 TORUS	[REDACTED] · Owner API 6D BALL VALVES (SDV, MOV AND MANUAL)	Document No.	[REDACTED] MEC-DS-006		
		Revision / Date	A · September 29, 2026		
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MECHANICAL · API 6D BALL VALVES (SDV, MOV AND MANUAL)					
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A	2026-09-29	Issued for Review			

NOTES

This datasheet covers every ball valve in classes A6, A1, D1 and S1 of  PIP-SPC-001, Piping Material Specification: the station shutdown valves SDV-101, SDV-102 and SDV-103 with electro-hydraulic spring-return actuators, the dump-line shutoff SDV-106, the meter-run motor-operated double block and bleed valves MOV-111, MOV-112, MOV-121, MOV-122 and MOV-115, the manual gear-operated valves NPS 8 to 12, and the NPS 2 and smaller manual valves. It also states the operating torque estimate and the actuator sizing requirements. Control valves, SDV-165 and relief valves are on the instrument datasheets. The check valve CKV-171 is on  MEC-DS-007. Tags and sizes follow the P&ID register  PRO-LST-101.

Values marked typical are for bid; confirm with vendor data (HOLD H-15).

DESIGN INPUTS

Table 1: Design Inputs

Input	Value	Source
Design pressure and temperature, class A6	1,440 psig at -20 to 133 °F; 1,420 psig at 150 °F	 PIP-SPC-001, Article 1.04
Differential pressure for torque sizing	1,440 psi, either direction	Emergency closure against a depressured side
Minimum design metal temperature	-20 °F	 GEN-DB-001, Section 7
Service	Dry sweet natural gas, 7 lb/MMscf water; solids possible upstream of V-101	 GEN-DB-001, Section 5
Area classification	Class I Division 2 Group D assumed; actuators certified Class I Division 1 Group D	Electrical to confirm
Power	480 V 3-phase for hydraulic pumps and MOV motors; 24 VDC UPS-backed for SDV solenoids	 GEN-DB-001, Section 9
Actuation	Zero emission: electric or self-contained electro-hydraulic, no natural-gas pneumatics	 GEN-DB-001, Sections 7 and 13

VALVE SCHEDULE

Table 2 lists the valves by tag. Weights are typical (HOLD H-15); SDV weights include a 1,350 lb actuator and MOV weights a 420 lb actuator. Root, vent, drain and test valves (NPS 3/4 API 602 gate, Class 800 socket weld) are counted in the material take-off and the valve list  MEC-LST-003, not tagged here.

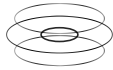
Table 2: Ball Valve Schedule

Tag	NPS	Class	Type	Operator	Line	Service and normal position	Weight (lb)
SDV-101	12	600 RF	Trunnion, full bore	EH spring return, fail closed	1001	Station inlet shutdown, open	3,650
SDV-102	12	600 RF	Trunnion, full bore	EH spring return, fail closed, 4 s or less	1033 / 1040	Overpressure shutdown, open	3,650



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Tag	NPS	Class	Type	Operator	Line	Service and normal position	Weight (lb)
HV-133D	1	800 SW	Floating	Lever	1161	Line 1033 maintenance vent, closed	25
HV-111A, 112A, 115A, 121A, 122A	3/4	800 SW	Floating	Lever	MOV body bleeds	DBB bleed to line 1120, closed	12 each
HV-165A	2	150 RF	Floating, full bore	Lever, lockable	1051	H-101 fuel supply, locked open	30
HV-165B	1	150 RF	Floating, full bore	Lever, lockable	1052	G-101 fuel supply, locked open	12
HV-180A	2	150 RF, stainless	Floating, full bore, CF8M	Lever	VS-101 base	Stack base drain to portable pan, closed	30
HV-180B	1	150 RF, stainless	Floating, CF8M	Lever, plugged outlet	VS-101 base	Purge and snuffing connection, closed	12
HV-191A	4	150 RF	Floating, full bore	Lever, lockable	1190	T-101 inlet (1060), locked open	70
HV-191B	2	150 RF	Floating, full bore	Lever, lockable	1061	T-101 inlet (1061), locked open	30
HV-191D, HV-191E	3	150 RF	Floating, full bore	Lever (HV-191E lockable)	1191	Loadout isolation, closed / locked closed	45 each
HV-191F	2	150 RF	Floating, full bore	Lever	1192	T-101 bottom drain, closed	30
HV-191G	4	150 RF	Floating, full bore	Lever, lockable	1193	Containment drain, locked closed	70

