Sanitary Sewers Design

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Outline

- Objective
- Overview Sanitary Drainage System
- Standard References
- Design
- Materials

Objective

Address the minimum requirements for Sanitary Sewers System that are located in Saudi Aramco facilities

General Overview of Sanitary Drainage System

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Overview of Sanitary Drainage System

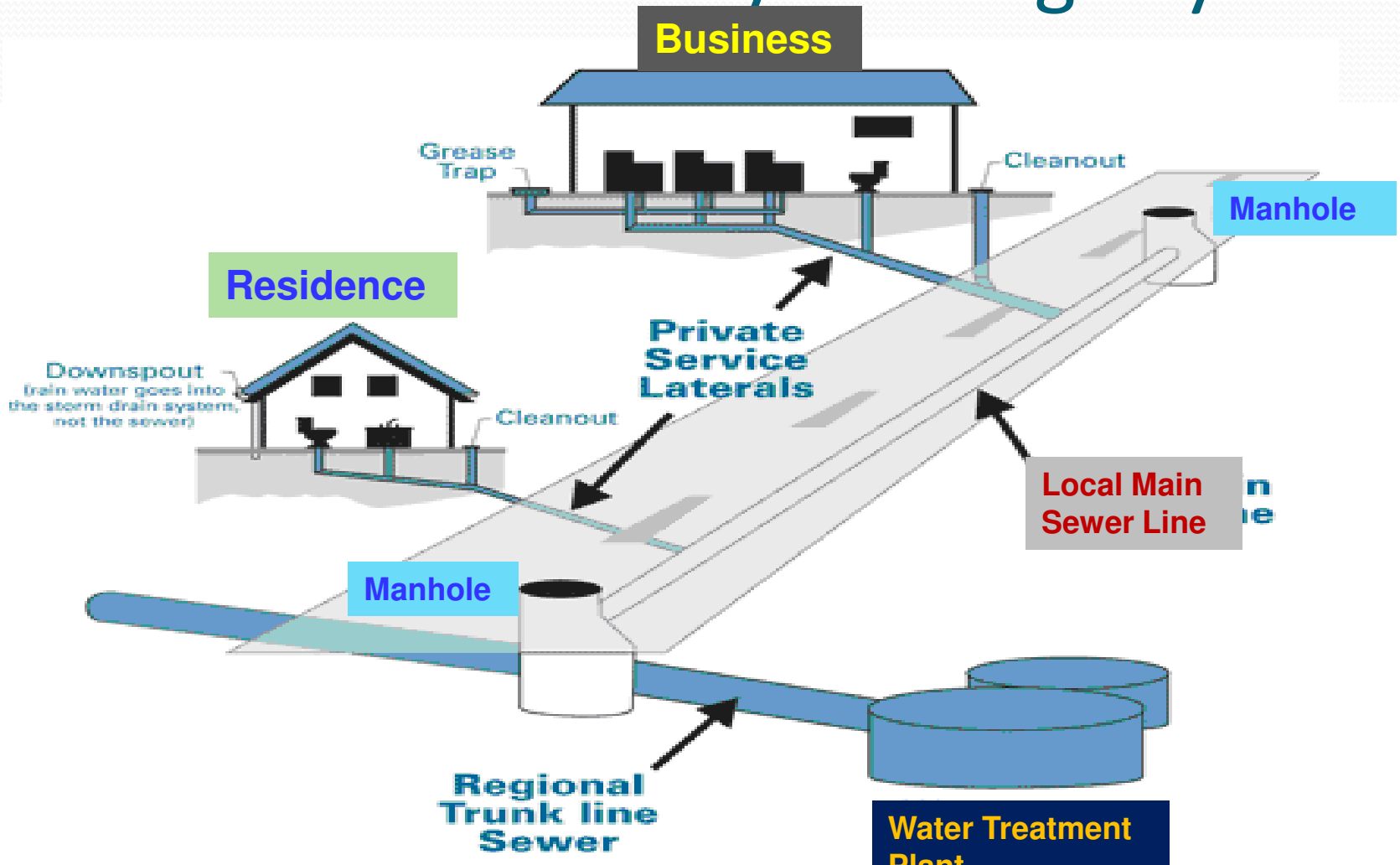
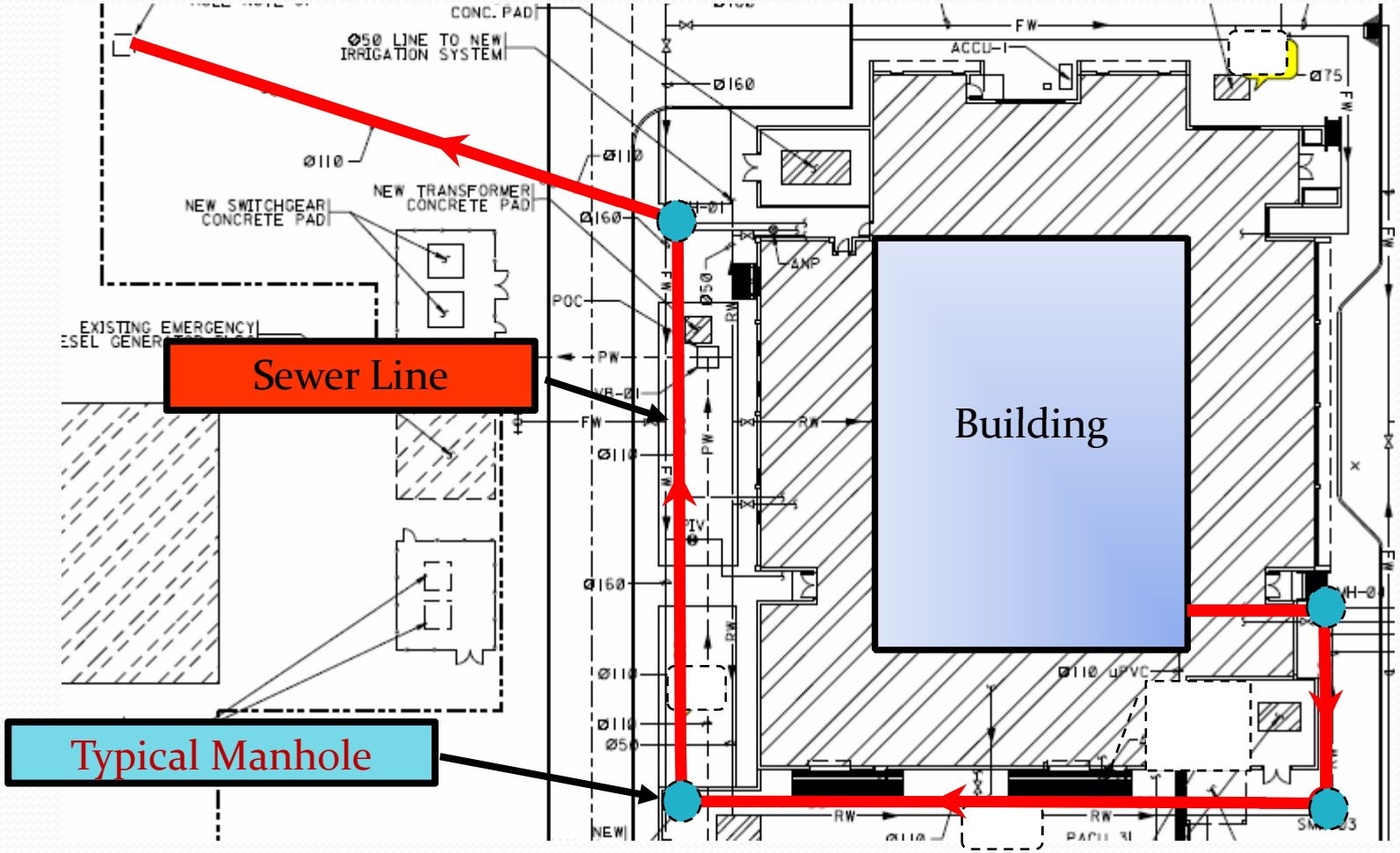


