Materials System Specification

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RTR (Fiberglass) Sewer Pipe and Fittings for Gravity Flow

Document Responsibility: Non-Metallic Standards Committee

Saudi Aramco DeskTop Standards

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1 Scope

1.1 This specification defines the requirements for fiberglass pipe, intended for use in gravity flow systems for conveying sanitary sewage, storm water, and some chemical and industrial wastes.

1.2 This specification covers glass-fiber-reinforced thermosetting resin pipe (RTRP), and glass-fiber-reinforced plastic-mortar pipe (RPMP) as defined in AWWA C950, couplings, fittings, and spools using polyester, vinyl ester or epoxy resin with unrestrained and restrained joints. For simplicity the fiberglass pipe that includes RTRP and RPMP is being referred as RTR pipe in the text of this specification.

1.3 The minimum temperature rating of pipe, couplings, fittings and spools shall be 49°C (120°F).

1.4 This specification does not apply to fiberglass pipe intended for use in Pressure Water Services applications. For such application refer to 01-SAMSS-034.

1.5 This specification does not apply to RTRP pipe intended for use in process water, injection water and hydrocarbon services applications. For such application refer to 01-SAMSS-042.

2 Conflicts and Deviations

2.1 Any conflicts between this specification and other applicable Saudi Aramco Materials System Specifications (SAMSSs), Engineering Standards (SAESs), 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 specification 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

References noted below are a part of this specification, to the extent indicated, and shall be the latest edition at the time of Purchase Order placement, unless otherwise noted in the Purchase Order documents.

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 Standard

SAES-A-004	*General Requirements for Pressure Testing*

Saudi Aramco Forms

Form 175-000000	*Inspection Requirement for Pipe and Fittings*
Form SA-7930	*Non-material Requirements (NMR)*

3.2 Industry Codes and Standards

American Society of Mechanical Engineers/American National Standards Institute

ASME B1.20.1	*Pipe Threads, General Purpose*
ASME B16.5	*Pipe Flanges and Flanged Fittings NPS ½ through NPS 24 Metric/Inch Standard*
ASME B31.3	*Process Piping*
ASME B46.1	*Surface Texture*

American Society for Testing and Materials

ASTM C33	*Standard Specification for Concrete Aggregates*
ASTM D638	*Standard Test Method for Tensile Properties of Plastics*
ASTM D695	*Standard Test Method for Compressive Properties of Rigid Plastics*
ASTM D2412	*Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading*
ASTM D2563	*Standard Practice for Classifying Visual Defects in Glass-Reinforced Plastic Laminate Parts*
ASTM D2925	*Standard Test Method for Beam Deflection of "Fiberglass" (Glass-Fiber-Reinforced Thermosetting Resin) Pipe under Full Bore Flow*

ASTM D3262	*Standard Specification for Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer Pipe*
ASTM D3567	*Standard Practice for Determining Dimensions of "Fiberglass" (Glass-Fiber-Reinforced Thermosetting Resin) Pipe and Fittings*
ASTM D4024	*Standard Specification for Machine Made "Fiberglass" (Glass-Fiber-Reinforced Thermosetting Resin) Flanges*
ASTM D4161	*Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Joints Using Flexible Elastomeric Seals*

American Water Works Association

AWWA C207	*Steel Pipe Flanges for Waterworks Service - Sizes 4 in. through 144 in. (100 mm through 3,600 mm)*
AWWA C950	*Fiberglass Pressure Pipe*

Manufacturers Standardization Society of the Valve & Fittings Industry, Inc.

MSS SP-44	*Steel Pipeline Flanges*

4 Purchase Order Information

The following information shall be as stated in the Purchase Order:

- Required pipe size and length,
- Temperature rating if higher than the minimum required (paragraph of 1.3 of this specification). Provide chemical analysis of the fluid if the pipe is used for other than sanitary sewers, oily water sewers, and water services,
- Specific service and installation considerations including buried and/or above ground installation,
- Cell classification in accordance with standards in Section 6,
- Pipe-end configuration (spigot, bell, flanges, etc.),
- Type of joints as listed in Section 7 of this specification,
- Required number and size of couplings and fittings, if any,
- Adhesive kits required, if any, (specify type and construction of pipe & fittings for which it is suitable),
- Special tools required, if any,

- Special packing, marking, & shipping, if any (Sections 13 and 14).

