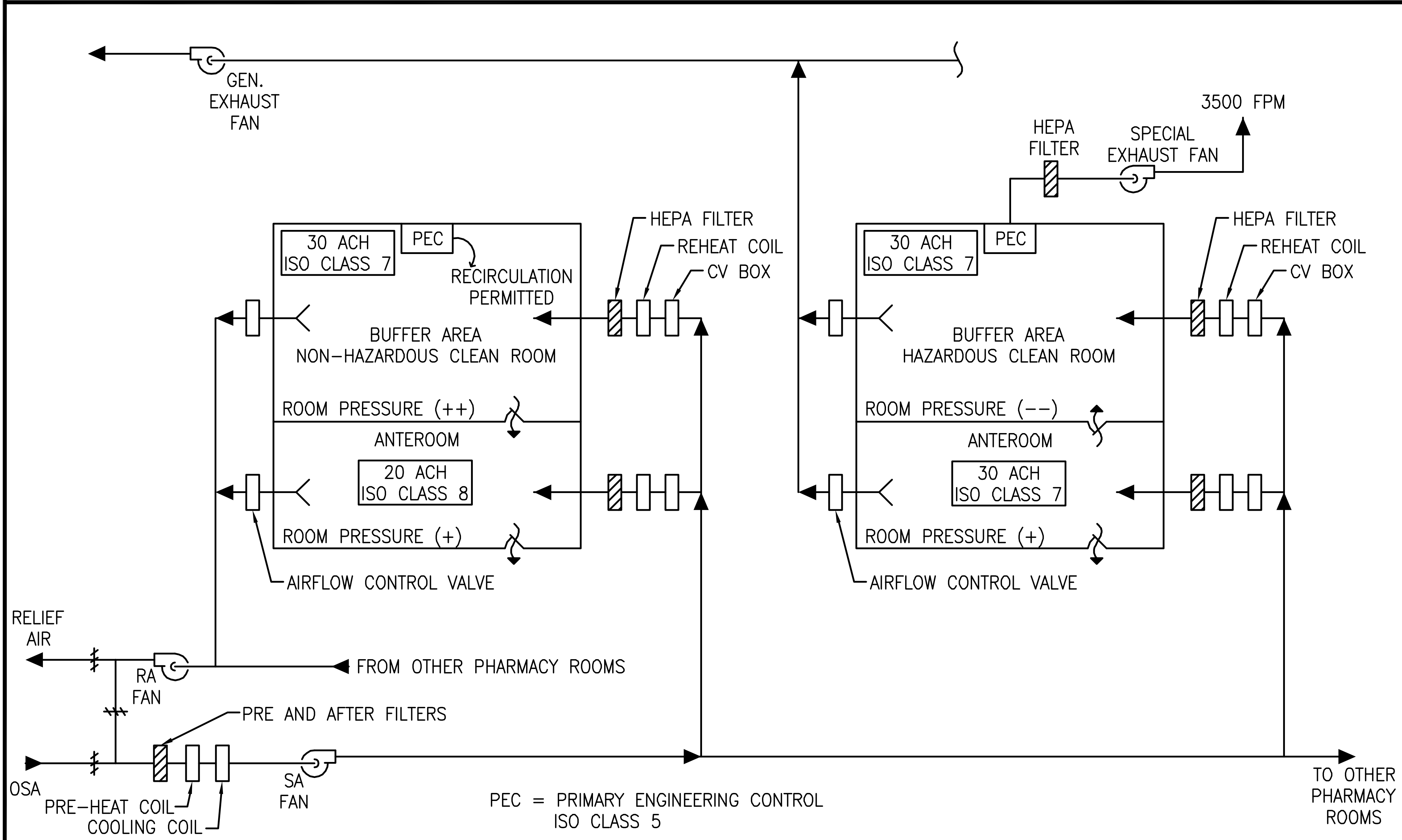
AIR FLOW DIRECTION TO BE MAINTAINED.

DIRECTION OF DOOR SWING

(±.0X) MINIMUM PRESSURE TO BE MAINTAINED (IN INCHES OF WATER GAUGE), AND MONITORED

PHARMACY COMPOUNDING AREAS

Not to Scale



HAZARDOUS / NON-HAZARDOUS ROOMS

Not to Scale

RADIOLOGY SUITE – AIR HANDLING UNIT

AHU Data Sheet	
Air Handling Unit Type	● VAV ● **Note 1**
Inside Design Conditions	Room Data Sheets
Minimum Outside Air	Chapter 2 and Room Data Sheets
Minimum Supply Air Changes per Hour	Room Data Sheets
Return Air	Permitted
Economizer Cycle	ASHRAE 90.1 – 2007
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade D
Cooling Source	● Chilled water from the central chilled water plant ● Refer to Room Data Sheet for the dedicated chiller requirements
Heating Source	● Use high pressure steam from the central boiler plant as the primary source for generating heating hot water and producing “clean steam” for winter humidification. ● Use medium pressure steam from the central boiler plant for unit mounted pre-heat coils.
General Exhaust System(s)	Required
Special Exhaust System(s)	Not Required
Heat Recovery System	Not Required
Emergency Power	Not Required
Special Requirements	**Note 2**

Note 1:

A/E shall be familiar with the related publications of the Office of Construction & Facilities Management.

- Radiology Service Design Guide
- Radiation Therapy Service

These publications contain 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.

Note 2: For HVAC ducts penetrating the lead-lined walls and ceiling, ensure coordination with the architectural discipline and provide treatment as specified by the equipment manufacturer.

RADIOLOGY SUITE – ROOM DATA SHEETS

Chest Room – Room Data Sheet	
Inside Design Conditions	● Cooling 75 F [24 C] Dry-Bulb Temperature 50% Relative Humidity ● Heating 70 F [21 C] Dry-Bulb Temperature 40% Relative Humidity ● 5 F [2.8 C] Dead-Band
Minimum Supply Air Changes per Hour	6 – VAV permitted
Return Air	Permitted
Exhaust Air	Not Required
Room Noise Level	NC 35
Individual Room Temperature Control	Required
Room Air Balance	Positive (+)

CT Suite
General: This suite comprises two separate rooms: ● CT Control Room ● CT Scanning Room

CT Control Room – Room Data Sheet	
Inside Design Conditions	● Cooling 75 F [24 C] Dry-Bulb Temperature 50% Relative Humidity ● Heating 70 F [21 C] Dry-Bulb Temperature 40% Relative Humidity ● 5 F [2.8 C] Dead-Band ● **Note 1**
Minimum Supply Air Changes per Hour	6 – VAV permitted
Return Air	Permitted
Exhaust Air	Not Required
Room Noise Level	NC 40
Individual Room Temperature Control	Required
Room Air Balance	Positive (+)

RADIOLOGY SUITE – ROOM DATA SHEETS

CT Scanning Room – Room Data Sheet	
Inside Design Conditions	● Cooling 75 F [24 C] Dry-Bulb Temperature 50% Relative Humidity ● Heating 70 F [21 C] Dry-Bulb Temperature 40% Relative Humidity ● 5 F [2.8 C] Dead-Band ● **Note 1**
Minimum Supply Air Changes per Hour	6 – VAV permitted
Return Air	Permitted
Exhaust Air	Not Required
Room Noise Level	NC 40
Individual Room Temperature Control	Required
Room Air Balance	Positive (+)
Note 1: Verify with the equipment vendor the need for a dedicated chiller for this room and/or control room. Establish capacity, configuration, and layout of the chilled water system in consultation with the architectural discipline. Investigate the need for a back-up cooling arrangement.	

Film Library and Viewing – Room Data Sheet	
Inside Design Conditions	● Cooling 75 F [24 C] Dry-Bulb Temperature 50% Relative Humidity ● Heating 70 F [21 C] Dry-Bulb Temperature 40% Relative Humidity ● 5 F [2.8 C] Dead-Band
Minimum Supply Air Changes per Hour	4 – VAV permitted
Return Air	Permitted
Exhaust Air	Not Required
Room Noise Level	NC 40
Individual Room Temperature Control	Required
Room Air Balance	Neutral (0)

General Purpose Radiographic/Fluoroscopic Room w/Control – Room Data Sheet	
Inside Design Conditions	● Cooling 75 F [24 C] Dry-Bulb Temperature 50% Relative Humidity ● Heating 70 F [21 C] Dry-Bulb Temperature 40% Relative Humidity ● 5 F [2.8 C] Dead-Band
Minimum Supply Air Changes per Hour	6 – VAV permitted
Return Air	Permitted
Exhaust Air	Not Required
Room Noise Level	NC 40
Individual Room Temperature Control	Required
Room Air Balance	Positive (+)

RADIOLOGY SUITE – ROOM DATA SHEETS

General Purpose X-Ray Room – Room Data Sheet	
Inside Design Conditions	● Cooling 75 F [24 C] Dry-Bulb Temperature 50% Relative Humidity ● Heating 70 F [21 C] Dry-Bulb Temperature 40% Relative Humidity ● 5 F [2.8 C] Dead-Band
Minimum Supply Air Changes per Hour	6 – VAV permitted
Return Air	Permitted
Exhaust Air	Not Required
Room Noise Level	NC 40
Individual Room Temperature Control	Required
Room Air Balance	Positive (+)

Interventional Radiology Suite
General: This suite comprises three separate rooms: ● Special Procedure Room ● Special Procedure Control Room ● Special Procedure System Component Room

Special Procedure Room – Room Data Sheet	
Inside Design Conditions	● Cooling 75 F [24 C] Dry-Bulb Temperature 50% Relative Humidity ● Heating 70 F [21 C] Dry-Bulb Temperature 40% Relative Humidity ● 5 F [2.8 C] Dead-Band
Minimum Supply Air Changes per Hour	15 – VAV permitted
Return Air	● Permitted ● **Note 1**
Exhaust Air	Not Required
Room Noise Level	NC 35
Individual Room Temperature Control	Required
Room Air Balance	Positive (+)
Note 1: Provide two return air pick-ups with high and low return air inlets at each pick-up. Locate the two pick-ups as far away as possible from each other.	

RADIOLOGY SUITE – ROOM DATA SHEETS

Special Procedure Control Room – Room Data Sheet	
Inside Design Conditions	● Cooling 75 F [24 C] Dry-Bulb Temperature 50% Relative Humidity ● Heating 70 F [21 C] Dry-Bulb Temperature 40% Relative Humidity ● 5 F [2.8 C] Dead-Band
Minimum Supply Air Changes per Hour	6 – VAV terminal permitted
Return Air	Permitted
Exhaust Air	Not Required
Room Noise Level	NC 40
Individual Room Temperature Control	Required
Room Air Balance	Positive (+)

Special Procedure System Component Room – Room Data Sheet	
Inside Design Conditions	● Cooling 70 F [21 C] Dry-Bulb Temperature 50% Relative Humidity ● Heating 70 F [21 C] Dry-Bulb Temperature 30% Relative Humidity ● 5 F [2.8 C] Dead-Band ● **Note 1**
Minimum Supply Air Changes per Hour	● To meet cooling load requirements ● **Note 2**
Return Air	● Permitted ● **Note 3**
Exhaust Air	Not Required
Room Noise Level	NC 40
Individual Room Temperature Control	Required
Room Air Balance	Positive (+)
Note 1: Provide a dedicated AC unit to serve the Special Procedure System Component Room. Coordinate unit capacity and configuration with the equipment manufacturer. **Note 2:** Provide environmental air to meet ventilation requirement. **Note 3:** Distribute air supply at or near the floor level and pick up return air at the ceiling level.	

RADIOLOGY SUITE – ROOM DATA SHEETS

Mammography Room – Room Data Sheet	
Inside Design Conditions	● Cooling 75 F [24 C] Dry-Bulb Temperature 50% Relative Humidity ● Heating 70 F [21 C] Dry-Bulb Temperature 40% Relative Humidity ● 5 F [2.8 C] Dead-Band
Minimum Supply Air Changes per Hour	6 – VAV permitted
Return Air	Permitted
Exhaust Air	Not Required
Room Noise Level	NC 35
Individual Room Temperature Control	Required
Room Air Balance	Positive (+)

Radiographic Fluoroscopic Room with Control – Room Data Sheet	
Inside Design Conditions	● Cooling 75 F [24 C] Dry-Bulb Temperature 50% Relative Humidity ● Heating 70 F [21 C] Dry-Bulb Temperature 40% Relative Humidity ● 5 F [2.8 C] Dead-Band
Minimum Supply Air Changes per Hour	6 – CV required
Return Air	Not Permitted
Exhaust Air	100%
Room Noise Level	NC 40
Individual Room Temperature Control	Required
Room Air Balance	Negative (-) for the room and the adjoining toilet

Radiology Waiting Room – Room Data Sheet	
Inside Design Conditions	● Cooling 75 F [24 C] Dry-Bulb Temperature 50% Relative Humidity ● Heating 70 F [21 C] Dry-Bulb Temperature 40% Relative Humidity ● 5 F [2.8 C] Dead-Band
Minimum Supply Air Changes per Hour	12 – CV required
Return Air	Not Permitted
Exhaust Air	100%
Room Noise Level	NC 40
Individual Room Temperature Control	Required
Room Air Balance	Negative (-)

RADIOLOGY SUITE – ROOM DATA SHEETS

Ultrasound Room (with Connected Toilet) – Room Data Sheet	
Inside Design Conditions	● Cooling 75 F [24 C] Dry-Bulb Temperature 50% Relative Humidity ● Heating 70 F [21 C] Dry-Bulb Temperature 40% Relative Humidity ● 5 F [2.8 C] Dead-Band
Minimum Supply Air Changes per Hour	8 – VAV permitted
Return Air	Permitted
Exhaust Air	Not Required
Room Noise Level	NC 40
Individual Room Temperature Control	Required
Room Air Balance	Positive (+) – Ultrasound Room Negative – Toilet

SPINAL CORD INJURY UNIT – AIR HANDLING UNIT

AHU Data Sheet	
Air Handling Unit Type	● VAV ● **Notes 1 and 2**
Inside Design Conditions	Room Data Sheets
Minimum Outside Air	Chapter 2
Minimum Supply Air Changes per Hour	Room Data Sheets
Return Air	Room Data Sheets
Economizer Cycle	ASHRAE 90.1 – 2007
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade D
Cooling Source	Chilled water from the central chilled water plant
Heating Source	● Use high pressure steam from the central boiler plant as the primary source for generating heating hot water and producing "clean steam" for winter humidification. ● Use medium pressure steam from the central boiler plant for unit mounted pre-heat coils.
General Exhaust System(s)	Required
Special Exhaust System(s)	Not Required
Heat Recovery System	Not Applicable
Emergency Power	Not Required

Note 1:

A/E shall become familiar with the related publications of the Office of Construction & Facilities Management.

- Spinal Cord Injury/Disorders (SCI/D) Center Design Guide
- SCI/D Long Care

These publications contain valuable information about the space layout, equipment list, and utility requirements. A design guide plate for each room shows tentative room dimensions and the equipment layout.

Note 2: For rooms not covered in this appendix, refer to Appendix 6-B or the Spinal Cord Injury Design Guide.

SPINAL CORD INJURY UNIT – ROOM DATA SHEETS

Litter Storage – Room Data Sheet	
Inside Design Conditions	● Cooling 77 F [25 C] Dry-Bulb Temperature 55% Relative Humidity ● Heating 68 F [20 C] Dry-Bulb Temperature 30% Relative Humidity ● 9 F [12.7 C] Dead-Band
Minimum Supply Air Changes per Hour	4 – VAV permitted
Return Air	Permitted
Exhaust Air	Not Required
Room Noise Level	NC 40
Individual Room Temperature Control	Required
Room Air Balance	● Negative (-) ● **Note 1**
Note 1: Provide make-up air through door undercut or transfer grille.	

Patient Bedroom – (Spinal Cord Injury Unit) – Room Data Sheet	
Inside Design Conditions	● Year Around Conditions 70 F [21 C] to 82 F [27.8 C] Dry-Bulb Temperature 30% to 50% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	● 6 – VAV permitted ● **Note 2**
Return Air	Permitted
Exhaust Air	Through the connecting toilet
Room Noise Level	NC 35
Individual Room Temperature Control	Required
Room Air Balance	● Positive (+) with respect to toilet ● Negative (-) with respect to corridor
Note 1: The HVAC system shall be sized and selected to maintain any room temperature within the specified range. Cooling load calculations shall be based on 70 F [21 C] and 50% relative humidity. Heating load calculations shall be based on 82 F [27.8 C] and 30% relative humidity. **Note 2:** Per 2007 ASHRAE Handbook of Applications, minimum air changes per hour may be reduced to 4 when using a supplemental heating system.	

SPINAL CORD INJURY UNIT – ROOM DATA SHEETS

Private Litter Bath – Room Data Sheet	
Inside Design Conditions	● Year Around Conditions 70 F [21 C] to 82 F [27.8 C] Dry-Bulb Temperature 30% to 50% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	15 – CV required
Return Air	Not Permitted
Exhaust Air	● 100% ● **Note 2**
Room Noise Level	NC 45
Individual Room Temperature Control	Required
Room Air Balance	Negative (-)

Note 1: The HVAC system shall be sized and selected to maintain any room temperature within the specified range. Cooling load calculations shall be based on 70 F [21 C] and 50% relative humidity. Heating load calculations shall be based on 82 F [27.8 C] and 30% relative humidity.

Note 2: Connect room exhaust to the general exhaust system.

Transfer Equipment Storage – Room Data Sheet	
Inside Design Conditions	● Cooling 77 F [25 C] Dry-Bulb Temperature 55% Relative Humidity ● Heating 68 F [20 C] Dry-Bulb Temperature 30% Relative Humidity ● 9 F [12.7 C] Dead-Band
Minimum Supply Air Changes per Hour	4 – VAV permitted
Return Air	Permitted
Exhaust Air	Not Required
Room Noise Level	NC 40
Individual Room Temperature Control	Required
Room Air Balance	● Negative (-) ● **Note 1**

Note 1: Provide make-up air through a door undercut or transfer grille.

STANDALONE SMOKING FACILITY – AIR HANDLING UNIT

AHU Data Sheet and Room Data Sheet	
Air Handling Unit Type	● CV ● **Notes 1 - 3**
Inside Design Conditions	● Cooling 77 F [25 C] Dry-Bulb Temperature 55% Relative Humidity ● Heating 70 F [21 C] Dry-Bulb Temperature Winter humidification Optional ● Night Unoccupied Mode 59 F [15.0 C] Dry-Bulb Temperature
Minimum Outside Air	● Occupied – 100% ● Night Unoccupied – 0%
Minimum Supply Air Changes per Hour	● 12 or 80 CFM [40 Liters/Second] per person
Return Air	● Permitted during unoccupied modes in day and night time ● **Note 4**
Economizer Cycle	Not Applicable
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade B
Cooling Source	● Chilled water for the chilled water plant ● Dedicated DX unit (split system) or single unit
Heating Source	Select heating fuel (steam, hot water, hot water glycol, gas, or electricity) in consultation with the VA Authorities.
General Exhaust System(s)	Required
Special Exhaust System(s)	Not Applicable
Heat Recovery System	Not Required
Emergency Power	Not Required
Individual Room Temperature Control	Required
Room Air Balance	Neutral (0)

STANDALONE SMOKING FACILITY – AIR HANDLING UNIT

AHU Data Sheet and Room Data Sheet

Note 1: A dedicated, standalone (detached) smoking facility is required per VHA Directive 2003-035 dated July 1, 2003 (Expiration Date: July 31, 2008). Indoor smoking must not interfere with the safety of non-smokers. Per VHA Guidelines, smoking is permitted only for the long-term care patients and mental health program patients.

Note 2:

Compliance

● ASHRAE Standard 62.1 (Latest Edition)
● Joint Commission on Accreditation of Healthcare Organizations (JCAHO).

Note 3: Evaluate and use one of the following three HVAC system selection options:

(a) Use of the chilled water system with modulating control valve is the preferred option to ensure effective control of the space humidity in cooling mode.

(b) With the option of the DX units, provide two refrigeration compressors to ensure effective dehumidification at part load. A single DX coil shall be of the intertwined configuration.

(c) With the option of the chilled water or DX systems, control the supply air temperature leaving the cooling coil and use reheat to prevent overcooling during the build-up of space humidity cycle and activation of the high-humidity override mode.

Note 4: Convert the HVAC system from 100% outside air to 100% re-circulatory mode – either manually with a selector switch or automatically with an occupancy sensor.

SUPPLY PROCESSING AND DISTRIBUTION – AIR HANDLING UNIT

AHU Data Sheet	
Air Handling Unit Type	● CV ● **Note 1**
Inside Design Conditions	Room Data Sheets
Minimum Outside Air	100%
Minimum Supply Air Changes per Hour	Room Data Sheets
Return Air	Not Permitted
Economizer Cycle	Not Applicable
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade B
Cooling Source	Chilled water from the central chilled water plant
Heating Source	● Use high pressure steam from the central boiler plant as the primary source for generating heating hot water and producing “clean steam” for winter humidification. ● Use medium pressure steam from the central boiler plant for unit mounted pre-heat coils.
General Exhaust System(s)	Provide a general exhaust system to serve the SPD area only.
Special Exhaust System(s)	Provide two special exhaust systems – one for Ethylene Oxide (ETO) Chamber and another for the Manual and Automatic Equipment Wash Area.
Heat Recovery System	Per ASHRAE Standard 90.1 – 2007, evaluate the use of a heat recovery system to transfer energy between the exhaust and incoming outside air streams.
Emergency Power	Not Required
Additional Energy Conservation Measures	To meet the mandated goal of 30% additional energy conservation above ASHRAE 90.1 – 2004, evaluate the use of desiccant dehumidification system to reduce the dew-point temperature of the incoming outside air.

Note 1:

(a) Refer to Figure 6A-3 for an air flow diagram.

(b) Entry into SPD from decontamination side – negative (-) with respect to adjoining spaces.

(c) Entry into SPD from clean side – positive (+) with respect to adjoining spaces.

