Plumbing installation level IV

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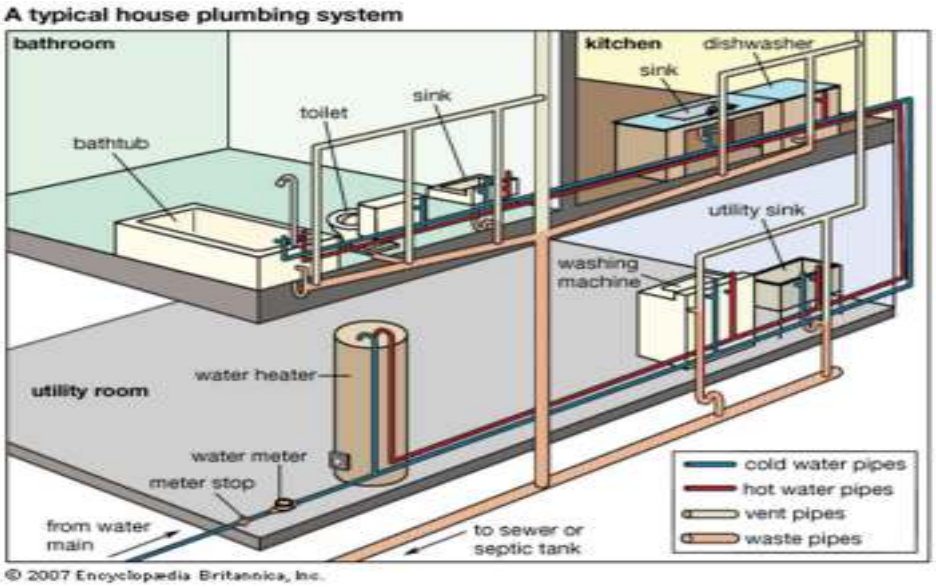

Module Title: Designing and sizing hot and cold water services

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Acronym

OHS ---------- occupational health and safety

CPVC ---------- chlorinated poly vinyl chloride

PVC ----------poly vinyl chloride

EESA ----------Ethiopian standard agency

ES ----------ergonomic of human systems

ISO ---------- international system organization

EBCS ----------Ethiopian building code of standards

PEX ----------cross-linked poly ethylene

CAD---------- computer aided design

LCA ---------- life cycle assessment

SIA ---------- social impact assessment

EIA ---------- economic impact assessment

ISA ---------- integrated sustainable assessment

ESG ---------- environmental, social and governance

Introduction to the Module

The Designing and sizing hot and cold water services helps to know the Prepare for planning, Identify system requirements, Plan service and system layout, in plumbing installation field. This module cover skill, knowledge and attitude required to Designing and sizing hot and cold water services.

This module is designed to meet the industry requirement under the plumbing installation work occupational standard, particularly for the unit of competency: Designing and sizing hot and cold water services this module covers the units:

- Prepare for planning.
- Identify system requirements.
- Plan service and system layout

Learning Objective of the Module

- Identify Prepare for planning.
- Identify system requirements
- describe Plan service and system layout

Module Instruction

For effective use these modules trainees are expected to follow the following module instruction:

1. Read the information written in each unit
2. Accomplish the Self-checks at the end of each unit
3. Perform Operation Sheets which were provided at the end of units
4. Do the “LAP test” given at the end of each unit and
5. Read the identified reference book for Examples and exercise

Unit one: Prepare for planning

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- concept of design hot and cold water system
- Nature and scope of, hot and cold water services
- Safety (OHS) and environmental requirements.
- Authority and statutory regulatory
- Sequencing and organizing work.
- Selecting, materials tools and equipment.
- Work area Preparing.

Preparing water pump sets. This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- identify design hot and cold water system
- Identify Nature and scope of, hot and cold water services
- Follow Safety (OHS) and environmental requirements.
- Define Authority and statutory regulatory
- Follow Sequencing and organizing work.
- Identify Selecting, materials tools and equipment.
- Prepare work area

1.1. Concept of design hot and cold water system

The design of hot and cold water systems is a complex task that requires careful consideration of a number of factors. By following the design considerations outlined above, you can design a water system that meets the needs of your building and its occupants.

Hot and cold water systems are essential for any building, providing water for drinking, bathing, cleaning, and other purposes. The design of a hot and cold water system is important to ensure that it meets the needs of the building and its occupants, and that it is efficient and cost-effective.

Design Considerations: When designing a hot and cold water system, there are a number of things to consider, including:

Pipe sizing: The pipes must be sized correctly to handle the expected flow rate of water.

Insulation: The pipes should be insulated to prevent heat loss and to reduce the risk of freezing.

Water heaters: The water heaters must be sized correctly to meet the hot water demand of the building.

Pressure relief valves: Pressure relief valves must be installed to protect the system from excessive pressure.

Temperature control valves: Temperature control valves must be installed to ensure that the hot water is delivered at a safe temperature. **There are two main types of hot and cold water system**

Centralized systems: In a centralized system, the hot and cold water are heated and stored in a central location, such as a boiler room. The water is then distributed to the various fixtures in the building through a system of pipes.

Decentralized systems: In a decentralized system, the hot and cold water are heated and stored at each fixture. This type of system is typically used in smaller buildings or in buildings where there is a high demand for hot water.

Factors to Consider: When designing a hot and cold water system, there are a number of factors to consider, including:

Type of building: The type of building will have a significant impact on the design of the water system. For example, a residential building will have different requirements than a commercial or industrial building.

Number of occupants: The number of people who will be using the water system will also affect the design. For example, a large office building will need a larger water system than a small house.

Water usage patterns: It is important to consider how the water will be used in the building. For example, if there is a high demand for hot water in the morning, then the hot water system will need to be designed to meet this demand.

Energy efficiency: It is important to design the water system to be as energy-efficient as possible. This can be done by using insulation, efficient water heaters, and other technologies.

1.2 .Nature and scope of hot and cold water services

Hot water services: Hot water services are typically provided at a temperature of between 120 and 140 degrees Fahrenheit (49 and 60 degrees Celsius). This temperature is high enough to kill harmful bacteria, but not so high that it can cause scalding.

Cold water services: Cold water services are typically provided at a temperature of between 55 and 65 degrees Fahrenheit (13 and 18 degrees Celsius). This temperature is cool enough to be refreshing and comfortable, but not so cold that it can cause hypothermia.

Scope of services: The scope of hot and cold water services can vary depending on the customer's needs. For example, a residential customer may only need hot and cold water for basic hygiene and sanitation purposes. A commercial customer, on the other hand, may need hot and cold water for a variety of purposes, such as food preparation, dishwashing, and laundry.

Water quality: Hot and cold water services should provide water that is safe to drink and use for other purposes. The water should be free of harmful bacteria and other contaminants.

Hot and cold water services are an essential part of modern life, and play an important role in public health and well-being.

Hot and cold water services are the provision of a continuous supply of hot and cold water to buildings and other structures. This is an essential service for human health and well-being, and is used for a variety of purposes, including:

Hygiene: Hot and cold water are essential for maintaining personal hygiene, such as bathing, showering, and washing hands.

Sanitation: Hot and cold water are also essential for maintaining sanitary conditions in homes and other buildings, such as cleaning toilets and sinks.

Food preparation: Hot and cold water are essential for food preparation, such as washing food, cooking, and cleaning dishes.

Drinking: Hot and cold water are also essential for drinking, and can be used to make beverages such as tea and coffee.

Hot and cold water services can be provided in a variety of ways, including:

Municipal water supply: In many areas, municipal water utilities provide both hot and cold water to homes and businesses. The water is heated at a central location and then distributed to customers through a network of pipes.

On-site water heating: In some areas, or for buildings that are not connected to a municipal water supply, hot water is heated on-site using a variety of methods, such as boilers, water heaters, and solar panels.

Cold water supply: Cold water is typically supplied from a municipal water supply or from a private well.

The scope of hot and cold water services can vary depending on the specific needs of the customer. For example, a residential customer may only need hot and cold water for basic hygiene and sanitation purposes. A commercial customer, on the other hand, may need hot and cold water for a variety of purposes, such as food preparation, dishwashing, and laundry.

Hot and cold water services are essential for modern life, and play an important role in public health and well-being.

1.3. Safety and environmental requirements

When designing and sizing hot and cold water systems, it is important to consider both safety and environmental requirements. This includes designing systems to prevent scalding, Legionella growth, and electric shock. It is also important to design systems to be as water- and energy efficient as possible, and to select materials that minimize environmental impact.

Temperature control: Hot water systems should be designed to prevent scalding, typically by limiting the temperature to 60 degrees Celsius or below at the outlet. This can be achieved through thermostatic mixing valves or other temperature control devices.

Legionella control: Hot water systems should be designed to prevent the growth of Legionella bacteria, which can cause Legionnaires' disease. This can be achieved by maintaining a high temperature in the hot water tank (60 degrees Celsius or above) and by ensuring that there is adequate circulation of water in the system.

Electrical safety: All electrical components of hot and cold water systems must be properly installed and maintained to prevent electric shock.

Other hazards: Other hazards to consider include slips and trips, falls from heights, and exposure to hazardous chemicals.

Environmental requirements

Water efficiency: Hot and cold water systems should be designed to be as water-efficient as possible. This can be achieved by using water-saving fixtures, such as low-flow showerheads and toilets, and by rainwater harvesting.

Energy efficiency: Hot water systems should be designed to be as energy-efficient as possible. This can be achieved by using insulation, solar hot water systems, and heat recovery systems.

Material selection: Materials used in hot and cold water systems should be selected to minimize environmental impact. For example, lead-free pipes and fittings should be used to prevent water contamination.

1.4. Authority and statutory regulatory

Authority and Statutory Regulatory for Design and Sizing Hot and Cold Water Service

The design and sizing of hot and cold water services is a critical aspect of any building project. It is important to ensure that the system is designed to meet the needs of the occupants while also complying with all relevant statutory and regulatory requirements.

Authority: The authority for the design and sizing of hot and cold water services in a particular jurisdiction will vary depending on the local government structure. In most cases, the authority will be vested in the local building authority. However, in some cases, there may be other authorities involved, such as the water utility or the health department.

Statutory and Regulatory Requirements: The statutory and regulatory requirements for the design and sizing of hot and cold water services will also vary depending on the jurisdiction. However, there are some common requirements that apply to most jurisdictions. These requirements typically relate to the following:

- The quality of the water supply
- The safety of the water supply
- The efficiency of the water supply
- The accessibility of the water supply
- Design and Sizing Considerations

When designing and sizing a hot and cold water service, there are a number of factors that need to be considered. These factors include:

- The expected demand for hot and cold water
- The type of water supply (e.g., mains pressure or gravity fed)
- The length and configuration of the pipe work

The type of hot water system (e.g., storage or instantaneous)

The type of cold water storage (e.g., header tank or cistern)

The energy efficiency requirements

Compliance with Statutory and Regulatory Requirements

It is important to ensure that the design and sizing of any hot and cold water service complies with all relevant statutory and regulatory requirements. This can be done by consulting with the local building authority and other relevant authorities.

