

Engineering Standard

SAES-S-040

31 December 2003

Saudi Aramco Water Systems

Plumbing and Utilities Standards Committee Members

Al-Mulhim, Khalid A., Chairman

Al-Hamid, Adel S., Vice Chairman

Al-Sultan, Sultan A.

Al-Ugla, Ali A.

Al-Zahrani, Saleh A.

Churches, David K.

Cole, Anthony R.

Dbass, Saad M.

Fadley, Gary L.

Evans, David G.

Magtanong, Henry L.

Salour, Sassan X.

Saudi Aramco DeskTop Standards

Table of Contents

1	Scope.....	2
2	Conflicts and Deviations.....	2
3	References.....	2
4	Definitions.....	5
5	Design.....	7
6	Installation.....	17

Previous Issue: 31 July 2000 Next Planned Update: 1 January 2009

Revised paragraphs are indicated in the right margin

Primary contact: Khalid A. Al-Mulhim on 874-5230

Page 1 of 22

1 Scope

- 1.1 This Saudi Aramco Engineering Standard sets forth the minimum requirements for potable water systems, fire and raw combined water systems, irrigation water systems and well water systems in Saudi Aramco facilities, or those systems under the operation and maintenance of Saudi Aramco.
- 1.2 This standard does not include:
- a) The conveyance of potable water from the discharge ends of isolation valves on a water distribution system to and within buildings, facilities and points of use. Refer to SAES-S-060.
 - b) Conversion of seawater or raw water to drinking water; or any water treatment facility. Refer to Saudi Aramco Sanitary Code, GI-0151.006.
 - c) Dedicated firewater systems. Refer to SAES-B-017.
 - d) Plant process water piping systems. Refer to "L" Standards.
 - e) The distribution of reclaimed wastewater. Refer to SAES-A-104.
 - f) Seawater intakes, pumping and piping systems. Refer to "L" Standards.
 - g) Chilled water, condenser water and cooling water for air conditioning purpose. Refer to SAES-K-001.

2 Conflicts and Deviations

- 2.1 Any conflicts between this standard and other applicable Saudi Aramco Engineering Standards (SAESs), Materials System Specifications (SAMSSs), Standard Drawings (SASDs), or industry standards, codes, and forms shall be resolved in writing by the company or buyer representative through the Manager, Consulting Services Department of Saudi Aramco, Dhahran.
- 2.2 Direct all requests to deviate from this standard in writing to the company or buyer representative, who shall follow internal company procedure SAEP-302 and forward such requests to the Manager, Consulting Services Department of Saudi Aramco, Dhahran.

3 References

The selection of material and equipment, and the design, construction, maintenance, and repair of equipment and facilities covered by this standard shall comply with the latest edition of the references listed below unless otherwise noted.

3.1 Saudi Aramco References

Saudi Aramco Engineering Procedure

*SAEP-302 Instructions for Obtaining a Waiver of a
Mandatory Saudi Aramco Engineering
Requirement*

Saudi Aramco Engineering Standards

SAES-A-004 Pressure Testing

SAES-A-104 Wastewater Treatment, Reuse and Disposal

SAES-B-017 Firewater System Design

SAES-B-008 Restrictions to Use of Cellars, Pits, and Trenches

SAES-B-067 Safety Identification and Safety Colors

SAES-D-100 Atmospheric and Low-Pressure Tanks

SAES-G-005 Centrifugal Pumps

*SAES-H-002 Internal and External Coatings for Steel Pipelines
and Piping*

SAES-K-001 Heating, Ventilating and Air Conditioning

SAES-L-008 Selection of Valves

*SAES-L-100 Applicable Codes and Standards for Pressure
Piping Systems*

SAES-L-105 Piping Materials Specifications

SAES-L-120 Piping Flexibility Analysis

SAES-L-132 Materials Selections of Piping Systems

SAES-L-310 Design of Plant Piping

SAES-L-350 Construction of Plant Piping

SAES-L-410 Design of Pipelines

*SAES-L-450 Construction of On-Land and Near-Shore
Pipelines*

SAES-L-610 Non-Metallic Piping

SAES-S-010 Sanitary Sewers

SAES-S-020 Industrial Drainage and Sewers

SAES-S-060 Saudi Aramco Plumbing Code

SAES-S-070 Installation of Utility Piping Systems

SAES-X-400 Cathodic Protection of Buried Pipelines

SAES-X-600 Cathodic Protection In-Plant Facilities

Saudi Aramco Materials System Specifications

01-SAMSS-005 Pipe: Cement-Lined, Shop Applied

01-SAMSS-034 RTR (fiberglass) Pressure Pipe and Fittings Saudi Aramco Standard Drawings ||