5 Definitions

Buyer or Purchaser: The Company (Saudi Aramco, AOC, or ASC) that places the order for the material.

Buyer's Representative: The person who acts on behalf of the Buyer, who may be from the Consulting Services Department (CSD), Inspection Department (ID), Purchasing Department, or user organization.

Independent Agency: The Saudi Aramco-approved independent agency. A third party, not listed as Saudi Aramco-approved Independent Agency and reporting tests to Saudi Aramco that has been witnessed by Consulting Services Department or Inspection Department of Saudi Aramco, is also qualified as an Independent Agency.

Manufacturer: RTR piping manufacturing facility, that has made at the proposed plant at least one RTR piping system with the same materials, manufacturing process, product design, design pressure and temperature, and joint type as the system on order. The system shall have performed satisfactorily in service for at least 1 year.

Saudi Aramco's Engineer: The Chairman of Non-Metallic Standards Committee in Consulting Services Department, Dhahran.

Vendor: The other party that supplies the material who may or may not be the manufacturer of the product.

6 Cell Classification

All pipes, joints, fittings, couplings, and spools, supplied under this specification, shall be identified by cell classification method as stated in ASTM D3262. Equivalent cell classifications by other ASTM standards are also acceptable.

7 Materials and Fabrication

7.1 All pipes, joints, fittings, couplings, and spools, supplied under this specification, shall be identified by cell classification system from the standards listed in Section 6. Equivalent cell classifications by other ASTM standards are also acceptable.

7.2 The product shall meet the performance requirements of Section 9 of this specification.

7.3 Pipe and couplings shall be filament-wound using polyester, vinyl ester or epoxy resin and fiberglass reinforcement.

7.4 Resin System

Resin shall be suitable for the services specified, and shall be noted by the vendor in his proposal. The resin system used for the interior liner, the structural wall, fittings, and adhesives, shall be polyester, vinyl ester or epoxy, with suitable curing agents so that it meets the performance requirements and temperature limits in this Specification.

7.5 Glass Reinforcement

The structural wall reinforcement shall be of commercial-grade glass fiber, suitable for the services specified in the Purchase Order, treated with a compatible binder and coupling agent.

7.6 Fillers

Siliceous sand may be used as filler as specified in cell classification. Siliceous sand shall conform to ASTM C33, except that the requirements for gradation need not apply.

7.7 Additives

Resin additives such as pigments, dyes or coloring agents may be used, provided they do not detrimentally affect the performance of the pipe. The pipe shall contain a UV inhibitor if requested on the Purchase Order. Pipe and fittings that will be exposed to sunlight when installed, shall contain UV inhibitor.

7.8 Reinforcing Fiberglass Ribs

Pipe sizes 2600 mm (102 inch) and higher may be manufactured with reinforcing fiberglass external ribs to achieve the required stiffness.

7.9 Joint Types

The pipe shall have one or a combination of the following joining systems that shall provide for fluid tightness for the intended service condition.

a) Unrestrained Joints

1. Gasketed bell-and-spigot
2. Gasketed bell and bell coupling for use with spigot and pipe

b) Restrained Joints

1. Bell-and-spigot, adhesive bonded
2. Butt-and-wrap, with reinforced overlays

3. Mechanical joints: flanged, and restrained gasketed joints

4. Non-commercially available special joints or any proprietary joints shall have a prior approval from the Chairman of Non-Metallic Standards Committee.