Some common requirements that apply to most jurisdictions

These requirements typically relate to the following:

- The quality of the water supply
- The safety of the water supply
- The efficiency of the water supply
- The accessibility of the water supply
- Design and Sizing Considerations

When designing and sizing a hot and cold water service, there are a number of factors that need to be considered.

These factors include:

- The expected demand for hot and cold water
- The type of water supply (e.g., mains pressure or gravity fed)
- The length and configuration of the pipe work
- The type of hot water system (e.g., storage or instantaneous)
- The type of cold water storage (e.g., header tank or cistern)
- The energy efficiency requirements

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1.5. Sequencing and organizing work

Sequencing and organizing work for designing and sizing hot and cold water service is an important part of any plumbing project. By carefully planning the work, you can ensure that the project is completed on time and within budget, and that the finished system meets all of the required codes and standards.

The following is a suggested sequence of work for designing and sizing hot and cold water service:

Collect information. This includes gathering information about the building, such as the number of occupants, the types of fixtures, and the peak water demand. You will also need to collect information about the local water supply, such as the water pressure and temperature.

Design the system. This involves selecting the appropriate pipe sizes and materials, and determining the layout of the system. You will also need to design the hot water system to ensure that it can provide an adequate supply of hot water to all of the fixtures.

Size the system. This involves calculating the flow rates and pressures required for each fixture. You will also need to size the hot water tank to ensure that it can meet the peak hot water demand.

Draw the plans. Once the system has been designed and sized, you will need to draw the plans for the system. This includes drawing a piping diagram and a schematic of the hot water system.

Obtain permits. If required by local code, you will need to obtain a permit for the plumbing work.

Install the system. Once the permit has been obtained, you can install the system according to the plans.

Test the system. Once the system has been installed, you need to test it to make sure that it is **working properly**. This includes testing the water pressure and temperature at each fixture.

Insulate the system. Once the system has been tested, you need to insulate the hot water pipes to prevent heat loss.

There are some additional tips for sequencing and organizing the work:

Start with the biggest tasks. This will help you to stay on track and avoid getting bogged down in the details.

Break down the work into smaller tasks. This will make the work more manageable and easier to schedule.

Assign tasks to the appropriate people. Make sure that everyone knows what they are responsible for and when the tasks need to be completed.

Create a timeline for the project. This will help you to stay on track and identify any potential problems early on.

Be flexible and adaptable. Things don't always go according to plan, so be prepared to make adjustments as needed.

1.6. Selecting, materials tools and equipment

Selecting the appropriate materials, tools, and equipment is essential for designing and sizing hot and cold water service. The following is a list of some of the most common materials, tools, and equipment used in this process:

Materials

Pipe: Copper, CPVC, PEX, and PVC are the most common types of pipe used in hot and cold water systems. The type of pipe you choose will depend on a number of factors, including the type of system, the water pressure and temperature, and the budget.

Fittings: Fittings are used to connect pipes together and to change the direction of flow. There are a variety of different types of fittings available, including elbows, tees, unions, and couplings.

Valves: Valves are used to control the flow of water in the system. There are a variety of different types of valves available, including gate valves, ball valves, and globe valves.

Hot water tank: The hot water tank is used to store hot water for the system. There are a variety of different types of hot water tanks available, including gas, electric, and solar.

Insulation: Insulation is used to prevent heat loss from the hot water pipes. There are a variety of different types of insulation available, including foam, fiberglass, and rubber.

Tools and equipment

Pipe cutter: A pipe cutter is used to cut pipe.

Pipe bender: A pipe bender is used to bend pipe.

Pipe size: A pipe size is used to determine the correct size of pipe for the system.

Pipe threaded: A pipe threaded is used to create threads on the ends of pipes.

Soldering iron: A soldering iron is used to solder copper pipes together.

Crimping tool: A crimping tool is used to crimp PEX fittings.

Valve wrench: A valve wrench is used to open and close valves.

Pressure gauge: A pressure gauge is used to measure the water pressure in the system.

Thermometer: A thermometer is used to measure the water temperature in the system.

In addition to the materials, tools, and equipment listed above, you may also need some additional items, depending on the specific system you are designing and sizing. For example, if you are designing a hot water system with **a solar hot water tank**, you will need to purchase solar panels and a solar controller.

When selecting materials, tools, and equipment for designing and sizing hot and cold water service, it is important to choose high-quality products from reputable manufacturers. This will help to ensure that the system is reliable and durable.

1.7. Work area preparing

To design and size a hot and cold water service system,

The following information is needed:

Building type and occupancy: This will determine the types and number of plumbing fixtures that need to be served, as well as the expected demand for hot water.

Water supply pressure and temperature: This information is needed to determine the appropriate pipe sizes and fittings, as well as the type of hot water heater that is required.

System layout: This includes the location of the water supply, the hot water heater, the plumbing fixtures, and the distribution piping.

Once this information has been gathered, the following steps can be taken to design and size the system:

Determine the peak demand for hot water: This can be done using a variety of methods, such as the fixture unit method or the demand factor method.

Select the appropriate hot water heater: The size of the hot water heater must be sufficient to meet the peak demand for hot water.

Size the distribution piping: The pipe sizes must be large enough to carry the peak flow of water without excessive pressure loss.

Select the appropriate plumbing fixtures: The plumbing fixtures must be compatible with the water supply pressure and temperature.

Design the system layout: The system layout should be designed to minimize the length of pipe runs and to ensure that all of the plumbing fixtures are adequately served.

Preparing for Designing and Sizing Hot and Cold Water Service Lecture Note

To prepare for a lecture note on designing and sizing hot and cold water service, the following steps can be taken:

Gather information on the topic: This includes information on the different types of hot water heaters, the fixture unit method, the demand factor method, pipe sizing, and plumbing fixture selection.

Organize the information in a logical way: The lecture note should be organized in a way that makes it easy for students to follow. The information should be presented in a clear and concise manner.

Create illustrations and diagrams: Illustrations and diagrams can be used to help students understand the different concepts that are being discussed.

Develop practice problems: Practice problems can be used to help students apply the information that they have learned.

The lecture note should be designed to be informative and engaging. It should provide students with the knowledge and skills that they need to design and size hot and cold water service systems.

Types of hot water heaters: Storage tank heaters, tankless water heaters, and solar water heaters.

Water heater efficiency: How to choose a water heater that is energy efficient.

Water heater installation: Safety considerations and best practices for installing water heaters.

Hot water distribution systems: Types of distribution systems, pipe sizing, and insulation.

Water conservation: Measures that can be taken to conserve water in hot and cold water service systems.

Self-cheek-1

Part-I: Choose the correct answer

1. Which of the following is not a consideration in the design of a hot and cold water system?

A. Peak demand
C. Insulation
B. Pipe sizing
D. Fire safety

2. What is the purpose of a safety valve in a hot water system?

A. To prevent the pressure from exceeding a safe level

B. To prevent the water from boiling over

C. To prevent the water from freezing

D. All of the above

3. Which of the following is a typical requirement for the design of a cold water system?

A. The water must be maintained at a temperature below 20 degrees Celsius.

B. The water must be free of harmful bacteria.

C. The water must be available at all times.

D. All of the above

Part-II: Say true for right statement and false for wrong one

1. The hot and cold water systems in a building should be inter connected.

2. The hot water system should be insulated to prevent heat loss.

3. The cold water system should be designed to provide a minimum pressure of 15 psi at all fixtures.

Part-III: Answer the following questions accordingly

1. What are the two main types of hot water systems?

2. What are the main safety considerations for the design of a hot water system?

Unit two: Identify system requirements.

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- Gathering information's and specification
- Ethiopian standards for designing
- Determining Quantity, location and point of fixtures
- Sizing hot and, cold water services systems.

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Gather information's and specification
- identify Ethiopian standards for design
- Determine Quantity, location and point of fixtures
- Describe the Size of hot and, cold water services systems.

2.1. Gathering information's and specification

Is a type of document that provides guidance on how to gather information and specifications for a particular task or project. a variety of topics, such as:

- What types of information and specifications are needed?
- Where to find the information and specifications
- How to evaluate the information and specifications
- How to document the information and specifications

Gathering information and specification are often used in engineering and construction projects, but they can also be used in other industries, such as software development and manufacturing.

Here are some examples of topics that might be covered in a gathering information and specification lecture note for a hot and cold water service system:

Types of information and specifications needed:

- Type of building or structure
- Size of the building (square footage)
- Number of occupants
- Water pressure and flow rate that is available from
- Type of plumbing fixtures that will be used
- the municipal water supply
- Hot water temperature requirements
- Local building codes and regulations
- Where to find the information and specifications:
- Building owner or manager
- Architect or engineer

- Plumbing contractor
- Local building department
- Manufacturers of plumbing fixtures and equipment
- How to evaluate the information and specifications:
- Check the information for accuracy and completeness
- Make sure that the information and specifications meet your specific needs
- Compare the information and specifications from different sources to get the best possible value

Information and specifications documentation

Create a spreadsheet or database to track the information and specifications

Include all relevant information, such as the source of the information, the date it was obtained, and any comments or notes

Type of building or structure

- Number of occupants
- Type of plumbing fixtures that will be used
- Water pressure and flow rate that is available from the municipal water supply
- Hot water temperature requirements
- Local building codes and regulations
- Specific information for each plumbing fixture
- Fixture unit (FU) value
- Flow rate
- Hot water requirement (if applicable)
- Specific information for piping

- Pipe material
- Pipe diameter
- Pipe length
- Pipe routing
- Insulation requirements

Once you have gathered this information, you can use the following steps to design and size your hot and cold water service system:

Calculate the total FU demand for the building. This is done by adding up the FU values for all of the plumbing fixtures.

Size the main water supply line. The main water supply line should be sized to handle the total FU demand for the building. You can use a pipe sizing chart to determine the correct size of pipe to use.

Size the hot water heater. The hot water heater should be sized to provide the required amount of hot water at the desired temperature. You can use a hot water heater sizing calculator to determine the correct size of hot water heater to use.

Size the hot water and cold water piping. The hot water and cold water piping should be sized to handle the flow rate and pressure drop for each plumbing fixture. You can use a pipe sizing chart to determine the correct size of pipe to use.