04-SAMSS-001 Gate Valves ||

Saudi Aramco Standard Drawings

AE-036412 Guard Post and Guardrail Details ||

AD-036009 Direct Buried Water Line Valve

AB-036155 Supports for Plastic Piping

DD-950079 Valve Supports for Plastic Pipelines (For reference only) ||

AA-036744 Valve Boxes Construction Details (For reference only) ||

Saudi Aramco General Instruction

GI-0151.006 Implementing the Saudi Aramco Sanitary Code (SASC) ||

Saudi Arabian Standards Organization

SASO SSA/14 Pipes for Potable Water of Unplasticized Plastic (Polyvinyl Chloride)

SASO SSA/15 Methods of Testing of Pipes for Potable Water of Unplasticized Plastic (Polyvinyl Chloride)

3.2 Industry Codes and Standards

American National Standards Institute

ANSI B16.1 Cast Iron Pipe Flanges and Flanged Fittings

American Society of Mechanical Engineers

ASME B31.3 Chemical Plant and Petroleum Refinery Piping

American Petroleum Institute

API 5L Specification for Line Pipe

American Society for Testing and Materials

<i>ASTM A53</i>	<i>Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless</i>
<i>ASTM D1785</i>	<i>Polyvinyl Chloride (PVC) Plastic Pipe, Schedules 40, 80, and 120</i>
<i>ASTM D3350</i>	<i>Polyethylene Plastics Pipe and Fittings Materials</i>
<i>ASTM F439</i>	<i>Socket Type CPVC Plastic Pipe Fittings, Schedule 80</i>
<i>ASTM F441</i>	<i>CPVC Plastic Pipe, Schedule 40 and 80</i>
<i>ASTM F714</i>	<i>Polyethylene Plastic Pipe (SDR-PR) Based on Outside Diameter</i>
<i>ASTM F1248</i>	<i>Determination of Environmental Stress Corrosion Crack Resistance (ESCR) of Polyethylene Pipe</i>

American Water Works Association

<i>AWWA C111</i>	<i>Rubber Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings</i>
<i>AWWA C151</i>	<i>Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids</i>
<i>AWWA C510</i>	<i>Double Check Valve Backflow Prevention Assembly</i>
<i>AWWA C511</i>	<i>Reduced-Pressure Principle Backflow Prevention Assembly</i>

International Organization for Standardization

<i>ISO 2531</i>	<i>Ductile Iron Pipes, Fittings and Accessories for Pressure Pipelines</i>
<i>ISO 4633</i>	<i>Rubber Seals - Joint Rings for Water Supply, Drainage and Sewerage Pipelines - Specifications for Materials</i>

4 Definitions

FORTTRAN notation is used for formulas, i.e. "xy" is "X" raised to the "y" power.

ADC (Average Daily Consumption): It is an average daily water usage in millions of liters per day by occupants based on the consumption tables included in this standard. It

does not include water consumption for irrigation, industrial plant process water and firewater.

Backflow: Refer to glossary section of Saudi Aramco Sanitary Code, GI-0151.006, Chapter SASC-S-13.

BFP (Backflow Prevention) Device: It is a device or means used to prevent backflow into a potable water system.

Community Area: Same as "Saudi Aramco Camp" in SAES-L-001.

Cross-Connection: Refer to glossary section of Saudi Aramco Sanitary Code, GI-151.006.

Drinking Water: Refer to Saudi Aramco Sanitary Code GI-0151.006, Chapter SASC-S-01 under "Potable Drinking Water", and the definition of Potable Water in this Standard.

Irrigation: Any water used to supply moisture to plant life, trees, shrubs, etc. This water may or may not be Potable Water.

Irrigation piping network: piping network carrying water for irrigation purpose from downstream of an isolation valve located on a branch of a water distribution piping network, to the point of use. It consists of mains and branches. Irrigation piping network may be a part of an independent irrigation system having no connection with potable water distribution systems. In this case, water used for irrigation, may or may not be potable water.

Irrigation System: It consists of irrigation piping network, valves, cross-connection controls and all appurtenances carrying or supplying water for irrigation to the point of use.

