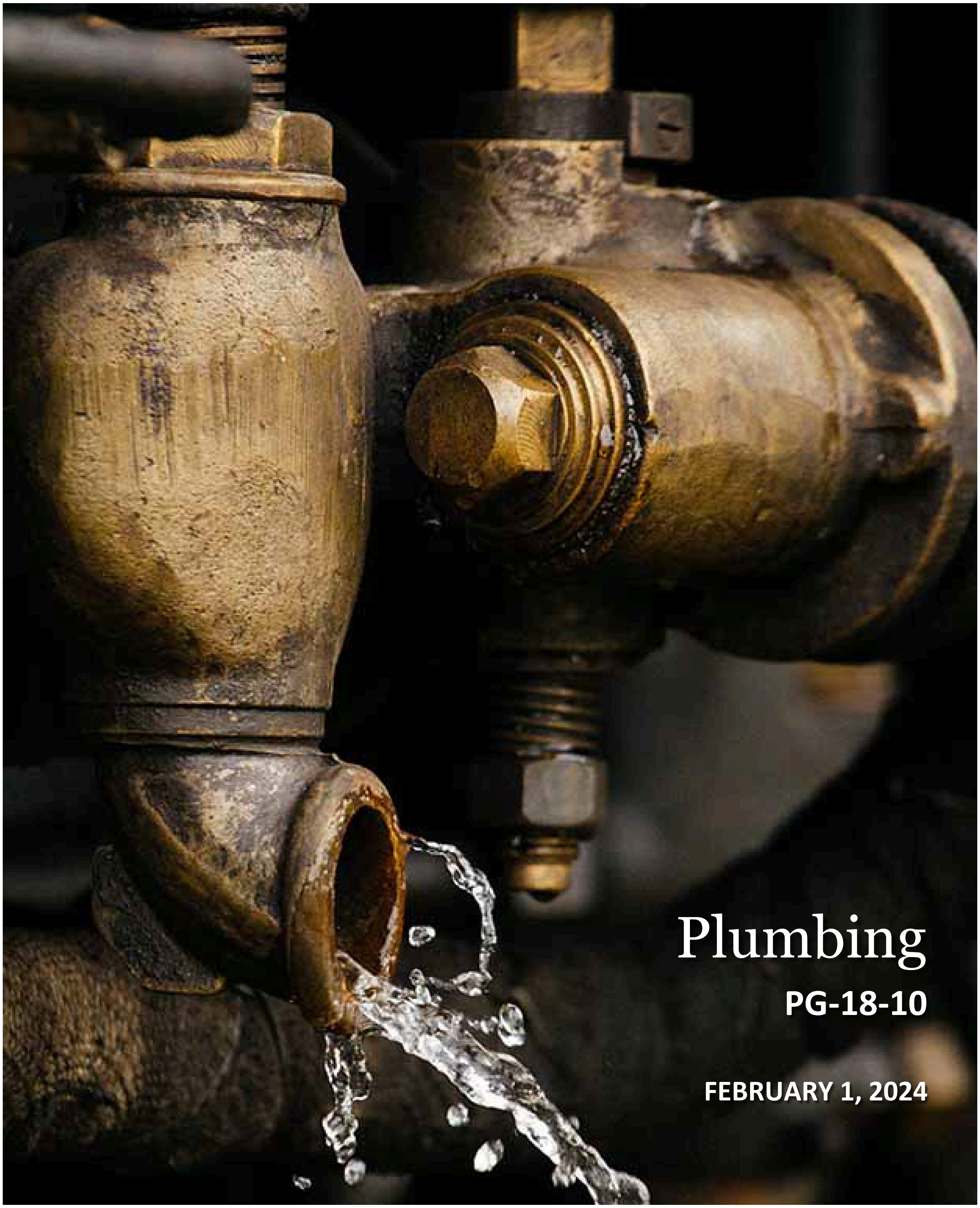
VA

U.S. Department of Veterans Affairs

Office of Construction & Facilities Management

Office of Facilities Planning

Facilities Standards Service



Plumbing

PG-18-10

FEBRUARY 1, 2024

design manual

TABLE OF CONTENTS

1 GENERAL REQUIREMENTS

1.1 PURPOSE

This manual is a directive for Architecture and Engineering design professionals (hereafter referred to as A/E or designer) for the planning and design of the drainage, waste, vent, water distribution, storm drainage, natural gas and fuel gas, medical gas, medical vacuum, and specialty systems at U.S. Department of Veterans Affairs (VA) facilities. VA facilities have a wide range of occupants including patients, employees, volunteers, and visitors. An important mission of VA is to provide healthcare to Veterans who, in some cases, have severe disabilities, including sight, hearing, and mobility. The A/E must always keep the interest of the sick and/or disabled Veteran in mind when making decisions in locations where design choices affect Veterans.

This design manual will be utilized for all VA projects, including major, minor, and NRM projects. Systems must be designed in a manner that will result in the facility being sanitary, safe, reliable, and sustainable. This manual is intended for use by the A/E and others engaged in the design and renovation of VA facilities. These facilities include but are not limited to:

- Acute Care
- Administrative Buildings
- Ambulatory Care Centers
- Animal Research Facilities
- Cemetery Administration Buildings
- Cemetery Visitor Facilities
- Central Utility Plants
- Clinical Additions
- Community-Based Outpatient Clinic (CBOC)
- Community Living Centers (CLC)
- Domiciliary
- Drug/Alcohol Rehabilitation
- New Hospitals
- Equipment Storage
- Laboratory Buildings
- Laundry Facilities
- Medical Research
- Mental Health - Inpatient
- Outpatient Clinics
- Parking Structures
- Psychiatric Care Facility
- Rehabilitation Medicine
- Rehabilitation/Prosthetics
- Replacement Hospitals
- Warehouses

1.1.1 DEVIATIONS AND VA AUTHORITY

Deviations from this manual may be proposed to promote new concepts and design enhancements and to contend with adverse existing conditions and limitations in renovation projects. Deviations must not conflict with Federal Regulations, Public Laws, Executive Orders, or the needs of the end users. Any deviations are subject to review and written approval by the VA Authority. The VA Authority for all Veteran's Health Administration (VHA) projects is the Director of the Office of Capital Assets Management, Engineering and Support (OCAMES). The VA Authority for VACO, VBA and NCA projects is the Director of the Office of Construction and Facilities Management (CFM). Request for deviations shall be submitted in writing by the A/E through the facility's Contracting Officer's Representative (COR) and to Waiver Requests (sharepoint.com) in sufficient detail to explain the issues. The amount of documentation will vary on a case-by-case basis but in general may contain some or all of the following elements:

- Narrative explanation of the requested deviation (provided in all cases).
- Construction cost impact (provided in all cases).
- Equipment and material data sheets when applicable.
- Photographs of existing conditions when applicable.
- Calculations, including cost estimates.
- Drawings and sketches.
- Other background information such as codes, standards, etc.

The complete request for deviation must include all the required elements listed above in a concise narrative package with supporting data which clearly communicates what the deviation is, why the deviation is being required, and the operational, maintenance, energy, cost and schedule impacts of accepting the deviation and of rejecting the deviation. Deviations from Section 4.5 *Legionella* Mitigation in VA Facilities must be approved by the Facility Water Safety Committee.

1.2 RESPONSIBILITY

The A/E will provide all necessary professional services to perform planning and design of the systems for the project. The A/E is responsible and liable for the professional design in accordance with the contract, good engineering practices, VA standards, VA project-specific requirements (if any), and applicable codes.

1.3 SUSTAINABLE DESIGN

VA's design and construction programs are required to comply with numerous federal mandates, including laws and Executive Orders, and VA policies related to energy efficiency, renewable energy, water conservation, and other sustainability requirements. Refer to the Office of Construction and Facilities Management's (CFM's) Technical Information Library (TIL) for details of VA's Sustainability requirements.

Most major VA projects, including leases, are required to pursue third-party green building certification. The required rating system may include LEED®, Green Globes®, or another rating system specified within the CFM sustainability standards or General Service Administration (GSA) leasing standards. If the building(s) in a project is/are required to achieve third-party green building certification, coordinate plumbing design with appropriate disciplines and ensure plumbing design meets all minimum program requirements and targeted credits/point levels. Sustainability Goals will be established by the Integrated Design Team (VA and A/E) at the beginning of a project. Overarching goals may be directed solely by the VA.

1.4 COMMISSIONING

Per the VA Whole Building Commissioning Process Manual, commissioning is typically conducted by a third-party Commissioning Agent (CxA) arranged by the VA Project Manager. The A/E will coordinate with VA project staff and the third-party CxA to identify commissioning-related requirements and support the commissioning process. In rare instances, the A/E may be contracted to provide commissioning services. In those instances, commissioning must be performed in accordance with the VA Whole Building Commissioning Process Manual and applicable specifications published on the TIL.

1.5 METERING

For all new construction, renovations, Energy Savings Performance Contracts (ESPC), and Utility Energy Service Contracts (UESC), install building level utility meters in all buildings in the project that are greater than 5,000 gross square in feet. Provide meters for potable water, gas, steam, electricity, and thermal energy. Metering systems must be coordinated with the VA facility and the VA national metering reporting system.

1.6 NATIONAL CODES AND STANDARDS

The International Plumbing Code (IPC), National Fire Protection Association (NFPA) 54 (National Fuel Gas Code), and NFPA 99 (Health Care Facilities Code), American Society of Heating Refrigeration and Air Conditioning Engineers (ASHRAE) 90.1 (Energy Standard for Buildings Except Low-Rise Residential Buildings), ASHRAE Handbook HVAC Applications, and the American Society of Plumbing Engineers (ASPE) Data Books are the major referenced standards used in the Plumbing Design Manual. Most of these references are available to VA engineers and employees on the Healthcare Environment and Facilities Programs (HEFP) website (http://vaww.hefp.va.gov/) accessible via the VA intranet or can be obtained from the following sources:

- The latest IPC can be obtained from the International Code Council, 5203 Leesburg Pike, Suite 600; Falls Church, VA, 22041, https://www.iccsafe.org/.
- The latest NFPA 54 and NFPA 99 can be obtained from National Fire Protection Association, 1 Battery March Park, Quincy, MA 02269, https://www.nfpa.org/.
- The latest ASHRAE Standards and Guidelines can be obtained at https://www.ashrae.org/.
- The latest ASPE Data Book can be obtained at https://www.aspe.org/.

Unless specifically stated otherwise, the latest edition adopted by the VA and federal government will be used.

Additionally, Chapter 15 of the IPC lists standards that are referenced in various sections of the IPC and VA Master Plumbing Specifications. These references are also given in the text of this manual where appropriate.

1.7 VA HOSPITAL BUILDING SYSTEM

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

Due to the modular concept of the VA Hospital Building System and the Guiding Principles for Sustainable Federal Buildings, the A/E will find that plumbing schematic/design development decisions occur much earlier in the overall planning/design process when compared to a conventional design process. Equipment selection and main distribution sizing should be evaluated as soon as the size and number of modules is determined.

The methodology has been successfully used nationwide for capital and operating cost containment, shortened delivery schedules, and improved space utilization flexibility. All new and replacement VA hospital buildings will 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 11-A.

1.8 VA DESIGN STANDARDS

VA standards are described in this section. All the manuals, guides, details, lists, requirements, and references in this section are found on the CFM TIL at https://www.cfm.va.gov/til/ unless otherwise noted. The key VA Design Standards concerning plumbing system design are listed below.

1.8.1 Master Construction Specifications (PG-18-1)

This reference defines a standardized specification for the A/E to assure that the contractors provide equipment and systems that meet the design intent in terms of performance, quality, regulatory compliance, and cost.

1.8.2 Design and Construction Procedures (PG-18-3)

This reference establishes minimum consistent design/construction practices and references the VAHBS methodology.

1.8.3 Standard Details and CAD Standards (PG-18-4)

VA has adopted the U.S. National CAD Standard (NCS) Version 4, which is amended by the VHA National CAD Standard Application. A link to the NCS standards and the VHA National CAD Standard Application Guide is found on the TIL website.

Note: The A/E will utilize VA Standard Details to the fullest extent possible. A modification to a Standard Detail requires the approval of VA Authorities.

1.8.4 Equipment Guide List (PG-18-5)

This is a reference for planning and development of equipment requirements for VA facilities.

1.8.5 Design Manuals (PG-18-10)

These standards are intended to convey general and specific design requirements for VA facilities.

- Fire Protection Design Manual: Provides the fire protection engineering design criteria for all categories of VA construction and renovation projects.
- Asbestos Abatement Design Manual: Serves as a guide for the planning and design of asbestos abatement projects location at VA facilities.

- Site Design Manual: Provides planning and design of the site layout, storm water management, building location and orientation, site utilities, landscaping and irrigation.
- Physical Security and Resiliency Design Manual for VA Facilities: Provides physical security standards required for facilities to continue operation during a natural or manmade extreme event and for facilities that are required to protect the life safety of patients and staff in an emergency.
- Sustainable Design Manual: Covers sustainability-related requirements that all projects must comply with.
- Automated Transport Systems (Elevator) Design Manual: Provides engineering design criteria for elevator systems.

1.8.6 Design Guides (PG-18-12)

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 design.

1.8.7 Barrier Free Design Standard (PG-18-13)

This supplement to Architectural Barriers Act Accessibility Standards (ABAAS) provides guidelines to better meet the barrier free needs of VA in its healthcare facilities.

1.8.8 Design Submission Requirements (PG-18-15)

These references provide 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. These references also provide general and specific VA cost estimating philosophies.

1.8.9 Design and Standards Alerts

CFM uses Standards Alerts to notify designers of changes to design standards that have not yet been included in VA specifications and design manuals. Design Alerts are used to alert designers to important recommendations related to the design of VA facilities. Alerts can be found on CFM's TIL.

1.8.10 VA Building Information Modeling (BIM) Standard (PG-18-13)

VA has adopted BIM to achieve better quality documents for construction and to provide electronic data for facilities management.

1.8.11 Seismic Design Handbook (H-18-8)

This reference establishes code and other requirements, including occupancy categories, for new or existing VA facilities located in seismic areas so these facilities remain functionally operational after an earthquake.

1.8.12 Signage Design Manual (PG-18-10)

This reference provides guidelines for the design of signs and provides detailed information on the development of a signage system.

1.8.13 Cultural Resource Management Procedures (H-7545)

This handbook discusses requirements of cultural resource legal authorities outlined in VA Directive 7545 and elaborates on assignment of responsibilities.

1.9 ADDITIONAL DESIGN CRITERIA AND STANDARDS

There are several other federal and industry design references and standards that are applicable to VA projects. The standards, codes, and guides listed below are to be reviewed and incorporated on a project specific basis as determined by the project scope of work.

1.9.1 National Fire Protection Association (NFPA)

The National Fire Protection Association develops and publishes codes and standards intended to minimize the possibility and effects of fire and other risks (https://www.nfpa.org/).

1.9.2 Centers for Disease Control and Prevention Biosafety in Microbiological and Biomedical Laboratories (CDC BMBL)

The latest CDC BMBL publication provides fundamentals of containment include the microbiological practices, safety equipment, and facility safeguards that protect laboratory workers, the environment, and the public from exposure to infectious microorganisms that are handled and stored in the laboratory. (https://www.cdc.gov/biosafety/publications/)

1.9.3 Architectural Barriers Act Accessibility Standards (ABAAS)

This document contains scoping and technical requirements for accessibility at federal sites and facilities by individuals with disabilities. These requirements are to be applied during the design, construction, additions to, and alteration of sites, facilities, buildings, and elements to the extent required by regulations issued by federal agencies under the *Americans with Disabilities Act of 1990* (ADA). ABAAS replaces the *Uniform Federal Accessibility Standards* (UFAS), which was VA's previous standard for accessibility.

1.9.4 Sustainability and Historic Federal Buildings

The goal of this guidance is to assist federal decision makers, usually capital asset managers, facility managers, and other program and project managers, in their considerations regarding sustainability and historic federal buildings. Decision makers will consider historic preservation outcomes; and to take advantage of opportunities for meeting historic preservation, energy efficiency, and sustainability goals together in the administration of federal buildings. (Sustainability and Historic Federal Buildings | Advisory Council on Historic Preservation (achp.gov)

1.9.5 National Environmental Policy Act (NEPA)

The National Environmental Policy Act (NEPA) requires federal agencies to integrate environmental values into their decision-making processes by considering the environmental impacts of their proposed actions and reasonable alternatives to those actions.

To meet NEPA requirements federal agencies conduct Capitalized Environmental Impact Assessments during project planning. In some cases, an agency prepares a detailed statement known as an Environmental Impact Statement (EIS). The results of NEPA analysis are integrated into planning and decision making, and often influence the design of projects. NEPA requirements must be addressed beginning at the earliest possible point in project planning; the A/E will be tasked to provide VA with the data and expert advice needed to address these requirements.

1.9.6 National Historic Preservation Act (NHPA) and related standards

The National Historic Preservation Act (NHPA) and related laws, regulations and executive orders collectively require federal agencies to consider, where possible protect, and if feasible make productive use of historic buildings, structures, sites, landscapes, and other types of "cultural resource" (See VA Directive/Handbook 7545). Under regulations implementing Section 106 of the NHPA, agencies review and consult about the effects of their proposed actions on historic properties and execute binding commitments that must be reflected in the design of projects. Detailed standards issued by the Secretary of the Interior (https://www.nps.gov/orgs/1739/tps-publications.htm#technical) influence the design of projects that modify historic buildings and structures. Like NEPA requirements, those of the NHPA and related authorities must be addressed beginning at the earliest possible point in project planning; the A/E is often tasked to provide VA with the data and expert advice needed to address them.

1.10 COORDINATION

The A/E will coordinate all work to avoid design conflicts and eliminate potential change orders. Of particular focus, are concealed and underground areas and site utility coordination.

The A/E will coordinate with federal, state, county, and local agencies to determine required permitting for the project and provide the VA Project Manager with a summary of the permit requirements, copies of permit applications and copies of correspondence, meeting minutes and other supporting documentation.

1.11 LOCAL CODES AND REQUIREMENTS

While federal agencies are not required to abide by most state and local building codes, the A/E must be aware of state and local codes in order to harmonize design characteristics to local and regional conditions. The A/E will bring local and regional climatic and geographic conditions and provisions of local building codes that are significantly different from national codes and conditions to the attention of VA. Of particular focus, must be local codes, code amendments, and/or conditions related to coastal, hurricane-prone, arctic, seismically active regions, or other climatic or regional conditions that warrant additional measures to protect the integrity of systems.

1.11.1 Local Utility Providers

The A/E will follow the rules and regulations of local utility companies, where applicable. The A/E will investigate potential rebates, and other programs offered by local utility companies for the use of specific types of equipment and provide a detailed summary of potential savings to the VA Project Manager.

The A/E will coordinate with local utility providers to verify the location, size and characteristics of existing utility mains and/or service lines available for connection to the proposed facility. The A/E will forward to the VA Project Manager copies of correspondence, meeting minutes and applications for utility service from utility company representatives. The Facility Chief Engineer will negotiate for new services or changes to existing building services or changes to existing building services as necessary.

1.12 PROJECT SPECIFIC REQUIREMENTS AND INFORMATION

1.12.1 VA Provided Materials

The A/E must contact the VA Project Manager or Facility Chief Engineer for all needed data, including the following:

- Facility Development Plan
- Building number assignments
- All existing drawings of the site, especially any utility plans.
- Design objectives
- Limitations
- Design criteria specific to the project
- Site requirements

1.12.2 Proprietary Items

The use of trade names or other indications that identify a product of an individual manufacturer on any project must not be used under any circumstance, unless specifically approved by VA. Where VA authorizes specific products, etc., the following shall be identified:

- Where necessary to identify existing equipment.
- Where an existing system is to be extended and competitive manufacturers cannot meet performance or dimensional requirements.
- Where required by a public utility or municipal system as a condition of service. This will be stated explicitly in the specifications.

1.13 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 and maintenance, energy/cost management, and for planning modifications. The transfer of the appropriate data will be in the Construction Operations Building Information Exchange (COBie) format developed by the A/E and contractor. The A/E must coordinate with the VA facility's Contracting Officer's Representative (COR) about the level of CAFM required.

---END OF SECTION---

2 PLUMBING DESIGN CRITERIA

2.1 TEST PRIOR TO DESIGN

During the schematic design stage, a testing agency will be enlisted to conduct a water analysis test and a hydrant flow test of the two nearest water hydrants. At a minimum, the test must include static and residual pressures, flow, and a water quality analysis including pH, bacterial count, residual chlorine, total hardness as $CaCO_3$, total dissolved solids, and alkalinity. This water quality report will also identify recommended water treatment design concepts for specialized demands such as building humidification, steam cooking, dialysis and laboratory water, boiler feedwater and cooling tower makeup and other specific project needs. The water quality report will be issued on the A/E or testing company's letterhead.

2.2 EQUIPMENT PADS

All floor-mounted equipment will be placed on concrete housekeeping pads. Equipment and equipment pads will be placed in a manner that provides maintenance staff access to all controls, electrical panels, valves, and instrumentation. Coordinate details of pad construction (reinforcement, dimensions, and seismic requirements) with the structural engineer and design to comply with VA Standards.

2.3 PIPING

Avoid plumbing over medical operating rooms; food preparation areas, (serving and storage areas); telecommunication rooms; and electrical rooms containing main distribution panels or motor control centers. Plumbing piping above pharmacy compounding suites is restricted to piping that serves pharmacy compounding suites. Piping over such areas can be made only after approval from the medical center or VA Project Manager. When piping is necessary in these areas, clearly indicate leak protection equipment, such as drain pans, on drawings and in specifications.

Plumbing penetration sleeves will extend 50 mm [2 inches] above the floor and 25 mm [1 inch] below the floor and include a built-in water stop and appropriate seal. Protect all fire and smoke barrier penetrations and floor/ceiling assemblies per the latest edition of the International Building Code (IBC).

2.4 PIPE SUPPORT DESIGN

Design plumbing support systems so as to prevent strains and stresses that might result in a failure of the system. The contract documents will indicate all supports and other provisions designed to protect piping from damage resulting from expansion, contraction, structural settlement piping movement, building movement, seismic event, etc.

2.5 BASE AND VIBRATION ISOLATORS

Prevent transmission of mechanical vibrations to the building structure by isolating all equipment that is subject to movement. See VA Master Specification 23 05 41, Noise and Vibration Control for HVAC Piping and Equipment for requirements.

2.6 FREEZE CONDITIONS

Where the project is subject to freeze conditions, design piping to include proper insulation or heat tracing when the pipes will be located outside the building, in an attic space, in a crawl spaces, or in an outside wall. Any wall hydrants used must be non-freeze hydrants. hydrant. Where a project is subject to freeze conditions, insulate all vertical and horizontal roof drain leaders to prevent condensation from damaging building finishes. Freeze conditions are based on VA HVAC weather conditions that are below 4.4 deg C [40 deg F].

2.7 SEISMIC REQUIREMENTS

Earthquake-resistive design for plumbing equipment and piping will comply with the requirements of VA Publication H-18-8, Seismic Design Requirements.

2.8 CONTRACT DRAWINGS

2.8.1 General

(a) Show plumbing work on drawings using a minimum scale of 1:100 [1/8" = 1'0"]. Enlarged plans and sections will be indicated at a scale of 1:50 [1/4" = 1'0"].
(b) Plumbing design and plumbing seismic design will only be indicated on "PL"-Series drawings (see VHA National CAD Standard Application Guide).
(c) Show piping on the floor level it is being installed on.
(d) Indicate pipe sizes on both floor plan and riser diagrams.
(e) Identify rooms on plans with name and number.
(f) The following will be indicated on the plumbing drawings:

i. Show drainage area in square feet [square meters] for each roof drain and totals for building at outside building wall.
ii. For new construction, show fixture unit count at base of each soil and waste stack and for each sanitary sewer at outside building wall.
iii. Show inverts elevations for all sewers at outside building wall and five feet outside the building wall.
iv. Show dimension from adjacent column line to sanitary and building service water at building entrance. These dimensions will then be coordinated with site utilities.
v. Show centerline elevation for all pressure systems at outside building wall.
vi. Show finished floor elevation at each level.

2.8.2 Basic Design Parameters

The following systems inside buildings and within 1.5 m [5 feet] of the outside of the building, when applicable, will be shown on the plumbing drawings:

- Domestic water, cold, hot, hot water return, cold water return.
- Laboratory water, cold, hot, hot water return, cold water return.
- Industrial water, cold, hot, hot water return, cold water return.
- Sewer/vent/waste.

- Neutralization and vent systems including connection to sanitary sewer.
- Roof drains and drain leaders.
- Reagent water, hemodialysis, and other pure water systems.
- Demineralization (sometimes called deionization water treatment)
- Natural gas.
- Medical gases.
- Medical vacuum.
- Compressed air.
- Dental air.
- Oral evacuation systems.
- Pool piping.
- Potable water treatment.
- Reverse Osmosis (RO) water treatment.
- Sub soil drainage (Coordinate with Civil for responsibility).
- Equipment pads.
- Seismic restraint systems.
- Rainwater harvesting.
- Graywater harvesting.
- Graywater distribution.
- Solar water heating.
- Water disinfection.
- Emergency eyewash and shower.
- Legionella eradication/mitigation system.

2.8.3 Plumbing Fixture Numbers

Identify on the plumbing drawings all equipment requiring connections to the plumbing systems by appropriate symbol number (example, P-103); coordinate "P" number designations with specifications and drawings.

2.8.4 Symbols and Abbreviations

VA has adopted many National CAD standards abbreviations as well as retained many older VA legacy abbreviations. In specifications and descriptive documents, when the first instance of an abbreviation occurs, the full phrase is written followed by the abbreviation in parentheses. Subsequent occurrences of the phrase will use the abbreviation. Do not use the designation Not in Contract (N.I.C.) on the drawings.

On drawings, an index of abbreviations and symbols will be included on drawing P-OXXX General Notes. A list of plumbing abbreviations and symbols can be found on the Technical Information Library under standard details. See DETAILS, PG-18-4 (https://www.cfm.va.gov/til/sDetail.asp).

2.8.5 Cross Sections

Due to the space requirements of plumbing systems and ductwork, closely coordinate the layout of these systems. Where areas of interference are apparent, prepare cross sections resolving utility conflicts when BIM model drawings are not available.

2.8.6 Stack and Riser Diagrams

Provide schematic (one line) diagrams for the following systems installed within the buildings: soil, waste, and vent; reagent grade water; potable water supply and return (hot and cold); medical gas and vacuum; medical gas and vacuum alarms; medical gas low voltage wiring; laboratory gas and vacuum; laboratory gas and vacuum alarms; fuel gas; storm water; oral evacuation systems; dental compressed air and dental alarm systems. These diagrams will include the following types of information. Identification of critical control points for these distribution systems is important for operations and maintenance.

- Piping size and type
- Tanks (storage, expansion, chemical feed)
- Valves
- Heat exchangers
- Pumps including size and controls
- Cross connections (backflow preventers)
- Drains
- Filters
- Supplemental process equipment
- Sampling ports and monitoring locations

Provide riser diagrams for the following systems: water, natural gas, medical gases, medical vacuum, and dental systems may be shown in plan-view and two-dimensional plumbing pipe riser representation showing relative vertical position. Drainage systems (such as: sanitary waste and vent, storm drainage, and specialty waste) will be shown in isometric projection. Indicate building finished floor elevations, size of all horizontal and vertical piping, fixture numbers being served, room locations, and means of connection between fixtures and the stacks and mains. Show each system complete and continuous.

2.8.7 Equipment Schedules

Provide plumbing schedules, including capacity, control settings, services, and sizes for all plumbing equipment and other equipment requiring plumbing services. The plumbing schedules will be organized on the construction documents as listed in Appendix 13-C.1.6.

The plumbing designer will follow the schedule drawing format and organization as defined in this manual.