SUPPLY PROCESSING AND DISTRIBUTION – AIR HANDLING UNIT (Back Up Data)

Heat Dissipation:

- Information given below is based on installation of the recessed sterilizers using steam supplied by the central boiler plant.
- Determine the number of sterilizers and their sizes. Sterilizers are available in small, medium, and large sizes.
- Sterilizers are available as single door or double door type. While the single door sterilizers open only on the clean side, double door sterilizers open on both the soiled and clean sides. Heat is dissipated on each side with double door sterilizers. With single door sterilizers, heat is not dissipated on the dirty side.
- In addition to the heat dissipated by the sterilizers, there is a product load, which should be accounted for on the clean side where the sterilized products are removed. Add the product load to the radiated load to determine the total cooling requirements.
- In the matrix given below, the heat dissipation data is given.

Small Sterilizer – Single Door Up to 21 inches x 21 inches x 38 inches [525 mm x 525 mm x 950 mm]	
Heat Dissipation:	
Control End (Dirty End)	Radiated Load: 0 BTUH
Remote End (Clean End)	● Radiated Load: 1,535 BTUH [450 Watts] ● Product Load: 1,750 BTUH [513 Watts] ● Total Load: 3,285 BTUH [963 Watts]
Recessed Space (Between Clean and Dirty Sides)	Radiated Load: 4,295 BTUH [1,258 Watts]

Small Sterilizer – Double Door Up to 21 inches x 21 inches x 38 inches [525 mm x 525 mm x 950 mm]	
Heat Dissipation:	
Control End (Dirty End)	Radiated Load: 1,535 BTUH [450 Watts]
Remote End (Clean End)	● Radiated Load: 1,535 BTUH [450 Watts] ● Product Load: 1,750 BTUH [513 Watts] ● Total Load: 3,285 BTUH [963 Watts]
Recessed Space (Between Clean and Dirty Sides)	Radiated Load: 4,295 BTUH [1,258 Watts]

SUPPLY PROCESSING AND DISTRIBUTION – AIR HANDLING UNIT (Back Up Data)

Medium Sterilizer – Single Door Up to 26.5 inches x 36 inches x 61 inches [663 mm x 900 mm x 525 mm]	
Heat Dissipation:	
Control End (Dirty End)	Radiated Load: 0 BTUH
Remote End (Clean End)	● Radiated Load: 3,110 BTUH [911 Watts] ● Product Load: 3,500 [1,025 Watts] ● Total Load: 6,610 BTUH [1,936 Watts]
Recessed Space (Between Clean and Dirty Sides)	Radiated Load: 9,770 BTUH [2,863 Watts]

Medium Sterilizer – Double Door Up to 26.5 inches x 36 inches x 61 inches [663 mm x 900 mm x 1525 mm]	
Heat Dissipation:	
Control End (Dirty End)	Radiated Load: 3,110 BTUH [911 Watts]
Remote End (Clean End)	● Radiated Load: 3,110 BTUH [911 Watts] ● Product Load: 3,500 [1,025 Watts] ● Total Load: 6,610 BTUH [1,936 Watts]
Recessed Space (Between Clean and Dirty Sides)	Radiated Load: 9,770 BTUH [2,863 Watts]

Large Sterilizer – Single Door Up to 26 inches x 62 inches x 76 inches [650 mm x 1550 mm x 1900 mm]	
Heat Dissipation:	
Control End (Dirty End)	Radiated Load: 0 BTUH
Remote End (Clean End)	● Radiated Load: 6,235 BTUH [1,827 Watts] ● Product Load: 6,500 BTUH [1,904 Watts] ● Total Load: 12,735 BTUH [3,731 Watts]
Recessed Space (Between Clean and Dirty Sides)	Radiated Load: 17,500 BTUH [5,127 Watts]

Large Sterilizer – Double Door Up to 26 inches x 62 inches x 76 inches [650 mm x 1550 mm x 1900 mm]	
Heat Dissipation:	
Control End (Dirty End)	Radiated Load: 6,235 BTUH [1,827 Watts]
Remote End (Clean End)	● Radiated Load: 6,235 BTUH [1,827 Watts] ● Product Load: 6,500 BTUH [1,904 Watts] ● Total Load: 12,735 BTUH [3,731 Watts]
Recessed Space (Between Clean and Dirty Sides)	Radiated Load: 17,500 BTUH [5,127 Watts]

SUPPLY PROCESSING AND DISTRIBUTION – ROOM DATA SHEETS

Decontamination Dressing Room – Room Data Sheet	
Inside Design Conditions	●Cooling 65 F [18.3 C] Dry-Bulb Temperature 80% Relative Humidity ●Heating 65 F [18.3 C] Dry-Bulb Temperature 30% Relative Humidity
Minimum Supply Air Changes per Hour	4
Return Air	Not Permitted
Exhaust Air	100%
Room Noise Level	NC 40
Individual Room Temperature Control	Required
Room Air Balance	● Positive (+) with respect to: - Soiled Receiving and Decontamination Area - Toilets ● Negative (-) with respect to: - Surrounding Area

SUPPLY PROCESSING AND DISTRIBUTION – ROOM DATA SHEETS

ETO Sterilizer/Aerator Room and ETO Tank Storage – Room Data Sheet	
Inside Design Conditions	Conditioned by transfer air
Minimum Exhaust Air Changes per Hour	10
Return Air	Not Permitted
Exhaust Air	● 100% ● **Note 1**
Room Noise Level	NC 45
Individual Room Temperature Control	Not Required
Room Air Balance	Negative (-) with respect to the clean side

Note 1:

(a) Provide a dedicated exhaust system to serve ETO sterilizer, mechanical chase, ETO cylinder storage space, ETO aerator, ETO relief valve discharge pipe, and ETO sterilizer door area.

(b) Coordinate exhaust requirements with the equipment manufacturer.

(c) Exhaust fan shall operate 7 (days a week) x 24 (hours a day) even when the AHU is shutdown.

(d) Provide emergency power for the exhaust fan.

(e) Exhaust duct shall be continuously welded.

(f) Exhaust air shall be discharged from the highest point (minimum 10 Feet [3.0 Meters]) above the building in accordance with the recommendations of the dispersion analysis.

(g) Provide an airflow control valve in each exhaust branch duct to ensure exact balancing of all branch ducts with widely varying static pressure drops.

(h) Provide local and ECC alarm capabilities in the event of exhaust fan malfunction or failure.

(i) Do not attempt heat recovery from the exhaust air stream of the ETO exhaust system.

SUPPLY PROCESSING AND DISTRIBUTION – ROOM DATA SHEETS

Equipment Storage and Testing Room – Room Data Sheet **Clean/Sterile Storage – Room Data Sheet** **Case Cart – Room Data Sheet** **Dispatcher's Control Room – Room Data Sheet**	
Inside Design Conditions	●Cooling 73 F [23.0 C] Dry-Bulb Temperature 55% Relative Humidity ●Heating 68 F [20.0 C] Dry-Bulb Temperature 35% Relative Humidity
Minimum Supply Air Changes per Hour	4
Return Air	Not Permitted
Exhaust Air	100%
Room Noise Level	NC 40
Individual Room Temperature Control	Required
Room Air Balance	Positive (+) with respect to: ● Automatic Equipment Wash ● Manual Equipment Washroom ● Toilets ● HAC ● Surrounding Area Negative (-) with respect to: ● Preparation, Assembly, and Sterilization Room

Manual and/or Automatic Equipment Wash Area – Room Data Sheet	
Inside Design Conditions	Conditioned by transfer air
Minimum Exhaust Air Changes per Hour	10
Return Air	Not Permitted
Exhaust Air	● 100% ● **Note 1**
Room Noise Level	NC 45
Individual Room Temperature Control	Not Required
Room Air Balance	Negative (-) with respect to the clean side
Note 1: **(a)** Provide a dedicated "wet exhaust" system to serve this space. **(b)** Coordinate exhaust requirements with the equipment manufacturer. **(c)** Provide emergency power for the spark-proof exhaust fan and explosion-proof motor. **(d)** Exhaust duct shall be continuously welded, stainless steel. **(e)** Do not attempt heat recovery from the wet exhaust.	

SUPPLY PROCESSING AND DISTRIBUTION – ROOM DATA SHEETS

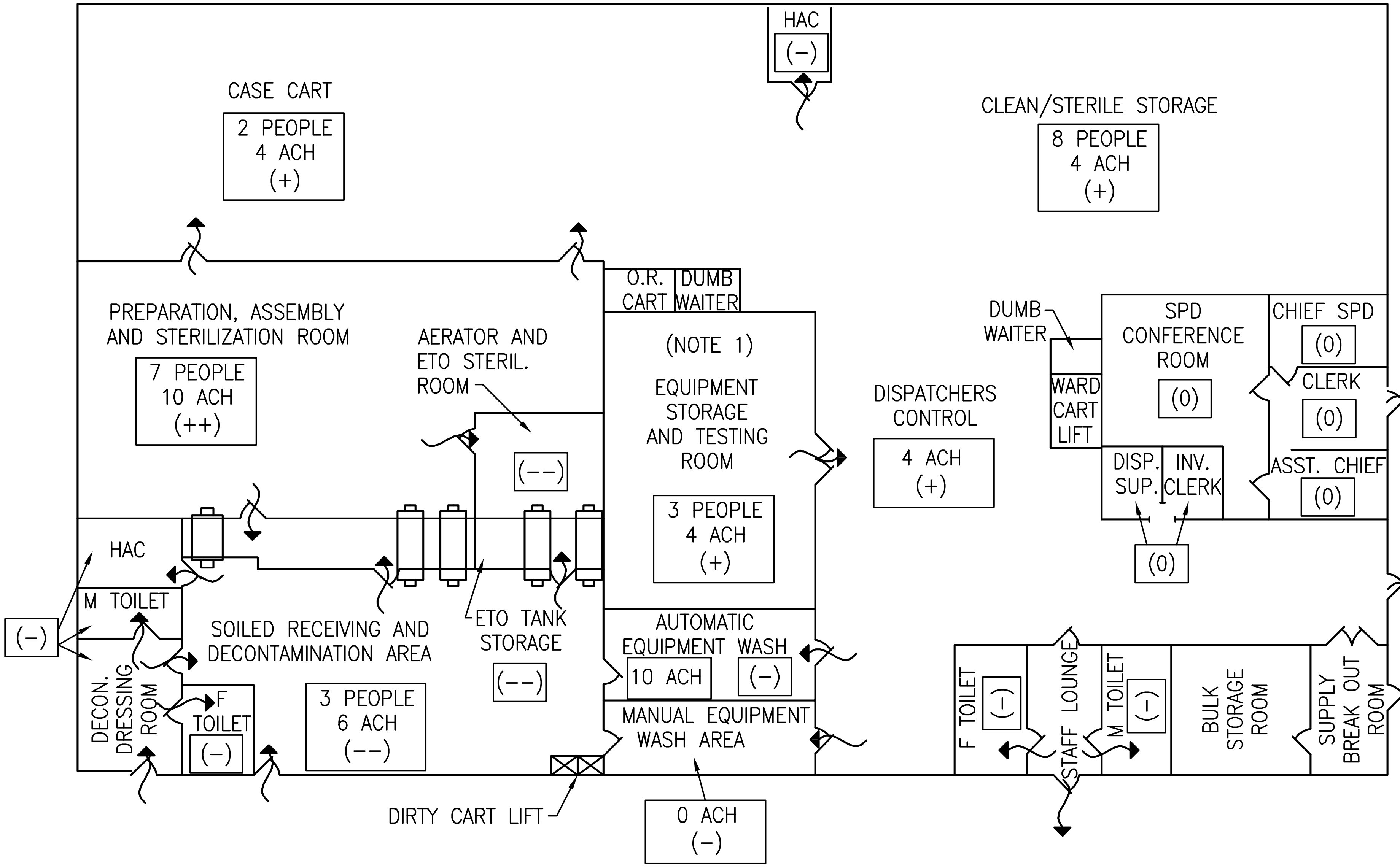
Preparation, Assembly, Packaging, and Sterilization – Room Data Sheet	
Inside Design Conditions	●Cooling 73 F [23.0 C] Dry-Bulb Temperature 55% Relative Humidity ●Heating 68 F [20.0 C] Dry-Bulb Temperature 35% Relative Humidity
Minimum Supply Air Changes per Hour	10
Return Air	Not Permitted
Exhaust Air	● 100% ● **Note 1**
Room Noise Level	NC 40
Individual Room Temperature Control	Required
Room Air Balance	● This is the cleanest space in the SPD Department. Maintain this space under double positive (+ +) air balance with respect to the adjoining spaces by retaining 30% air in the room, after making allowance for the make-up air needs of the ETO enclosure and sterilizer chamber. Air from other spaces shall not be allowed to enter into this room. Design air distribution layout accordingly. ● Provide an airflow control valve in the exhaust air duct leaving this room to demonstrate compliance. ● Provide positive pressure indicator between Preparation, Assembly, Packaging and Sterilization room and the case cart area.
Note 1: Provide continuous canopy hood over the sterilizers and draw exhaust air into the hood and over the sterilizers.	

SUPPLY PROCESSING AND DISTRIBUTION – ROOM DATA SHEETS

Soiled, Receiving, and Contamination Area – Room Data Sheet	
Inside Design Conditions	●Cooling 65 F [18.3 C] Dry-Bulb Temperature 80% Relative Humidity ●Heating 65 F [18.3 C] Dry-Bulb Temperature 30% Relative Humidity
Minimum Supply Air Changes per Hour	6
Return Air	Not Permitted
Exhaust Air	● 100% ● **Note 1**
Room Noise Level	NC 45
Individual Room Temperature Control	Required
Room Air Balance	● This is the most soiled space in the SPD Department. Maintain this space under double negative (- -) air balance with respect to the adjoining spaces by admitting at least 30% make-air in the room and ensuring that air from this room does not ex-filtrate into other spaces. Design air distribution layout accordingly. ● If required, provide an exhaust fan complete with ductwork to inject clean make-up air from the clean side.
Note 1: Provide continuous canopy hood over the sterilizers and draw exhaust air into the hood and over the sterilizers	

NOTE 1 : PARTITION WALLS ARE OPTIONAL
ACH : AIR CHANGES PER HOUR
: DIRECTION OF AIRFLOW

\+ : POSITIVE AIR BALANCE
\- : NEGATIVE AIR BALANCE
0 : NEUTRAL AIR BALANCE



SUPPLY PROCESSING AIR FLOW DIAGRAM

Not to Scale

SURGICAL SUITE – AIR HANDLING UNIT

AHU Data Sheet	
Air Handling Unit Type	● VAV ● **Notes 1-3**
Inside Design Conditions - Operating Rooms	● Room Data Sheet ● **Notes 4 and 5**
Minimum Outside Air	100%
Minimum Supply Air Changes per Hour	Room Data Sheet
Return Air	Not Permitted
Economizer Cycle	Not Applicable
Filtration – Supply Air System	● Pre-Filters: VA Grade B ● After Filters: VA Grade C ● Final-Filters: VA Grade E ● **Note 6**
Filtration – Exhaust Air System	Provide VA Grade A filters in the exhaust air stream, when a heat recovery device is installed.
Cooling Source	Provide a dedicated, air-cooled chiller to serve the surgical suite, recovery rooms, and intensive care units. See Chapter 4 for the required interface between the central chilled water plant and the dedicated air-cooled chiller.
Heating Source	● Use high pressure steam from the central boiler plant as the primary source for generating heating hot water and producing “clean steam” for winter humidification. ● Use medium pressure steam from the central boiler plant for unit mounted pre-heat coils.
General Exhaust System(s)	● Provide a general exhaust system to exhaust air from all spaces. ● Provide a pressure-independent, airflow control valve in each main exhaust duct takeoff (from each operating room), formed after connecting two or four exhaust branch duct takeoffs of each operating room. The airflow control valve shall track the supply air volume to maintain the required air balance under occupied/unoccupied mode. ● Group the remaining exhaust duct takeoffs from each non-operating room (space) to form a common exhaust main. Install a pressure-independent, airflow control valve in the common main duct to make the exhaust system pressure-independent. ● During unoccupied mode, all support areas shall continue to operate at the full design flow rates.
Special Exhaust System(s)	Not Required
Heat Recovery System	Per ASHRAE Standard 90.1 – 2007, evaluate the use of a heat recovery system to transfer energy between the exhaust and incoming outside air streams
Emergency Power	Provide emergency power for all components of the HVAC systems, including DDC controls.

SURGICAL SUITE – AIR HANDLING UNIT

AHU Data Sheet	
Additional Energy Conservation Measures	To meet the mandated goal of 30% additional energy conservation above ASHRAE 90.1 – 2004, evaluate the use of desiccant dehumidification system to reduce the dew-point temperature of the incoming outside air.

Note 1:

(a) For each operating room, provide a two-position, pressure-independent air terminal unit to reduce the supply air volume to half during unoccupied mode.

(b) Provide a variable speed drive for the supply air fan to adjust the supply air volume in response to the reduced air volume during unoccupied mode and variation in the filter loading. Provide a variable speed drive for the general exhaust fan to track the supply air fan to maintain the required air balance. Provide airflow-measuring devices in the supply and exhaust air systems to measure and monitor the respective air volumes.

Note 2: Supply Air Ductwork

(a) Construct all supply air ductwork from the downstream side of the supply air fan discharge to the inlet of each air terminal unit from stainless steel. All joints (longitudinal and transverse) shall be watertight. Provide airtight access panels at each elbow and at 20 Foot [6 Meter] intervals in straight duct runs for cleaning and access. All ductwork shall be low-velocity type with maximum velocity through the main ducts not to exceed 1,800 Feet/Minute [9.0 Meters/Second]. Do not install any acoustic devices (sound attenuators – acoustic lining) in the supply air ductwork.

(b) Construct all air terminal units serving operating rooms, Cystoscopy Room, Clean Corridor, and Soiled Corridor from galvanized steel. Do not install any acoustic devices (sound attenuators – acoustic lining). All terminal reheat coils shall be equipped with copper tubes and copper fins.

(c) Construct all ductwork and air distribution system on the downstream side of the above terminal units from welded stainless steel. Use of flexible ductwork is ***not*** permitted for connecting air terminal units and air distribution devices. See Room Data Sheets.

(d) Construct all remaining air terminal units serving the support functions described in the room data sheets as standard, factory-fabricated units of conventional galvanized steel. Use of acoustic devices (sound attenuators – acoustic lining) is permitted.

(e) Construct all supply air ductwork on the downstream side of the remaining terminal units serving the support areas from galvanized steel. All joints (longitudinal and transverse) shall be watertight. All ductwork shall be low-velocity type with maximum velocity through the main ducts not to exceed 1,500 Feet/Minute [7.5 Meters/Second]. Do not install any acoustic devices (sound attenuators – acoustic lining) in the supply air ductwork. Supply air outlets shall be constructed from galvanized steel or aluminum.

Note 3: Provide high and low limit set points (> 60 F [15.6 C] and < 40F [4.4 C]) to shut down the AHU in the event the supply air temperature exceeds the above limits.

SURGICAL SUITE – AIR HANDLING UNIT

AHU Data Sheet

Note 4:

(a) Calculate the cooling capacity for the operating rooms based on 62 F [16.7 C] dry-bulb temperature, 60% relative humidity, and approximately 48 F [8.9 C] dew-point temperature. Optimize parameters such as cooling coil selection (rows deep, fins spacing, and coil face velocity) and chilled water temperature entering the cooling coil to obtain the required dew-point temperature for the conditioned air.

(b) Where lower than 60% relative humidity at 62 F [16.7 C] dry bulb temperature is required, lower the leaving chilled water from the dedicated chiller to the extent permitted by the chiller manufacturer for stable operation. See Chapter 4 for the arrangement requiring two cooling coils in series.

Note 5: Humidification

(a) Primary Humidification (up to 30% Relative Humidity at 80 F [26.7 C] Dry-Bulb Temperature): Provide a unit-mounted (alternate location – main supply air duct) primary humidifier to maintain 46 F [7.8 C] dew-point temperature. When located in the supply air duct, provide welded, stainless steel duct on the upstream and downstream sides of the humidifier as shown in the VA Standard Detail. Pitch the stainless steel duct to collect liquid steam at the lowest end. Provide a drain on the bottom face of the duct.

(b) Humidification (up to 45% Relative Humidity): Provide a duct-mounted, terminal humidifier for each operating room, Cystoscopy Room, Clean Corridor, and Soiled Corridor, to raise the air dew-point temperature from 46 F [7.8 C] to 57.8 F [14.3 C]. Provide individual room humidity control to maintain space relative humidity up to 45% at 80 F [26.7 C] dry-bulb temperature. ***Locate terminal air unit and terminal humidifier outside the operating room.***

(c) Locate terminal humidifier on the downstream side of the supply air terminal units. See VA Standard Detail. Select the type and location of the terminal humidifier to ensure that the moisture released by the terminal humidifier is fully absorbed into the supply air stream. Provide elbow between humidifier and final terminal filter. Provide drain area. This is critical to ensure the success of the secondary humidification.

Note 6:

(a) Locate pre-filters (first bed) and after-filters (second bed) in a common section (frame) on the upstream side of the supply air fan.

(b) Locate final filters (third bed) on the downstream side of each individual air terminal unit serving the surgical suite. See Room Data Sheet for details.

SURGICAL SUITE – ROOM DATA SHEETS

Anesthesia Workroom and Equipment – Room Data Sheet	
Inside Design Conditions	● Year Around Conditions 70 F [21 C] to 75 F [24 C] Dry-Bulb Temperature 30% to 50% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	8 – CV required
Return Air	Not Permitted
Exhaust Air	100%
Room Noise Level	NC 35
Terminal Filtration	VA Grade C
Individual Room Temperature Control	Required
Room Air Balance	Negative (-)
Note 1: The HVAC system shall be sized and selected to maintain any room temperature within the specified range. Cooling load calculations shall be based on 70 F [21 C] and 50% relative humidity. Heating load calculations shall be based on 75 F [24 C] and 30% relative humidity.	

