Objectives

• Provide a general understanding of plumbing systems within hospitals:

• Identify the major systems in a typical hospital plumbing system.

• Discuss the patient and staff interaction with plumbing systems within a hospital.

• Examine the fixtures and devices that are unique to hospitals.

• Review the design methodology that separates hospitals from other commercial buildings.
WHAT IS A PLUMBING SYSTEM?

PLUMBING SYSTEMS HAVE TO PERFORM THESE BASIC FUNCTIONS:

• BRING CLEAN POTABLE COLD AND HOT WATER TO A FIXTURE.

• REMOVE ANY WASTE WATER DISCARDED BY A FIXTURE.

• COLLECT STORM WATER FROM A ROOF.
Plumbing Systems within a Hospital provide a **Fundamental** Means of Sanitation and Cleanliness to a Hospital or Healthcare Facility – IF DESIGNED CORRECTLY!!!

- Plumbing Provides Clean Water for Patient and Equipment Use
  - Keep water clean once within the building
  - Treat water where required.
- Must Remove all Unwanted Wastes.
  - People “Waste”
  - Equipment Drainage
  - Medical / Laboratory / Special Wastes
- All Must Function Reliably
  - Function over Form
PLUMBING FIXTURES
PLUMBING FIXTURES - PURPOSE

Plumbing Systems and Patient / Building Interaction

• Plumbing Fixtures are the Front Line for Human Interaction with a Plumbing System.
  – Patients
  – Staff
  – Visitors

• Clean and Reliable
• High Performance
• Prevent Infections
PLUMBING FIXTURES – DESIGN CONSIDERATIONS

Durability
• Fixture Material
  – Vitreous China
  – Heavy Gauge Stainless Steel
  – Solid Brass/Bronze
• Fixture Support
  – All Floor Mounted Supports
• Performance
  – Daily Patient Care
  – Daily Cleaning Operations
  – Cost of Fixture Failure
  – Shelf-Stock

Aesthetic
• Mental Healing
  – Individual Patient Rooms
  – Room Décor
  – Technological Amenities

Specification
• Simplicity
  – Up Front Installation Effort
  – Effect to Maintenance Staff
  – Cost to Repair/Replace
PLUMBING FIXTURES – TYPES

Standard Plumbing Fixtures
• Water Closets
• Showers
• Lavatories
• Service Sinks/Mop Receptors

Health Care Fixtures
• Bariatric Water Closets
• Bed Pan Washers
• Exam Sinks
• Surgeon’s Scrub Sinks
• ICU/Patient Care Modules
• Clinical Service Sinks
• Laboratory Sinks
• Nuclear Medicine/Imaging
WATER CLOSETS
Common In Every Building, Water Closets Have Special Considerations In A Hospital.

- Physical Abuse
  - Patients, Family, Wheelchairs
- Harsh Cleaning Chemicals
- Infectious Control Requirements
  - Wall Mounted over Floor Mounted
  - Minimize Crevices
  - Anti-Microbial surfaces and Seat
- Exceptional Performance
  - Paper Towels
  - Remote Locations
- Sleek, Modern Look of Modern Hospital Rooms
  - Water Closet is an Eyesore
LAVATORIES
Hand Washing Is A Fundamental Necessity In Any Healthcare Institution. How Are Hospitals Different?

– Location, location, location and opportunity for infection
  • Public Toilet Rooms
  • Patient Toilet Rooms
– Temperature Control – ASSE 1070
– Used by Staff, Patients, and Family
– Support Patient Weight
– Manual Vs. Automatic
  • John Hopkins Study
  • Hand Washing vs. Multi-Task Sink
  • Hospital Preference??

– Infectious Control Requirements
  • Solid / Anti-Microbial surfaces
  • Minimize Splashing / Sink Design
  • Laminar Faucet / Flow Velocity
  • Faucet Flow Control Device Location
– Cleaning
SHOWERS

Showers In Hospitals Are Essential To Patient Care And Sanitation.

– ADA Requirements
  • Handheld and/or Stationary Showerhead
  • Non-Positive Shut off of Handheld
  • All Lever Handle Controls

– Temperature Control - ASSE 1016

– Infectious Control Requirements
  • Wall Mounted over Floor Mounted
  • Minimize Crevices
  • Anti-Microbial surfaces

– Low Flow Considerations

– Floor Drainage/Slip Hazards
  • Drain Location
  • Floor Pitch
  • Spray Direction

– Grab Bar / Slide Bar
Service Sinks – Mop Receptors in EVS
In hospitals, a service sink is only part of a typical EVS closet.