2.9 INTERDISCIPLINARY COORDINATION

The plumbing designer will coordinate the following:

- Building plumbing fixture count
- Plumbing chase wall inside dimension and construction type for adequate water closet carrier clearances
- Plumbing fixture heights and clearances, especially for Architectural Barriers Act Accessibility Standards (ABAAS)accessibility
- Access doors shown on plans for plumbing equipment including but not limited to, water hammer arresters, valves, and air vents. Access doors must not diminish wall, ceiling, or floor rating.
- Shower pan construction (solid surface or tile)
- Fire-stopping for penetrations through fire and smoke barriers and floor/ceiling assemblies
- Floor drains, liquid waste, and supply connections for mechanical and medical equipment
- Fire protection drains
- Electrical power requirements for plumbing equipment
- Interface with energy management and control systems
- Solar hot water equipment
- Piping locations, sizes, and materials.
- Coordination with site utilities.

2.10 CALCULATIONS AND REVIEW SUBMITTALS

Submit plumbing engineering calculations at various stages in the submission process. Refer to Program Guide PG-18-15 Volumes B and C for the submission requirements for what will be submitted at each stage. Submit calculations required under the contract and submission requirements in Appendix 13-C.

---END OF SECTION---

3 PLUMBING FIXTURES, FAUCETS, FITTINGS AND EQUIPMENT

3.1 PLUMBING FIXTURES

3.1.1 General

(a) Locate plumbing fixtures where indicated by VA Program Guide PG-18-5 (Equipment Guide List), PG-18-12 (Design Guides) and other programming design requirements.

(b) Faucets will have a laminar flow device of brass, Monel®, or stainless-steel trim. Showerhead internal construction will be of brass, Monel®, or stainless steel. Due to legionella risk, aerators are prohibited in patient care buildings. Flow restrictors at the base of the lavatory sink or sink faucet are preferred.

(c) Coordinate the use of sensor (electronic) faucets with the requirements of the end-user and the Infection Prevention and Control staff (for VHA projects). Electronic faucets can be an effective water conservation measure and can prevent contact with potentially contaminated surfaces, yet some studies have suggested that the complexity of electronic faucets combined with lower water flow rates can promote the growth of *Legionella* and other water borne pathogens. For healthcare projects, the A/E and VA Project Manager should document discussions and conclusions in the project's Infection Control Risk Assessment (ICRA).

(d) Use low-flow fixtures in order to support sustainable design requirements for water conservation. All materials and equipment being installed which falls into a category covered by the EPA's WaterSense® program must be WaterSense® labeled or meet or exceed WaterSense® program performance requirements, unless disallowed for infection control reasons. Plumbing fixtures with the flow rates defined below are allowed for VA projects.

Fixture	Flowrate
Water Closet	4.8 Liter per flush (Lpf) [1.28 gallons per flush (gpf)]
Dual flush water closet	6.0 Lpf/4.2 Lpf [1.6 gpf/1.1 gpf]
Urinal	1.9 Lpf [0.5 gpf]
Low flow urinal	0.5 Lpf [0.125 gpf]
Public lavatory	0.95L per cycle/1.9 Liters per minute (L/min) [0.25 g per cycle/0.5 gallons per minute (gpm)]
Private patient room, exam room, & treatment room sinks	5.7 L/min [1.5 gpm]
Clinical sink	8.3 L/min [2.2 gpm]
Mop sink	9.5 L/min [2.5 gpm]
Kitchenette/pantry sinks	8.3 L/min [2.2 gpm]
Patient room showers	7.6 L/min [2.0 gpm]
Kitchen equipment	flow rate per equipment requirements and manufacturer requirements

(e) The faucet timing will be sufficient to deliver water at a temperature range between 29.4 deg C [85 deg F] and 43.3 deg C [110 deg F]. Domestic hot water must be available within

15 seconds of the time of operation. The faucet spout will be gooseneck style to allow for fingers-up rinsing.

(f) Sensor-operated faucets, if used, will be electrically hardwired and on emergency power for all new construction. Battery operated sensor faucets may be considered for renovation projects after coordination with Facility Engineering and Green Environmental Management System (GEMS) staff. Low lighting levels in restrooms can adversely affect the operation of photovoltaic-powered faucets and are not recommended.

(g) Hand-free controls will be employed for staff use and for scrub-up sinks, BSL-3 laboratories, pharmacy clean rooms, and other functions as needed.

(h) Where required to meet water use reduction requirements, waterless urinals may be used after approval by VA authorities. Waterless urinals are limited to non-patient/healthcare areas.

(i) Dual flush water closets will not be used.

(j) Plumbing fixture numbers, description, fixture units, and minimum branch sizes are indicated in Article 3.5, Plumbing Fixture Schedules. Most VA plumbing fixture units for use in supply, waste and vent sizing comply with equivalent water supply and drain fixture units from IPC, with exceptions noted in Article 3.5, Plumbing Fixture Schedules.

(k) Individual shower and tub-shower combination valves must be combination pressure balancing/thermostatic valves that conform to the requirements of ASSE 1016/ASME A112.1016/CSA B125.16 and must be installed at the point of use. For other fixtures (excluding emergency fixtures), tempered water will be delivered through water-temperature limiting device that conforms to ASSE 1070 and between 29.4 deg C and 43.3 deg C [85 deg F and 110 deg F]. The mixing valve will be installed as close to the fixture as possible to reduce the amount of stored tempered water to reduce the risk of *Legionella* growth.

(l) Emergency eyewash and shower equipment must be provided in accordance with VHA Directive 7704 (Emergency Eyewash and Shower Program). It is VA Policy to provide employees, students, and volunteers with emergency eyewash and shower stations where there is reasonable probability of injury to the eyes or skin occurring because of exposure to hazardous chemicals or materials. A list of required locations will be prepared in consultation with facility Safety and Health staff, in consultation with Facility Management staff. Emergency eyewash or combination eyewash and shower stations will meet ANSI Z358.1, "American National Standard for Emergency Eyewash and Shower Equipment". Refer to ANSI standards for emergency fixture location requirements. Water supply will be delivered within the temperature range of 15.6 deg C [60 deg F] and 37.8 deg C [100 deg F]. Provide an ASSE 1071 compliant mixing valve for the tepid water supply. If a waste pipe is available within five feet of the combination eyewash/shower station, provide a floor drain adjacent to the unit. Piped drains for emergency eyewash and shower equipment are not required by the IPC, but occupants prefer piped drains for housekeeping purposes. Extraordinary hazard material (e.g., poisons) should not discharge directly into the sanitary drain system and should have a spill containment and holding system. Oily waste should have a containment or oil water separator. Frequent testing as required by the VHA Directive will refill the trap seal. Consider the use of deep seal traps, trap guards, or trap primers to reduce the problem of unused traps drying out. Designer will ensure the use of sanitary drains are not prohibited for infection control reasons. No floor drains are allowed in pharmacy areas.

3.1.2 Bariatric Plumbing Fixtures

(a) Floor mounted bariatric water closets are preferred for public or private bathrooms intended to serve bariatric patients. Bariatric water closets must comply with ASME/ANSI A112.19.2 and be rated for 454 kg [1,000 pounds] when tested in accordance with ASME/ANSI A112.19.2. NOTE: The Contracting Officer's Representative (COR) should check with local union, clinical staff, and EMS for their preference.

(b) The bariatric water closet will be identified by its own fixture (P-#) number. The drawing will have an installation note that identifies the bariatric water closet and alerts the contractor to the special fastening and installation requirements.

(c) The minimum space on both sides of the fixture will be 533 mm [21 in.] between the wall and the fixture for staff to assist the patient.

(d) Lavatories will not be installed within 1.8 m [6 ft.] of a bariatric water closet.

3.2 SPECIAL EQUIPMENT

3.2.1 Dialysis Machines

Hemodialysis machines will be provided with a special dialysis wall box with indirect waste and water connections in accordance with manufacturer guidelines. Hemodialysis water systems will be protected by a reduced pressure backflow preventer located between the potable water system and the input to the pretreatment components of the dialysis machine water system.

3.2.2 Heart and Lung Machines

Heart and lung machines must be provided with a funnel type drain. If the apparatus is located in the operating room, an indirect waste is required.

3.2.3 Distilled Water Stills

Stills for producing distilled water will be provided with a cold-water connection with a vacuum breaker and floor sink or funnel drain. Drain connection must be provided with air gap.

3.2.4 Sterilizers

Sterilizers must be provided with an acid-resistant floor sink or funnel type floor drain, a backflow-protected (ASSE 1013) water supply and steam and condensate connections in accordance with manufacturer's specifications.

3.2.5 Film Processing Areas

Film processing areas will be provided with an acid-resistant floor sink or funnel drain for indirect waste; and a hot, cold, and/or tempered water supply operating between 4.4 deg C and 32.2 deg C [40 deg F and 90 deg F]. Brass or copper drain piping is not allowed for photo-developing equipment. Polypropylene, high silica cast iron, borosilicate glass (BSG), polyvinylidene fluoride (PVDF), or 316L stainless steel are options for pipe and drain fittings. Waste streams containing silver (recovering) must be constructed of polyvinyl chloride (PVC) pipe and fittings. If concentration and quantity of acid waste requires neutralization, then acid waste will be piped separately through a plastic neutralization tank prior to entering the sanitary system. Refer to VA Master Specification 22 66 00 (Chemical Waste Systems for Laboratory and Healthcare Facilities) for more information. The use of these areas are limited, confirm its use with the facility's COR prior to design.

3.2.6 Chemical Fume Hoods

The plumbing drawings will indicate in schedule format the cold and hot water, vacuum, compressed air, natural gas, chemical drain and vent, and medical vacuum and gases connections for chemical fume hoods. The plumbing plans will show fume hood equipment and connections and will cross-reference the scheduled data and equipment drawings.

3.2.7 Kitchen Equipment

The contract drawings will indicate in schedule format the natural gas, steam, condensate, cold and hot water, drain, indirect drain, and vent connections for kitchen equipment. The plumbing plans will show kitchen equipment and connections in 1:50 [1/4" = 1'0"] and will cross-reference the scheduled data and equipment drawings. The plumbing designer will coordinate connections with the equipment supplier.

3.2.8 Trash Room/Loading Dock

Provide a steam gun (steam and water mixer) with hose for this area. At minimum, a trench drain and floor sink with a minimum 75 mm [3"] outlet is required for all loading dock areas. A requirement for trash rooms is a floor drain with removable strainer and integral cleanout.

3.3 ELECTRIC WATER COOLERS

Provide wall-hung, self-contained, electric, wheelchair-accessible water coolers. Provide hi-low units in areas where only one unit is provided. Provide water bottle filler units unless infection control limitations prevent their use. Coordinate with electrical designer for power requirements.

Centralized drinking water cooling systems are not allowed for new construction or major renovation projects. Replace the centralized drinking water fountains with self-contained electric water coolers whenever the opportunity exists. Existing centralized drinking water cooling systems should be decommissioned and replaced with de-centralized electric water coolers.

3.4 REDUCED-PRESSURE BACKFLOW PREVENTERS

Where reduced pressure backflow preventers are required, provide positive drainage to a floor sink or sump capable of handling peak discharge flow. Alternatively, use a flood control valve protection valve that detects continuous water discharge from the backflow preventer and shuts down the valve in case of abnormality.

3.5 PLUMBING FIXTURE SCHEDULE

Use the following data for design of water and drainage systems, in conjunction with and superseding data found in the IPC. Plumbing fixtures are described in VA Master Specification 22

40 00, (Plumbing Fixtures). Use manufacturer's data for fixtures not included in table below or the IPC. Estimate any continuous demand separately and add this amount in liters per minute [gallons per minute] to the demand of the fixtures in liters per minute [gallons per minute].

PLUMBING FIXTURE SCHEDULE

P-Number	Description	DFU	CW WSFU	HW WSFU	Total WSFU	Waste Pipe Size mm [inches]	Vent Pipe Size mm [inches]	CW Pipe Supply Size mm [inches]	HW Pipe Supply Size mm [inches]
101, 105, 107, 110-113, 114, 115	Water Closet, Flush Valve, Public	4	10	–	10	75 [3]	50 [2]	25 [1.0]	–
101, 105, 107, 110-113, 114, 115	Water Closet, Flush Valve, Private	4	6	–	6	75 [3]	50 [2]	25 [1.0]	–
106	Water Closet, Tank Type, Public	4	5	–	5	75 [3]	50 [2]	15 [0.5]	–
106	Water Closet, Tank Type, Private	3	2.2	–	2.2	75 [3]	50 [2]	15 [0.5]	–
201-202 203-204	Urinal, Washout	2	3	–	3	50 [2]	40 [1.5]	20 [.75]	–
205-206	Urinal, Waterless (Note 2)	2	–	–	–	50 [2]	40 [1.5]	–	–
301, 302, 307	Bathtub, Private	2	1	1	1.4	40 [1.5]	40 [1.5]	15 [0.5]	15 [0.5]
304	Bathtub, End Type	2	1.5	2	2	40 [1.5]	40 [1.5]	15 [0.5]	15 [0.5]
305	Perineal Bath (Sitz)	2	1.5	2	2	40 [1.5]	40 [1.5]	15 [0.5]	15 [0.5]
401, 404, 408, 413, 415, 417-418, 420	Lavatory, Public	1	1.5	1.5	2.0	40 [1.5]	40 [1.5]	15 [0.5]	15 [0.5]

P-Number	Description	DFU	CW WSFU	HW WSFU	Total WSFU	Waste Pipe Size mm [inches]	Vent Pipe Size mm [inches]	CW Pipe Supply Size mm [inches]	HW Pipe Supply Size mm [inches]
401, 404, 413, 415, 417, 418, 420	Lavatory, Private	1	0.5	0.5	0.7	40 [1.5]	40 [1.5]	15 [0.5]	15 [0.5]
501-503	Service Sink	2	3	3	4	75 [3]	40 [1.5]	15 [0.5]	15 [0.5]
505	Clinical Service Sink Faucet	5	10	3	10	100 [4]	50 [2]	15 [0.5]	15 [0.5]
505	Clinical Service Sink Flush Valve	-	10	-	10	-	-		-
507	Plaster Sink	3	3	3	4	50 [2]	40 [1.5]	15 [0.5]	15 [0.5]
510, 512, 514, 516, 524, 528, 530	Sink, CRS	3	1.5	1.5	2	40 [1.5]	40 [1.5]	15 [0.5]	15 [0.5]
519, 520	Surgeons Scrub Sink	3	1.5	1.5	2	40 [1.5]	40 [1.5]	15 [0.5]	15 [0.5]
521, 522, 527	Laundry Tub	2	3	3	4	40 [1.5]	40 [1.5]	15 [0.5]	15 [0.5]
604, 608, 609	Electric Water Cooler	0.5	0.25	–	0.25	40 [1.5]	40 [1.5]	15 [0.5]	–
606	Drinking Fountain	0.5	0.25	–	0.25	40 [1.5]	40 [1.5]	15 [0.5]	–
701-704, 711	Shower, Public	2	3.0	3.0	4.0	50 [2]	40 [1.5]	15 [0.5]	15 [0.5]
701-704, 711	Shower, Private	2	1	1	1.4	50 [2]	40 [1.5]	15 [0.5]	15 [0.5]
705	Thermostatic Mixing Valve Wall-Mounted, Thermometer and Hose Assembly	–	3	3	4	–	–	15 [0.5]	15 [0.5]
706	Emergency Shower	–	–	–	–	Note 1	–	32 [1.25]	32 [1.25]
707	Emergency Shower Eye & Face Wash	–	–	–	–	Note 1	–	32 [1.25]	32 [1.25]

P-Number	Description	DFU	CW WSFU	HW WSFU	Total WSFU	Waste Pipe Size mm [inches]	Vent Pipe Size mm [inches]	CW Pipe Supply Size mm [inches]	HW Pipe Supply Size mm [inches]
708	Emergency Eye & Face Wash	–	–	–	–	Note 1	–	20 [.75]	20 [.75]
709	Emergency Eye & Face Wash (Pedestal Mounted)	–	–	–	–	40 [1.5] Note 1	–	20 [.75]	20 [.75]
801	Wall Hydrant	–	–	–	–	–	–	15 [0.5]	–
802, 804	Hose Bibb	–	–	–	–	–	–	15 [0.5]	15 [0.5]
806	Lawn Faucet	–	–	–	–	–	–	15 [0.5]	–
807	Reagent Grade Water Faucet	–	–	–	–	–	–	25 [1.0]	–
808	Washing Machine Supply/Drain Unit	3	3	3	4	50 [2]	40 [1.5]	15 [0.5]	15 [0.5]
809	Dialysis Box	–	–	–	–	50 [2] **	50 [2] **	15 [0.5] *	–
810	Thermostatic Steam/Water Mixing Valve	–	2.25	–	2.25	–	–	20 [.75]	–

* Reagent Grade Water where required by program
** Chemical-Resistant Drain Pipe

Note 1: Provide drain in accordance with Section 3.1.1(l).
Note 2: For use in non-patient areas only. Requires VHA approval.

Acronyms:

Drainage Fixture Unit (DFU)
Cold Water (CW)
Hot Water (HW)
Water Supply Fixture Unit (WSFU)

---END OF SECTION--

4 WATER SUPPLY AND DISTRIBUTION

4.1 GENERAL

Patient care buildings must have a minimum of two separate service entrances each designed for full demand (serving potable, process, and fire protection systems). These services must enter the building at separate locations from a piped loop around the building. The purpose of this provision is to provide an uninterrupted water supply to facilitate maintenance and repair functions.

When applicable, comply with potable water storage requirements as listed in the VA Physical Security and Resiliency Design Manual (PSRDM). Coordinate water storage tank(s), equipment location, and utility requirements with VA Authorities, Project Manager, and Hospital Emergency Department (ED) staff.

Refer to Appendix 15-E Service Pipe Schedule for pipe types allowed for water supply piping.

Patient Care Buildings are buildings in which one or more of the following medical care functions take place and include:

- Acute Care
- Ambulatory Care
- Community-Based Outpatient Clinic (CBOC)
- Domiciliary
- Drug/Alcohol Rehabilitation
- Hospital
- Community Living Center (Long-Term Care)
- Medical Research
- Mental Health – Inpatient
- Outpatient Clinic
- Psychiatric Care Facility
- Rehabilitation Medicine
- Rehabilitation/Prosthetics

4.2 DOMESTIC HOT WATER SYSTEMS

Instantaneous and tank type water heaters are the domestic water heater systems most used. Instantaneous water heaters are best suited for service conditions requiring a steady and continuous supply of hot water. In these systems, hot water is heated as it flows through the tubes of a shell and tube system. These systems require thermostatic mixing valves to maintain a uniform temperature because the ratio heating capacity to hot water volume is relatively small. Semi-instantaneous water heaters are very similar to instantaneous ones but have a limited storage capacity that helps the system meet momentary surges in hot water demand. Alternatively, storage water heaters are best used for service conditions where hot-water requirements are not constant, and a large volume of heated water is held in storage for periods of peak demand. The amount of storage required is calculated on the demand profile and the water heater recovery capacity. *Legionella* is always a concern when water is stagnant. To avoid stagnant storage conditions, designers should consider semi-instantaneous and instantaneous hot water heater systems when feasible. Tank systems can be considered if life-cycle-cost effective but will be designed for continuous flow to limit stagnation, a tank sized adequately for the application and not oversized, and the ability to maintain a minimum water temperature of 60 deg C [140 deg F] necessary to kill bacteria.

Plate heat exchangers are a type of instantaneous hot water heater that uses metal plates to transfer heat as opposed to the more traditional shell and tube design. Plate heat exchangers transfer the heat between two fluids (i.e., water or steam). The advantage of plate type exchangers is that they are more efficient and smaller in size than the shell and tube heaters. The disadvantages are they can be more expensive and create a higher pressure drop.

An optimal hot-water heating system design is achieved by sizing the system properly to meet peak demand, enhances system efficiency and is life cycle cost-effective. Minimize the use of oversized piping and long pipe runs, which can delay delivery of hot water to the users and waste both energy and water resources. Designers and plumbing contractors will coordinate with the architect for the best routing of hot water piping systems that comply with current Legionella standards. Hot water piping must be circulated and routed as close as possible to fixtures. See volume-based distance requirements in Section 4.4.2. Where required, double-walled heat exchangers will be used in accordance with the IPC requirements for water supply and distribution. All water heater equipment must meet the requirements of the most current VA Master Specifications for Plumbing Systems.

Design analysis of economic criteria, peak demand requirements, daily variations, minimum flow, space restrictions, and energy sources available will be used to determine the type of water heater system provided. Designers must take into consideration the project requirements for backup energy sources for critical utilities including domestic water. Water heaters must be connected to emergency power when available. The VA Physical Security Manual requires that mission critical buildings have alternate sources of energy to maintain continuous operation during natural or man-made extreme events.

4.2.1 Water Heater Efficiency

Domestic water heater efficiency must meet or exceed the ASHRAE 90.1 minimum efficiency for service water heaters. Gas water heaters up to 530 liters [140 gallons] are covered under the Federal Energy Management Program (FEMP) and the ENERGY STAR® program. Federal laws and Executive Orders mandate the purchase of gas water heaters that meet or exceed the ENERGY STAR® listed minimum efficiency. More information regarding the FEMP can be found at: https://energy.gov/eere/femp/covered-product-categories.

4.2.2 Water Heater Energy Source Selection

For facilities at which a central energy plant exists, preference will be given to indirect heating sources of steam or hot water from the central plant. Decentralized (local) water heating may be used for special applications, if an indirect source is not readily available, or if the building has been targeted for Net Zero Greenhouse Gas Emissions or electrification.

Utilize lifecycle cost analysis to determine the best water heater for the application. When developing lifecycle cost analyses, follow the current requirements shown in the VA Sustainable Design Manual. If the building has been selected for Net Zero Greenhouse Gas Emissions or electrification in support of the Federal Building Performance Standards, gas-fired water heaters are not allowed.

In cases where local electric water heaters are considered, include at least one heat pump-stye water heater as an option during lifecycle cost analysis.

Electric water heaters should be preferred if any of the following criteria apply: 1) the building has been selected to be a Net Zero Greenhouse Gas Emissions building, 2) the building is required to electrification in accordance with the Federal Building Performance Standards, 3) the building’s electric supply mix is predominantly renewably-sourced electricity, 4) an indirect (central plant) heat source is not available, or 5) other source fuels (e.g., natural gas) are not available.

4.2.3 Water Heaters for Patient Care and Research Buildings

Design water heater systems for patient care and research buildings for redundancy of the peak load of the building hot water demand. Use a minimum of two water heaters, each sized for 100% of building demand. If more than two water heaters are to be installed, size all water heaters so that the system will continue to provide 100% of building demand should one water heater be out of operation. Hot water systems will not use seals, gaskets or other components constructed of natural rubber which can support the build-up of biofilms. Hot-water recirculation and return piping must be used and sized appropriately.

4.2.3.1 Instantaneous and Semi-Instantaneous Water Heaters

Provide a minimum of two shell and tube instantaneous or semi-instantaneous central water heaters. Each water heater should be sized for 100% of the building's hot water demand. Water heaters must not operate simultaneously to avoid a drop in efficiency. Water heaters must be piped to allow for the facility maintenance program to rotate between the two water heaters and allow the off-line water heater to be drained. Heating system will be capable of supplying the peak flow demand at a minimum discharge temperature of 60 deg C [140 deg F]. The system must have a high turndown ratio to account for periods of minimum flow. Provisions will be made for the water heaters to provide 76.7 to 82.2 deg C [170 to 180 deg F] water at reduced flow of 113 L/min (30 gpm) for thermal eradication purposes. Provide a high temperature alarm device to detect mixing valve failure. Alarm will sound and report to Building Automation System (BAS) when water temperature exceeds ±2.8 deg C [±5 deg F] from the setpoint of 60 deg C [140 deg F]. The use of plate and frame heat exchangers will be considered by the medical center. Include a hot water re-circulating loop system and design for water discharge at a minimum of 60 deg C [140 deg F] or higher as necessary to maintain minimum hot-water recirculating temperature of 51.1 deg C [124 deg F] to prevent the growth of bacteria (*Legionella*).

4.2.3.2 Tank-Type Water Heaters

Provide a minimum of two tank type central water heaters. Each water heater should be sized for 100% of the building hot water demand. Water heaters must not operate simultaneously to avoid a drop in efficiency. Water heaters must be piped to allow for the facility maintenance program to rotate between the two water heaters and allow the off-line water heater to be drained. Tank-type water heaters will be designed to maintain a minimum water temperature of 60 deg C [140 deg F]. Tank-type water heaters must be capable of raising the discharge temperature to 76.7 to 82.2 deg C [170 to 180 deg F] for thermal eradication purposes. Circulating tank water heaters will be considered to limit temperature stratification within the tank to limit the growth of *Legionella*. Heaters must be capable of withstanding thermal and/or chemical eradication procedures to control bacteria. Provide with access for cleaning and disinfection. Include a hot water re-circulating loop system and design for water discharge at a minimum of 60 deg C [140 deg F] or higher as necessary to maintain minimum hot-water recirculating temperature of 56.6 deg C [134 deg F] to prevent the growth of bacteria (*Legionella*).

4.2.3.3 Dietetic Equipment

Provide duplex shell and steam coil booster heaters to generate the flow demand at 82.2 – 90.6 deg C [180 - 195 deg F] with each heater sized to supply 50% of demand. The use of plate and frame heat exchangers will be considered by the medical center. Provide a hot water re-circulating system. Design sanitary drain systems using chemical sanitation agents in accordance with Federal, state, and local requirements.

4.2.3.4 Booster Heaters

Provide simplex shell and tube booster heaters capable of 60 – 71.1 deg C [140 - 160 deg F] at point of use for areas needing higher water temperatures for sanitary reasons including cage washers, cart washers and sterilizers. The use of plate and frame heat exchangers will be considered by the medical center.

4.2.4 Water Heaters for Non-Patient Care Buildings

Non-patient care areas can be served with a single water heater sized for 100% of peak demand. Water heaters must be designed with a minimum discharge temperature of 60 deg C [140 deg F]. System must have a high turndown ratio to account for periods of minimum flow. Tank-type water heaters must be designed to maintain a minimum water temperature of 60 deg C [140 deg F]. Water heaters must be capable of raising the discharge temperature to 76.7 to 82.2 deg C [170 to 180 deg F] for thermal eradication purposes. The use of plate and frame heat exchangers will be considered when hot water heating systems are available. For buildings of less than 1,400 sq. m [15,000 sq. ft.] with no shower facilities, provide fuel fired instantaneous or tank type water heaters instead of shell and tube central heaters. Electric water heaters may be considered with VA Authorities approval.

4.2.5 Instantaneous Tankless Water Heaters (Point of Use)

Instantaneous tankless point of use (electric or gas) water heaters are not generally permitted as a primary source of hot water. Instantaneous tankless point-of-use water heaters are permitted for incidental use, sporadic equipment demands, or remote individual fixtures (e.g., lavatory, sink, shower, service sink) in non-patient areas with written justification. Provide a lifecycle cost analysis comparison of at least three system options when providing justification. Point of use instantaneous water heaters are permitted for use at emergency fixtures to supply ANSI standard "tepid water" immediately at the emergency fixture or group of emergency fixtures.

4.2.6 Sizing of Water Heaters

Size instantaneous and semi-instantaneous water heaters using the WSFU method contained in the ASHRAE Handbook, Applications, Service Water Heating. Plumbing WSFU are indicated in Article 3.5, Plumbing Fixture Schedules. When a facility has more than one-hundred patient bathrooms, the "Bathroom Group" fixture unit number may be substituted for the individual component WSFU. A bathroom group consists of a toilet, lavatory, and shower or bathtub. See IPC for details. Special equipment demands such as dishwashers, sterilizers, and laboratory glass washers must be added to the water heater load at 100% diversity.

Storage tank type heaters will be sized using the gallon per hour method for fixtures contained in the ASHRAE Handbook, Applications, *Service Water Heating*. The ASHRAE Handbook includes fixture rates for a number of end-uses and demand factors for several building types including hospitals and office buildings. For fixtures and building types not listed, designers will determine the demand based on experience and standard practice. For clinics use a demand factor of 0.4 and a storage capacity factor of 1.0.