Clean Corridor – Room Data Sheet	
Inside Design Conditions	● Year Around Conditions 68 F [20 C] to 75 F [24 C] Dry-Bulb Temperature 40% to 50% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	6 – CV required
Return Air	Not Permitted
Exhaust Air	100%
Room Noise Level	NC 40
Terminal Filtration	VA Grade E (HEPA)
Individual Room Temperature Control	Required
Room Air Balance	Positive (+)
Note 1: The HVAC system shall be sized and selected to maintain any room temperature within the specified range. Cooling load calculations shall be based on 68 F [20 C] and 50% relative humidity. Heating load calculations shall be based on 75 F [24 C] and 40% relative humidity.	

SURGICAL SUITE – ROOM DATA SHEETS

Controls and Communication Center – Room Data Sheet	
Inside Design Conditions	● Year Around Conditions 70 F [21 C] to 75 F [24 C] Dry-Bulb Temperature 30% to 50% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	8 – CV required
Return Air	Not Permitted
Exhaust Air	100%
Room Noise Level	NC 40
Terminal Filtration	VA Grade C
Individual Room Temperature Control	Required
Room Air Balance	Neutral (0)
Note 1: The HVAC system shall be sized and selected to maintain any room temperature within the specified range. Cooling load calculations shall be based on 70 F [21 C] and 50% relative humidity. Heating load calculations shall be based on 75 F [24 C] and 30% relative humidity.	

SURGICAL SUITE – ROOM DATA SHEETS

Cystoscopy Rooms – Room Data Sheet	
Inside Design Conditions	● Year Around Conditions 68 F [20 C] to 73 F [22.7 C] Dry-Bulb Temperature 30% to 60% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	● 20/10 Unoccupied ● **Note 2**
Return Air	Not Permitted
Exhaust Air	100%
Air Distribution	**Note 3**
Room Noise Level	NC 35
Terminal Filtration	VA Grade E (HEPA)
Individual Room Temperature Control	● Required ● **Note 4**
Room Air Balance	Positive (+) with respect to the adjoining corridor during both modes of operation

Note 1: The HVAC system shall be sized and selected to maintain any room temperature within the specified range. Cooling load calculations shall be based on 62 F [16.7 C] and 60% relative humidity. Heating load calculations shall be based on 80 F [26.7 C] and 30% relative humidity.

Note 2:

(a) Change from occupied to unoccupied mode shall be accomplished either by a manual selector switch or by a DDC electronic time clock. Location of the manual switch shall be decided in consultation with the local surgical service. During unoccupied mode, the supply air changes shall be reduced to half.

(b) Provide an airflow control valve in the exhaust air duct to adjust the exhaust air volume in unison with the supply air volume and to maintain the positive air balance during the occupied and unoccupied modes of operations.

(c) Turn off the terminal humidifier during unoccupied mode

Note 3: Air distribution for each Cystoscopy Room shall consist of stainless steel multiple slot panel diffusers positioned around the operating tables to discharge 60% supply air in a vertical air stream inclined at a 15 degree outward angle. Percentage distribution may vary with the manufacturer. The remaining 40% of air shall be delivered downward over the operating area using perforated face outlets. Provide a minimum of two exhaust registers in each O.R., located diagonally opposite each other, 7 inches [175 mm] above the finished floor. The exhaust air quantity shall be at least 15% less than the supply air to maintain positive air balance between the O.R. and the adjoining areas.

Note 4: Record and maintain the space temperature and humidity data at the ECC. Store the data in the form of Excel type spreadsheets.

SURGICAL SUITE – ROOM DATA SHEETS

Frozen Section Laboratories – Room Data Sheet	
Inside Design Conditions	● Year Around Conditions 70 F [21 C] to 75 F [24 C] Dry-Bulb Temperature 30% to 50% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	12 – CV Required
Return Air	Not Permitted
Exhaust Air	100%
Room Noise Level	NC 40
Terminal Filtration	VA Grade C
Individual Room Temperature Control	Required
Room Air Balance	Negative (-)
Note 1: The HVAC system shall be sized and selected to maintain any room temperature within the specified range. Cooling load calculations shall be based on 70 F [21 C] and 50% relative humidity. Heating load calculations shall be based on 75 F [24 C] and 30% relative humidity.	

Gas Cylinder Storage Room – Room Data Sheet	
Inside Design Conditions	Conditioned by 100% Make-Up Air
Minimum Supply Air Changes per Hour	6
Return Air	Not Permitted
Exhaust Air	100%
Room Noise Level	NC 40
Terminal Filtration	Not Applicable
Individual Room Temperature Control	Not Required
Room Air Balance	Double Negative (- -)

Heart Lung Machine Preparation – Room Data Sheet	
Inside Design Conditions	● Year Around Conditions 70 F [21 C] to 75 F [24 C] Dry-Bulb Temperature 30% to 50% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	8 – CV required
Return Air	Not Permitted
Exhaust Air	100%
Room Noise Level	NC 35
Terminal Filtration	VA Grade C
Individual Room Temperature Control	Required
Room Air Balance	Neutral (0)
Note 1: The HVAC system shall be sized and selected to maintain any room temperature within the specified range. Cooling load calculations shall be based on 70 F [21 C] and 50% relative humidity. Heating load calculations shall be based on 75 F [24 C] and 30% relative humidity.	

SURGICAL SUITE – ROOM DATA SHEETS

Instrument Preparation and Storage Room – Room Data Sheet	
Inside Design Conditions	● Year Around Conditions 70 F [21 C] to 75 F [24 C] Dry-Bulb Temperature 30% to 50% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	8 – CV Required
Return Air	Not Permitted
Exhaust Air	100%
Room Noise Level	NC 40
Terminal Filtration	VA Grade C
Individual Room Temperature Control	Required
Room Air Balance	Positive (+)
Note 1: The HVAC system shall be sized and selected to maintain any room temperature within the specified range. Cooling load calculations shall be based on 70 F [21 C] and 50% relative humidity. Heating load calculations shall be based on 75 F [24 C] and 30% relative humidity.	

Nerve Block Induction Room – Room Data Sheet	
Inside Design Conditions	● Year Around Conditions 70 F [21 C] to 75 F [24 C] Dry-Bulb Temperature 30% to 50% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	10 – CV required
Return Air	Not Permitted
Exhaust Air	100%
Room Noise Level	NC 40
Terminal Filtration	VA Grade C
Individual Room Temperature Control	Required
Room Air Balance	Positive (+)
Note 1: The HVAC system shall be sized and selected to maintain any room temperature within the specified range. Cooling load calculations shall be based on 70 F [21 C] and 50% relative humidity. Heating load calculations shall be based on 75 F [24 C] and 30% relative humidity.	

SURGICAL SUITE – ROOM DATA SHEETS

Operating Rooms – Room Data Sheet	
Inside Design Conditions	● Year Around Conditions 62 F [16.7 C] to 80 F [26.7 C] Dry-Bulb Temperature 30% to 60% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	● 20/10 Unoccupied ● **Note 2**
Return Air	Not Permitted
Exhaust Air	100%
Room Noise Level	NC 35
Terminal Filtration	VA Grade E (HEPA)
Air Distribution	**Note 3**
Individual Room Temperature Control	● Required ● **Note 4**
Room Air Balance	Positive (+) with respect to the adjoining corridor during both modes of operation

Note 1: The HVAC system shall be sized and selected to maintain any room temperature within the specified range. Cooling load calculations shall be based on 62 F [16.7 C] and 60% relative humidity. Heating load calculations shall be based on 80 F [26.7 C] and 30% relative humidity.

Note 2:

(a) Change from occupied to unoccupied mode shall be accomplished either by a manual selector switch or by a DDC electronic time clock. Location of the manual switch shall be decided in consultation with the local surgical service. During unoccupied mode, the supply air changes shall be reduced to half.

(b) Provide an airflow control valve in the exhaust air duct to adjust the exhaust air volume in unison with the supply air volume and to maintain the positive air balance during the occupied and unoccupied modes of operations.

(c) Turn off the terminal humidifier during unoccupied mode

Note 3: Air distribution for each operating room shall consist of stainless steel multiple slot panel diffusers positioned around the operating tables to discharge 60% supply air in a vertical air stream inclined at a 15 degree outward angle. Percentage distribution may vary with the manufacturer. The remaining 40% of air shall be delivered downward over the operating area using perforated face outlets. Provide a minimum of two exhaust registers in each O.R., located diagonally opposite each other, 7 inches [175 mm] above the finished floor. The exhaust air quantity shall be at least 15% less than the supply air to maintain positive air balance between the O.R. and the adjoining areas.

Note 4: Record and maintain the space temperature and humidity data at the ECC. Store the data in the form of Excel-type spreadsheets.

SURGICAL SUITE – ROOM DATA SHEETS

Plaster Splint Storage – Room Data Sheet	
Inside Design Conditions	● Year Around Conditions 70 F [21 C] to 75 F [24 C] Dry-Bulb Temperature 30% to 50% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	4 – CV Required
Return Air	Not Permitted
Exhaust Air	100%
Room Noise Level	NC 40
Terminal Filtration	VA Grade C
Individual Room Temperature Control	Required
Room Air Balance	Negative (-)
Note 1: The HVAC system shall be sized and selected to maintain any room temperature within the specified range. Cooling load calculations shall be based on 70 F [21 C] and 50% relative humidity. Heating load calculations shall be based on 75 F [24 C] and 30% relative humidity.	

Radiographic Film Processing Room – Room Data Sheet	
Inside Design Conditions	● Year Around Conditions 70 F [21 C] to 75 F [24 C] Dry-Bulb Temperature 30% to 50% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	8 – CV Required
Return Air	Not Permitted
Exhaust Air	100%
Room Noise Level	NC 40
Terminal Filtration	VA Grade C
Individual Room Temperature Control	Required
Room Air Balance	Negative (-)
Note 1: The HVAC system shall be sized and selected to maintain any room temperature within the specified range. Cooling load calculations shall be based on 70 F [21 C] and 50% relative humidity. Heating load calculations shall be based on 75 F [24 C] and 30% relative humidity.	

SURGICAL SUITE – ROOM DATA SHEETS

Soiled Corridor – Room Data Sheet	
Inside Design Conditions	● Year Around Conditions 70 F [21 C] to 75 F [24 C] Dry-Bulb Temperature 30% to 50% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	6 – CV required
Return Air	Not Permitted
Exhaust Air	100%
Room Noise Level	NC 40
Terminal Filtration	VA Grade E (HEPA)
Individual Room Temperature Control	Required
Room Air Balance	Negative (-) with respect to the Operating Rooms
Note 1: The HVAC system shall be sized and selected to maintain any room temperature within the specified range. Cooling load calculations shall be based on 70 F [21 C] and 50% relative humidity. Heating load calculations shall be based on 75 F [24 C] and 30% relative humidity.	

Soiled Holding/Disposal Room – Room Data Sheet	
Inside Design Conditions	Conditioned by 100% Make-Up Air
Minimum Supply Air Changes per Hour	10 – CV required
Return Air	Not Permitted
Exhaust Air	100%
Room Noise Level	NC 40
Terminal Filtration	Not Applicable
Individual Room Temperature Control	Not Required
Room Air Balance	Double Negative (- -)

SURGICAL SUITE – ROOM DATA SHEETS

Sub-Sterile Room – Room Data Sheet	
Inside Design Conditions	● Year Around Conditions 70 F [21 C] to 75 F [24 C] Dry-Bulb Temperature 30% to 50% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	Not Required – All make-up air from the adjoining spaces
Return Air	Not Permitted
Exhaust Air	● 100% ● **Notes 2 and 3**
Room Noise Level	NC 40
Terminal Filtration	VA Grade C
Individual Room Temperature Control	Not Required
Room Air Balance	Double Negative (- -)

Note 1: The HVAC system shall be sized and selected to maintain any room temperature within the specified range. Cooling load calculations shall be based on 70 F [21 C] and 50% relative humidity. Heating load calculations shall be based on 75 F [24 C] and 30% relative humidity.

Note 2:

(a) Change from occupied to unoccupied mode shall be accomplished either by a manual selector switch or by a DDC electronic time clock. Location of the manual switch shall be determined in consultation with the local surgical service. During unoccupied mode the supply air changes shall be reduced to half.

(b) Provide an airflow control valve in the exhaust air duct to adjust the exhaust air volume in unison with the supply air volume and to maintain the positive air balance during the occupied and unoccupied modes of operations.

(c) Turn off the terminal humidifier during unoccupied mode.

Note 3: Room exhaust shall pass through the canopy hood serving the sterilizer.

Suggested Operating Guidelines

The following matrix is provided for the benefit of the Engineering Services at the VA Facilities as the suggested operating guidelines for the operation of the surgery suite system. The matrix establishes relationship between:

- Actual chilled water temperature entering the surgery air-handling unit
- Resulting inside temperature and humidity at varying chilled water temperatures
- Status of the cooling source (central plant or a dedicated chiller)

Use this matrix in conjunction with the notes written below and in consultation with the surgery department.

Surgical Suite Air – Handling Unit
Cooling Back-Up Data for System Operation
Inside Design Conditions – Chilled Water Temperature – System Availability

Inside Design Conditions			Discharge Air Dew-Point Degrees F	Required Chilled Water Temperature Degrees F	Can Use Central Plant? Yes/No	Require to Use Dedicated Chiller? Yes/No
Temperature Degrees F	Humidity % RH	Dew-Point Degrees F				
62	55		44.67	40.67 (41)	No	Yes
62	60	47.98	46.98	42.98 (43)	Yes	Yes
65	50	45.94	44.94	40.94 (41)	No	Yes
65	55	48.46	47.46	43.46 (43)	Yes	Yes
65	60	50.80	49.80	45.80 (46)	Yes	Yes
68	45	45.90	44.90	40.90 (41)	No	Yes
68	50	48.70	47.70	43.70 (44)	Yes	Yes
68	55	51.26	50.26	46.26 (46)	Yes	Yes
68	60	53.62	52.62	48.62 (49)	Yes	Yes

Notes

(1) It is assumed that the central chilled water plant shall be operated to deliver chilled water at 42 F. Dedicated chiller shall be required below 42 F.

(2) It is assumed that the discharge air dew-point temperature of the air leaving the cooling coil shall be 1 F lower than the maximum dew-point at 1.0 sensible heat factor.

(3) It is assumed that the cooling coil selection shall be optimized to obtain the required duty conditions. The coil selection shall evaluate the parameters such as coil face velocity, row depth, chilled water supply temperature, and fins per inch (limiting value = 11 fins per inch [433 fins per meter]) to obtain the required design conditions.

WAITING AND PATIENT ADMITTING AREAS – AIR HANDLING UNIT

AHU Data Sheet and Room Data Sheet	
Air Handling Unit Type	● CV ● **Note 1**
Inside Design Conditions	● Cooling 75 F [24 C] Dry-Bulb Temperature 50% Relative Humidity (Uncontrolled) ● Heating 70 F [21 C] Dry-Bulb Temperature 30% Relative Humidity (Optional)
Minimum Outside Air	100%
Minimum Supply Air Changes per Hour	12
Return Air	Not Permitted
Economizer Cycle	Not Applicable
Room Noise Level	NC 40
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade C
Cooling Source	Chilled water from the central chilled water piping
Heating Source	● Use high pressure steam from the central boiler plant as the primary source for generating heating hot water and producing “clean steam” for winter humidification. ● Use medium pressure steam from the central boiler plant for unit mounted pre-heat coils.
General Exhaust System(s)	Required
Special Exhaust System(s)	Not Required
Heat Recovery System	Per ASHRAE Standard 90.1 – 2007, evaluate the use of a heat recovery system to transfer energy between the exhaust and incoming outside air streams.
Emergency Power	Not Required
Individual Room Temperature Control	Required
Room Air Balance	Negative (-) **Note 2**
Additional Energy Conservation Measures	To meet the mandated goal of 30% additional energy conservation above ASHRAE 90.1 – 2004, evaluate the use of desiccant dehumidification system to reduce the dew-point temperature of the incoming outside air.

WAITING AND PATIENT ADMITTING AREAS – AIR HANDLING UNIT
Note 1: **(a)** The feasibility of providing a dedicated air-handling unit primarily to serve the waiting and admission area shall be evaluated on a project-by-project basis. ASHRAE 2007 Application Handbook recommends the use a separate air-handling unit (100% outside air) and an exhaust system for such an application to minimize the possibility of transmitting airborne infectious diseases. **(b)** If the capacity of the AHU is less than 5000 CFM [2358.5 Liters/Second], consider serving this area from the adjoining environmental AHU. **Note 2:** To maintain negative air balance, exhaust air pick-up shall be located over the patient waiting area thereby allowing supply and make-up air to flow in the direction of seating and waiting areas.

APPENDIX 6-B: INDIVIDUAL ROOM DATA SHEETS

Acute Respiratory Patient Room – Room Data Sheet	
Inside Design Conditions	● Year Around Conditions 70 F [21 C] to 75 F [24 C] Dry-Bulb Temperature 30% to 50% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	6 – CV Required
Return Air	Not Permitted
Exhaust Air	● 100% ● **Note 2**
Room Noise Level	NC 35
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade D
Individual Room Temperature Control	Required
Room Air Balance	Negative (-)
Note 1: The HVAC system shall be sized and selected to maintain any room temperature within the specified range. Cooling load calculations shall be based on 70 F [21 C] and 50% relative humidity. Heating load calculations shall be based on 75 F [24 C] and 30% relative humidity. **Note 2:** Connect room exhaust to the general exhaust system.	

Attic Space – Room Data Sheet	
Inside Design Conditions	● Heating 50 F [10 C] ● Ventilation 95 F [35 C] – Adjustable (Ventilation System Activation Set Point) ● **Notes 1 – 3**
Minimum Exhaust Air Changes per Hour	10
Return Air	Not Applicable
Exhaust Air	100%
Room Noise Level	NC 45
Filtration	Not Applicable
Individual Room Temperature Control	● Required in Heating Mode ● Thermostatic Activation in Ventilation Mode
Room Air Balance	Neutral (0)

Note 1: Provide thermostatically controlled heating system comprising of terminal heating devices, such as, unit heaters. Provide multiple heaters, as required, to ensure uniform heat distribution. Provide local, non-DDC control loop.

Note 2:

(a) Provide thermostatically controlled exhaust ventilation system comprising of multiple, directly driven exhaust fans, as required, to cover the complete attic space. Use of direct drive fans is recommended to minimize maintenance. Exhaust fans shall be equipped with motorized dampers and exhaust louvers.

(b) Provide intake air louvers equipped with motorized dampers.

Note 3:

(a) Coordinate louver requirements with the architectural discipline.

(b) Coordinate access in and out of the attic space, with the architectural discipline, to deliver and maintain the heating and ventilation equipment.

(c) Coordinate roof insulation requirements with the architectural discipline. To avoid excessive heat build-up in summer and heat escape in winter, insulation should be installed on the underside of the slopping roof with vapor barrier, as required.

Audiology Instrument Calibration and Repair Shop – Room Data Sheet	
Inside Design Conditions	● Cooling 75 F [24 C] Dry-Bulb Temperature 50% Relative Humidity ● Heating 70 F [21 C] Dry-Bulb Temperature 30% Relative Humidity ● 5 F [2.8 C] Dead Band
Minimum Supply Air Changes per Hour	4 – VAV Permitted
Return Air	Permitted
Exhaust Air	Not Required
Room Noise Level	40
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade C
Individual Room Temperature Control	Required
Room Air Balance	Positive (+)

Audiology Office/Therapy Room – Room Data Sheet	
Inside Design Conditions	● Cooling 75 F [24 C] Dry-Bulb Temperature 50% Relative Humidity ● Heating 70 F [21 C] Dry-Bulb Temperature 30% Relative Humidity ● 5 F [2.8 C] Dead Band
Minimum Supply Air Changes per Hour	6 – VAV Permitted
Return Air	Permitted
Exhaust Air	Not Required
Room Noise Level	35
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade C
Individual Room Temperature Control	Required
Room Air Balance	Neutral (0)

Audiometric – Room Data Sheet	
Inside Design Conditions	● Cooling 75 F [24 C] Dry-Bulb Temperature 50% Relative Humidity ● Heating 70 F [21 C] Dry-Bulb Temperature 30% Relative Humidity ● 5 F [2.8 C] Dead Band
Minimum Supply Air Changes per Hour	6 – VAV Permitted
Return Air	Permitted
Exhaust Air	Not Required
Room Noise Level	● 25 ● **Note 1**
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade C
Individual Room Temperature Control	Required
Room Air Balance	Neutral (0)
Note 1: Coordinate the installation of the packaged sound booth and its HVAC system, if any. Take appropriate acoustic measures to maintain the design NC level.	

Barber Shop – Room Data Sheet	
Inside Design Conditions	● Cooling 75 F [24 C] Dry-Bulb Temperature 50% Relative Humidity ● Heating 70 F [21 C] Dry-Bulb Temperature 30% Relative Humidity ● 5 F [2.8 C] Dead Band
Minimum Supply Air Changes per Hour	4 – VAV Permitted
Return Air	Required
Exhaust Air	Not Required
Room Noise Level	NC 40
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade C
Individual Room Temperature Control	Required
Room Air Balance	Neutral (0)

Battery Charging Rooms – Room Data Sheet	
Inside Design Conditions	● Cooling 75 F [24 C] Dry-Bulb Temperature 50% Relative Humidity ● Heating 70 F [21 C] Dry-Bulb Temperature 30% Relative Humidity
Minimum Supply Air Changes per Hour	8 – CV Required
Return Air	Not Permitted
Exhaust Air	● 100% ● **Note 1**
Room Noise Level	NC 40
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade C
Individual Room Temperature Control	Required
Room Air Balance	Negative (-)
Note 1: **(a)** Provide a special exhaust system for the Automatic Transport System (ATS) and Wheel Chair Charging Areas, where lead acid batteries are charged. Do not provide exhaust system for the spaces where Ni-Cad batteries are charged, as these batteries do not generate fumes. **(b)** Coordinate the need, location, and size of a canopy hood, where required, with the architectural discipline, to exhaust space air through the hood. Assume 100 Feet/Minute [0.5 Meter/Second] face velocity over the hood face area. **(c)** Provide a continuously operating special exhaust system with: ● Spark-proof construction fan and explosion-proof motor ● Welded stainless steel ductwork ● Emergency power for the fan and controls ● Status monitoring (DDC) with local and ECC alarm capabilities	

Biomedical Instrument Repair Shop – Room Data Sheet	
Inside Design Conditions	● Cooling 75 F [24 C] Dry-Bulb Temperature 50% Relative Humidity ● Heating 70 F [21 C] Dry-Bulb Temperature 30% Relative Humidity
Minimum Supply Air Changes per Hour	6 – CV Required
Return Air	Not Permitted
Exhaust Air	● 100% ● **Note 1**
Room Noise Level	NC 40
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade C
Individual Room Temperature Control	Required
Room Air Balance	Negative (-)

Note 1:

(a) Repair activities involving the use of chemicals, such as, mercury and xylene, may require a canopy or a general chemical fume hood (VA Type H7). Coordinate the need, location and size of the hood with the architectural discipline.