- **Rugged**
  - Terrazzo Construction
  - Adequate Faucet Bracing for Bucket Support
  - Solid Brass Construction
  - Stainless Steel Wall Guards

- **Temperature Delivery**
  - High Temperature for Sanitation
  - Probable Low Temperature/Scald Protection

- **Infectious Control Requirements**
  - Chemical Dispensers
  - Water Pressure Delivery
  - Protection of the Potable Water Supply
Bariatric Water Closets – Designated Bariatric Patient Rooms

In hospitals, plumbing design must take into account bariatric patients and patients with limited ability to seat themselves.

– Overall Design
  • Bariatric Needs are on the Rise in U.S.
  • Wall Mounted vs. Floor Mounted

– Fixture/Carrier Weight Considerations
  • Standard Wall Mounted – 500lb
  • Heavy Duty – 750lb
  • Extra Heavy Duty – 1,000lb +

– Fixture Material
  • Type 304 Stainless Steel, “Bend over Break”
  • Anti-Microbial Epoxy Coating

– Fixture Performance
  • Chemical Dispensers
  • Water Pressure Delivery
  • Protection of the Potable Water Supply
Bed Pan Washers in ICU, Patient Room, and Soiled Utility Rooms

For patients who cannot leave their bed, hospital practice is the use of a bed pan. What comes next?

– Clean the Bed Pan
– Types of Bed Pan Washers
  • Mounted on toilet flush valve – CW only
  • Wall Mounted handheld washer – CW and HW
– Location
  • ICU and Patient Rooms – Integral to toilet fixture
  • Soiled Utility Rooms – Wall Mounted w/ Clinical Service Sinks
– Backflow Prevention
  • Integral Atmospheric Vacuum Breaker
  • Consult Local Codes
PLUMBING FIXTURES – EXAM SINK

Exam Room Sinks In Exam Rooms, ED, Procedure Rooms
Basic Function Identical To Lavatory – What’s The Difference? – Not Much
– Location, Location, Location And Opportunity For Infection
  • Exam Rooms
  • Meds Rooms, Nurse Stations, Soiled Utility Rooms
– Temperature Control – ASSE 1070
– Used by Staff, Patients, and Family
– Support Patient Weight
  • Wall mounted vs. in Casework
– Manual Vs. Automatic
  • Hand Washing vs. Multi-Task Sink
– Infectious Control Requirements
  • Solid / Anti-Microbial surfaces
  • Minimize Splashing / Sink Design
  • Laminar Faucet / Flow Velocity
  • Faucet Flow Control Device Location
– Cleaning
  • Aggressive Chemicals
Hospitals Contain Many Types Of Sinks, But Many Of The Design Considerations Remain The Same. Some Basic Thoughts When Thinking Of Sinks Are:

- **Minimize Splashing**
  - Coordinate Faucet Outlet To Discharge On Sink Bowl “Sweet Spot”
  - Use Laminar Flow Outlets
  - Coordinate Spout Height To Be Appropriate For Application

- **Anti-microbial Surfaces**
  - Vitreous China
  - Composite Materials

- **Hands-free Operation**
  - Reduce Bacteria Spread
  - John Hopkins Study

- **Durability For Application**
  - Quality Vitreous China
  - Heavy Gauge Stainless Steel
  - Terrazzo

- **Low Flow Where Appropriate**
  - Feasible For Hand Washing
  - Not Applicable For Service Sinks
Located Immediately Outside Operating Room, Scrub Sinks Provide Essential Pre-op Sanitation.

Basic Function To Fight Infection Transfer – Completely Hands Free!!

- Surgeons Hand Washing Purpose
  - Remove Debris And Transient Microorganisms From The Nails, Hands, And Forearms
  - Reduce The Resident Microbial Count To A Minimum
  - Inhibit Rapid Rebound Growth Of Microorganisms.

- Use Of Anti-microbial Soap Over High Temperature
  - Non-scalding
  - Excessive Use Of Hot Water Dries Hands

- Controls
  - Infra-red Electronic Faucet And Soap Dispenser
  - Knee Or Foot Control

- Location
  - Clean Corridor At Operating Room Entry

- Faucet
  - Laminar Or Non-aerated Rose Spray
  - ASSE 1070 Temperature Control
Typically Located In Intensive Care Units, Patient Care Modules Provide A Multi-purpose Plumbing Fixture Station To Patient Care.

- **Concealed Water Closet And Integral Seat/Water Closet**
  - Swing Type Or Flip Down Seat Cover
- **Handheld Bedpan Washer**
- **Lavatory**
  - Infra-red Electronic Faucet And Soap Dispenser
  - Knee Or Foot Control
- **Options**
  - Orientation Of “Fixtures”
  - Colors / Finishes / Materials
- **Plumbing Requirements**
  - Each “Fixture” Requires Individual Rough-in
  - Water Closet Carrier For Wall Mount Option
  - Backflow Preventer For Bedpan Washer
- **Design Options**
  - Traditional Fixtures Over PCM?
  - Provide Solid Surface “Shell”
Located in Soiled Utility Rooms, Clinical Service Sinks Primarily Serve to Clean Bed-Pans and Dispose of Human Waste.