Draw the water service drawing. The water service drawing is a detailed plan of the water supply system for the building. It shows the location of all of the plumbing fixtures, as well as the size and routing of all of the piping.

Design considerations

There are a number of factors to consider when designing a hot and cold water service system. These include:

Water pressure and flow rate: The water pressure and flow rate that is available from the municipal water supply will determine the size of the piping that can be used.

Pipe materials: The type of pipe material that is used will depend on the specific application. Copper pipe is commonly used for both hot and cold water systems, but PVC and CPVC pipe can also be used.

Insulation: Hot water pipes should be insulated to prevent heat loss. This is especially important in cold climates.

Drainage: The water service drawing should also show the location of all of the drainage pipes.

2.2 Ethiopian standards for designing

The Ethiopian Standards Agency (ESA) is responsible for developing and issuing national standards in Ethiopia. The ESA has a number of standards related to design, including:

- ES ISO 9241-110:2012 Ergonomics of human-system interaction - Part 110: Dialogue principles
- ES ISO 9241-161:2013 Ergonomics of human-system interaction - Part 161: Design for usability
- ES ISO 9241-210:2010 Ergonomics of human-system interaction - Part 210: Human-centered design for interactive systems

These standards provide guidance on how to design products and services that are safe, efficient, and easy to use. They are based on the principles of ergonomics and human-centered design.

In addition to the ESA standards, there are a number of other international standards that are relevant to design in Ethiopia. These include:

- ISO 14001:2015 Environmental management systems - Requirements with guidance for use
- ISO 9001:2015 Quality management systems - Requirements
- ISO 45001:2018 Occupational health and safety management systems - Requirements with guidance for use

Finally, it is important to be aware of the infrastructure and resources available in Ethiopia when designing products or services. For example, many parts of Ethiopia do not have reliable access to electricity or the internet, so it is important to design products and services that can be used without these resources.

Ethiopian standards for hot and cold water systems

EBCS-9 2013 - Ethiopian Building Code of Standard - Plumbing Services

Other relevant standards

Designing hot and cold water systems

- Load calculations
- Pipe sizing
- Valve selection
- Equipment selection
- System layout
- Sizing hot and cold water systems
- Flow rate requirements
- Pressure requirements
- Hot water temperature requirements
- Installation of hot and cold water systems
- Best practices
- Common mistakes to avoid

2.2. Determining Quantity, location and point of fixtures

Quantity is a measurable property of an object or collection of objects. It is the amount or number of something. Quantities can be compared using the relationships "more than", "less than", and "equal". Quantities can also be added, subtracted, multiplied, and divided.

Quantities are often expressed as a product of a number and a unit of measurement. For example, the quantity of water in a glass might be expressed as 250 milliliters (mL). The number 250 is the magnitude of the quantity, and the unit mL is the type of quantity.

Quantities are used in all areas of science and engineering. For example, physicists study the quantities of mass, length, and time. Chemists study the quantities of moles and concentration. Engineers study the quantities of force, work, and energy.

Quantities can also be used in everyday life. For example, we use quantities when we measure ingredients for a recipe, when we buy groceries, or when we calculate the distance we need to travel.

Here are some examples of quantities:

- Number of apples in a basket
- Mass of a car
- Volume of a swimming pool
- Length of a road
- Temperature of a room
- Speed of a train
- Price of a gallon of gasoline

Quantities are an important part of our world, and they help us to understand and interact with it in a meaningful way.

Location is the place where something is situated or where something happens. It can be described in absolute terms, such as latitude and longitude, or in relative terms, such as north of the river or near the library.

Location is an important concept in many different fields, including geography, navigation, real estate, and business. It can be used to describe the position of a person, object, or event, and to understand the relationships between different places.

There are two main types of location:.

Absolute location: is the exact position of a place on Earth, usually given in terms of latitude and longitude. For example, the Empire State Building is located at 40.7 degrees north (latitude), 74 degrees west (longitude).

Relative location: is the position of a place in relation to other places. For example, New York City is located on the east coast of the United States, and San Francisco is located on the west coast.

Location can also be described at different scales. For example, the location of a house can be described in terms of its address, its neighborhood, and its city. The location of a country can be described in terms of its continent and its neighboring countries.

Location is an important concept because it can help us to understand the world around us. It can also help us to make decisions about where to live, work, and travel.

Here are some examples of location:

- The location of a store can affect its sales.
- The location of a school can affect the quality of education.
- The location of a hospital can affect the quality of healthcare.
- The location of a company's headquarters can affect its ability to attract and retain employees.

The point of a fixture is to securely locate and support a work piece during machining or assembly. This ensures that the work piece is held in the correct position and orientation, and that it is stable enough to withstand the forces of machining or assembly. This can lead to a number of benefits, including:

Increased accuracy and precision: Fixtures can help to ensure that all parts produced are identical, within a very tight tolerance. This is because the fixture positions the work piece in the same way each time, and it is supported in a way that prevents it from moving.

Reduced labor costs: Fixtures can help to reduce the amount of labor required to produce a part. This is because the fixture can hold the work piece in place while the operator performs the machining or assembly operation. This can free up the operator to perform other tasks, or to operate multiple machines.

Improved safety: Fixtures can help to improve safety by reducing the risk of accidents. This is because the fixture can hold the work piece in place, and it can also provide shielding to protect the operator from flying debris or sharp edges.

Fixtures are used in a wide variety of industries, including manufacturing, construction, and automotive. Some common examples of fixtures include:

Drill jigs: Drill jigs are used to guide drill bits to the correct location on a work piece. This helps to ensure that the holes are drilled accurately and in the correct position.

Vise jaws: Vise jaws are used to hold work pieces in place in a vise. This allows the work piece to be machined or assembled accurately.

Welding fixtures: Welding fixtures are used to hold work pieces in place while they are being welded. This helps to ensure that the welds are strong and accurate.

Assembly fixtures: Assembly fixtures are used to hold work pieces in place while they are being assembled. This helps to ensure that the parts are assembled correctly and accurately.

To determine the quantity, location, and point of fixtures, the following steps should be taken:

- Identify the type of building and its intended use. This will help to determine the types and number of fixtures that are required. For example, a residential building will have different fixture requirements than a commercial building.
- Develop a floor plan of the building. This will help to visualize the location of fixtures and to ensure that they are properly spaced.
- Identify the specific locations where fixtures will be installed. This should be done in consultation with the building owner or occupant.
- Determine the point of connection for each fixture. This will involve locating the water supply and drainage lines.

Once the quantity, location, and point of fixtures have been determined, the hot and cold water service system can be designed and sized. The following steps should be taken:

Calculate the total water demand for the building. This can be done by using a fixture unit (FSU) table. Each fixture is assigned a certain number of FUs, which is based on its flow rate. The total FUs for the building are then added together to determine the total water demand.

- Determine the pipe sizes required to meet the water demand. This can be done using a pipe sizing table. The pipe size is determined based on the flow rate and the desired velocity of the water.
- Design the layout of the hot and cold water piping system. The piping system should be designed to minimize the distance that the water has to travel from the water heater to the fixtures.

Select the appropriate water heater. The size of the water heater should be based on the total hot water demand for the building.

2.3. Sizing Hot and Cold Water Services Systems

Sizing hot and cold water services systems is an important part of designing a plumbing system. The goal is to ensure that the system can provide enough water to meet the needs of the occupants or users of the building, while also minimizing energy consumption and costs.

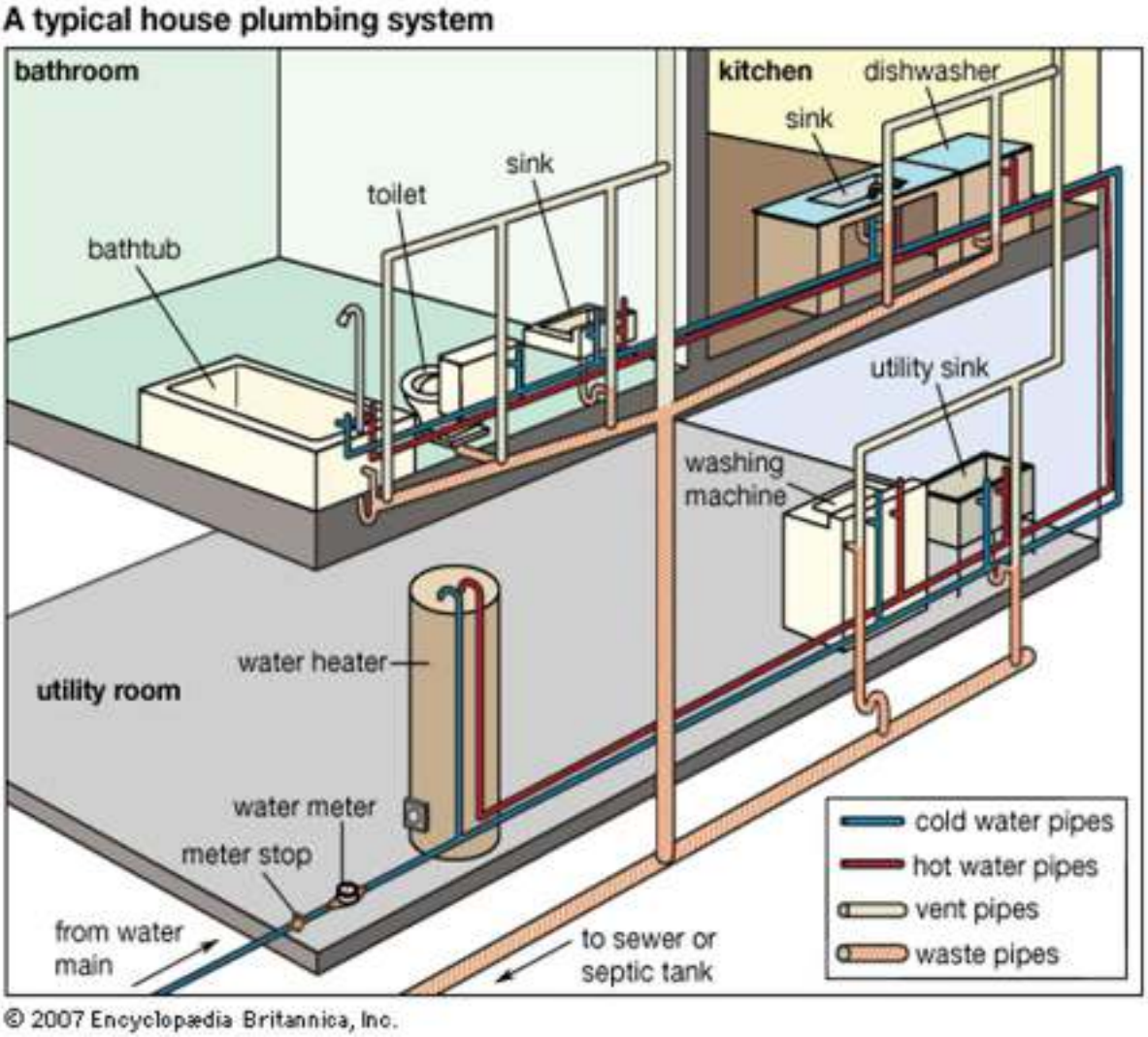

Figure 2.1 Hot and Cold Water Services

The type and number of plumbing fixtures in a building will vary depending on the type of building, its size, and its occupancy. However, some of the most common plumbing fixtures found in buildings include:

Sinks: Sinks are used for washing hands, dishes, and other items. They are available in a variety of sizes and styles, including kitchen sinks, bathroom sinks, and utility sinks.