The supply of water from the utility provider varies in temperature by season and location. Designers will obtain the seasonal cold water service temperature from the water provider for the past three years (minimum). The lowest seasonal temperature recorded will be used to calculate the water heating energy requirements.

4.2.7 Thermostatic Mixing Valves

Master Thermostatic Water Mixing Valves (MTMV) are used to temper water distribution from the hot water source. These valves must conform to the requirements of ASSE 1017. Designer must consider the use of hi-low type master TMV for applications requiring a wide range of flow. Provide a lockable bypass with normally closed valve for thermal eradication situations. Provide ball valves, check stops, and unions on hot and cold-water supply inlets. Provide adjustable temperature setting in accordance with ASSE 1017. The use of a MTMV is not required for systems where the water heater is capable of controlling discharge water temperature.

The use of tempering valves, on all plumbing fixtures where people access water from the potable hot water distribution system is required to prevent scald injury. The water temperature delivered from the outlet must not exceed 43.3 deg C [110 deg F]. Provide ASSE 1070 tempering valves at individual point-of-use fixtures such as sinks and lavatories. Provide ASSE 1016 valves for shower and tub-shower applications that are thermostatic and pressure balancing (combination) type. In public restrooms, ASSE 1070 or ASSE 1069 tempering device may, if properly sized, serve multiple fixtures in accordance with manufacturer's requirements. Provide ASSE 1071 valves to temper water at emergency eyewash and showers locations. Install tempering devices as close to the fixture as possible to minimize the volume of tempered and stagnant water in high-risk patient areas. Additional circulation connections may be necessary to avoid dead ends.

All point of use tempering valves must:

- Meet ASSE requirements for water temperature control for intended use
- Be “Lead Free” complying with NSF 372 (ASSE 1071 types excluded)
- Have cast bronze bodies with corrosion resistant internal parts preventing scale and biofilm build-up
- Have internal parts able to withstand disinfecting operations of chemical and thermal treatment of water temperatures up to 82.2 deg C [180 deg F]
- Allow easy temperature adjustments to allow hot water circulation
- Have integral check valves with screens and stop

4.2.8 Hot-Water Recirculation Loops and Return Piping

Recirculating water systems provide a means of controlling heat loss and final delivery temperatures. Hot-water recirculation is required for all patient care buildings. Hot-water recirculation in non-patient care buildings must be in accordance with IPC. Hot-water recirculation systems must be designed to meet the following requirements:

- Must be located as close to the end-use fixture as practical. Domestic hot water must be available at each hot water outlet within 15 seconds of the time of operation. Design hot water velocity not to exceed 182.9 cm/sec. [6 feet per second (fps)]. Due to constant circulation and elevated water temperatures, particular attention should be paid to water velocities in circulating hot water systems. Both the supply and return piping should be sized so that the maximum velocity does not exceed the above recommendations. Care should be taken to ensure that the circulating pump is not oversized, and that the return piping is not undersized; both are common occurrences in installed piping systems.
- Size the hot water return lines by the heat loss method as outlined in the ASHRAE Applications Handbook, Service Water Heating; or ASPE Data Book Volume 2, Plumbing Systems, Domestic Water Heating Systems.
- Insulation thickness will be governed by ASHRAE 90.1. Insulation thickness and re-circulating pump size will also be selected to limit the domestic hot water system temperature loss not to exceed 3.3 deg C [6 deg F].
- Patient care and Research Buildings require redundant re-circulating pumps to allow for maintenance and repair without a system shutdown. Sequence of operations must not allow for both pumps to run simultaneously. Pumps running in parallel will double the flow rate and result in excessive water velocity and pipe erosion.
- For high rise buildings, domestic hot water return loops of substantially varying pressures, as a result of pressure zoning or static head differences cannot successfully be joined to a single pressure zone water heater. Locate individual pressure zone water heaters within the pressure zones, where return pressures would vary substantially, causing deadhead on the lower pressure return circuits.

- Include provisions for isolating and balancing the system. See article 4.2.9 for more direction on system balancing.
- The use of heat tracing will not be used in lieu of hot water recirculation systems.

4.2.9 Shut-Off and Balancing Valves

Balancing ensures a constant supply of hot or cold water within reach of each fixture. The pump provides the circulation, but balancing is required to ensure that each riser (or branch) receives its proportional share of hot water (see Schematic Drawing 14.1.6). This is accomplished by making the pressure drop in each supply branch or riser equal so that the corresponding circulated water flow is equal. Provide balancing valve groups to include ball valve, temperature & pressure test plug, BAS temperature sensor port, analogue thermometer with thermowell, balancing valve, check valve, and ball valve in the hot water return circulating branch lines at the point of connections to the return main. Return mains must not have integral balancing valves in series with branch balancing valves. Single loop return systems do not require balancing valves. Provide notes in the contract documents for the balance agency to set flow rate to the gpm as calculated by the system designer and provide a comprehensive test and balancing report at project closeout. The Designer will use the circulation rates for all parts of the circulating piping and the total circulation rate required. Circulation rates are based on the heat loses in the piping system based on an allowable temperature drop of 3.3 deg C [6 deg F]. See ASHRAE Handbook, Applications, Service Water Heating, for details on hot-water recirculation loops and return piping. The balancing valve will be the type specified in VA Master Specification 22 05 23. Provide thermostatic balancing valves on hot water return systems unless special occurrences require manual balancing valves. Provide similar arrangement for cold water balancing valve groups when cold water recirculation is implemented. Provide reverse acting thermostatic balancing valves on cold water return systems where supply water temperature is below 18.3 deg C (65 deg F) year-round. In areas where water supply temperature is above 18.3 deg C (65 deg F) for some or all of the year, the addition of a preset manual balancing valve will be required to prevent short cycling of the cold water return system. Velocities in hot water return piping will be checked to ensure it does not exceed 1.21 m/sec [4 fps] and cold water return piping, if recirculating is necessary, will not exceed 2.4 m/sec [8 fps].

4.2.10 Heat Traps

Install heat traps (either valve type or loops) on the cold-water makeup inlet and hot water outlet connections of all hot water storage tanks for energy savings. Loop type heat traps tend to be less problematic and are preferred. Loops should be a minimum of 46 cm [18 in.].

4.3 DEVICE CALIBRATION

Provide temperature and pressure test plugs for access at all temperature and pressure indicating devices, where analog (gauges and thermometers) and digital (sensors for the EMCS system) devices are to be used.

4.4 GENERAL PIPING DESIGN GUIDELINES

The following design practices for the design of domestic water piping system will be followed:

4.4.1 Definitions

(a) Dead End - A length of uncirculated or unused pipe with one end open to the system and the other end terminating at a cap, blind flange, seldom used outlet, or closed valve.

(b) Fixture Runout - A length of pipe with one end connected to the system (branch, riser or main) and the other end connecting to a supply stop for a piece of equipment or plumbing fixture.

(c) Oxidant Level - The amount of an oxidizing substance, such as chlorine, that is used for disinfection of the water supply.

4.4.2 Requirements for Piping Systems

(a) **Dead Ends:** The following design requirements will be followed for dead-ends:

- Dead ends will be no greater than two pipe diameters from the branch, riser or main that it is connected to. Ideally the existing tee or fitting should be removed if the piping has no future use.
- Dead ends, no greater in length than two pipe diameters, will terminate with a ball valve and capped, threaded adapter or butterfly valve and blank flange to provide a means of periodic flushing. Provide a means to eliminate trapped fluid between the valve and the cap, plug, or flange.
- Dead end mitigation is for renovation work.

(b) **Fixture Run-out:** The following requirements will be followed for water supply piping to fixtures:

- **Hot or Tempered/Tepid Water Supply:** Pipe length will be as short as possible to supply the fixture or equipment. Maximum fixture run-out lengths where the source of hot or tempered water is a circulation loop pipe or heat traced pipe is 0.7 L [24 oz.] total volume. The following are exceptions: Each fixture in the bathroom group will be evaluated to ensure turnover of hot or tempered water even if separate feed lines with individual ball valves and water hammer arresters are required for each fixture. Piping must be arranged to reduce the run-out length from the circulated main to the fixture. For public lavatories and low flow lavatory fixtures 1.9 L/m [.5 gpm], the hot water run-outs lengths will be limited to a total maximum volume of 0.35 L [12 oz.]. For lavatory faucets, other than public lavatory faucets (including hand washing sinks in patient and exam rooms), the maximum volume will be 0.7 L [24 oz.] whether the source of hot water is from a hot-water recirculation loop or directly from a heater or boiler.
- **Cold Water Supply:** Pipe length will be as short as possible to supply the fixture or equipment. In patient care buildings, the maximum allowable fixture run-out length of the pipe will be determined based on the maximum allowable pipe volume method. Maximum fixture run-out lengths for cold water piping to sinks, lavatories and showers will be limited to a 0.7 L [24 oz.] total volume. The maximum allowable volume for water closets is 4.85 L [164 oz.] (1 water closet flush of 1.28 gpf). The maximum volume for urinals is 1.9 L [64 oz.] (1 urinal flush of .5 gpf). Each fixture will be evaluated to ensure turnover of cold water even if separate feed lines with individual ball valves and water hammer arresters are required for each fixture. Piping

must be arranged to reduce the run-out length from the cold water main (or circulated main if implemented).

- **Bathroom Groups:** A bathroom group is a group of fixtures located in a private bathroom consisting of a water closet, lavatory, bathtub or shower, including or excluding a bidet. The maximum allowable pipe volume for cold water in bathroom groups is 4.85 L [164 oz.] (1 water closet flush of 1.28 gpf) when water closets are flushed a minimum of 1 time per day. In this configuration, the cold-water supply to all the fixtures of the bathroom group will be in series with the water closet connected as the final fixture. The water closet flushing will provide for cold water turnover within the bathroom group. See schematic drawing 14.1.3. Designers will discuss expected water closet usage with the medical staff prior to completing the design. Specify the use of automatic flushing valves with timers to ensure daily flushing of cold-water line from the final element. Alternatively, water closets will be piped separately from the sink and shower.
- **Ice Machines:** Pipe length will be as short as possible to supply the equipment. The maximum allowable fixture run-out length of the pipe will be determined based on the maximum allowable pipe volume method. Maximum run-out lengths for ice machines will be limited to a 0.35 L [12 oz] total volume.
- If the maximum fixture run-out length is exceeded, water must be recirculated as close to the fixture or device as possible using the chase or wall cavity. A water return line with balancing valve (or similar device) will be used to provide continual water flow near fixture.
- The domestic water supply mains and branches may run directly over the lavatories, showers, and other plumbing fixtures requiring hot water.
- Point of Use Hot Water Heaters can be used in accordance with Section 4.2.4.
- Minimum size of fixture water supply pipes will be in accordance with the IPC.

(c) Provide proper space/maintenance access for the selected supplemental water disinfecting treatment system that is to be employed or may be employed in the future. Provide access to clean the interior of all water storage tanks. See section below for tank construction. Provide a means to flush all lines through outlets.

(d) Provide means to easily remove and disinfect all outlet devices, such as showerheads. **Aerators are prohibited, all faucets on lavatories and sinks will be fitted with a laminar flow device.** Utilize self-draining showerheads, constructed from metal. Plastic showerhead components will not be allowed.

(e) Whenever practical, plastic hoses and equipment containing natural rubbers will NOT be used for any purpose in domestic cold, hot and hot water return lines. Copper or chrome plated brass tubing or pipe will be used to connect to fixtures.

(f) Install thermostatic mixing valves (TMV) with internal check valves as close to the fixtures as possible to minimize the volume of tempered water sitting in pipe or tubing.

(g) Use of press-connect type fittings **is prohibited**. They may only be used in an emergency and will be replaced with approved fittings within six (6) months of emergency. Notice must be provided to VHA/Healthcare Environment and Facilities Program (HEFP) via email to VHAHealthcareEng@va.gov upon installation and replacement of press-connect type fittings.

4.5 LEGIONELLA MITIGATION IN VA FACILITIES

4.5.1 Purpose

Veteran's Health Administration (VHA) Policy establishes guidelines for the prevention and control of healthcare-associated Legionella disease in VHA buildings. Designer to obtain the Water Management Plan (WMP) from the VA COR. The plumbing design should comply with the WMP and the latest adopted edition of ASHRAE 188. For buildings that are subject to this VHA policy, the following design features must be included:

(a) The efficacy of biocides on suppressing or killing waterborne pathogens is dependent on multiple factors such as water quality, organic and inorganic contaminants, pH levels, disinfectant concentrations, and contact time. Water entering the building will be continuously monitored for the following by means of gauges, sensors, and a grab sample port:

- Temperature
- Oxidant level (water disinfectant)
- pH
- Pressure

(b) Water systems within the building will be monitored as follows in the table below. Temperature and oxidant levels are the two primary engineering controls to limit bacterial growth. Oxidant levels will be measured continuously as water enters the building and through grab samples taken from building plumbing fixtures. Temperature will be measured throughout the domestic water system (hot and cold). In addition to being a primary control measure, temperature can be a secondary indicator of flow since temperature of stagnant water will lower for hot water and rise for cold water.

WATER MONITORING DEVICES

Location	Hot Water	Cold Water
Tanks *	T	T
Mains/Risers	T (most remote location**)	T (most remote location)
Branch (zone)	T (most remote fixture)	T (most remote fixture)
Recirculation	T – at end of return system and prior to mixing	T – at end of return system and prior to mixing
Recirculation Pump	Flow	Flow
Service Entrance	N/A	Oxidant Residual Level

T = temperature monitoring

* Bacterial growth is most prominent in stagnant areas such as storage tanks. Use of tanks in cold water systems (where temperature is not controlled) is discouraged.

** Location at longest distance from source for all mains or risers

4.5.2 Background

Legionella is a bacterium that causes respiratory diseases collectively referred to as *Legionellosis* that includes *Legionella* pneumonia. *Legionella* pneumonia is also known as *Legionnaires* Disease (LD). *Legionella* bacteria are found naturally in water and have been associated with disease from building water distribution systems. LD occurs after inhalation or aspiration of contaminated water. *Legionella* bacteria are not transmitted from person to person. The elderly and people with immune compromised systems are most at risk. *Legionella* bacteria growth increases in tepid water in a range from 20 deg C [68 deg F] to 50.5 deg C [123 deg F].

Given the various factors and complexities associated with LD, 100% prevention of LD is likely not possible. However, prevention and control practices can be implemented to reduce the risk of exposing people to *Legionella* in building water distribution systems. The following are engineering controls that will suppress *Legionella* growth. More than one control may be necessary for successful inhibition of *Legionella* growth.

(a) Temperature

- Maintenance of appropriate hot water temperatures is required. Water above 56.6 deg C [134 deg F] inhibits growth of Legionella in hot water systems. Precautions for the prevention of scalding will be included in the hot water distribution system.
- Cold water temperatures below 19.4 deg C [67 deg F] inhibit the growth of Legionella. Ideally, cold water temperatures should be maintained below 19.4 deg C [67 deg F] to the greatest extent practicable. However, adding mechanical means to cool a building’s water supply is not always practical or a cost-effective mitigation strategy. During the schematic design phase, this strategy will be analyzed to determine if the existing cold-water temperature is found to contribute to increased legionella findings. Additionally cooling systems will be compared to other mitigation strategies to determine the most cost-effective solution for the facility (including water recirculation). If there is no evidence of improved legionella reduction or data that supports the cooling as cost effective the system will be designed to accommodate the addition of cooling, if necessary, in the future.

(b) Flow

- Recirculation of water distribution systems is a means of limiting Legionella growth due to low flow or non-use periods. Recirculation aids in maintaining required water temperatures and biocide levels. Hot water (cold water circulation will be evaluated on the efficacy and overall impact on legionella mitigation.) distribution systems will be continuously circulated, and piping insulated.
- Maintenance of water distributions systems (e.g., mixing valves) and plumbing fixtures such as shower heads is necessary to limit the build-up of biofilms and other deposits (e.g., corrosion) that can harbor the bacteria and make it difficult to eradicate.
- In order to reduce areas of stagnant water, distribution systems will be designed to eliminate dead ends and minimize fixture run-outs. Designer may suggest some automated manner to ensure all lines are properly flushed // daily // weekly // by

means of automation such as running a fixture at the end of each line for // 30 min // 60 min // required time to empty line // to properly remove stagnant water.

(c) Oxidant (Disinfectant)

- Maintenance of disinfectant at a sufficient level to control Legionella growth may be required. The minimum level required to suppress bacterial growth will vary from building to building and by the type of oxidant (disinfectant) used. Monitoring of levels is required.

4.5.3 Piping Design Guidelines for Legionella Mitigation

The following design requirements will be included:

- In accordance with the VHA policy, cold water temperatures should be maintained below 19.4 deg C [67 deg F] to the greatest extent practicable. An evaluation of the need to chill the domestic cold-water supply will be evaluated/included at the schematic phase. Legionella can propagate in temperatures exceeding 19.4 deg C [67 deg F]. An evaluation of the need to have a recirculation system for the domestic cold-water distribution system will be evaluated/included at the schematic phase. For cold water systems, although circulation back to the source location (incoming water service and downstream of backflow preventer) for the building is ideal, for renovation efforts, recirculation within the department (or floor) area of renovation would be acceptable. Should circulating cold water become necessary, basis of design will ensure circulation during low flow conditions of no less than 3 turnovers per 12 hrs.
- Ice maker water supply lines will be copper and insulated. Contractor shall avoid routing water lines near source of heat such as the compressor system of the ice maker.
- Cold and hot water piping systems will be insulated in accordance with the latest version of ASHRAE 90.1.
- If no such requirement is stated, domestic water piping will have a minimum of 1-inch-thick insulation.
- To enable thermal eradication and emergency shock chlorination, consider providing taps for connection of temporary booster heaters. Provide adequate electrical connections. Refer to Schematic 14.1.2.
- PVC pipe will not be used for sanitary and vent lines because of the high temperature water during thermal eradication. Cast iron will be used.
- **Aerators are prohibited** to reduce exposure to *Legionella* contaminated water.
- Piping materials will be in accordance with VA Master Spec 22 11 00 Facility Water Distribution.
- Piping and components must be cleaned and protected from accumulation of debris and contamination prior to and during installation.
- Ensure that newly installed piping and components are flushed of debris and disinfected prior to being placed into service.

4.5.4 Supplemental Water Disinfection Methods

In addition to maintaining the appropriate water temperatures, minimum concentrations of various biocides (e.g., oxidizing agents such as chlorine) can inhibit the growth of *Legionella* in building potable water distribution systems. When considering the use of supplemental water disinfection methods for the prevention of *Legionella*, plumbing designers and the VA project manager (in collaboration with other facility stakeholders such as infectious diseases and infection prevention and control) will review the merits of the many types of supplemental systems available prior to making a final selection. VHA recognizes United States (U.S.) Environmental Protection Agency (EPA) approved oxidants (chlorine, monochloramine, and chlorine dioxide) as acceptable disinfectants for use in potable water distribution systems. Use of an alternative biocide is permitted if the medical facility obtains a waiver. Information on the different systems and techniques is available on the EPA's website and through other sources including ASHRAE.

Designers will select the necessary equipment, piping, and controls. Adequate space will be provided for maintenance and operations. The EPA regulates contaminant levels and disinfectant treatment for use under the Safe Drinking Water Act. Usually, the EPA delegates primacy to States for the regulation and enforcement of the Act within individual State boundaries. Systems must be specifically approved or recognized for the intended use by the State regulatory water authority. Federal and state safety regulations and permitting will be followed. Designers will coordinate permitting requirements with the local authority having jurisdiction. The facility must consult with the State (or its delegated local water authority) for regulating drinking water for guidance on system selection, achieving an appropriate biocide residual level at building outlets for *Legionella* growth suppression, system design, system operation, and ensuring compliance with regulations regarding water treatment system(s) and safety. Once a type of system is selected, either the State (or its delegated local water authority) or the manufacturer of the system must provide the minimum and maximum outlet biocide levels in writing for both hot and cold water.

Design parameters to evaluate for supplemental water disinfection include:

- Potential impact of supplemental disinfectant on special use water systems (see 4.5.6).
- Need for emergency power.
- System may need to be duplex for redundancy and maintenance.
- Spare parts may need to be purchased and stored locally.
- Federal and state safety regulations and permitting must be observed.
- Interaction of supplemental disinfection if shock chlorination is used as an emergency remediation method.
- Ensure enough maintenance access is provided around equipment.
- Provide sample points throughout the system to monitor effectiveness. Some critical points should be provided with automated data collection and alarm.
- Operational and maintenance requirements must be maintained to ensure system effectiveness.
- System must be equipped with automated features to provide ease of use and proper maintenance and operation.

- Requirements for off gassing associated with the specific chemicals (for example Sodium hypochlorite).
- Chemical spill containment systems must be provided.
- Chemical storage requirements.

4.5.5 Emergency Water Disinfection Methods

Emergency disinfection is the process of implementing immediate, temporary actions to reduce the amount of Legionella in a water distribution system.

4.5.5.1 Thermal Eradication

Thermal eradication requires potable water in the system to be raised to 71.1 – 76.7 deg C [160 – 170 deg F] and flushed through every fixture for 30 minutes. Some design considerations are as follows:

- Central water heating equipment must be capable of raising water temperature to 82.2 deg C [180 deg F].
- Master thermostatic mixing valve located in the hot water distribution system may have to be bypassed to allow hot water to circulate in the distribution system.
- Select point-of-use thermostatic mixing valves that are amenable to thermal eradication procedures. See VA Master Specification 22 05 23 for required mixing valves.
- Consider providing taps for connection of temporary booster heaters to facilitate thermal eradication (see schematic drawings 14-1.2).
- Provide adequate electrical connections for temporary booster heaters. Coordinate with electrical engineer.
- All equipment and appurtenances in the system will need to be reviewed for operation at elevated temperature (e.g., ensure water supply stops can withstand required temperatures).
- Existing building piping will need to use a means of tempering discharge will need to be considered to accommodate code requirements on discharge to sanitary sewer (max temp of 60 deg C [140 deg F]). New building piping must be rated for the highest temperature wastewater. Ensure discharge is compliant with the local requirements.

4.5.5.2 Hyper-Chlorination

Installation of a chlorinator is required. Hyper-chlorination involves the addition of chlorine to the water system in one of the forms listed above.

Some design considerations are as follows:

- Provide taps for connection of temporary equipment (see schematic drawing 14-1.2).
- All equipment and appurtenances in the system will need to be reviewed for operation at elevated oxidant levels.

4.5.6 Special Use Water Systems (e.g., hemodialysis, laboratory, pharmacy compounding)

It is essential to consider the implications of Legionella mitigation strategies on special use water systems within the building. Special use water systems include Hemodialysis, Laboratory Service, Pharmacy Compounding, and Sterile Processing Service (SPS). Water treatment strategies and chemical disinfectants may result in the introduction of products into, or the formation of disinfection byproducts in, the building water supply at concentrations that may be toxic to patients on hemodialysis. Accordingly, the impact of mitigation strategies must account for potential toxicity, methods for removal of the chemical agent and byproducts from the special use water system, and availability of assay methods to measure the chemical agent and byproducts for assuring patient safety. VA authorities responsible for the oversight of special use water systems are to be consulted during design development of the project and prior to any final decisions regarding water treatment strategies for Legionella.

4.6 INSPECTIONS AND WITNESS OF TESTS

The inspection plan needs the approval of the project technical COR. Frequency and requirements for inspections and testing must be added to the construction documents. Regarding inspections and test witnessing, the plumbing drawings and specifications will coordinate with the VA Manual on Systems Commissioning and the project's commissioning specifications.

Ensure that newly installed and renovated piping and distribution system components are flushed of debris and disinfected prior to being placed into service. Piping and components must be cleaned and protected from accumulation of debris and contamination prior to and during installation. Documentation of flushing and disinfection must be maintained. Disinfection for new installations or maintenance of piping, equipment, and components will be conducted in accordance with the requirements of the IPC, American Water Works Association (AWWA C651-05), and VA Master Construction Specifications.

4.7 WATER DISTRIBUTION SYSTEMS

(a) Where practical size incoming water service for future expansion. Provide sufficient length of pipe prior to backflow preventer for new branch connection.

(b) Water Storage Tanks: Provide adequate space for maintenance access to clean the interior of all water storage tanks. Tanks will be provided with a man way access to allow for inspection, maintenance, and cleaning. Tanks will be constructed to minimize stagnation and thermal gradients. Mechanical cooling may be needed to maintain water temperature.

4.7.1 Metering for Use

(a) All buildings greater than five thousand square feet will install building-level advanced utility meters for electricity, natural gas, and/or steam, if used. In addition, install advanced utility meters for steam condensate, chilled water, hot water, domestic water, and/or non-potable water, if used.

(b) Install sub-meters for cooling tower makeup water and boiler makeup water.

(c) Energy or water intensive operations (i.e., laundry facilities, kitchen operations and data centers), regardless of size, must be similarly metered.

(d) Advanced meters or metering devices and supporting systems (e.g., transmitters, web connections) must provide data at least once every 15 minutes.

(e) In addition to providing data to building operators, building-level meters must transmit meter data directly to the existing data aggregation device in use at the facility.

(f) Projects involving metering or installation of a data aggregation device must follow VA Master Construction Specifications Section 25 10 10, Advanced Utility Metering System.

(g) The designer will investigate whether credit can be obtained from the public utility company for water consumed, but not discharged into the sanitary sewerage system. If credit is available and adequate water pressure is available, provide meters connected to the building energy management and control system for these water consumers. Examples of users are the irrigation system, cooling tower and boiler make-up, and possibly vacuum pumps.

(h) Install advanced water meters on all water wells installed on VA-owned property for agency use.

4.7.2 Measuring and Indicating Devices

Analog gauge and electronic sensors/devices will be used in tandem as much as practical. The gauge device will provide a local or immediate indicator of current conditions for troubleshooting and verification purposes. The electronic sensor/device will be used for continuous monitoring of water conditions and will be connected to the building automation system. All electrical devices will be on emergency power. All measuring devices will be calibrated in accordance with the manufacturer's recommendations.

4.7.3 Water Hammer Arresters

Size the piping for the hot and cold-water systems not to exceed the maximum velocity allowed by the IPC, latest edition. Provide necessary water hammer arresters in accordance with the American Society of Sanitary Engineers (ASSE) Standard 1010, Water Hammer Arresters. Size and locate arresters per Plumbing Drainage Institute (PDI) Standard PDI-WH 201, Water Hammer Arresters, latest edition, requirements. Show quantity and type of water hammer arresters on plans and riser diagrams. Water hammer arresters will be installed with inlet isolation valves to allow for maintenance. Provide access (including access doors where applicable) for each arrester. Coordinate locations with all applicable drawings. Water hammer arresters will conform to VA Master Specification 22 11 00 Facility Water Distribution.

4.7.4 Trap Primers

All floor drains and floor sinks will have a single or manifold electronic trap primer supply or utilize trap guards. The trap primer control box will be recessed. Traps primer control box will be located a maximum of 6.1 m [20 ft.] from the traps(s) being served unless shown otherwise on the construction documents. Pressure type trap primers may also be considered. Trap primers will be ASSE 1018 or 1044 approved. Designers will minimize the run-out length of piping for the trap primer and ensure water is flushed through to minimize the potential impact bacterial growth in stagnant water. Trap guards must be ASSE 1072 approved. .

4.8 WALL HYDRANTS

Provide wall hydrants a maximum of 61 m [200 ft.] apart at loading docks and at building entrances, with a minimum of one wall hydrant on each exterior wall. Where freeze conditions exist, wall-hydrants will be non-freeze type.

4.9 COORDINATION

Designers will coordinate electrical supply to including but not limited to, pumps, electronic faucets, electronic flush valves, electronic trap primers, and electronic water coolers.