Isolation Valve: It is a valve installed on a branch of a piping network supplying water to a building, facility, fire fighting equipment, firewater system, or a point of use. It is used to isolate the building, facility, fire fighting equipment, firewater system, or a point of use from the rest of the water system without disrupting the water distribution system.

Main: The main of any system of continuous piping is the principal artery of the system to which branches may be connected.

PDC (Peak Daily Consumption): It is a peak daily water usage calculated by multiplying ADC by a peaking factor [abbreviation PF(PDC)] of PDC, rounded to two decimal places, plus the daily water consumption for irrigation.

PF (Peaking Factors): These factors are calculated using formulae included in this standard. They are used in the calculations to determine peak daily water consumptions with abbreviation PF(PDC), and peak hourly water consumption with abbreviation PF(PHC).

PHC (Peak Hourly Consumption): It is a peak hourly water usage calculated by multiplying ADC by a peaking factor [abbreviation, PF(PHC)] of PHC, rounded to two decimal places, plus the hourly water consumption for irrigation.

Plant Area: Refer to SAES-L-100 and SAES-L-310.

Potable Water: The water that is satisfactory for culinary and domestic purposes and meets the requirements of GI-0151.006, Saudi Aramco Sanitary Code, Chapter SASC-S-01 and any other requirements set by Environmental Compliance Division of Environmental Protection Department. Both drinking water and raw water are potable water.

Raw Water: Refer to Saudi Aramco Sanitary Code GI-0151.006, Chapter SASC-S-01, and the definition of Potable Water in this Standard.

Water Distribution Piping Network: It is a piping network in a water distribution system that conveys water from a water storage facility to the discharge end of isolation valves. It consists of mains and branches.

Water Distribution System: It consists of water distribution piping network, water booster stations, valves, cross-connection controls and all appurtenances carrying or supplying water to the discharge end of isolation valves. It refers to potable water systems that may be drinking water, raw water or raw/fire combined water distribution system.

Water Transmission Line: It is a segment of water piping system from water well fields to a water storage or water treatment facility. It also refers to a piping network that conveys water from a water treatment plant to a water storage facility.

5 Design

5.1 Design Consumption Rates

5.1.1 Raw water consumption rates

Actual water meter readings, approved by the Chairman of Plumbing and Utilities Standards Committee, shall be used. In case the actual water meter readings are not available, the following method shall be used for estimating raw water consumption rate.

5.1.1.1 For ADC of raw water, the values from the Table 2 of this standard shall be used. ADC rates for facilities not listed in the Table 2, shall be calculated in accordance with paragraph 5.1.3 of this standard.

5.1.1.2 Peaking Factors for raw water consumption rates shall be calculated using the following formulae.

- a) For an ADC of raw water from 0 to 36 million liters per day:

Peaking factor for peak daily raw water consumption rate:

$$\text{PF(PDC)} = (0.000005)(\text{ADC}^3) + (0.000017)(\text{ADC}^2) - (0.020777)(\text{ADC}) + 1.97$$

Peaking factor for peak hourly raw water consumption rate:

$$\text{PF(PHC)} = -(0.000002)(\text{ADC}^3) + (0.001799)(\text{ADC}^2) - (0.126803)(\text{ADC}) + 4.00b$$

- b) For an ADC of raw water greater than 36 million liters per day:

Peaking factor for peak daily raw water consumption rate:

$$\text{PF(PDC)} = 1.48$$

Peaking factor for peak hourly raw water consumption rate:

$$\text{PF(PHC)} = 1.68$$

5.1.1.3 PDC of raw water = ADC x PF(PDC) + daily consumption for irrigation from Table 3 of this standard + average daily consumption for plant processing.

5.1.1.4 PHC of raw water = ADC x PF(PHC) + (daily consumption for irrigation from Table 3 of this standard/24 hours) + average hourly consumption for plant processing.

5.1.2 Drinking water consumption rates:

Actual water meter readings, approved by the chairman of Plumbing and Utilities Standards Committee, shall be used. In case the actual water meter readings are not available, the following method shall be used for estimating raw water consumption rate.

5.1.2.1 For ADC of drinking water, the values from the Table 2 of this standard shall be used. ADC rates for facilities not listed in the Table 2, shall be calculated in accordance with paragraph 5.1.3 of this standard.