Figure 2.2 Sinks

Toilets: Toilets are used for the disposal of human waste. They come in different designs, such as one-piece or two-piece toilets, and can have various flushing mechanisms.

Figure 2.3 Toilets

Bathtubs: Bathtubs are used for bathing and relaxing. They can be made from a variety of materials, such as acrylic, cast iron, and fiberglass.

Figure 2.4 Bathtubs

Showers: Showers are used for bathing and cleaning. They can be installed in bathtubs or as stand-alone units.

Figure 2.5 Shower

Faucets: Faucets are used to control the flow of water from a sink, bathtub, or shower. They come in a variety of styles and finishes.

Figure 2.6. Faucet

Urinals: Urinals are used by men for urination. They are typically found in public restrooms.

Figure 1.7 Urinal

Bidets: Bidets are used for cleaning after using the toilet. They are most common in Europe and Asia, but are becoming increasingly popular in the United States.

Figure 2.8 Bidet

Drinking fountains: Drinking fountains provide access to clean drinking water. They are typically found in public places, such as schools, offices, and parks.

Figure 2.9. Drinking fountain and filters

The number of plumbing fixtures in a building will depend on the size and occupancy of the building. For example, a large office building will have more plumbing fixtures than a small residential home. Additionally, buildings with specialized uses, such as hospitals and schools, may have additional plumbing fixtures that are specific to their needs.

some examples of the type and number of plumbing fixtures that might be found in different types of buildings:

Residential home:

- Kitchen sink
- Bathroom sink
- Toilet
- Bathtub or shower
- Laundry sink (optional)
- Office building:
- Bathroom sinks
- Toilets
- Urinals (in men's restrooms)
- Bidets (optional)
- Drinking fountains
- School:
- Bathroom sinks
- Toilets
- Urinals (in boys' restrooms)
- Drinking fountains
- Kitchen sinks (in cafeterias and other food preparation areas)

Hospital:

- Bathroom sinks
- Toilets
- Showers
- Bidets
- Surgical sinks
- Eyewash stations
- Mop sinks

The expected water usage for each plumbing fixture will vary depending on the type of fixture, its water efficiency, and how it is used. However, here are some general estimates:

- Sink: 2-5 gallons per use
- Toilet: 1.28-1.6 gallons per flush (older toilets may use up to 6 gallons per flush)
- Bathtub: 20-60 gallons per bath
- Shower: 2.5-10 gallons per minute (depending on the flow rate of the showerhead)
- Faucets: 1.5-2.2 gallons per minute (depending on the flow rate of the faucet)
- Urinals: 0.5-1 gallon per flush
- Bidets: 0.25-1 gallon per use
- Drinking fountains: 0.1-0.25 gallons per minute

It is important to note that these are just estimates, and actual water usage may vary depending on the factors mentioned above. For example, a long shower will use more water than a short shower, and a toilet with a leaky valve will use more water than a properly functioning toilet.

To reduce water usage, it is important to choose water-efficient plumbing fixtures and to use them wisely. For example, you can save water by taking shorter showers, turning off the faucet when you brush your teeth, and fixing any leaky faucets or toilets.

some additional tips for reducing water usage in your home or office:

- Install water-efficient fixtures, such as low-flow toilets and showerheads.
- Turn off the faucet when you brush your teeth, shave, or wash dishes.
- Take shorter showers.
- Fix any leaky faucets or toilets.
- Water your lawn and garden early in the morning or late in the evening when the sun is not as strong.
- Collect rainwater to use for watering plants or washing your car.

Peak water demand is the highest volume of water needed during a specific period of time, such as a day, hour, or month. It is important to calculate peak water demand in order to design water supply systems that can meet the needs of all users during even the busiest times.

Peak water demand calculation

There are a number of different methods for calculating peak water demand. The most common method is to use a peaking factor. A peaking factor is a ratio of peak water demand to average water demand. Peaking factors can be determined based on historical data or on estimates of future water use.

Once the peaking factor has been determined, the following equation can be used to calculate peak water demand:

Peak water demand = Average water demand * Peaking factor

Example

A city has an average water demand of 10 million gallons per day (MGD). The peaking factor for the city is 2.5. Therefore, the peak water demand for the city is 25 MGD.

Factors that affect peak water demand

Peak water demand can be affected by a number of factors, including:

Time of day: Peak water demand typically occurs in the morning and evening when people are getting ready for work and school or coming home from work and school.

Time of year: Peak water demand is typically higher in the summer when people are using more water for irrigation and air conditioning.

Type of building: Commercial and industrial buildings tend to have higher peak water demands than residential buildings.

Climate: Cities in hot climates typically have higher peak water demands than cities in cold climates.

Water conservation

There are a number of ways to reduce peak water demand, such as:

Water conservation measures: Encouraging people to conserve water through measures such as watering their lawns less often and taking shorter showers can help to reduce peak water demand.

Water-efficient fixtures: Installing water-efficient fixtures such as low-flow toilets and showerheads can also help to reduce peak water demand.

Demand response programs: Demand response programs offer incentives to customers to reduce their water use during peak periods.

Minimum supply pressure calculation

The minimum supply pressure can be calculated using the following equation:

Minimum supply pressure = Static pressure + Dynamic pressure

Static pressure is the pressure at the fixture when no water is flowing. It is equal to the elevation of the fixture above the water source multiplied by the specific gravity of water (0.00433 psi/foot).

Dynamic pressure is the pressure loss due to friction as water flows through the pipes. It can be calculated using a number of different methods, such as the Hazen-Williams equation or the Darcy-Weisbach equation.

Example

A water supply system has a static pressure of 30 psi at the most remote fixture. The dynamic pressure loss due to friction is 5 psi. Therefore, the minimum supply pressure for the system is 35 psi.

Factors that affect minimum supply pressure

The minimum supply pressure can be affected by a number of factors, including:

Type of fixture: Different types of fixtures require different minimum supply pressures. For example, a showerhead requires a higher minimum supply pressure than a faucet.

Length of piping: The longer the piping run, the greater the dynamic pressure loss.

Pipe size: Smaller pipes have greater dynamic pressure losses than larger pipes.

Pipe material: Different pipe materials have different friction coefficients.

Water conservation

Water conservation measures can also affect the minimum supply pressure. For example, reducing the flow rate of fixtures can also reduce the minimum supply pressure required.

There are a number of different methods for **sizing pipes**. The most common method is to use the Hazen-Williams equation. The Hazen-Williams equation is a formula that can be used to calculate the friction loss in pipes. It takes into account the following factors:

- Pipe diameter
- Pipe length
- Flow rate
- Hazen-Williams coefficient (C-factor)

The C-factor is a measure of the smoothness of the pipe material. The higher the C-factor, the smoother the pipe material and the less friction loss there will be.

To size a pipe using the Hazen-Williams equation, you will need to know the following:

- Flow rate (Q)
- Pipe length (L)
- Desired friction loss (h_f)
- Hazen-Williams coefficient (C)

Once you have this information, you can use the following equation to calculate the required pipe diameter (d):

```
d = sqrt((4 * Q^2) / (pi * v^2))
```

Where:

- d is the pipe diameter in inches
- Q is the flow rate in cubic feet per second (cfs)

- Pi is a mathematical constant with a value of approximately 3.14
- v is the velocity of the water in the pipe in feet per second (fps)
- The velocity of the water in the pipe can be calculated using the following equation:

- `v = Q / (pi * d^2)`

Once you have calculated the required pipe diameter, you can check to make sure that the friction loss is within the acceptable range. The acceptable range for friction loss will vary depending on the application. However, a typical range is 4 to 10 feet per 100 feet of pipe.

If the friction loss is too high, you will need to increase the pipe diameter. If the friction loss is too low, you can reduce the pipe diameter.

Other pipe sizing methods

In addition to the Hazen-Williams equation, there are a number of other methods for sizing pipes. Some of these other methods include:

Velocity method: This method involves sizing the pipe to ensure that the velocity of the water in the pipe is within the acceptable range.

Pressure drop method: This method involves sizing the pipe to ensure that the pressure drop in the pipe is within the acceptable range.

Nomo graphs: Nomo graphs are graphical charts that can be used to size pipes quickly and easily.

Choosing the right pipe sizing method

The best pipe sizing method to use will depend on the specific application. For example, if you are sizing a pipe for a water supply system, you will need to consider the following factors:

- The type of water (potable or non-potable)
- The flow rate
- The pressure drop
- The water temperature
- The type of pipe material

Calculate the flow rate of pipe in diameter 25 pipe

The flow rate of a pipe depends on the diameter of the pipe, the velocity of the fluid, and the cross-sectional area of the pipe. The following equation can be used to calculate the flow rate:

- Flow rate = Velocity × Cross-sectional area
- The velocity of the fluid can be estimated using the following equation:
- Velocity = Flow rate / Cross-sectional area

For a pipe with a diameter of 25 millimeters, the cross-sectional area can be calculated using the following equation:

Cross-sectional area = $\pi \times (\text{Diameter} / 2)^2$

Where π is a mathematical constant with a value of approximately 3.14.

Assuming that the fluid is water and the velocity of the fluid is 1 meter per second, the flow rate of a 25-millimeter pipe can be calculated as follows:

- Flow rate = Velocity × Cross-sectional area
- Flow rate = 1 m/s × π × (25 mm / 2)²
- Flow rate = 2945.24 liters per minute

Therefore, the flow rate of a 25-millimeter pipe is approximately 2945.24 liters per minute.

It is important to note that the actual flow rate of a pipe may vary depending on a number of factors, such as the type of fluid, the temperature of the fluid, and the roughness of the pipe walls.

Velocity requirements

Velocity requirements for water supply systems vary depending on the type of system and the specific application.

