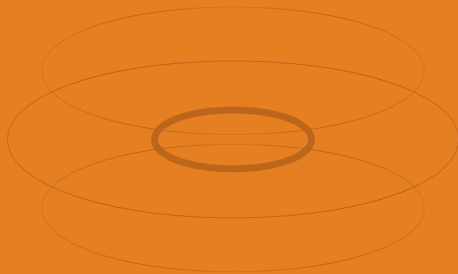


OWNER

Piping Material Specification



Document No.: PIP-SPC-001

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Project:



T O R U S

, County,

ISSUE SUMMARY AND APPROVAL

This page records each issue of PIP-SPC-001. The preparer, reviewer and approver sign for each revision.

Rev.	Date	Issue purpose	Description
A	2026-09-29	Issued for Review	First issue

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SECTION IP-SPC-001 PIPING MATERIAL SPECIFICATION

PART 1 GENERAL

1.01 SUMMARY

- A. This section defines the piping classes, materials, components, pressure-temperature ratings, branch connections, valves, fabrication, examination, testing and marking for all piping of the , from insulating joint IJ-101 to the outboard flange of the receiving pipeline operator's tap valve (tie-in TI-02), including the buried outlet lateral 12"-G-1042-A6.
- B. Five piping classes are defined, as summarized in Table 1-1. Each line on the Line List, MEC-LST-001, shall be built to the class shown in its line number.
- C. Vendor-packaged piping on the meter skid SK-110, the fuel gas skid FG-101, the line heater H-101 coil and burner train, and the analyzer systems in B-101 shall meet the class of the connecting line unless the vendor's code of construction is stricter.
- D. Related work specified elsewhere:
1. Piping fabrication and installation: SPC-SPC-006.
 2. Welding: SPC-SPC-007. Nondestructive examination: SPC-SPC-008.
 3. External coating of buried pipe: SPC-SPC-009. Above-ground painting: SPC-SPC-010.
 4. Hydrostatic testing, dewatering and drying: SPC-SPC-011.
 5. Instrument tubing installation: SPC-SPC-014.
 6. Valve purchase data: MEC-DS-006, API 6D Ball Valves; MEC-DS-007, Check Valve CKV-171; MEC-DS-008, Insulating Joints.

Table 1-1: Piping Classes

Class	Rating	Service	Material
A6	ASME B16.5 Class 600 RF	Natural gas: station process piping IJ-101 to IJ-102, outlet lateral, fuel take-off to PCV-161, drains up to the A6 / D1 break	Carbon steel, API 5L X52 PSL2 and ASTM A106 Gr B
A1	ASME B16.5 Class 150 RF	Fuel gas downstream of PCV-161 only (lines 1051, 1052, 1151, 1152 and burner train connections)	Carbon steel, ASTM A106 Gr B
D1	ASME B16.5 Class 150 RF	Liquid drains downstream of the A6 / D1 breaks to T-101; T-101 loadout, bottom drain and containment drain	Carbon steel, ASTM A106 Gr B

Class	Rating	Service	Material
S1	ASME B16.5 Class 150 RF, Group 2.1	Vent and blowdown downstream of restriction orifices, PSV and TSV outlets and vent valves: lines 1070 to 1077, 1120, 1160, 1161, 1170, orifice downstream flanges, VS-101	Stainless steel, dual-certified 304/304L (316/316L acceptable)
T1	Compression tube fittings, 6,000 psig class	Instrument, sample and analyzer tubing	316 stainless steel, ASTM A269 TP316 SMLS

Note 1: SMLS denotes pipe made without a longitudinal weld seam (API 5L and ASTM designation); ERW denotes electric resistance welded pipe.

1.02 REFERENCES

A. The following codes and standards apply, in the edition in force on the design date unless noted:

- 49 CFR Part 192, Subparts B, C, D, E and J, including 192.105 (design formula), 192.111 (design factor) and 192.505 (test requirements for compressor, regulator and measuring stations).
- ASME B31.8-2022, Gas Transmission and Distribution Piping Systems, including 814 (materials), 831 (components), 831.4 (branch reinforcement), 833.2 (restrained pipe), 841.1.1 (design formula) and 841.3 (testing).
- ASME B16.5, B16.9, B16.10, B16.11, B16.20, B16.21, B16.25, B16.34, B16.36, B16.48 and B36.10M / B36.19M.
- API 5L, 46th Edition (PSL2); API 6D; API 6FA and API 607; API 598; API 602; API 608; API 623; API 624; API 641; API RP 578.
- MSS SP-25, SP-44, SP-75, SP-95 and SP-97.
- ASTM A105 / A105N, A106, A182, A193, A194, A234, A269, A312, A320, A333, A350, A352, A370, A403, A694 and A961.
- 40 CFR Part 60, Subpart OOOOb (fugitive emissions from valves).

B. Project documents:

- GEN-DB-001, Basis of Design (Sections 4 and 7).
- MEC-CAL-001, Pipe Wall Thickness; MEC-CAL-002, Branch Reinforcement; MEC-CAL-003, Hydrostatic Test; MEC-CAL-006, Flanges, Gaskets, Bolting and Pressure-Temperature Ratings.
- PRO-CAL-006, Control Valve Sizing (acoustic insulation requirement).

1.03 DEFINITIONS

A. AARH: arithmetic average roughness height. AED: anti-explosive decompression (elastomer resistant to rapid gas decompression). BE: beveled end. CVN: Charpy V-notch impact test. DBB: double block and bleed. MDMT: minimum design metal temperature. PE: plain end. PMI: positive material identification. RF: raised face. SW: socket weld. WN: weld neck. SMYS: specified minimum yield strength.