5.1.2.2 Peaking Factors for drinking water consumption rates shall be calculated using the following formulae.

a) For an ADC of drinking water from 0 to 2.40 million liters per day:

Peaking factor for peak daily drinking water consumption rate

$$\text{PF(PDC)} = (0.005343)(\text{ADC}^3) + (0.085977)(\text{ADC}^2) - (0.420892)(\text{ADC}) + 1.82$$

Peaking factor for peak hourly drinking water consumption rate:

$$\text{PF(PHC)} = -(0.097019)(\text{ADC}^3) + (0.662192)(\text{ADC}^2) - (1.57161)(\text{ADC}) + 3.35$$

b) For an ADC of drinking water greater than 2.40 million liters per day:

Peaking factor for peak daily drinking water consumption rate:

$$\text{PF(PDC)} = 1.38$$

Peaking factor for peak hourly drinking water consumption rate:

$$\text{PF(PHC)} = 2.05$$

5.1.2.3 PDC of drinking water = ADC x PF(PDC).



5.1.2.4 $PHC \text{ of drinking water} = ADC \times PF(PHC)$.

5.1.3 Water consumption rates for facilities not listed in Table 2 of this standard shall be determined by fixture units' method using Chart A-2 or A-3 of the Uniform Plumbing Code, which is a part of the Saudi Aramco Plumbing Code in accordance with SAES-S-060. This flow rate must then be converted into liters per day by multiplying by the estimated time of usage during each day. The time of usage is a matter of judgment on the part of the design engineer.

5.2 Water Wells

5.2.1 Any Saudi Aramco facility solely dependent upon well water shall have not less than one operating and one standby well.

5.2.2 The minimum total capacity of all operating wells shall be the cumulative of the following consumption rates.

Raw water ADC for plants and communities, plus
Raw water ADC for plants processing, plus
Raw water ADC for irrigation, plus
Drinking water ADC for plants and communities, plus
Loss of water from the manufacture of drinking water.

5.2.3 The minimum number of operating wells required shall be determined from the minimum required capacity calculated in accordance with the paragraph 5.2.2 of this standard, and after derating each well to 90% of its rated capacity or to the actual output of the well pump, whichever is less.

5.2.4 The constructional and operational requirements shall be in accordance with GI-0151.006, Saudi Aramco Sanitary Code, Chapter SASC-S-01.

5.3 Water Transmission Lines

5.3.1 Water transmission lines and pumping capacity shall be designed to carry 150% of the minimum total required water consumption rates as calculated in paragraph 5.2.2 of this standard.

5.3.2 The design of transmission lines shall be in accordance with SAES-L-410.

5.3.3 The maximum velocity within a transmission line shall be in accordance with SAES-L-132.

5.4 Storage

5.4.1 Water storage tanks shall be designed in accordance with SAES-D-100, and shall comply with all construction and operational requirements of GI-0151.006, Saudi Aramco Sanitary Code, Chapter SASC-S-01.

The storage capacity of raw water shall meet the following requirements:

5.4.1.1 The minimum storage capacity of raw water in Saudi Aramco community areas shall be the cumulative of the following consumption rates:

50 percent of the PDC of raw water, plus;

50 percent of the PDC of drinking water including the quantity of water loss from the manufacture of drinking water, plus;

100 percent of firewater reserve storage in accordance with SAES-B-017.

5.4.1.2 The minimum storage capacity of raw water in Saudi Aramco plant areas shall be the cumulative of the following consumption rates:

50 percent of the ADC of raw water, plus;

100 percent of the daily process flow requirements, plus;

100 percent of firewater reserve storage in accordance with SAES-B-017.

5.4.2 The minimum storage capacity of drinking water in Saudi Aramco community or plant areas shall be not less than 14 hours of the PDC of drinking water.

5.5 Water Distribution Systems

5.5.1 Water distribution piping network shall be designed using the Hazen-Williams formula for the calculation of head losses and velocities. The following values shall be used for the piping materials listed in Table 1.

Table 1 - Head Losses and Velocities

Piping Material	Hazen-Williams
PVC, CPVC, HDPE and RTR (fiberglass)	140

Cement Lined Steel	120
Ductile Iron, Cement lined	120
Existing Steel (Good)	100
Existing Steel (Poor)	60

5.5.2 The design flow rate for fire and raw water combined system in Saudi Aramco facilities shall be based on the larger of the following:

- a) PHC of raw water or,
- b) PDC of raw water plus firewater flow rate in accordance with SAES-B-017.