Diagram of a sanitary sewer system

Sanitary Drainage System



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References

- Saudi Aramco Engineering Standards
  - SAES-A-104 Wastewater Treatment, Reuse & Disposal
  - SAES-B-068 Electrical Area Classification
  - SAES-G-005 Pumps
  - SAES-H-002 Internal and external Coatings
  - SAES-H-003 Coating Requirements for Concrete Surfaces
  - SAES-L-105 Piping Material Specifications
  - SAES-M-006 Security and General Purpose Fencing
  - SAES-Q-001 Design and Construction of Concrete Structures
  - SAES-S-020 Industrial Drainage and Sewers
  - SAES-S-060 Plumbing Code
  - SAES-S-070 Installation of Utility Piping Systems
  - SAES-Z-004 Supervisory Control and Data Acquisition (SCADA) System.

References

- Saudi Aramco Materials System Specifications

• 01-SAMSS-029	RTR (Fiberglass) Sewer Pipe and Fittings for Gravity Flow
• 01-SAMSS-034	RTR(Fiberglass) Pressure Pipe and Fittings
• 12-SAMSS-024	Fiber-Reinforced Plastic (FRP) Manhole and Access Covers with Frame

References

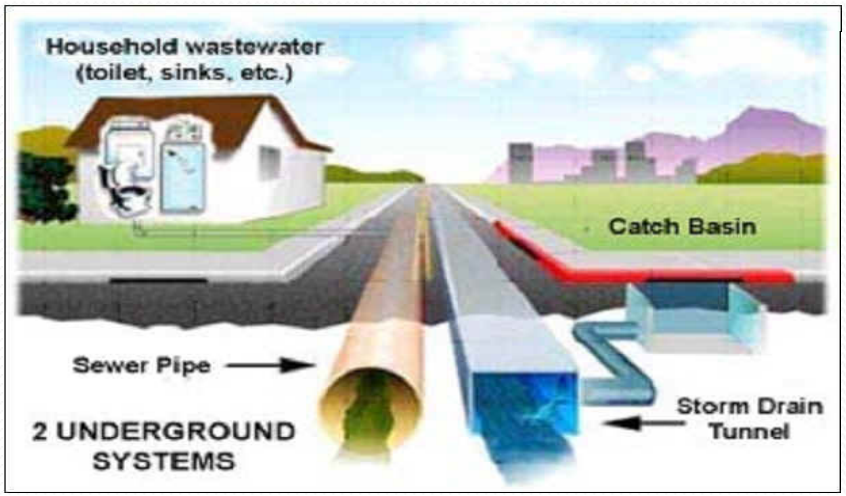
- Saudi Aramco Standard Drawing
  - AB-036380 Sanitary Sewer Manhole Precast Concrete Plan, Section and Detail
- Saudi Aramco General Instruction
  - GI-0151.006 Implementing the Saudi Aramco Sanitary Code