- B. Class break: the joint at which the governing class changes. A class break shall be a flanged joint or the butt weld behind the flange of the higher-rated class, as defined for each class in PART 2.

1.04 DESIGN CONDITIONS

- A. The design conditions in Table 1-2 shall govern component selection. The ASME B16.5 Group 1.1 Class 600 rating falls from 1,480 psig at 100 °F to 1,360 psig at 200 °F. By linear interpolation it equals the station maximum allowable operating pressure (MAOP) of 1,440 psig at 133.3 °F and is 1,420 psig at 150 °F. The pipe wall is not affected, because the temperature derating factor is 1.0 below 250 °F. Class A6 therefore carries two coincident design points, 1,440 psig up to 133 °F and 1,420 psig at 150 °F. The maximum operating temperature of the station, 120 °F in the summer case of GEN-DB-001, is below 133 °F. Blocked-in solar heating above 133 °F is limited by TSV-136, PSV-101 and PSV-157, all set at 1,440 psig. The engineer of record (EOR) shall confirm this approach.
- B. Line 1022, from the H-101 outlet to the control valve inlet header, can receive gas at bath temperature if the heater temperature control fails. It is therefore designed for a third coincident point of 1,360 psig at 200 °F. The maximum supply pressure is 1,150 psig (GEN-DB-001, Section 6), so this point is not reached in operation.
- C. The line heater coil design of 1,440 psig at 250 °F exceeds the Class 600 rating at 250 °F (1,335 psig). The coil inlet and outlet nozzles N1 and N2 shall therefore be Class 900 RF (2,000 psig at 250 °F). The mating flanges at the ends of lines 1020 and 1022 shall be Class 900 RF weld neck, bored to the 0.375 in line wall, and form part of class A6. The Class 900 / Class 600 break is the butt weld behind the Class 900 flange.
- D. Class S1 serves vent and blowdown gas that cools by Joule-Thomson expansion to well below the -20 °F carbon steel MDMT. It is therefore austenitic stainless steel with a -150 °F minimum design temperature. Its Group 2.1 Class 150 rating is 275 psig at -150 to 100 °F and 255 psig at 150 °F, which is adequate because the header is open to atmosphere through VS-101.

Table 1-2: Design Conditions by Class

Class	Design pressure and temperature	Coincident alternates	MDMT	Corrosion allowance
A6	1,440 psig at -20 to 133 °F	1,420 psig at 150 °F (flange limited); line 1022 1,360 psig at 200 °F	-20 °F above grade, 32 °F buried	0.000 in
A1	285 psig at -20 to 100 °F	272 psig at 150 °F	-20 °F	0.000 in
D1	285 psig at -20 to 100 °F	272 psig at 150 °F	-20 °F	0.000 in (Schedule 80 wall carries margin)
S1	275 psig at -150 to 100 °F	255 psig at 150 °F	-150 °F	0.000 in

Class	Design pressure and temperature	Coincident alternates	MDMT	Corrosion allowance
T1	1,440 psig at -20 to 150 °F (A6 service); 285 psig (A1 service)	Heat-traced lines to 200 °F	-20 °F	None

E. Test pressures shall be as given in Table 1-3. The Class 600 flange shell test is $1.5 \times 1,480 = 2,220$ psig, which ASME B16.5 rounds up to 2,225 psig; SPC-SPC-011 limits any Class 600 flange to 2,220 psig, leaving a 60 psi window above the 2,160 psig minimum. With the high point held at the 2,190 psig top of the target band, the largest elevation difference allowed within one test section is $(2,220 - 2,190) / 0.4361 \text{ psi/ft} = 69 \text{ ft}$. Test sections and low-point pressures are set in MEC-CAL-003.

Table 1-3: Test Pressures

Class	Minimum at high point	Maximum at any point	Medium	Hold
A6	2,160 psig ($1.5 \times 1,440$), band 2,160 to 2,190 psig	2,220 psig at any Class 600 flange; 100 % SMYS of the thinnest item	Water	8 h strength test, then leak test at MAOP (49 CFR 192.505)
A1	430 psig (1.5×285 , rounded up)	450 psig (Class 150 shell test)	Water	Per MEC-CAL-003
D1	430 psig	450 psig	Water	Per MEC-CAL-003
S1	415 psig (1.5×275 , rounded up)	425 psig (Class 150 Group 2.1 shell test)	Water, chloride 50 ppm maximum	Per MEC-CAL-003
T1	2,160 psig (A6 service) or 430 psig (A1 service)	Tubing rating, Article 2.08	Water or nitrogen	Per SPC-SPC-014

1.05 SUBMITTALS

A. The Contractor and each vendor shall submit, for review before fabrication:

1. Mill test reports (EN 10204 type 3.1 or equal) for every pressure-containing item, with CVN results where CVN testing is required.
2. Valve data books per MEC-DS-006 and MEC-DS-007, including fire-test, fugitive-emission and torque certificates.
3. Welding procedure specifications and qualification records per SPC-SPC-007, including stainless procedures with ferrite measurement for class S1.
4. PMI procedure and PMI records.
5. Flange joint assembly procedure and torque records per MEC-CAL-006.

1.06 QUALITY ASSURANCE

- A. Every pressure-containing item shall carry its heat number, and the mill test reports shall be kept with the weld map as records under 49 CFR 192 and SPC-SPC-020.
- B. Materials shall not be substituted without written approval of the EOR.
- C. PMI shall be carried out by portable X-ray fluorescence using the API RP 578 method, on:
 - 1. 100 % of stainless steel items: all class S1 components and weld deposits, T1 tubing, tube fittings, instrument valves and manifolds, the SP-141 probe and thermowells.
 - 2. The trim (ball and stem) of every ball and globe valve NPS 2 and larger, at receipt.
 - 3. A 10 % spot check of carbon steel forgings for residual elements where a CVN substitution is in doubt.