(b) Provide a special exhaust system with:

- Manual start/stop (locate the manual start/stop switch on the hood to start or stop the special system)
- Spark-proof construction fan and explosion-proof motor
- Welded stainless steel ductwork
- Status monitoring (DDC) with local and ECC alarm capabilities

(c) When the hood is not in use, return the room air back to the AHU unit providing the room supply air. Provide a motorized damper in the room return air duct takeoff. The damper shall close when the hood exhaust system is in operation and vice-versa.

Blood Draw Room – Room Data Sheet	
Inside Design Conditions	● Cooling 75 F [24 C] Dry-Bulb Temperature 50% Relative Humidity ● Heating 70 F [21 C] Dry-Bulb Temperature 30% Relative Humidity ● 5 F [2.8 C] Dead Band
Minimum Supply Air Changes per Hour	6 – VAV Permitted
Return Air	Permitted
Exhaust Air	Not Required
Room Noise Level	NC 35
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade C
Individual Room Temperature Control	Required
Room Air Balance	Neutral (0)

Chapel – Room Data Sheet	
Inside Design Conditions	● Cooling 75 F [24 C] Dry-Bulb Temperature 50% Relative Humidity ● Heating 70 F [21 C] Dry-Bulb Temperature 30% Relative Humidity ● 5 F [2.8 C] Dead Band
Minimum Supply Air Changes per Hour	6 – VAV Permitted
Return Air	Permitted
Exhaust Air	Not Required
Room Noise Level	NC 30
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade C
Individual Room Temperature Control	● Required ● **Note 1**
Room Air Balance	Neutral (0)
Note 1: For large chapels requiring 5,000 CFM [2,358.5 Liters/Second] supply air volume, provide a dedicated air-handling unit similar to the auditorium system described in Appendix 6-A.	

Class Rooms – Room Data Sheet	
Inside Design Conditions	● Cooling 75 F [24 C] Dry-Bulb Temperature 50% Relative Humidity ● Heating 70 F [21 C] Dry-Bulb Temperature 30% Relative Humidity ● 5 F [2.8 C] Dead Band
Minimum Supply Air Changes per Hour	● 6 – VAV Permitted ● **Note 1**
Return Air	Permitted
Exhaust Air	Not Required
Room Noise Level	NC 35
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade C
Individual Room Temperature Control	Required
Room Air Balance	Neutral (0)
Note 1: Evaluate and incorporate the following control sequence to reduce the carbon-dioxide concentration at part load conditions. Install a CO_2 sensor in the branch return air duct serving the classroom. During part load condition with low sensible heat factor, should the space CO_2 level rise above the set point, the VAV box shall modulate to the open position to admit more supply air and along with more outside air to dilute the CO_2 level. Activate reheat as necessary to maintain the space temperature.	

Clean Utility Room/Storage Room – Room Data Sheet	
Inside Design Conditions	● Cooling 75 F [24 C] Dry-Bulb Temperature 50% Relative Humidity ● Heating 70 F [21 C] Dry-Bulb Temperature 30% Relative Humidity ● 5 F [2.8 C] Dead Band
Minimum Supply Air Changes per Hour	4 – VAV Permitted
Return Air	Permitted
Exhaust Air	Not Required
Room Noise Level	NC 40
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade C
Individual Room Temperature Control	● Required ● **Note 1**
Room Air Balance	Positive (+)
Note 1: Evaluate combining this room with other rooms on a common thermostat.	

Computer Lab Room – Room Data Sheet	
Inside Design Conditions	● Year Around Conditions 75 F [24 C] Dry-Bulb Temperature (Maximum) 30% to 50% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	4 – VAV permitted
Return Air	Permitted
Exhaust Air	Not Required
Room Noise Level	NC 40
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade C
Individual Room Temperature Control	Required
Room Air Balance	Neutral (0)
Note 1: The HVAC system shall be sized and selected to maintain any room temperature within the specified range. Cooling load calculations shall be based on 75 F [24 C] and 50% relative humidity. Heating load calculations shall be based on 75 F [24 C] and 30% relative humidity.	

Conference Rooms – Room Data Sheet	
Inside Design Conditions	● Cooling 75 F [24 C] Dry-Bulb Temperature 50% Relative Humidity ● Heating 70 F [21 C] Dry-Bulb Temperature 30% Relative Humidity ● 5 F [2.8 C] Dead Band
Minimum Supply Air Changes per Hour	● 6 – VAV Permitted ● **Note 1**
Return Air	Permitted
Exhaust Air	Not Required
Room Noise Level	NC 35
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade C
Individual Room Temperature Control	Required
Room Air Balance	Neutral (0)
Note 1: Evaluate and incorporate the following control sequence to reduce the carbon-dioxide concentration at part load conditions. Install a CO_2 sensor in the branch return air duct serving the classroom. During part load condition with low sensible heat factor, should the space CO_2 level rise above the set point, the VAV box should modulate towards open position to admit more supply air and along with more outside air to dilute the CO_2 level. Activate reheat as necessary to maintain the space temperature.	

Corridors – Room Data Sheet	
Inside Design Conditions	● Cooling 75 F [24 C] Dry-Bulb Temperature 50% Relative Humidity ● Heating 70 F [21 C] Dry-Bulb Temperature 50% Relative Humidity ● 5 F [2.8 C] Dead Band ● **Note 1**
Minimum Supply Air Changes per Hour	● 4 – CV or VAV, as required ● **Note 2**
Return Air	Permitted
Exhaust Air	Not Required
Room Noise Level	NC 40
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade C
Individual Room Temperature Control	Required
Room Air Balance	**Note 3**
Note 1: Dead-band is not applicable to constant volume systems. **Note 2:** Adjust corridor air supply to meet make-up air requirements of the adjoining spaces, such as, toilets, janitor closets, soiled storage/utility spaces etc. **Note 3:** Air supplied to the corridors is used to maintain required air balance in the adjoining occupied and unoccupied spaces.	

Crawl Space (Pipe Basement) – Room Data Sheet	
Inside Design Conditions	● Heating 50 F [10 C] ● Ventilation 95 F [35 C] ● **Notes 1 – 3**
Minimum Exhaust Air Changes per Hour	10
Return Air	Not Applicable
Exhaust Air	100%
Room Noise Level	NC 45
Filtration	Not Applicable
Individual Room Temperature Control	● Required in Heating Mode ● Thermostatic Activation in Ventilation Mode
Room Air Balance	Neutral (0)

Note 1:

(a) Provide thermostatically controlled heating system comprising of terminal heating devices, such as, unit heaters. Provide multiple heaters, as required, to ensure uniform heat distribution.

(b) To ensure cost control and simplified system operation, use of unit-mounted, local (non-DDC) thermostats is acceptable with fan on/off control, not requiring an automatic hot water or steam control valve.

Note 2:

(a) Provide a manually and/or thermostatically controlled exhaust ventilation system.

(b) Exhaust Fan(s): Provide multiple exhaust fans, as required, to ensure uniform ventilation to cover the entire crawl space. Provide direct-drive fans to minimize maintenance. Exhaust fan(s) shall be equipped with motorized dampers.

(c) Provide intake air louvers equipped with motorized dampers.

(d) Activate the exhaust fans when the crawl space temperature measured by a dedicated wall-mounted space thermostat exceeds 95 F [35 C]. The reverse shall occur upon fall in temperature. In high humid areas, exhaust system can be activated by a space humidistat upon increase in the space humidity above 65% RH (adjustable).

Note 3:

(a) Coordinate louver requirements with the architectural discipline.

(b) Design should address access to and from the crawl space to deliver and maintain the heating and ventilation equipment.

(c) Coordinate the need for an areaway(s) with the architectural discipline and the VA Authorities. Provide a floor drain in the areaway. Coordinate the access to clean the areaways and the floor drains.

Dressing Room – Room Data Sheet	
Inside Design Conditions	● Cooling 75 F [24 C] Dry-Bulb Temperature 50% Relative Humidity ● Heating 70 F [21 C] Dry-Bulb Temperature 30% Relative Humidity ● 5 F [2.8 C] Dead Band
Minimum Supply Air Changes per Hour	4 – VAV Permitted
Return Air	Permitted
Exhaust Air	Not Required
Room Noise Level	NC 40
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade C
Individual Room Temperature Control	● Not Required ● **Note 1**
Room Air Balance	Neutral (0)
Note 1: Connect this room to a common air terminal unit serving identical spaces.	

Electrical Equipment Rooms – Room Data Sheet	
● Electrical Closets (Without Internal Heat Gain) – **Note 1** ● Electrical Closets/Rooms (With Internal Heat Gain) – **Note 2** ● Main Electrical Rooms and/or Transformer Vaults – **Note 3**	
Inside Design Conditions	● Cooling 86 F [30 C] Dry-Bulb Temperature ● Heating 50 F [10 C] Dry-Bulb Temperature ● **Note 4**
Minimum Supply Air Changes per Hour	● As required to maintain selected space temperature ● **Note 5**
Return Air	● Cooling Mode – Permitted ● Ventilation Mode – Not Permitted
Exhaust Air	● 100% Ventilation Mode ● **Note 6**
Room Noise Level	NC 40
Filtration	As provided by the selected cooling unit
Individual Room Temperature Control	Required
Room Air Balance	Neutral (0)

Note 1: Do not provide HVAC for the electrical closets without any heat gain.

Note 2: For electrical closets, or rooms, equipped with dry transformers for secondary (or tertiary) electrical distribution, use any one of the following HVAC solutions.

(a) Provide conditioned supply air (constant volume) from any nearby air-handling unit in service year around and 24-hours a day. Return the room air back to the system. Provide a high-limit temperature sensor in the closet/room to alarm at the ECC in the event that space temperature exceeds 95 F [35 C].

(b) Where an all-air system is not available, provide a dedicated, thermostatically controlled fan coil unit using year around chilled water from the central plant or a dedicated chiller. With the dedicated chiller, connect multiple rooms or closets. Provide a high-limit temperature sensor in the closet/room to alarm at the ECC in the event that space temperature exceeds 95 F [35 C].

(c) Provide a dedicated thermostatically controlled DX system (single package or closed-loop) to remove the heat gain and maintain the set point. Provide a high-limit temperature sensor in the closet/room to alarm at the ECC in the event that space temperature exceeds 95 F [35 C]. Coordinate location of the outdoor section of the DX unit with the architectural discipline and the facility personal.

(d) Provide minimum outside air per ASHRAE 62.1 – 2007.

Note 3: Provide a dedicated all-air system with economizer cycle (do not use economizer cycle in high humidity areas) with mechanical cooling (chilled water from the central plant or dedicated DX system). Coordinate location of the outdoor DX unit with the architectural discipline and the VA Authorities. Filtration for the AHU shall be VA Grade A Pre-Filters and VA Grade B After-Filters per ASHRAE 62.1 – 2007.

Electrical Equipment Rooms – Room Data Sheet
● Electrical Closets (Without Internal Heat Gain) – **Note 1** ● Electrical Closets/Rooms (With Internal Heat Gain) – **Note 2** ● Main Electrical Rooms and/or Transformer Vaults – **Note 3**
Note 4: Maintain minimum space temperature at 50 F [10 C] in the winter season. Estimate net heat gain and loss at the winter design temperature. Provide an electric unit heater if the net heat gain is not sufficient to maintain 50 F [10 C] space temperature. **Note 5:** **(a)** Assume heat gain due to the transformers as 3% of the **anticipated actual peak demand** and NOT based on the rated nameplate capacity. Ensure coordination with the equipment manufacturer for the actual heat gain. **(b)** Coordinate locations of the intake and relief air louvers with the architectural discipline. Louvers shall meet the physical security requirements. **(c)** Do not locate fan coil units or indoor DX units inside the electrical rooms to avoid damage due to possible water leaks or overflow through the drain pans. **(d)** Avoid excessive runs of field-installed refrigerant piping associated with split DX systems and excessive horizontal runs of cooling coil condensate drain piping. **Note 6:** **(a)** Do not use the exhaust ventilation system, with 100% outside air, in high-humidity areas to avoid damage to the electrical and mechanical equipment. **(b)** Do not use the exhaust ventilation system, with 100% outside air, in dry areas, where the ambient design temperature (Chapter 7 – Column 1a – 0.4%) is in excess of 90 F [32 C] to avoid large air volume in circulation (higher fan motor horsepower) and build up of excessive space temperature, as high as 104 F [40 C].

Elevator Machine Rooms – Room Data Sheet	
Inside Design Conditions	● Cooling 77 F [25 C] Dry-Bulb Temperature ● **Note 1**
Minimum Supply Air Changes per Hour	● As required to maintain space temperature ● **Note 2**
Return Air	100%
Exhaust Air	Not Permitted
Room Noise Level	NC 45
Filtration	As provided by the selected cooling unit
Individual Room Temperature Control	Required
Room Air Balance	Neutral (0)

Note 1:

(a) Provide a thermostatically controlled, dedicated unit, capable of providing mechanical cooling year around.

(b) Use any one of the following system configurations, shown in the order of VA preference:

● Provide a take-off from an all-air system if available in the vicinity and in operation for 7 days a week, 24 hours a day, and year around. Provide a constant volume air terminal unit and return room air back to the unit.

● Provide a dedicated, thermostatically controlled, fan coil unit, if chilled water is available 7 days a week, 24 hours a day, and year around. Avoid excessive horizontal runs of the cooling coil condensate piping.

● Provide a dedicated, thermostatically controlled, DX unit either as a single package or as a split-system. Coordinate location of the outdoor unit with the architectural discipline and the VA Authorities. Avoid excessive runs of refrigerant piping and cooling coil condensate piping. The room thermostat for the DX system can be a local closed-loop type without any interface with the DDC controls.

● Provide a DDC temperature sensor to monitor the machine room temperature and provide ECC alarms in the event the space temperature exceeds 86 F [30 C].

● Provide emergency power for the HVAC systems and associated controls.

● Do not install HVAC components or piping inside the elevator machine room.

Note 2: Coordinate cooling capacity and heat dissipated by the equipment with the equipment manufacturer.

Engineering Control Center (ECC) Room – Room Data Sheet	
Inside Design Conditions	● Cooling 75 F [24 C] Dry-Bulb Temperature 55% Relative Humidity ● Heating 70 F [21 C] Dry-Bulb Temperature ● **Note 1**
Minimum Supply Air Changes per Hour	As required to meet the inside design conditions
Return Air	Permitted
Exhaust Air	Not Required
Room Noise Level	NC 40
Filtration	As provided by the selected cooling unit
Individual Room Temperature Control	Required
Room Air Balance	Neutral (0)
Note 1: Provide a dedicated cooling/heating terminal unit. Configuration of the terminal unit shall be project-specific. In the absence of an all-air system or chilled water for a fan coil unit, use of a through the wall air-conditioner, PTAC, or a heat pump is acceptable.	

Engineering Shops (Maintenance) – Room Data Sheet	
● Carpentry **● Electrical** **● Machine** **● Paint** **● Plumbing** **● Welding**	
Inside Design Conditions	● Cooling 80 F [26.7 C] Dry-Bulb Temperature 60% Relative Humidity (Maximum) **● Note 1** ● Heating 68 F [20 C] Dry-Bulb Temperature
Minimum Supply Air Changes per Hour	● 6 **● Note 2**
Return Air	Permitted from clean areas
Exhaust Air	Note 3
Room Noise Level	NC 45
Filtration	As provided by the selected cooling unit
Individual Room Temperature Control	Required
Room Air Balance	Neutral (0)
Compliance	American Council of Governmental Industrial Hygienists (ACGIH)

Note 1:

(a) Provide mechanical cooling for the facilities. Evaluate the use of ventilation where feasible.

(b) Provide individual room temperature control for each shop, physically separated from other areas. Group control is permitted where multiple shops are located in one large common room.

(c) HVAC system configuration shall depend upon the size of the shop area and the type of shops. Evaluate the use of a dedicated air-handling unit for systems larger than 5,000 CFM (2,358.0 Liters/Second). Additional system configurations are:

● Provide a take-off from an all-air system if available in the vicinity. Provide a VAV air terminal unit.

● Provide a dedicated, thermostatically controlled, fan coil unit, if chilled water is available. Avoid excessive horizontal runs of the cooling coil condensate piping.

● Provide a dedicated, thermostatically controlled, DX unit either as a single package or as a split-system. Coordinate location of the outdoor unit with the architectural discipline and the VA Authorities. Avoid excessive runs of refrigerant piping and cooling coil condensate piping. The room thermostat for the DX system can be a local closed-loop type without any interface with the DDC controls.

Note 2: Coordinate cooling capacity and heat dissipated by the equipment with the shop equipment layout and the equipment manufacturer.

Engineering Shops (Maintenance) – Room Data Sheet
● Carpentry **● Electrical** **● Machine** **● Paint** **● Plumbing** **● Welding**
Note 3: **(a)** Provide a dedicated exhaust system for welding exhaust. **(b)** Provide outside air, as required, in the paint shops and paint storage rooms to dilute the concentration of paints.

Examination Room (Eye Treatment Room) – Room Data Sheet	
Inside Design Conditions	● Cooling 75 F [24 C] Dry-Bulb Temperature 50% Relative Humidity ● Heating 70 F [21 C] Dry-Bulb Temperature 30% Relative Humidity ● 5 F [2.8 C] Dead Band
Minimum Supply Air Changes per Hour	6 – VAV Permitted
Return Air	Permitted
Exhaust Air	Not Required
Room Noise Level	NC 35
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade C
Individual Room Temperature Control	Required
Room Air Balance	Neutral (0)

Examination Room (Isolation) – Room Data Sheet	
Inside Design Conditions	● Year Around Conditions 70 F [21 C] to 75 [24 C] Dry-Bulb Temperature 30% to 50% Relative Humidity ● **Notes 1 and 2**
Minimum Supply Air Changes per Hour	12 – CV Required
Return Air	Not Permitted
Exhaust Air	● 100% ● Note 3
Room Noise Level	NC 35
Filtration	Note 4
Individual Room Temperature Control	Required
Room Air Balance	● Negative (-) or Positive (+) ● An anteroom is required to protect the adjoining environment from the patients

Note 1: The HVAC system shall be sized and selected to maintain any room temperature within the specified range. Cooling load calculations shall be based on 70 F [21 C] and 50% relative humidity. Heating load calculations shall be based on 75 F [24 C] and 30% relative humidity.

Note 2: Refer to Isolation Room Positive (+) with anteroom in this appendix for requirements.

Note 3: Locate supply air outlets and exhaust air inlets to create the direction of airflow, required for air balance in conjunction with the anterooms. Use of the reverse isolation rooms is not permitted.

Note 4: When the isolation room is located in the Nursing Wing, VA Grade A Pre-Filters and VA Grade D After-Filters shall be used. When the isolation room is located in the ICU unit, VA Grade A Pre-Filters, VA Grade C After-filters, and VA Grade E Final Filters shall be used. See Appendix 6-A.

Examination Room (Multipurpose) – Room Data Sheet	
Inside Design Conditions	● Cooling 75 F [23.9 C] Dry-Bulb Temperature 50% Relative Humidity ● Heating 70 F [21.1 C] Dry-Bulb Temperature 30% Relative Humidity ● 5 F [2.8 C] Dead Band
Minimum Supply Air Changes per Hour	6 – VAV Permitted
Return Air	Permitted
Exhaust Air	Not Required
Room Noise Level	NC 35
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade C
Individual Room Temperature Control	Chapter 2
Room Air Balance	Neutral (0)

Examination Room (Patient) – Room Data Sheet	
Inside Design Conditions	● Cooling 75 F [24 C] Dry-Bulb Temperature 50% Relative Humidity ● Heating 70 F [21 C] Dry-Bulb Temperature 30% Relative Humidity ● 5 F [2.8 C] Dead Band
Minimum Supply Air Changes per Hour	6 – VAV Permitted
Return Air	Permitted
Exhaust Air	Not Required
Room Noise Level	NC 35
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade C
Individual Room Temperature Control	Chapter 2
Room Air Balance	Neutral (0)

Examination Room Women's Health (with Toilets) – Room Data Sheet	
Inside Design Conditions	● Cooling 75 F [24 C] Dry-Bulb Temperature 50% Relative Humidity ● Heating 70 F [21 C] Dry-Bulb Temperature 30% Relative Humidity ● 5 F [2.8 C] Dead Band
Minimum Supply Air Changes per Hour	● 6 – Examination Room ● VAV Permitted
Return Air	Permitted (Examination Room Only)
Exhaust Air	● From Toilet only ● **Note 1**
Room Noise Level	NC 35
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade C
Individual Room Temperature Control	Required
Room Air Balance	● Negative (-) Toilet Room ● Positive (+) Examination Room with respect to Toilet
Note 1: Transfer make-up air from the examination room into the toilet. Do not supply conditioned air under positive pressure to the toilet.	

Exterior Stairs – Room Data Sheets	
Inside Design Conditions	Heating Only 50 F [10 C]
Minimum Supply Air Changes per Hour	Not Applicable
Return Air	Not Applicable
Exhaust Air	Not Applicable
Room Noise Level	NC 45
Filtration	Not Applicable
Individual Room Temperature Control	● Required ● **Note 1**
Room Air Balance	Not Applicable
Note 1: Provide a thermostatically controlled, terminal heating unit (examples: cabinet heater, finned tube radiator, or convector). Provide local, closed-loop non-DDC control.	