4.10 BACKFLOW PREVENTERS

The domestic water supply must be protected from contamination due to non-potable liquids, solids, and gases being introduced into the potable water supply through back-siphonage and backpressure. Water supply to all equipment, fixtures, and pure water systems will be evaluated as to the potential contamination hazard level. All backflow preventers will comply with ASSE requirements. Buildings with a single service entrance will be provided with dual full flow, parallel piped reduced pressure backflow preventers to allow for maintenance without a water shutdown. Patient care buildings will have two separate service entrances that will allow for servicing without an outage. Provide a backflow preventer device as listed in IPC Chapter 6, Water Supply and Distribution and the following:

4.10.1 Reduced Pressure Backflow Preventers

Reduced pressure backflow preventers conforming to ASSE 1013 will be installed for the following equipment applications and systems. Provide positive air gap discharge drainage for full flow from all reduced pressure backflow preventers by means of floor drains, pumps, or through wall openings at grade.

- Deionizers
- Sterilizers
- Stills
- Dialysis, Deionized or Reverse Osmosis Water Systems
- Water make up to heating systems, cooling tower, chilled water system, generators, and similar equipment consuming water
- Water service entrance from loop system
- Dental equipment
- Power washer
- Cart washer
- All laboratory and industrial water systems

4.10.2 Atmospheric Vacuum Breakers

Atmospheric vacuum breakers conforming to ASSE 1001 will be installed for the following equipment applications and systems.

- Hose bibs and sinks with threaded outlets

- Disposers
- Showers (handheld type)
- Hydrotherapy units
- Autopsy, on each hot and cold-water outlet at each table or sink
- All kitchen equipment, if not protected by air gap
- Ventilating hoods with wash down system
- Film processor
- Detergent system
- Fume hoods
- Glassware washers

4.10.3 Hose Connection Vacuum Breakers

Hose connection vacuum breakers conforming to ASSE 1011 will be installed in the following locations for equipment and fixtures requiring non-continuous pressure:

- Hose bibbs and wall hydrants.
- Faucets with threaded outlets:
  - Service Sinks
  - Laundry Tubs

Provide cold water connection and/or treated water with a backflow preventer to the controlled temperature room humidification system.

4.10.4 Fire Sprinkler Systems and Standpipes

Fire sprinkler systems and standpipes will be protected against backflow by a double check prevention assembly meeting the requirements of the IPC and VA Master Specification 21 10 00 (Water-Based Fire Suppression Systems). Fire sprinkler systems connected to non-potable sources or systems that contain additives or antifreeze and are connected to the potable water system will be protected against backflow by a reduced pressure backflow prevention device conforming to ASSE 1013.

4.11 PRESSURE-REDUCING VALVES

Minimize the use of pressure-reducing valves by providing separate domestic hot water heating systems for each pressure zone in multi-story buildings.

4.12 DOMESTIC WATER BOOSTER SYSTEMS

4.12.1 Minimum Pressure

Provide factory prefabricated pump package. Use variable speed pumping to maintain a minimum pressure of 241 kPa [35 psig] at the most remote plumbing fixtures or the minimum pressure requirements of connected equipment, whichever is higher. Obtain a flow test indicating static and residual pressures and flow volume to use in calculating minimum water pressure required. In minimum pressure calculations, use residual pressure at design flow. Investigate for daily pressure fluctuations experienced by the building water supply and modify starting pressures accordingly. Provide a pressure gauge on the top floor branch adjacent to the riser as described in Section 4.7.2.

4.12.2 Patient Care Buildings

(a) Use a three-pump system. System will be configured so that at least two pumps will be in service if any one pump is taken out of service.

(b) Each pump will be sized for 50% of the total water demand.

(c) Pumps will be set up based on factory Proportional Integral Derivative (PID) and panel to run pumps in most energy efficient manner to balance the run time of each pump.

(d) Provide pumps on a factory mounted skid, with integral Variable Frequency Drive (VFD) on each pump, and factory programmed control panel.

(e) Install a hydro-pneumatic tank on the booster system discharge and "NO-FLOW" shutdown controls.

(f) The domestic water booster pump package including VFD, controls, and controlling devices will be on emergency power.

(g) Discharge pressure will be controlled using Pulse Width Modulated-Based (PWM) variable frequency drives through a packaged booster pump controller.

(h) Use spring-loaded swing check valves on pump discharge.

(i) Pumps discharge pressure, temperature, and alarms will be monitored by the BAS.

4.12.3 Non-Patient Care Buildings

(a) Use a two-pump system. Size each pump for 100% of the total water demand. If a three-pump system is used, each pump will be sized for 50% of the total water demand. In either case, pumps will be set up based on factory PID and panel to run pumps in most energy efficient manner to balance the run time of each pump. Provide pumps on a factory mounted skid, with integral VFD on each pump, and factory programmed control panel. Provide a pneumatic tank and "NO-FLOW" shutdown controls. Pumps discharge pressure, temperature, and alarms will be monitored by the BAS.

4.13 SOLAR DOMESTIC WATER HEATING

The following requirement applies to all new buildings and buildings undergoing major renovation:

Develop a lifecycle cost analysis for a minimum of three hot water technologies, of which one must be a partial solar hot water system providing at least thirty percent of the building's hot water demand. If the solar hot water system is determined to be lifecycle cost effective, as compared to the other systems, installation of the solar hot water system is required in accordance with 42 U.S.C. § 6834(a)(3)(A)(iii)

4.13.1 Basic Solar System Design

The main components added to a conventional heating system when solar thermal energy is used are:

- Collector field with collector field piping and support structure
- Heat transfer fluid (water glycol mixture)

- A storage tank system
- Pump for solar loop and pumps for other loops
- Heat exchanger(s) to transfer heat from one loop to another will be double walled with an air gap open to the atmosphere between the two walls.
- Expansion and safety devices for each closed loop
- A controller with temperature sensors in collector field and storage tank that turns the pump on and off

Since the solar thermal system will provide only a percentage of the main water heating source, an auxiliary (back-up) water heater is necessary to provide 100% of the hot water demand load in the event of high demand or periods of too little solar radiation. All potable water storage tanks will maintain a minimum water temperature of 60 deg C [140 deg F] necessary to kill bacteria. The auxiliary (back-up) water heater must be capable of heating water to 82 deg C (180 deg F) for thermal eradication events at a reduced flow of 113 L/min (30 gpm). Provisions must be included to thermally eradicate the potable solar water storage tank before startup when the potable solar storage water tank is taken offline during periods of non-use. Provisions must be made to fully isolate and drain the potable solar storage water tank during periods of non-use. Systems will be designed to prevent contamination from non-potable liquids, solids or gases being introduced into the potable water supply through cross-connections or any other piping connections to the system. Solar hot water equipment will conform to the requirements of VA Master Specification 23 56 00, Solar Hot Water Heating System.

Selecting the right solar water heating system will depend on three key factors: climate, budget, and water usage needs. There are several technologies available to heat water efficiently. Solar water heating systems may be used throughout the United States on any building with a south-facing roof or unshaded grounds for installation of a collector. In addition, reliable off-the-shelf systems may be selected from the Directory of the Solar Rating and Certification Corporation at: https://www.solar-rating.org/index.html.

System sizing estimates based on climate:

- Sunbelt - use 0.09 sq. m [1 sq. ft.] of collector per 7.61 L [2 gal] of tank capacity (daily usage).
- Southeast and Mountain states - use 0.09 sq. m [1 sq. ft.] of collector per 5.71 L [1.5 gal] of tank capacity.
- Midwest and Atlantic states - use 0.09 sq. m [1 sq. ft.] of collector per 3.79 L [1.0 gal] of tank capacity.
- New England and the Northwest - use 0.09 sq. m [1 sq. ft.] of collector per 2.81 L [0.75 gal] of tank capacity.

Estimates will be affected by water temperature, consumption amount, and the solar resource available at the site.

4.13.2 Simple System Calculation

A simple evaluation procedure can help to determine if solar water heating is appropriate. Traditional solar hot water heating systems are most cost effective in facilities with the following:

- Constant water heating load throughout the week and year; housing units and dining facilities are examples.
- High fuel costs to heat water; this is area specific.
- Sunny climates: this is area specific.

The economic viability of a solar system depends on the following aspects, including but not limited to:

- Amount of annual sunshine.
- Heating energy requirements throughout the year.
- Cost of the solar system.
- Price of conventional fuels.
- Temperature of hot water that is required.
- Annual operation and maintenance costs.

---END OF SECTION---

5 SANITARY DRAINAGE SYSTEMS

5.1 SANITARY DRAINAGE

5.1.1 Pipe Design

Sanitary pipe design slope in accordance with International Plumbing Code, IPC Table 710.1(1).

Designs should avoid sanitary waste piping buried in slabs under electrical rooms, surgical areas and like areas. Avoid routing waste piping above electrical, food, surgical, computer rooms, and similar areas. Waste piping will be properly insulated in areas where condensation is possible. Two-way directional cleanouts will be provided at the building exterior to provide effective cleaning of mains upstream or downstream of flow.

Drainage systems will be designed for flow by gravity and the use of a pumping system will be avoided wherever possible. If pumping systems are required, equipment will be duplex type with each pump having the capacity of discharging 100 percent of the incoming peak flow. Design will arrange plumbing system to prevent sewage backflow in the building due to stoppage in the exterior sewer by providing relief outside the building through sewer manhole.

5.1.2 Floor Drains

Floor drains will not be installed in private or individual toilet rooms with a single water closet. Provide at least one floor drain in public toilet rooms containing two or more water closets or a combination of one water closet and one urinal. Floor drains must be provided with a trap primer or trap guard.

In all cases, floor drains are to be installed in bathrooms with shower fixtures, unless the entire floor slopes to the shower drains.

Floor drains will be installed in Mechanical Rooms unless noted otherwise in Contract Documents.

5.1.3 Fixture Units

See Article 3.5, Plumbing Fixture Schedule, for drainage fixture units (DFU) and waste/vent minimum fixture branch sizes. Sanitary waste piping will be designed to maintain a velocity of 2 feet per second (fps). Special attention should be given to the design of sanitary waste systems serving low-consumption water closets as well as systems transporting waste that increases the potential for pipeline stoppages. Fixture connections will be arranged to provide increased trailing water such as pipe drain slope and size to enhance drain line carry, especially for waterless urinals and low-consumption toilet fixtures. Environmental Protection Agency (EPA) studies show that 100 mm [4 in] drain pipe with a 1% slope is adequate, but a 75 mm [3 in] drain pipe with a 2% slope was better. In a renovation project, the A/E must ensure the existing sanitary system will be able to support proposed changes. If the condition of existing drain-line piping is in question (i.e., concerns about defects, root intrusion, sagging, excessive corrosion), the A/E and the VA facility will coordinate how to proceed.

5.1.4 Sanitary Connections

Provide an adequate number of sanitary exit connections from a building. Design each sanitary sewer connection not to exceed 300 mm [12 in] diameter and provide at least two connections from each building with the following exception: one sewer is adequate for a building that can be served by a 150 mm [6 in] or less diameter pipe. Dedicated branch lines serving food service areas will connect to the building drain independent of other areas of the building to avoid possible waste stoppages in the main lines to back up into sanitary kitchen areas.

5.1.5 Fats, Oil, and Grease (FOG) Removal Systems

Kitchen waste containing FOG will be provided with a piped grease interceptor removal system. Provide access to interceptor for maintenance. Kitchen sanitary and vent piping will be cast iron. Refer to VA Master Specification 22 13 23 for small point-of-use removal systems located within the building envelope. Refer to VA Master Specification 33 33 00 for large concrete systems installed outside of the building envelope.

5.1.6 Dialysis Sanitary Drains

Sanitary drains for dialysis systems will consist of chemical resistant pipe (CRP) and terminate over a drain with an air gap. Refer to the standard detail in the VA TIL and VA Master Specifications for materials.

5.1.7 Waste Neutralization Systems

A corrosion resistant waste and vent system will be provided to serve laboratory research areas, aggressive waste discharges, cage wash areas and associated floor drainage and equipment (except for bedding and solid waste disposal).

Laboratory waste or other special waste and vent systems will be separate from the general use sanitary system and will be provided in accordance with the general drainage design considerations for the conventional building waste system. The A/E will carefully evaluate sizing of laboratory waste systems. Many items of equipment do not directly correspond to flow rates and values of common Hunter’s Curve fixture unit tables, as the tables are based around flow discharge characteristics of domestic plumbing fixtures and water closets. Cage and tunnel washers and similar equipment can generate particularly high peak flows and often produce suds laden wastes. Diligence will be provided to validate system sizing for proper operation and for consideration of waste stack arrangement, segregation of wastes, and appropriate relief venting and suds control design to prevent backflow.

The use of pH treatment systems are not automatically required at all laboratories, however automatic monitoring systems (as a minimum) are required for all lab and vivaria buildings. The A/E will discuss the need for pH treatment systems with VA Authorities based on the specific facility, though practice is generally to install pH treatment systems for most lab and vivaria facilities to protect campus infrastructure and ensure compliance with regulations. Where pH adjustment systems are utilized, the A/E will consider the characteristics of effluent to be treated. In general, pH treatment systems will be of the active type, capable of positively neutralizing acidic or caustic pH to acceptable parameters in consideration of varied inflow rates and pH levels, through use of automatic injection and mixing of acid and base reagents, monitored and controlled by a programmable logic controller (PLC) or by treatment systems relying on limestone or marble chips for alkaline waste streams. Treatment systems utilizing limestone or marble chips are not suitable for wastes containing solids or slurry including cage wash areas. pH treatment systems will be fully accessible and will not be in rooms housing air handler units or mechanical air intakes. The A/E will consider segregation of pH treatment equipment and chemicals in a dedicated, properly ventilated service area, and will ensure provisions for removal and replacement of equipment. The cleaning and disposal of trapped solids and media is subject to strict disposal guidelines, requires extensive maintenance, and as such any application of limestone/marble chip systems will be carefully evaluated. The A/E will evaluate whether a batch-type, or continuous flow-through, system is most desirable. Waste streams with significant solid matter load is better suited to the batch-type process, however in either case the selected system will be specially designed to, automatically handle the anticipated solid load, and flush all solids without requiring extensive operator maintenance, strainers, or exposure to the waste stream. Laboratory waste treatment systems will be sized to the system demand and consider the facility load profile. Most laboratory waste streams are effectively treated in a very short time utilizing continuous flow/hybrid systems, and excessive retention times are typically not required when using properly designed equipment.

The A/E will specify quality pH monitors and components, and pH monitors, pumps, and similar controls will not be located inside the tank. Systems will utilize sufficiently sophisticated controls to match reagent injection to the influent requirements and influent and effluent characteristics. Continuous, flow-through systems will include controls and tank designs to permit limited retention in the event of a spike in the pH of the influent stream. Batch-type systems will default to continuous flow-through mode in the event a batch tank is removed for service. Dual mixers should be provided for reliability. System discharge valve and controls will be on emergency power to ensure continuous drainage and prevent flooding.

5.1.8 Chemical-Resistant Piping

Provide chemical-resistant pipe for all waste and vent piping serving laboratory fixtures and film processing equipment. When fusion joint plastic piping systems are used, mechanical joints will be installed at traps and trap arms for maintenance reasons. Chemical drainage (acid or alkaline) will pass through a neutralizing system before connecting to the building sanitary drainage system. Install chemical-resistant vent pipe independently of other vent systems through the roof. For pipe materials refer to Appendix 15-E Service Pipe Schedule.

5.1.9 Cast Iron Piping

Cast iron is the preferred material for sanitary and vent piping due to noise reduction, durability, fire resistive properties, and it is made of nearly 100 percent recycled content. With written approval from the VA Authorities, PVC pipe meeting VA Master Specifications installed per the Plastic Pipe Institute recommendations can be used in low temperature, horizontal, buried soil and waste pipe in buildings under 1,400 sq. m [15,000 sq. ft.]. Switch to cast iron above grade.

5.1.10 Cleanouts

Show and identify the type of cleanouts on the plans and stack and riser diagrams. Cleanouts will be extended to the floor where the fixture(s) served are located. For example, extend a cleanout serving a floor drain to the same floor level of the drain. Do not locate cleanouts above ceilings or in crawl spaces. In addition to the requirements of the IPC, provide a cleanout at the top and bottom of all waste and soil stacks, install "end of run" cleanouts for a group of fixtures. Cleanouts will extend above the flood rim elevation of any fixture located near the cleanout and be connected to the same waste line.

Cleanout intervals will be spaced according to the IPC.

5.1.11 Waste and Vent Systems

Sovent® or other alternative combination waste and vent systems **are prohibited**. Mechanical vent devices, such as air admittance valves and other non-conventional systems will not be used without prior approval of VA Authorities. If approved, installation will be in strict accordance with the IPC or local code, whichever is more stringent. Access to mechanical vent devices will be clearly indicated on the drawings.

5.2 GRAYWATER RECYCLING SYSTEM

Graywater recycling systems can reduce potable water consumption for landscape irrigation. A graywater recycling system will be considered only if economically feasible after a life cycle cost analysis review. Graywater recycling systems will be considered primarily for below grade landscape irrigation. Graywater recycling systems may be considered for industrial uses in non-patient care buildings only with approval of VA Authorities.

Graywater recycling systems will comply with IPC or local codes whichever is more stringent. At a minimum, system components will include a filter system for incoming graywater, a vented reservoir tank with tank drain and overflow connected to the sanitary drainage system by airgap. An approved disinfection unit will treat the water prior to distribution to flushing fixtures. The distribution piping will be clearly marked "Non-Potable Water, Not Safe for Drinking". Graywater for flushing will be dyed by a vegetable-based dye if required by code.

Only wastewater from tubs, showers, lavatories, clothes washers, and laundry trays will be collected for graywater recycling.

A backflow protected potable water connection will provide system make-up water.

5.3 SCHEDULE OF FLOOR DRAINS

Indicate the size and type of all floor drains on the plans and diagrams. See VA Master Specification 22 13 00, FACILITY SANITARY SEWERAGE for floor drain descriptions.

Animal Areas	Type	Waste Pipe Size mm/[in.]	Remarks
Cubicle Housing	F	100 [4]	
Large Animal Conventional	J	100 [4]	Flushing rim, stainless steel trench with grate
Receiving & Examination	F	75 [3]	
Cage Washroom	F	75 [3]	
Cage Washer	I	100 [4]	
Dark Room	X	75 [3]	
Infectious Animal Suite:	N	100 [4]	
Sterilizer			Install per manufacturer's requirements
Necropsy	K	100 [4]	Sealable FD – flushing rim
Post-Operative Intensive Care	K	100 [4]	Sealable FD – flushing rim
Quarantine Room	F	75 [3]	

Dietetic Areas	Type	Size mm/[in.]	Remarks
Can Crusher	S	75 [3]	
Can Wash Pit	S	100 [4]	
Canteen	S	75 [3]	Modify with 50 mm [2 in] hole in grate
Dining Room Serving Line	S	75 [3]	Modify with 50 mm [2 in] hole in grate
Dishwashing Room Floor	S	75 [3]	
Food Conveyer Belt	S	50 [2]	Under belt with 15 mm [1/2 in] grate
Hood Washdown	none	75 [3]	Stub up to 75 mm [3 in] pipe 150 mm [6 in] AFF
Hot Food Table	S	75 [3]	With 15 mm [1/2 in] grate
Kitchen, Main	S	75 [3]	Prep area
Kitchen, Main	S	75 [3]	At kettles and cooker

Dietetic Areas	Type	Size mm/[in.]	Remarks
Kitchen, Serving	S	75 [3]	With 15 mm [1/2 in] grate
Platform Scale Pit	S	75 [3]	
Pot Sink	S	75 [3]	No grate
Prep, Meat and Dessert	S	75 [3]	At each kettle with sediment basket
Prep, Vegetable	S	75 [3]	With 15 mm [1/2 in] grate
Pulper	S	100 [4]	With 50 mm [2 in] hole in grate
Refrigerator, Chilled Vegetable	S	75 [3]	Inside, with air gap
Refrigerator, Garbage	S	75 [3]	Inside
Refrigerator, Machine Room	S	75 [3]	
Refrigerator, Walk-In	S	75 [3]	Outside refrigerator door with depressed grate
Scullery	S	75 [3]	For portable sink, with depressed grate
Tray Make-Up	S	75 [3]	With 50 mm [2 in] hole in grate
Trayveyor Shafts	S	75 [3]	With 50 mm [2 in] hole in grate
Vending Machine Room	S	75 [3]	

Film Processing Areas:	Type	Size mm/[in.]	Remarks
Cardiac Cath. Dark Room	T	100 [4]	At XP6 w/full flow thru funnel
Processing Unit	T	75 [3]	With full flow thru funnel
Roll Processing	T	50 [2]	
Chemical Storage Sump	X	50 [2]	

Hospital Areas	Type	Size mm/[in.]	Remarks
Aide-A-Bath	M	75 [3]	
Autopsy Room	J	75 [3]	Flushing rim type
Bldg. Management/Storage	D	75 [3]	
Cart Storage Room	C	50 [2]	
Cart Wash	R	100 [4]	

Hospital Areas	Type	Size mm/[in.]	Remarks
Clean Work Area	C	75 [3]	
Congregate Bath	C/S	50 [2]	
Cysto Room	L/S	75 [3]	At foot of table
Deep Therapy Equipment Room	M	50 [2]	
Glasswasher	R/S	75 [3]	
Hydrotherapy Area (stainless steel)	C	50 [2]	Adjacent to tub
Hydrotherapy Congregate Bath	O	75 [3]	With 20 mm [3/4 in] grate or (stainless steel) 50 mm [2 in] hole in grate
Ice Machine	M	50 [2]	
Laboratory	F	75 [3]	
Linear Accelerator	C	50 [2]	
Perineal Bath	C	50 [2]	
Shower, Double	C/D	75 [3]	
Shower, Single	C/D	50 [2]	
Soiled Linen Collection Room	D	75 [3]	
SPD Sterilizers	R/S	100 [4]	
Trash Collection Room	D	75 [3]	
Washer Sterilizers	R	100 [4]	50 mm [2 in] hole in grate

Laundry Areas	Type	Size mm/[in.]	Remarks
Laundry	B/F	75 [3]	F for seamless vinyl
Lint Collector	H	100 [4]	

Mechanical Equipment Areas:	Type	Size mm/[in.]	Remarks
Boiler House	E	75 [3]	With 15 mm [1/2 in] grate
Boiler Water Column Drain	V	100 [4]	One for each boiler
Compressor Room	E	75 [3]	Modify with funnel
Fan Room	E	75 [3]	With 15 mm [1/2 in] grate
Incinerator Room	E	100 [4]	

Mechanical Equipment Areas:	Type	Size mm/[in.]	Remarks
Machine Room	E	75 [3]	
Mechanical Equipment Room	E	100 [4]	With 15 mm [1/2 in] grate when adjacent to equipment
Paint Spray Booth	H	100 [4]	
Steam Service Entrance Pit	E	75 [3]	
Water Softener	R	100 [4]	

Miscellaneous Areas:	Type	Size mm/[in.]	Remarks
Finished Walk Areaway	B	100 [4]	
Window Well Areaway	B	75 [3]	
Silver Recovery Room	T	75 [3]	
Parking Decks	E	100 [4]	
Parking Garage	E	100 [4]	

Types:

B – Galvanized body with nickel bronze grate, medium duty with secondary strainer, min. 175 mm [7 in.].

C – Body with nickel bronze grate, light duty, square 150 mm [6 in.] with vandal proof screws.

D – Body with flange, satin nickel bronze or satin bronze grate, 175 mm [7 in.] square or round.

E – Heavy duty body with non-tilting nickel bronze or ductile iron grate, removable sediment bucket, min. 300 mm [12 in.] square. Extra heavy-duty grate for traffic use.

F – Body with flange, satin nickel bronze or satin bronze grate, use for seamless vinyl floors.

G – Body coated with acid resistant porcelain enamel finish with nickel bronze grate, 200 mm [8 in.] in diameter, with perforated aluminum sediment basket.

H – Body with secondary strainer, loose set nickel bronze grate, 300 mm [12 in.] diameter or square.

I – Body coated with acid resistant enamel finish with loose set nickel bronze grate, 300 mm [12 in.] square, with 100 mm [4 in.] deep aluminum enameled finish sediment basket with grips, wide flange for seamless floor.

J – Body (heavy duty) with flushing rim and nickel bronze grate, 280 mm [11 in.] diameter and deep seal trap.

K – Same as J except solid bronze grate.

L – Body (heavy duty) with solid bronze grate with 50 mm [2 in.] long by 20 mm [3/4 in.] pipe brazed or threaded into center of grate, gas tight installation with deep seal trap, and flushing rim.

M – Body with nickel bronze adjustable funnel strainer and round or square grate.

N – Body coated wide flange for seamless floors, with acid resistant enamel finish with nickel bronze grate, 200 mm [8 in.] diameter, 50 mm [2 in.] deep aluminum enameled sediment basket with grips.
O – Body coated with acid resistant enamel finish, 300 mm [12 in.] diameter or square, dome type secondary strainer without grate.
P – Body coated with acid resistant enamel finish with a loose set nickel bronze grate, 300 mm [12 in.] square, 100 mm [4 in.] deep aluminum enameled finish sediment basket with grips.
R – Body coated with acid resistant enamel finish with secondary dome strainer and without grate, 200 mm [8 in.] square.
S – Floor sink, 304 Stainless Steel body with polished interior with internal dome strainer, non-tilting loose grate, 300 mm [12 in.] square.
T – Polypropylene chemical resistant body, schedule 40 or 80 with funnel strainer and integral trap.
V – Body with oval funnel strainer and square grate, 232 square cm [36 sq. in.].
W – Open sight drain. Washing machine drain or mechanical room condensate.
X – Polypropylene chemical resistant body, schedule 40 or 80 with integral trap.
Y – Galvanized body with extra heavy duty polished bronze grate, vandal-proof, min. 230 mm [9 in.], with under deck clamp, suitable for parking decks.

NOTES:

1. All floor drains must comply with ANSI A112.6.3.
2. All floor drains must have cast iron (CI) bodies unless stated otherwise.
3. Floor drains for general floor drainage are located by architect. Use Type "C" in finished areas.
4. Connect cooling tower drain, overflow, and blowdown to the sanitary sewer.
5. Provide drain type as recommended by manufacturer at floor level for ethylene oxide sterilizer fitting. Caulk fitting tight.
6. Provide trap primer or trap guards for all drains not receiving a direct discharge.

---END OF SECTION---

6 BUILDING STORM DRAINAGE SYSTEMS

6.1 STORM SYSTEM DRAINAGE

The plumbing designer must consult with the local authorities having jurisdiction (AHJ) to determine local requirements for storm water drainage. The storm drainage system will collect clear water from roof drains. Condensate from air conditioning units will be collected by the storm water drainage system unless prohibited by local AHJ.

6.2 ROOF DRAIN LEADER INSULATION

In heated spaces: insulate the roof drain basins, roof drain leaders, and overflows above lay-in or hard ceilings. Roof drain leaders installed in non-heated spaces must be insulated and heat traced.

6.3 CALCULATIONS

The plumbing designer will submit sizing calculations for area/roof drain systems. Pipe sizing will be based upon the local rates of rainfall as indicated in the IPC or in accordance with the requirements of the local AHJ, whichever is more conservative.

6.4 STORM CONNECTIONS

Maximum allowable size for storm drain is 300 mm [12 in.]. Provide backwater valves where backflow of storm water into the building is anticipated.

6.5 SCHEDULE OF AREA/ROOF DRAINS

Indicate the size and type of all area/roof drains on the plans and diagrams. See Master Specifications 22 14 00, FACILITY STORM DRAINAGE for roof drain descriptions.

6.6 LOCATION OF DRAIN LEADERS

Drain leaders will be in permanent shafts or building columns and not in interior partitions. Vertical piping will be designed with minimal offsets and will avoid the placement of horizontal piping above conference spaces, offices, electrical rooms, telecommunication rooms, and other critical areas. Secondary overflow drain leaders or scuppers will discharge to a visible/conspicuous (such as adjacent to a frequently used door) location as required by the IPC.