1.07 DELIVERY, STORAGE AND HANDLING

- A. Pipe and fittings shall be delivered with end protectors on beveled ends and plugs in socket-weld and threaded ends.
- B. Stainless steel items shall be stored off the ground, segregated from carbon steel, and handled with non-metallic slings. Carbon steel tools, wire brushes and grinding wheels shall not be used on stainless steel.
- C. FBE-coated pipe shall be stored and handled per SPC-SPC-009.
- D. Valves shall be shipped in the fully open position (ball valves) or closed position (gate and globe valves) with flange covers, and stored indoors or under cover with actuators protected.

PART 2 PRODUCTS

2.01 GENERAL MATERIAL REQUIREMENTS

- A. Impact testing: all carbon steel pressure-containing items in classes A6, A1 and D1 above grade shall be CVN tested at -20 °F, the MDMT set by GEN-DB-001, Section 7, as follows:
 - 1. Line pipe API 5L X52 PSL2: pipe body and ERW seam, full-size equivalent 30 ft-lb average of three, 22 ft-lb minimum individual, transverse where the size permits.
 - 2. ASTM A106 Gr B small-bore pipe used in A6: 15 ft-lb average, 10 ft-lb minimum, sub-size specimens scaled per ASTM A370. ASTM A333 Gr 6 is an acceptable alternate.
 - 3. MSS SP-75 WPHY-52 fittings: same values as the pipe.
 - 4. Forgings (flanges, socket-weld fittings, branch outlet fittings, plugs): ASTM A105N normalized, with supplementary CVN testing to ASTM A961 at -20 °F, 20 ft-lb average, 15 ft-lb minimum. ASTM A350 LF2 Class 1 is an acceptable alternate.
 - 5. Valve pressure-retaining parts: forged ASTM A350 LF2 Class 1 or cast ASTM A352 LCC, impact tested at -50 °F. ASTM A216 WCB, and A105 without impact testing, shall not be used in A6 above-grade service.

- B. Chemistry: API 5L X52 PSL2 pipe shall have a maximum CE(Pcm) of 0.20 for walls up to 0.750 in.
- C. Bolting: ASTM A193 Gr B7 studs with two ASTM A194 Gr 2H heavy hex nuts, fluoropolymer coated, are accepted for the -20 °F MDMT in classes A6, A1 and D1. The EOR may require ASTM A320 Gr L7 studs with A194 Gr 7 nuts at IJ-101, IJ-102 and the buried flange at TI-02, where impact-tested bolting is preferred.
- D. Fugitive emissions: all valves NPS 2 and larger shall be type tested to API 641 (quarter-turn) or API 624 (rising stem), to meet 40 CFR 60 Subpart OOOOb.
- E. Control valves (FCV-131, FCV-132, LCV-104, TCV-152), relief valves and SDV-165 are specified on the instrument datasheets. Their bodies shall be Class 600 RF in A6 and Class 150 RF in A1, with materials per paragraph A.

2.02 CLASS A6: PIPE

- A. Pipe shall be as listed in Table 2-1. NPS 3 and larger shall be API 5L X52 PSL2, SMLS or ERW. NPS 2 and smaller shall be ASTM A106 Gr B SMLS. NPS 2 and larger shall be beveled per ASME B16.25; NPS 1-1/2 and smaller shall be plain end for socket welding.
- B. The required wall shall be calculated with the design formula of 49 CFR 192.105 and ASME B31.8, 841.1.1, with design factor $F = 0.50$, longitudinal joint factor $E = 1.0$ and temperature derating factor $T = 1.0$:

49 CFR 192.105; ASME B31.8, 841.1.1

$$t = \frac{PD}{2SFET}$$

- C. For NPS 12, $t = 1,440 \times 12.750 / (2 \times 52,000 \times 0.50) = 0.3531$ in, and 0.375 in (standard weight) is selected. The hoop stress is 24,480 psi (47.1 % SMYS) at 1,440 psig and 36,720 psi (70.6 % SMYS) at the 2,160 psig test. The code formula uses nominal wall, so mill tolerance is not deducted.

Table 2-1: Class A6 Pipe

NPS	Schedule	Wall (in)	Material	t required (in)	Hoop at 1,440 psig (% SMYS)	Hoop at 2,160 psig (% SMYS)
1/2	160	0.188	A106 Gr B	0.0346	9.2	13.8
3/4	160	0.219	A106 Gr B	0.0432	9.9	14.8
1	80	0.179	A106 Gr B	0.0541	15.1	22.7
1-1/2	80	0.200	A106 Gr B	0.0782	19.5	29.3
2	80	0.218	A106 Gr B	0.0977	22.4	33.6

NPS	Schedule	Wall (in)	Material	t required (in)	Hoop at 1,440 psig (% SMYS)	Hoop at 2,160 psig (% SMYS)
3	80	0.300	X52 PSL2	0.0969	16.2	24.2
4	80	0.337	X52 PSL2	0.1246	18.5	27.7
8	XS	0.500	X52 PSL2	0.2388	23.9	35.8
10	80	0.594	X52 PSL2	0.2977	25.1	37.6
12	STD	0.375	X52 PSL2	0.3531	47.1	70.6
12 (line 1042)	XS	0.500	X52 PSL2	0.3531	35.3	53.0

Note 1: NPS 10 Schedule 80 is set by the AGA Report No. 9 meter tube bore and is used for every NPS 10 line (1011, 1012, 1015) so the bore is uniform.