Gift Shops (Retail Stores) – Room Data Sheets	
Inside Design Conditions	● Cooling 75 F [23.9 C] Dry-Bulb Temperature 50% Relative Humidity ● Heating 70 F [21.1 C] Dry-Bulb Temperature 30% Relative Humidity ● 5 F [2.8 C] Dead Band
Minimum Supply Air Changes per Hour	4 – VAV Permitted
Return Air	Permitted
Exhaust Air	Not Required
Room Noise Level	NC 40
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade C
Individual Room Temperature Control	Required
Room Air Balance	Neutral (0)

Housekeeping Aide Closet (HAC)/Janitor's Closet – Room Data Sheet	
Inside Design Conditions	Conditioned by make-up air
Minimum Supply Air Changes per Hour	Not Applicable
Return Air	Not Permitted
Exhaust Air	● 100% ● Highest of: - 10 air changes per hour - 1 CFM/SF [23.0 Liters/Second/Square Meter] - 50 CFM [24.0 Liters/Second]
Room Noise Level	NC 45
Filtration	Not Applicable
Individual Room Temperature Control	Not Required
Room Air Balance	Double Negative (- -)

Hydrotherapy – Room Data Sheet	
Inside Design Conditions	● Cooling 70 F [21 C] Dry-Bulb Temperature 50% Relative Humidity ● Heating 82 F [27.8 C] Dry-Bulb Temperature 30% Relative Humidity
Minimum Supply Air Changes per Hour	6 – CV required
Return Air	Not Permitted
Exhaust Air	● 100% ● **Note 1**
Room Noise Level	NC 40
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade D
Individual Room Temperature Control	Required
Room Air Balance	Negative (-)
Note 1: Provide a dedicated wet exhaust system with aluminum ductwork. Wet exhaust from other similar spaces can be grouped together.	

Information Technology Closet – Room Data Sheet	
Inside Design Conditions	● Cooling 75 F [24 C] Dry-Bulb Temperature ● Heating 65 F [18.3 C] Dry-Bulb Temperature ● **Notes 1-3**
Minimum Supply Air Changes per Hour	As required to meet the inside design conditions
Return Air	Permitted
Exhaust Air	Not Required
Room Noise Level	NC 40
Filtration	As provided by the selected cooling unit
Individual Room Temperature Control	Required
Room Air Balance	Neutral (0)

Note 1: Use any one of the following HVAC solutions.

(a) Provide conditioned supply air (constant volume) from any nearby air-handling unit in service year around and 24-hours a day. Return the room air back to the system. Provide a high-limit temperature sensor in the closet/room to alarm at the ECC in the event that space temperature exceeds 95 F [35 C].

(b) Where an all-air system is not available, provide a dedicated, thermostatically controlled fan coil unit using year around chilled water from the central plant or a dedicated chiller. With the dedicated chiller, connect multiple rooms or closets. Provide a high-limit temperature sensor in the closet/room to alarm at the ECC in the event that space temperature exceeds 95 F [35 C].

(c) Provide a dedicated thermostatically controlled DX system (single package or closed-loop) to remove the heat gain and maintain the set point. Provide a high-limit temperature sensor in the closet/room to alarm at the ECC in the event that space temperature exceeds 95 F [35 C]. Coordinate location of the outdoor section of the DX unit with the architectural discipline and the facility personal.

(d) Provide minimum outside air per ASHRAE 62.1 – 2007.

Note 2: Maintain minimum space temperature at 65 F [18.3 C] in the winter season. Estimate net heat gain and loss at the winter design temperature. Provide an electric unit heater if the net heat gain is not sufficient to maintain 65 F [18.3 C] space temperature.

Note 3: Surrounding rooms maintained at 30-50% relative humidity.

Isolation Rooms Negative (–) with Anteroom – Room Data Sheet	
Inside Design Conditions	● Year Around Conditions 70 F [21 C] to 82 F [27.8 C] Dry-Bulb Temperature 30% to 50% Relative Humidity ● **Notes 1 and 2**
Minimum Supply Air Changes per Hour	● 12 – CV Required ● **Note 3**
Return Air	Not Permitted
Exhaust Air	● 100% ● **Note 4**
Room Noise Level	NC 35
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade C ● Final Filters – VA Grade E
Individual Room Temperature Control	Required
Room Air Balance	● Negative (-) ● **Note 5**
TB Criteria	**Notes 6-10**

Note 1: The HVAC system shall be sized and selected to maintain any room temperature within the specified range. Cooling load calculations shall be based on 70 F [21 C] and 50% relative humidity. Heating load calculations shall be based on 82 F [27.8 C] and 30% relative humidity.

Note 2: Provide a terminal HEPA filter – VA Grade E downstream of air terminal unit.

Note 3:

● Supply air in the anteroom at 10 air changes per hour, 60 CFM [28.3 Liters/Second] (minimum).

● Provide airflow control valve in each exhaust duct connection to ensure accurate air balance

Note 4: Provide a special exhaust system to serve the patient’s bedroom, connecting toilet, and anteroom. The exhaust system shall be equipped as follows:

● Discharge above the highest roof using a 10 Feet [3.0 Meters] tall stack and the discharge velocity of 3,500 Feet/Minute [17.8 Meters/Second].

● Provide exhaust fan with emergency power.

● Maintain exhaust duct under negative air pressure over its entire run.

● Provide VA Grade A and E filters in the exhaust duct near the exhaust fan suction.

Note 5: Provide air flow control valves in the branch return air cuts from the anteroom and the patient room. Maintain negative pressure at 0.02 inch WG [5 Pascal] in the patient room.

Isolation Rooms Negative (–) with Anteroom – Room Data Sheet
Note 6: The health care authorities at the medical center and/or the health care planners shall be responsible for classifying the specific medical center as a high or low incidence area and shall be responsible for determining the location and quantity of specialized rooms which would be established for S/KI TB patients. **Note 7:** The health care authorities at the medical center and/or the health care planners and Pathology shall be responsible for identifying BSL3 Clinical Mycobacterial Laboratories that require special architectural and engineering controls in accordance with BSL3 biosafety guidelines recommended by Center for Disease Control (CDC) and National Institutes of Health (NIH). **Note 8: Reference Documents:** **(a)** Center for Disease Control (CDC): "Guidelines for Preventing the Transmission of Mycobacterium Tuberculosis in Health-Care Facilities, 2005", MMWR Morbidity and Mortality Weekly Report, published by U.S. Department of Health and Human Services-Public Health Service. **(b)** VA Publication, "Program and Facility Planning for Tuberculosis Programs", August 18, 1995. **(c)** CDC/NIH Publication "Biosafety in Microbiological and Biomedical Laboratories", 5th Edition, February 2007. **Note 9:** Where the VA Design Criteria exceed the minimum requirements outlined in the CDC document, compliance with the VA Criteria is mandatory for all new facilities and major renovation projects. For existing facilities where compliance with the VA Criteria may not be feasible (or cost-effective) due to the limitations of the configuration of the HVAC system, the minimum requirements outlined in the CDC document shall suffice. **Note 10:** The following areas are designated as "TB Treatment Rooms" for the purpose of this criteria. They typically are spaces where procedures are performed and/or treatments are administered to the S/KI TB patients. The requirements of the Room Data Sheets for the Isolation Rooms Negative (-) with Anteroom apply to these areas: **(a)** Diagnostic Sputum Induction **(b)** Administration of Aerosolized Pentamidine (AP) Drug. This also includes other aerosol treatments, cough-inducing procedures, or aerosol-generating procedures. **(c)** Bronchoscopy **(d)** S/KI TB Isolation Rooms **(e)** TB Treatment Rooms **(f)** TB Dental Operatory **(g)** TB Dialysis Room **(h)** TB Radiology Room

Isolation Rooms Negative (–) with Anteroom – Room Data Sheet
(i) Clinical Mycobacterial BSL3 Laboratories **(j)** In addition, all toilets, bathrooms, janitor closets, and locker rooms associated with S/KI TB Isolation Rooms or treatment rooms.

Isolation Rooms Positive (+) with Anteroom – Room Data Sheet	
Inside Design Conditions	● Year Around Conditions 70 F [21 C] to 82 F [27.8 C] Dry-Bulb Temperature 30% to 50% Relative Humidity ● **Notes 1 - 3**
Minimum Supply Air Changes per Hour	12 – CV Required
Return Air	Permitted
Exhaust Air	Not Required
Room Noise Level	NC 35
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade C ● Final Filters – VA Grade E
Individual Room Temperature Control	Required
Room Air Balance	● Positive (+) ● **Note 4**
Note 1: The HVAC system shall be sized and selected to maintain any room temperature within the specified range. Cooling load calculations shall be based on 70 F [21 C] and 50% relative humidity. Heating load calculations shall be based on 82 F [27.8 C] and 30% relative humidity. **Note 2:** Do not provide air to anteroom. **Note 3:** Provide a terminal HEPA filter – VA Grade E downstream of air terminal unit. **Note 4:** Provide air flow control valves in the branch return air ducts from the anteroom and the patient room. Maintain positive pressure at 0.02 inch WG [5 Pascal] in the patient room.	

Kinesiotherapy Therapy – Treatment Clinic – Room Data Sheet	
Inside Design Conditions	● Year Around Conditions 70 F [21 C] to 82 F [27.8 C] Dry-Bulb Temperature 30% to 50% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	6 – VAV permitted
Return Air	Permitted
Exhaust Air	Not Required
Room Noise Level	NC 40
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade D
Individual Room Temperature Control	Required
Room Air Balance	Neutral (0)
Note 1: The HVAC system shall be sized and selected to maintain any room temperature within the specified range. Cooling load calculations shall be based on 70 F [21 C] and 50% relative humidity. Heating load calculations shall be based on 82 F [27.8 C] and 30% relative humidity.	

Kitchenettes – Room Data Sheet	
Inside Design Conditions	● Not Applicable ● **Note 1**
Minimum Supply Air Changes per Hour	6 – Make Up Air or Minimum 50 CFM [24.0 Liters/Second]
Return Air	Not Permitted
Exhaust Air	● 100% ● **Note 2**
Room Noise Level	NC 40
Filtration	Not Applicable
Individual Room Temperature Control	Not Required
Room Air Balance	Double Negative (- -)
Note 1: Kitchenettes are generally located as the adjoining spaces to the corridors, conference rooms, lounges, and such spaces. Required make-up air is drawn from such spaces. **Note 2:** Connect to the general exhaust system.	

Library – Room Data Sheet	
Inside Design Conditions	● Cooling 75 F [24 C] Dry-Bulb Temperature 50% Relative Humidity ● Heating 70 F [21 C] Dry-Bulb Temperature 30% Relative Humidity ● 5 F [2.8 C] Dead Band
Minimum Supply Air Changes per Hour	4 – VAV Permitted
Return Air	Permitted
Exhaust Air	Not Required
Room Noise Level	NC 30
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade C
Individual Room Temperature Control	Required
Room Air Balance	Neutral (0)

Loading Dock – Room Data Sheet	
Inside Design Conditions	● Not Required ● Terminal air curtain with heating ● **Note 1**
Minimum Supply Air Changes per Hour	Not Applicable
Return Air	Not Applicable
Exhaust Air	Not Applicable
Room Noise Level	Not Required
Filtration	As furnished with the air curtain
Individual Room Temperature Control	Not Required
Room Air Balance	Not Required
Note 1: Provide an air curtain with a heating element. Interlock the air curtain start with the operating mechanism of the loading dock door. Heating element shall be activated only after the air curtain is in operation and the ambient temperature has dropped below 40 F [4.4 C], adjustable.	

Locker Rooms (with Toilets) – Room Data Sheet	
Inside Design Conditions	● Cooling 75 F [24 C] Dry-Bulb Temperature 50% Relative Humidity ● Heating 70 F [21 C] Dry-Bulb Temperature 30% Relative Humidity
Minimum Supply Air Changes per Hour	10 – CV Required
Return Air	Not Permitted
Exhaust Air	100%
Room Noise Level	NC 40
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade C
Individual Room Temperature Control	Required
Room Air Balance	Negative (-)

Locker Rooms (without Toilets) – Room Data Sheet	
Inside Design Conditions	● Cooling 75 F [24 C] Dry-Bulb Temperature 50% Relative Humidity ● Heating 70 F [21 C] Dry-Bulb Temperature 30% Relative Humidity
Minimum Supply Air Changes per Hour	6 – CV Required
Return Air	Not Permitted
Exhaust Air	100%
Room Noise Level	NC 40
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade C
Individual Room Temperature Control	Required
Room Air Balance	Negative (-)

Lounge (Employees) – Room Data Sheet	
Inside Design Conditions	● Cooling 75 F [24 C] Dry-Bulb Temperature 50% Relative Humidity ● Heating 70 F [21 C] Dry-Bulb Temperature 30% Relative Humidity ● 5 F [2.8 C] Dead Band
Minimum Supply Air Changes per Hour	4 – VAV Permitted
Return Air	Permitted
Exhaust Air	**Note 1**
Room Noise Level	NC 40
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade C
Individual Room Temperature Control	Required
Room Air Balance	Negative (-)
Note 1: When the lounge is equipped with food warming equipment, refrigerator, wash basin or vending machine etc., exhaust 50% of the supply air through the general exhaust system. Return remaining supply air. Return all supply air if the lounge does not include equipment described above.	

Maintenance Garages – Room Data Sheet	
Inside Design Conditions	● Heating and/or Ventilation Only ● Heating Only 60 F [15.6 C]
Minimum Supply Air Changes per Hour	●1.5 CFM/SF [7.6 Liters/Second/Sq Meter] ● **Note 1**
Return Air	Not Permitted
Exhaust Air	100%
Room Noise Level	NC 50
Filtration	Not Applicable
Individual Room Temperature Control	Required
Room Air Balance	Positive (+)
Compliance	American Council of Governmental Industrial Hygienists (ACGIH)
Note 1: See 2007 ASHRAE Applications Handbook and NFPA 88B for additional requirements.	

Mechanical Equipment Rooms (MERs) – Room Data Sheets	
● MER (Air-Handling Unit Rooms) – **Note 1** ● MER (Heating Room – PRV, Heat Exchanger, Pumps) – **Note 2** ● MER (Refrigeration Equipment – Chillers) – **Note 3**	
Inside Design Conditions	● Cooling See applications below ● Heating 50 F [10 C] Dry-Bulb Temperature ● **Note 4**
Minimum Supply Air Changes per Hour	See applications below
Minimum Outside Air	0.5 CFM/Square Feet [2.5 Liters/Second/Square Meter] – Refrigeration Room
Return Air	Permitted – Cooling Mode Not Permitted – Ventilation System
Exhaust Air	100% – Ventilation Mode
Room Noise Level	NC 45-50
Filtration	See applications below
Individual Room Temperature Control	Required
Room Air Balance	Neutral (0)

General: Numerous design options are available for the three mechanical room configurations outlined above. Select an appropriate design solution based on the actual project-specific conditions.

Note 1: Air-Handling Unit Rooms

(a) High-Humidity Areas – Mechanical Cooling and Heating
Using AHU operating 24 hours a day:

- Provide a dedicated, constant volume air terminal unit with reheat to maintain the space temperature between 50 F [10 C] and 82 F [26.7 C]
- Provide minimum 6 air changes per hour
- Return room air back to the system
- Filtration according to the serving AHU
- Provide thermostatically controlled unit heater to maintain 50 F [10 C] for the MER, where AHU shuts down during unoccupied hours

(b) All Other Areas – Heating
Provide a thermostatically-controlled unit heater to maintain 50 F [10 C].

Note 2: Heating Room – PRV, Heat Exchanger, Pumps

(a) Radiated heat due to the steam PRV, steam piping, and hot water heating system can result in substantially higher space temperature.

(b) First Stage: Provide a thermostatically-controlled exhaust system with minimum 20 air changes per hour. As an energy conservation measure, provide a two-speed motor. Upon rise in space temperature above an adjustable set point, operate the fan at high speed to maintain the set point.

Mechanical Equipment Rooms (MERs) – Room Data Sheets
● MER (Air-Handling Unit Rooms) – **Note 1** ● MER (Heating Room – PRV, Heat Exchanger, Pumps) – **Note 2** ● MER (Refrigeration Equipment – Chillers) – **Note 3**

(c) Second Stage: Provide a thermostatically-controlled cooling unit, such as a fan coil unit, to maintain the set point at 86 F [30 C], when the space temperature cannot be maintained by the exhaust ventilation system. Provide filtration as available with the cooling unit. During cooling mode, exhaust shall be de-energized.

(d) Do not use an exhaust system (100% outside air) for high humidity locations.

Note 3: Refrigeration Equipment – Chillers

(a) For mechanical rooms equipped with refrigeration equipment, the capacity of make-up air heating and cooling unit shall be based on the criteria given in ASHRAE Standard 15 - 2007 (Safety Standard for Refrigeration Systems) and reproduced below:

- 0.5 CFM/Square Feet [2.54 Liters/Second/Square Meter] of floor area during occupied mode
- 20 CFM [9.43 Liters/Second] per person (chiller rooms are mostly unoccupied)
- Ventilation air required for diluting the refrigerant spill as described in the ASHRAE Standard 15 – 2007 above

(b) First Stage: Provide a thermostatically-controlled exhaust system with minimum 20 air changes per hour. As an energy conservation measure, provide a two-speed motor. Upon rise in space temperature above an adjustable set point, operate the fan at high speed to maintain the set point.

(c) Second Stage: Provide a thermostatically-controlled cooling unit, such as a fan coil unit, to maintain the set point at 86 F [30 C], when the space temperature cannot be maintained by the exhaust ventilation system. Provide filtration as available with the cooling unit. During cooling mode, exhaust shall be de-energized.

(d) Do not use an exhaust system (100% outside air) for high humidity locations.

(e) Provide an emergency exhaust system to be activated by a refrigerant leak detection system. Provide the system (control panel) and sensors as recommended or furnished by the chiller manufacturer. Provide interface with the building DDC control system – locally and at ECC for audible – visible – and printed alarm messages upon leak detection and activation of the emergency exhaust system and make-up air unit. Provide emergency power for the exhaust system and make-up air unit. Design the exhaust duct layout and locations of the air inlets per ASHRAE Standard 15 – 2007 and manufacturer's recommendations.

Note 4: Design the mechanical cooling system based on hermetic chillers. Include a note on the drawings requiring the contractor to increase the cooling capacity to accommodate for open-centrifugal chillers.

Medical Records – Room Data Sheet	
Inside Design Conditions	● Cooling 75 F [24 C] Dry-Bulb Temperature 50% Relative Humidity ● Heating 70 F [21 C] Dry-Bulb Temperature 30% Relative Humidity ● 5 F [2.8 C] Dead Band
Minimum Supply Air Changes per Hour	4 – VAV Permitted
Return Air	Permitted
Exhaust Air	Not Required
Room Noise Level	NC 40
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade C
Individual Room Temperature Control	Required
Room Air Balance	Neutral (0)

Medication Room – Room Data Sheet	
Inside Design Conditions	● Cooling 75 F [24 C] Dry-Bulb Temperature 50% Relative Humidity ● Heating 70 F [21 C] Dry-Bulb Temperature 30% Relative Humidity ● 5 F [2.8 C] Dead Band
Minimum Supply Air Changes per Hour	4 – VAV Permitted
Return Air	Permitted
Exhaust Air	Not Required
Room Noise Level	NC 40
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade C
Individual Room Temperature Control	Required
Room Air Balance	Positive (+)

Minor Operating Room or Trauma Room or Procedure Room (Class A Surgical) – Room Data Sheet	
Inside Design Conditions	● Year Around Conditions 70 F [21 C] to 75 F [24 C] Dry-Bulb Temperature 30% to 50% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	15 – CV Required
Return Air	● Permitted ● **Note 2**
Exhaust Air	Not Required
Room Noise Level	NC 40
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade D
Individual Room Temperature Control	Required
Room Air Balance	Positive (+)
Note 1: The HVAC system shall be sized and selected to maintain any room temperature within the specified range. Cooling load calculations shall be based on 70 F [21 C] and 50% relative humidity. Heating load calculations shall be based on 75 F [24 C] and 30% relative humidity. **Note 2:** Determine the type of procedures scheduled to take place in consultation with the VA Authorities. If the room is used for performing surgery, on a routine basis, design the HVAC system as a conventional operating room with special air distribution as described in Appendix 6-A. For this room, special air distribution configuration of a conventional operating room is not required for this room.	

Multipurpose Room – Room Data Sheet	
Inside Design Conditions	● Cooling 75 F [24 C] Dry-Bulb Temperature 50% Relative Humidity ● Heating 70 F [21 C] Dry-Bulb Temperature 30% Relative Humidity ● 5 F [2.8 C] Dead Band
Minimum Supply Air Changes per Hour	6 – VAV Permitted
Return Air	Permitted
Exhaust Air	Not Required
Room Noise Level	NC 40
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade C
Individual Room Temperature Control	● Required ● **Note 1**
Room Air Balance	Neutral (0)
Note 1: For multipurpose rooms equipped with folding partition(s), provide individual room temperature control on either side of the partition.	

Nurse's Station (Communication) – Room Data Sheet	
Inside Design Conditions	● Year Around Conditions 70 F [21 C] to 75 F [24 C] Dry-Bulb Temperature 30% to 50% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	6 – VAV Permitted
Return Air	Permitted
Exhaust Air	Not Required
Room Noise Level	NC 35
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade D
Individual Room Temperature Control	Required
Room Air Balance	Neutral (0)
Note 1: The HVAC system shall be sized and selected to maintain any room temperature within the specified range. Cooling load calculations shall be based on 70 F [21 C] and 50% relative humidity. Heating load calculations shall be based on 75 F [24 C] and 30% relative humidity.	