Cold water: The recommended maximum velocity for cold water in water supply systems is 8 feet per second (fps). This is to prevent water hammer and erosion of the pipes.

Hot water: The recommended maximum velocity for hot water in water supply systems is 5 fps. This is to prevent the formation of scale and to reduce the risk of pipe burns.

Fire protection systems: The recommended minimum velocity for water in fire protection systems is 10 fps. This is to ensure that adequate water flow is available to extinguish a fire.

In addition to these general guidelines, there are a number of other factors that can affect the required velocity of water in a water supply system, including:

Pipe size: Smaller pipes have higher velocity requirements than larger pipes.

Pipe material: Different pipe materials have different friction coefficients.

Water temperature: Hot water has a lower viscosity than cold water, so it can flow faster at the same velocity.

System pressure: Higher system pressure allows for higher water velocities.

It is important to consult with a qualified engineer to determine the specific velocity requirements for a water supply system.

Velocity requirements for different types of water supply systems:

Residential water supply systems: 8 fps for cold water and 5 fps for hot water.

Commercial water supply systems: 8 fps for cold water and 5 fps for hot water.

Industrial water supply systems: 8 fps for cold water and 5 fps for hot water.

Fire protection systems: 10 fps.

Circulating systems: are used to keep hot water moving through the pipes in a hot water system. This ensures that hot water is available at the tap immediately, without having to wait for the cold water to drain out of the pipes first.

Circulating systems typically consist of a pump, a return line, and a check valve. The pump circulates the hot water from the water heater through the pipes and back to the water heater. The return line allows the cooled water to return to the water heater to be reheated. The check valve prevents the cooled water from flowing back into the hot water pipes.

There are two main types of circulating systems:

Continuous circulating systems: These systems circulate the hot water continuously, even when no hot water is being used. This results in the highest level of comfort, but it also consumes the most energy.

Demand circulating systems: These systems only circulate the hot water when a hot water tap is turned on. This result in lower energy consumption, but it may take a few seconds for the hot water to reach the tap.

Circulating systems can be installed in both new and existing hot water systems. They are especially beneficial in homes with long pipe runs, as they can help to reduce the amount of water that is wasted while waiting for the hot water to arrive.

Benefits of circulating systems

Reduced water waste: Circulating systems help to reduce water waste by eliminating the need to wait for the hot water to arrive at the tap.

Increased comfort: Circulating systems provide instant hot water at the tap, which can be especially beneficial in cold weather.

Reduced energy consumption: Demand circulating systems can help to reduce energy consumption by only circulating the hot water when it is needed.

Drawbacks of circulating systems

Increased cost: Circulating systems can be more expensive to install than traditional hot water systems.

Increased maintenance: Circulating systems require regular maintenance, such as cleaning the pump and replacing the check valve.

Energy consumption: Continuous circulating systems consume more energy than traditional hot water systems.

The numberof fittings in a pipe run: will vary depending on the specific application and the design of the system

For example, a simple pipe run from a water heater to a kitchen sink may only have a few fittings, such as a coupling, an elbow, and a nipple. However, a more complex pipe run that serves multiple fixtures may have many more fittings, such as tees, crosses, and unions.

As a general rule of thumb, it is best to minimize the number of fittings in a pipe run. This is because each fitting adds resistance to the flow of fluid, which can reduce the pressure and flow rate at the point of use. Additionally, fittings can be potential leak points, so it is important to use high-quality fittings and install them properly.

some common pipe fittings and their typical use cases:

Fitting | Use Case

Coupling: Connects two pipes of the same size.

Elbow: Changes the direction of a pipe run.

Nipple: Short piece of pipe used to connect two fittings.

Tee: Connects three pipes together.

Cross: Connects four pipes together.

Union: Allows two pipes to be disconnected and reconnected without cutting the pipe. |

When designing a pipe run, it is important to consider the following factors:

- The type of fluid being transported.
- The flow rate of the fluid.
- The pressure at the point of use.
- The length of the pipe run.
- The number of fittings required.

Types of water heater:

Storage water heaters: These are the most common type of water heater. They have a large tank that stores heated water until it is needed. Storage water heaters can be powered by gas, electricity, or a combination of the two.

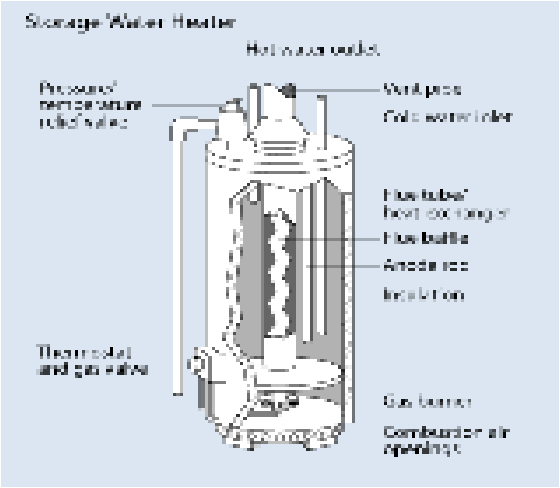

Figure 2.10 Storage water heaters

Tank less water heaters: These water heaters heat water on demand, so you never run out of hot water. Tank less water heaters are more energy-efficient than storage water heaters, but they can also be more expensive to purchase and install.

Figure 2.11 Thankless water heaters

Heat pump water heaters: Heat pump water heaters work by transferring heat from the air or ground to the water in the tank. Heat pump water heaters are very energy-efficient, but they may not be as effective in cold climates.

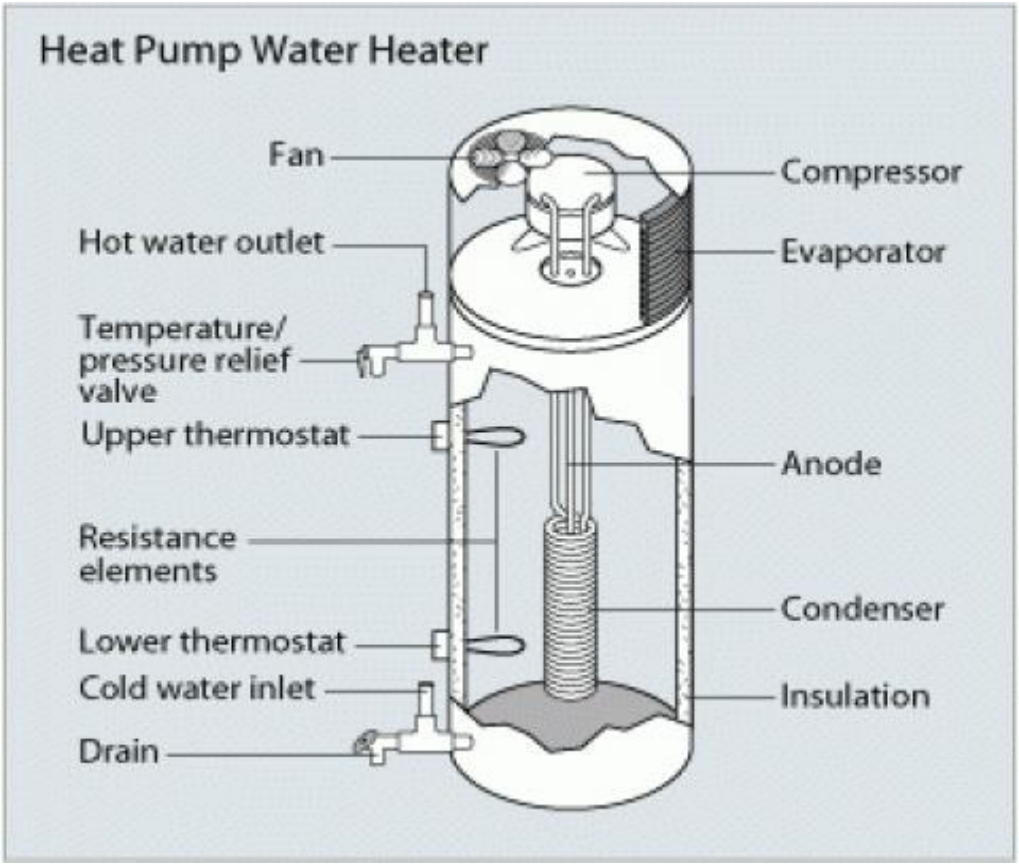

Figure 2.12 Heat pump water heaters

Solar water heaters: Solar water heaters use solar energy to heat water. Solar water heaters can be very energy-efficient, but they can also be more expensive to purchase and install.

Figure 2.13 Solar water heaters

some additional things to consider when choosing a water heater:

Fuel type: Do you want a gas, electric, or solar water heater?

Capacity: How much hot water do you need? The capacity of the water heater will depend on the size of your household and your hot water usage habits.

Energy efficiency: Look for a water heater with a high Energy Factor (EF). The EF is a measure of how efficiently the water heater uses energy.

Cost: Water heaters can range in price from a few hundred dollars to several thousand dollars. Consider your budget when making a decision.

Self-check-2

Part-I: Choose the correct answer.

1. Which of the following is NOT a key consideration when gathering information for the design of a hot and cold water system?

A) The number of occupants in the building

B) The type of fixtures and appliances that will be used

C) The availability of sunlight for solar water heating

D) The size of the building

2. Which of the following is NOT a requirement of the Ethiopian standards for designing hot and cold water systems?

A) The use of pressure-reducing valves

B) The use of backflow prevention devices

C) The use of tempering valves for hot water

D) The use of copper pipes for all water lines

3. Which of the following is the most important factor to consider when determining the quantity of fixtures for a hot and cold water system?

A) The number of occupants in the building

B) The type of building

C) The size of the building

D) The availability of water pressure

Part-II: Say true for right statement and false for wrong one

1. The Ethiopian standards for designing hot and cold water systems are based on international standards.

2. The quantity of fixtures for a hot and cold water system should be determined based on the maximum occupancy of the building.

3. The size of the hot and cold water pipes should be the same throughout the system.

Part-III: Answer the following questions accordingly

1. What are the three main sources of information that should be gathered for the design of a hot and cold water system?

2. What are the two main factors to consider when sizing a hot and cold water system?

OPERATION SHEET # 1

Operation title: Prepare design and sizing hot and cold water supply Line according to the given instructions.

Purpose: To practice and demonstrate the knowledge and skill required on Prepare designing and sizing for water supply Line according to the given instructions**.**

Tools and equipment:

- Pipe
- fixture
- heater
- Calculator
- Mater

Procedures:

Steps 1. Obtain a plumbing symbols guide. This will help you understand the different symbols used in the drawings. You can find plumbing symbols guides online or at your local library.

