Purad® PVDF High Purity Piping Specification

PART 1: GENERAL

1.1 Summary

Furnish a complete high purity PVDF piping system to include pipe, fittings, specialty fittings, and valves.

1.2 References

The following standards apply to products used within this section.

ASTM D 1598	ASTM D 1599
ASTM D 2122	ASTM D 2657
ASTM D 2837	ASTM D 3222
DVS 2207-15	ISO 10931

The system design shall meet the requirements of ASME/ANSI B31.3 for design criteria where temperature and pressure fall within the limits of the code.

1.3 Definitions

PVDF: Polyvinylidene Fluoride
Purad®: Asahi/America's high purity PVDF piping system

1.4 System Description and Pressure Rating

System shall be a Purad® PVDF system made of uniform pipe and fitting resin. System pressure ratings shall be based on continuous use of 50 years at 68º F.

Purad® pipe and fittings shall be based on a Standard Dimensional Ratio (SDR) according to ISO 10931.

1/2" through 2-1/2" (20 - 75mm) shall be SDR 21
3" through 12" (90 - 315mm) shall be available in SDR 21 and SDR 33.

Pressure rating for pipe and fittings, unless otherwise noted, shall be 230psi (16 bar) for SDR 21 material and 150psi (10 bar) for SDR33.

1.5 System Performance Requirements

System performance requirements shall handle the following:

Operating Pressure:	(TBD by Engineer/Project Owner)
Operating Temp:	(TBD by Engineer/Project Owner)
Test Pressure:	(TBD by Engineer/Project Owner)
Media:	(TBD by Engineer/Project Owner)

1.6 Submittals

Submit the following:

A. Product data for the system specified; relative to material dimensions of individual components profiles and finishes.

B. Product certificates signed by manufacturer of Purad® PVDF piping product, stating compliance to stated requirements.

C. Welder certificates, certifying that welders comply with the installation procedures as outlined by ASTM D-2657 & DVS 2207-15. All required training should be scheduled and completed at to job start-up.

D. Qualification of firms supplying Purad® PVDF: Firms must have a minimum of five years' experience in design, installation and operation of thermoplastic high-purity piping systems.

1.7 Quality Assurance

Obtain components from a single source having responsibility and accountability to answer and resolve problems regarding proper installation, compatibility, performance, and acceptance.

1.8 Delivery, Storage and Handling

A. Deliver all Purad® PVDF pipe to arrive on-site inside protected hard black PE tubes. Cardboard tubes are not allowed. Within tubes, pipe shall be capped and bagged in polyethylene static free, non-tear bags for cleanroom applications. See Section 2.3.B for pipe quantities per bag.

B. Deliver all Purad® PVDF fittings to arrive on-site double bagged in boxes, when possible, layered with bubble packing or expanding Styrofoam to prevent damage.

C. Store products on elevated platforms in a dry location with protection from the environment. Failure to protect pipe from damage during the project may result in longer start up times, pressure failures or premature breakage.

D. Lift, support and transport Purad® PVDF piping per manufacturers' recommendations.

1.9 Warranty

Warranty period is one year after date of substantial completion for job installations lasting no longer than one year. Asahi/America is not responsible for failures due to installation error or neglect.

PART 2: PRODUCTS

2.1 Manufacturers

Subject to compliance with requirements products which may be incorporated in the work include: The Purad® PVDF System as supplied by Asahi/America, Inc. of Lawrence, Massachusetts, 800-343-3618. Produced by Alois Gruber GmbH AGRU of Bad Hall, Austria.

2.2 Material

Pipe, valves and fittings shall be made from HP resin produced by Solvay Solexis. The resin shall meet or exceed the requirements outlined for a Type II suspension grade homopolymer resin in ASTM D-3222.

Resin must be approved for contact with foodstuff as per the FDA CFR, Title 21 (2001) 177.1520

Resin must meet USP Class VI requirements

Pipe shall be made of Solef® 1010/0001 HP resin.
MFI = 4-7 g/10 min.

Fittings 1/2"-2" shall be made of Solef® 1009/0001 HP resin.
MFI = 12-16 g/10min.

Fittings 2-1/2" -10" shall be made of Solef® 1008/0001 HP resin.
MFI = 22-27 g/10 min.