Offices – Room Data Sheet	
Inside Design Conditions	● Cooling 75 F [23.9 C] Dry-Bulb Temperature 50% Relative Humidity ● Heating 70 F [21.1 C] Dry-Bulb Temperature 30% Relative Humidity ● 5 F [2.8 C] Dead Band
Minimum Supply Air Changes per Hour	4 – VAV Permitted
Return Air	Permitted
Exhaust Air	Not Required
Room Noise Level	● NC 35 – Private Offices ● NC 40 – General/Open Offices
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade C
Individual Room Temperature Control	Chapter 2
Room Air Balance	Neutral (0)

Orthopedic Clinic (Cast Room) – Room Data Sheet	
Inside Design Conditions	● Cooling 75 F [24 C] Dry-Bulb Temperature 50% Relative Humidity ● Heating 70 F [21 C] Dry-Bulb Temperature 30% Relative Humidity ● 5 F [2.8 C] Dead Band
Minimum Supply Air Changes per Hour	6 – VAV Permitted
Return Air	Permitted
Exhaust Air	Not Required
Room Noise Level	NC 40
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade C
Individual Room Temperature Control	Required
Room Air Balance	Negative (-)

PACS Viewing Room – Room Data Sheet	
Inside Design Conditions	● Cooling 75 F [24 C] Dry-Bulb Temperature 50% Relative Humidity ● Heating 70 F [21 C] Dry-Bulb Temperature 30% Relative Humidity ● 5 F [2.8 C] Dead Band
Minimum Supply Air Changes per Hour	6 – VAV Permitted
Return Air	Permitted
Exhaust Air	Not Required
Room Noise Level	NC 35
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade C
Individual Room Temperature Control	Required
Room Air Balance	Neutral (0)

Pharmacy Storage Space (Central Warehouse) – Room Data Sheet	
Inside Design Conditions	● Cooling 75 F [24 C] Dry-Bulb Temperature 50% Relative Humidity ● Heating 70 F [21 C] Dry-Bulb Temperature 30% Relative Humidity ● 5 F [2.8 C] Dead Band
Minimum Supply Air Changes per Hour	4 – VAV Permitted
Return Air	Permitted
Exhaust Air	Not Required
Room Noise Level	NC 40
Filtration	Per selected cooling unit
Individual Room Temperature Control	● Required ● **Note 1**
Room Air Balance	Neutral (0)

Note 1:

(a) Mechanical cooling is required for the pharmacy storage space, even though the central warehouse in which it is located is generally not air-conditioned.

(b) Since the area of the pharmacy storage is relatively small (approximately 3,000 Square Feet [279.0 Square Meters]) and the intent is to keep the space cool, if the conventional VAV system, specified above is not available, it can be substituted by:

- Dedicated constant-volume air-conditioning unit
- Fan coil unit
- Dedicated DX system, if chilled water is not available

(c) Provide remote alarm at ECC for inside temperature.

Physical Therapy – Treatment Clinic – Room Data Sheet	
Inside Design Conditions	● Year Around Conditions 70 F [21 C] to 82 F [27.8 C] Dry-Bulb Temperature 30% to 50% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	6 – VAV permitted
Return Air	Permitted
Exhaust Air	Not Required
Room Noise Level	NC 40
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade D
Individual Room Temperature Control	Required
Room Air Balance	Neutral (0)

Note 1: The HVAC system shall be sized and selected to maintain any room temperature within the specified range. Cooling load calculations shall be based on 70 F [21 C] and 50% relative humidity. Heating load calculations shall be based on 82 F [27.8 C] and 30% relative humidity.

Pool Dressing/Male – Toilet and Shower – Room Data Sheet **Pool Dressing/Female – Toilet and Shower – Room Data Sheet**	
Inside Design Conditions	● Cooling 75 F [24 C] Dry-Bulb Temperature 55% Relative Humidity ● Heating 80 F [26.7 C] Dry-Bulb Temperature 30% Relative Humidity
Minimum Supply Air Changes per Hour	4 – CV required
Return Air	Not Permitted
Exhaust Air	● 100% ● **Note 1**
Room Noise Level	NC 45
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade D
Individual Room Temperature Control	Required
Room Air Balance	Negative (-)
Note 1: Connect room exhaust to the area general exhaust system or to the therapeutic exhaust system.	

Procedure Room (Aerosolized Pentamidine) – Room Data Sheet	
Inside Design Conditions	● Year Around Conditions 70 F [21 C] to 75 F [24 C] Dry-Bulb Temperature 30% to 50% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	12 – CV Required
Return Air	Not Permitted
Exhaust Air	● 100% ● **Note 2**
Room Noise Level	NC 35
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade D
Individual Room Temperature Control	Required
Room Air Balance	● Negative (-) ● **Note 3**

Note 1: The HVAC system shall be sized and selected to maintain any room temperature within the specified range. Cooling load calculations shall be based on 70 F [21 C] and 50% relative humidity. Heating load calculations shall be based on 75 F [24 C] and 30% relative humidity.

Note 2: Provide a special exhaust system to discharge all room air outdoors from the highest point above the building roof. Provide 10 Feet [3.0 Meters] as the minimum stack height. Adjust stack height upwards, if required per dispersion analysis. Rooms with similar exhaust requirements can be combined together and served by a common exhaust fan.

(a) Maintain entire ductwork under negative air balance.

(b) Allow exhaust air to pass through a set of pre-filters (VA Grade A) and after-filters (VA Grade E – HEPA). Locate filters closest to the fan intake connection.

(c) Provide an airflow control valve to measure and set air volume under varying static pressure drops through the filters. Locate airflow control valve downstream of the filters.

(d) Provide emergency power for the fan and associated controls.

(e) Provide local (audible and visible) and ECC alarm to indicate system and/or air balance disruption.

Note 3: Locate supply and exhaust air outlets/inlets to create the direction of airflow required for negative air balance.

Procedure Room EGD (Gastric – Esophageal – Motility) – Room Data Sheet	
Inside Design Conditions	● Year Around Conditions 70 F [21 C] to 75 F [24 C] Dry-Bulb Temperature 30% to 50% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	8 – CV Required
Return Air	Not Permitted
Exhaust Air	● 100% ● **Note 2**
Room Noise Level	NC 35
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade D
Individual Room Temperature Control	Required
Room Air Balance	Negative (-)
Note 1: The HVAC system shall be sized and selected to maintain any room temperature within the specified range. Cooling load calculations shall be based on 70 F [21 C] and 50% relative humidity. Heating load calculations shall be based on 75 F [24 C] and 30% relative humidity. **Note 2:** Exhaust can be connected to the general exhaust system.	

Procedure Room (General Purpose) – Room Data Sheet	
Inside Design Conditions	● Year Around Conditions 70 F [21 C] to 75 F [24 C] Dry-Bulb Temperature 30% to 50% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	12 – CV Required
Return Air	Permitted
Exhaust Air	Not Required
Room Noise Level	NC 35
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade D
Individual Room Temperature Control	Required
Room Air Balance	Positive (+)
Note 1: The HVAC system shall be sized and selected to maintain any room temperature within the specified range. Cooling load calculations shall be based on 70 F [21 C] and 50% relative humidity. Heating load calculations shall be based on 75 F [24 C] and 30% relative humidity.	

Pulmonary Exercise Room (with Patient Toilet and Shower) – Room Data Sheet	
Inside Design Conditions	● Year Around Conditions 70 F [21 C] to 75 F [24 C] Dry-Bulb Temperature 30% to 50% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	10 – VAV Permitted
Return Air	Permitted (From exercise room only)
Exhaust Air	● 100% (From toilet and shower) ● Admit all make-up air from the exercise room through the door undercut
Room Noise Level	40
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade D
Individual Room Temperature Control	Required
Room Air Balance	● Exercise Room – Neutral (0) ● Toilet/Shower – Double Negative (- -)
Note 1: The HVAC system shall be sized and selected to maintain any room temperature within the specified range. Cooling load calculations shall be based on 70 F [21 C] and 50% relative humidity. Heating load calculations shall be based on 75 F [24 C] and 30% relative humidity.	

Reagent Grade Water Treatment Room – Room Data Sheet	
General: These rooms, generally located near SPD (Supply, Processing, and Distribution) and/or laboratories, produce de-ionized water. 100% exhaust is required to remove corrosive chemicals used in the process of de-ionization. Coordinate with the architectural discipline and the project scope of work if any canopy type hood is required. Exhaust room air through the hood at 100 CFM/Square Feet [507 Liters/Second/Square Meter] of the hood face area.	
Inside Design Conditions	● Cooling 75 F [23.9 C] Dry-Bulb Temperature 50% Relative Humidity ● Heating 70 F [21.1 C] Dry-Bulb Temperature 30% Relative Humidity
Minimum Supply Air Changes per Hour	8 – CV Required
Return Air	Not Permitted
Exhaust Air	● 100% ● **Note 1**
Room Noise Level	40
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade C
Individual Room Temperature Control	Required
Room Air Balance	Negative (-)
Note 1: Provide a corrosion-resistant, special exhaust system to run continuously. **(a)** Provide welded stainless steel ductwork. **(b)** Maintain entire ductwork under negative air balance. **(c)** Provide emergency power. **(d)** Provide spark-resistant exhaust fan with explosion-proof motor. **(e)** Provide local and ECC alarms. **(f)** Provide fan status monitoring.	

Scope Cleaning and Clean Storage – Room Data Sheet	
Inside Design Conditions	● Cooling 75 F [24 C] Dry-Bulb Temperature 50% Relative Humidity ● Heating 70 F [21 C] Dry-Bulb Temperature 30% Relative Humidity
Minimum Supply Air Changes per Hour	6 – CV Required
Return Air	Not Permitted
Exhaust Air	100%
Room Noise Level	35
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade C
Individual Room Temperature Control	Required
Room Air Balance	● Scope Cleaning – Negative (-) ● Clean Storage – Positive (+)

Signal Closet – Room Data Sheet	
Inside Design Conditions	● Cooling 75 F [24 C] Dry-Bulb Temperature ● Heating 65 F [18.3 C] Dry-Bulb Temperature ● **Notes 1-3**
Minimum Supply Air Changes per Hour	As required to meet the inside design conditions
Return Air	Permitted
Exhaust Air	Not Required
Room Noise Level	NC 40
Filtration	As provided by the selected cooling unit
Individual Room Temperature Control	Required
Room Air Balance	Neutral (0)

Note 1: Use any one of the following HVAC solutions.

(a) Provide conditioned supply air (constant volume) from any nearby air-handling unit in service year around and 24-hours a day. Return the room air back to the system. Provide a high-limit temperature sensor in the closet/room to alarm at the ECC in the event that space temperature exceeds 95 F [35 C].

(b) Where an all-air system is not available, provide a dedicated, thermostatically controlled fan coil unit using year around chilled water from the central plant or a dedicated chiller. With the dedicated chiller, connect multiple rooms or closets. Provide a high-limit temperature sensor in the closet/room to alarm at the ECC in the event that space temperature exceeds 95 F [35 C].

(c) Provide a dedicated thermostatically controlled DX system (single package or closed-loop) to remove the heat gain and maintain the set point. Provide a high-limit temperature sensor in the closet/room to alarm at the ECC in the event that space temperature exceeds 95 F [35 C]. Coordinate location of the outdoor section of the DX unit with the architectural discipline and the facility personal.

(d) Provide minimum outside air per ASHRAE 62.1 – 2007.

Note 2: Maintain minimum space temperature at 65 F [18.3 C] in the winter season. Estimate net heat gain and loss at the winter design temperature. Provide an electric unit heater if the net heat gain is not sufficient to maintain 65 F [18.3 C] space temperature.

Note 3: Surrounding rooms maintained at 30-50% relative humidity.

Soiled Utility Room and Soiled Holding/Disposal Room – Room Data Sheet	
Inside Design Conditions	Not Required
Minimum Supply Air Changes per Hour	10 – Make-Up Air
Return Air	Not Permitted
Exhaust Air	100%
Room Noise Level	NC 45
Filtration	Not Applicable
Individual Room Temperature Control	Not Required
Room Air Balance	● Double Negative (- -) ● **Note 1**
Note 1: Admit make-up air through the door undercut and transfer grille (if required) from the adjoining areas.	

Special Procedure Room (Bronchoscopy) – Room Data Sheet	
Inside Design Conditions	● Year Around Conditions 70 F [21 C] to 75 F [24 C] Dry-Bulb Temperature 30% to 50% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	12 – CV Required
Return Air	Not Permitted
Exhaust Air	100%
Room Noise Level	35
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade D
Individual Room Temperature Control	Required
Room Air Balance	Negative (-)
Note 1: The HVAC system shall be sized and selected to maintain any room temperature within the specified range. Cooling load calculations shall be based on 70 F [21 C] and 50% relative humidity. Heating load calculations shall be based on 75 F [24 C] and 30% relative humidity.	

Special Procedure Room (Cardiac Catheterization) – Room Data Sheet	
Inside Design Conditions	● Year Around Conditions 70 F [21 C] to 75 F [24 C] Dry-Bulb Temperature 30% to 50% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	15 – CV Required
Return Air	Not Permitted
Exhaust Air	100%
Room Noise Level	35
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade D
Individual Room Temperature Control	Required
Room Air Balance	Positive (+)
Note 1: The HVAC system shall be sized and selected to maintain any room temperature within the specified range. Cooling load calculations shall be based on 70 F [21 C] and 50% relative humidity. Heating load calculations shall be based on 75 F [24 C] and 30% relative humidity.	

Special Procedure Room (Colonoscopy – EGD) – Room Data Sheet	
Inside Design Conditions	● Year Around Conditions 70 F [21 C] to 75 F [24 C] Dry-Bulb Temperature 30% to 50% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	8 – CV Required
Return Air	Not Permitted
Exhaust Air	100%
Room Noise Level	35
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade D
Individual Room Temperature Control	Required
Room Air Balance	Negative (-)
Note 1: The HVAC system shall be sized and selected to maintain any room temperature within the specified range. Cooling load calculations shall be based on 70 F [21 C] and 50% relative humidity. Heating load calculations shall be based on 75 F [24 C] and 30% relative humidity.	

Special Procedure Room (Cystoscopy) – Room Data Sheet	
Inside Design Conditions	● Year Around Conditions 70 F [21 C] to 75 F [24 C] Dry-Bulb Temperature 30% to 50% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	15 – CV Required
Return Air	Not Permitted
Exhaust Air	100%
Room Noise Level	35
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade D
Individual Room Temperature Control	Required
Room Air Balance	Positive (+)
Note 1: The HVAC system shall be sized and selected to maintain any room temperature within the specified range. Cooling load calculations shall be based on 70 F [21 C] and 50% relative humidity. Heating load calculations shall be based on 75 F [24 C] and 30% relative humidity.	

Special Procedure Room (Endoscopy) – Room Data Sheet	
Inside Design Conditions	● Year Around Conditions 70 F [21 C] to 75 F [24 C] Dry-Bulb Temperature 30% to 50% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	8 – CV Required
Return Air	Not Permitted
Exhaust Air	100%
Room Noise Level	35
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade D
Individual Room Temperature Control	Required
Room Air Balance	Negative (-)
Note 1: The HVAC system shall be sized and selected to maintain any room temperature within the specified range. Cooling load calculations shall be based on 70 F [21 C] and 50% relative humidity. Heating load calculations shall be based on 75 F [24 C] and 30% relative humidity.	

Special Procedure Room (Fluoroscopy) – Room Data Sheet	
Inside Design Conditions	● Year Around Conditions 70 F [21 C] to 75 F [24 C] Dry-Bulb Temperature 30% to 50% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	8 – CV Required
Return Air	Not Permitted
Exhaust Air	100%
Room Noise Level	35
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade D
Individual Room Temperature Control	Required
Room Air Balance	Negative (-)
Note 1: The HVAC system shall be sized and selected to maintain any room temperature within the specified range. Cooling load calculations shall be based on 70 F [21 C] and 50% relative humidity. Heating load calculations shall be based on 75 F [24 C] and 30% relative humidity.	

Special Procedure Room (Gastrointestinal – GI) Room Data Sheet	
Inside Design Conditions	● Year Around Conditions 70 F [21 C] to 75 F [24 C] Dry-Bulb Temperature 30% to 50% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	10 – CV Required
Return Air	Not Permitted
Exhaust Air	100%
Room Noise Level	35
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade D
Individual Room Temperature Control	Required
Room Air Balance	Negative (-)
Note 1: The HVAC system shall be sized and selected to maintain any room temperature within the specified range. Cooling load calculations shall be based on 70 F [21 C] and 50% relative humidity. Heating load calculations shall be based on 75 F [24 C] and 30% relative humidity.	

Special Procedure Room (Photocopy) – Room Data Sheet	
Inside Design Conditions	● Year Around Conditions 70 F [21 C] to 75 F [24 C] Dry-Bulb Temperature 30% to 50% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	6 – CV Required
Return Air	Not Permitted
Exhaust Air	100%
Room Noise Level	35
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade D
Individual Room Temperature Control	Required
Room Air Balance	Negative (-)
Note 1: The HVAC system shall be sized and selected to maintain any room temperature within the specified range. Cooling load calculations shall be based on 70 F [21 C] and 50% relative humidity. Heating load calculations shall be based on 75 F [24 C] and 30% relative humidity.	

Special Procedure Room (Sigmoidoscopy) – Room Data Sheet	
Inside Design Conditions	● Year Around Conditions 70 F [21 C] to 75 F [24 C] Dry-Bulb Temperature 30% to 50% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	8 – CV Required
Return Air	Not Permitted
Exhaust Air	100%
Room Noise Level	35
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade D
Individual Room Temperature Control	Required
Room Air Balance	Negative (-)
Note 1: The HVAC system shall be sized and selected to maintain any room temperature within the specified range. Cooling load calculations shall be based on 70 F [21 C] and 50% relative humidity. Heating load calculations shall be based on 75 F [24 C] and 30% relative humidity.	

Standby Generator Room

Background Information: The Physical Security Design Manual requires all new Mission Critical Facilities (medical centers) be provided with full standby electrical power. Mission Critical Facilities are those required to continue operation during natural or man-made extreme events.

It is assumed the generator plant will be sized at 8 to 10 watts per gross building square foot. This will yield plants in the range of 6 to 12 MW.

Recognizing only 35 to 40% of the input energy into the prime mover is converted into usable electricity and the rest is rejected in the form of heat; it is paramount that the ventilation systems for the standby generator rooms be thoroughly addressed. See heat balance Figure 6B-1.

Submit a detailed analysis showing all options and systems selected to provide proper ventilation and cooling for the standby generator space. 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 need to be consulted to ascertain the range of heat rejection from the various components. See Figure 6B-1 for average heat rejection values. Assuming the prime movers are reciprocating diesel engines, consideration needs to 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.

The analysis shall compare unit mounted radiators to remote radiators. The analysis shall include the cost of louvers and control devices. Louvers in areas prone to hurricanes or wind-debris hazards shall be certified by the manufacturer to 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.

The remote radiator design and location shall meet the requirements of the Physical Security Design Manual for critical outdoor mechanical equipment. In areas designated as hurricane prone, the remote radiator design shall also meet the wind load and damage protection requirements for hurricane locations.

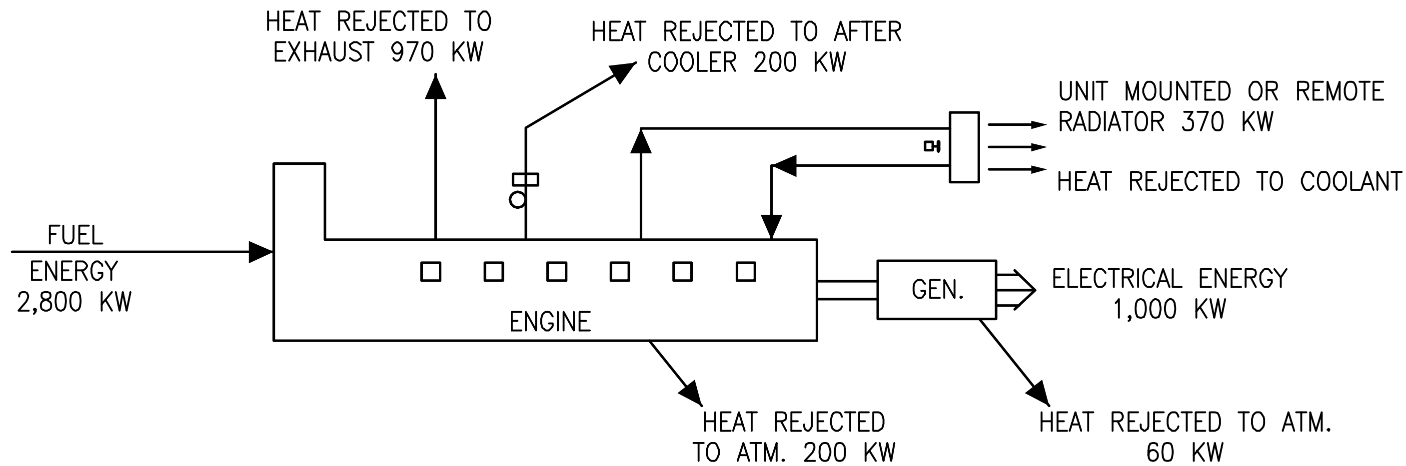
There are several options available: the electrical equipment including the generator and onboard or nearby electrical equipment can be specified for wet locations, or remote radiators can be used thereby drastically reducing the louver area requirement. A system with a mix of unit mounted radiators and remote units could be proposed. A separate detailed acoustic analysis shall be submitted for the final design of the standby generator facility.

Design considerations:

- The switchgear and control rooms shall be fully air-conditioned. If remote radiators are used and only minimal louvers required for combustion in ventilation consideration should be given to air conditioning the engine bay. The louvers would then be fitted with electrically controlled actuators to open as needed. No air conditioning during operation.