References

- Industry Codes and Standards
  - American National Standards Institute
    - ANSI A14.3 Safety Requirements for Fixed Ladders
  - American Society for Testing and Materials
    - ASTM A53 Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
    - ASTM D1785 PVC Plastic Pipe, Schedules 40, 80, and 120
    - ASTM D2564 Solvent Cements PVC Plastic Piping Systems
    - ASTM D2665 PVC)Plastic drain, Waste, and Vent Pipe and Fittings
    - ASTM D2855 Making Solvent Cemented Joints with PVC Pipe
    - ASTM D3212 Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
    - ASTM D3311 Drains, Waste, and Vent (DWV) Plastic Fittings Patterns
    - ASTM D3350 Polyethylene Plastics Pipe and Fittings Materials
    - ASTM F585 Insertion of Flexible Polyethylene Pipe into Existing Sewers

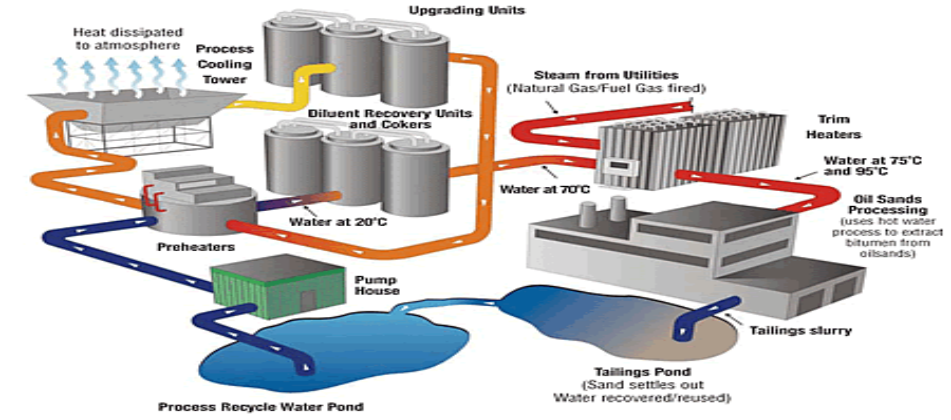
Design

- Wastes Prohibited for Discharge into Public Sewers
  - Rain water, surface water, ground water, roof run-off, subsurface drainage, or cooling water



Design

- Wastes Prohibited for Discharge into Public Sewers
  - Unpolluted industrial process water
  - Liquid or vapor having a temperature more than 65°C (149°F).
  - Water or waste containing more than 100 parts per million by weight of animal fat, vegetable fat, oil, or grease.
  - Hydrocarbon solids, liquids or gases or any other flammable or explosive solids, liquids or gases.
  - Any garbage that has not been properly shredded.