All resins shall not introduce contaminations into the ultra high purity water. Specifically, all raw materials in product manufacturing shall be free of chemical additives, fillers, property enhancers and reinforcements, such as antioxidants, anti-static agents, colorants, flame retardants, heat stabilizers lubricants, mold release agents, pigments, plasticizers, processing aids, ultraviolet stabilizers and viscosity depressants.

In addition, manufacturer shall test all lots to ensure the melt flow index is within allowable range.

Traceability of all molded and extruded components must be molded into or otherwise printed on the outside of the piping component.

2.3 Pipe

A. Production

All pipe shall be produced on a dedicated extruder completely within a class 100 cleanroom and shall be packaged within a class 100 section of the cleanroom. Pipe must be in-line stress relieved as it is extruded. Post extrusion annealing is not allowed. Surface finish is as follows:

Size Inches	Size mm	Result
1/2" – 9"	20-225 mm	Ra = 5.91μ" (0.15μm)
10" – 12"	250-315 mm	Ra = 15.75μ" (0.40μm)

In addition, the manufacturer shall conduct continuous checking for micropores. The micropores shall not exceed a size of 1 micron.

B. Packaging

All pipes shall have ends sealed with PE bags and then capped and single bagged. Pipe shall be sleeved in a PE encasement, purged with high purity nitrogen and heat-sealed. Pipe is then packed into a hard PE tube for shipping protection. Cardboard tubes are not acceptable. The following chart designates quantities of pipe per PE shipping tube:

Size inches	Size mm	Quantity Per Tube
1/2"	20	Five
3/4"	25	Four
1"	32	Three
1 1/4"	40	One
1 1/2"	50	One
2"	63	One
2 1/2"	75	One
3"	90	One
4"	110	One
6"	160	One
8"	200	One
9"	225	One
10"	250	One
12"	315	One

C. Pressure Rating

All pipe shall meet the requirements of Section 1.4.

2.4 Fittings

A. Production

All standard fittings through 12" (315mm) shall be injected molded. All fittings are to be molded with equipment in a class 100 cleanroom environment. After secondary machining all fittings shall be cleaned for a minimum of 1 hour in an automated 6-basin Hot DI rinse Stations. The DI Rinse water shall be 70° C with resistivity above 18MΩ and TOC ≤10PPB. Surface finish is as follows:

Size Inches	Size mm	Result
1/2" – 9"	20-225mm	Ra = 7.80μ" (0.20μm)
10" – 12"	250-315 mm	Ra = 15.75μ" (0.40μm)

B. Packaging

All molded fittings are to be packaged in a class 100 cleanroom immediately after the cleaning process. All machined fittings are to be packaged in a class 1000 cleanroom. Fittings are to be double bagged, purged with clean dry Class 100 air or nitrogen in PE/Nylon composite bags. Bags are to be silicone free and anti-static.

C. Specialty Fittings

Specialty fittings are to include restraint fittings, butt fusion instrumentation fittings, sanitary connections, etc. Specialty fittings shall be machined or molded of the same PVDF resin family as the pipe and fittings and shall be packaged according to the requirements of section 2.4.B.

D. Pressure Rating

All fittings, unless otherwise noted, shall meet the requirements of Section 1.4.

2.5 Valves

All valves shall be produced in the same manner as High Purity Fittings

A. Type 342 Spigot Diaphragm Valves:

1/2"-4" (20mm –110mm) shall be the type 342 of the Purad® system. The Valves shall have a PVDF body (Solef Resin) and a PTFE diaphragm with EPDM backing. Valve bodies are to be unibody, molded design with a 150psi rating at 70º F. All metal nuts and bolts must be capped or covered to reduce metal exposure. Top Works must include integral lockout device on the handle and position indicator.

B. Type 342 Flanged Diaphragm Valves:

1/2" – 1" (20mm – 32mm) and 2-1/2" (75mm) shall be type 342 with stub end and backing ring IR welded onto both sides. Top works must include locking device on the handle and position indicator. All metal nuts and bolts must be capped or covered to reduce metal exposure. Top Works must include integral lockout device on the handle and position indicator.

C. Type 342 Molded Flanged Diaphragm Valves:

1-1/4" - 4" (40mm – 110mm), excepting 2-1/2" (75mm) shall be type 342 single PVDF body design with flanges molded as part of the body. Diaphragm shall be PTFE with EPDM backing. All metal nuts and bolts must be capped or covered to reduce metal exposure. Top Works must include integral lockout device on the handle and position indicator.