Standby Generator Room	
• Additional factors required by the Physical Security Design manual shall be factored into the final design and analysis. • If remote radiators are used glycol needs to be added for systems subject to freezing. • A complete and detailed heat balance of the entire system shall be included in the analysis. • Engine exhaust must be safely conveyed from the engine through the piping and any auxiliary equipment to the atmosphere within allowable pressure drops. • Maintain a separate exhaust for each engine to reduce the possibility of condensation in the off engines. • Provide individual silencers or mufflers for each exhaust system. • For the exhaust system use welded tube turns with radius of at leased 4 pipe diameters. • The air intakes and exhaust outlets shall be located so air does not short circuit. Air shall pass over the engine-generator set before it is exhausted. Additional ventilation shall be provided as required to reject the heat from the engine-generator set, muffler (if installed in room) and exhaust pipe. See VA Master Specification 26 32 13 (16208) ENGINE GENERATORS for the muffler and exhaust piping, which is to be covered with calcium silicate insulation.	
Inside Design Conditions	● Cooling 85 F [29.4 C] Dry-Bulb Temperature ● Heating 40 F [18.3 C] Dry-Bulb Temperature ● **Note 1**
Minimum Supply Air Changes per Hour	4 air changes per hour or greater if load requires – Engine Off
Return Air	Permitted – Engine Off
Exhaust Air	Required – During Operation
Room Noise Level	Not Applicable
Filtration	Pre-Filters – VA Grade A during operation
Individual Room Temperature Control	Required – Engine Off
Room Air Balance	Negative (-) – During Operation
Note 1: The following apply to stand-by or emergency generators: **(a)** Provide motorized dampers for all louvers. Dampers shall fail-open on loss of power (spring to open). **(b)** During operation, room temperature shall not exceed maximum ambient temperature recommended by engine generator manufacturer.	

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^{o}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, ^{o}F (#6x3413)/(#3x1.08)	25	21	26	21	29	26
12	ROOM VENT RATE @ 15^{O} 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

Therapeutic Pool – Room Data Sheet	
Inside Design Conditions	● Cooling 77 F [25 C] Dry-Bulb Temperature 50% Relative Humidity ● Heating 82 F [27.8 C] Dry-Bulb Temperature 30% Relative Humidity
Minimum Supply Air Changes per Hour	● 12 – CV required ● **Note 1**
Return Air	Not Permitted
Exhaust Air	● 100% ● **Note 2**
Room Noise Level	NC 45
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade D
Individual Room Temperature Control	Required
Room Air Balance	Negative (-)

Note 1: Evaluate minimum air changes per hour with the expected evaporation losses and resultant space relative humidity. Increase the supply air volume to keep the relative humidity below 60%.

Note 2: Provide a dedicated wet exhaust system with the following features:

● Welded stainless steel ductwork

● Coated fan to prevent corrosion

● Bearings outside the air stream

Therapy Room (Occupational)	
Inside Design Conditions	● Cooling 75 F [23.9 C] Dry-Bulb Temperature 50% Relative Humidity ● Heating 70 F [21.1 C] Dry-Bulb Temperature 30% Relative Humidity ● 5 F [2.8 C] Dead Band
Minimum Supply Air Changes per Hour	6 – VAV Permitted
Return Air	Permitted
Exhaust Air	Not Required
Room Noise Level	35
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade C
Individual Room Temperature Control	Required
Room Air Balance	Neutral (0)

Therapy Room (Physical) – Room Data Sheet	
Inside Design Conditions	● Cooling 75 F [23.9 C] Dry-Bulb Temperature 50% Relative Humidity ● Heating 70 F [21.1 C] Dry-Bulb Temperature 30% Relative Humidity ● 5 F [2.8 C] Dead Band
Minimum Supply Air Changes per Hour	6 – VAV Permitted
Return Air	Permitted
Exhaust Air	Not Required
Room Noise Level	35
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade D
Individual Room Temperature Control	Required
Room Air Balance	Negative (-)

Toilets – Patients (Interior) – Room Data Sheet	
Inside Design Conditions	Conditioned by make-up air
Minimum Supply Air Changes per Hour	Not Applicable
Return Air	Not Permitted
Exhaust Air	Highest of: ● 10 air changes per hour ● 50 CFM [24.0 Liters/Second] ● Room air balance
Room Noise Level	NC 35
Filtration	Not Applicable
Individual Room Temperature Control	Not Required
Room Air Balance	Double Negative (- -)

Toilets – Patients (Perimeter) – Room Data Sheet	
Inside Design Conditions	● Heating 68 F [20 C] ● **Note 1**
Minimum Supply Air Changes per Hour	Not Applicable
Return Air	Not Permitted
Exhaust Air	Highest of: ● 10 air changes per hour ● 50 CFM [24.0 Liters/Second] ● Room air balance
Room Noise Level	NC 35
Filtration	Not Applicable
Individual Room Temperature Control	Required – Heating Mode
Room Air Balance	Double Negative (- -)
Note 1: Provide radiant ceiling panels.	

Toilets – Public (Interior) – Room Data Sheet	
Inside Design Conditions	● Cooling 77 F [25 C] Dry-Bulb Temperature 50% Relative Humidity
Minimum Supply Air Changes per Hour	● 6 – CV Required ● **Note 1**
Return Air	Not Permitted
Exhaust Air	● 100% ● Highest of: – 10 air changes per hour – 70 CFM [33.0 Liters/Second] per each water closet and/or urinal – Room air balance ● **Note 2**
Room Noise Level	NC 40
Filtration	Not Applicable
Individual Room Temperature Control	Required
Room Air Balance	Double Negative (- -)
Note 1: For toilets with exhaust volumes greater than 300 CFM [141.6 Liters/Second], provide a thermostatically-controlled, dedicated constant volume air terminal unit. **Note 2:** Admit make-up air from the adjoining corridor via door undercut and transfer grille.	

Toilets Public (Perimeter) – Room Data Sheet	
Inside Design Conditions	● Cooling 77 F [25 C] Dry-Bulb Temperature 50% Relative Humidity ● Heating 70 F [21.1 C] Dry-Bulb Temperature 30% Relative Humidity
Minimum Supply Air Changes per Hour	● 6 – CV Required ● **Notes 1 and 2**
Return Air	Not Permitted
Exhaust Air	● 100% ● Highest of: – 10 air changes per hour – 70 CFM [33.0 Liters/Second] per each water closet and/or urinal – Room air balance ● **Note 3**
Room Noise Level	NC 40
Filtration	Not Applicable
Individual Room Temperature Control	Required
Room Air Balance	Double Negative (- -)
Note 1: For toilets with exhaust volume greater than 300 CFM [141.6 Liters/Second], provide a thermostatically controlled, dedicated constant volume air terminal unit with reheat coil. **Note 2:** For toilets with exhaust volumes less than 300 CFM [141.6 Liters/Second], install thermostatically-controlled perimeter heat delivered by unit heaters, cabinet heaters, convectors, or baseboard radiators. **Note 3:** Admit make-up air from the adjoining corridor via door undercut and transfer grille.	

Trash Collection Room – Room Data Sheet	
Inside Design Conditions	Heating Only 50 F [10.0 C]
Minimum Supply Air Changes per Hour	● 15 – CV Required ● **Note 1**
Return Air	Not Permitted
Exhaust Air	● 20 Air Changes per Hour ● 100% ● **Note 2**
Room Noise Level	NC 45
Filtration	Pre-Filters – VA Grade A
Individual Room Temperature Control	Required – Heating Mode only
Room Air Balance	Double Negative (- -)
Note 1: If the required make-up air for exhaust is not available from the adjoining spaces, provide a dedicated HV unit (capacity – 15 air changes per hour). **Note 2:** Provide a dedicated exhaust fan. Fan shall run continuously. Allow the difference between the exhaust and supply air volume to enter via door undercut and transfer grille.	

Treatment Room (Chemotherapy) – Room Data Sheet	
Inside Design Conditions	● Year Around Conditions 70 F [21 C] to 75 F [24 C] Dry-Bulb Temperature 30% to 50% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	10 – CV Required
Return Air	Not Permitted
Exhaust Air	100%
Room Noise Level	NC 35
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade D
Individual Room Temperature Control	Required
Room Air Balance	Negative (-)
Note 1: The HVAC system shall be sized and selected to maintain any room temperature within the specified range. Cooling load calculations shall be based on 70 F [21 C] and 50% relative humidity. Heating load calculations shall be based on 75 F [24 C] and 30% relative humidity.	

Treatment Room (Dermatology) – Room Data Sheet	
Inside Design Conditions	● Year Around Conditions 70 F [21 C] to 75 F [24 C] Dry-Bulb Temperature 30% to 50% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	6 – VAV Permitted
Return Air	Permitted
Exhaust Air	Not Required
Room Noise Level	NC 35
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade D
Individual Room Temperature Control	Required
Room Air Balance	Negative (-)
Note 1: The HVAC system shall be sized and selected to maintain any room temperature within the specified range. Cooling load calculations shall be based on 70 F [21 C] and 50% relative humidity. Heating load calculations shall be based on 75 F [24 C] and 30% relative humidity.	

Treatment Room (Phototherapy) and Shower Room – Room Data Sheet	
Inside Design Conditions	● Year Around Conditions 70 F [21 C] to 75 F [24 C] Dry-Bulb Temperature 30% to 50% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	6 – VAV Permitted
Return Air	Permitted
Exhaust Air	From Shower Room only
Room Noise Level	NC 35
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade D
Individual Room Temperature Control	Required
Room Air Balance	● Neutral (0) – Phototherapy Treatment ● Negative (-) – Shower Room
Note 1: The HVAC system shall be sized and selected to maintain any room temperature within the specified range. Cooling load calculations shall be based on 70 F [21 C] and 50% relative humidity. Heating load calculations shall be based on 75 F [24 C] and 30% relative humidity.	

Tub Room – Room Data Sheet	
Inside Design Conditions	● Year Around Conditions 70 F [21 C] to 82 F [27.8 C] Dry-Bulb Temperature 30% to 50% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	10 – CV required
Return Air	Not Permitted
Exhaust Air	● 100% ● **Note 2**
Room Noise Level	NC 40
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade D
Individual Room Temperature Control	Required
Room Air Balance	Negative (-)
Note 1: The HVAC system shall be sized and selected to maintain any room temperature within the specified range. Cooling load calculations shall be based on 70 F [21 C] and 50% relative humidity. Heating load calculations shall be based on 82 F [27.8 C] and 30% relative humidity. **Note 2:** Connect room air exhaust to the general exhaust system.	

Ventilatory Test Room (Spirometry) – Room Data Sheet	
Inside Design Conditions	● Year Around Conditions 70 F [21 C] to 75 F [24 C] Dry-Bulb Temperature 30% to 50% Relative Humidity ● **Note 1**
Minimum Supply Air Changes per Hour	12 – CV Required
Return Air	Not Permitted
Exhaust Air	● 100% ● **Notes 2 and 3**
Room Noise Level	35
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade D
Individual Room Temperature Control	Required
Room Air Balance	Negative (-)
Note 1: The HVAC system shall be sized and selected to maintain any room temperature within the specified range. Cooling load calculations shall be based on 70 F [21 C] and 50% relative humidity. Heating load calculations shall be based on 75 F [24 C] and 30% relative humidity. **Note 2:** Provide low-level exhaust grilles 7 inches [175 mm] above finished floor. **Note 3:** Room air exhaust can be connected to the general exhaust system.	

Vestibules – Room Data Sheet	
Inside Design Conditions	● Heating Only 50 F [10 C] ● **Note 1**
Minimum Supply Air Changes per Hour	● 1.0 CFM/Square Foot [5.0 Liters/Second/Square Meter] ● **Note 2**
Return Air	Not Permitted
Exhaust Air	Not Required
Room Noise Level	NC 45
Filtration	As supplied with the cabinet heaters
Individual Room Temperature Control	Required
Room Air Balance	Positive (+) with respect to outdoors

Note 1: Provide a thermostatically controlled, ceiling or floor-mounted, terminal heater(s). Coordinate heater type, location, and access with the architectural discipline.

(a) Floor-Mounted Cabinet Heaters – Provide cabinet heaters in vertical configuration with top return and bottom horizontal supply configuration, discharging air at the floor level.

(b) Ceiling-Suspended Cabinet Heaters – Provide supply and return air ductwork with the ceiling-mounted cabinet heaters. Locate supply air outlet(s) and return air inlet(s) to ensure uniform air and heat distribution. For floor-to-ceiling glass entrance, provide wall-to-wall linear diffusers.

(c) Provide local, closed-loop thermostatic control, without interface with the building DDC controls system.

Note 2: Admit supply air at the rate of 1.0 CFM/Square Feet [5.0 Liters/Second/Square Meter] of vestibule area, under positive pressure, from the lobby air terminal unit. Allow the conditioned supply air to ex-filtrate outdoors.

Visual Fields Room and Photography Room – Room Data Sheet	
Inside Design Conditions	● Cooling 75 F [24 C] Dry-Bulb Temperature 50% Relative Humidity ● Heating 70 F [21 C] Dry-Bulb Temperature 30% Relative Humidity ● 5 F [2.8 C] Dead Band
Minimum Supply Air Changes per Hour	6 – VAV Permitted
Return Air	Permitted
Exhaust Air	Not Required
Room Noise Level	35
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade C
Individual Room Temperature Control	Required
Room Air Balance	Neutral (0)

Vital Signs Station – Room Data Sheet	
Inside Design Conditions	● Cooling 75 F [24 C] Dry-Bulb Temperature 50% Relative Humidity ● Heating 70 F [21 C] Dry-Bulb Temperature 30% Relative Humidity ● 5 F [2.8 C] Dead Band
Minimum Supply Air Changes per Hour	6 – VAV Permitted
Return Air	Permitted
Exhaust Air	Not Required
Room Noise Level	35
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade C
Individual Room Temperature Control	Not Required
Room Air Balance	Neutral (0)

Walk-In Refrigerators and Freezers – Room Data Sheet	
Inside Design Conditions	**Notes 1 - 3**
Minimum Supply Air Changes per Hour	**Note 4**
Return Air	Not Applicable
Exhaust Air	Not Applicable
Room Noise Level	Not Applicable
Filtration	Not Applicable
Individual Room Temperature Control	Not Applicable
Room Air Balance	Neutral (0)

Note 1: Coordinate the equipment installation and design with the VA Master Specifications and Standard Details. The revised specifications are:

(a) Section 11 41 21 - Walk-In Coolers and Freezers

(b) Section 11 53 23 - Laboratory Refrigerators

(c) Section 11 78 13 - Mortuary Refrigerators

Exception to Note 1:
Constant temperature rooms, covered under the 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.

Note 2: Make provision to prevent frost formation and subsequent floor heaving for the equipment mounted on grade or above the grade with fill. Provide heating cables in coordination with the electrical discipline to prevent freezing below the grade or concrete sub-floor. Evaluate the possibility of using waste heat for anti-frost system, to conserve energy.

Note 3: Provide emergency electrical power for the equipment and controls serving refrigerators and servers.

Note 4: Use ASHRAE recommendations about the heat gain factors, load calculations, and compressor running time while selecting the equipment to maintain the temperatures listed below:

(a) Dairy Freezers: -20 F [-28.9 C]

(b) Ice Cream Freezers: -20 F [-28.9 C]

(c) Meat Freezers: -12 F [-24.4 C]

(d) Fresh Meat Refrigeration: 32 F [0.0 C]

(e) Walk-In Refrigerators: 36 F [2.2 C]

(f) Autopsy (Mortuary) Cold Room: 36 F [2.2 C]

(g) Subsistence Storage (Supply Service): 36 F [2.2 C]

Warehouse (Central) – Room Data Sheet	
Inside Design Conditions	● Heating 68 F [20 C] – Occupied Mode 50 F [10 C] – Unoccupied Mode ● **Note 1**
Minimum Supply Air Changes per Hour	6 – CV Required
Return Air	● Permitted ● **Note 2**
Exhaust Air	● Up to 100% ● **Note 3**
Room Noise Level	45
Filtration	● Pre-Filters – VA Grade A ● After-Filters – VA Grade B
Individual Room Temperature Control	● Required ● Heating Mode Only
Room Air Balance	Positive (+)
Note 1: Central warehouse is generally provided with a heating and ventilation unit, complete with air distribution system, that is, supply, exhaust, outside, and return air ducts and inlets/outlets. Use of mechanical cooling shall be evaluated on a case-by-case basis, particularly in high humidity locations. **Note 2:** During night setback and morning warm-up cycles, the HV unit shall operate in 100% re-circulatory mode with outside air dampers in closed position and return air damper in open position. **Note 3:** Provide an exhaust system to relieve room air during summer ventilation mode.	

CHAPTER 7: CLIMATIC DATA

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7.1 CLIMATIC CONDITIONS FOR VA MEDICAL CENTERS

Table 7-1 Climatic Conditions for VA Medical Centers

Location	Weather Station	Latitude	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%		
				Db	Wb	Db	Db	Wb	Db			Maximum	Minimum
ALABAMA													
Birmingham	Birmingham	33.57	630	95.2	75.6	18.6	92.7	75.2	23.0	78.5	77.6	98.1	10.2
Montgomery	Montgomery	32.28	203	95.9	76.4	23.7	93.6	76.0	27.2	79.6	78.4	98.7	15.5
Tuscaloosa	Tuscaloosa Municipal AP	33.22	167	96.1	76.4	20.1	99	77	24.7	79.7	78.6	99.2	11.2
Tuskegee*	Tuskegee AP	32	195	96	79	22	95	79	22	-	-	-	-
ALASKA													
Anchorage	Anchorage	61.17	115	40.6	58.4	-10.7	67.9	57.1	-5.8	60.1	58.6	76.4	-15.6
ARIZONA													
Phoenix	Phoenix	33.42	1112	110.2	70.0	37.2	108.1	69.9	40.1	76.0	75.1	114.5	32.8
Prescott	Prescott Love Field	34.65	5039	94.2	60.8	16.7	91.5	60.6	20.5	26.7	25.7	98.7	9.2
Tucson	Tucson	32.12	2556	105.3	66.0	31.6	102.9	65.6	34.4	72.3	71.4	109.1	26.3
ARKANSAS													
Fayetteville	Fayetteville Drake Field	36.00	1250	95.3	75.3	7.5	92.8	75.1	14.1	78.2	77.2	99.1	0.5
Little Rock	Little Rock AFB	34.92	338	99.3	77.2	15.2	96.4	77.3	20.4	80.9	79.8	101.7	7.9
N. Little Rock	North Little Rock	34.83	558	95.1	76.0	15.2	92.7	75.9	20.6	78.3	77.4	98.2	10.2

Table 7-1 Climatic Conditions for VA Medical Centers

Location	Weather Station	Latitude	Elevation	Col. 1a 0.4% Summer Db	Col. 1a 0.4% Summer Wb	Col. 1b 99.6% Winter Db	Col. 2a 1% Summer Db	Col. 2a 1% Summer Wb	Col. 2b 99% Winter Db	Col. 3 Wet Bulb 0.4%	Col. 3 Wet Bulb 1%	Annual Extreme Daily-Mean Db Maximum	Annual Extreme Daily-Mean Db Minimum
CALIFORNIA													
Fresno	Fresno	36.77	328	103.5	71.1	30.7	101.0	70.1	33.0	73.5	72.0	107.8	27.2
Livermore*	Livermore	37	545	100	71	24	97	70	24	-	-	-	-
Loma Linda	Riverside-March AFB	33	1539	101	68	34	98	68	36	72	71	107	29
Long Beach	Long Beach	33.82	56	91.5	68.0	40.8	87.7	67.3	43.1	72.2	70.8	101.8	35.8
Los Angeles	Los Angeles	33.92	105	84.2	64.2	43.9	80.4	64.5	46.1	70.0	68.9	95.2	39.2
Martinez*	Concord	38	195	100	7	24	97	70	24	-	-	-	-
Palo Alto	San Jose INTL AP	37.37	49	92.4	67.1	35.7	88.9	66.4	37.8	69.6	68.2	100.5	31.8
Menlo Park	San Jose INTL AP	37.37	49	92.4	67.1	35.7	88.9	66.4	37.8	69.6	68.2	100.5	31.8
San Diego	San Diego	32.72	30	84.7	67.7	44.8	81.5	67.7	46.9	72.8	71.3	92.8	41.0
San Francisco	San Francisco	37.62	16	83.0	62.9	40.0	78.2	62.0	40.0	65.1	63.5	94.5	34.4
Sepulveda	Burbank-Glendale-Pasadena	34.20	738	98.3	69.0	39.0	94.5	68.5	41.4	73.5	71.9	105.4	33.6
COLORADO													
Denver	Denver Stapleton INTL AR	39.77	5285	93.5	60.5	-4.0	90.8	60.0	3.3	64.6	63.5	98.9	-12.2
Ft. Lyon*	La Junta Municipal AP	38.05	4203	99.6	64.6	-1.5	97.0	64.2	6.1	68.5	67.6	104.5	-6.7
Grand Junction	Grand Junction	39.12	4839	96.6	61.5	3.4	94.4	60.7	8.9	65.3	64.2	100.6	-0.8
CONNECTICUT													
Newington	Hartford/ Brainard FD	41.73	20	90.5	N/A	7.0	87.8	N/A	11.5	N/A	N/A	N/A	N/A