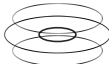
Note 1: The SDV equalizing bypass valves HV-101H, HV-102H and HV-103H are NPS 1 globe valves and are listed under GLOBE VALVES.

COMMON REQUIREMENTS, NPS 3 AND LARGER

Table 3: Common Requirements for Trunnion Ball Valves

Item	Requirement
Design standard	API 6D, latest edition; trunnion-mounted ball, three-piece forged or two-piece bolted body
Class and ends	ASME Class 600, RF flanged to ASME B16.5, 125 to 250 microinch AARH
Face-to-face	ASME B16.10 long pattern: NPS 12, 33.0 in; NPS 10, 31.0 in; NPS 8, 26.0 in
Bore	Full opening, not less than the API 6D minimum (typical NPS 12, 11.94 in; NPS 10, 10.00 in; NPS 8, 7.94 in). HV-101A and HV-101B matched to the 12.000 in pipe bore within 0.06 in for pig passage
Body, bonnet, end closures	ASTM A350 LF2 Class 1 forged or ASTM A352 LCC cast, Charpy tested at -50 °F
Ball, stem, trunnion	A350 LF2 or A694 F52 with 0.003 in electroless nickel or hard chrome on sealing surfaces; stem 17-4PH H1150 or AISI 4140 with electroless nickel; blowout-proof stem; anti-static device
Seats and seals	PEEK or nylon 12 insert in a metal seat ring; primary O-rings HNBR or FKM qualified for rapid gas decompression (ISO 23936-2 or NORSOK M-710); graphite fire-safe secondary seals
Seat arrangement	SDVs and manual valves: double block and bleed, both seats self-relieving to line. MOVs: double block and bleed with body bleed valves routed to line 1120
Fire and emissions	Fire type tested to API 6FA or API 607; fugitive emission type tested to API 641, with API 641 production stem leak test
Connections	Body vent and drain, NPS 1/2 NPT plugged (flanged NPS 1/2 on MOVs for the bleed); emergency sealant injection fittings on seats and stem, NPS 8 and larger
Lifting and supports	Lifting lugs rated for twice the valve weight; support feet or pad on NPS 12, bearing on pipe support type SV-1 (MEC-CAL-005)



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Item	Requirement		
Coating	Three-coat external system per SPC-SPC-010; stems and actuators vendor standard		
Shell test	1.5 × 1,480 = 2,220 psig, rounded per API 6D to 2,225 psig		
Seat tests	Hydrostatic 1.1 × 1,480 = 1,628 psig each seat; 80 psig air or nitrogen; supplementary high-pressure gas seat test on SDV-101, SDV-102, SDV-103 and all MOVs (API 6D supplementary test requirements, high-pressure gas seat test), leakage ISO 5208 Rate A		
Other tests	Cavity relief, double block and bleed, anti-static, breakaway torque at 1,440 psi with breakaway, running and end torques recorded, functional test with actuator fitted		
Documentation	API 6D data book, mill test reports, NDE and test certificates, torque test report, SIL certificate for SDV-102, general arrangement with center of gravity		