- **Water Closet Function**
  - Vitreous China Bowl with Flush Valve

- **Service Sink Function**
  - Service Sink Faucet with Support Bracket
  - Faucet without Hose Thread Option

- **Bedpan Washing Function**
  - Wall Mounted CW and HW with Handheld Spray
  - Knee or Foot Control

- **Plumbing Rough-in**
  - Toilet Waste and CW connections
  - CW and HW for Faucet
  - CW and HW for BPW

- **Floor Mounted Carrier**
  - Unique to Clinical Service Sinks
  - Fixture Floor Rim 28” to 30” A.F.F.
A Hospital Can Have Many Different “Laboratory” Applications, And Lab Sink Design Must Flow Suit.

– Grossing Lab – Dissection
  • CW And HW Supply W/ Backflow Prevention
  • Garbage Grinder
  • Indirect Waste Connection

– Pathology Lab - Testing
  • Hand Washing Application – CW And HW Supply
  • Possible Acidic Wastes From Pathology Chemicals

– Casting Lab
  • CW And HW Supply
  • Plaster/Solids Interceptor

– Prosthetic Lab
  • CW And HW Supply
  • Plaster/Solids Interceptor

– Autopsy Lab
  • Hand Washing Application – CW And HW Supply
  • Possible Acidic Wastes From Autopsy Chemicals
PLUMBING FIXTURES – NUCLEAR MEDICINE AND IMAGING

Special Cancer Detection and Treatment Applications along with advanced imaging techniques call for special plumbing considerations

– Imaging Suites – MRI, X-Ray, CAT Scan
  • Protection Against Imaging Equipment Interference
  • Protect Against Metal Radiation Absorption

– Methods of Protection
  • Fixture Isolation
  • Lead Wrapping of Piping
  • Lead Room Enclosure – Required in Many Instances
  • Possible Acidic Wastes from Pathology Chemicals

– Hot Labs/Nuclear Medicine
  • Combination Sinks, Hot and Cold Waste
  • Lead Lined Storage Bay for Storage Until Decay
  • Special Service employed by Hospital for Pickup
INTERMISSION
PLUMBING DOMESTIC WATER SYSTEMS

Domestic Water is the “Lifeblood” of a plumbing system and the building. It’s the system that will provide water to all plumbing fixtures, boilers, cooling towers, chillers, medical equipment, maintenance equipment, hose bibbs, water features, etc.
DOMESTIC WATER - BOOSTER PUMPS

- Used to pressurize piping systems in tall buildings or when more pressure is needed than the municipality can provide.
- Typically duplex or triplex systems with variable speed drives and intelligent control.
- Provided with N+1 minimum redundancy to maintain typical hospital flow in case of pump failure.
- Normal and emergency power in case of domestic water supply to critical equipment or patient use.
- BAS connectivity with alarms indicating out of range performance or failure.
DOMESTIC WATER – PIPING DISTRIBUTION

Water Distribution Considerations

- Incoming Water Quality
- Piping Materials
- Hot Water Systems and Delivery Temperature
- Secondary Disinfection
- Distribution System and Critical Areas
- Pressure Control and Equipment Requirements
- Water Treatment for Boiler and Laboratory / Medical Equipment Supply
- Kitchen Water Supply
- Central Sterile
- Backflow Prevention
DOMESTIC WATER – INCOMING WATER SUPPLY

In hospital design, knowledge of the incoming water quality is critical. Poor water quality such as hard water, chlorine levels, and chemicals added by a municipality can adversely affect a plumbing system. Lack of understanding and treatment can cause premature equipment failure and piping corrosion.

To combat any of these, engineers must ask the municipality for their annual water quality report. By obtaining this report, engineers can determine:

• Water Hardness
• Phosphate Levels
• Chlorine Levels (at injection point)
• General Bacteria Levels
DOMESTIC WATER – INCOMING WATER SUPPLY

After obtaining the water quality report – Engineers must determine the next course of action.

• Point of Entry Water Treatment
  – Water Softening
  – Pre-Filtering

• Water Piping Materials
  – Follow Local Codes!!
  – Choose Materials Less Reactive to known challenges

• Understanding of Specialized Filtration and Treatment Requirements
  – Softened Water for Equipment and Kitchens
  – Reverse Osmosis Water for Steam Boiler Supply
  – Deionized Water for Lab and Imaging Use
DOMESTIC WATER – PIPING MATERIALS

Piping material selection has a very large impact on the building performance, reliability, and overall construction cost.