D. Flanged Diaphragm Valves:

6"-10" (160mm – 250mm) shall be Type-15 or Type-G single PVDF body with flanges molded as part of the body. Diaphragm shall be two-piece style with PTFE and separate EPDM backing. Top works shall include a position indicator and travel stop.

E. Type 343 Zero Dead Leg Valve:

1/2" x 1/2" through 6" x 2" (20mm x 20mm through 160mm x 63mm) reduced dead leg (zero dead leg) valves shall be Type 343 Style from the Purad® System. Valves shall be made of PVDF Solef resin. Valve bodies are to be unibody, molded design with a 150psi rating at 68º F. All metal nuts and bolts must be capped or covered to reduce metal exposure. Top Works must include integral lockout device on the handle and position indicator.

F. Ball Valves:

1/2" - 2" (20mm - 63mm) Purad® PVDF ball valves shall be made with natural polyvinylidene resin. O-rings are to be FKM. Ball valves shall be offered in spigot ends. Supplied cleaned and double bagged, lubricant-free.

G. Flow Meters:

Available in polysulfone (PSU) and polyamide (PA) Frank M123 and M335 flow meters shall be supplied with spigot ends suitable for high purity welding. Float shall be PVDF, unions shall be PVDF, and O-rings shall be FPM (FKM). Flow ranges available up to 135 gallons per minute with custom ranges available.

H. Ball check valves:

1/2" – 2" (20mm – 63mm) shall be true union. 2-1/2" – 4" (75mm – 110mm) shall be single union style with FKM O-rings. Ball check minimum shut off of 5psi and max operating pressure of 150psi at 68° F. Supplied cleaned and double bagged, lubricant-free.

I. Type V182 (Type-241) Pressure Regulating Valve w/ Gauge Guard:

1/2" – 2-1/2" (20mm – 75mm) shall be PVDF type V182 with PTFE/FKM diaphragms/seals. 1/2" – 1-1/2" (20mm – 50mm) shall be pressure rated to 150psi at 68° F. 2" – 2-1/2" (63mm – 75mm) shall be pressure rated to 90psi at 68° F. V182 regulating valves shall have an integral gauge guard and gauge for inline adjustments of the valve.

J. Type V186 Back Pressure Regulating Valve:

1/2" – 2" (20mm – 63mm) shall be PVDF type V186 with EPDM backed PTFE diaphragm. 2-1/2" (75mm) shall be PVDF type V86 with EPDM backed PTFE diaphragm. Valves shall be pressure rated to 150psi at 68° F. 2" – 2-1/2" (63mm – 75mm) shall be pressure rated to 90psi at 68° F.

2.6 Pipe/Valve Hangers and Supports

A. Support Spacing

Design pipe supports and anchors in accordance with Asahi/America's recommended support spacing for SDR 11 polypropylene pipe. See Section 4.3 for recommended support spacing for Purad piping systems

B. Supports and Hangers

Use Asahi/America's recommended support types per document "Asahi/America Engineering Design Guide." Metallic supports and clamps shall not come directly into contact with plastic piping systems.

2.7 Joining Equipment

Purad® PVDF installation shall be performed by factory certified and trained installers in accordance with manufacturer's ISO procedures, ASTM D 2657 and DVS 2207-15. Date of certification or re-certification shall not exceed two years from the beginning of project. Available joining techniques are as follows:

A. Butt-Fusion

Proper equipment selection should be based on pipe size and site conditions. Butt fusion equipment should be designed and tested to provide reliable welds. All equipment should utilize electronically controlled heating elements for accurate welding temperatures. Tools should also incorporate planing units to face ends prior to heating. Butt-fusion equipment supplied shall weld joints based on force or pressure and not mechanical stops.

B. Socket Fusion

Proper equipment selection should be based on pipe size and site conditions. Socket fusion tools shall be available in two styles; one portable style capable of welding 1/2"- 2" (20mm – 63mm) and a bench style capable of welding 3/4"- 4" (25mm – 110mm). Heating elements are to be electronically controlled for accurate welding temperatures. Tools should also incorporate male and female heater inserts with PTFE coating.