OPERATING TORQUE ESTIMATE

TORUS estimated the operating torque of each valve size so that actuators and gear operators could be specified at bid. The torque of a trunnion-mounted ball valve is the sum of the upstream seat friction, the trunnion bearing friction and the stem seal friction. Line pressure acts on the seat annulus and pushes the upstream seat onto the ball; the trunnions carry the ball load. The breakaway torque carries a static factor of 1.30 for dry gas, the running torque is taken as 60 % of breakaway, and the end-to-close torque is the reseating torque against full differential.

$$A_{ann} = \frac{\pi}{4}(D_s^2 - D_b^2) \quad R_m = \frac{D_b + D_s}{4}$$

$$T_{seat} = \mu_s (\Delta P + p_{spr}) A_{ann} R_m \quad T_{trun} = \mu_b \Delta P \frac{\pi}{4} D_s^2 \frac{d_t}{2}$$

$$T_{BTO} = 1.30(T_{seat} + T_{trun}) + T_{stem} \quad T_{ETC} = T_{seat} + T_{trun} + T_{stem}$$

For the NPS 2 floating ball, the ball load is carried on the downstream seat, so T_{trun} is replaced by $\mu_s \Delta P \frac{\pi}{4} D_s^2 R_m$. The assumed values (typical, HOLD H-15) are $\mu_s = 0.15$ for PEEK or nylon on a nickel-plated ball, $\mu_b = 0.10$ for a PTFE-lined trunnion bearing, and $p_{spr} = 60$ psi of seat spring preload on the annulus. The valve geometry is given in Table 4.

Table 4: Valve Geometry Used for Torque

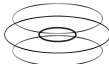
NPS	Bore D_b (in)	Seat seal D_s (in)	A_{ann} (in ²)	R_m (in)	Trunnion d_t (in)	Stem seal (lbf-in)
12	11.94	13.74	36.30	6.420	4.0	600
10	10.00	11.60	27.14	5.400	3.5	450
8	7.94	9.34	19.00	4.320	3.0	350
2 (floating)	1.94	2.64	2.52	1.145	n/a	60

For NPS 12 at 1,440 psi: $T_{seat} = 0.15 \times 1,500 \times 36.30 \times 6.420 = 52,441$ lbf-in; $T_{trun} = 0.10 \times 1,440 \times 148.3 \times 2.0 = 42,703$ lbf-in; breakaway = $1.30 \times 95,144 + 600 = 124,287$ lbf-in (10,357 lbf-ft); end to close = 95,744 lbf-in (7,979 lbf-ft). Table 5 gives all sizes.

Table 5: Estimated Valve Torque at 1,440 psi Differential

NPS	T_{seat} (lbf-in)	T_{trun} (lbf-in)	Breakaway (lbf-in)	Running (lbf-in)	End to close (lbf-in)
12	52,441	42,703	124,287	74,572	95,744
10	32,979	26,632	77,945	46,767	60,061
8	18,468	14,799	43,598	26,159	33,618



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NPS	T_{seat} (lbf-in)	T_{trun} (lbf-in)	Breakaway (lbf-in)	Running (lbf-in)	End to close (lbf-in)
2 (floating)	649	1,354	2,663	1,598	2,063

Note 1: These are bid estimates. The valve vendor's certified torques, including dry-gas and low-temperature factors, shall govern, and the actuator vendor shall resize against them while keeping the safety factors below.

SDV ACTUATORS, SDV-101, SDV-102, SDV-103

The shutdown valves shall have self-contained electro-hydraulic, spring-return, fail-closed scotch-yoke actuators with no external gas or hydraulic supply. A safety factor of 1.5 applies to the valve torque at every required point. The spring end torque (valve closed) shall be at least $1.5 \times 95,744 = 143,616$ lbf-in, and the spring start torque (valve open) at least $1.5 \times 124,287 = 186,431$ lbf-in. With a canted scotch-yoke spring of typical start-to-end ratio 1.8, the spring start is 258,509 lbf-in, which governs the hydraulic side. The hydraulic output shall be at least 330,048 lbf-in at 0° (breakaway plus spring end) and 402,126 lbf-in at 90° (end torque plus spring start), and the valve maximum allowable stem torque shall be at least 402,126 lbf-in so that no actuator output can overstress the stem.