• Water Service, High Pressure Mains, and Local Branch Distribution Piping
  – Metallic Piping for all Applications Choices from Ductile Iron, Galvanized Steel, and Copper
  – Determining Application Range Could Have Huge Impact on Plumbing Cost vs. Building Longevity
  – Ex. – Polyphosphates and Galvanized Piping

• Process Water
  – Purified Water vs. Metal Piping
  – CPVC, Polypropylene, Etc.

• “Value Engineering”
  – Hospitals are in it for the “Long Haul”
  – Advocate longevity over Up-Front Savings
  – Everything is an “Owner Decision”
    • Consultant Duties
DOMESTIC WATER – HOT WATER APPLICATIONS

Every hospital needs hot water, often delivered at many different temperatures for many different applications.

- **General Domestic Hot Water**
  - Patient Rooms, ICU Rooms, Surgery, Locker Rooms, Public Toilet Rooms, Medical Office, EVS,
  - Typical Temperature Delivery Range of 110°F to 140°F.

- **Specialized Patient Care**
  - Skilled Nursing or Assisted Living Spaces, Psychiatric Care Rooms
  - Typical Temperature Delivery Range of 90°F to 100°F.

- **Kitchen / Cafeteria Hot Water**
  - Full Kitchens, Canteens, Food Prep Rooms
  - Typical Temperature Delivery Range of 140°F to 150°F.

- **Laundry**
  - Typical Temperature Delivery Range of 170°F to 180°F.

- **Central Sterile Hot Water**
  - Main Area for Medical Tool and Equipment Disinfection
  - Typical Temperature Delivery Range of 140°F to 150°F.
DOMESTIC WATER – HOT WATER GENERATION

There are many ways to generate hot water in any building. Hospitals are no exceptions, however reliability and redundancy must be incorporated into the design.

- **Natural Gas**
  - Common, Easy To Maintain And Incorporate Redundancy With Multiple Boiler Design.
  - Limited On Location Within Building Due To Gas Availability And Intake/Exhaust Flue Routing
  - Respectable Recovery Rate, Storage And Large Floor Area Are Required.

- **Electric**
  - Common, Easy To Maintain And Incorporate Redundancy With Multiple Heater Design.
  - Less Than Desirable Recovery Rate, Storage And Large Floor Area Are Required.
  - Large Infrastructure Impact To Provide Power Supply To Heaters.

- **Steam**
  - Very Common And Practical. Typically Already Part Of Campus Or Building Heating Design.
  - Very Flexible In System Operation And Turn-down Via Control Valve.
  - Instantaneous Or Semi-Instantaneous, Therefor Very Small Floor Space Required.

- **Steam**
  - Very Common And Practical. Typically Already Part Of Campus Or Building Heating Design.

- **Alternate Methods**
  - Engineer Must Take In Owner Considerations and Maintain System Reliability

- **KEEP IT SIMPLE!!**
DOMESTIC WATER – TEMPERATURE CONTROL

Now That The Energy Source Has Been Selected, And The System Has Been Sized, We Must Determine Temperature Control Methods:

Master Temperature Control
- **Pros**
  - Cost Effective.
  - Consistent Understanding Of Building Operations.
  - Simplified System Maintenance.
  - “Architecturally Friendly” – Less Access Panels

- **Cons**
  - One Failure Could Have Catastrophic Consequences.
  - Hot Water Return Balancing Is Challenging
  - Temperature Creep With Recirculating Systems (Traditional Valves)
  - Maintenance Personnel “Tinkering”.

Point Of Use Temperature Control
- **Pros**
  - Less Opportunity For Mass Effect Scalding.
  - Limited Shut-down Required For Maintenance.
  - Difficult To Change After Initial Settings Established

- **Cons**
  - Huge Maintenance Concern
  - Access Panels Everywhere
  - Large Up-front Cost

Typically A Master Temperature Controller Is Chosen For Cost Considerations And General System Maintenance. Now What Technology To Use?
DOMESTIC WATER – TEMPERATURE CONTROL TECHNOLOGY

Now That The Energy Source Has Been Selected, And The System Has Been Sized, We Must Determine Temperature Control Methods:

Traditional Mixing Valves

• **Pros**
  – Equipment is Cost Effective.