5.5.3 The design flow rate for dedicated raw water system in Saudi Aramco facilities shall be based on the PHC or the PDC flow rate, whichever is greater. No firewater connection shall be made on such system.

5.5.4 The design flow rate for drinking water in Saudi Aramco facilities shall be based on the PHC of drinking water.

Absolute minimum (fire fighting conditions):

Refer to SAES-B-017 with:

- minimum tank level
- maximum water demand
- maximum firewater demand

5.5.5 The maximum velocity within a main of a water distribution piping network shall be in accordance with SAES-L-132.

5.5.6 The water distribution system pressures at the downstream of an isolation valve of any building, facility or at a user point shall be maintained within the following limits:

- a) Absolute minimum (fire fighting conditions):

Refer to SAES-B-017 with:

- minimum tank level
- maximum water demand
- maximum firewater demand

- b) Normal minimum:

275 kPa (40 psi) with: - tanks at minimum operating level (fire reserve only) - and maximum water demand.

- c) Normal maximum:
450 kPa (65 psi) with excluding variation in tank water levels.
 - d) Absolute maximum:
585 kPa (85 psi) with: - maximum static head (tank full or pump shut-in pressure).
- 5.5.7 Any branch of a water distribution piping network shall not be less than 63 mm nominal diameter.
- 5.5.8 Any branch of a water distribution piping network shall be sized to meet the firewater service demand of SAES-B-017 where fire service is involved.
- 5.5.9 The mains on water distribution piping network shall be laid out in closed loops with dual supply.

Exception:

The level of water supply reliability within a plant area is up to the proponent of the facility. The water distribution loop and / or dual supply may be omitted within plant area if it is not economically justified. However, a concurrence from the proponent of the facility is required.

- 5.5.10 Combined fire/raw water distribution mains shall meet the minimum diameter requirements of SAES-B-017.
- 5.5.11 Unavoidable dead legs shall not exceed 91 m in length. A hydrant or flushing valve shall be provided on the end of raw water dead legs, and a flushing valve shall be installed on the end of drinking water dead legs.
- 5.5.12 Minimum clear distance between raw and drinking water lines, if installed in the same trench, shall be 300 mm.
- 5.5.13 Separations between water lines and sanitary sewer systems shall be in accordance with SAES-S-010.
- 5.5.14 Separations between water lines and industrial drainages and sewer systems shall be in accordance with SAES-S-020.
- 5.5.15 Color coding of piping network covered in this standard shall be in accordance with SAES-A-104, SAES-B-067, and Saudi Aramco Sanitary Code GI-0151.006.
-

- 5.5.16 Irrigation system shall be designed such that it can be easily disconnected from the water distribution system to function as a separate system when another type of water becomes available in future
- 5.5.17 A branch piping of a raw/firewater combined distribution system, serving firewater systems of a building or a facility shall be connected upstream of the isolation valve of the raw water supply piping.
- 5.5.18 Refer to SAES-L-350, for utility water piping connection to process equipment.

5.6 Water Booster Pump Stations

- 5.6.1 A water booster pump station shall be installed when the water storage tank head is insufficient to provide the normal minimum required pressure at the downstream of an isolation valve of any building, facility or at a user point as specified in paragraph 5.5.6.
- 5.6.2 A water booster pump station shall have the following requirements.
 - a) The pump set shall consist of one pump or a group of pumps of equal operating capacity and one equal capacity standby pump.
 - b) The total capacity of operating pumps shall be based on the design flow rates as specified in Section 5.3 of this standard.
 - c) All pumps shall be installed in parallel.
 - d) Each pump shall be able to maintain the normal minimum required pressure at the downstream of an isolation valve of any building, facility or at a user point as specified in Para. 5.5.6.
- 5.6.3 Water booster pumps shall comply with SAES-G-005.
- 5.6.4 If the water booster pumps are the primary source of firewater supply, then the booster pump system shall be in compliance with SAES-B-017.

5.7 Valves

- 5.7.1 Selection and installation of valves shall be in accordance with SAES-L-008 and shall also conform to SAES-L-105. Valves serving mains or branch piping to fire fighting equipment or any fire water system shall also meet the requirements of SAES-B-017.