6.7 UNDERSLAB AND FOUNDATION DRAINAGE

Sump and associated pumping equipment for sub-soil drain tile will be located inside of the building. Some situations may require sumps and associated pumping equipment to be located outside of the building. In all instances, sufficient clearance will be provided for maintenance and replacement access. Pumps will be provided in a redundant (duplex) configuration and be connected to an emergency power source.

6.8 RAINWATER HARVESTING SYSTEM

Rainwater harvesting systems can help reduce potable water consumption for the building and for landscape irrigation. A rainwater harvesting system will be considered if economically feasible after a life cycle cost analysis review and approval by VA Authorities. Rainwater harvesting systems will only be considered for flushing of water closets, urinals, and flushing rim floor drains in **non-patient care buildings** or for below grade landscape irrigation.

Rainwater harvesting systems will comply with the IPC and NFPA 99. At a minimum, system components will include a vortex filter for incoming rainwater, a vented storage tank with float, controller panel, sediment filter, disinfection unit, day tank, booster pump with backflow preventer, pump, and overflow drain to the storm drainage system. The distribution piping will be clearly marked “Non-Potable Water, Not Safe for Drinking”. See Section 09 91 00 Painting for additional information. If rainwater is being used as nonpotable water in the building, then the rainwater must be dyed with a vegetable-based dye. Comply with the Plumbing Design Manual if requirements are more stringent than the IPC.

Only rainwater from the building roof will be collected for the distribution system. A backflow protected potable water connection will provide back-up system make-up water.

---END OF SECTION---

7 SPECIALTY TRAPS, INTERCEPTORS, AND SEPARATORS

7.1 SAND/GRIT TRAPS

Sand interceptors will be provided where sand, grit or sediment may enter the wastewater stream. Wastewater collected from garage drains or car washes will discharge to a sand/grit interceptor prior to an oil/water separator. Floor drains in mechanical rooms, area ways, and garages will be equipped with sediment buckets.

7.2 OIL/WATER INTERCEPTORS

Oil interceptors will be provided to serve potential sources of oil discharge (including transformer vaults) and will be engineered to provide effluent discharge levels to solvent extractable matter of mineral or synthetic origin to a maximum of 10 ppm and total suspended solids to a maximum of 350 ppm. In some cases, the use of coalescing filters may be required (depending on application) to ensure clean discharge in accordance with most current environmental discharge regulations. In accordance with ASME A17.1 “Safety Code for Elevator and Escalators” and the VA Transport Services (Elevators) Design Manual, elevator pits will have sump pumps provided with control systems capable of pumping water at a rate of 11.4 m^3/h (3000 gal/h) until oil in the water is detected. Once oil in the water is detected the pump will stop and activate an alarm. Oil laden water will be removed prior to pump restart. The operator will be provided with a manual override to restart the pump. The sump discharge will connect to the building sanitary sewer line by an airgap unless directed otherwise by the local AHU.

7.3 GREASE INTERCEPTORS

Drains and fixtures discharging fat, oil, or grease-laden waste (FOG), within 3 m [10 ft] of the cooking battery, in kitchen areas; and as required by the State Health Department and local authorities, must discharge to a grease interceptor before connecting into the sanitary sewer.

Grease interceptors must be sized for compliance with the requirements of the local authority. Where permitted by the local authority, grease interceptors will comply with the Plumbing and Drainage Institute (PDI) Guideline PDI-G101. Drains, fixtures, and equipment must discharge to the grease interceptor, as required by the State Health Department and the local authority. Food grinders, condensate drains, and hand washing sinks wastes are prohibited from extending to the grease interceptor and must not be connected.

7.4 PLASTER TRAPS/INTERCEPTORS

Plaster interceptors will be provided when precious metals, heavy metals, (such as silver and barium) or sediment is in the waste drainage from spaces such as dental laboratories, cast rooms, prosthodontics laboratories, barium procedure areas, and spaces employing blood analyzers. Interceptors for barium waste will be aluminum.

7.5 CONTAMINATED WATER AND SANITARY WATER RETENTION

When applicable, comply with contaminated water storage requirements as listed in the VA Physical Security and Resiliency Design Manual. Coordinate decontamination equipment location and utility requirements with VA Authorities, Project Manager and Hospital Emergency

Department (ED) staff. Consult with the local authority having jurisdiction (AHJ) for proper discharge and disposal of contaminated wastewater.

---END OF SECTION---

8 MEDICAL GASES AND VACUUM

8.1 GENERAL

8.1.1 Water-Cooled Equipment

Test water or obtain analysis from the medical center to determine if additional water treatment is required for water-cooled equipment. If so, describe additional water treatment requirements in the specifications. Water quality for water cooled equipment is per manufacturer's minimum requirements. Single pass potable water will not be used for equipment cooling.

Establish water pressure at the required equipment locations to determine if booster water pumps are necessary. If pressure is less than 345 kPa [50 psig], the equipment may not perform adequately. Investigate several manufacturers' requirements to maintain competition and to reduce the incidence of change orders.

8.1.2 Renovation Projects

In renovation projects, survey the medical center to ascertain the type of existing medical gas station outlets and medical vacuum terminal inlets. The master specification requires that new outlets and inlets match the existing terminal connections. In the case where existing station outlets or terminal inlets are not U.L.-approved, or not gas-specific, or meet current NFPA 99 requirements, the contracting officer (CO) will include provisions for competitive bids on new outlets and inlets. Coordinate with staff for existing system flows, diversities, and capacities.

8.2 MEDICAL GAS AND VACUUM SYSTEMS

8.2.1 Oxygen, Medical Compressed Air, Medical Vacuum, Nitrous Oxide, Nitrogen Systems, Carbon Dioxide, Waste Anesthesia Gas Disposal and Instrument Air

Design oxygen, medical compressed air, medical vacuum, nitrous oxide, nitrogen, carbon dioxide, waste anesthesia gas disposal (WAGD), and instrument air systems in accordance with current editions of:

- NFPA 55, Compressed Gases and Cryogenic Fluids Code
- NFPA 99, Healthcare Facilities
- Compressed Gas Association (CGA) Publication M1
- Guide for Medical Supply Systems at Consumer Sites
- Master Specification 22 62 00, Vacuum Systems for Laboratory and Healthcare Facilities
- Master Specification 22 63 00, Gas Systems for Laboratory and Healthcare Facilities
- American Society of Plumbing Engineers (ASPE) Data Book Volume 3 - Special Plumbing Systems
- ASSE/IAPMO/ANSI Series 6000 Professional Qualification Standard for Medical Gas System Personnel

Projects that include these systems require installers to be ASSE 6010 certified; testing personnel must be ASSE 6020 certified, and inspectors and verifiers must be ASSE 6030 certified.

8.2.2 Medical Gas and Vacuum Systems Criteria:

(a) The designer must provide a riser diagram for Medical Gas and Vacuum Systems including but not limited to oxygen, medical air, and vacuum systems with the design flow, pipe sizes, and calculated pressure on each outlet, at each zone valve and at any branch in the system. Flow shall be in LPM and Pressure in PSI.

(b) The designer shall perform calculations for oxygen and medical air systems using multiple iterations to determine worst case scenario by relocating high flow (predominantly ventilators) at multiple locations based on potential use and room types (See 2b for more detail). Designer shall calculate the flow and pressure drop, identify critical path for pressure drop calculations to ensure branch and main pipe sizing are per maximum allowable pressure drop defined. Design must use a commercially available product or literature such as a table from recognized manufacturers such as BeaconMEDAES or approved equal.

Note: Most commercially available tables are for Type L copper piping therefore a correction factor shall be applied to those tables or a formula to avoid under-sizing of VA required Type K copper piping. The correction factor for type K copper pipe sizing shall be 20% for smaller piping (2 inch and smaller) and 10% for larger piping (larger than 2 inch). **Type L copper is prohibited unless approved by HEFP for any special/unusual situation through waiver process.**

i. VHA design guides shall be consulted for number of outlets required in each area. This supersedes the ASPE or FGI requirements. The calculations shall assume that all outlets are in use when there are two or fewer outlets. For areas with 3 or more outlets, consider all outlets in use per diversity indicated in ASPE table except one outlet count as spare and not used for load calculations.

ii. Designer of record shall coordinate with medical center the basis of design for the number of ventilators (see high flow bed below) intended to be used and their possible locations. Note: the potential locations that ventilators may be used may exceed the number of ventilators which will require the calculation of system pressure drop with different scenarios of deployment. The Medical Center (MC) will also define high flow apparatus (i.e., high flow cannula).

iii. The base design flows for each outlet shall be per ASPE Vol 3 table 2-18 (2019), unless department/room is not listed in ASPE table, contact OHE for guidance or defined herein. If the ASPE table defines the flow in the room, it will be divided equally over the number of outlets defined in the associated ASPE table. The total flow shall be calculated using flow per outlet as defined in ASPE table or defined herein using the number of outlets per VA design guides.

iv. Minimum pipe size shall be 1/2 inch for oxygen and medical air piping system.

v. Diversity shown in ASPE shall be used unless otherwise noted (reference table above). For departments with outlets defined as the trigger for diversity, the designer shall count diversity using number of outlets totaled for each bed.

vi. Surgical outlets are part of a surgical boom assembly. Refer to surgical Design Guide.

(c) For medical oxygen and medical air system: Design piping systems pressure drop not to exceed 34 kPa [5 psig] in entire piping system which includes but not limited to main piping from the tank to the building or risers, and branch piping up to the most remote or highest flow outlet.

(d) Patient rooms oxygen system design shall be designed using diversity per ASPE table and number of outlets installed per bed in each zone up to the zone valve (NOT the total of all outlets in the system, no diversity beyond zone valves). The total flow at each zone must be added to derive total flow at main branches and mains in designing piping distribution system.

(e) High flow rooms Oxygen and medical air system design: Designer of record shall use the following criteria for high flow beds such as ventilators and other such equipment.

A. High flow Bed (Beds with ventilators or high flow equipment):

a) <u>For beds with ventilator:</u> one (1) outlet at the flow rate of 120 lpm, and the remaining outlets at 15 lpm or as per the flow defined in 2c whichever is greater.

b) <u>For beds with high flow equipment:</u> one (1) outlet at the flow rate of 70 lpm and the remaining outlets at 15 lpm or as per the flow defined in 2c whichever is greater.

(f) Medical Vacuum System:

a) The minimum size of vacuum piping shall be 20 mm [3/4 in.] with 15 mm [1/2 in.] drops to individual inlets permitted.

b) Minimum design flow rate for any pipe section is 113 L/min [4 cfm].

c) Max system pressure drop in Medical Vacuum shall not exceed 3-inch HG from source to most remote outlet.

(g) It is not acceptable to have smaller diameter pipe feeding into larger diameter pipes in oxygen, other medical gases, medical air, and vacuum system when designing piping distributions.

(h) It is not acceptable to have cross-ties/loops in piping layout for oxygen, other medical gases, medical air, and vacuum system when designing piping distributions.

(i) Oxygen system main and risers shall be designed for increase load by 10 percent to accommodate future expansion.

(j) Oxygen systems service valves should be installed that allows for maintenance without disrupting the entire floor.

8.2.3 Central Supply Systems

Design medical gas and vacuum systems to deliver the following pressures or vacuum at the points of use for the longest pipe run:

(a) **Oxygen:** 345 kPa [50 psig].

(b) **Nitrous Oxide:** 345 kPa [50 psig].

(c) **Nitrogen:** 1378 kPa [200 psig].

- **(d)** **Medical Air:** 345 kPa [50 psig].
- **(e)** **Medical Vacuum:** 51 kPa [15 in Hg].
- **(f)** **Carbon Dioxide:** 345 kPa [50 psig].
- **(g)** **WAGD:** 20 kPa [6 in Hg].

8.2.3.1 Sizing the Systems

All systems will comply with NFPA 99 requirements. Bulk gas systems will be designed in accordance with NFPA 55, Compressed Gases and Cryogenic Fluids Code. CGA M-1, Guide for Medical Supply Systems at Consumer Sites, captures the requirements from these codes along with best practices to provide a comprehensive document for the process of designing, locating, installing, starting up, maintaining, testing, removing, and documenting work on a medical gas supply system. Designer will review cost along with calculated load analysis to determine whether bulk tanks, manifolds or support equipment will be used.

For system sizing, designers should use data from recognized manufacturers such as BeaconMEDAES or approved equal. Pipe sizing charts used should be specific to the gas being sized. Diversity factors of all systems will be determined by recommendations found in the ASPE Data Book Volume 3, the VA Plumbing Design Manual and VA Medical Staff. After reviewing PG 18-5, Equipment Guide and PG-18-12 Design Guide, coordinate with Medical Staff and A/E to determine the quantity of compressed air outlets, vacuum system inlets and diversity factors required during the program phase of the project.

The medical vacuum system will be sized based upon Chapter 2 "Plumbing Design for Healthcare Facilities" of the ASPE Data Book Volume 3, Special Plumbing Systems. Medical vacuum systems, associated equipment, and the entire piping system including main and branch piping will be designed for increase load by 25 percent to accommodate future expansion. WAGD systems will be sized for 100 percent of the calculated demand with no diversity factor. Do not combine medical vacuum and WAGD systems due to potential of fire or explosion. Obtain written approval from the medical center for a combined system. If the medical vacuum and WAGD systems are combined, size the medical vacuum system to accommodate the combined load plus 25 percent capacity for future expansion. Oil flooded pumps are preferred, the system must be connected to the BAS. Confirm with the medical center if the system combines upstream or downstream of the zone valve box. Systems must comply with NFPA 99 requirements.

8.2.3.2 System Setup

- **(a)** Place a source shut-off valve for each medical gas and vacuum system at the immediate outlet (or inlet, in the case of vacuum) of the source of supply, so that the entire supply source, including all accessory equipment, can be isolated from the entire pipeline system.
- **(b)** Include sufficiently sized and properly constructed storage space for the gas cylinders with manifold systems. Primary and reserve banks are required for cylinder gas sources.
- **(c)** The medical air compressors and medical vacuum pumps will serve the medical air and medical vacuum systems only.

(d) Locate compressors and pumps in a clean, relatively cool environment (i.e., not with steam equipment, not to exceed 38 deg C [100 deg F] ambient temperature and max 60% relative humidity). Locate equipment in an area where it can be monitored regularly.

(e) Medical air compressors and vacuum pumps will be multiplexed as noted by NFPA 99 with single receivers. Size compressors and pumps such that 100% of the peak design load is carried with any single unit out of service. Provide three-way valve bypass at receiver.

(f) Vacuum systems will be protected with appropriate filtration (0.3-micron hydrophobic filter or equivalent) on the suction side of the pumps to minimize the potential for contamination of the vacuum pumps.

(g) Liquid oxygen containers will either:

1. Comply with appropriate requirements of the ASME Boiler and Pressure Vessel Code, Section VIII, Unfired Pressure Vessels; insulation surrounding the liquid oxygen container will be noncombustible material.
2. Be designed, constructed, tested, and maintained in accordance with the U.S. Department of Transportation (DOT) Specifications and Regulations for 4L containers.

(h) High-pressure gaseous oxygen containers will either:

1. Be designed, constructed, and tested in accordance with appropriate requirements of the ASME Boiler and Pressure Vessel Code, Section VIII, Unfired Pressure Vessels.
2. Be designed, constructed, tested, and maintained in accordance with U.S. Department of Transportation (DOT) Specifications and Regulations.

(i) The preferred location for manifold systems is indoors adjacent to the loading dock. The room will have a minimum of 10 air changes per hour of outside ventilated air with a maximum temperature of 32 deg C [90 deg F]. There will be no doors, vents, or other direct access between the anesthetizing location or the storage location and any combustible agents. The room will be properly labeled and secured.

(j) Medical Air compressors will be a type that provides "Medical Compressed Air," as defined by NFPA 99 and meets VA Master Specification 22 63 00, Gas Systems for Laboratory and Healthcare Facilities.

(k) Design medical air compressor, air dryers, filters, and pressure regulators for the medical air system in duplex as required by NFPA 99, each sized for 100% of the load using duplex twin tower desiccant dryers. Include continuous line dew point and carbon monoxide monitoring with sample connections on the discharge piping downstream of the filters and regulators. Locate monitors at the pump control panel or integrated with the control panel.

(l) Locate the medical air compressor system intake outdoors above the roof or downstream of the air handler final filter. Intake will be located at least 7.6 m [25 ft.] (may be more depending upon prevailing wind direction and velocity) from any building opening or other intake, and where no contamination from engine exhausts, fuel storage vents, vacuum system discharges, particulate matter, or odor of any type is anticipated. Air that is already filtered for ventilation system use is an acceptable source of air for medical air compressors. Combined intakes must be sized for no restriction while flowing the maximum intake possible and provided with an isolation valve at the header for each compressor served.

(m) Combine discharge from each medical vacuum pump into one discharge pipe, sized for no restriction while flowing the maximum discharge possible, and provide an isolation valve at the header for each pump served. Exhaust discharge at the highest point of the building, above and at least 7.6 m [25 ft] horizontally (maybe more depending upon prevailing wind direction and velocity) from any intake, door, window, louvered or ventilating opening of the building.

(n) Central supply systems for oxygen, medical air, nitrous oxide, carbon dioxide, and all other patient medical gases will NOT be piped to, or used for, any purpose except patient care applications. Prohibited uses of medical gases include but not limited to fueling torches, blowing down or drying any equipment (such as laboratory equipment, endoscopes, or other scopes), or any other purposes. Also prohibited is using oxygen or medical air to raise, lower, or otherwise operate booms or other devices in operating rooms (ORs) or other areas.

8.2.4 Piping Systems

(a) Design pressure piping systems not to exceed 10 percent of system working pressure.

(b) Provide main line supply line with a shut-off valve. Locate valve to be accessible by authorized personnel only, downstream of the source valve, and outside of the source room, enclosure, or area where the main valve enters the building. Identify this valve. A main line valve is not required when the source shut-off valve is accessible within the building.

(c) Each branch or riser supplied from the main line will have an in-line shut-off valve adjacent to the main. Each branch supplied from a riser will have an in-line shut-off valve, adjacent to the riser. Conceal in-line shut-off valves (e.g., above ceiling with ceiling tag, or in a locked equipment room) and make a provision to lock them open. Provide an in-line shut-off valve upstream of the zone valve box to allow relocation/renovation of the zone valve box. Provide additional service valves above ceiling to subdivide areas for maintenance. All service valves must be as noted by NFPA 99.

(d) Include a zone valve in a cabinet with other medical gas zone valves, for all anesthetizing locations and branches serving station outlets and inlets in conformance with NFPA 99.

(e) Combine WAGD piping with the medical vacuum system piping above ceiling and after zone valve per NFPA 99 requirements. Combined WAGD and medical vacuum system are not recommended. Obtain written approval from the medical center for a combined system.

(f) Except for nitrogen systems, medical gas station outlets and vacuum station inlets in new buildings will be quick coupler type. Where building alterations or additions occur, station outlets and inlets will be compatible with those of the existing building, without the use of secondary adapters.

(g) All nitrogen station outlets are required to be DISS-type and will be located as an integral part of the nitrogen control panel (NCP) within the room being served.

(h) Locations of piped medical gas station outlets and vacuum station inlets are indicated in VA Program Guide PG-18-5, Equipment Guide List.

(i) Provide a protective pipe enclosure for exterior oxygen lines. Burial depth will be a minimum 0.6 m [2 ft.] below grade. Provide warning tape that is acid and alkali-resistant with a metallic core encased in a protective jacket, detectable by metal detector.

(j) Design the oxygen and medical air systems to accommodate the ventilators. Coordinate the requirement for the use of ventilators, and other high flow apparatus with the medical center, including the pulmonology department. Coordination would include documenting the basis of design for the ventilators, the number of ventilators and where they are to be used.

(k) Oxygen and medical air pipe sizing:

1. The designer must provide a riser diagram for oxygen and medical air system with the design flow, pipe sizes, and calculated pressure at each outlet, at each zone valve and at any branch in the system.
2. Flow must be in liters per minute (L/min), and pressure must be in pounds per square inch (PSI).
3. Minimum pipe size shall be 1/2 inch for oxygen and medical air piping system.
4. Pipe sizing is based on estimated max flow, length of pipe run, and allowable system pressure drop.
5. For oxygen and medical air systems, the system pressure drop must not exceed 34 kPa [5 psig] in entire piping system which includes but not limited to main piping from the tank to the building or risers, and branch piping up to the most remote or highest flow outlet.
6. The source pressure of medical air and oxygen systems is 55 PSIG.
7. Outlets: VA design guides shall be consulted for the number of outlets required in each room type.

(l) The minimum size of vacuum piping will be 20 mm [3/4 in.] with 15 mm [1/2 in.] drops to individual inlets permitted.

1. Vacuum System: Minimum design flow rate for any pipe section is 113 L/min [4 cfm].
2. Design vacuum piping systems not to exceed 10 kPa [3 in Hg] loss for longest run of pipe from the vacuum pump to the most remote vacuum inlet.

(m) Smaller diameter pipes must not feed into larger diameter pipes in oxygen, medical air, vacuum systems, and other medical gases.

(n) Cross-ties are not acceptable in piping layouts layout for oxygen, other medical gases, medical air, and vacuum system when designing piping distributions.

(o) Oxygen system main and risers must be designed to increase load by 10 percent to accommodate future expansion.

(p) Oxygen and medical air systems service valves should be installed that allow for maintenance without disrupting the entire floor.

8.2.5 Alarms

Coordinate the NFPA 99 facility category with the medical center. If the facility is considered a Category 1 facility, the following must be incorporated into the design:

(a) To ensure continuous responsible observation, two master system alarms, in separate warning locations, are required for each medical gas and vacuum system.

(b) The primary warning location will be supervised by responsible personnel and will be located at one of the following (in order of priority): boiler plant control office, engineering control center, or in the office or principal working area of the individual responsible for the maintenance of the medical gas system. The primary alarm point will be an alarm point in the direct digital control system and a physical, labeled, visual alarm indicator inside the primary warning location.

(c) The secondary warning location will be situated to ensure continuous surveillance during the working hours of the facility. Suitable secondary warning locations may include intensive care nursing units, fire station, telephone switchboard, security office, or other continuously-staffed location.

(d) Coordinate both master alarm panel locations with the user facility and the other design services. When deciding upon alarm locations, consider emergency power circuits, engineering control center data relay interface locations, and the facility's established procedures for monitoring alarm signals. Provide the following on plumbing drawings:

- Low voltage wiring and pressure switches associated with master alarm signals and panels (on floor plans).
- Low voltage wiring diagram associated with master alarm signals and panels.
- Conduit and/or communication cable runs from the sensor locations to area alarm panels (on floor plans and medical gas and vacuum system diagrams).

Each medical gas and vacuum system will have a local area alarm installed at the corresponding nurse's station in all areas where medical gas and vacuum station outlets and inlets are installed.

8.2.6 Connections to Existing Medical Gas Systems

(a) Coordinate time for shut down of any existing medical gas system with the medical center. The work will be completed by an ASSE 6010 certified installer.

(b) All zone valves and gas riser valves should be shut off if the section to which they connect cannot be totally isolated from the remainder of the system.

(c) Ensure that the correct type of pipe tubing and fittings are being used. All medical gas and oxygen will be cleaned for oxygen service. All medical gas piping and fittings will be cleaned for oxygen service. Materials, installation, and testing will be in accordance with NFPA 99 requirements.

(d) Prior to joining the new system to the existing the new pipeline should be checked for particulate or other forms of contamination. New piping will be cleaned, tested, and purged in accordance with NFPA 99.

(e) A spot check of the existing pipelines in the facility must be made to determine the level of cleanliness present.

(f) Reduce the pressure to 0 Pa [0 psig] and make the tie-in as quickly as possible.

(g) Install a shut-off valve at the connection of the new line to the existing line. The valve assembly should be fabricated and brazed onto the connecting line.

(h) The use of shape memory alloy couplings is recommended when making connections to existing medical gas systems upon approval from the VA facility. Additionally, NFPA 99 approved Axially Swaged connections can be used upon approval from the VA facility.

(i) "Hot" taps and associated type valves are prohibited in medical gas systems unless approved by Office of Health Equity (OHE)

(j) After the tie-in is made and allowed to cool, the source gas, i.e., oxygen, is slowly bled back into the pipeline. The work area is tested for leaks with soapy water and any leaks are repaired.

(k) After any leaks are repaired and the line is fully recharged, blow down and testing are performed. The zone closest to the main is opened to the system, the closest outlet to the work is accessed, and the main blown through the outlet. After the outlet blows clear into a white cloth, an oxygen analyzer is used to determine that only oxygen is present. An additional check is made at the zone most distant from the site of the work.

(l) Prior to putting system into service testing will be conducted by a party technically competent and experienced in the field of medical gas and vacuum pipeline testing and meeting the requirements of ASSE 6030, Professional Qualifications Standard for Medical Gas Systems Verifiers. Testing will be performed by a party other than the installing contractor.

(m) When connecting to an existing system coordinate with hospital personnel for current system assumed flow rates and diversities. The entire existing system does not need to be brought up to the current VA standards (sizing, flow rates, etc.). Only the newly installed have meet the current standards. Notify the COR of deficiencies in the existing system when comparted to the new standards.

8.3 LABORATORY GAS AND VACUUM SYSTEMS FOR RESEARCH AND MEDICAL LABORATORIES

Design laboratory compressed air, laboratory vacuum, natural gas, and miscellaneous laboratory cylinder gas systems in accordance with current editions of:

- NFPA 54, National Fuel Gas Code
- NFPA 58, Liquefied Petroleum Gas Code
- NFPA 59A, Standard for the Production, Storage, and Handling of Liquefied Natural Gas (LNG)
- NFPA 99, Healthcare Facilities
- ASPE Data Book Volume 3
- Master Specification 22 62 00, Vacuum Systems for Laboratory and Healthcare Facilities
- Master Specification 22 63 00, Gas Systems for Laboratory and Healthcare Facilities

8.3.1 Central Supply Systems

(a) Provide minimum 690 kPa [100 psig] laboratory air at the compressor discharge. Run 690 kPa [100 psig] air to a storage room (or other non-working or unfinished space) in the laboratory area being served. Valve and cap the 690 kPa [100 psig] air line for future connection. Tee off the 690 kPa [100 psig] line and locate a pressure-regulating valve to reduce the air pressure to 345 kPa [50 psig]. Run 345 kPa [50 psig] air to all outlets in laboratory hoods and benches.

(b) If specifications for laboratory equipment being purchased by the medical center are known, and the equipment requires higher air pressures, provide additional tee, regulator, and piping to that equipment at the required pressure.

(c) Natural gas, Liquefied Petroleum Gas (LPG), Liquefied Natural Gas (LNG) and manifold laboratory gas system pressures will be determined on a project basis.

(d) Design laboratory vacuum systems to deliver 51 kPa [15 in Hg] of vacuum at the point of use.

(e) Place a source shut-off valve for each laboratory gas and vacuum system at the immediate outlet (or inlet, in the case of vacuum) of the source of supply, so that the entire supply source, including all accessory equipment, can be isolated from the entire pipeline system.

(f) In facilities where manifold laboratory gases occur, ensure that adequately sized and properly constructed storage space is provided for the gas cylinders. Primary and reserve banks are required for cylinder gas sources.

(g) Locate laboratory air compressors and vacuum pumps in a clean, relatively cool environment (i.e., not with steam equipment, exceeding 38 deg C [100 deg F] ambient temperature). Locate equipment in an area where it can be monitored regularly.

(h) Laboratory medical air compressors and vacuum pumps will be multiplexed with single receivers. Compressors and pumps will be sized such that 100% of the peak design load is carried with the largest single unit out of service. Provide three-way valve bypass at receiver.

(i) Vacuum systems will be protected with appropriate filtration (0.3-micron hydrophobic filter or equivalent) on the suction side of the pumps to minimize the potential of the vacuum pumps.