• **Cons**
  – Multiple Valves Required to Maintain Desired Pressure Drop (5PSI or Less)
  – Manifold Piping system Inlet/Outlet raises Installation costs.
  – Hot Water Return Balancing Is Challenging

Digital Temperature Recirculating Valves

• **Pros**
  – Less Equipment Required to Maintain Desired Pressure Drop. (5PSI or Less)
  – Precise Temperature Control.
  – Simplified BAS Connectivity
  – Data Logging / Legal Protection.
  – Simplified Hot Water Return Balancing and System Start-Up
  – Simplified Maintenance

• **Cons**
  – Equipment Costs
DOMESTIC WATER – SECONDARY DISINFECTION

- Secondary Disinfection Is Critical In Hospital Plumbing Design. Failure To Implement A Means Of Secondary Disinfection Can Expose Patients To Multiple Types Of Infection, Most Notably Legionella, And Cost A Hospital Millions Of Dollars In Legal Expenses, Which Will Trickle Down To The Design Team.
- We Must Determine What Hospital Areas Are At The Highest Risk For Legionella Contraction.
  - Children And Seniors
  - Pulmonary Patients
  - Intensive Care Units
  - Cancer Treatment Units
  - Post-surgery Recovery Units
DOMESTIC WATER – SECONDARY DISINFECTION

Available Technologies / Methods
• Chemical Methods
  – Direct Chlorine Injection
  – Chlorine Dioxide
• Non Chemical Means
  – Thermal Flush Or Eradication
  – Ultraviolet Light
  – Copper Silver Ionization
• Points Of Consideration In Selection Appropriate Technology
  – Effect On Piping System
  – Risk Of Patient Harm Of Scalding / Chemical Exposure
  – Disinfection System Residual
  – Treatment Of Biofilm On Piping Interior
  – Scientific Approach And Affirmation Of Effectiveness In Legionella Treatment
  – System Cost And Maintenance
• Design Engineers Must Weigh All Considerations And Advise On A Technology As Part Of Every Hospital Design Project, And Even Consider A Letter Indicating Owner Acceptance Or Waiver From Liability.
DOMESTIC WATER – DISTRIBUTION SYSTEM

We’ve established the fixture locations, equipment locations, water quality requirements, and water service – now let’s get that water where we need it. But how?

• General Piping Distribution
  – Pumps to pressurize water and deliver 30PSI to the most remote fixture.
  – Heaters Located based on previously stated considerations.
  – Hot Water Return piping designed to maintain low “time to hot water” waits.
  – Pressure Reducing Valves to limit water delivery to 80PSI.

• Low Flow Fixture Considerations
  – Extensive Hot Water Recirculation system with long piping extensions to fixtures, larger pumps for increased head losses.
  – Higher pressure requirements for low flow control devices.
DOMESTIC WATER – DISTRIBUTION SYSTEM

We Also Must Avoid Critical Areas In Case Of Leaks And Accessibility Issues

• Common Areas – Water And Electricity Don’t Mix!
  – Electrical Rooms
  – Telecommunications Rooms
  – UPS/Data Rooms
  – Coordination With All Trades, Including Architect In Case Of Fixture Relocation.
  – Coordinate Water Proofing Requirements.
  – Elevator Machine Rooms

• Specialized Hospital Areas
  – MRI / Imaging Suites
  – Operating Rooms
  – Clean Utility Rooms/Storage
DOMESTIC WATER – PRESSURE CONTROL

Many Specialized medical equipment pieces require precise pressure, temperature, and water quality delivery.

• Specific temperature and pressure requirements
  – Backflow preventions via RPZ or Air Gap
  – Pressure control Via pump or PRV
  – Temperature Control Via ASSE rated TMV
  – Water Quality Via Softeners and Filters/UV

• Equipment
  – Scope Sterilizers
  – Operating Room Cleaning Equipment/Sterilizers
  – Central Sterile Washing Equipment
  – Wheelchair Washing Equipment
  – Laundry/Kitchen Equipment.
DOMESTIC WATER – WATER TREATMENT

Hospitals Commonly Use Steam For Heating, Humidification And Heating. Boiler Plants Are The Heart Of A Hospital, And Water Quality Plays A Vital Role In Steam Boiler Efficiency And Reduced Corrosion.

• Reverse Osmosis Water For Steam Boiler Make-up
  – System Typically Designed At 100% Redundant – Two Parallel Skids Alternating Operation Daily.
  – Must Have Water Quality Report To Design System!
  – Pre-softening And Activated Carbon Filtration For Chlorine Removal
  – Sodium Bisulphite Option For Chlorine Removal.
  – Ro Membrane Array
  – Permeate Storage
  – Re-pressurization Pumps
  – Several Layers Of System Status And Alarm Notifications
    • Low Delivery Water Pressure – Typical Minimum 50PSI To 60PSI
    • Pre-softener Skid Failure
    • RO Membrane Failure
    • Permeate Tank Low Level
DOMESTIC WATER – WATER TREATMENT