- 5.7.2 Valves shall be provided:
- a. On water transmission lines—not more than 500 meters apart.
 - b. On major lines feeding to water distribution systems - not more than 1 km apart.
 - c. In a water distribution piping network - not more than 500 meters of main shall be isolated during single failure.
 - d. On all those branches of a water distribution piping network supplying water to buildings, facilities, fire fighting equipment, firewater systems, or any user's points.
- 5.7.3 Selection and installation of isolation valves serving mains or branch piping to fire fighting equipment or any firewater system shall meet the requirements of SAES-B-017.
- 5.7.4 Direct buried valves shall be installed in accordance with Saudi Aramco Standard Drawing AD-036009. If valves are installed in a valve box, Saudi Aramco Standard Drawing AA-036744 may be referred for valve box construction. Step-iron/ladder shall be provided in a valve box as needed. Above ground installed valves, shall be protected against accidental damage. Saudi Aramco Standard Drawing AE-036412 may be referred for guard post and guardrail details.
- Exception:*
- Valves shall be directly buried or installed above ground in areas where valve boxes are prohibited by SAES-B-008.*
- 5.7.5 Self-actuating pressure control valves shall be installed as necessary to meet the following requirements. Such valves shall be located in valve boxes; or installed above ground in areas where valve boxes are prohibited by SAES-B-008.
- a) To reduce the water distribution system pressure to the allowable normal pressure limits as specified in paragraph 5.5.6 of this standard, at the downstream of isolation valves of any building, facility or at a user point.
 - b) To reduce pressure variations in water distribution systems to maintain the pressure variations within the allowable normal pressure limits as specified in paragraph 5.5.6 of this standard at the downstream of isolation valves of any building, facility or at a user point.

- c) To reduce the water distribution system pressure to the pressure required for irrigation purpose in an irrigation system. Remote-control valves with pressure regulation may also be used for such purpose.

5.7.6 Where wide ranges of flow and pressure fluctuations may occur it will be necessary to install both a large and a small pressure control valve operating in parallel to meet the requirement of paragraph 5.7.8 (b) of this standard.

5.7.7 Provide drain valves as required to facilitate maintenance and repairs.

5.7.8 Gear Operators are required for following valve sizes and pressure ratings. (Refer to 04-SAMSS-001, Gate Valves)

Gear Operator Requirements

Pressure Class	NPS (in)
150	24 and over
300	16 and over
400	10 and over
600	8 and over
900 and higher	6 and over

5.7.9 Remote-control valves shall be used in irrigation system to control the water usage to different irrigation zones.

5.7.10 Flanges shall comply with ANSI B16.1 dimensions.

5.7.11 Flat-faced flanges shall be mated with flat-faced flanges only and shall use full face gaskets. When the raised-face of a raised-faced flange is machined off, it can be used as a flat-faced flange.

5.8 Cross-Connection Control

5.8.1 Cross-connection controls to protect potable water systems shall be provided in accordance with the requirements of GI-0151.006, Saudi Aramco Sanitary Code, Chapter SASC-S-01; and SAES-S-060, Chapter 6.

5.8.2 In addition to the requirements specified in paragraph 5.8.1 of this standard, a BFP assembly, shall be installed at the following locations:

- a) Between a water distribution system and an irrigation piping network. A BFP assembly shall be installed on every sprinkler circuit of irrigation piping network downstream from the remote-control valve.

- b) Between a Saudi Aramco-owned water line and a municipal or ministry owned water line. A BFP assembly shall be installed on upstream of the isolation valve on Saudi Aramco owned water distribution system.
- c) Between Saudi Aramco owned water systems that can be operated independently.

5.8.3 All BFP assemblies shall conform to AWWA C510, AWWA C511 or Saudi Aramco recognized industry standards. These assemblies shall be certified or listed by the agencies approved by the chairman of Plumbing and Utilities Standard Committee.

5.8.4 All BFP assemblies shall be tested at the time of installation, repair, or relocation and on an annual schedule thereafter.

5.9 Disinfection

Water wells (or other water source) and collection, conveyance including transmission lines, treatment, storage and distribution systems, or parts thereof, which are newly constructed, have been repaired or have otherwise become contaminated, shall be thoroughly disinfected in accordance with GI-0151.006, Saudi Aramco Sanitary Code, Chapter SASC-S-01.