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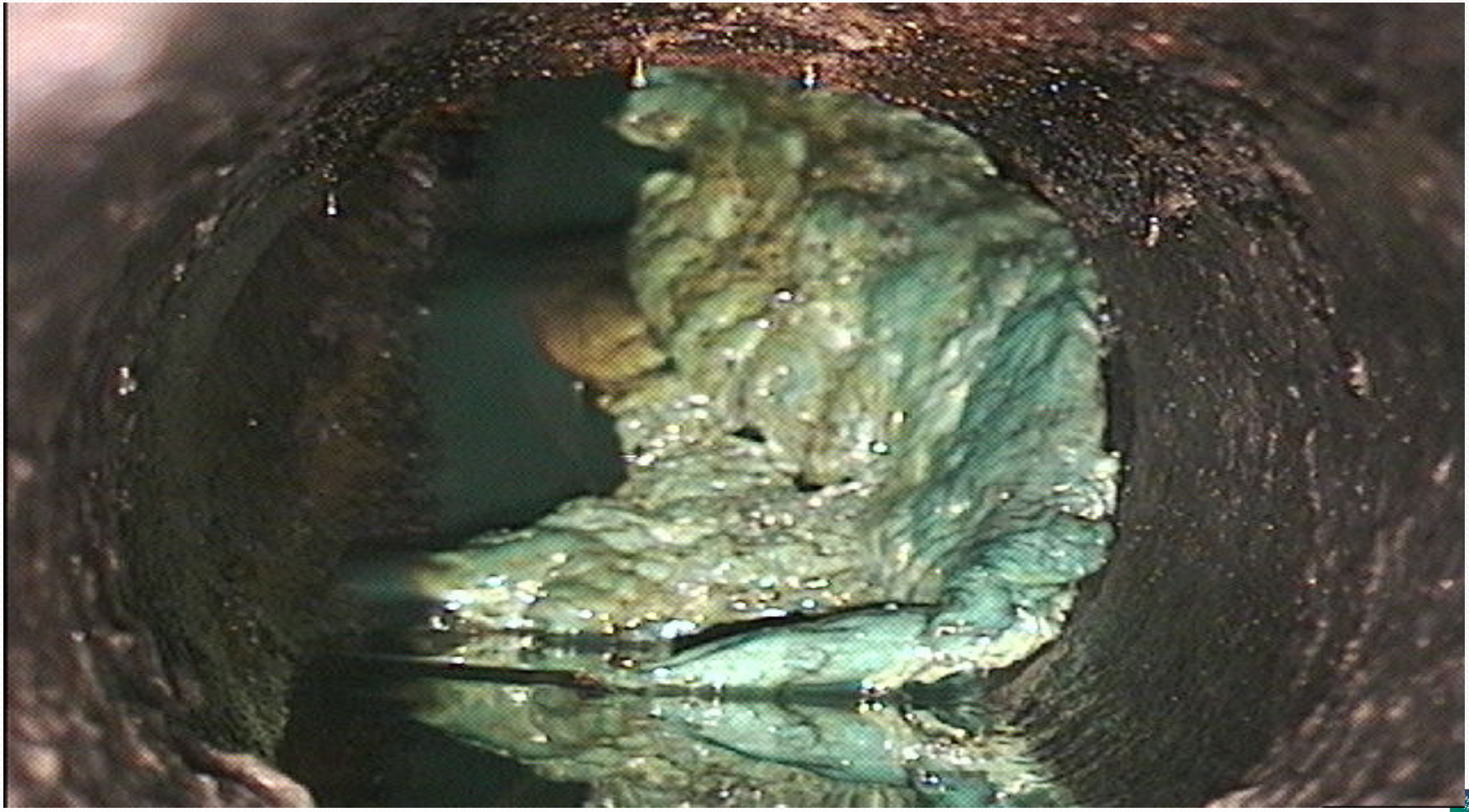
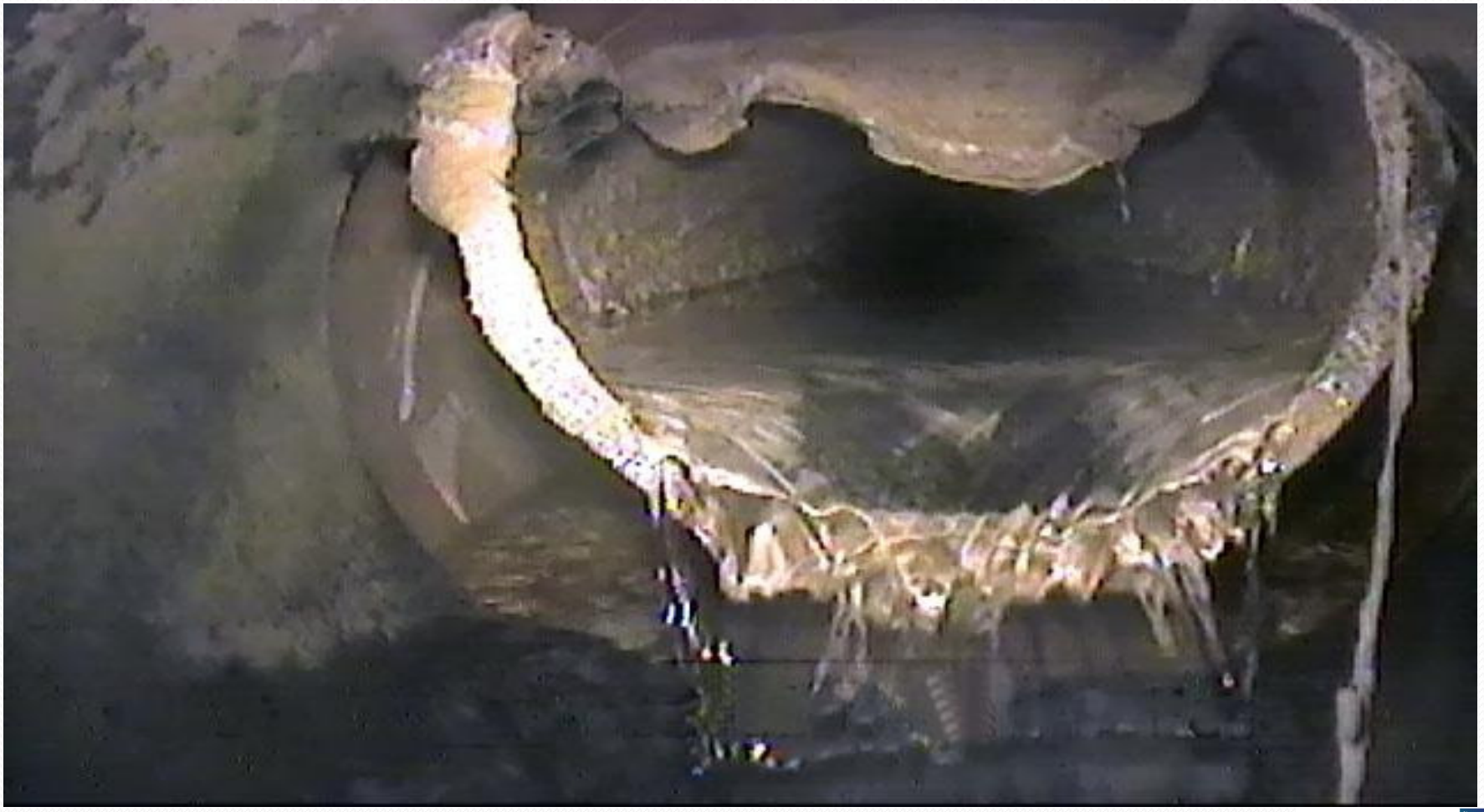
Pipe clogged due to chemical waste



Pipe damaged due to high temperature liquid or vapor Waste



- Wastes Prohibited for Discharge into Public Sewers
  - Ashes, cinders, sand, mud, straw, shavings, metal, glass, rags, feathers, tar, plastics, wood, paunch manure, or any other solid or viscous substance capable of causing obstruction to the flow in sewers or causing other interference with the proper operation of waste disposal facilities.
  - waters or wastes having a pH lower than 5.5 or higher than 9.0 or having any other corrosive property capable of causing damage or hazard to structures, equipment, and personnel associated with the waste disposal facilities.