Steps 2. Identify the different parts of the plumbing system. This includes the water supply lines, drainage lines, vents, fixtures, and appliances.

Steps 3. Read the schedules that accompany the drawings. These schedules will provide more detailed information about the plumbing system, such as the size and type of pipes, the materials used, and the fixtures and appliances that are included.

Steps 4. Trace the lines on the drawings to understand how the plumbing system is connected. This will help you visualize how the water and waste will flow through the system.

Steps 5. Check for any errors or omissions in the drawings. This is important to do before you start any plumbing work.

PRECAUTION:

1. use safety tools and materials
2. The overall frame rigidity is relatively poor, it is difficult to open and close.

Quality Criteria: Assured performing of all the activities according to the procedures.

Lab Test 1

Instructions: Perform the following activity as required standard

Task 1: Collect necessary material and equipment for your work.

Task 2: Determine heating system

Task 3: Determine pipe size

Task 4: Finalize your work

Unit.3 Plan service and system layout

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- Laying hot and cold water service system
- Specifying and optimizing materials
- Recording plans
- Sustainability principles and concepts
- Restore work area

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Lay out hot and cold water service system
- Specify and optimizing materials
- Record plans
- Identify Sustainability principles and concepts
- Explain restore work area

3.1. Laying hot and cold water service system

Laying a hot and cold water service system is the process of installing plumbing pipes to distribute hot and cold water throughout a building. This system is essential for providing clean water for drinking, cooking, bathing, and other household needs.

The first step in laying a hot and cold water service system is to design the system. This involves determining the location of all fixtures, such as sinks, faucets, and showers, and then routing the pipes to connect each fixture to the main water supply.

Once the system has been designed, the next step is to install the pipes. This can be done using a variety of materials, including copper, PVC, and PEX. The specific type of material used will depend on the specific needs of the system and the budget of the homeowner.

Once the pipes have been installed, the next step is to connect them to the main water supply and to each fixture. This is done using a variety of fittings, such as elbows, tees, and couplings.

Once the pipes have been connected, the next step is to test the system to ensure that it is working properly. This involves turning on the water supply and checking for leaks at all of the connections.

Finally, once the system has been tested and found to be working properly, the next step is to insulate the hot water pipes. This helps to prevent heat loss and to reduce energy costs.

Here are some general tips for laying a hot and cold water service system:

- Use high-quality materials and fittings.
- Make sure that all connections are tight and secure.
- Insulate hot water pipes.
- Test the system thoroughly before putting it into use.

Laying hot and cold water pipes in residential buildings is a complex task that should be completed by a qualified plumber. However, there are some basic things that homeowners should know about the process.

Planning: The first step is to plan the layout of the pipes. This will involve identifying the locations of all fixtures, such as faucets, showers, and toilets. It is also important to consider the size of the pipes, as this will determine how much water can flow through them.

Installation: Once the layout has been planned, the pipes can be installed. This typically involves drilling holes in walls and floors to run the pipes. The pipes are then connected to each other and to the fixtures using fittings.

Insulation: It is important to insulate the hot water pipes to prevent heat loss and condensation. This can be done using foam insulation or fiberglass insulation.

Testing: Once the pipes have been installed, they must be tested to make sure that they are watertight. This can be done by turning on the water supply and checking for leaks.

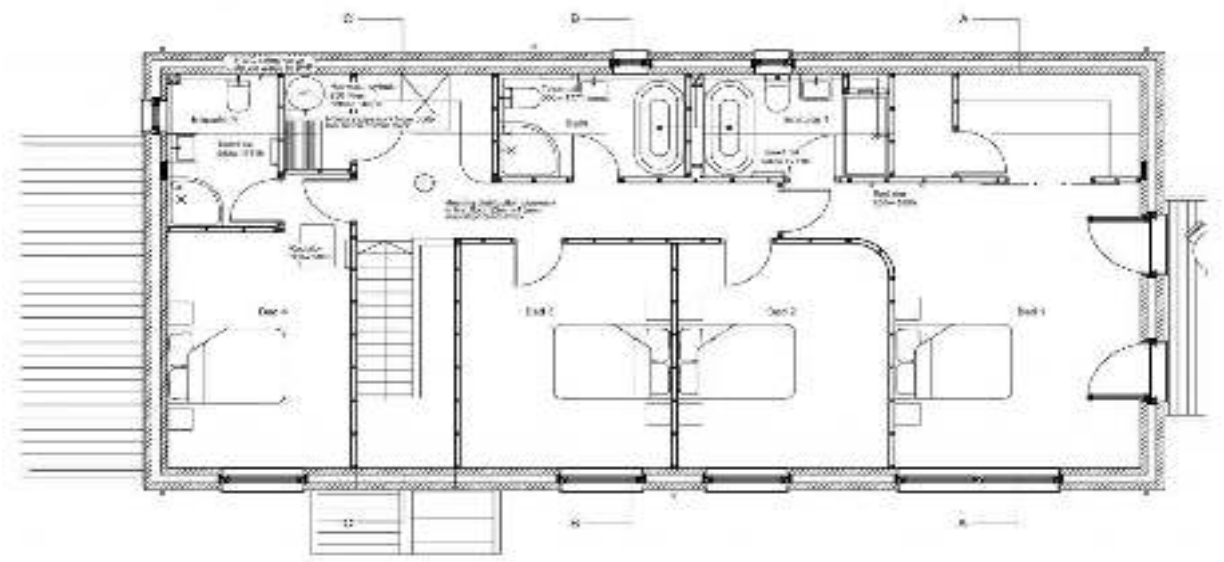

Figure 3.1 Laying hot and cold water service system

Plumbing for hot and cold water distribution is the system of pipes and fittings that carries hot and cold water from the water heater and cold water main to the various plumbing fixtures in a building.

The most common types of piping used for hot and cold water distribution are copper and PEX. Copper piping is durable and has a long lifespan, but it can be expensive. PEX piping is a newer

type of piping that is becoming increasingly popular. It is less expensive than copper piping and is also very durable.

The hot and cold water supply lines are typically run parallel to each other, with the hot water line on the left and the cold water line on the right. This helps to prevent the hot and cold water lines from interfering with each other. The hot and cold water lines are also typically run in a straight line, with as few bends as possible. This helps to reduce the amount of friction in the pipes, which can improve the water flow.

The hot and cold water supply lines are connected to the water heater and the cold water main, respectively. The hot and cold water supply lines are also connected to the various plumbing fixtures in the building, such as sinks, toilets, and showers.

The hot and cold water supply lines should be insulated to prevent heat loss or gain. This helps to improve the efficiency of the water heater and the overall energy efficiency of the building.

The hot and cold water supply lines should be installed in accordance with all applicable building codes and regulations.

Here are some additional tips for designing and installing a hot and cold water distribution system:

- Use the shortest possible runs of pipe to reduce friction and improve water flow.
- Install shut-off valves at all fixtures and appliances to facilitate maintenance and repairs.
- Insulate all hot water pipes to prevent heat loss and save energy.
- Use a pressure regulator to reduce water pressure to a safe level, if necessary.
- Test the system regularly for leaks and other problems.

The commissioning and testing of hot and cold water systems is a critical step in ensuring that they are installed correctly and will operate safely and efficiently. It is important to have these systems commissioned and tested by a qualified plumber or plumbing contractor.

The commissioning and testing process typically includes the following steps:

1. Inspection: The plumber or contractor will inspect the entire system to ensure that it has been installed correctly and that all components are functioning properly. This includes checking the pipe work for leaks, the valves for proper operation, and the temperature and pressure settings.

2. Flushing: The system will be flushed to remove any debris or sediment that may have accumulated during installation. This is important to prevent the buildup of scale and other deposits, which can reduce the efficiency of the system and shorten its lifespan.

3. Testing: The system will be tested to ensure that it is operating safely and efficiently. This includes checking the water pressure, temperature, and flow rate. The plumber or contractor may also perform a hydraulic test to check the system for leaks.

4. Balancing: The system will be balanced to ensure that all fixtures are receiving the correct amount of water pressure and flow rate. This is important to prevent water hammer and other problems.

5. Documentation: The plumber or contractor will provide the building owner or operator with a commissioning and testing report. This report should document all of the work that was performed and the results of the tests.

In addition to the commissioning and testing steps listed above, the plumber or contractor may also perform the following:

Sanitizing: The system may be sanitized to remove any bacteria or other microorganisms that may be present. This is important to protect the health of building occupants.

Training: The plumber or contractor may provide training to building owners or operators on how to operate and maintain the hot and cold water system. This training is important to ensure that the system is used safely and effectively.

3.2. Specifying and optimizing materials

The specification and optimization of materials is a critical step in the design and manufacturing of any product. The right material can make a big difference in the performance, cost, and durability of a product.

There are a number of factors to consider when specifying and optimizing materials, including:

The application: What will the product be used for? What are the performance requirements?

The environment: Where will the product be used? What environmental conditions will it be exposed to?

The cost: How much is the product budget? What is the cost of the different materials under consideration?

The manufacturing process: How will the product be manufactured? What are the processing requirements of the different materials under consideration?

Once these factors have been considered, a list of candidate materials can be generated. These materials can then be evaluated based on their properties, such as strength, stiffness, weight, corrosion resistance, and cost.

There are a number of different methods for optimizing materials. One common method is to use a design of experiments (DOE) approach. In a DOE, different combinations of material properties are tested to see which combination produces the best results.

Another common method for optimizing materials is to use computer simulation. Computer simulation can be used to model the performance of a product under different conditions, using different materials. This can help to identify the best material for a particular application.

Once a material has been selected, it is important to specify the material properties correctly. This is typically done by providing the supplier with a material specification.

The material specification should include the following information:

The material grade: This identifies the specific type of material.

The chemical composition: This specifies the chemical elements that are present in the material and their relative proportions.

The mechanical properties: This specifies the mechanical properties of the material, such as strength, stiffness, and ductility.

The physical properties: This specifies the physical properties of the material, such as density, melting point, and electrical conductivity.

By carefully specifying and optimizing materials, engineers can design and manufacture products that meet the required performance requirements at a competitive cost.

some additional tips for specifying and optimizing materials:

Use standard specifications: Whenever possible, use standard material specifications. This will make it easier to find suppliers and ensure that the material meets the required quality standards.

Consider multiple materials: Don't be afraid to consider multiple materials for a particular application. Sometimes, a combination of materials can provide the best results.

Work with a materials engineer: If you are unsure about which material to choose or how to specify it, consult with a materials engineer. They can help you to select the right material for your application and ensure that it is properly specified.