7.10 Adhesives and solvent cleaners

Adhesive for bonded joints shall be of a material suitable for the services and design conditions specified. Cleaning fluids/agents and adhesives shall be compatible with the resin used to manufacture the pipe, pipe seals and gaskets. Adhesives shall be provided in a self-contained kit with all necessary materials and instructions. The adhesive kit shelf life at 38°C shall not be less than 9 months from the date of shipment. Adhesive kits shall indicate the required storage conditions and date of expiration of shelf life. Adhesives shall be suitable for use in a 48°C working environment.

7.11 Flexible Elastomeric Seals and Joint Tightness

The chemical composition of the flexible elastomeric seals shall be compatible with the type of service and environment to which it will be subjected.

7.12 Fittings

Flanges, wyes and other drainage fittings may be compression-molded, manufactured from mitered section of pipe, or manufactured by the filament wound process, using thermosetting polyester, vinyl ester or epoxy resin and fiberglass reinforcement such that the resistance to chemical attack and the temperature rating are equal to or better than that of the pipe. All such fittings used for drainage shall be of the drainage type, having a smooth interior water way of the same diameter as the piping served and shall be compatible with the type of pipe used.

7.13 Except for compression-molded fittings, all pipe, fitting, and flange surfaces that are exposed to the fluid shall have a smooth, uniform, resin-rich liner with a thickness of 0.51 ± 0.13 mm (0.020 ± 0.005 in). The interior liner shall be reinforced with either nonwoven polyester fibers or glass veil surfacing mat. Polyester or glass veil liner reinforcement is not required on 100 mm (4 in) and smaller fittings at the mitered joints, provided all gaps at the joints are completely filled with epoxy resin to act as an effective corrosion barrier and to prevent the presence of any exposed glass fibers.

7.14 All machined or cut surfaces shall be post-coated with catalyzed resin except for bonding surfaces for field joints and mechanical fiberglass threads. Post-coating shall be performed within four hours of machining or other surface preparation.

7.15 Adhesive-bonded joints, if any, shall be bell and spigot type and shall not require a field-applied overwrap to develop the required strength.

7.16 Flanges, if provided, shall be flat-faced, or flat-faced with a confined O-ring gasket groove.

7.17 All pipe, fittings and flanges for a particular new installation shall be manufactured or supplied by the same Vendor to avoid incompatibility due to intermixing of products from different manufacturers.

7.18 Threads shall be per ASME B1.20.1 and shall conform to the requirements of ASME B31.3, paragraph A314.2.2. Threaded joints are not permitted in piping manufactured using any kind of fillers, such as reinforced plastic mortar piping (RPMP).

8 Dimensions and Tolerances

8.1 Dimensions and surface finishes shall be measured in accordance with ASTM D3567 and ASME B46.1. The average wall thickness of the pipe shall not be less than the nominal wall thickness published in the manufacturer literature, current at the time of purchase. The minimum wall thickness at any point shall not be less than 87.5% of the nominal wall thickness, when measured in accordance with ASTM D3567.

8.2 Flange bolt hole sizes and the number of bolt holes and bolt hole circles for up to 600 mm (24 in.) nominal pipe size shall comply with ASME B16.5.
For larger than 600 mm (24 in.) nominal pipe size, flange bolt hole sizes and the number of bolt holes and bolt hole circles shall comply with AWWA C207, or MSS SP-44.

8.3 Unless otherwise defined in the Purchase Order, specified face-to-face, centerline-to-face, and centerline-to-centerline dimensions of special fabrications (spools) shall have a tolerance of ± 12 mm (½ in). Lateral offset of flanges from the pipe centerline and rotation of flanges shall be limited to 6 mm (¼ in). Flange face alignment shall be within 3 mm (⅛ in) of the required position when measured across the flange face. These tolerances may be doubled at the most for piping 450 mm nominal size and larger.

9 Performance Requirements

9.1 General

9.1.1 The Manufacturer shall perform design type tests, as required in Section 9.2 of this specification, on materials made at each manufacturing facility where materials for Buyer would be produced.