C. Non-Contact Butt-Fusion

Proper equipment selection should be based on installation requirements and line sizes. Tool shall be fully automatic (SP series).

SP Series:

Tool shall be made available in the following models

SP 110-S	1/2" – 4"	(20mm – 110mm)
SP 250-S	4" – 10"	(110mm – 250mm)
SP 315-S	4" – 12"	(110mm – 315mm)

Tools shall possess electronic planer and infrared heating element. Tools will utilize and measure the welding pressures to join material and not mechanical stops. To avoid improper welded joints, tool shall automatically operate clamps and control joining force. Tools shall possess the following features:

1. Computer control and automatic fusion.
2. Touch screen for tool operation and parameter selection.
3. Restricted access through use of barcode or RFID cards.
4. Automatic label printouts after each weld.
5. Ability to display and graph weld processes as weld is proceeding.
6. Memory storage of welds
7. Magnetic clamps to reduce change out time from one size to another.
8. Vertical and horizontal adjustment for pipe alignment.

D. Beadless Electro Fusion

High Performance Fusion (HPF) equipment should be designed to weld all PVDF pipe valves and fittings constructed of Solvay Solef® resin 1/2-2" (20mm – 63mm). Equipment shall incorporate a bar code scanner to set all weld parameters. An internal balloon shall be used to eliminate a bead formation. Where usage of the balloon is not possible, weld will be conducted without balloon. Each weld will be done utilizing an HPF coupling.

PART 3: EXECUTION

3.1 Installation

A. Facilities

Subassembly and fabrication work should be conducted in a separate, temporary clean room located within the building. Cleanroom should be equipped with the following to provide a clean installation:

1. Provide Laminar flow HEPA filters in room ceiling to reach a level of class 10,000.
2. The quantity of filters should be determined by providing a minimum of 60 room air changes per hour.
3. Ideal set up is to place welding equipment directly under a filter. In addition, nitrogen should be available for purging the pipelines with a positive pressure if the assemblies expand beyond the bounds of the room.

B. Tools

All fusion tools utilized are to be dedicated for clean build only, and should be kept separate. Special attention should be given to the fusion tools to prevent the possibility of contaminating a weld. The contractor shall lease or purchase all necessary welding equipment from the manufacturer. At the end of the installation, any necessary equipment needed on-site should be sold to the owner. Contractor is responsible for proper maintenance and care of the fusion tools during construction.

C. Certification

Installers shall be pre-qualified as per section 2.7. Manufacturer shall provide on-site training in the assembly and installation of the Purad® PVDF piping system as needed.

3.2 Testing

A. Inspection

Prior to pressure testing, the system shall be examined for the following items:

1. Pipe shall be completed per drawing layout with all pipe and valve supports in place.
2. Pipe, valves, and equipment shall be supported as specified, without any concentrated loads on the system.
3. Pipe shall be in good conditions, void of any cracks, gouges or deformation.
4. Pipe flanges shall be properly aligned. All flange bolts should be checked for correct torques.
5. All diaphragm valve bonnet bolts shall be checked for correct torques.
6. All joints should be reviewed for appropriate welding technique:

    Butt: To have two beads, 360° around the joint.

    Socket: To have two beads on the end of the fitting and on the outside of the pipe in contact.

    Non-Contact: Identity labels shall identify weld certification by the print “welding parameters OK”. Joints should have two beads 360° around the joint.

Manufacturer to supply inspection procedures beyond the above recommendations. If any deficiencies appear, the quality control manager shall provide directions for repair.

B. Pressure Test

1. Test fluid should be deionized water, with quality level set by Quality Control Engineer. In all cases test must be done hydrostatically. Air test is not allowed

2. Filling the system-Open all valves and vents to purge the system of air. Slowly inject the water into the system, making sure that air does not become trapped in the system.

3. Begin pressurizing the system in increments of 10psi. Bring the system up to 100psi and hold. Allow system to hold pressure for a minimum of two hours and up to a recommended 12 hours. Check pressure gauge after one hour. Due to natural creep effects on plastic piping the pressure will have decreased. If drop is less than 10%, pump the pressure back up. At this time the system may be fully pressurized to desired test pressure.

4. If after one hour the pressure has decreased more than 10%, test is considered a failure. Note the 10% value may need to be greater for larger systems, or systems experiencing significant thermal changes.