Typical RO Filtration System Flow Diagram
DOMESTIC WATER – KITCHEN AND LAUNDRY SUPPLY

Hospitals Often Have Their Own Food Service And Laundry Plant. When Designing Domestic Water Supply To These Areas, Engineers Need To Have A Good Understanding Of All The Equipment And Water Supply Requirements In Each:

• Kitchen
  – Pre-rinse Stations
  – Dishwashers
  – Steamers
  – Soup Kettles
  – Hot/Cold Bins

• Laundry
  – Washing Machines
  – Dryers
  – Steam Presses

Equipment Specific Flow, Pressure, And Backflow Requirements Must Be Coordinated. Equipment Cut Sheets Need To Be Provided By The Respective Consultant Selecting The Equipment, And Coordination With The Municipality Must Be Made For Backflow Prevention.
DOMESTIC WATER – CENTRAL STERILE

Central Sterile Is A Vital Component To Hospital Function. Disruption Of The Sterilization Plant Typically Results In Disruption Of Basic Hospital Functions. When Designing A Domestic Water Supply For Central Sterile Equipment, Knowledge Of Water Requirements Is Critical.

• Domestic Water Coordination Considerations:
  – Large Volume Of Cold And Hot Water Consumption
  – Equipment Specific Backflow And Pressure Requirements
    • Often Each CW And HW Supply Requires An RPZ.
  – Piping And Equipment Within Room Must Be Capable Of Sanitization
    • Backflow And Control Valves Must Be Located In Separate Room.
    • Piping Insulation Should Be PVC Jacket For Cleaning.
INTERMISSION
PLUMBING WASTE SYSTEMS

Sanitary Waste Systems Play A Vital Role In Hospital Plumbing Systems. While In Many Instances They Are Not Much Different Than Typical Commercial Buildings, The Impact Of Sanitary System Failure In A Hospital Can Be Immense.
While the majority of fixtures connect to a plumbing system that is very similar to that of a “standard” commercial building, special considerations must be made in hospital waste piping design:

- **Access for Maintenance**
  - Cleanouts in accessible locations, cannot be buried behind other piping/ductwork/structure or drywall.
  - Rodding of piping system in various areas is very frequent.
  - Turn up suspended cleanouts in high ceiling or sensitive areas.

- **Hospital Operational “Challenges”**
  - Paper towels
  - Rags
  - Plastic bottles

- **Shut Downs Are Costly!!**
  - Typical ICU room $15,000 to $25,000 per day
PLUMBING WASTE SYSTEMS – AREAS TO AVOID

Similar To Routing Domestic Water, Routing Of Waste Piping Must Be Well Thought Out, And Often Must Comply With Code Requirements.

• No Waste Piping Should Be Located Within:
  – Electrical Rooms, Telecommunication Rooms, Imaging, Clean Handling/Storage, Food Preparation, Operating Rooms And Other Similar Areas

• But What About Those Architects Who Put Fixtures Over That Operating Room? We Have A Few Options:
  – KINDLY Ask That Fixtures Above Are Relocated Such That Waste Piping Is Not Longer Above Sensitive Room
  – If This Is Not Possible, Drip Pans With Telltale Drains Can Be Utilized.
  – Confirm All Design Choices With And Telltale Drain Discharge With AHJ.
  – Provide Leak Detection, Bas Connection And Alarm If Leak Is Detected.
There Are Several Special Wastes That Are Created In Hospitals. They Typically Are Products Of Medical Processes Such As:

- Dialysis
- Casting and Prosthetics Laboratories
- Grossing, Pathology, And Autopsy Lab Wastes.
- A System Of Fixtures, Waste Receptacles, Disposers, Interceptors, Dilution Traps, Special Piping Materials, And Venting Is Required To Adequately Address the Various Waste Flows
- In Extreme Waste Scenarios, Containment and Professional Removal Is Required.

These Wastes Require Special Treatment Or “Filtration”, However Are Still Connected To The Traditional Sanitary System.
PLUMBING WASTE SYSTEMS – SPECIAL WASTE SYSTEMS

Waste Systems That Are Not Connected To A Traditional Sanitary System Are:

- Biohazard – Collection And Incineration
- Nuclear Medicine – Liquid Waste Piped To Delay Tanks Via Lead Wrapped Piping, Then Pumped To Sewer After Acceptable Time Frame Has Passed – Solid Waste Collected
SPECIAL PLUMBING SYSTEMS

Hospitals in general often contain the latest technology in the form of medical equipment, communication equipment, and data tracking. In the plumbing engineering world, a hospital is also a great place to find the latest plumbing systems technology:

• Dialysis Supply and Waste Systems
• Purified Water Systems
• Pathology Lab Waste Systems
• Emergency Fixture Plumbing Systems
Many ICU rooms, ED departments, and Rehabilitation Hospitals Provide Hemodialysis to patients with Kidney Failure. For plumbing design, dialysis involves a few simple yet critical design points

- Water Treatment
- Temperature Control
- Waste Treatment
SPECIAL PLUMBING SYSTEMS – DIALYSIS

Water Treatment For Inpatient Hemodialysis

Provide Reverse Osmosis Water To Dialysis Machine

- **Portable Water Cart Taken To Each Patient Room**
  - Pressure Requirements
  - Temperature Requirements – Tempered Loop Supply

- **Central Ro Water System**
  - Dedicated Central RO Filtration System
  - RO Supply Loop

- **Backflow Prevention Consideration**
  - Backflow Prevention At Tempered Loop
  - Backflow Prevention At RO Inlet
  - Backflow Prevention At Each Box Or On Water Cart
SPECIAL PLUMBING SYSTEMS – DIALYSIS

Waste Products From Dialysis

Two Separate Waste Flows from Hemodialysis Treatment

• Water Cart Waste (If Applicable)
  – Concentrate Reject Water from RO Filtration

• Dialysis Waste
  – Discharge from Patient Containing Urine, etc.
  – RO Supply Loop

• Waste Flows
  – Don’t Cross the Streams
  – Dialysis Waste is Corrosive
SPECIAL PLUMBING SYSTEMS – PURIFIED WATER

Hospitals Need Many types of purified water as part of their daily operation:

- **Reverse Osmosis**
  - Steam Boiler Feed, Dialysis, Low Grade Lab Applications

- **Deionized**
  - Testing Lab, Pathology Lab.
  - Several Grades of Deionized Water, categorized by its electrical resistivity
SPECIAL PLUMBING SYSTEMS – PURIFIED WATER

Reverse Osmosis

- System Comprised Of Several Filtration Components Working In Unison
  - Break Tank And Inlet Water Pressurization Pumps
  - Water Softeners And Break Tank
  - Chlorine Removal Via Activated Carbon Or Sodium Bisulphite
  - Membrane Array
  - Permeate Storage Tank
  - Re-pressurization Pumps

- Recirculation Not Required

- Membrane Maintenance
  - Cleaning Service
  - CIP System

- CPVC Piping or Similar
Deionized Water

• Typically Deionized Water Used In A Hospital Is Taken One Step Further Than RO Water In The Filtration Process
  – Ran Through Ion-exchange Bed To Create Deionized Water
  – Water Must Now Be Circulated And Re-filtered Continuously
  – Serpentine Piping System – No Dead Leg Over 6 Pipe Diameters
  – Packaged System, Plug And Play

• Typically A Maintenance Package Is Provided By The Manufacture To Maintain Equipment.

• Un-pigmented Polypropylene Piping Downstream Of Unit.
Pathology Labs Used Specialized Chemicals To Detect Cancer And Other Diseases. These Chemicals Are Disposed Of In The Waste System.

- **Acidic Waste**
  - Acid Resistant Piping
  - Acid Neutralizing Basin
- **Anti-foaming Chemicals**
  - Lab Chemicals Foam When Discharged
  - Anti-foaming Chemicals
  - Specialized Foam Containment Devices
SPECIAL PLUMBING SYSTEMS – EMERGENCY SYSTEMS

Specialized systems, hazardous medical chemicals and medicines, along with chemicals used to maintain equipment necessitate emergency plumbing fixtures.

• **OSHA Requirements**
  – Suitable Facilities for Quick Drenching or Flushing

• **ANSI Z358.1**
  – Refer to Local Code for Adopted Issuance
  – Tepid Water 60°F To 100°F
  – Minimum Wash Time 15 Minutes

• **Available Fixture Types**
  – Eyewashes
  – Eye/Face Washes
  – Showers
  – Safety Stations
  – Portable Units

• **Required Accessories**
  – Mixing Valves - ASSE 1071
SPECIAL PLUMBING SYSTEMS – EMERGENCY SYSTEMS

How Does An Architect/Engineer Know Where To Provide An Emergency Fixture?

- Minimum Fixture Required
  - Gather List of All Chemicals/Locations.
  - Attain An MSDS Sheet
  - Follow Recommendations Regarding Fixture Type.
- Plumbing Code Book
  - Does Not Indicate Minimum Requirements!!
- Owner Requested Locations
  - Back-of-house Shops
  - Nursing Stations
  - Patient Floor Corridors
SPECIAL PLUMBING SYSTEMS – EMERGENCY SYSTEMS

What does ANSI Z358.1 mean to a Plumbing Engineer?