(j) Laboratory air compressors and vacuum pumps will be designed and installed with regards to cleanliness and reliability as an NFPA 99 Category 3 system but will be completely independent of medical gas systems serving patients except as allowed by NFPA 99.

(k) Vivarium Gas for Animal Procedures: Oxygen, carbon dioxide, and other gas services to vivaria will be designed and installed with regards to cleanliness and reliability as an NFPA 99 Category 1 system but will be completely independent of medical gas systems serving humans.

(l) Design air dryers, filters, and pressure regulators for the laboratory air system in duplex, each sized for 100% of the load using duplex twin tower desiccant dryers. Include continuous dew point monitoring downstream of the regulator and carbon monoxide monitoring with sample connections on the discharge piping after the filters and regulators. Locate monitors adjacent to the control panel or integrated with the control panel.

(m) Locate the laboratory air compressor system intake outdoors above roof level or downstream of air handler final filter. Intake will be located at least 7.6 m [25 ft] (may be more depending upon prevailing wind direction and velocity) from any building opening or other intake, and where no contamination from engine exhausts, fuel storage vents, vacuum system discharges, particulate matter, or odor of any type is anticipated. Air that is already filtered for ventilation system use is an acceptable source for laboratory air compressors. Combined intakes must be sized for no restriction while flowing the maximum intake possible and provided with an isolation valve at the header for each compressor served.

(n) Combine discharge from each laboratory vacuum pump into one discharge pipe, sized for no restriction while flowing maximum discharge possible, and provide an isolation valve at the header for each pump served. Exhaust discharge at the highest point of the building, above and at least 7.6 m [25 ft.] horizontally (maybe more depending upon prevailing wind direction and velocity) from any door, window, or louvered or ventilating opening of the building.

8.3.2 Piping Systems

(a) Design medical gas pressure piping systems not to exceed 34 kPa [5 psig] loss from source to point of use of the longest pipe run. Vacuum piping system pressure drop will be designed not to exceed 10 kPa [3 in Hg] loss from source to point of use of the longest pipe run.

(b) Provide main line supply line with a shut-off valve. Locate valve to be accessible by authorized personnel only, downstream of the source valve, and outside of the source room, enclosure, or area where the main valve enters the building. Identify this valve. A main line valve is not required when the source shut-off valve is accessible within the building.

(c) Each branch and riser supplied from the main line will have an in-line shut-off valve adjacent to the main. Each branch supplied from a riser will have an in-line shut-off valve adjacent to the riser. Conceal in-line shut-off valves (e.g., above ceiling with ceiling tag, or in a locked equipment room). Comply with applicable codes and standards for concealed valves of flammable gases.

(d) Include a zone valve in a cabinet with other laboratory gas zone valves for branches serving laboratory gas outlets. Locate separate natural gas zone valve cabinets adjacent to other laboratory gas zone valve cabinets. Provide additional service valves above ceiling to subdivide areas for maintenance. Valves will be accessible only to maintenance personnel.

(e) Laboratory gas outlets and vacuum inlets will be standard needle valves.

(f) Locations of piped laboratory gas outlets and vacuum inlets are indicated in VA Program Guide PG-18-5, Equipment Guide List and PG-18-12, Design Guide and coordinated with Research and Laboratory Staffs.

(g) Provide an emergency natural gas solenoid valve for each laboratory area. Locate the emergency shut-off switch adjacent to each lab exit.

8.3.3 Alarms

To ensure continuous responsible observation, two master system alarms, in separate warning locations, are required for each laboratory gas and vacuum system.

The primary warning location will be supervised by engineering personnel and will be located at one of the following (in order of priority): boiler plant control office, engineering control center, or in the office or principal working area of the individual responsible for maintenance of the laboratory gas system.

The secondary warning location will be situated to ensure continuous surveillance during the working hours of the facility. Suitable secondary warning locations may include fire station, telephone switchboard, engineering control center, security office, or other continuously-staffed location.

Coordinate both master alarm panel locations with the user facility and the other design services. When deciding upon alarm locations, engineering control center data relay interface locations, and the facility's established procedures for monitoring alarm signals. Provide the following on the plumbing drawings:

- Low voltage wiring and pressure switches or sensors associated with master alarm signals and panels (on floor plans).
- Low voltage wiring diagram associated with master alarm signals and panels.
- Conduit and wiring runs from the sensor location to area alarm panels (on floor plans and laboratory gas and vacuum system diagrams

8.4 ORAL EVACUATION SYSTEM

Design the oral evacuation system in accordance with NFPA 99, Chapter 15 "Dental Gas and Vacuum Systems". Coordinate the level of sedation with the VA Facility to determine the correct design category. Also, coordinate with VA Master Specification 22 62 19.74, Dental Vacuum and Evacuation Equipment, and the following:

8.4.1 High Volume Oral Evacuation (HVE) - General

Locate HVE system outlets in floor-mounted utility junction centers. A utility junction center (UJC) is a grouping of specific utilities brought to a designated location in each dental operatory to provide convenient points of connection to the dental operating unit equipment, which will be furnished by VA. A single 50 mm [2 in.] diameter wall outlet will be provided in each recovery room.

8.4.2 Airflow and Vacuum Requirements

(a) Design airflow of 3.3 L/sec [7 scfm] at each UJC.
(b) Design airflow of 3.3 L/sec [7 scfm] at wall outlet in recovery rooms.
(c) System will develop and maintain a vacuum of 27 Pa [8 in Hg].
(d) No diversity will be assumed when sizing HVE systems.

8.4.3 Vacuum Relief Valves

Provide a vacuum relief valve at the end of each trunk line.

8.4.4 High Volume Oral Evacuation (HVE) Systems

(a) Oral evacuation systems are wet systems that must be piped below the finish floor elevation of the Dental area to prevent the possibility of contaminates re-entering the patient care area in the event of a power outage. Experience has proven that routing piping above and in ceilings can be problematic. When overhead pipe routing cannot be avoided, provide cleanout fittings at the base of all risers, and observe these requirements:

- Minimize lift height.
- Vertical pipe run from inlet to overhead pipe will be 1/2-inch diameter or in accordance with manufacturer's recommendation.
- The vertical pipe will "tee" into the top of the overhead branch main.
- The available vacuum level to satisfy performance requirements will be based on a reduction of the pump-generated vacuum at the rate of 3.39 kPa [1 in. Hg] for each 335 mm [1.1 ft.] rise.

(b) Provide duplex or multiplex high efficiency, continuous duty, vacuum producers each capable of carrying 70% of the design load. Pumps will be sized to produce 27 kPa [8 in. Hg] of vacuum at an airflow of 425 L/m [15 scfm] at each UJC. Refer to VA Master Specification 22 62 19.74 Dental Vacuum and Evacuation Equipment for requirements. Locate remote from dental facilities at an elevation lower than UJCs.

(c) Vacuum systems will be protected with appropriate filtration (0.3-micron hydrophobic filter or equivalent) on the suction side of the pumps to minimize the potential for contamination of the vacuum pumps. The piping run for the UJC should continuously slope back to the vacuum source to facilitate the transportation of fluids and particles. Minimum required slope will be 6.35 mm per 3 m [1/4-in. per 10 ft.].

(d) Combine exhausts into a common pipe sized for one vacuum producer. Discharge exhaust pipe to outdoors above roof of portion of building where located. Do not discharge within a 3 m [10 ft.] radius of any door, window, air intake, or ventilation opening.

(e) Increase airflow demand as follows to compensate for friction losses:

The Total Number of Utility Junction Centers (UJC)	% Increase
9 to 20	10
21 to 44	15

(f) Install separators ahead of each vacuum producer. Quantity and size will be as follows:

The Total Number of Utility Junction Centers (UJC)	Quantity	Size L [gallon]
6	2	75 [20] each
710	2	150 [40] each
11 and above	2	300 [80] each

(g) AMALGAM separators will be installed on vacuum lines in dental offices per EPA, Effluent Limitations Guidelines and Standards for Dental Category, also called "the Dental Rule". For additional information visit https://www.epa.gov/eg/dental-effluent-guidelines and SECTION 22 62 19.74 DENTAL VACUUM AND EVACUATION EQUIPMENT.

8.5 DENTAL COMPRESSED AIR SYSTEMS

Design central piped dental compressed air distribution system in accordance with current editions of NFPA 99, Compressed Gas Association Standards, Master Specification 22 61 13.74, DENTAL COMPRESSED-AIR PIPING and 22 61 19.74, DENTAL COMPRESSED-AIR EQUIPMENT (DENTAL COMPRESSED AIR SYSTEM), and the following:

8.5.1 Dental Compressed Air Systems and Equipment

Dental compressed air systems and equipment will be completely independent of the medical and laboratory air systems and equipment.

8.5.2 Central Supply System Pressure Requirements

(a) Verify the pressure requirements for the dental clinic with the VA authorities and design the system accordingly. Design systems for the demand utilizing diversity factors indicated in the charts at the end of this chapter.

(b) High pressure dental air compressors will be designed to produce air at a maximum of 965 kPa [140 psig] with a single stage, without excess noise and vibration. The system must comply with NFPA 99. Compressors will be duplex and sized such that 100% of the design load is carried by the largest single unit out of service. Refer to VA Master Specification Section 22 61 19.74 for technical details on compressor equipment.

(c) Low pressure dental air compressors will be designed to produce air at a maximum of 690 kPa [100 psig] with a single stage, without excess noise and vibration. The system must comply with NFPA 99. The compressors will be multiplex and sized such that 100% of the design load is carried by the largest single unit out of service. Refer to VA Master Specification Section 22 61 19.74 for technical details on compressor equipment.

(d) Include primary and secondary air dryers, filters, pressure regulators, all with a valve bypass. Continuous line dew point and carbon monoxide monitoring will be included.

(e) Locate compressors in a clean, relatively cool environment (i.e., not with steam equipment, not to exceed 38 deg C [100 deg F] ambient temperature). Locate equipment in an area where qualified personnel can monitor it regularly.

(f) Place a source shut-off valve at the immediate outlet of the source regulator, so that the entire supply source, including all accessory equipment, can be isolated from the entire pipeline system.

(g) Locate the dental air compressor system intake outdoors above roof level, or downstream of air handler final filter. Intake will be located at least 7.6 m [25 ft.] (may be more depending upon prevailing wind direction and velocity) from any building opening or other intake, and where no contamination from engine exhausts, fuel storage vents, vacuum system discharges, particulate matter, or odor of any type is anticipated. Air that is already filtered for ventilation system use is an acceptable source of air for dental air compressors. Combined intakes must be sized for no restriction while flowing the maximum intake possible and provided with an isolation valve at the header for each compressor served.

(h) Dental air system design will comply with NFPA 99 requirements.

8.5.3 Piping Systems

(a) Size piping mains to accommodate 25% excess capacity for future expansion. Design low pressure system to deliver a regulated 690 kPa [100 psig], not to exceed 35 kPa [5 psig] loss from source for the longest pipe run to point of use. Design high pressure system to deliver a regulated 965 kPa [140 psig], not to exceed 35 kPa [5 psig] loss from source for the longest pipe run to point of use.

(b) Provide pipe riser of 15 mm [1/2 in.] minimum pipe for each Utility Junction Center (UJC) in the dental treatment rooms. Connect riser to branch or main line. Provide shutoff valve at each UFC.

(c) Each branch riser supplied from the main line will have an in-line shut-off valve adjacent to the main. Conceal in-line shut-off valves (e.g., above ceiling with ceiling tag, or in a locked equipment room).

(d) To minimize piping, locate multiple air pressure regulators in or near the dental suite as required.

(e) Locations of piped dental air outlets are indicted in VA Program Guide PG-18-5, Equipment Guide List and PG-18-12, Dental Design Guide.

(f) Air that is normally used for dental laboratory restorative and fabrication techniques may be provided by same source for dental treatment rooms.

(g) Provide an emergency gas solenoid shut-off valve on the natural gas line to the treatment rooms and laboratory areas at the exit of each area.

(h) Natural gas from a single source for dental treatment rooms and dental laboratories is allowed.

(i) Fuel gas (i.e., natural gas) valves will be provided with lockout devices to prevent unauthorized access when patients are alone in rooms, or the rooms are left unattended for periods of time. Coordinate this requirement with the Chief of Dental Services.

8.5.4 Dental Air System Demand

The dental air system will be sized utilizing criteria and methods found in the following tables. The designer will calculate the dental clinic demand, laboratory demand and sterilization demand from the tables to determine the total dental air system demand required.

8.5.4.1 Dental Treatment Room Equipment

Air volume, pressure requirements, and simultaneous use factors for Dental Treatment Room Equipment are listed in the following schedules. For equipment not listed coordinate requirements with the Chief of Dental Service:

AREA	EQUIPMENT	VOLUME L/s [scfm]	PRESSURE kPa [psig]
Exam, general treatment operatory, and dental hygiene rooms	Needle valve wall outlet	0.12 [0.25]	345 [50]
Exam, general treatment operatory, and dental hygiene rooms	UJC	1.4 [3]	690 [100]
Oral Surgery	DISS outlet to surgical hand piece	10 [21.1]	965 [140]
Oral Surgery	UJC	1.4 [3]	965 [140]

QUANTITY OF OUTLETS/UJC per DENTAL CLINIC	CLINIC DIVERSITY, FACTOR (PERCENT)
1 through 3	100
4 through 6	90
7 through 12	80
13 through 19	70
20 and over	60

(a) To determine the total clinic demand-load, the designer will use the number of outlets and utility junction centers (UJC) and their volume requirements times a diversity factor as found in the above tables.

Oral Surgery
Example: 2 (DISS outlets) x 10 L/s (volume) x 100 (percent diversity) = 20 L/s

Example: 6 (UJC) x 1.4 L/s (volume) x 90 (percent diversity) = 7.6 L/s

Total 27.6 L/s

8.5.4.2 Prosthetics Laboratory

Air volume, pressure requirements, and simultaneous use factors for dental laboratory equipment are listed in the following schedules. For equipment not listed coordinate requirements with the Chief of Dental service.

EQUIPMENT	VOLUME L/s [scfm]	PRESSURE kPa [psig]
Needle valve in benches and casework	0.12 [0.25]	345 [50]
Quick coupler for lab air-gun	0.12 [0.25]	345 [50]
Quick coupler for lab hand piece	1.4 [3]	345 [50]
Threaded valve for shell blaster or sandblaster	10 [21.1]	690 [100]
Threaded valve for micro-blaster	1.4 [3]	690 [100]
Pneumatic chisel	0.85 [1.8]	700 [101.5]
Micro-finisher	1.4 [3]	690 [100]

NUMBER OF LAB OUTLETS/EQUIPMENT DENTAL LABORATORY	LABORATORY DIVERSITY FACTOR (PERCENT)
1 through 5	60
6 through 10	50
11 through 19	40
20 and over	30

(a) To determine the total laboratory demand-load, the designer will use the number of outlets and equipment connections and their volume requirements times a diversity factor as found in the tables above.

Example: 4 (needle valves) x 0.12 L/s (volume) x 60 (percent diversity) = 0.29 L/s

Example: 2 (valves for sandblaster) x 10 L/s (volume) x 60 (percent diversity) = 12 L/s

Total 12.29 L/s

(b) To determine the sterilization demand, multiply the number of hand piece purge stations by 0.472 L/s. Calculate the demand at 100% with no diversity factor.

8.5.4.3 Standard Dental Air Demand

The standard dental air demand for the facility will be the sum of the dental clinic demand, dental laboratory demand, and the sterilization demand.

8.6 DESIGN FOR DENTAL UNIT WATER LINES

In 2003, Center for Disease Control (CDC) published its Guidelines for Infection Control in Dental Health-Care Settings which concluded that “dental unit water that remains untreated or unfiltered is unlikely to meet drinking water standards.” Subsequent studies have demonstrated that daily flushing of water lines does not affect biofilm or reliably improve water quality.

Therefore, municipal water supplied to utility junction centers (UJC) will require a supplemental water treatment system or chemical treatment product. Using untreated municipal water at the utility junction centers (UJC) is prohibited. Water supplied from an alternate source by means of a reservoir at the dental unit is a viable alternative. Commercial methods to improve the quality of water used in dental treatment are available. Methods containing self-contained water systems combined with chemical treatment, in-line micro filters, and combinations of these methods have proven effective. Plumbing Designers will coordinate the dental unit water requirements with the Chief of Dental Services early in the design process.

---END OF SECTION---

9 FUEL GAS SYSTEMS

9.1 INTERIOR FUEL GAS SYSTEMS

Design natural gas piping systems in accordance with NFPA 54; Liquefied Petroleum Gas (LP-Gas) in accordance with NFPA 58; Liquefied Natural Gas (LNG) in accordance with NFPA 59A; National Fuel Gas Code, latest edition. Boiler systems, site distribution, and HVAC equipment are not covered in this manual. Refer to the VA Steam Generation, Site Development, and HVAC Design Manuals.

Provide a solenoid valve in the natural gas supply line to the dental laboratory and the dental clinic operatories with an emergency shut-off valve at the exit in a conspicuous location for each area. The shutoff valve must be specifically designed and listed for this intended purpose at the system operating pressure, fuel type and location. Valve will be the type that shuts off the flow of gas in the event of electrical current failure (normally closed). The valve remains closed until manually reopened.

Provide a solenoid valve in the gas supply to the kitchen area with an emergency shut-off located in the area. In addition to the kitchen emergency shutoff valve, a solenoid valve with automatic fire protection systems is required for automatic gas shutoff at each kitchen gas appliance served by a hood. Coordinate with the kitchen equipment drawings.

Provide a solenoid valve in the gas supply to gas fired equipment in the Mechanical Room with an emergency shut-off valve located in a conspicuous location near the exit.

---END OF SECTION---

10 SPECIALTY SYSTEMS

10.1 PLUMBING FOR BIOLOGICAL SAFETY LEVEL 3 LABORATORIES

(a) Design for Biological Safety Level 3 Laboratories will be in accordance with the CDC Biosafety in Microbiological and Biomedical Laboratories (BMBL) Manual.

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

(c) Provide a dedicated hands-free (sensor) hand washing sink located near the exit from the laboratory and not in the vestibule.

(d) The suction side of the vacuum pump will be piped to a 0.2-micron hydrophobic inline filter with a valve bypass place as close as possible to the laboratory. Some mechanism for the decontamination of filters will be incorporated into the design of the vacuum system.

(e) The vacuum pump discharge will have a sampling port and will be vented to the atmosphere in a secured location at least 3 m [10 ft.] away from any air intake (mechanically operated equipment, doors, or operable window) locations.

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

(g) An autoclave will be made available inside the laboratory for decontamination purposes.

(h) All pipe penetrations will be sealed watertight while maintaining fire rating of wall.

10.2 LABORATORY WATER SYSTEMS

(a) Clinical Laboratory Reagent Water (CLRW) must be monitored for resistivity, microbial content and total organic carbon.

- Ionic impurities: >10-megaohms-cm at 25 deg C [77 deg F]
- Microbiological Impurities: <10 CFU/ml
- Organic Impurities: Total organic carbon <500 ng/g (ppb)
- Particulate and Colloid Content: <0.22 micro m

(b) Special Reagent Water - base characteristics are the same as CLRW with additional requirements meeting manufacturer’s specifications.

(c) Instrument Feed Water - water used by automated instruments for internal rinsing, dilution and water bath functions must be per manufacturer’s specifications.

(d) Autoclave Water – feed water for autoclaves and dishwashers with heat drying cycles should have low levels of inorganics, organic and particular impurities so as to leave little residue on washed lab ware. These specifications vary with type of equipment selected.

(e) VA authorities responsible for the oversight of Laboratory Systems will be consulted during design.

10.3 PLUMBING FOR ANIMAL CARE (VIVARIUM) FACILITIES

(a) A floor or trench drain with an automatic watering system will be provided for large animal rooms. Holding rooms designed to accommodate fish tanks and/or rodent swim tanks will be provided with a wall hydrant with backflow protection.

(b) Both potable and non-potable (industrial) water systems will be provided. Reduced pressure zone backflow preventers (ASSE 1013) will be installed on the industrial water supply pipe to protect the potable water supply. Non-potable water piping will be identified by color marking or metal tags in accordance with the IPC. At outlets, such as hose-connections, open ended pipes, or faucets providing non-potable water signage will identify outlets as “non-potable water - not safe for drinking.”

(c) Hot water serving animal care facilities will be heated to 60 deg C [140 deg F] and tempered down to 43. 3 deg C [110 deg F] at point of use with mixing valves at each fixture (ASSE 1070).

(d) The minimum pressure at the farthest plumbing fixture is 240 kPa [35 psig]. A pressure-reducing valve will limit maximum pressure at any plumbing fixture to 551 kPa [80 psig]. All water outlet fittings will be equipped with vacuum breakers.

(e) Potable water will connect to all fixtures requiring a potable water connection, including, emergency showers, and eye washes.

(f) The designer will investigate the animal watering requirements for the facility. Unless directed otherwise, the minimum level of water treatment will be done using a reverse osmosis process. Other treatment requirements may include ultraviolet (UV) sterilized, chlorination, and acidification processes, these treatments need to be reviewed with the VA Facility.

(g) Oxygen, medical vacuum, and medical air will be provided for the vivarium exam, treatment, and preparation rooms. Vivarium surgery rooms will have oxygen, medical vacuum, medical air, nitrous oxide, and nitrogen. Necropsy will be provided with oxygen and laboratory air. These systems must be separate from medical, laboratory, and dental systems. Consult with the VA Facility about design requirements.

10.4 HEMODIALYSIS WATER DISTRIBUTION SYSTEM DESIGN

10.4.1 General

It is critical that the water distribution system for hemodialysis meet the water quality guidelines stipulated by the most current Association for the Advancement of Medical Instrumentation (AAMI) guidance found in ANSI/AAMI/ISO Standards. During the design process, the plumbing designer must coordinate with the medical center and the medical director for the hemodialysis unit.

10.4.2 Hemodialysis Water Treatment System Description

(a) The incoming water supply temperature for dialysis treatment will be within the range required by the hemodialysis water purification device manufacturer. The thermostatic mixing valve (ASSE 1017, ASSE 1069 or ASSE 1070) will have a thermometer, normally closed bypass valve, and will be accessible for maintenance and daily monitoring of supply temperature.

(b) Downstream of the thermostatic mixing valve, the water supply will be protected by a reduced pressure backflow prevention device (ASSE 1013).

(c) A duplex booster pump package with lead/lag sequence control function may be necessary to maintain minimum supply pressure. This booster pump will be controlled by a pressure switch.

(d) A water analysis may require an acid injection system to lower water pH level and maintain a pH level between 7.0 and 8.0. The acid injection system, if required, will be placed upstream of the multi-media filtration equipment.

(e) After the backflow prevention device and booster pump package, the water will enter a multi-media filtration system to remove particulate matter.

(f) Once the multi-media filtration equipment removes the fine particulate, the water will pass through a water softener to reduce hardness and prolong life of the reverse osmosis membrane that is located further downstream.

(g) Upon leaving the multi-media filtration equipment, the water will pass through primary and polishing carbon filters to remove chlorine and chloramines from the water.

(h) After the carbon filters, the water will be treated by a reverse osmosis (RO) package and delivered into an optional RO storage tank. A low-level condition at the storage tank will engage the RO equipment to fill the tank to the high-level position.

(i) A pure water re-circulating pump will draw water from the tank and through an ultra-filtration system that includes ultra-violet (UV) light disinfection system to destroy and remove the remaining bacteria. Piping will be in accordance with VA Master Specification 22 11 00 for dialysis water piping. Water will be recirculated as close to the dialysis box as possible. Refer to VA Standard detail SD 22 40 00-17.

(j) 90 Degree fittings are prohibited in the piping system.

10.4.3 Hemodialysis Water Treatment Monitoring System

The hemodialysis water treatment equipment will be installed to facilitate continuous monitoring of equipment and alarm status. Some water quality parameters will be monitored at the start of each shift. The following points will be monitored:

HEMODIALYSIS WATER TREATMENT MONITORING POINTS

Equipment	Local Monitoring	Remote Monitoring Engineering Control Center
Reduced pressure backflow preventer	Pressure drop, local inlet and outlet pressure gauges	
Thermostatic mixing valve	Local thermometer	
Acid feed system	pH level local indicator	Remote pH level indication
Multimedia filtration package	Pressure drop, local inlet and outlet pressure gauges	High pressure drop alarm
Water softener	Hardness level and salt level	Equipment status
Primary and polishing carbon tanks	Local indication of chlorine and chloramines levels, local alarm indication	Remote indication of chlorine and chloramines levels

Equipment	Local Monitoring	Remote Monitoring Engineering Control Center
Reverse osmosis package	Local indication of equipment status	Remote indication of equipment status
Deionizer/demineralizer package	Pressure drop, local inlet and outlet pressure gauges across each tank, equipment status	Remote indication of equipment status

10.5 PHARMACY PLUMBING REQUIREMENTS

(a) Refer to VA Pharmacy Design Guide PG 18-12 - Pharmacy Services Design Guide

(b) Floor drains and floor sinks will not be installed in pharmacy cleanroom suites.

(c) An automatically operated sink for hand washing will be located near the exit door of the anteroom. The controls will have battery backup or be placed on emergency power.

10.6 STERILE PROCESSING SERVICES (SPS)

Designers must ensure that SPS incoming water quality meets AAMI TIR 34 and sterile processing equipment manufacturer's specifications for microbial and chemical quality. Water quality can impact patient safety and efficacy of device reprocessing. Sterile processing departments must ensure water quality in a healthcare facility meets the needs for maintaining patient safety and preserving the life expectancy of instrumentation.

10.6.1 General Considerations

Water treatment systems will be designed to produce both "utility" and "critical" quality of water with characteristics as specified in AAMI TIR34. Designers will provide a system layout that allows for routine equipment maintenance and monitoring of water quality. The design of the water distribution system is critical to maintaining the quality of the water to the point of use.

The water treatment process must be effective, reliable, and economical. The design of the water treatment system will consider the desired quality of the product water; the characteristics of the incoming tap water; and the volume, rate, and frequency of use.

A water treatment system has three elements: pretreatment, a principal water treatment process, and distribution. The pretreatment part of a water treatment system may consist of softening and carbon filtration and is intended to protect the principal water treatment components. The principal treatment process generally consists of DI, RO, distillation, or a combination of these processes. To maintain water quality, the distribution system should be designed to routinely disinfect by means of ultraviolet (UV) light.

10.6.2 Physical Layout

The water treatment system should be in a secure area immediately adjacent to the areas in which the treated water is to be used. Access to the treatment system should be restricted to those individuals responsible for monitoring and maintaining the system.

The layout of the water treatment system will provide easy access to all components of the system, including all meters, gauges, and sampling ports used for monitoring system performance. Provide an area for performing on-site water sample tests. Alarms, such as those associated with deionizer exhaustion or low water levels in a storage tank, should be configured to sound both in the water treatment area, in the occupied SPS space, and the VAMC central alarm monitoring location, such as the boiler plant.

Schematic diagrams must identify components, valves, sample ports, and flow direction. Additionally, piping will be labeled to indicate the contents of the pipe and the direction of flow. Designer will specify that that all major water system components are labeled in a manner that identifies the component, its function, how its performance is verified, and what actions must be taken if performance is not within an acceptable range.

10.6.3 Water Distribution and Storage

Water distribution systems will be configured as a continuous loop and designed to minimize bacterial proliferation and biofilm formation. For minimization of biofilm formation, a minimum velocity of 3 feet per second (ft/sec) is required in the distal portion of the loop under conditions of peak demand. A multistage centrifugal pump made of inert materials is required to distribute the purified water and aid in effective disinfection. Product water distribution systems will be constructed of materials that do not contribute chemicals (e.g., aluminum, copper, lead, zinc) or bacterial contaminants to the purified water. The choice of materials used for a water distribution system also depends on the proposed method of disinfection. Water distribution systems should be designed with sample ports for monitoring bacteria levels.