5. Test is to be witnessed by Quality Control Engineer and certified by the contractor.

3.3 Cleaning of HP PVDF Piping System

System shall be cleaned at completion of project according to requirements set by owner.

PART 4: APPENDICES

Disclaimer: This information is provided for convenience. For additional information, please consult Asahi/America's engineering design guide or contact our engineering staff at 781-321-5409.

4.1 Material Properties

Table 1. Material Properties Purad® PVDF

	Properties	Condition	Standard	Units	PVDF
Physical	Specific density at 23 °C	23°C (73.4°F)	ISO 1183	g/cm^3	1.78
	Melt Flow Rate (MFR)	230°C / 5 kg	ISO 1133	g/10 min	6 - 24
Mechanical Properties	Tensile stress at yield	50 mm/min	ISO 527	MPa	50
	Elongation at yield	50 mm/min	ISO 527	%	9
	Elongation at break	50 mm/min	ISO 527	%	80
	Impact strength unnotched	23°C (73.4°F)	ISO 179	kJ/m^2	124
	Impact strength notched	23°C (73.4°F)	ISO 179	kJ/m^2	11
	Ball indentation hardness according to Rockwell	23°C (73.4°F)	ISO 2039-1	MPa	80
	Flexural strength	23°C (73.4°F)	ISO 178	MPa	80
	Modulus of elasticity		ISO 527	MPa	2000
Thermal Properties	Vicat-Softening point	VST/B/50	ISO 306	°C °F	140 284
	Heat deflection temperature	HDT/B	ISO 75	°C °F	145 293
	Linear coefficient of thermal expansion		DIN 53752	$K^{-1} \times 10^{-4}$	1.2
	Thermal conductivity	20°C (68°F)	DIN 52612	W/(m x K)	0.2
	Flammability		UL94		V-0
Electrical Properties	Specific volume resistance		DIN 53482	Ω x cm	>10^{13}
	Specific surface resistance		DIN 53482	Ω	>10^{12}
	Relative dielectric constant	1 MHz	DIN 53483		7.25
	Dielectric strength		DIN 53481	kV/mm	22
General	Physiologically nontoxic		EEC 90/128		Yes
	Food contact (FDA)				Yes
	NSF 51				Yes
	NSF 61				Yes
	USP Class IV				Yes
	UV resistance				Yes
	Color				Natural

4.2 Pressure Rating

Permissible operating pressure for Purad® piping systems based on years of operation and temperature. These tables are for water, a safety correction factor shall be applied for chemical service. Consult Asahi/America Engineering staff for chemical recommendations. Additionally, a system reduction factor of 0.8 shall be used for influences such as welding, joints, flange, and bending loads for aboveground installations and 1.0 should be used for below ground installation.

Table 2. Permissible Operating Pressures for Purad® PVDF (psi)

Temperature		1 Year		5 Years		10 Years	
°C	°F	PVDF 150 SDR 33	PVDF 230 SDR 21	PVDF 150 SDR 33	PVDF 230 SDR 21	PVDF 150 SDR 33	PVDF 230 SDR 21
10	50	177	284	174	277	171	276
20	68	161	258	157	251	155	249
30	86	145	232	141	226	139	223
40	104	129	207	126	203	125	200
50	122	116	184	112	180	110	177
60	140	102	164	99	158	97	157
70	158	93	142	86	138	86	136
80	176	77	123	74	119	74	117
90	194	67	106	64	103	62	100
95	203	61	99	58	94	55	87
100	212	57	90	52	84	45	73
110	230	46	75	36	58	30	49
120	248	36	58	25	41	22	35
130	266	25	41	17	28	-	-
140	284	17	28	12	19	-	-

Temperature		25 Years		50 Years	
°C	°F	PVDF 150 SDR 33	PVDF 230 SDR 21	PVDF 150 SDR 33	PVDF 230 SDR 21
10	50	170	271	168	268
20	68	154	245	152	244
30	86	138	220	136	218
40	104	123	197	122	194
50	122	109	174	107	173
60	140	96	154	94	151
70	158	83	133	83	132
80	176	73	116	70	112
90	194	55	87	46	75
95	203	45	73	39	62
100	212	38	59	52	58
110	230	25	41	22	35
120	248	17	28	-	-