Note 2: NPS 8 extra strong is used only for the pig receiver kicker, line 1101. The control valve branches 1031 and 1032 are NPS 12 standard weight with 12 × 8 concentric reducers at the FCV-I31 and FCV-I32 flanges; the line numbers keep their original size prefix.

Note 3: The buried outlet lateral 1042 is 0.500 in, with 0.500 in 3R riser bends, because the 0.375 in wall does not meet the API RP 1102 road-crossing check in MEC-CAL-001. The IJ-102 downstream pup is 0.500 in, so no taper is needed at the IJ-102 outlet weld.

Note 4: NPS 6 is not used in station piping; the NPS 6 heater coil is in the heater vendor's scope.

2.03 CLASS A6: FITTINGS

- A. Fittings shall be as listed in Table 2-2, with walls matched to the connecting pipe at the weld end.
- B. The pig path (line 1001 from IJ-101 to HV-101B) and lines 1041 and 1042 shall use 3R bends (ASME B16.9 3R elbows or induction bends, radius not less than $3 \times \text{NPS}$), gauged after fabrication with a plate of 95 % of the internal diameter. No reducer and no unbarred branch larger than 25 % of the run diameter shall be placed on the pig path.
- C. The receiver branch on line 1001 shall be a barred straight tee, with flow bars at 1 in maximum clear spacing welded to the branch bore.
- D. Mitre bends, wrinkle bends, and cold field bends exceeding 1.5 degrees per joint shall not be used.

Table 2-2: Class A6 Fittings

Item	NPS	Standard	Material	Wall or class
Elbow 90 and 45 LR, tee, reducing tee, reducer, cap	3 to 12	ASME B16.9, MSS SP-75	WPHY-52, CVN -20 °F, SMLS or welded with 100 % RT seam	Match pipe

Item	NPS	Standard	Material	Wall or class
Elbow 90, 3R (pig path, 1041, 1042)	12	ASME B16.9 3R or induction bend	WPHY-52	0.375 in (1001, 1041); 0.500 in (1042)
Barred tee	12 × 12	MSS SP-75 body	WPHY-52; bars A36 or better	0.375 in
Elbow, tee, reducer, cap	2	ASME B16.9	A234 WPB SMLS, CVN -20 °F	Schedule 80
Elbow, tee, coupling, cap, plug	1/2 to 1-1/2	ASME B16.11	A105N, CVN -20 °F	Class 6000 SW; unions not permitted
Swage nipple	1/2 to 2	MSS SP-95	A105N or A106 B	Schedule 160 / 80
Branch outlet (weldolet, sockolet, nipolet)	3/4 to 4	MSS SP-97	A105N, CVN -20 °F	Bore to suit run; Class 6000
Nipple	1/2 to 1-1/2	ASTM A106 B SMLS	A106 B	Schedule 160 (3/4 and smaller), 80; 4 in minimum

2.04 CLASS A6: FLANGES, GASKETS AND BOLTING

- A. Flanges shall be weld neck only; slip-on flanges shall not be used in any class. Flanges, gaskets and bolting shall be as listed in Table 2-3.
- B. Class 600 RF flange faces shall have a 125 to 250 microinch AARH finish and shall be bored to the pipe inside diameter. ASTM A694 F52 shall be used where needed to match the X52 pipe strength at the bevel per MSS SP-44.

Table 2-3: Class A6 Flanges, Gaskets and Bolting

Item	NPS	Standard	Material	Rating or type
Weld-neck flange	2 to 12	ASME B16.5	A105N (CVN -20 °F); A694 F52 where bore match requires	Class 600 RF
Weld-neck flange, thermowell nozzle	1-1/2	ASME B16.5	A105N	Class 600 RF
Socket-weld flange, instrument nozzle only	1/2 to 1-1/2	ASME B16.5	A105N	Class 600 RF
Weld-neck flange, H-101 N1 and N2 companion	12	ASME B16.5	A105N or A694 F52	Class 900 RF (Article 1.04 C)
Blind flange	2 to 12	ASME B16.5	A105N	Class 600 RF
Spectacle blind, spacer and blank	2 to 12	ASME B16.48	A516-70N or A105N	Class 600

Item	NPS	Standard	Material	Rating or type
Orifice flange (upstream side of RO-181, RO-182, RO-183, RO-172B)	2	ASME B16.36	A105N	Class 600 RF WN
Gasket	All	ASME B16.20	Spiral-wound 316 / flexible graphite, carbon steel outer ring, 316 inner ring	Class 600 (Class 900 at H-101)
Stud bolts	All	ASME B16.5 lengths	A193 B7 with 2 × A194 2H, fluoropolymer coated	Full thread

C. Insulating gasket kits shall be used only where the cathodic protection design calls for them. None are required at IJ-101 and IJ-102, which are monolithic joints (MEC-DS-008).

2.05 CLASS A6: VALVES

- A. Valves shall be as listed in Table 2-4 and Table 2-5. Detailed purchase requirements, torque sizing and actuators shall be per MEC-DS-006 and MEC-DS-007.
- B. Ball valves NPS 3 and larger shall be trunnion-mounted to API 6D, full opening, with face-to-face per ASME B16.10 long pattern: NPS 12, 33.0 in; NPS 10, 31.0 in; NPS 8, 26.0 in. Valves on the pig path shall have a bore matched to the 12.000 in pipe inside diameter within 0.06 in.
- C. NPS 2 Class 600 ball valves shall be gear operated, because the lever length needed at full differential would exceed 24 in (MEC-DS-006).