Design

- Wastes Prohibited for Discharge into Public Sewers
  - Waters or wastes containing a toxic or poisonous substance in sufficient quantity to injure or interfere with any sewage treatment process.
  - Any noxious or malodorous gas or substance that is capable of creating a public health impact.

Design

- Sizing Gravity Public Sewers

Each gravity public sewer shall be designed to carry the Peak Flow Rate (PFR)

Peak Flow Rate (PFR) which is the average flow rate (AFR) multiplied by the appropriate peaking factor (PF)

Design

Sizing Gravity Public Sewers

Peak Flow Rate (PFR) = Average Flow Rate (AFR) X Peaking Factor (PF)

The Average Flow Rate (AFR) shall be determined for each building or facility served.

Peaking factors (PF's):

For an AFR from 0 to 24,000,000 liters per day:

$PF = (0.00163)(AFR)^2 - (0.08790)(AFR) + 2.90$

For an AFR >24,000,000 liters per day:

Use PF = 1.73

Design

- Sizing Gravity Public Sewers

Gravity public sewers shall have the following characteristics:

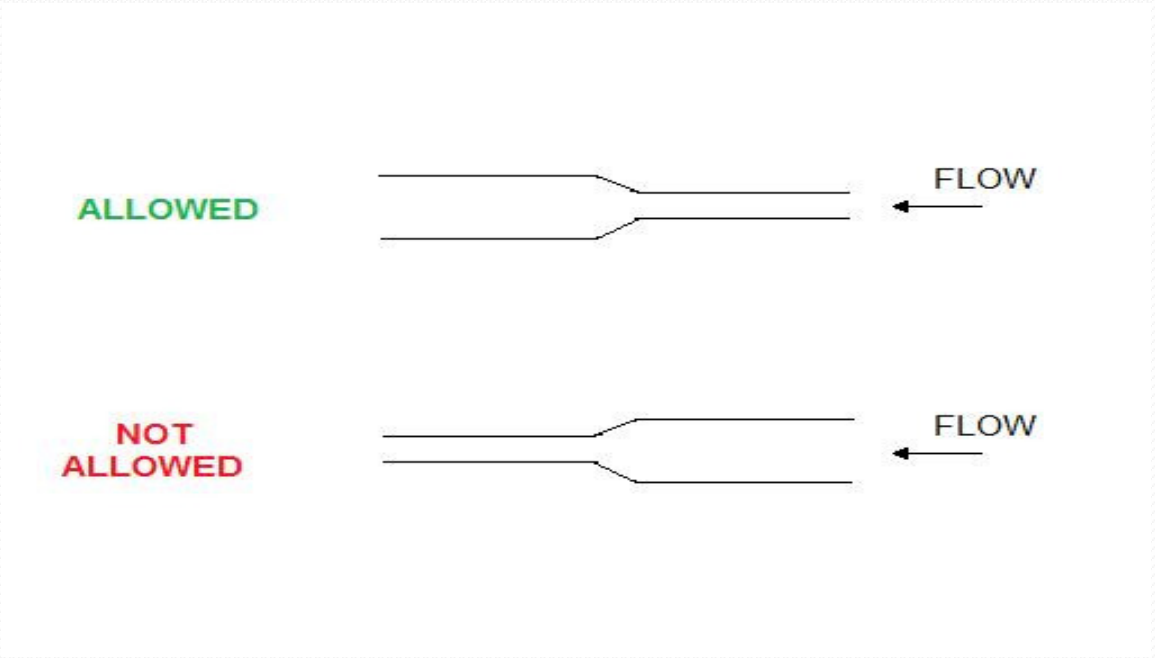
- The minimum velocity shall be 0.77 m/s (2.5 ft/s) at 75% of full flow rate.
- The slope should be continuously down hill, without low points or high points.
- The maximum depth-of-flow shall not exceed 75% of the internal pipe diameter at the applicable PFR.

Design

- Gravity Public Sewers
  - The minimum size of a public sewer shall be 200 mm (8 inch) nominal diameter
  - Public sewers shall be laid in a straight line between manholes