9.1.2 Design type tests shall be witnessed and certified by an independent agency.

9.1.3 Testing and test reports shall pertain to items representative of those supplied under the Purchase Order. Design type testing shall be repeated after any change in materials, manufacturing methods, or product design.

9.1.4 The Manufacturer shall provide supporting background information of paragraph 7.2 of this specification, for review by Buyer's Representative before purchase order award.

9.2 Design Type Tests

9.2.1 Chemical Resistance Determination

The chemical resistance shall be carried out as per ASTM D3262. A certification from an affiliate manufacturing plant or resin suppliers can be accepted if the same materials and process are used. If the test data is not available, the Manufacturer may submit documented service data to Saudi Aramco's Engineer for approval.

9.2.2 Long-Term Ring Bending Strength

Long term ring bending shall be determined in accordance with AWWA C950 with stress relaxation or creep failure test instrumented to detect an abrupt significant reduction in mechanical properties or as an alternative may be tested in accordance with ASTM D3262. The test data shall be statistically extrapolated to establish strength at 50 years.

9.2.3 Flange Ratings

Flanges, if provided, shall be rated and marked at not less than 35 kPa (5 psi) in accordance with ASTM D4024. The manufacturer shall test, on a one-time basis, three samples of minimum, median and maximum flange sizes of the manufacturing range at the plant. As alternative for each diameter, a design method can be submitted as a substitute to the test described in ASTM D4024. The design method shall be submitted for approval to Saudi Aramco Engineer by the vendor.

9.2.4 Joint Integrity Test

9.2.4.1 Joints shall be of unrestrained or restrained types as defined in ASTM D3262.

9.2.4.2 For qualifying manufacturer's jointing procedures and methods, the joints shall be tested as follows:

a) Gasketed joints shall be tested in accordance with ASTM D4161 for the pipe manufactured for nonpressure service, and shall meet the performance requirements of Section 6 and 7 of ASTM D4161. Restrained rigid joints, such as bell-and-spigot adhesive bonded, butt-and-wrap lamination joints and bell-and-spigot with laminated overlays shall be exempt from the angular deflection requirement. One test as per Sections 6 and 7 of ASTM D4161 shall be performed for each gasket profile.

b) Restrained rigid joints, such as bell-and-spigot adhesive bonded, butt-and-wrap lamination joints and bell-and-spigot with laminated overlays shall meet or exceed the hoop tensile and axial tensile strength requirements of the pressure Class 50 pipe as tested in accordance with AWWA C950. One test for each jointing method shall be performed to establish design stress values.

9.2.5 Beam Strength Test

9.2.5.1 Pipe shall be tested in accordance with ASTM D2925, with the exception that the ends of the test specimens may be capped with the end caps unrestrained and simply supported at their centers of gravity.

9.2.5.2 Temperature of the fluid, used for the test, shall be maintained at the maximum temperature rating of the pipe, ±2°C.

9.2.5.3 The apparent elastic modulus of the pipe, calculated using the total maximum measured deflection, shall not be less than 6900 MPa (1,000,000 psi).

9.2.5.4 Beam strength test can be substituted by testing a sample for tension per ASTM D638 and compression per ASTM D695, and should meet or exceed the values of Table 7 of ASTM D3262.

10 Quality Control (QC) Test Requirements

10.1 General

The items manufactured to this specification are subject to verification by Buyer's Representative in accordance with Saudi Aramco Inspection Requirements Form 175-000000, attached to the Purchase Order.

10.2 Pipe Stiffness

10.2.1 The pipe stiffness shall be determined in accordance with ASTM D2412. The sampling method shall be in accordance with AWWA C950.

10.2.2 The pipe shall exhibit, without structural damage, the minimum stiffness of 165 kPa (24 psi) at 5% deflection.

10.2.3 At 10% deflection, there shall be no visual indication of cracking, crazing, interlaminar separation or structural damage. The Manufacturer shall indicate which small pipe sizes cannot reach 10% deflection, and shall report the maximum deflection for such cases.