Table 2-4: Class A6 Valves, Construction

Type	NPS	Standard	Body and ends	Trim and seats	Operator
Ball, trunnion-mounted	3 to 12	API 6D	LF2 or LCC, Class 600 RF	ENP or hard-chrome ball, PEEK or nylon inserts, AED O-rings	Gear NPS 8 and larger; actuated per MEC-DS-006
Ball, floating	2	API 6D or API 608	LF2, Class 600 RF	As above	Gear
Ball, floating	1/2 to 1-1/2	ASME B16.34	LF2 or A105N, Class 800 SW	316 ball, PEEK seats	Lever
Gate	1/2 to 1-1/2	API 602	A105N (CVN) or LF2, Class 800 SW × SW or SW × NPT	13 % Cr, Stellite seats, bolted bonnet	Handwheel
Globe	1 to 2	ASME B16.34, API 623	LF2 or LCC, Class 600 RF (NPS 2), Class 800 SW (NPS 1)	Stellited plug and seat	Handwheel
Check	12	API 6D	LF2 or LCC, Class 600 RF	Per MEC-DS-007	None

Type	NPS	Standard	Body and ends	Trim and seats	Operator
Instrument manifold	1/2	Manufacturer, ASME B16.34 rated	316 SS, 6,000 psig	316, Stellite	T-bar

Table 2-5: Class A6 Valves, Testing and Application

Type	Shell test	Seat test	Features	Typical tags
Ball, trunnion-mounted	2,225 psig	1,628 psig (1.1 × 1,480) and 80 psig gas	DBB, self-relieving seats, API 6FA / 607 fire safe, anti-static, blowout-proof stem, API 641	SDV-101 to 103, MOV-111 to 122, MOV-115, HV-101A to C, HV-103A to D, HV-158A to C, HV-131A/B, HV-132A/B
Ball, floating NPS 2	2,225 psig	1,628 psig and 80 psig gas	As above	BDV-102, BDV-181 to 183, HV-172A, HV-101E, HV-101G, HV-104A/B/D, HV-161A, SDV-106
Ball, floating small bore	API 598	API 598	Class 800 SW	HV-133D, MOV body bleeds HV-111A, 112A, 115A, 121A, 122A
Gate	API 598	API 598	Outside screw and yoke	Root, vent, drain and test connections
Globe	API 598	API 598	API 624	HV-101D, HV-101F, HV-104C, HV-104E, HV-101H, HV-102H, HV-103H
Check	2,225 psig	1,628 psig reverse	Axial nozzle, non-slam	CKV-171

2.06 CLASS A1 AND CLASS D1: CLASS 150 CARBON STEEL

- A. Class A1 serves fuel gas only. The A6 / A1 break is at the PCV-161 outlet on FG-101 (vendor scope).
- B. Class D1 serves liquid drains. The A6 / D1 breaks are at the outlet flange of the last Class 600 item: the LCV-104 station outlet valve HV-104B, HV-104E and HV-101F. Line 1060 downstream of LCV-104 is NPS 4 D1, sized below the erosional velocity at the flash rate. No closable valve shall sit on the D1 section between a break and T-101 except the locked-open inlet valves HV-191A and HV-191B.
- C. **HOLD, D1 blow-by.** SDV-106 closes the V-101 dump line upstream of LCV-104 on low-low level or tank high-high level through the safety PLC. If LCV-104 fails open and SDV-106 does not close, gas at up to 1,440 psig would enter line 1060 downstream of the break. The 285 psig D1 design pressure is valid only if the process blow-by calculation shows the flowing pressure in lines 1060 and 1190 and at T-101 stays within 285 psig and within the T-101 emergency vent capacity. Until that calculation is issued, lines 1060 and 1190 carry this hold (Process).

D. Pipe shall be as listed in Table 2-6 and Table 2-7. Wall selection in both classes is governed by mechanical strength and burial loads (A1) and by internal corrosion from free water and solids (D1), not by pressure: the required wall is under 10 % of the selected wall in every case. D1 uses Schedule 80 throughout, which leaves about 0.19 in of corrosion margin on NPS 2 without a formal allowance.

Table 2-6: Class A1 Pipe

NPS	Schedule	Wall (in)	Material	<i>t</i> required (in)	Hoop at 285 psig (% SMYS)	Hoop at 430 psig (% SMYS)	Ends
1/2	160	0.188	A106 Gr B	0.0068	1.8	2.7	PE, SW
3/4	160	0.219	A106 Gr B	0.0086	2.0	2.9	PE, SW
1	80	0.179	A106 Gr B	0.0107	3.0	4.5	PE, SW
1-1/2	80	0.200	A106 Gr B	0.0155	3.9	5.8	PE, SW
2	80	0.218	A106 Gr B	0.0193	4.4	6.7	BE

Table 2-7: Class D1 Pipe

NPS	Schedule	Wall (in)	Material	<i>t</i> required (in)	Hoop at 285 psig (% SMYS)	Hoop at 430 psig (% SMYS)	Ends
3/4	160	0.219	A106 Gr B	0.0086	2.0	2.9	PE, SW
1	80	0.179	A106 Gr B	0.0107	3.0	4.5	PE, SW
2	80	0.218	A106 Gr B	0.0193	4.4	6.7	BE
3	80	0.300	A106 Gr B	0.0285	4.8	7.2	BE
4	80	0.337	A106 Gr B	0.0366	5.4	8.2	BE

E. Buried A1 fuel gas lines 1051 and 1052 shall be FBE coated with 48 in cover, butt welded at NPS 2 and socket welded at NPS 1 with 100 % magnetic particle examination. Buried flanges and threaded joints shall not be used; soil-to-air risers shall be wrapped.