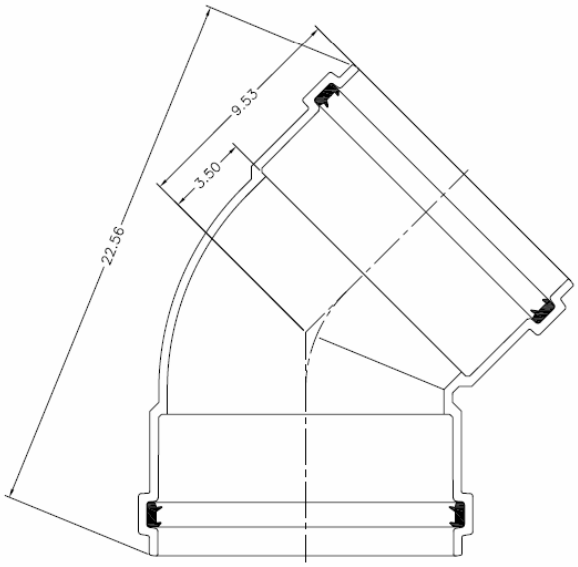
Design

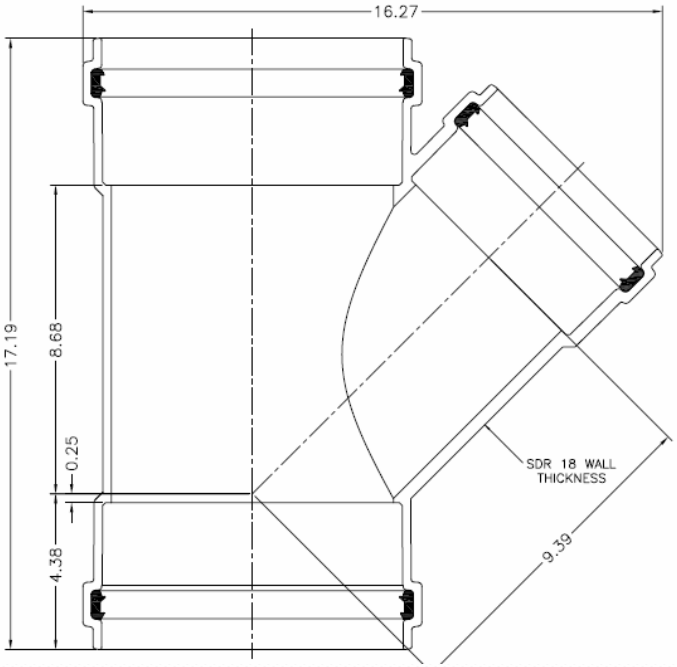
- Gravity Public Sewers
  - Pipe shall not reduce in size in the direction of flow



Design

- Gravity Public Sewers
  - DWV (drain, waste and vent) type fittings shall be used in gravity flow system





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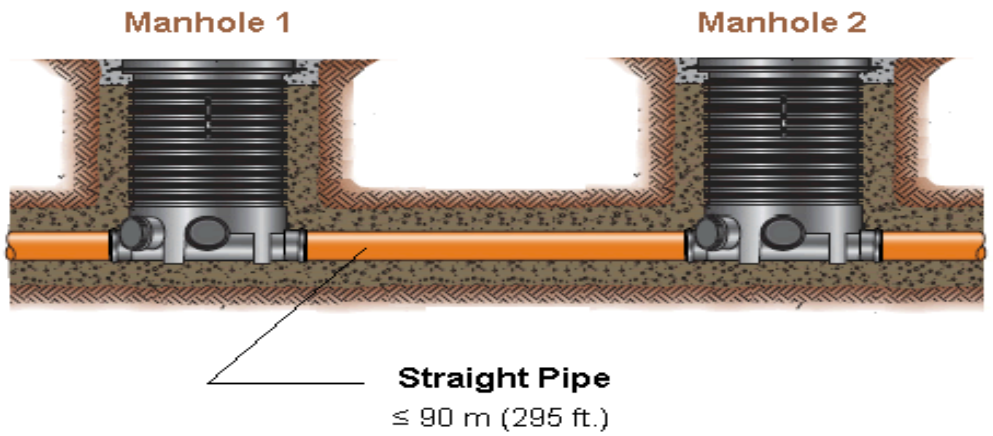
Design

- Gravity Public Sewers
  - No elbows, wyes, or other fittings that change the direction of sewers between manholes shall be permitted



Design

- Gravity Public Sewers
  - The maximum distance between manholes for public sewers shall be 90 meters (295 feet)
  - No portion of a sewer system and no discharge from a sewer system shall be located within 15 meters (50 feet) of any well, spring, or other source of potable water supply