Table 7-1 Climatic Conditions for VA Medical Centers

Location	Weather Station	Latitude	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%		
				Db	Wb	Db	Db	Wb	Db			Maximum	Minimum
West Haven*	West Haven AP	41	6	88	76	3	84	76	3	-	-	-	-
DELAWARE													
Wilmington	Wilmington	39.67	79	91.7	75.2	10.6	89.1	74.0	15.0	78.0	76.6	96.4	3.7
DISTRICT OF COLUMBIA													
Washington	National AP	38	66	95	76	15	92	76	20	79	78	99	8
FLORIDA													
Bay Pines	St. Petersburg	27.92	10	93.4	79.0	42.6	91.9	78.5	46.0	82.2	81.3	95.7	34.2
Coral Gables	Miami	25.78	7	91.6	77.5	46.3	90.4	77.4	50.5	80.0	79.3	94.5	40.0
Gainesville	Gainesville Regional AP	29.70	131	93.6	76.8	29.6	92.1	76.5	33.3	79.9	79.0	97.4	22.3
Lake City	Gainesville Regional AP	29.70	131	93.6	76.8	29.6	92.1	76.5	33.3	79.9	79.0	97.4	22.3
Miami	Miami	25.78	7	91.6	77.5	46.3	90.4	77.4	50.5	80.0	79.3	94.5	40.0
Orlando	Orlando Executive AP	28.55	105	93.9	76.3	6.8	92.6	76.1	7.2	80.1	79.1	96.6	32.2
Tampa	Tampa	27.97	10	92.5	77.5	36.6	91.4	77.5	40.6	80.5	79.9	94.9	29.9
GEORGIA													
Atlanta	Atlanta	33.65	1033	93.9	74.8	18.8	91.6	74.3	23.9	77.4	76.3	96.4	10.8
Augusta	Augusta	33.37	148	96.8	76.1	21.3	94.4	75.9	24.8	79.2	78.1	100.4	14.2
Dublin*	Dublin AP	32	215	96	79	21	93	78	21	-	-	-	-
Decatur	Atlanta	33.65	1033	93.9	74.8	18.8	91.6	74.3	23.9	77.4	76.3	96.4	10.8

Table 7-1 Climatic Conditions for VA Medical Centers

Location	Weather Station	Latitude	Elevation	Col. 1a 0.4% Temperatures Summer Db	Col. 1a 0.4% Temperatures Summer Wb	Col. 1b 99.6% Winter Db	Col. 2a 1% Summer Db	Col. 2a 1% Summer Wb	Col. 2b 99% Winter Db	Col. 3 Wet Bulb 0.4%	Col. 3 Wet Bulb 1%	Annual Extreme Daily-Mean Db Maximum	Annual Extreme Daily-Mean Db Minimum
HAWAII													
Honolulu	Honolulu	21.32	16	89.6	73.8	60.8	88.7	73.5	62.8	76.8	75.9	91.0	57.0
IDAHO													
Boise	Boise	43.57	2867	97.0	63.9	1.6	94.1	62.8	9.1	66.1	64.6	103.0	-2.3
ILLINOIS													
Chicago W. Side	W. Chicago/DU Page	41.92	758	90.5	75.2	-6.4	88.0	74.0	-0.2	78.4	76.6	95.4	-12.8
Chicago Lakeside	W. Chicago/DU Page	41.92	758	90.5	75.2	-6.4	88.0	74.0	-0.2	78.4	76.6	95.4	-12.8
Danville*	Danville	40	558	93	78	-3	90	77	-4	-	-	-	-
Downey*	Waukegan	42	680	92	78	-6	89	76	-6	-	-	-	-
Hines	Meigs Field	41	623	92	74	-3	89	73	3	77	76	97	-10
Marion*	Mt. Vernon (AWOS)	38.32	479	93.2	77.5	3.1	91.0	76.8	9.9	81.3	79.1	97.4	-8.1
INDIANA													
Ft Wayne	Ft. Wayne	41.00	827	90.9	74.3	-3.6	88.1	73.0	1.9	77.5	75.8	94.7	-10.4
Indianapolis	Indianapolis	39.72	807	91.1	75.8	-1.8	88.6	74.6	4.1	78.4	77.1	94.3	-9.2
Marion*	Marion	40	791	91	77	-4	90	75	-4	-	-	-	-
IOWA													
Des Moines	Des Moines	41.52	965	93.5	76.0	-7.8	90.3	74.8	-2.9	78.2	76.9	97.9	-14.2
Iowa City*	Iowa City	41	645	92	80	-11	89	78	-11	-	-	-	-
Knoxville	Des Moines	41.52	965	93.5	76.0	-7.8	90.3	74.8	-2.9	78.2	76.9	97.9	-14.2

Table 7-1 Climatic Conditions for VA Medical Centers

Location	Weather Station	Latitude	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%		
				Db	Wb	Db	Db	Wb	Db			Maximum	Minimum
KANSAS													
Leavenworth	Kansas City, MO AP	39	1024	96	75	-1	93	75	4	78	77	100	-7
Topeka	Topeka	39.07	886	96.5	75.8	-1.6	93.6	75.6	4.4	79.1	77.8	100.9	-8.0
Wichita	Wichita	37.65	1339	101.0	72.9	2.6	97.8	73.0	8.7	77.1	75.9	104.9	-2.4
KENTUCKY													
Lexington	Lexington	38.02	988	91.1	74.5	4.5	88.8	73.9	10.6	77.3	76.0	94.5	-2.8
Louisville	Louisville	38.17	489	93.1	76.4	6.7	90.9	75.7	12.5	78.9	77.6	96.3	0.3
LOUISIANA													
Alexandria	England AFB	31.32	89	96.7	77.8	26.0	93.9	77.6	29.6	80.9	80.0	98.9	19.7
New Orleans	New Orleans	29.98	10	93.8	78.8	30.6	92.1	78.3	34.4	81.3	80.4	96.4	24.6
Shreveport	Shreveport	32.47	259	97.5	76.8	22.7	95.1	76.8	26.7	79.5	78.8	99.8	16.8
MAINE													
Togus	Augusta Airport	44.32	348	87.1	70.4	-3.4	83.8	68.9	1.0	73.3	71.4	93.1	-10.4
MARYLAND													
Baltimore	Baltimore	39.17	154	93.6	75.0	12.3	90.9	74.3	16.7	78.1	76.9	97.8	4.8
Perry Point	Baltimore AP	39.17	154	93.6	75.0	12.3	90.9	74.3	16.7	78.1	76.9	97.8	4.8
MASSACHUSETTS													
Bedford	Boston	42.37	16	90.8	73.1	7.7	87.6	71.7	12.3	76.0	74.3	96.0	1.4
Boston	Boston	42.37	16	90.8	73.1	7.7	87.6	71.7	12.3	76.0	74.3	96.0	1.4
Brockton*	Taunton	41	20	89	75	5	86	74	5	-	-	-	-

Table 7-1 Climatic Conditions for VA Medical Centers

Location	Weather Station	Latitude	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%		
				Db	Wb	Db	Db	Wb	Db			Maximum	Minimum
North Hampton*	Springfield/Westover AFB	42	247	90	75	-5	87	73	-5	-	-	-	-
West Roxbury	Boston	42.37	16	90.8	73.1	7.7	87.6	71.7	12.3	76.0	74.3	96.0	1.4
MICHIGAN													
Ann Arbor*	Ypsilanti	42	777	92	75	1	89	74	1	-	-	-	-
Allen Park	Detroit Metro CAP	42	663	90	73	0	87	72	5	76	74	95	-7
Battle Creek*	Battle Creek AP	42	939	92	76	1	88	74	1	-	-	-	-
Detroit	Detroit Metro CAP	42	663	90	73	0	87	72	3	76	74	95	-7
Iron Mountain*	Escanaba	45.7545	614	81.8	67.9	-7.9	79.2	67.3	-2.9	72.3	70.1	87.6	-15.2
Saginaw	Saginaw AP	43	669	90	74	0	87	72	4	77	75	96	-6
MINNESOTA													
Minneapolis	Minneapolis/St. Paul	44.87	837	91.0	73.2	-14.9	87.8	71.8	-9.4	76.7	74.7	96.5	-20.8
St. Cloud	St. Cloud	45.55	1027	89.5	N/A	-20.4	86.2	N/A	-14.7	N/A	N/A	95.6	-27.6
MISSISSIPPI													
Jackson	Jackson	32.32	331	95.9	76.7	21.1	93.9	76.4	25.1	79.9	78.9	98.6	14.6
Biloxi	Keesler AFB	30.42	23	93.5	80.2	30.3	91.5	79.4	34.9	83.5	82.2	97.0	20.8
Gulfport	Keesler AFB	30.42	23	93.5	80.2	30.3	91.5	79.4	34.9	83.5	82.2	97.0	20.8
MISSOURI													
Columbia	Columbia	38.82	886	94.7	75.7	-0.3	91.7	75.6	5.4	78.9	77.5	99.0	-7.9
Kansas City	Kansas City	39.28	1.33	95.8	75.6	-2.1	92.6	75.4	3.5	79.1	77.7	100.2	-8.0
Poplar Bluff	Poplar Bluff	36.77	479	94.4	77.2	8.0	92.0	76.6	14.4	80.0	78.7	99.1	2.3

Table 7-1 Climatic Conditions for VA Medical Centers

Location	Weather Station	Latitude	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%		
				Db	Wb	Db	Db	Wb	Db			Maximum	Minimum
St. Louis (JBO)	St. Louis	38.75	564	95.5	76.7	2.0	93.0	76.1	8.0	79.4	78.1	99.3	-4.6
MONTANA													
Ft. Harrison	Helena	46.58	3898	91.0	61.0	-17.1	87.8	60.2	-9.8	63.9	62.2	96.7	-23.0
Miles City	Miles City Municipal ARPT	46.43	2628	98.2	65.8	-18.2	94.6	64.8	-11.7	69.7	68.0	103.1	-23.8
NEBRASKA													
Grand Island	Grand Island	40.97	1857	96.4	73.0	-7.3	93.1	72.5	-1.8	76.9	75.2	101.9	-13.6
Lincoln	Lincoln CO	40	1188	97	74	-7	94	74	-2	78	76	103	-11
Omaha	Eppley Airfield	41.32	981	94.6	76.4	-7.4	91.6	75.3	-1.5	79.2	77.5	99.3	-12.8
NEVADA													
Reno	Reno	39.50	4400	95.1	60.9	8.8	92.5	60.0	14.9	63.0	61.6	99.6	3.7
NEW HAMPSHIRE													
Manchester*	Grenier AFB	43	253	91	75	-8	88	74	-8	-	-	-	-
NEW JERSEY													
East Orange	Newark	40.70	30	93.4	74.9	10.3	90.4	73.3	14.8	77.4	76.1	98.2	4.6
Lyons*	New Brunswick	40	86	92	77	6	89	76	6	-	-	-	-
NEW MEXICO													
Albuquerque	Albuquerque	35.03	5315	96.0	60.2	15.9	93.5	60.1	19.9	65.3	64.4	100.1	8.7

Table 7-1 Climatic Conditions for VA Medical Centers

Location	Weather Station	Latitude	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%		
				Db	Wb	Db	Db	Wb	Db			Maximum	Minimum
NEW YORK													
Albany	Albany	42.75	292	88.5	72.8	-2.9	85.7	71.2	2.2	75.4	73.8	93.6	-11.7
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 Int.	40.65	13	89.5	73.4	13.1	86.3	72.1	17.5	77.0	75.8	96.3	6.8
Brooklyn	NYC/ John F. Kennedy Int. AP	40.65	13	89.5	73.4	13.1	86.3	72.1	17.5	77.0	75.8	96.3	6.8
Buffalo	Buffalo	42.92	705	86.1	70.7	2.2	83.7	69.5	6.2	74.3	72.6	90.4	-4.7
Canandaigua*	Geneva	42	590	90	75	-3	87	73	-3	-	-	-	-
Castle Point	Poughkeepsie	41.63	154	91.3	74.0	0.6	88.5	72.6	6.2	76.7	75.1	96.3	-8.8
Montrose*	Newberg-Stewart AFB	41	460	90	76	-1	88	74	-1	-	-	-	-
New York City	NYC/John F. Kennedy Int. AP	40.65	13	89.5	73.4	13.1	86.3	72.1	17.5	77.0	75.8	96.3	6.8
Northport*	Suffolk Co. AFB	40	57	86	76	7	83	74	7	-	-	-	-
Syracuse	Syracuse	43.12	407	88.4	72.8	-2.7	85.6	71.0	2.9	75.4	73.6	92.5	-11.7
St. Albans	NYC/John F. Kennedy Int. AP	40.65	13	89.5	73.4	13.1	86.3	72.1	17.5	77.0	75.8	96.3	6.8

Table 7-1 Climatic Conditions for VA Medical Centers

Location	Weather Station	Latitude	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%		
				Db	Wb	Db	Db	Wb	Db			Maximum	Minimum
NORTH CAROLINA													
Durham	Durham	36	440	93	76	16	90	75	20	78	77	96	9
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	35.42	2169	88.2	72.1	12.2	85.8	71.3	16.9	74.7	73.4	91.8	3.8
Salisbury	Winston-Salem AP	36	971	92	74	18	89	74	23	77	76	96	8
NORTH DAKOTA													
Fargo	Fargo	46.90	899	91.1	71.6	-21.1	87.8	69.9	-16.5	75.3	73.2	97.3	-25.7
OHIO													
Brecksville	Cleveland	41.40	804	89.1	74.3	1.0	86.3	72.4	6.1	76.3	74.7	93.3	-5.6
Chillicothe*	Chillicothe	39	638	95	78	0	92	76	0	-	-	-	-
Cincinnati	Lunken Field	39	482	93	74	5	90	75	12	77	76	96	-3
Cleveland	Cleveland	41.40	804	89.1	74.3	1.0	86.3	72.4	6.1	76.3	74.7	93.3	-5.6
Dayton	Dayton	39.90	1004	90.5	74.3	-0.6	88.0	73.1	5.1	76.9	75.3	94.5	-7.6
OKLAHOMA													
Muskogee*	Muskogee	35	610	101	79	10	98	78	10	-	-	-	-
Oklahoma City	Oklahoma City	35.40	1302	99.5	74.2	10.3	96.7	73.9	15.7	77.4	76.4	102.7	4.7

Table 7-1 Climatic Conditions for VA Medical Centers

Location	Weather Station	Latitude	Elevation	Col. 1a 0.4% Summer Db	Col. 1a 0.4% Summer Wb	Col. 1b 99.6% Winter Db	Col. 2a 1% Summer Db	Col. 2a 1% Summer Wb	Col. 2b 99% Winter Db	Col. 3 Wet Bulb 0.4%	Col. 3 Wet Bulb 1%	Annual Extreme Daily-Mean Db Maximum	Annual Extreme Daily-Mean Db Minimum
OREGON													
Portland	Portland	45.58	39	90.8	67.5	21.9	86.6	66.2	27.0	69.2	67.6	98.8	19.2
Roseburg*	Roseburg AP	43	505	93	69	18	90	67	18	-	-	-	-
White City	Medford	42.37	1299	98.6	66.9	21.6	95.1	65.7	24.7	68.7	67.2	104.2	16.2
PENNSYLVANIA													
Altoona	Altoona CO	40	1503	89	72	5	86	70	10	74	72	92	-5
Butler*	Butler	40	1100	90	75	1	87	74	1	-	-	-	-
Coatesville*	New Castle	41	825	91	75	2	88	74	2	-	-	-	-
Erie	Erie	42.04	738	85.8	72.7	2.9	83.3	71.3	7.7	75.1	73.5	90.5	-3.1
Lebanon	Harrisburg AP	40	308	92	74	9	89	73	13	77	76	97	2
Philadelphia	Philadelphia	39.87	30	92.7	75.6	11.6	90.1	74.5	15.8	78.3	77.0	97.0	5.6
Pittsburgh	Pittsburgh	40.50	1224	89.1	72.5	1.8	86.2	70.9	7.5	74.9	73.3	92.6	-4.6
Wilkes-Barre	Wilkes-Barre/s	41.32	948	88.1	71.6	2.9	85.2	70.3	7.6	74.6	73.0	92.6	-3.9
PUERTO RICO													
San Juan	San Juan	18	62	92	77	69	90	78	69	81	80	94	56
RHODE ISLAND													
Providence	Providence	41.72	62	89.7	73.2	6.1	86.5	71.6	10.8	76.3	74.8	95.8	-0.7
SOUTH CAROLINA													
Charleston	Charleston	32.90	39	94.2	78.2	25.4	92.1	77.7	29.1	80.5	79.5	98.4	18.9
Columbia	Columbia	33.95	226	96.6	75.3	20.8	94.2	75.1	24.6	78.4	77.5	100.4	13.7

Table 7-1 Climatic Conditions for VA Medical Centers

Location	Weather Station	Latitude	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%		
				Db	Wb	Db	Db	Wb	Db			Maximum	Minimum
SOUTH DAKOTA													
Ft. Meade	Rapid City	44.03	3169	95.3	65.5	-11.0	91.5	65.4	-5.3	70.7	69.0	102.0	-17.3
Hot Springs	Rapid City	44.03	3169	95.3	65.5	-11.0	91.5	65.4	-5.3	70.7	69.0	102.0	-17.3
Sioux Falls	Sioux Falls	43.57	1427	93.5	73.4	-15.2	90.0	72.6	-10.1	77.1	75.3	99.3	-22.0
TENNESSEE													
Memphis	Memphis	35.03	285	96.2	77.6	16.8	94.1	77.2	21.4	80.3	79.4	98.7	10.5
Mountain Home	Bristol-Tri-City AP	36	1519	89	72	9	87	72	14	75	74	92	-1
Murfreesboro*	Murfreesboro AP	35	608	97	78	9	94	77	9	-	-	-	-
Nashville	Nashville	36.12	591	94.4	75.4	11.6	92.0	75.2	16.7	78.3	77.3	97.1	3.5
TEXAS													
Amarillo	Amarillo	35.22	3602	97.2	66.3	6.8	94.6	66.3	12.4	71.1	70.0	100.9	0.5
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 AP	32	597	100	74	17	98	74	24	78	77	103	14
Houston	Houston	29.97	108	96.9	76.8	27.7	94.9	76.8	31.5	80.1	79.3	99.7	22.4
Kerrville	San Antonio	29.52	794	98.1	73.6	26.7	96.4	73.7	30.7	78.2	77.4	100.7	20.3
Marlin	Waco	31.62	509	100.8	75.2	22.3	98.9	75.3	26.6	78.7	78.00	104.1	16.5
San Antonio	San Antonio	29.52	794	98.1	73.6	26.7	96.4	73.7	30.7	78.2	77.4	100.7	20.3
Temple*	Temple	31	675	100	78	22	99	77	22	-	-	-	-
Waco	Waco AP	31.62	509	100.8	75.2	22.3	98.9	75.3	26.6	78.7	78.00	104.1	16.5

Table 7-1 Climatic Conditions for VA Medical Centers													
Location	**Weather Station**	**Latitude**	**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%**		
				Db	**Wb**	**Db**	**Db**	**Wb**	**Db**			**Maximum**	**Minimum**
UTAH													
Salt Lake City	Salt Lake City	40.77	4226	97.0	62.9	7.0	94.5	62.2	12.8	66.7	65.4	100.9	0.7
VERMONT													
White River Junction	Barre	44	1165	85	70	-10	83	68	-6	72	70	91	-18
VIRGINIA													
Hampton	Norfolk	36.90	30	93.7	76.7	20.4	91.2	75.9	24.4	78.7	77.8	97.8	14.6
Richmond	Richmond	37.50	164	94.7	76.4	14.7	92.1	75.5	19.3	78.9	77.7	98.2	6.9
Salem	Roanoke	37.32	1175	92.1	73.1	12.7	89.6	72.5	17.3	75.4	74.4	95.8	5.1
WASHINGTON													
American Lake	Olympia	46.97	200	87.0	66.4	18.0	82.9	64.8	23.2	67.8	65.9	94.8	10.2
Seattle	Seattle Int. AP	47	449	85	65	23	81	64	28	66	65	92	19
Spokane	Fairchild AFB	47.63	2438	91.1	62.2	3.6	88.0	61.5	9.9	64.8	63.3	96.2	-2.4
Vancouver	Portland Ore. CO	45	39	90	67	22	86	66	27	69	67	99	18
Walla Walla	Walla Walla	46.10	1165	98.9	66.9	6.4	94.9	65.6	14.6	69.0	67.1	104.9	4.7
WEST VIRGINIA													
Beckley*	Beckley	37	2330	83	73	-2	81	71	-2	-	-	-	-
Clarksburg*	Clarksburg	39	977	92	76	6	90	75	6	-	-	-	-
Huntington	Huntington	38.37	837	91.4	74.5	6.9	89.0	73.8	12.5	77.4	76.1	94.6	-1.3
Martinsburg	Martinsburg AP	39	558	94	74	8	91	73	14	77	75	99	-3

Table 7-1 Climatic Conditions for VA Medical Centers

Location	Weather Station	Latitude	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%		
				Db	Wb	Db	Db	Wb	Db			Maximum	Minimum
WISCONSIN													
Madison	Madison	43.12	860	90.0	73.7	-10.3	87.0	72.2	-4.8	76.7	74.6	94.7	-16.6
Tomah	La Crosse	43.87	673	91.7	75.0	-13.7	88.5	73.2	-7.3	78.1	76.0	97.8	-18.6
Wood	Milwaukee	42.95	692	89.7	74.6	-5.2	86.2	72.4	0.1	76.9	75.0	95.3	-11.2
WYOMING													
Cheyenne	Warren AFB	41	6142	87	58	-7	85	57	0	62	61	92	-15
Sheridan	Sheridan	44.77	3967	94.2	63.3	-14.6	90.7	62.5	-7.8	67.1	65.3	99.2	-21.6

NOTES:

- The climatic conditions table data is based on the 2005 ASHRAE Handbook of Fundamentals and the Department of Defense Engineering Weather Data, an asterisk identifies 1978. Use column 1a and 1b for design of New Hospitals, NHCU, outpatient clinics, and other patient care buildings. Use column 2a and 2b for design of regional offices and laundry-type buildings.

*Not listed by ASHRAE.

APPENDIX 7-A: HIGH AND LOW HUMIDITY AREAS

Table 7-A1: HIGH HUMIDITY AREAS – DEW-POINT HOURS	
5-Year Averages	
Location	**=> 60°F**
San Juan	8474
Honolulu	7951
Miami	7020
West Palm Beach	6606
Viera	6025
Tampa	5788
Orlando	5703
Bay Pines	5406
Houston	5152
New Orleans	5104
Panama City	5037
Pensacola	4838
Gainesville	4774
Lake City	4774
Charleston	4368
Biloxi	4114

Table 7-A2: LOW HUMIDITY AREAS – DEW-POINT HOURS	
5-Year Averages	
Location	**<= 35°F**
Albuquerque	5211
Anchorage	4947
Cheyenne	5556
Denver	5115
Fargo	4099
Las Vegas	5083
Reno	5748
Tucson	4063

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