F. Components shall be as listed in Table 2-8. Class 150 gaskets shall be ASME B16.21 flexible graphite, because Class 150 bolting cannot seat spiral-wound gaskets at NPS 3, 4 and 8 (MEC-CAL-006).

Table 2-8: Class A1 and D1 Components

Item	NPS	Standard	Material	Rating or type
Elbow, tee, reducer, cap	2 to 4	ASME B16.9	A234 WPB SMLS	Match pipe
Socket-weld fittings and plugs	1/2 to 1-1/2	ASME B16.11	A105N	Class 3000
Branch outlets	3/4 to 3	MSS SP-97	A105N	Weldolet (BW), sockolet Class 3000
Weld-neck and blind flanges	1 to 4	ASME B16.5	A105N (CVN -20 °F above grade)	Class 150 RF
Gasket	All	ASME B16.21	Flexible graphite sheet with tanged 316 insert, 1/8 in, full RF pattern	Class 150
Stud bolts	All	ASME B16.5 lengths	A193 B7 with 2 × A194 2H, fluoropolymer coated	
Ball valve, floating, full bore	1 to 4	ASME B16.34 or API 608	LF2 or A105N body, 316 ball, PTFE or PEEK seats, lever	HV-165A (NPS 2), HV-165B (NPS 1), HV-191A to HV-191G
Ball valve, actuated, fail closed	2	ASME B16.34	LF2, electro-hydraulic spring return (instrument datasheet)	SDV-165
Gate valve	1/2 to 1-1/2	API 602	A105N, Class 800 SW, handwheel	Vents, drains, test connections
Dry-break coupling with cap	3	Manufacturer	Carbon steel and 316, hydrotested to 450 psig	Truck loadout on line 1191

2.07 CLASS S1: CLASS 150 STAINLESS STEEL, VENT AND BLOWDOWN

- A. Class S1 shall apply to every line downstream of a restriction orifice, a PSV or TSV outlet, or a vent valve: header 1070, branches 1071 to 1077, 1120, 1160, 1161 and 1170, the downstream flange of each restriction orifice (RO-181, RO-182, RO-183, RO-172B), and the vent stack VS-101 with its base connections HV-180A and HV-180B.
- B. Pipe shall be ASTM A312 TP304/304L dual certified, as listed in Table 2-9. Walls are set by mechanical strength, blowdown reaction and acoustic vibration, not by pressure. NPS 4 serves lines 1072 and 1073.

Table 2-9: Class S1 Pipe

NPS	Schedule	Wall (in)	Material	t required (in)	Hoop at 275 psig (% SMYS)	Hoop at 415 psig (% SMYS)	Ends
3/4	80S	0.154	A312 TP304/304L SMLS	0.0096	3.1	4.7	PE, SW
1	80S	0.179	A312 TP304/304L SMLS	0.0121	3.4	5.1	PE, SW
2	40S	0.154	A312 TP304/304L, SMLS or welded with 100 % RT	0.0218	7.1	10.7	BE
3	40S	0.216	A312 TP304/304L	0.0321	7.4	11.2	BE
4	40S	0.237	A312 TP304/304L	0.0413	8.7	13.1	BE
8	40S	0.322	A312 TP304/304L	0.0791	12.3	18.5	BE

Note 1: SMYS 30,000 psi (dual-certified 304/304L meets TP304). For NPS 8, $t = 275 \times 8.625 / (2 \times 30,000 \times 0.50) = 0.0791$ in against 0.322 in selected.

C. Components shall be as listed in Table 2-10.

Table 2-10: Class S1 Components

Item	NPS	Standard	Material	Rating or notes
Elbow, tee, reducer, cap	2 to 8	ASME B16.9	A403 WP304/304L-S (or -W with 100 % RT)	Match pipe
Socket-weld fittings and plugs	3/4 to 1	ASME B16.11	A182 F304/304L	Class 3000
Branch outlets	3/4 to 4	MSS SP-97	A182 F304/304L	Weldolet NPS 2 and larger, socket Class 3000 smaller
Weld-neck and blind flanges	3/4 to 8	ASME B16.5	A182 F304/304L	Class 150 RF
Gasket	All	ASME B16.21	Flexible graphite with 316 insert (or B16.20 spiral wound with 316 inner and outer rings)	Leachable chloride 50 ppm maximum
Stud bolts	All	ASME B16.5 lengths	A193 B8M Class 2 studs, 2 × A194 8M nuts	Nickel-based anti-seize, no copper
Ball valve	3/4 to 2	ASME B16.34	CF8M or F316 body, 316 ball, PTFE or PEEK seats rated -150 °F	Class 150 RF; Class 800 SW at NPS 3/4 and 1 (HV-180A, HV-180B)

Item	NPS	Standard	Material	Rating or notes
Orifice downstream flange	2	ASME B16.36 / B16.5	A182 F304/304L	Class 600 RF face to mate the RO

D. Dissimilar-metal break: each restriction orifice shall be held between a Class 600 carbon steel orifice flange on the upstream (A6) side and a Class 600 F304/304L flange on the downstream side, bolted with A193 B8M Class 2 studs, with the downstream S1 pipe welded to the F304/304L flange. The break is therefore a bolted joint and there shall be no field weld between carbon and stainless steel. Where the vendor supplies the orifice in a single holder, the downstream half shall be F304/304L. PSV-101, PSV-157, PSV-161, TSV-136 and HV-133D outlet flanges bolt directly to S1 flanges on the same principle.

E. Austenitic stainless steel in these walls does not require impact testing at -150 °F (ASME B31.3, 323.2.2, applied as project practice because ASME B31.8 sets no impact test rule for austenitic stainless steel).

2.08 CLASS T1: INSTRUMENT TUBING

A. T1 components shall be as listed in Table 2-11. Tube fittings shall be of one manufacturer per system, and parts of different manufacturers shall not be intermixed.