10.3 Visual Inspection

Components shall be visually inspected for compliance with the defect limits in Table 1 of this specification.

Table 1 – Allowable Defects, RTR Pipe and Fittings Visual Acceptance Limits(1)

Name		Interior Surface	Exterior Surface	O-Ring Sealing Surface
1	Air Bubble (2) (Void)	Not to penetrate any surface - limits apply to all surfaces, maximum dimension 1-2 mm diameter, 0.5 mm thickness, 4 per one m² area	Same requirements as for Interior Surface	Same requirements as for Interior Surface
2	Foreign Inclusion	Not to penetrate any surface - limits apply to all surfaces, maximum depth 1 mm, 1 per one m² area	Same requirements as for Interior Surface	Same requirements as for Interior Surface
3	Pit (2) (Pinhole)	Max. depth 0.25 mm, maximum width 1.0 mm, 35 per one m² area	Not to penetrate reinforced wall	Maximum dimension 0.25 mm
4	Porosity (Pinhole)	See Pit	See Pit	See Pit
5	Scratch	Max. depth 0.40 mm not to exceed liner thickness	Not to penetrate reinforced wall	Maximum depth 0.25 mm
6	Wormhole (Surface void)	See Note 2	See Note 2	See Note 2
7	Wrinkle	Max. depth 2 mm	Not applicable	None allowed
8	Other	See Note 3		

Notes:

1. All defect definitions per ASTM D2563 for RTR pipe and fittings.
2. If the void can be broken with the tip of a ballpoint pen, treat as a Pit. If the void cannot be broken with the tip of a ballpoint pen, treat as an Air Bubble.

3. Blisters, Burned Areas, Cracks, Crazing (surface cracks), Dry Spots, Edge Delamination, Internal Delamination, Fractures and Shorts not permitted with or without repair.

10.4 Hydrostatic Leak Test

10.4.1 All pipe, fittings and spools shall be hydrostatically leak tested at the factory in accordance with AWWA C950, to a minimum test pressure equal to 200 kPa (29 psig).

10.4.1.1 The hydrotest fixture for restrained-gasketed joint pipe and fittings shall use end plugs and gaskets that apply the full end load due to pressure to the component during test. For adhesive-bonded pipe and fittings, full end load does not have to be applied.

10.4.1.2 If air is used as the pressurizing medium, the component shall be completely submerged in clear water during the pressurization and inspection period.

10.4.1.3 All pipe, fittings, spools and joints shall be visually examined for leakage. Any item showing evidence of weeping or leakage shall be rejected.

10.4.2 The standard adhesive-bonded flanges, standard adapters, saddles, nonstandard fittings with plain ends configurations, and prefabricated spools with plain ends that cannot be hydrotested at the manufacturing facility due to size limitations and configurations shall be handled as follows:

a) The vendor shall require the Saudi Aramco Inspector's approval for field-testing of such items.

b) The vendor shall mark these items to be field hydrotested.

c) These items shall be hydrotested in accordance with SAES-A-004 after assembling at the job site.

d) The assembled items and the testing shall be at Vendor's risk.

e) Buyer's Representative shall witness the test. The rejected parts shall be removed from the system or repaired by the Vendor in accordance with a Saudi Aramco-approved repair procedure. The replaced or repaired part shall be retested.

10.5 Rejection

If the results of any QC test do not conform to the requirements of this specification, that test shall be repeated on two additional samples from the

same lot of pipe. Each of the two samples shall conform to the requirements specified. If either of the two additional samples fails, the lot shall be rejected.

11 Drawings and Test Reports Requirements

11.1 Drawings

Product drawings that show product dimensions and tolerances, including couplings, fittings and joints, shall be submitted one time for prior approval by Saudi Aramco's Engineer.

11.2 Test Reports

11.2.1 The Manufacturer's test reports, as summarized in Table 2, shall be made available to the Buyer's Representative to ensure that the same materials and manufacturing methods used in the fabrication of test specimens were used to make the components on order, and to assure compliance with the requirements of Section 9 of this specification.