4.3 Support Spacing

Table 3. Purad® PVDF SDR 21 Support Spacing (feet)

Pipe Size		68° F/ 20° C	86° F/ 30° C	104° F/ 40° C	122° F/ 50° C	140° F/ 60° C	158° F/ 70° C	176° F/ 80° C	212°F/ 100°C	248°F/ 120°C
mm	in									
20	1/2	2.8	2.6	2.5	2.5	2.3	2.1	2.0	1.6	1.5
25	3/4	3.1	3.0	2.8	2.6	2.5	2.3	2.2	2.0	1.6
32	1	3.6	3.4	3.3	3.1	3.0	2.8	2.6	2.3	2.0
40	1-1/4	3.9	3.8	3.6	3.4	3.3	3.1	3.0	2.5	2.1
50	1-1/2	4.6	4.4	4.3	3.9	3.8	3.6	3.3	3.0	2.5
63	2	5.0	4.8	4.6	4.4	4.3	4.1	3.9	3.4	2.8
75	2-1/2	5.3	5.1	5.0	4.8	4.6	4.4	4.3	3.7	3.0
90	3	5.7	5.5	5.3	5.1	5.0	4.8	4.6	3.9	3.4
110	4	6.4	6.2	6.0	5.8	5.5	5.3	5.1	4.4	3.9
125	4-1/2	6.7	6.6	6.4	6.0	5.8	5.7	5.3	4.8	4.3
140	5	7.1	6.9	6.7	6.4	6.2	6.0	5.7	5.1	4.4
160	6	7.6	7.4	7.3	6.9	6.6	6.4	6.0	5.5	4.8
180	7	8.1	7.8	7.6	7.3	6.9	6.7	6.4	5.7	5.0
200	8	8.5	8.3	8.0	7.6	7.4	7.1	6.7	6.0	5.3
225	9	9.0	8.9	8.5	8.1	7.8	7.4	7.1	6.4	5.7
250	10	9.4	9.2	8.9	8.5	8.1	7.8	7.4	6.7	6.0
280	11	10.1	9.7	9.4	9.0	8.7	8.3	8.0	7.1	6.4
315	12	10.6	10.5	10.1	9.7	9.2	8.9	8.5	7.6	6.7

Table 4. Purad® PVDF SDR 33 Support Spacing (feet)

Pipe Size		68° F/ 20° C	86° F/ 30° C	104° F/ 40° C	122° F/ 50° C	140° F/ 60° C	158° F/ 70° C	176° F/ 80° C	212°F/ 100°C	248°F/ 120°C
mm	in									
90	3	5.2	5.1	4.9	4.8	4.6	4.4	4.3	3.6	3.1
110	4	5.9	5.7	5.6	5.4	5.1	4.9	4.8	4.1	3.6
125	4-1/2	6.2	6.1	5.9	5.6	5.4	5.2	4.9	4.4	3.9
140	5	6.6	6.4	6.2	5.9	5.7	5.6	5.2	4.8	4.1
160	6	7.1	6.9	6.7	6.4	6.1	5.9	5.6	5.1	4.4
180	7	7.5	7.2	7.1	6.7	6.4	6.2	5.9	5.2	4.6
200	8	7.9	7.7	7.4	7.1	6.9	6.6	6.2	5.6	4.9
225	9	8.4	8.2	7.9	7.5	7.2	6.9	6.6	5.9	5.2
250	10	8.7	8.5	8.2	7.9	7.5	7.2	6.9	6.2	5.6
280	11	9.4	9.0	8.7	8.4	8.0	7.7	7.4	6.6	5.9
315	12	9.8	9.7	9.4	9.0	8.5	8.2	7.9	7.1	6.2

For gases and fluids with different densities, the conversion factors shown below should be used.

$$L = L_A * f_1$$

f_1 – conversion factor (See Table 5)
L – new support distance [mm]
L_A – permissible support distance (See Table 3 and Table 4)

Table 5. External Support Spacing Correction Factors based on Operating Media Density for PVDF

Material	SDR	Conversion factor f_1			
		Media density [g/cm³]			
		Gases	Water	Other Media	
		<0.01	1.00	1.25	1.50
Purad® PVDF	33	1.48	1.0	0.96	0.92
	21	1.36			