• **Purpose**
  – Define MINIMUM requirements of performance, use, testing, maintenance and training

• **Fixture Location**
  – Interpretation??
  – 10 Seconds / 55 Feet Max.
  – 1 Door / Must open in direction of travel

• **Fixture Performance**
  – Minimum Fixture Flow Rates
  – Min/Max Temperature Range - Tepid Water 60°F To 100°F
  – Accepted Spray Patterns
  – Stay-Open Control Valve
SPECIAL PLUMBING SYSTEMS – EMERGENCY SYSTEMS

Engineering Considerations When Designing An Emergency Plumbing System:

- **Flow Rate**
  - Showers – 20 GPM
  - Eye/Face Washes – 3 GPM
  - Eye Washes – 0.5 Gpm

- **Hot Water Availability**
  - Uninterrupted Tepid Water
  - Storage Type or Instantaneous Flow
  - **LARGE** HW Consumption
  - Quantity of Fixtures That will Operate

- **Mixing Valve Selection**
  - ASSE 1071
  - Cold Water Bypass Upon Failure

- **Supply Piping and Valves**
  - Sized for Large Flow
  - Valves Locked-Open or Handles Removed
SPECIAL PLUMBING SYSTEMS – EMERGENCY SYSTEMS

Local Code Requirements – Be Sure To Follow And Provide As Required
Examples Include:

- **Drainage**
  - OSHA And ANSI Z358.1 Do NOT Mandate Drains
  - Advise on Consideration
  - Local Codes Vary
  - Expensive And Often Unused
  - Acid Waste vs. Standard Waste

- **Alarms**
  - Notification Of Emergency Situation
  - Flow Switches
  - Strobes And Audible Siren
STORM COLLECTION / ROOF DRAINAGE

Storm Systems Collect Rain Water From A Roof Or Terrace And Drain To The Municipal Storm Sewer.

- Roof, Terrace, And Trench Drains
- Storm Piping
- Sized Based Off The Local Rainfall Rate.
- Primary And Overflow Systems In Many Locations.
Hospitals often locate imaging equipment and radiation treatment equipment in a basement. This equipment is very expensive, and must be protected from flooding at all costs.

- MRI
- CAT Scan
- Gamma Knife
- Proton Therapy
PLUMBING FOR A BASEMENT

Plumbing Design For A Basement Involves Many Different Considerations. Typically Gravity Flow To A Sewer Is Not Possible Due To The Fixture Discharge Being Lower Than The Municipal Main In The Street. Therefore, New Design Considerations Must Be Used

- Sanitary Waste Flow To Sewage Ejector Pumps
- Sub-soil Drainage Systems
- Sumps Pumps And Settling Basins
- Coordination With Geotechnical Engineer
- Emergency Power Considerations
SUBSOIL DRAINAGE

Subsoil Drainage Systems, or Drain Tile, is used to minimize hydrostatic pressure on below-grade walls and floor slabs to reduce cracking, seepage, and flooding.

- **Hydrostatic Pressure** – Force of water weight against basement walls or buoyancy of basement floor slab.

- **Drain Tile** – Perforated pipe used to direct underground storm water to sump pump system.

- **Sump Pumps** Must always be on emergency power.
Sump Pumps And Sewage Ejectors Pump Water From A Lower Elevation To A Higher Elevation

- Sized Based On Flow And Pressure Requirements
- Multiple Pumps Provided For Redundancy.
- Complex Controls Used To Operate Pumps And Alarm If Failure
- Emergency Power
Coordination with Electrical

- Power For Pumps
- Power For Electric Water Heaters
- Power For Electronic Mixing Valves
- Power For Electronic Plumbing Fixtures
- Heat Trace Cabling For Freeze Protection
Coordination with Mechanical

- Drainage For Equipment Service, Condensate Collection.
- Heated Plenums, Soffits, Or Shafts For Freeze Protection.
Coordination with Fire Protection

- Incoming Water Service And Utility Coordination.
- Drainage For Pumps And Equipment.
- Drainage At Dry Pipe And Pre-Action Valve Assemblies.
- Connections For Fire Water Tank Fill From Domestic Plumbing System.
Coordination with Architectural

- Equipment Rooms, Vertical Pipe Chases, Fixture Carrier Clearances.
- Ceiling Heights For Suspended Piping, Matrix Changes.
- Plumbing Fixture Location, Usage, Type, Model, Finish.
- Fountains, Pools, Emergency Fixtures.
- Drains, Hose Bibbs.
Coordination with Structural

- Above Grade Beam Penetrations.
- Below Grade Footing And Grade Beam Elevations And Sleeves.
- Weight Of Equipment.
- Elevator Pit Construction.