5.10 Certification

Plastic pipes, pipe liners and fittings such as PVC, CPVC, HDPE and RTRP (fiberglass pipe); and O-rings, gaskets, lubricants and adhesives, specified for potable water systems, shall be tested and certified as suitable for potable water use in accordance with National Sanitation Foundation (NSF) or equivalent standards approved by the chairman of Plumbing and Utility Standard Committee. A test certificate shall be submitted. The seal or mark of the certifying organization shall be indicated on the pipe.

6 Installation

6.1 Materials

6.1.1 Following are the acceptable materials for water transmission and distribution piping networks in hydrocarbon handling areas.

- a) 12LC0U or 12LEOU as per SAES-L-105; Steel pipe, ASTM A53 or API 5L, Grade B, cement lined or fusion bonded epoxy (FBE) lined per SAES-H-002. Such pipe shall be externally coated in

accordance with SAES-H-002 if installed below ground and cathodically protected if required by SAES-X-400.

- b) 12FEOU as per SAES-L-105; 01-SAMSS-034 RTR (fiberglass) pipe, to be used only below ground for all water services. See paragraph 6.1.1(f) of this standard for exception.
- c) Ductile iron pipe, AWWA C151, cement lined, and externally coated in accordance with SAES-H-002 if installed below ground. The joints shall be either ANSI B16.1 flanges or rubber compression rings per AWWA C111.
- d) Ductile iron pipe, ISO 2531, cement lined, and externally coated in accordance with SAES-H-002 if installed below ground. The joints shall be either ANSI B16.1 flanges or rubber compression rings per ISO 4633.
- e) On offshore structures, 12FEOU as per SAES-L-105; 01-SAMSS-034 RTR (fiberglass) pipe through 300 mm maximum size may be used for dedicated potable water services only. Such services shall not have any connections with firewater, fire/raw combined water or plant process water services.
- f) Nonmetallic pipe and fittings, such as CPVC schedule 80 (12PUOU per SAES-L-105), HDPE, and RTRP (fiberglass pipe) per 01-SAMSS-034 (12FEOU per SAES-L-105) may be used for above ground applications, when the above ground applications and the piping thereafter shall have no connections with either firewater, fire/raw combined water or plant process water services.

6.1.2 The materials listed in Section 6.1.1 and the following materials are the acceptable materials for water transmission and distribution piping network in all areas other than hydrocarbon handling areas. Those materials marked with double asterisks (**) shall be used for the replacement or repair of existing piping of the same type only.

- a) 12PVOU per SAES-L-105; PVC per SASO SSA/14/15, Class 5 pipe and fittings. Such pipe shall be used for below ground applications only. See Para 6.1.4 of this standard for exception.
- b) **PVC, ASTM D1785, Schedule 80, for lines 2 inches through 6 inches nominal diameter. Such pipe shall be used for below

ground applications only. See Para 6.1.4 of this standard for exception.

- c) High Density Polyethylene (HDPE) pipe, as specified in ASTM D3350, ASTM F1248 and ASTM F714. Such pipe shall be used for below ground applications only. See paragraph 6.1.4 of this standard for exception.

6.1.3 Following are the acceptable materials for irrigation piping network. Those materials marked with double asterisks (**) shall be used for the replacement or repair of existing piping of the same type only.

- a) 12PVOU as per SAES-L-105; PVC, SASO SSA/14/15, Class 5.
- b) **PVC, ASTM D1785, Schedule 80 for lines 2 inches through 6 inches nominal diameter.
- c) High Density Polyethylene (HDPE) pipe, per ASTM D3350, ASTM F1248 and ASTM F714.

6.1.4 Nonmetallic pipe and fittings, such as CPVC schedule 80 (12PUOU per SAES-L-105), HDPE and RTRP (fiberglass pipe) per 01-SAMSS-034 (12FEOU per SAES-L-105) may be used for above ground applications, when the above ground applications and the piping thereafter shall have no connections with either firewater, fire/raw combined water or plant process water services.

6.1.5 Above ground installed nonmetallic pipes exposed to sunlight shall contain ultraviolet inhibitor or shall be protected from ultraviolet attack in accordance with SAES-L-610.

6.2 Installation

6.2.1 Water transmission lines and water distribution piping network shall be installed in accordance with the following standards:

- a) Steel pipe shall be installed in accordance with SAES-L-350 and SAES-L-450. In addition, refer to SAES-X-600 to determine if cathodic protection is necessary.
- b) Cement lined ductile iron, 01-SAMSS-034 RTR (fiberglass), CPVC, PVC and HDPE pipes shall be installed in accordance with SAES-S-070, SAES-L-610 and Saudi Aramco Standard Drawing AB-036155.