Specifying and optimizing materials for designing and sizing hot and cold water service

Specifying materials

The type of material used for hot and cold water service pipes and fittings depends on a number of factors, including:

- The temperature and pressure of the water
- The type of water (e.g., potable water, non-potable water, recycled water)
- The environment in which the pipes will be installed (e.g., indoors, outdoors, underground)

The budget

Some common materials used for hot and cold water service include:

Copper: Copper is a durable and corrosion-resistant material that is well-suited for both hot and cold water service. It is also relatively easy to work with and install.

CPVC (chlorinated polyvinyl chloride): CPVC is a lightweight and durable plastic that is resistant to corrosion and high temperatures. It is a good choice for both hot and cold water service, but it can be **more expensive than copper.**

PEX (cross-linked polyethylene): PEX is a flexible and durable plastic that is resistant to corrosion and high temperatures. It is a good choice for both hot and cold water service, and it is often less expensive than copper and CPVC.

Optimizing materials

When selecting materials for hot and cold water service, it is important to consider the following factors:

Insulation: Insulating hot water pipes can help to reduce heat loss and save energy. Pipe insulation can be made from a variety of materials, including foam rubber, fiberglass, and mineral wool.

Corrosion resistance: Materials that are resistant to corrosion will last longer and require less maintenance.

Heat resistance: Materials that are resistant to heat can be used for hot water service without the risk of melting or deforming.

Cost: The cost of materials is a factor that must be considered when selecting materials for hot and cold water service.

Designing and sizing hot and cold water service

When designing and sizing hot and cold water service, it is important to consider the following factors:

Water demand: The water demand of the building or facility will determine the size of the pipes and fittings that are needed.

Water pressure: The water pressure in the building or facility will determine the type of pipe and fittings that can be used.

Pipe length: The length of the pipe runs will affect the water pressure and flow rate.

Pipe fittings: Pipe fittings can restrict the flow of water, so it is important to select fittings that are the right size for the pipe runs. Recording plans for designing and sizing hot and cold water service is the process of documenting the design and sizing of a hot and cold water system. This includes recording the following information:

- The type of system (e.g., central, decentralized)
- The water source (e.g., municipal, well)
- The demand for hot and cold water (e.g., gallons per minute)
- The pipe sizes and materials
- The location of all fixtures and equipment
- The design pressure and temperature

3.3. Recording plans

A plan is a predetermined course of action. It is a blueprint for goal achievement. Simply stated, it is setting goals and deciding how to achieve them. Planning is deciding in advance what to do, how to do it, when to do it and who is to do it. It bridges the gap from where we are to where we want to go.

Plans can be formal or informal, simple or complex, short-term or long-term. They can be created for individuals, teams, organizations, or even entire societies.

There are many different ways to plan, but the basic steps are typically the same:

1. Set a goal. What do you want to achieve?
2. Identify the steps needed to achieve your goal. What tasks need to be completed?
3. Estimate the time and resources needed for each step.
4. Create a timeline for completing the tasks.
5. Assign tasks to individuals or teams.
6. Identify potential risks and challenges.
7. Develop strategies to manage risks and challenges.
8. Monitor your progress and make adjustments as needed.

Planning is important because it helps us to:

Be more efficient and effective. When we have a plan, we can avoid wasting time and resources on unnecessary tasks.

Reduce risk. By identifying and planning for potential risks, we can minimize their impact.

Be more prepared. When we have a plan, we know what we need to do and when we need to do it. This can help us to stay on track and avoid surprises.

Communicate with others. A plan can be a valuable tool for communicating our goals and objectives to others. This can help to ensure that everyone is working towards the same thing.

Examples of plans:

- A business plan outlines the goals and strategies of a business.
- A marketing plan outlines the strategies for promoting and selling a product or service.
- A project plan outlines the steps and tasks required to complete a project.
- A personal plan outlines the goals and objectives that an individual wants to achieve in their life.

Planning is an essential skill for success in all areas of life. By taking the time to plan, we can increase our chances of achieving our goals.

A recording is a capture of data or signals that can be reproduced later. It can be audio, video, or both. Recordings are made using a variety of devices, including microphones, cameras, and recording software.

Recordings can be used for a variety of purposes, in

Here are some examples of recordings including:

Entertainment: Recordings of music, movies, and TV shows are used to entertain people.

Education: Recordings of lectures, classes, and other educational materials can be used to help people learn.

Business: Recordings of meetings, conferences, and training sessions can be used to document and share information.

Personal use: Recordings of family events, vacations, and other personal memories can be cherished for years to come.

Recordings can also be used as evidence in legal proceedings. For example, a recording of a confession or a crime in progress can be used to convict a criminal.

Recordings have played an important role in society for centuries. The first recordings were made using wax cylinders in the late 19th century. Since then, recording technology has evolved rapidly, and now we can make high-quality recordings using digital devices. A song on a CD or MP3 player

- A movie on a DVD or streaming service
- A TV show on a DVR or streaming service
- A lecture recorded on a smart phone
- A meeting recorded on a conference room phone
- A family event recorded on a home video camera
- A crime in progress recorded on a security camera

Recordings can be stored on a variety of media, including CDs, DVDs, hard drives, and cloud storage services. Recordings can also be shared online or streamed to devices.

Recordings are an important part of our lives. They help us to entertain ourselves, learn new things, document our experiences, and preserve our memories.

Recording plans are important for a number of reasons. First, they provide a record of the design of the system, which can be helpful for troubleshooting and maintenance purposes. Second, they can be used to obtain permits from local authorities. Third, they can be used to solicit bids from contractors.

There are a number of different ways to record plans for designing and sizing hot and cold water service. One common method is to use computer-aided design (CAD) software. CAD software allows users to create detailed drawings of the system, including pipe sizes, materials, and fixture locations. Another common method is to use hand-drawn sketches. Hand-drawn sketches are less precise than CAD drawings, but they can be a more cost-effective option for small projects.

Regardless of the method used, it is important to include all of the necessary information on the recording plans. This will help to ensure that the system is designed and sized correctly and that it meets all applicable codes and standards.

some examples of what might be included in recording plans for designing and sizing hot and cold water service:

- A site plan showing the location of the water source, fixtures, and equipment
- A schematic diagram of the system showing the piping layout
- A pipe sizing table showing the pipe diameter and material for each section of the system
- A fixture list showing the type and quantity of each fixture
- A water demand calculation showing the estimated demand for hot and cold water
- A design pressure and temperature calculation

3.4. Sustainability principles and concepts

Sustainability principles and concepts are the foundational ideas that guide the pursuit of a sustainable future. They are based on the understanding that the environment, society, and economy are interconnected, and that we must meet the needs of the present without compromising the ability of future generations to meet their own needs.

Some of the key sustainability principles and concepts include:

Systems thinking: This approach recognizes that the world is a complex system of interconnected parts, and that we need to understand how these parts interact in order to make sustainable decisions.

Resilience: This is the ability of a system to withstand and recover from shocks and disturbances. Resilience is essential for sustainability in the face of challenges such as climate change and resource scarcity.

Interconnectedness: This principle emphasizes that the environment, society, and economy are all interconnected, and that decisions made in one area can have unintended consequences in others.

Equity: This principle calls for fair and just treatment for all people, both present and future. It is essential for sustainability to ensure that everyone has access to the resources and opportunities they need to thrive.

Precaution: This principle states that we should take action to prevent or mitigate potential harms, even if there is scientific uncertainty about their likelihood or severity.

Participation: This principle emphasizes the importance of involving all stakeholders in decision-making processes that affect them. This helps to ensure that sustainability initiatives are fair and effective.

Transparency: This principle calls for open and honest communication about sustainability issues and initiatives. Transparency is essential for building trust and accountability.

Accountability: This principle states that we are all responsible for our actions and their impact on the environment, society, and economy. We must be held accountable for our choices and work together to build a more sustainable future.

These principles and concepts can be applied to all aspects of our lives, from the individual level to the global level. For example, we can use systems thinking to understand how our food choices impact the environment, society, and economy. We can build resilience in our communities by investing in renewable energy and sustainable transportation infrastructure. We can promote equity by ensuring that everyone has access to clean water and sanitation. And we can take precautionary action to address climate change by reducing our greenhouse gas emissions.

Sustainability assessment and measurement are the processes of evaluating and quantifying the environmental, social, and economic impacts of a product, process, or organization. They are essential tools for identifying and managing sustainability risks and opportunities, and for tracking progress towards sustainability goals.

There are a variety of different sustainability assessment and measurement methodologies available, each with its own strengths and weaknesses. Some of the most common methodologies include:

- **Life cycle assessment (LCA):** LCA is a holistic approach to assessing the environmental impacts of a product or service over its entire life cycle, from raw material extraction to disposal.
- **Carbon foot printing**: Carbon foot printing is a specific type of LCA that focuses on the greenhouse gas emissions associated with a product or service.
- **Social impact assessment (SIA**): SIA assesses the social impacts of a product, process, or organization on individuals, communities, and society as a whole.
- **Economic impact assessment (EIA):** EIA assesses the economic impacts of a product, process, or organization on the economy, including employment, investment, and trade.
- **Integrated sustainability assessment (ISA**): ISA combines elements of LCA, SIA, and EIA to provide a comprehensive assessment of the environmental, social, and economic impacts of a product, process, or organization.

The choice of sustainability assessment and measurement methodology will depend on the specific needs of the organization and the scope of the assessment. For example, a company that is developing a new product may want to conduct an LCA to identify and reduce the environmental impacts of the product. A company that is operating in a high-risk country may want to conduct an SIA to identify and mitigate the social impacts of its operations. And a government agency that is developing a new policy initiative may want to conduct an ISA to assess the overall environmental, social, and economic impacts of the initiative.

Sustainability assessment and measurement are essential tools for organizations of all sizes and types. By understanding and managing their sustainability impacts, organizations can reduce their risks, improve their performance, and build a more sustainable future.

Sustainability assessment and measurement can be used:

- A company can use LCA to identify the most environmentally damaging stages of its product life cycle and then make changes to reduce its environmental impact.
- A government agency can use SIA to assess the social impacts of a new infrastructure project before it is built, and then make changes to minimize the negative impacts and maximize the positive impacts.

- An investor can use ESG (environmental, social, and governance) criteria to assess the sustainability performance of potential investments.
- A consumer can use sustainability labels to choose products that have been assessed and certified to meet certain sustainability standards.

Sustainability management and governance are the processes and structures that organizations use to integrate sustainability into their business operations and decision-making. Sustainability management includes activities such as setting sustainability goals, developing and implementing sustainability strategies, and monitoring and reporting on progress. Sustainability governance includes the roles and responsibilities of different stakeholders in overseeing and managing sustainability initiatives.