Table 2-11: Class T1 Components

Item	Size	Standard	Material	Rating or notes
Tubing	1/4 × 0.035, 3/8 × 0.049, 1/2 × 0.065 in	ASTM A269 TP316 SMLS, fully annealed, 80 HRB maximum	316 SS	Minimum walls per SPC-SPC-014
Tube fittings	1/4 to 1/2	Two-ferrule, qualified to ASTM F1387	316 SS	
Instrument valves and manifolds	1/4 to 1/2	Manufacturer	316 SS, Stellite or PCTFE seats	6,000 psig at 100 °F
Process connection	1/2 NPT or 3/4 SW nipple	At root valve outlet	316 / carbon steel adaptor	Carbon steel to stainless break at the root valve
Tray and supports		SPC-SPC-014	316 or aluminum	Clamped at 3 ft maximum
Heat tracing and insulation	Lines 1080 and 1139	Instrument specification	Self-regulating, Class I Division 2	Above hydrocarbon dewpoint

B. The tubing pressure rating was checked with the ASME B31.3, 304.1.2 method, because B31.8 gives no tubing rule, using $S = 20,000$ psi, $E = 1.0$ and $Y = 0.4$, at nominal wall and at 90 % of nominal wall (the ASTM A269 tolerance). It was cross-checked with a design factor of 0.50 on the 25,000 psi SMYS. Table 2-12 shows that the lower of the two governs and exceeds the 2,160 psig test pressure for every size.

$$P = \frac{2SEt}{D - 2Yt}$$

Table 2-12: Class T1 Tubing Rating

Tube (in)	B31.3, nominal wall (psig)	B31.3, 90 % wall (psig)	F = 0.50 on SMYS (psig)	Governing (psig)	Service (psig)
1/4 × 0.035	6,306	5,605	3,500	3,500	1,440 design, 2,160 test
3/8 × 0.049	5,837	5,193	3,267	3,267	1,440 design, 2,160 test
1/2 × 0.065	5,804	5,163	3,250	3,250	1,440 design, 2,160 test

2.09 JOINT TYPES AND SIZE RANGES

A. Joint types shall be selected by size as shown in Table 2-13.

Table 2-13: Joint Types by Size

Range	Joint	Fittings	Valves	Branches
NPS 1/2 to 1-1/2	Socket weld	ASME B16.11 Class 6000 (A6), Class 3000 (A1, D1, S1)	Class 800 SW	Sockolet, nipolet or SW tee
NPS 2	Butt weld	ASME B16.9	Flanged RF	B16.9 tee, or weldolet on a larger run
NPS 3 to 12	Butt weld	ASME B16.9, MSS SP-75	Flanged RF, API 6D	Per Article 2.10

B. Threaded joints shall be permitted only on the outboard side of the first root, vent or drain valve (for plugs, gauges and tubing adaptors) and in T1 instrument connections. No threaded joint shall be used upstream of a line's first block valve or in buried service. Threads shall be ASME B1.20.1 NPT, sealed with an anaerobic thread sealant rated for natural gas; PTFE tape shall not be used. Plugs shall be hex head, A105N (F304/304L in S1), Class 6000 in A6 and Class 3000 elsewhere. Seal welding is not required; if applied, it shall cover all exposed threads.

C. Socket welds shall be made with a 1/16 in axial gap set before welding and a minimum of two passes.

2.10 BRANCH CONNECTIONS

A. Branch connections shall be selected from Table 2-14 for class A6 and Table 2-15 for classes A1, D1 and S1, with reinforcement adequacy per MEC-CAL-002. Stub-in and unreinforced fabricated branches shall not be used. The codes are: T, straight tee; R, reducing tee (ASME B16.9 or MSS SP-75); W, weldolet (MSS SP-97); S, sockolet; N, nipolet (3/4 in instrument connections); H, socket-weld tee.

Table 2-14: Class A6 Branch Connections

Branch NPS	Run 12	Run 10	Run 8	Run 4	Run 3	Run 2	Run 1-1/2 and smaller
12	T						
10	R	T					
8	R	R	T				
4	W	W	W	T			
3	W	W	W	R	T		
2	W	W	W	W	R	T	
1-1/2	W	W	W	S	S	S	H
1	S	S	S	S	S	S	H
3/4	S or N	S or N	S or N	S or N	S or N	S or N	H

Note 1: The receiver branch on line 1001 is a barred straight tee. The kicker 1101 uses a 12 × 8 reducing tee. The control valve branches 1031 and 1032 are NPS 12 from straight 12 × 12 header tees, reduced to NPS 8 only at the FCV flanges.

Note 2: The meter header tees on SK-110 are 12 × 10 reducing tees. Thermowell and SP-141 nozzles are weldolets with Class 600 WN flanges.

Note 3: Adjacent branch outlets shall be spaced not less than the larger of 2 in clear toe to toe or the reinforcement zone limit in MEC-CAL-002. No branch shall be welded within 2 in of a girth weld, or on a bend or fitting.

Table 2-15: Class A1, D1 and S1 Branch Connections

Branch NPS	Run 8	Run 4	Run 3	Run 2	Run 1-1/2 and smaller
8	T				
4	R	T			
3	W	R	T		
2	W	W	R	T	
1-1/2	S	S	S	S	H
1	S	S	S	S	H
3/4	S	S	S	S	H

Note 1: Class S1 uses F304/304L fittings. Vent branches enter the top of header 1070 on weldolets or sockolets. A 45 degree lateral fitting may be used where practical, subject to EOR approval of its reinforcement, which MSS SP-97 does not cover.