- 6.2.2 Valve supports shall be provided for 100 mm (4 inch) and larger valves, buried, installed in a valve box or installed above ground exposed. Saudi Aramco Library Drawing DD-950079 may be referred for valve supports.
- 6.2.3 Water storage tanks shall be installed and in accordance with SAES-D-100.
- 6.2.4 BFP devices and assemblies shall be installed in accordance with SAES-S-060.
- 6.2.5 Manufacturer's installation instructions shall be followed for the installation of all equipment that fall under the scope of this standard.
- 6.2.6 Dielectric unions shall be provided in accordance with SAES-L-105, at each piping connection having dissimilar metals.
- 6.2.7 Refer to SAES-L-120 and SAES-L-310, for flexibility, support and anchoring of metallic piping.
- 6.2.8 Flexibility, support and anchoring of nonmetallic piping shall be in accordance with ASME B31.3, Chapter VII.
- 6.3 Testing
 - 6.3.1 Water transmission, distribution and irrigation systems shall be tested in accordance with SAES-S-070 and SAES-A-004.
 - 6.3.2 Water storage tanks shall be tested in accordance with SAES-D-100.
- 6.4 Inspection and Backfilling

Water transmission, distribution and irrigation systems shall be inspected, repaired and backfilled in accordance with SAES-S-070, Sections 19, 20, 21 and 22.

Revision Summary

31 December 2003

Revised the "Next Planned Update". Reaffirmed the contents of the document and reissued with minor changes.

Table 2 - Average Daily Consumption ADC of Raw and Drinking Water

(In absence of measured or known flow rates, use the larger of the ADC values listed in SAES-A-104 and in this table.)

Consumer Type	Person Per ⁽¹⁾ Unit	Water ⁽¹⁾ Value	Consumption ⁽²⁾ Unit
Average Daily Consumption of Raw Water			
Domestic			
2-3 Bdrm House & Mobile Home	3.05	1750	LPHPD
4-5 Bdrm	6	2180	LPHPD
Executive House	6	2910	LPHPD
11+ Bachelor Unit	1	530	LPHPD
3-10 Bachelor Unit	1	350	LPHPD
Guest House	1	183	LPCPD
Community Support Facilities			
Office & Comm. Bldg.	-	3	LPSMPD
11+ Cafeteria	-	27	LPSMPD
3-10 Cafeteria	-	14	LPSMPD
Dental Clinic	-	379	LPCHPD
Gymnasium	1	132	LPCPD
Musalla	1	38	LPCPD
Average Daily Consumption of Drinking Water			
Domestic			
2-3 Bdrm House & Mobile Home	3.05	110	LPHPD
4-5 Bdrm	6	100	LPHPD
Executive House	6	130	LPHPD
11+ Bachelor Unit	1	76	LPHPD
3-10 Bachelor Unit	1	30	LPHPD
Guest House	1	57	LPCPD
Community Support Facilities			
Office & Comm. Bldg.	-	1.5	LPSMPD
11+ Cafeteria	-	14	LPSMPD
3-10 Cafeteria	-	7	LPSMPD
Dental Clinic	-	1893	LPCHPD
Gymnasium	1	19	LPCPD
Musalla	1	19	LPCPD

Notes:

(1) Based on AER-2278 (EPI 160-88), 1982.

(2) Abbreviations:

LPHPD Liters per House per Day
 LPCPD Liters per Capita per Day
 LPSMPD Liters per Square Meter per Day
 LPCHPD Liters per Dental Chair per Day
 L/Day Liters per Day
 L/Hour Liters per Hour

Table 3 - Raw Water Irrigation

Unit Type	Irrigation Area Unit Square Meters	Irrigation Method	
		Controlled LPDSM	Uncontrolled LPDSM
Established Areas			
11+ Family House	372	20.4	40.8
11+ Bachelor	57	20.4	40.8
3-10 Bachelor	268	20.4	40.8
Community Areas	As Planned	20.4	
New Areas			
11+ Town House	145	20.4	
11+ Detached	294	20.4	
11+ Bachelor	71	20.4	
Community Areas	As Planned	20.4	

Based on SAER-2278 (EPI 160-88), 1982.