Design

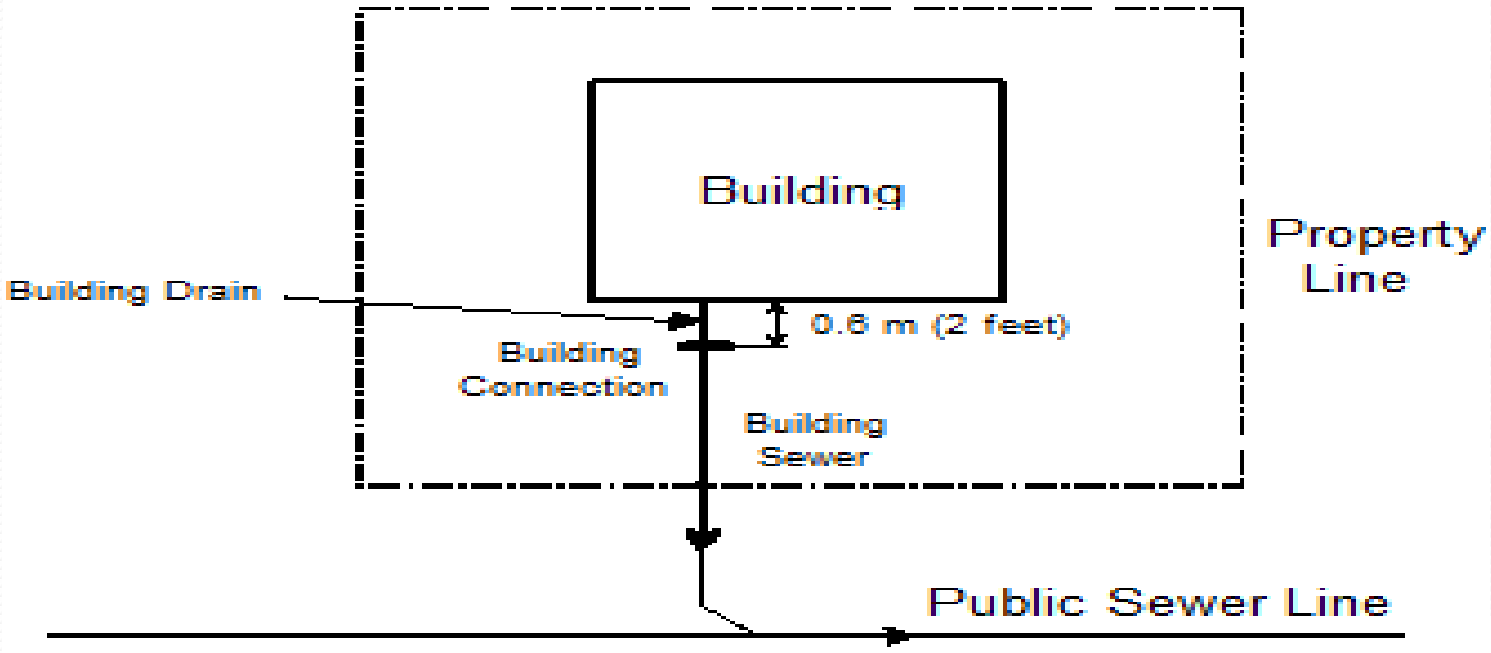
- Gravity Public Sewers
  - Public sewers that are parallel to potable water lines shall be separated from such lines by a minimum distance of 3 m
  - Public sewers be located below the potable water lines

Design

- Sanitary manholes shall have a minimum inside diameters:
  - 1.2 m for straight run manholes with a pipe diameter size of 600 mm or less
  - 1.8 m for straight run manholes for pipes larger than 600 mm diameter
  - 1.8 m for junction manholes

Design

- Gravity Public Sewers
  - The building sewer point of connection shall be 0.6 m (2 feet) from the building external wall



Design

- Lift Stations

  Lift stations receives 1800 cubic meters per day (475,560 gallons per day) or larger flows based on daily AFR shall be:

  - Wet well/dry well type and shall be housed in a building
  - Shall have odor / ventilation control

Design

- Lift Stations Pumps

  Lift stations shall use two or more pumps

  - The group of pumps shall consist of an operating pump or a group of equal capacity operating pumps, and one equal capacity standby pump
  - All pumps shall be specifically designed for pumping sewage and shall be capable of passing a 75 mm (3 inch) sphere
  - Pumps shall be nonclog type

Design

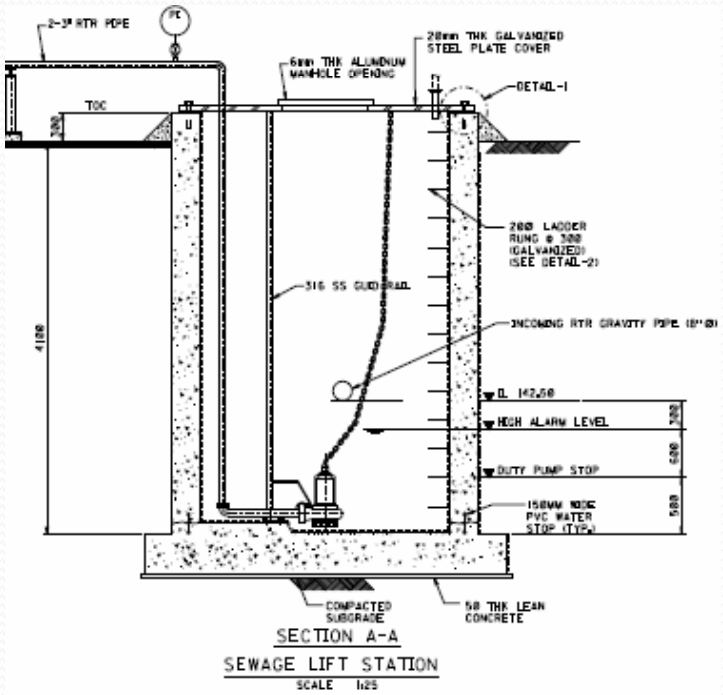
- Lift Stations Pumps

  Pumps with suction lifts are prohibited.