The pipework used to supply both grades of water should be appropriate to the quality of the water carried. Polyvinylchloride, polyvinylidene fluoride (PVDF), polypropylene, or stainless-steel pipes are required for purified critical water. The pipework should be free draining and should not contain dead ends or other areas where water could become stagnant. All connections should be solvent welded. Threaded joints are not allowed, because they contain spaces in which water could collect and stagnate, thereby increasing the potential for bacterial growth. Provision should be made for the routine disinfection of water distribution lines and associated equipment.

Storage tanks for purified critical water will drain from the lowest point of the base. Storage tanks will have a tight-fitting lid and be vented through a hydrophobic 0.2 µm air filter. The filter must be accessible for regular scheduled maintenance according to the manufacturer's written IFU. A means will be provided to effectively disinfect any storage tank installed in a water distribution system. Internal spray mechanisms can facilitate disinfection and rinsing of a storage tank. Water storage tanks for treated water will be designed with sample ports for monitoring bacteria levels.

10.6.4 Water Quality Monitoring

The designer will include instrumentation, meters, and/or gauges to allow for monitoring and alarming of the following water treatment system parameters:

- Temperature
- pH
- Hardness

- Conductivity
- Chlorides
- Pressure drop across filters, membranes, and other components as applicable

10.7 SILVER RECOVERY SYSTEM

10.7.1 Automatic Film Processor

Each automatic film processor, except those serving dental x-rays, will be connected to a central silver recovery system. An exception is that an isolated processor may be served by an individual recovery unit. Silver recovery units are not common for new construction.

10.7.2 Silver Recovery Equipment

Silver recovery equipment is not in the contract and will be furnished by the medical center. This equipment includes a holding tank and silver recovery tanks with platforms, rectifier units with shelf, storage cabinet, and worktable. This equipment will be housed in one room. Coordinate with the medical center.

10.7.3 Pipe Stub

Provide 40 mm [1.5 in.] pipe stub 150 mm [6 in.] above the floor at each automatic film processor to receive silver solution. Where possible, combine the silver solution piping into a single pipe for transport to the holding tank in silver recovery room. Pipe will be capped 1.8 m [6 ft.] above finished floor where the holding tank is scheduled to be installed. Drain pipe will be in accordance with VA Master Specification 22 66 00.

10.8 SHOP COMPRESSED AIR SYSTEM

Provide simplex air compressor to serve equipment and a minimum of one outlet on each wall in shop areas. The shop compressed air system will include intake silencer, filter, after cooler, and receiver. Interior outlets will be no farther apart than 7.6 m [25 ft.].

10.9 THERAPEUTIC POOL EQUIPMENT

10.9.1 Water Treatment System

Follow State and Local codes and regulations as well as the Association of Pool and Spa Professionals (APSP) and National Swimming Pool Foundation (NSPF) guidelines.

10.9.2 Pipes and Equipment

Use corrosion-resistant piping and equipment. Identify piping material on drawings.

10.9.3 Filter

Provide high rate 60 to 75 L/min per sq. m [15 to 20 gpm per sq. ft.] of filter surface area sand type, pressure filter.

10.9.4 Water Heater

Simplex shell and water coil heater will have the capacity to heat pool water from 4 to 34 deg C [40 to 94 deg F] in 24 hours with water entering the pool at not more than 49 deg C [120 deg F].

Pool temperature will be maintained between 24 and 27 deg C [75 and 80 deg F] for recreation purposes and between 30 and 34 deg C [86 and 94 deg F] for therapeutic purposes. Perform a life cycle cost analysis to determine best water heating solution (i.e., solar, heat pump, energy recovery, etc.).

10.9.5 Disinfection

Feed calcium hypochlorite solution into pool with influent water by adjustable pump to maintain a free chlorine residual level between 1.0 and 3.0 mg/L [1.0 and 3.0 ppm] or as required by Authorities Having Jurisdiction (AHJ).

10.9.6 pH Balancing

pH will be maintained between 7.2 and 7.8, with 7.4 to 7.6 pH being the ideal range.

10.9.7 Recirculating Pump

Pump will have the capacity to re-circulate entire contents of pool in 6 hours.

10.9.8 Equipment Room

Locate pool equipment in enclosed space one floor below pool room elevation or in an enclosed underground vault for pools on grade. Entrance to pool equipment room should be from pool apron and be lockable. The pool equipment room should include interior light, sump pump and access ladder.

10.9.9 Vacuum Cleaning Equipment

VA medical center will provide portable vacuum cleaning equipment. Do not design pool re-circulating pump for cleaning.

10.10 LAUNDRY

10.10.1 Laundry Equipment

All laundry equipment, including water treatment and heaters, is provided by the medical center unless noted otherwise. Provide utilities to serve the laundry equipment and toilet areas. The water supply for laundry use will be provided with a meter.

Laundry equipment heaters are designed and provided by separate contract (VA will furnish and install in conjunction with laundry equipment). The remainder of the laundry building will be served with a simplex heater as described in Article 4.2.4 Water Heaters for Non-Patient Care Buildings.

10.10.2 Floor Sinks and Floor Drains

Provide a minimum of one floor sink and one floor drain for the laundry facility, regardless of size.

10.10.3 Dedicated Sump

For laundry facilities or rooms with more than three washing machines, provide a dedicated sump with duplex grinder pumps in a lead lag configuration with each pump sized for 100 percent of the load. The sump discharge would then be hard piped into the sanitary sewer.

10.11 WATER SOFTENING SYSTEM

10.11.1 Softener

Design vertical, pressure-type, sodium cycle water softeners to comply with the following and Master Specification 22 31 11, WATER SOFTENERS. Regeneration will occur no more than once per day. Provide full size bypass. Size water softener as recommended in ASPE Data book, Volume 4, Plumbing Components and Equipment.

10.11.2 When required

(a) **Entire medical center:** Provide softening equipment when total hardness exceeds 170 mg/L [170 ppm] as CaCO3. Blend equipment effluent to a hardness of approximately 50 mg/L [50 ppm]. Design triplex softeners, each furnishing 50% of the maximum flow rate and exchange capacity. Provide a hard water bypass.

(b) **Steam cooking equipment:** Provide softening equipment when total hardness exceeds 30 mg/L [30 ppm]. Design simplex softener and a hard water bypass. Locate regeneration alarm in the office of dietitian.

(c) **Hot-water supply:** Provide softening equipment when total hardness exceeds 50 mg/L [50 ppm]. Design triplex softeners, each furnishing 50% of the maximum flow rate at an exchange capacity required for peak boiler feed-water make-up. Locate regeneration alarm in office of boiler plant operator.

(d) **Pretreatment to reverse osmosis package.** Refer to Article 10.4 and 10.12.

10.11.3 Salt Storage

When softened water is needed for the entire medical center, a storage facility with exterior access will be provided. Ensure total capacity is large enough to accommodate a three-month supply of salt. Locate the salt storage facility adjacent to a service road, preferably adjacent to the softener room.

When soft water is required for dietetic or boiler use, designate/reserve interior floor space in the dietetics storage areas for 180 kg [400 pounds] of salt near softeners.

10.11.4 Dealkalizing Equipment

As water analysis dictates, design a single chloride-anion pressure-type water-dealkalizing tank for boiler feed-water make-up to follow water softening equipment. Provide soft water bypass. System will comply with Master Specification 22 67 21, Water Dealkalizing System and the following.

10.11.5 Dealkalizer Tank

Dealkalizer Tank will provide 113 L/min [30 gpm] maximum flow rate with a capacity of 37,850 L [10,000 gallons] per day to reduce alkalinity to 20 mg/l [20 ppm].

10.11.6 Brine and Caustic Soda Tanks

Design a separate measuring tank of sufficient size to furnish amount of saturated salt and caustic soda solution required for one regeneration. Caustic soda will be approximately 10% by weight of total solution. Designate interior floor space for caustic storage.

10.11.7 Miscellaneous

Locate regeneration alarm bell in boiler plant office in addition to the alarms mentioned in Article 10.11.2.

Provide emergency shower and eye/face wash (P-707) adjacent to equipment.

10.12 REAGENT GRADE WATER SYSTEMS

10.12.1 Floor Space for Central Reagent Grade Equipment

As water analysis dictates, provide floor space for central reagent grade equipment. Design the piping system from the equipment room to the outlets. Equipment (pretreatment, reverse osmosis, buffer tank, deionizer, or a combination) will be furnished as part of the project for every significant upgrade or new installation project. Design piping to provide continuous loop to within 150 mm [6 inches] of outlet, or to the base of the faucet.

10.12.2 Floor Space for Regenerant Chemicals

Assign floor space for storing 30 days' supply of regeneration chemicals.

10.12.3 Emergency Shower and Eye/Face Wash

Provide emergency shower and eye/face wash in equipment room.

10.12.4 Chemical-Resistant Piping and Drains

Provide chemical resistant piping and drains in accordance with VA Master Specification Sections 22 66 00, Chemical-Waste Systems for Laboratory and Healthcare Facilities and 22 11 00, Facility Water Distribution.

10.13 PLUMBING FOR PARKING STRUCTURES

10.13.1 Water Distribution Systems

In locations subject to freezing, domestic water piping will be designed to allow pipes to be drained down to avoid freezing conditions. Provide a drain valve at the low point of the system.

Provide exterior non-freeze wall hydrants to be used for minimal irrigation, cleaning walks, etc. Locate wall hydrants a maximum of 61 m [200 ft.] apart, with a minimum of one wall hydrant on each exterior wall.

10.13.2 Storm Drainage Systems

Drainage calculations will be based on a 100-year, 1-hour rainfall rate (inches) per the International Plumbing Code (IPC) or as required by local code. Use trench drains and/or type "Y" floor drains with sediment buckets.

Provide all needed water quality measures such as sand/oil separation as required by the local authorities having jurisdiction (AHJ).

---END OF SECTION---

11 APPENDIX A: VA HOSPITAL BUILDING SYSTEM

11.1 DESCRIPTION OF MODULES

11.1.1 Introduction

The Redbook proposes a systematic or modular approach to the design of new hospital buildings where building systems are integrated into the planning modules from the start. Service modules are defined as one-story units of building volume with a footprint of approximately 930 square meters (sq. m) [10,000 square feet (sq. ft.)]. More recent designs have used service modules in the range of 1,860 sq. m [20,000 sq. ft.]. Each module is comprised of structural bays, a service zone, and a functional zone (often subdivided into space modules). Each service module is completely self-contained or combined with one or more other modules in a fire compartment.

11.1.2 Structural Bays

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

11.1.3 Service Zones

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.

11.1.4 Functional Zones

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

11.1.5 Fire Compartmentation

A fire compartment is a unit of area enclosed by a two-hour rated fire-resistant construction on all sides, from which there are at least two different exits.

11.1.6 Plumbing Utilities

The Redbook describes the plumbing supply and return risers being grouped together at one end of the service bay.

The horizontal sanitary waste pipes drain toward the service bays and connect to two or more waste stacks located in the service bay.

The storm drain follows the same concept as the sanitary waste.

11.2 ZONING OF PLUMBING SYSTEMS

The water heaters are centrally located in one or more equipment rooms in a location prescribed in the physical security manuals for Mission Critical or Life Safety Protected facilities.

The medical air, oxygen, and medical vacuum systems are usually located at the medical center's central utility building or basement mechanical room in a location prescribed in the physical security manuals for Mission Critical or Life Safety Protected facilities.

11.3 REFERENCES

1 Development Study-VAHBS (Red Book – revised 1976)
2 Supplement to Development Study (2006)

---END OF APPENDIX---

12 APPENDIX B: COMPUTER AIDED FACILITIES MANAGEMENT (CAFM)

12.1 CAFM AND EQUIPMENT SCHEDULE UTILIZATION

12.1.1 Introduction

The requirement for access to a master digital database drives the need to compile all A/E design data (not limited to plans, specifications, calculations, equipment selection, equipment submittal, commissioning/balance reports, and job-related communications), whether in letter or email format, in a digital, electronic format from the very start of a project. Thus, this need for digital data will affect the requirements for submission (see Design Submission Requirements).

12.1.2 Submission Requirements

While VA may not have determined the complete software architecture defined yet for the ultimate CAFM configuration, the A/E is to begin the digital submission process now.

12.1.3 Electronic Documentation

The electronic documentation and copies of the calculations, equipment selections, operations and maintenance manual, approved submittals, shop drawings, and other closeout documentation will be prepared by a computer software program complying with Section 508 of the Rehabilitation Act of 1973, as amended (29 U.S.C 794d). The manufacturer or vendor of the software used to prepare the electronic documentation will have a Voluntary Product Accessibility Template (VPAT) made available for review by VA and included as part of the submittal requirements. All available accessibility functions listed in the VPAT will be enabled in the prepared electronic files. Because Adobe Acrobat is a common industry format for such documentation, it is recommended that the A/E review and follow as a minimum requirement the document "Creating Accessible Adobe PDF files, A Guide for Document Authors", that is maintained and made available by Adobe free of charge.

12.1.4 Schedules

(a) The equipment and other schedules that previously appeared in the VA Technical Information Library (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 will be downloaded for use.

(b) The schedules all have a similar layout for consistent data presentation. Notes for special requirements are listed below. Positioning the cursor over column headings will cause pop-up notes to appear which contain recommended methodologies for determining the information to be input into that column. Columns may be hidden for use later in the design/construction process, and throughout the life of the equipment. The first few hidden columns will be filled out by the contractor and include data such as the equipment make, model and serial numbers. Other columns will be filled out by the test and balance agent and include the belt and sheave information.

(c) Initial use of the schedules is 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 hidden columns can be revealed by the facilities management group for their purposes.

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

(e) The Excel schedule files and CAFM data will formalize version tracking throughout all successive iterations.

---END OF APPENDIX---

13 APPENDIX C: A/E SUBMISSION REQUIREMENTS AND PLUMBING DESIGN MANUAL COORDINATION

13.1 GENERAL

13.1.1 Introduction

In this appendix, specific tasks outlined in the A/E Submission Instructions, Volumes B, C, D, E and F, (Program Guide, PG-18-15) 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.

13.1.2 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 prior approval by VA Authorities.

13.1.3 Compliance Requirements

For each submittal, the A/E will forward to the VA Authorities a detailed list of the submission requirements with notations indicating full or partial compliance. The list will also detail the A/E's justification for any deviation from the requirements.

13.1.4 BIM Requirements

See The VA BIM Guide available on CFM's TIL.

13.1.5 Specific Drawing Requirements

Where applicable, the contract drawings will include those listed below. For uniformity, drawings will be arranged in the order listed. See the VHA National CAD Standards (NCS) Application Manual for more organization detail.

- PP – 0xxx General Notes, Abbreviations, and Symbols (VA-Compliant)
- PD – 1xxx Demolition of Existing Plumbing Work, Floor Plans, If Applicable. Minor Demolition May Be Shown on New Construction Drawings. Extensive Demolition Requires Drawings for Demolition Only
- PS – 1xxx Plumbing Site Plan
- PP – 1xxx Plumbing Supply Distribution, Cold-Water, Cold-Water Return, Hot Water, Hot Water Return, Medical Air, Vacuum, Gas, Softened Water, Filtered Water, RO, and DI Water
- PP – 2xxx Plumbing Piping Large-Scale Partial Plans of Kitchens, Laboratories, Bathrooms, Restrooms, and Other Areas with Dense Plumbing Services and Connections
- PP – 3xxx Plumbing Piping Riser Diagrams, Sections for Supply and Return Piping
- PP – 4xxx Plumbing Standard Details (VA-Compliant)
- PP – 5xxx Plumbing Standard Schedules (VA-Compliant)
- PP – 6xxx Plumbing Flow Diagrams for Medical Air, Medical Vacuum, and RO Systems

- PP – 7xxx Plumbing System Control Diagrams, Sequence of Operations, and Points Lists
- PL – 1xxx Plumbing Waste, Drain, and Vent Piping
- PL – 2xxx Plumbing Waste, Drain, and Vent Isometrics

Room numbers and names will be shown on the plumbing plans at every review stage, including schematic submission. Where there is insufficient room on the plan view to show room names, room numbers only may be shown on the plan, with the room number and name tabulated on the drawing.

13.1.6 Equipment Schedules

Where used, equipment schedules will be listed in the following order, vertically, from right to left, to facilitate checking and future reference. The schedules would be placed on the sheet starting at the right edge of the sheet since the drawing set in bound on the left side. Refer to Appendix 12-B for equipment schedule utilization. For each item in a schedule, show the basis of design, including the manufacturer and model number selected. Include information e.g., the basis of design in a bound submission and organized by section as described in the chart at the end of this Appendix.

- Plumbing Fixture Schedule
- Water Filter Schedule
- Water Softener Schedule
- Domestic Water Thermal Expansion Tank Schedule
- Plumbing Pump Schedule
- Plumbing Package Booster Pump Schedule
- Storage Tank Schedule
- Electric Water Heater Schedule
- Gas-Fired Water Heater Schedule
- Steam to Hot Water Heat Exchanger Schedule
- Liquid to Liquid Heat Exchanger Schedule
- Storage Tank with Heat Exchanger Schedule
- Steam Booster Hot Water Heat Exchanger Schedule
- Packaged Reverse Osmosis Schedule
- Deionization Package Schedule
- Gas Pressure Regulator Schedule
- Food Service Steam/Gas Demand Schedule
- Equipment Connection Schedule
- Compressor Air System Schedule
- Vacuum Pump System Schedule
- Gas Manifold Systems
- Vibration Isolation Schedule

13.1.7 Schematic Design Level 1 (SD1) Submission Requirements

The following describes the submission requirements for schematic level 1 (SD1) in addition to requirements listed in PG 18-15 Vol. B for Major Projects, and Vol. C for Minor and NRM Projects.

(a) **Code Review, Summary:** Perform a code review summary narrative, including requirements for grease traps and storm water management systems. The International Plumbing Code (IPC) will be used.

(b) Based on schematic design level 1 architectural programming information, create a schematic design level SD1 fixture count schedule. For specialized fixtures and equipment, obtain maximum instantaneous flow rates. Obtain SD1 level maximum instantaneous flow rates for items such as landscaping (if supplied by building water), cooling tower, and mechanical equipment makeup. Calculate the SD1 level water supply fixture unit water load and convert it to gallons per minute (gpm) flow rate.

For renovation projects, the plumbing engineer will submit a narrative describing the existing plumbing utilities and services and making recommendations for replacement or reconditioning of fixtures.

For all projects, conduct a formal meeting with operations staff to determine the capacity for medical center campus medical air, vacuum, and other specialized services.

Prepare a utility study that summarizes the available capacity of all utilities and services required for the project. Interviews and anecdotal evidence will not form the basis for engineering decision making. Tests will be conducted to determine available utility capacity.

The utility study should include design decisions for the type of sensor operated faucets, scope of safety showers, eyewash stations, etc. The scope for demolition will be defined in the study. The status of salvaged equipment, owner furnished equipment, owner installed equipment, pre-purchased equipment, seismic requirements, and PG-18-13 Barrier Free Design Guide requirements.

13.1.8 Schematic Design Level 2 (SD2) Submission Requirements

The following describes the submission requirements for schematic design level 2 (SD2) in addition to requirements listed in PG 18-15 Vol. B for Major Projects, and Vol. C for Minor and NRM Projects.

- Identify zones where acid waste would be installed.

13.1.9 Design Development Level 1 (DD1) Submission Requirements

The following describes the submission requirements for Design Development level 1 (DD1) in addition to requirements listed in PG 18-15 Vol. B.

(a) On plumbing plans, identify locations where utilities enter building and where sanitary sewer & storm sewer will exit the building.

(b) Prepare discipline coordination document provides the following information to other design team members:

- Natural gas loads to Civil Engineer
- Building service water line size and water supply fixture unit totals to Civil Engineer.

- Building sanitary and storm sewer line size and waste fixture unit totals to Civil Engineer
- Plumbing equipment electrical requirements to Electrical Engineer
- Oxygen demand to Medical Center
- Medical gas and vacuum demand to Medical Center
- Compressed air demand to Medical Center
- Space requirements to Architect
- Available water makeup line location to Mechanical Engineer
- EMCS point data to Mechanical Engineer

13.1.10 Design Development Level 2 (DD2) Submission Requirements

The following describes the submission requirements for Design Development level 2 (DD2) in addition to requirements listed in PG-18-15 Vol. B for Major Projects, and Vol. C for Minor and NRM Projects.

(a) Update design narrative to reflect building programming changes.
(b) On plumbing plans, update sources for medical air, gas, and vacuum from DD1.
(c) On plumbing plans, update locations where utilities enter building and where sanitary sewer & storm sewer will exit the building.

(d) Submit outline specifications with important notes specific to the project.

13.1.11 Construction Document Level 1 (CD1) Submission Requirements

An updated design narrative that addresses comments from the design development level 2 (DD2) in addition to requirements listed in PG 18-15 Vol. B for Major Projects, and Vol. C for Minor and NRM Projects.

Complete plumbing plans that include the following data:

- Completed and cross-referenced water supply riser diagrams with room numbers, plumbing fixtures, and equipment identified.
- Plumbing specifications based upon a redlined set of VA Master Specifications. The redlined set will clearly identify modifications, deletions, and insertions. All deviations from the master specifications will be submitted to the VA Authorities for approval with explanations for the deviations.

Binder Division	Submission Requirements
Tab 1	Building service water pipe size calculations. Peak building water demand calculation.
Tab 2	Pressure zone design calculations
Tab 3	Cold water (potable, laboratory, and industrial) pipe size calculations.
Tab 4	Hot water pipe size calculations.

Binder Division	Submission Requirements
Tab 5	Water softening equipment demand and pipe size calculations. Basis of design equipment selection, cut-sheets.
Tab 6	Reverse osmosis equipment demand and pipe size calculations. Basis of design equipment selection, cut-sheets.
Tab 7	Water demineralization (deionization equipment demand calculations.
Tab 8	Hot water re-circulating and boosters pump size calculation. Pump basis of design cut-sheet and pump curves.
Tab 9	Hot water generation calculations, heat exchanger equipment size calculations, and hot water storage calculations. Hot water generation and heat exchanger equipment cut-sheets and basis of design. Include domestic solar water heating calculations.
Tab 10	Thermal expansion, hot water storage, and pure water buffer tank size calculations.
Tab 11	Booster heater demand calculations for areas such as Dietetics. Basis of design hot water generation and heat exchanger equipment selection cut-sheets.
Tab 12	Therapeutic pool (filtering and heating demand calculations).
Tab 13	Soil, waste, and vent pipe size calculations.
Tab 14	Storm drainage pipe sizing calculations with roof or drainage areas identified.
Tab 15	Grease, hair, oil interceptor size calculations. Interceptor basis of design equipment selection and cut-sheets.
Tab 16	Sump pump system design calculations, sump basis of design equip. selection and cut-sheets.
Tab 17	Fuel gas pipe sizing.
Tab 18	Medical vacuum demand, pipe size, and equipment size calculations. Medical vacuum basis of design equipment selection, cut-sheets.
Tab 19	Medical air demand, pipe size, and equipment size calculations. Medical air basis of design equipment selection, cut-sheets.
Tab 20	Oxygen storage demand and pipe size calculations.
Tab 21	Shop and lab compressed air pipe size calculations. Air compressor basis of design equipment selection, cut-sheets.
Tab 22	Shop and lab vacuum pipe size calculations. Vacuum pump basis of design equipment selection, cut-sheets.

Binder Division	Submission Requirements
Tab 23	Nitrogen and other compressed gas storage demand and pipe size calculations.
Tab 24	Nitrous oxide pipe size calculations.
Tab 25	Oral evacuation and dental system calculations, basis of design equipment selection, cut-sheets.
Tab 26	Silver recovery piping.

---END OF APPENDIX---

14 APPENDIX D: SCHEMATIC DIAGRAMS

14.1 INTRODUCTION

In this Appendix, typical diagrams of plumbing equipment and systems are provided. Coordinate mixing valve and heater piping requirements with manufacturer’s requirements.

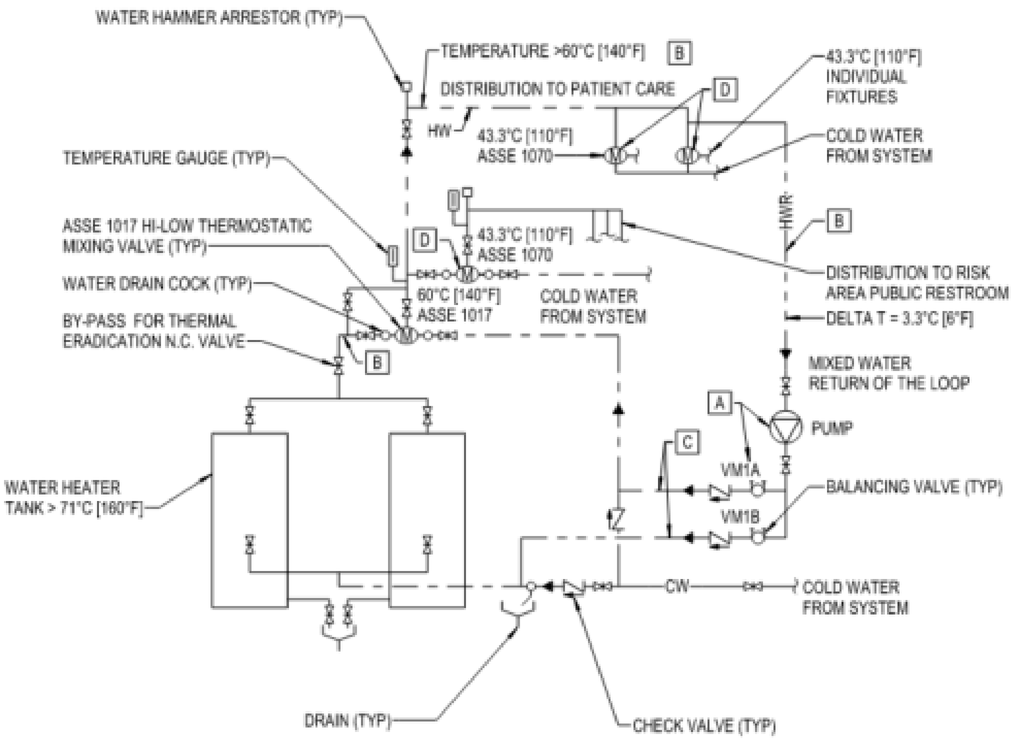
14.1.1 Master Thermostatic Mixing Valve

KEY POINTS OF THE RECIRCULATION:

- A USE OF RECIRCULATION SYSTEMS: CIRCULATING LOOP AND BALANCING VALVES.
- B ENSURE THAT THE TARGET TEMPERATURE IS ACHIEVED THROUGHOUT ALL LEVELS OF THE LOOP.
- C MIXING OF HWR WITH CW ENSURES PROPER FUNCTION OF 1017 MIXING VALVE IN ACCORDANCE WITH MANUFACTURERS RECOMMENDATION.
- D MIXING VALVES MUST BE AS CLOSE AS POSSIBLE TO THE POINT OF USE.

NOTES:

VM: BALANCING VALVE TO STABALIZE CIRCUIT TEMPERATURE.
VM1A: OPEN BETWEEN 70 AND 90% OR MANUFACTURER'S INSTRUCTIONS.
VM1B: OPEN BETWEEN 30 AND 10% OR MANUFACTURER'S INSTRUCTIONS.