PART 3 EXECUTION

3.01 FABRICATION

- A. Piping shall be fabricated and installed per SPC-SPC-006 and welded per SPC-SPC-007.

- B. Class S1 welding shall use a GTAW root with an argon back purge held at 0.1 % (1,000 ppm) oxygen or less from before arc strike through the second pass, ER308L or ER316L filler, and a deposit ferrite number of FN 3 to 8. Stainless steel shall be worked only with dedicated stainless tooling and shall not contact galvanized or carbon steel.
- C. Post-weld heat treatment is not required by wall thickness. The heaviest pipe wall in the station piping is 0.594 in (NPS 10 Schedule 80), below the ASME B31.8 stress-relieving threshold of 1-1/4 in (ASME B31.8, stress relieving requirements). Vessels V-101 and PR-101 shall follow ASME BPVC Section VIII, Division 1, UCS-56.
- D. Flanged joints shall be assembled to the controlled torque values in MEC-CAL-006 (target 50 % of bolt yield stress), in a cross pattern and in not less than three passes, with assembly records per SPC-SPC-006.
- E. T1 tubing shall be bent only with tube benders, to a radius not less than 3 × OD; every fitting shall be checked with a gap-inspection gauge. Tubing shall slope toward the process tap for liquid service and away from the analyzers for gas service.
- F. Acoustic insulation shall be installed on FCV-131 and FCV-132, because the predicted noise of 85.6 dBA at 1 m exceeds the 85 dBA limit (PRO-CAL-006). It shall consist of a removable jacket on each valve body and bonnet and on 10 ft of the downstream NPS 12 pipe including the 12 × 8 expander: mineral wool with a mass-loaded vinyl barrier and aluminum jacket, 10 to 15 dB insertion loss (typical, confirm with vendor data, HOLD H-15). The pipe shall be painted per SPC-SPC-010 before insulation.
- G. Meter tubes from flow conditioner to test well shall be insulated for heat conservation by the SK-110 vendor, and line 1080 shall be heat traced and insulated per the instrument specification. No other process insulation is required.

3.02 EXAMINATION

- A. All butt welds in all classes shall receive 100 % radiography or automated ultrasonic examination, as required by GEN-DB-001, Section 7. Acceptance shall be to API 1104 for A6 butt welds and to SPC-SPC-008 for other welds.
- B. All fillet, socket and branch-connection welds shall receive 100 % magnetic particle or liquid penetrant examination. Class S1 shall use liquid penetrant only.
- C. Class S1 shall receive 100 % PMI of pipe, fittings, flanges, valve bodies, bolting and every weld deposit.

3.03 TESTING

- A. Piping shall be hydrostatically tested per SPC-SPC-011 at the pressures in Table 1-3, in the sections set by MEC-CAL-003.
- B. Class S1 test water shall contain not more than 50 ppm chloride, and S1 sections shall be drained and dried within 24 h of completing the test.

- C. In-line ball valves shall be half open during the test. Items not rated for the test pressure (instruments, relief valves, analyzer probes, meters where the vendor does not certify the body) shall be removed or blinded.
- D. T1 tubing shall be leak tested with nitrogen and bubble solution after the hydrostatic test, per SPC-SPC-014.

3.04 CLEANING AND COATING

- A. Piping shall be cleaned of mill scale, weld spatter and debris before test, and the pig path and outlet lateral shall be gauged per Article 2.03 B.
- B. Buried carbon steel (line 1042 and the buried portions of lines 1051 and 1052) shall receive fusion-bonded epoxy, 14 to 16 mil, with an abrasion-resistant overlay at road bores, and field joints of two-part epoxy or FBE per SPC-SPC-009. Soil-to-air transitions shall be wrapped from 12 in below to 12 in above grade.
- C. Above-grade carbon steel shall receive the three-coat system (zinc-rich epoxy primer, epoxy intermediate, polyurethane topcoat) per SPC-SPC-010, with line color and flow arrows to the Owner's standard.
- D. Stainless steel (classes S1 and T1) and valve stems shall not be painted. Supports under S1 piping shall carry non-metallic or stainless isolation pads.
- E. Header 1070 shall slope continuously at not less than 1:200 toward VS-101, with no pockets.

3.05 MARKING

- A. Pipe shall be marked per API 5L or ASTM (stencil, including heat number and test pressure). Fittings and forgings shall be marked per MSS SP-25 and MSS SP-75 by low-stress die stamping or stencil; walls 0.25 in and thinner shall not be stamped. Valves shall carry the MSS SP-25 marking and the API 6D nameplate.
- B. Spools shall be marked with the line number, spool number and the weld numbers from the isometric drawings PIP-DWG-010 to PIP-DWG-015.
- C. Stainless steel shall be marked only with chloride-free and sulfur-free markers.

3.06 ACCEPTANCE

- A. Piping shall be accepted when the examination records of Article 3.02, the test records of Article 3.03, the PMI records and the flange-joint assembly records are complete and reviewed, and the mill test reports are reconciled with the weld map.
- B. The following open items shall be closed before the piping is issued for construction:
 - 1. HOLD H-15: valve bores, face-to-face dimensions of actuated and check valves, trim materials, and vendor pressure limits of the meters, control valves and H-101 coil (Vendors).
 - 2. HOLD H-16: upstream lateral MAOP, assumed 1,440 psig across IJ-101 (Owner).
 - 3. D1 blow-by pressure in lines 1060 and 1190, Article 2.06 C (Process).

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4. Confirmation of the coincident A6 design points, Article 1.04 A, and of the bolting grade at IJ-101, IJ-102 and TI-02, Article 2.01 C (EOR).

END OF SECTION