  - Exception
    - Self-Priming Pumps for small lift stations (under peak flow rate of 475,000 gallons per day) can be used as specified below:
    - Maximum suction lift 6 meters (20 feet) between low-low liquid level and pump centerline

Design

- Lift Stations Pumps
  - Submersible pumps for small lift stations (under peak flow rate 475,000 gallons per day)



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Design

- Lift Stations Pumps
  - Submersible pumps for small lift stations shall have the following additional requirements:
    - 316 stainless steel guide rails and chain for maintenance removal.
    - Steel monorail and manual hoisting equipment to facilitate removal of the pumps
    - Two separate upper and lower mechanical seals with moisture detector between seals
    - Rag removal by bar screen or in-channel grinder on wet well inlet, or grinder (chopper) pump on 50 mm (2 inch) discharge pumps

Design

- Lift Stations Pumps
  - Open drive shaft pumps and motors with enclosed type drive shafts are not acceptable
  - The pumps shall be spaced to prevent vortexing cavitations when the pumps are operating
  - It shall be possible to remove the pumps without disturbing the discharge piping
  - Bolted-down steel hatches shall be provided for the removal of each pump and for personnel ingress/egress into the wet well

Design

- Lift Stations Wet Well Operating Volume Sizing

Wet well operating volume shall be sized to the following equation:

- $V = C_T(Q)/4$
  - Where: V = minimum required capacity m^3 (gallons)
  - C_T = minimum time in minutes of one pumping cycle between successive motor starts (Minimum CT shall be 15 minutes)
  - Q = pump capacity, m^3/min (gallon/minute)

Design

- Wet well lift stations volume design

  The wet well volume must include enough volume

  - To prevent suction vortexing with at minimum of 0.5 meter (1.64 feet) vertical distance between the pump intake and the bottom of the operating volume
  - For controls to operate properly
  - For high-level alarms

Design

Wet well lift stations

- High liquid level shall be at least 300 mm (12 inch) below the invert of the lowest incoming sewer
- A corrosion resistant access firmly affixed to the interior wet well wall.
- Ladders shall be handrail type that meets ANSI A14.3
- Grab bars are prohibited.
- Ladder shall be of fiberglass material or plastic coated aluminum.

Design

Wet well lift stations

- Shall be of air tight construction
- Shall have a minimum size of 75 mm (3 inch) gooseneck vent
- Vent shall terminates not less than 3 m above the lift station deck level
- Emergency pump connections shall be provided on the inlet sewer and on the force main

Design

Wet well Lift Stations

- Concrete shall have a minimum compressive strength of 35 MPa (5000 psi) for water retaining structures
- Steel reinforcing bars in concrete shall be epoxy coated
- Electrical and electronical equipment and wiring shall be suitable for Class I, Zone 1
- Wet well ends /corners shall be sloped 10 degrees and the floor slop shall be not less than 1:65 (1.5%) to the pump intakes and have a smooth finish.

Design

Wet Well/Dry Well Lift Stations

- The dry well shall have a forced ventilation system
- The dry well shall have an automatic sump pump with a standby pump that returns spills or wash-down water to the wet well
- The dry well deck shall have removable access covers for the removal of pumps and/or motors

Design

Wet Well/Dry Well Lift Stations

- Pump motors shall be Totally Enclosed Fan Cooled (TEFC)
- Pumps shall non-clog
- The drive shaft shall have safety guards
- The drive shaft shall have intermediate bearings with structural supports as required to prevent excessive vibration
- Stainless steel greasing tubing shall be provided to grease any intermediate bearings

Design

Lift Stations Power Supply

- Each lift station shall have two independent power supply sources, each fed from separate transformers
- The power supply sources shall be interconnected with an automatic transfer switch to provide a continuous source of power to the lift station.
- Emergency generator may also be used as a second power source.

Design

Lift Stations Control Systems

Control systems shall consist of

- Wet well liquid level sensing devices
- A motor control panel
- An alarm system

Design

Lift Stations Control Systems

Sensors for a duplex pump system shall be set to provide the following:

a) Low Level Sensor: All pumps off

b) First Level Sensor: Lead pump on

c) Second Level Sensor: Both pumps on

d) High Level Sensor: Actuate high level alarm

Design

Lift Stations motor control panels

- NEMA Type 1 motor control enclosures with gasketed doors shall be used inside of buildings.
- Circuit breakers shall be provided for each motor
- Motor starters shall be full voltage, nonreversing magnetic, with overload relay protection
- Control transformers equipped with an integral fuse block for secondary protection shall be provided for each starter

Design

Lift Stations motor control panels

shall have the following features:

- Liquid level controls shall be off/on switch devices that open and close in response to predetermined liquid elevations and that cause the pump(s) to start or stop
- Submersible pumps shall have probes within the oil reservoir for the purpose of detecting a leakage of the outer seal of the motor.
- A warning light, a test light, and a test push button shall be provided for each motor

Design

Lift Stations motor control panels

- Each lift station pump shall be fitted with a dedicated flow transmitter
- The flow transmitter shall be installed on the pump discharge piping, upstream of connection to common pump header piping
- The high level alarm shall be actuated before starting the stand-by pump

Design

Lift Stations motor control panels

If the Centralized Operation Building is available :

- lift stations shall be linked via SCADA systems to be monitored
- Programmable Logic Controllers (PLC's) shall be provided for lift stations

Design

Lift station force mains

- Force mains shall be based on effluent velocity between .77 m/s and 5 m/s
- Force main shall be at least one pipe size larger than the pump discharge size
- Thrust blocks shall be provided for underground force mains
- All force main connections to a gravity sewer system shall be through a manhole

Materials

Acceptable Piping Materials for Gravity Sanitary Sewer Piping

- Reinforced Thermosetting Resin (RTR) fiberglass pipes
- High Density Polyethylene (HDPE)
- PVC

Q&A