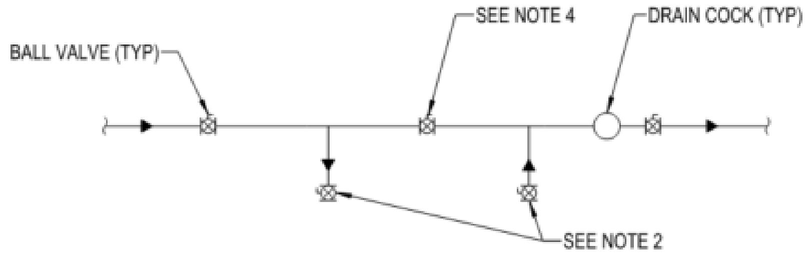


NOTES:

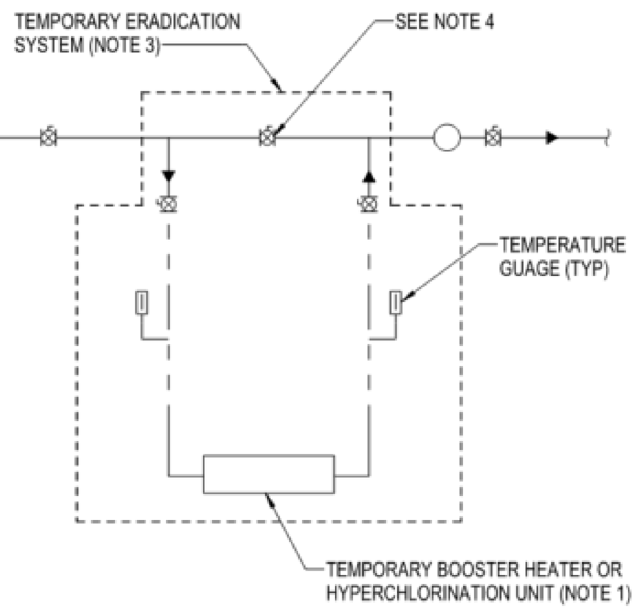
MIXING VALVES MUST ALLOW EASY CLEANING AND DISINFECTION OPERATION.
- DISMANTLE AND CLEAN HOSES, SHOWERHEADS AND MIXING VALVES ONCE A YEAR.
- HOT AND COLD WATER DISTRIBUTION PIPES MUST BE INSULATED IN ACCORDANCE WITH SECTION 220711.
-REFER TO MASTER MIXING VALVE MANUFACTURER'S INSTALLATION GUIDELINES.

***ENTIRE HOT WATER DISTRIBUTION SYSTEM SHOULD BE SET AT 140° F. MASTER MIXING VALVE WOULD ONLY BE REQUIRED IF HEATER HAD TO PROVIDE OUTLET TEMPERATURE AT 160° F DUE TO SIZE LIMITATIONS. HOT WATER IN THE DISTRIBUTION SYSTEM AT 140°F PROVIDES A BACTERIA "KILL ZONE" IN 32 MINUTES AT THIS TEMPERATURE. THIS ALSO ELIMINATES A EXPENSIVE ITEM (MASTER MIXING VALVE) AND MAINTENANCE COSTS OUT OF THE SYSTEM. MIXING VALVES ARE ALREADY REQUIRED AT ALL POINT OF USE PLUMBING FIXTURES FOR SCALD PREVENTION. THE 140° F DISTRIBUTION SYSTEM ALSO ESSENTIALLY PROVIDES A VOLUME OF STORED HOT WATER SIMILAR TO A TANK.

14.1.2 Temporary Eradication System Connection



TYPICAL HOT WATER SYSTEM NORMAL OPERATION

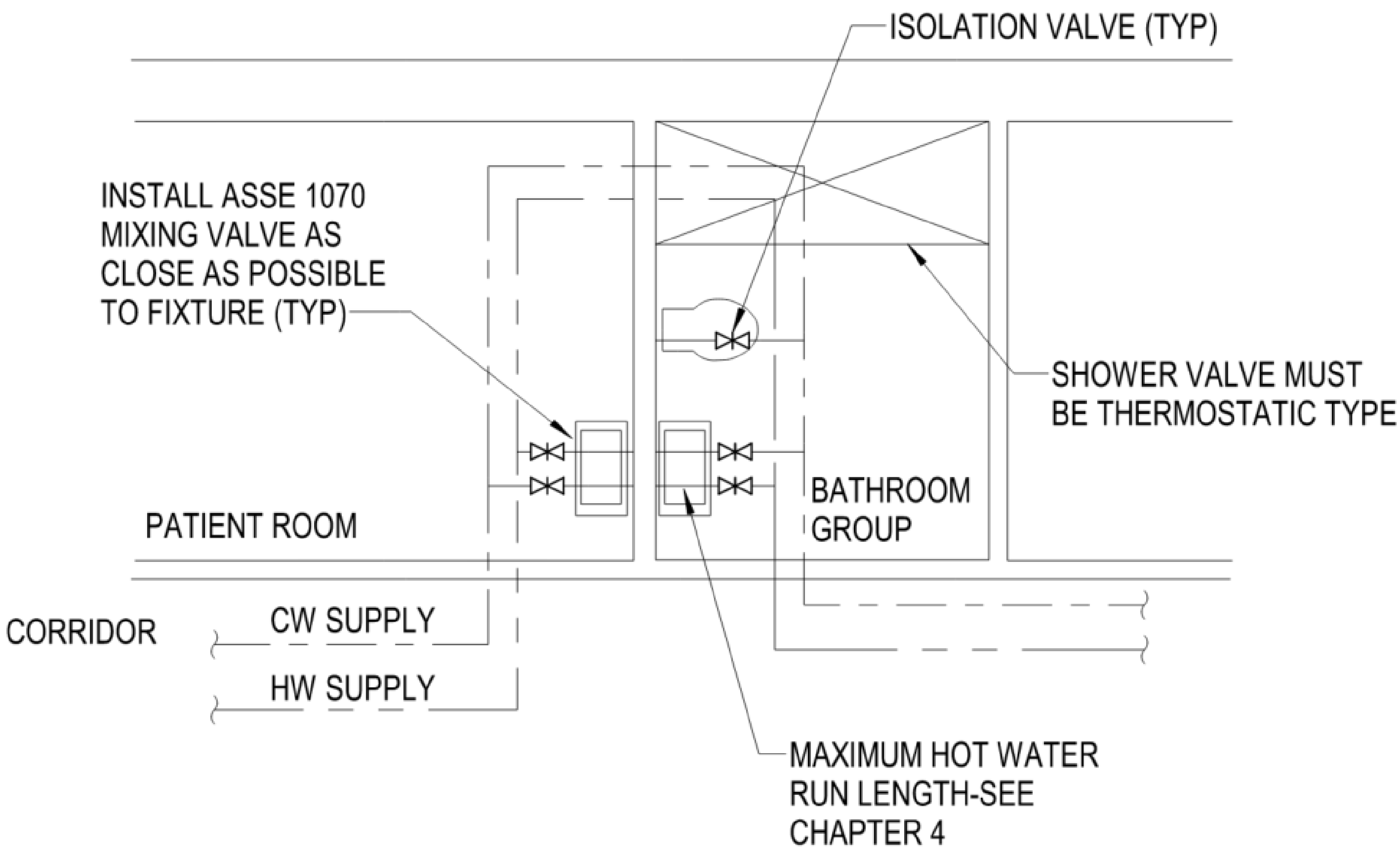


TYPICAL HOT WATER SYSTEM WITH TEMPORARY ERADICATION SYSTEM

NOTES:

1. COORDINATE ELECTRICAL POWER REQUIREMENTS. PROVIDE DISCONNECT AND JUNCTION BOX FOR TEMPERATURE CONNECTION.
2. PROVIDE LINE SIZE TAKE OFF AND VALVES. VALVES MUST BE PLACED NO FURTHER THAN 2 PIPE DIAMETERS FROM THE MAIN.
3. MINIMIZE RUNOUT LENGTH OF TEMPORARY PIPING.
4. VALVE MUST BE CLOSED DURING SYSTEM THERMAL ERADICATION AND OPEN DURING NORMAL OPERATION.

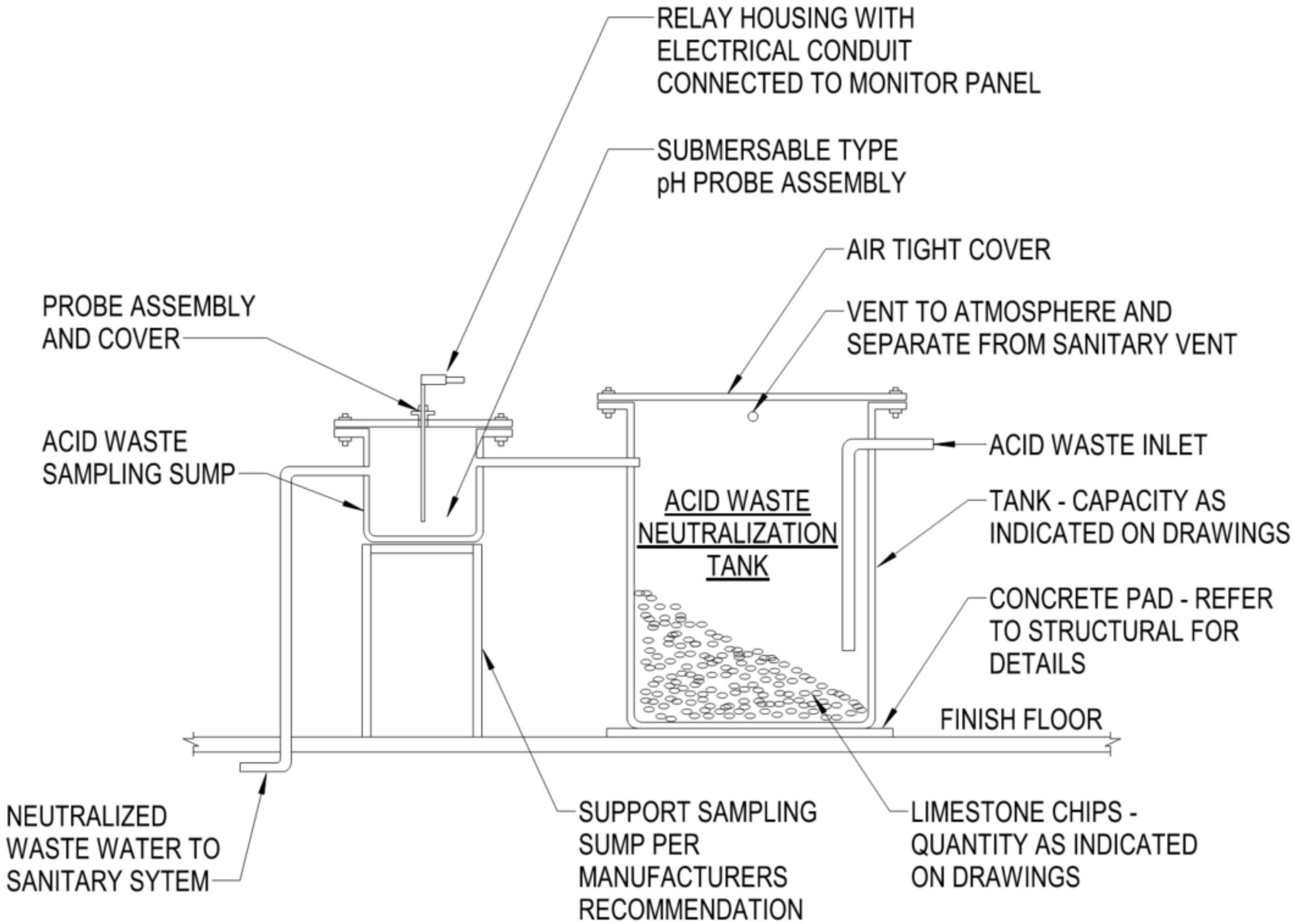
14.1.3 Cold Water / Hot Water Connection of Plumbing Fixture



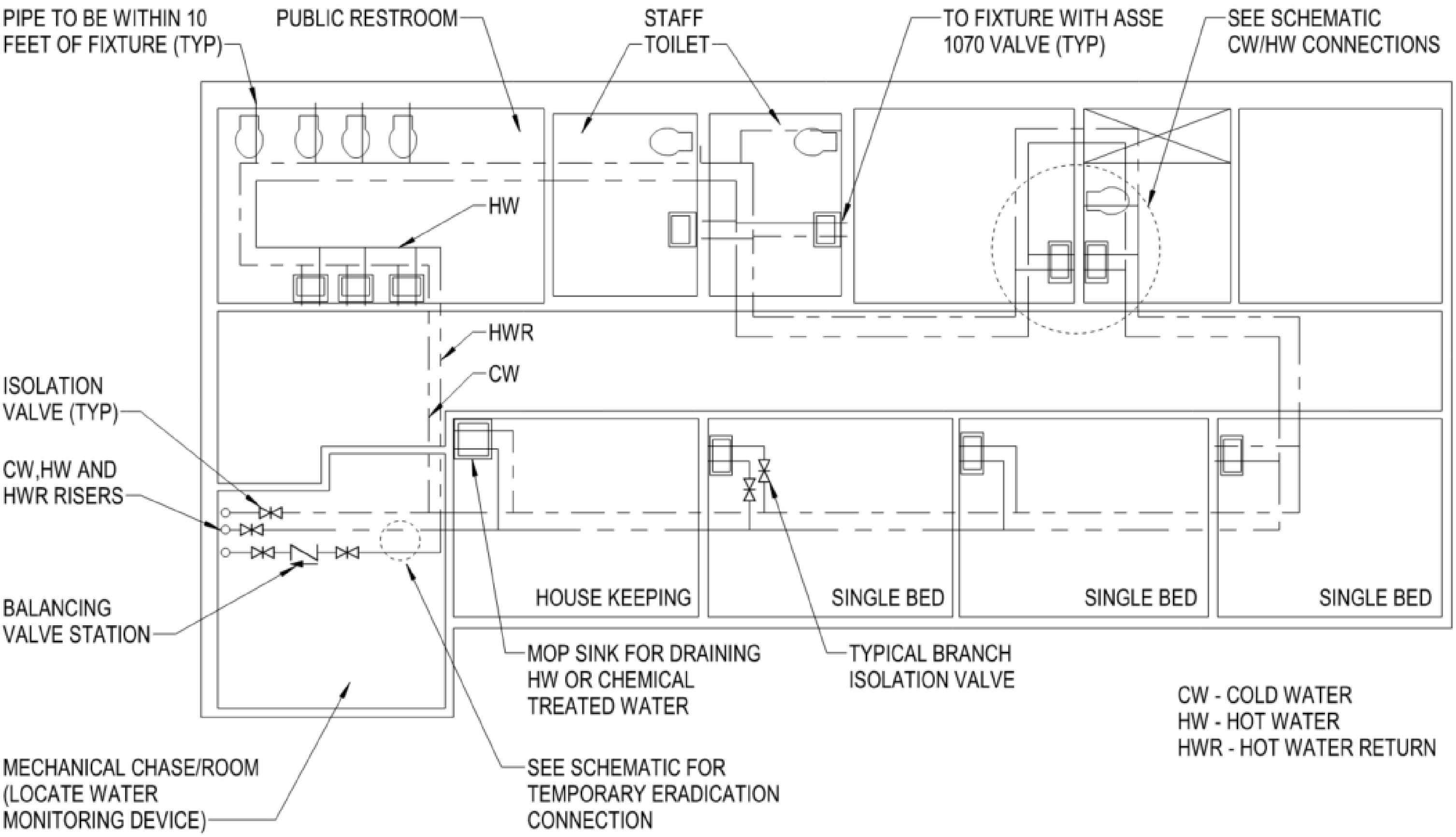
NOTES:

1. MINIMIZE COLD AND HOT WATER FIXTURE RUN-OUT DISTANCE BY LOCATING HOT AND COLD WATER MAINS AS CLOSE AS PRACTICAL TO THE FIXTURES.

14.1.4 Acid Waste Neutralization System



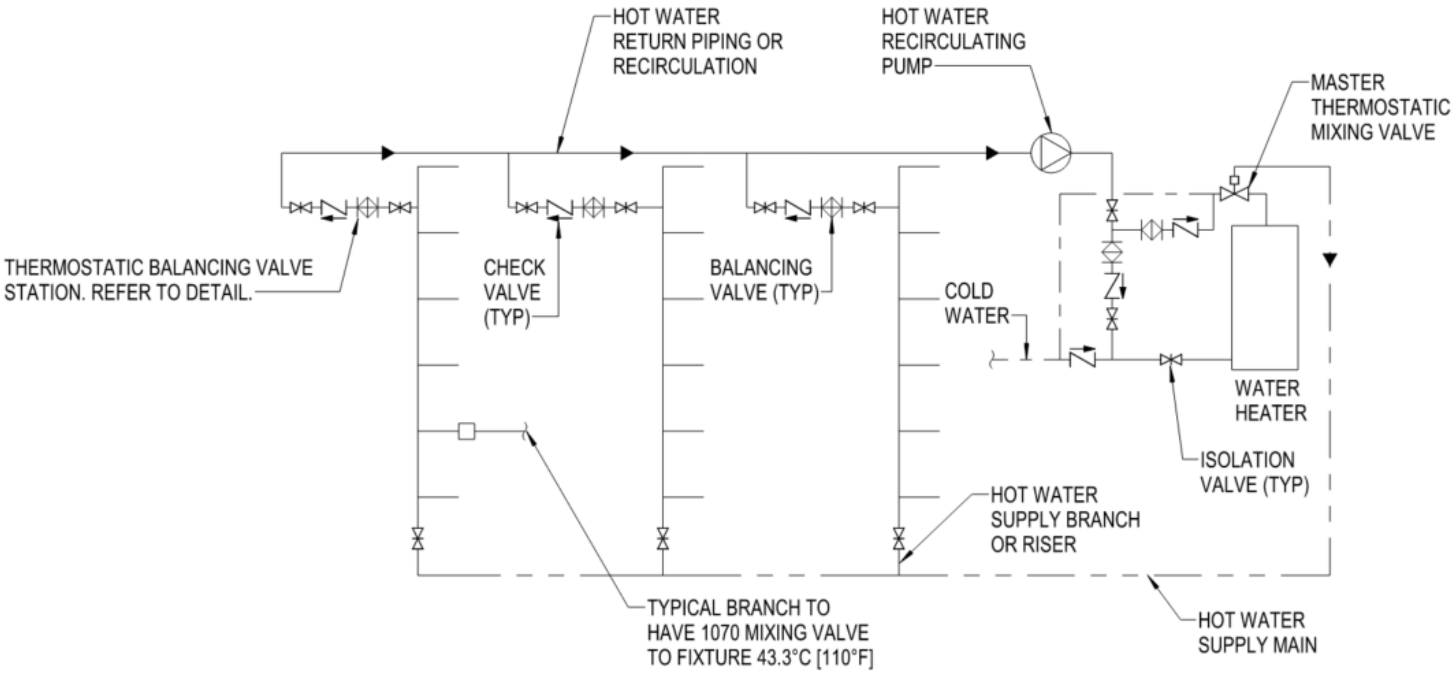
14.1.5 Hot Water / Hot Water Return Pipe Routing in a Typical Ward



NOTES:

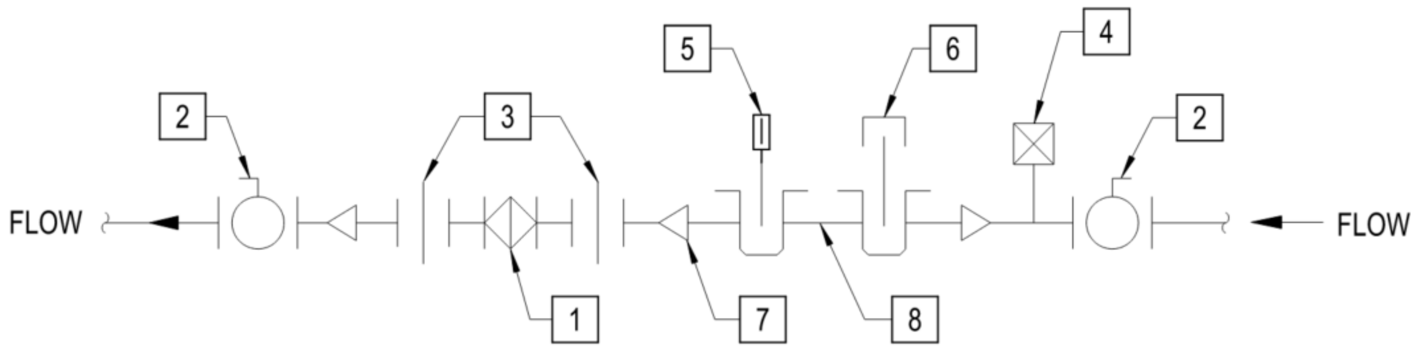
1. PROVIDE ENGINEERING WITH ABILITY ABILITY TO ISOLATE SECTIONS FOR ERADICATION.
2. VALVES ALLOW WARD TO BE ISOLATED FROM REST OF POTABLE WATER SYSTEM.

14.1.6 Hot Water Circulation with Master Thermostatic Mixing Valve



***ENTIRE HOT WATER DISTRIBUTION SYSTEM SHOULD BE SET AT 60°C [140° F]. MASTER MIXING VALVE WOULD ONLY BE REQUIRED IF HEATER HAD TO PROVIDE OUTLET TEMPERATURE AT 71°C [160°F] DUE TO SIZE LIMITATIONS. HOT WATER IN THE DISTRIBUTION SYSTEM AT 60°C [140°F] PROVIDES A BACTERIA "KILL ZONE" IN 32 MINUTES AT THIS TEMPERATURE. THIS ALSO ELIMINATES A EXPENSIVE ITEM (MASTER MIXING VALVE) AND MAINTENANCE COSTS OUT OF THE SYSTEM. MIXING VALVES ARE ALREADY REQUIRED AT ALL POINT OF USE PLUMBING FIXTURES FOR SCALD PREVENTION. THE 60°C [140° F] DISTRIBUTION SYSTEM ALSO ESSENTIALLY PROVIDES A VOLUME OF STORED HOT WATER SIMILAR TO A TANK.

14.1.7 Thermostatic Balancing Valve



NOTES: #

(THERMOSTATIC BALANCING VALVE DETAIL ONLY)

1. THERMOSTATIC BALANCING VALVE WITH INTEGRAL STRAINER AND CHECK VALVE. MATCH LINE SIZE OR PROVIDE MINIMUM 3/4".
2. FULL PORT BALL VALVE.
3. UNION.
4. PRESSURE TEST PLUG.
5. THERMOMETER.
6. PLUGGED 3/4" FIP ADAPTER FOR BUILDING MANAGEMENT SYSTEM SENSOR CONNECTION.
7. REDUCER FOR LINE SIZE ADJUSTMENT (IF REQUIRED), TYPICAL.
8. PIPE SECTION MUST BE 2" TO ACCOMMODATE THERMOWELLS IN FLOW.

---END OF APPENDIX---

15 APPENDIX E: SERVICE PIPE SCHEDULE

15.1 PIPE SERVICE, MATERIAL, FITTINGS AND JOINTS

SERVICE	FIBERGLASS FILAMENT WOUND	SCHED 40 BLACK STEEL	CAST IRON –HUB & SPIGOT	CAST IRON –NO HUB	DUCTILE IRON AWWA C151	CPVC CHEMICAL WASTE	SCHED 80 PVC	SCHED 40 PVC	POLYPROPYLENE (FUSION JOINT)	COPPER TYPE K	COPPER TYPE L	COPPER DWV ASTM B 306	CHROME PLATED BRASS	STAINLESS STEEL ASTM A269	STAINLESS STEEL ASTM 312	STAINLESS STEEL 316	POLYETHYLENE TUBING	PVDF	GALVANIZED STEEL	HIGH SILICON IRON	BOROSILICATE GLASS PIPE (BSG)
FACILITY WATER DISTRIBUTION																					
SERVICE CONNECTIONS TO BLDG ≥3” (NOTE 1)					X																
SERVICE CONNECTIONS TO BLDG <3” (NOTE 1)										X											
INTERIOR DOMESTIC WATER PIPING (NOTE 1)										X	X										
INTERIOR DOMESTIC WATER PIPING >6” (NOTE 1)															X						
TRAP PRIMER WATER PIPING (NOTE 1)										X											
EXPOSED PIPING IN FINISHED ROOMS (NOTE 1)													X								
FACILITY SANITARY AND VENT PIPING																					
CAST IRON DWV BELOW GRADE, ABOVE GRADE, AND 5’ OUTSIDE OF BUILDING (NOTE 2)			X	X																	
COPPER DWV – ABOVE GROUND (NOT URINAL DRAIN) (NOTE 2)												X									
PVC DRAIN PIPE (EXCEPT AS INDICATED IN PARA. 2.1) (NOTE 2)								X													
PUMP DISCHARGE PIPING (NOTE 2)											X								X		
EXPOSED PIPING IN FINISHED ROOMS (NOTE 2)													X								

SERVICE	FIBERGLASS FILAMENT WOUND	SCHED 40 BLACK STEEL	CAST IRON –HUB & SPIGOT	CAST IRON –NO HUB	DUCTILE IRON AWWA C151	CPVC CHEMICAL WASTE	SCHED 80 PVC	SCHED 40 PVC	POLYPROPYLENE (FUSION JOINT)	COPPER TYPE K	COPPER TYPE L	COPPER DWV ASTM B 306	CHROME PLATED BRASS	STAINLESS STEEL ASTM A269	STAINLESS STEEL ASTM 312	STAINLESS STEEL 316	POLYETHYLENE TUBING	PVDF	GALVANIZED STEEL	HIGH SILICON IRON	BOROSILICATE GLASS PIPE (BSG)
FACILITY STORM DRAINAGE																					
CAST IRON PIPE BELOW GRADE, ABOVE GROUND, AND 5' OUTSIDE OF BUILDING (NOTE 3)			X	X																	
COPPER DWV – DRAINAGE ABOVE GROUND (NOTE 3)										X											
STORM SEWER PIPE FOR SINGLE STORY (NOTE 3)								X													
PUMP DRAIN < 4" (NOTE 3)										X	X										
PUMP DRAIN PIPING > 4" (NOTE 3)																			X		
ROOF DRAIN WITH CLAMPING DEVICE (NOTE 3)				X																	
GENERAL SERVICE COMPRESSED AIR																					
PIPE, TUBE, AND FITTINGS (NOTE 4)										X	X										
CHEMICAL WASTE SYSTEMS LAB & HEALTH CARE FACILITIES																					
CHEMICAL WASTE & VENT PIPING IN LAB & SPD (NOTE 5)						X			X							X		X		X	X
ETO PIPING BUTT WELDED JOINTS AND FITTINGS (NOTES 1 & 5)															X						
SILVER RECOVERY (ASTM D2665) (NOTE 5)								X													
REVERSE OSMOSIS WATER EQUIPMENT																					
LOW PRESSURE FEED & RECYCLE PIPING (NOTE 6)							X														
HIGH PRESSURE REJECT & RECYCLING (NOTE 6)														X							
LOW PRESSURE CONTROL & PRESSURE GAUGE (NOTE 1)																	X				

SERVICE	FIBERGLASS FILAMENT WOUND	SCHED 40 BLACK STEEL	CAST IRON –HUB & SPIGOT	CAST IRON –NO HUB	DUCTILE IRON AWWA C151	CPVC CHEMICAL WASTE	SCHED 80 PVC	SCHED 40 PVC	POLYPROPYLENE (FUSION JOINT)	COPPER TYPE K	COPPER TYPE L	COPPER DWV ASTM B 306	CHROME PLATED BRASS	STAINLESS STEEL ASTM A269	STAINLESS STEEL ASTM 312	STAINLESS STEEL 316	POLYETHYLENE TUBING	PVDF	GALVANIZED STEEL	HIGH SILICON IRON	BOROSILICATE GLASS PIPE (BSG)
REAGENT WATER AND DIALYSIS WATER																					
DISTRIBUTION PIPE AND FITTINGS (NOTE 1)									X								X				
FACILITY FUEL SYSTEMS																					
DIESEL FUEL OIL (NOTE 7)	X	X																			
NATURAL GAS SYSTEMS (NOTE 8)		X											X								

NOTES:

(1) See VA Master Specification 22 11 00 for details.
(2) See VA Master Specification 22 13 00 for details.
(3) See VA Master Specification 22 14 00 for details.
(4) See VA Master Specification 22 15 00 for details.
(5) See VA Master Specification 22 66 00 for details.
(6) See VA Master Specification 22 67 19.16 for details.
(7) See VA Master Specification 23 10 00 for details.
(8) See VA Master Specification 23 11 23 for details.

---END OF APPENDIX---

16 INDEX

---END OF INDEX---