Effective sustainability management and governance is essential for organizations of all sizes and types. By integrating sustainability into their core business operations, organizations can reduce their environmental and social impacts, improve their performance, and build a more sustainable future.

the key elements of sustainability management and governance:

- Leadership and commitment: Sustainability must be championed by senior leadership and embedded throughout the organization.
- Strategy and planning: Organizations should develop a sustainability strategy that outlines their goals, targets, and actions for achieving sustainability.
- Implementation: Organizations should implement their sustainability strategy through a variety of programs and initiatives.
- Monitoring and reporting: Organizations should monitor their progress towards sustainability goals and report on their performance to stakeholders.
- Sustainability governance should ensure that sustainability is integrated into all aspects of the organization, including its decision-making processes, risk management systems, and performance management frameworks. It should also ensure that stakeholders have a voice in the organization's sustainability initiatives.

Here are some of the key benefits of effective sustainability management and governance:

- Reduced environmental and social impacts
- Improved operational efficiency and productivity
- Enhanced brand reputation and customer loyalty
- Attracted and retained top talent
- Reduced regulatory risk
- Increased access to capital

Many organizations are now adopting sustainability standards and frameworks to help them manage and govern their sustainability initiatives. Some of the most common sustainability standards and frameworks include:

- Global Reporting Initiative (GRI) Standards
- Sustainability Accounting Standards Board (SASB) Standards
- ISO 14001 Environmental Management System
- ISO 26000 Social Responsibility Standard
- UN Global Compact

B Sustainability principles and concepts of designing and sizing hot and cold water service include:

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Water conservation: Designing and sizing hot and cold water systems to minimize water waste. This can be achieved by using low-flow fixtures and appliances, rainwater harvesting systems, and grey water recycling systems.

Renewable energy: Designing and sizing hot and solar water heating systems to use renewable energy sources to heat water. This can reduce greenhouse gas emissions and save on energy costs.

Durability: Designing and sizing hot and cold water systems using durable materials and construction methods to extend their lifespan. This can reduce the need for replacement and repairs, which can save money and resources.

Some specific concepts and strategies that can be used to achieve these sustainability principles:

Use efficient fixtures and appliances. This includes low-flow toilets and showerheads, water-efficient washing machines and dishwashers, and energy-efficient water heaters.

Insulate pipes. This helps to reduce heat loss from hot water pipes and cold water gain from chilled water pipes.

Design systems with short pipe runs. This minimizes the amount of water that needs to be heated or chilled, and reduces the amount of energy lost through pipe friction.

Use rainwater harvesting systems. These systems collect rainwater from rooftops and other surfaces and store it for later use. This can reduce the amount of municipal water used for irrigation, washing cars, and other non-potable purposes.

Use grey water recycling systems. These systems collect and treat wastewater from sinks, showers, and baths for reuse in irrigation or other non-potable applications. This can further reduce the amount of municipal water used.

Use solar water heating systems. Solar water heating systems use the sun's energy to heat water. This can reduce greenhouse gas emissions and save on energy costs.

When designing and sizing hot and cold water systems, it is important to consider the following factors:

Water demand: The amount of water that will be used by the occupants of the building. This will depend on the type and size of the building, the number of occupants, and their water usage habits.

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Water pressure: The water pressure that is available at the site. This will determine the type and size of pumps that need to be used.

Pipe sizing: The pipes need to be sized to meet the water demand and pressure requirements.

By considering these factors and using sustainable design principles, it is possible to design and size hot and cold water systems that are efficient, water-conserving, and durable.

Here are some additional tips for designing and sizing sustainable hot and cold water systems:

Use a demand-based water heating system. These systems heat water only when it is needed, which can save energy and money.

Install a recalculating pump. This pump circulates hot water through the pipes so that it is available immediately when a tap is turned on. This can reduce water waste and save energy.

Use a water softener. This can help to prevent scale buildup in pipes and fixtures, which can improve water efficiency and extend the lifespan of the system.

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- ISO 26000 Social Responsibility Standard
- UN Global Compact

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Durability: Designing and sizing hot and cold water systems using durable materials and construction methods to extend their lifespan. This can reduce the need for replacement and repairs, which can save money and resources.

Some specific concepts and strategies that can be used to achieve these sustainability principles:

Use efficient fixtures and appliances. This includes low-flow toilets and showerheads, water-efficient washing machines and dishwashers, and energy-efficient water heaters.

Insulate pipes. This helps to reduce heat loss from hot water pipes and cold water gain from chilled water pipes.

Design systems with short pipe runs. This minimizes the amount of water that needs to be heated or chilled, and reduces the amount of energy lost through pipe friction.

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Peak water demand: The maximum amount of water that will be used at any given time. This will typically occur during peak periods, such as in the morning when people are getting ready for work or school.

Water pressure: The water pressure that is available at the site. This will determine the type and size of pumps that need to be used.

Pipe sizing: The pipes need to be sized to meet the water demand and pressure requirements.

By considering these factors and using sustainable design principles, it is possible to design and size hot and cold water systems that are efficient, water-conserving, and durable.

Here are some additional tips for designing and sizing sustainable hot and cold water systems:

Use a demand-based water heating system. These systems heat water only when it is needed, which can save energy and money.

Install a recalculating pump. This pump circulates hot water through the pipes so that it is available immediately when a tap is turned on. This can reduce water waste and save energy.

Use a water softener. This can help to prevent scale buildup in pipes and fixtures, which can improve water efficiency and extend the lifespan of the system.

Use a water filter. This can help to remove impurities from the water, which can improve water quality and extend the lifespan of fixtures and appliances.

3.5. Restore work area

Restoring a work area is the process of returning it to its original condition after it has been used for a project or task. This may involve cleaning up debris, putting away tools and equipment, and repairing any damage that was caused.

Restoring a work area is important for safety and efficiency. A cluttered and unorganized work area can be dangerous, and it can also make it difficult to find the tools and materials you need. A clean and organized work area is a safe and productive place to work.

The steps involved in restoring a work area:

1. Identify and dispose of any hazardous materials. This may include used chemicals, solvents, or other materials that could pose a risk to your health or safety.
2. Clean up any debris. This may include dust, dirt, sawdust, or other materials that were generated during the project or task.
3. Put away tools and equipment. Make sure that all tools and equipment are clean and in good condition before putting them away.
4. Repair any damage that was caused. This may involve fixing holes in the walls, replacing broken windows, or cleaning up spills.
5. Inspect the work area to make sure that it is safe and ready for use.

   Restoring a work area is an important part of any project or task. By following the steps above, you can help to ensure that your work area is safe and efficient.

   Some additional tips for restoring a work area:

- Start by cleaning up the largest items first. This will help to make the space feel more organized and less cluttered.
- Use a broom and dustpan to sweep up any debris. You may also want to use a vacuum cle aner to get into hard-to-reach places.
- Put away all tools and equipment in their designated storage areas. This will help to keep your work area organized and make it easier to find what you need when you need it.

- Repair any damage that was caused during the project or task. This will help to prevent further damage and keep your work area looking its best.
- Inspect the work area to make sure that it is safe and ready for use. This includes checking for any trip hazards, electrical hazards, or other potential hazards.

Restoring, designing, sizing, and hot and cold water service in a work area is a complex process that requires careful planning and execution. The goal is to create a safe and efficient system that provides the necessary amount of hot and cold water to all fixtures and appliances in the work area.

The first step is to assess the current state of the work area and identify any areas that need to be restored or upgraded. This may involve repairing or replacing damaged pipes, valves, and fixtures. It is also important to consider the future needs of the work area and ensure that the new system is designed to accommodate growth.

Once the current state of the work area has been assessed, the next step is to design the new system. This involves determining the size and type of pipes, valves, and fixtures that are needed. It is also important to consider the layout of the work area and ensure that the new system is easy to access and maintain.

Once the system has been designed, the next step is to size it. This involves determining the amount of hot and cold water that is needed to meet the needs of the work area. This will depend on the number of fixtures and appliances in the work area, as well as the type of work that is performed.

Finally, the hot and cold water service needs to be installed. This involves connecting the pipes, valves, and fixtures to the main water supply. It is important to follow all applicable codes and regulations when installing the system.

- Some tips for restoring, designing, sizing, and hot and cold water service in a work area:

- Use high-quality materials and components. This will help to ensure that the system is durable and reliable.
- Consider the future needs of the work area. Design the system so that it can be easily expanded as needed.
- Make sure the system is easy to access and maintain. This will help to reduce downtime and maintenance costs.
- Follow all applicable codes and regulations when installing the system.

Self-check-3

Part-I: Choose the correct answer

1. Which of the following is NOT a factor to consider when specifying materials for a hot and cold water service system?

   A. Temperature rating of the materials
   C. Cost of the materials
   B. Pressure rating of the materials
   D. Corrosion resistance of the materials

2. Which of the following is NOT a best practice for recording plans for a hot and cold water service system?

   A. Using a computer-aided design (CAD) program to create drawings of the system
   B. Labeling all pipes and fittings clearly
   C. Including notes on the drawings that explain the function of each component of the system
   D. Using abbreviations and symbols that are not universally recognized

3. Which of the following is NOT a sustainability principle that can be applied to the design and installation of a hot and cold water service system?

   A. Using water-efficient fixtures and appliances
   B. Using materials that are made from recycled content
   C. Insulating pipes to reduce heat loss
   D. Using a water heater that is powered by renewable energy

4. Which of the following is NOT a step involved in restoring a work area after laying a hot and cold water service system?

   A. Removing all debris from the work area
   B. Repairing any damage to the walls or floors
   C. Testing the water system to ensure that it is working properly
   D. Leaving the work area in a clean and tidy condition

Part-II: Say true for right statement and false for wrong one

1. It is important to use materials that are rated for the temperature and pressure of the water system when laying a hot and cold water service system.
2. Recording plans for a hot and cold water service system is not necessary, as experienced plumbers can easily install the system without the need for drawings.
3. Sustainability principles can be applied to the design and installation of a hot and cold water service system to reduce environmental impact and save money on energy costs.
4. It is important to restore the work area to its original condition after laying a hot and cold water service system.

Part-III: Answer the following questions accordingly

1. What are some of the factors to consider when specifying materials for a hot and cold water service system?
2. What are some of the benefits of recording plans for a hot and cold water service system?
3. What are some of the sustainability principles that can be applied to the design and installation of a hot and cold water service system?

Reference book

1. Hot and Cold Water Supply by Robert H. Garrett (BSI, 2023)
2. Plumbing Designers Guide by David W. Smith
3. Plumbing Engineering Design Handbook by Dwight D. Davis
4. Water Supply and Drainage in Buildings by the American Society of Plumbing Engineers (ASPE)

Developer's Profile

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