11.2.2 The required testing for compliance with this specification is summarized in Table 2 of this specification.

11.2.3 QC tests as described in Section 10 of this specification shall be performed at the intervals described in the indicated industry standards.

11.2.4 Documents of QC tests performed during fabrication shall be traceable to the manufactured items. The documents on the items shall be submitted to the Buyer's Representative for quality conformance verifications.

11.2.5 The Manufacturer shall maintain a record of all QC tests for a period of not less than two years, as per AWWA C950 and, if requested, shall submit the data to the Purchaser.

Table 2 – Summary of Required Drawings and Testing

		Required By Spec. Section	Component Testing, Size, Configuration, and Timing
1	**Certified Drawings**		
	a. Pipe Couplings, Fittings, Joints	11.1	All P.O. items
2	**Design Type Test**		
	b. Chemical Resistance	9.2.1	Single
	c. Long-Term Ring Bending Strength	9.2.2	Single
	d. Flange Pressure Rating	9.2.3	One sample of each minimum, medium and maximum of manufacturing range
	e. Joint Strength Test	9.2.4	Single of each type
	f. Beam Strength Test	9.2.5	One sample of each minimum, medium and maximum of manufacturing range
3	**Quality**		
	a. Pipe Stiffness	10.2	ASTM D2412 / AWWA C950
	d. Visual Inspect	10.3	All Sizes
	e. Hydrostatic Leak Test	10.4	All Sizes
	f. Dimensions	8.0	ASTM D3567 / AWWA C950

12 Nonmaterial Requirements

12.1 The Vendor shall provide the parts' data and documentation as specified in Form SA-7930, Nonmaterial Requirements (NMR), if the form is attached to the Quotation Request and the Purchase Order.

12.2 If requested by the Purchaser, the Vendor shall provide a quotation to provide complete or partial installation supervision services to the Buyer, such as to provide personnel to monitor installation of the entire RTR piping system, and to check joints, supports and anchors, and ensure that they are properly installed.

13 Identification Tagging

13.1 All components shall be permanently marked for proper identification. All required marking shall remain legible under normal handling and installation practices. The marking shall include the following:

- Manufacturer's name or trade name, and identification code
- Temperature rating
- Nominal diameter
- Cell classification in accordance with industry standards (from Section 6 of this specification)
- Inspection and hydrotesting mark
- Date and shift of manufacture

- SAMS stock number (if applicable)
- Purchase Order number
- Flange designation code

13.2 Stenciled paint markings or labels shall be covered by a catalyzed resin topcoat. Adhesive-bonded paper or plastic labels without a catalyzed resin topcoat shall not be used.

13.3 Small fittings and flanges that cannot be marked shall be tagged.

14 Packing and End Protectors

14.1 Packing

14.1.1 Unless otherwise specified in the Purchase Order, pipe, fittings, O-rings, gaskets, locking rings, and adhesives shall be packed in a manner to withstand rough handling. The size and type of packing shall permit long-term storage.

14.1.2 The packages shall be provided with skids to facilitate handling by forklift truck unless otherwise instructed by the purchaser.

14.2 End Protectors

14.2.1 End protectors shall be provided and securely attached to open ends of all pipes.

14.2.2 End protectors shall be designed to protect the pipe ends from impact damage, contamination, and weathering of machined bonding surfaces due to ultraviolet exposure. They shall have an open center permitting inspection of the pipe bore.

14.2.3 Flange faces on fabricated piping shall have protective covers not smaller than the flange outside diameter.

14.2.4 All threaded connections shall be protected with protective caps.

Revision Summary

30 June 2003	Major revision.
21 November 2009	Minor revision.
24 April 2011	Editorial revision to transfer document responsibility from Plumbing and Utilities Standards Committee to Materials and Corrosion Standards Committee.
20 March 2013	Editorial revision to change the document responsibility from Materials and Corrosion Control to Non-Metallic Standards Committee.