Table 6: SDV Actuator Requirements

Parameter	SDV-101	SDV-102	SDV-103
Valve breakaway / end to close (lbf-ft)	10,357 / 7,979	10,357 / 7,979	10,357 / 7,979
Minimum spring end torque (lbf-ft)	11,968	11,968	11,968
Minimum spring start torque (lbf-ft)	15,536 required; about 21,542 expected	Same	Same
Minimum hydraulic torque at 0° / 90° (lbf-ft)	27,504 / 33,510	27,504 / 33,510	27,504 / 33,510
Valve maximum allowable stem torque (lbf-ft)	33,510 minimum	33,510 minimum	33,510 minimum
Closing time, full stroke (spring)	10 to 30 s	4 s or less, not faster than 3 s	10 to 30 s
Opening time (hydraulic pump)	60 to 180 s	60 to 180 s	60 to 180 s
Trip solenoids, 24 VDC, de-energize to trip	1	2 in 1oo2	1
Limit switches	ZSO-101, ZSC-101	ZSO-102, ZSC-102	ZSO-103, ZSC-103
Local control	HS-101 open, close, reset	Local reset only, after safety system reset	Local open and close

SDV-102 shall close in 4 s or less, because the overpressure analysis, repeated with the real gas density, showed that slower closure lets the trunk pressure rise past the allowable limit. On a trip the spring drives the piston, and the oil returns to the reservoir through a quick-exhaust dump valve and a lockable flow control. TORUS sized the return path for a cylinder that can deliver the largest hydraulic torque (402,126 lbf-in) over the full 90° stroke, at an assumed 2,500 psi working pressure and 85 % mechanical efficiency:

$$V_{oil} = \frac{T_{max}(\pi/2)}{p_h \eta} = \frac{402,126 \times 1.571}{2,500 \times 0.85} = 297 \text{ in}^3$$

A 3.5 s design stroke, which leaves 0.5 s of margin on the 4 s limit and stays above the 3 s minimum set to limit surge, therefore needs a hydraulic return (dump) flow of $297 / 3.5 \times 60 / 231 = 22.1$ gpm. Because the valve closes on spring energy, this flow is carried by the quick-exhaust dump valve and return line; the pump only recharges the actuator for reopening. The constant-torque cylinder is the conservative case; a scotch yoke of the same end torque sweeps less oil. The vendor shall demonstrate full-stroke closure of SDV-102 in 4 s or less at -20°F oil temperature with the specified hydraulic fluid (typical values, HOLD H-15).



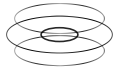
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Table 7: Further SDV Actuator Requirements

Item	Requirement
Manual operation	Hydraulic hand pump for opening without power; mechanical position indicator
Priority	Emergency shutdown overrides local open
Partial stroke	SDV-102: 15 % partial-stroke test initiated from the safety system, travel monitored by position transmitter
Safety integrity	SDV-102 valve and actuator assembly certified SIL 2 capable (IEC 61508); final target per the LOPA
Enclosure	NEMA 4X, certified Class I Division 1 Group D, temperature class T3 or better; reservoir heater for -20 °F
Mounting	ISO 5211, vendor-supplied stem adaptor

SDV-106 ACTUATOR

SDV-106 closes the V-101 dump line upstream of LCV-104 on low-low level, tank high-high level and station emergency shutdown, through the safety PLC. For the NPS 2 floating ball at 1,440 psi the requirements in Table 8 follow from Table 5 with a 1.5 safety factor.

Table 8: SDV-106 Requirements

Item	Requirement	Item	Requirement
Spring end torque	3,094 lbf-in minimum (1.5 × 2,063)	Spring start torque	3,995 lbf-in minimum (1.5 × 2,663)
Motor drive to open	7,089 lbf-in minimum	Closing time	10 s or less
Actuator	Electric, spring return, fail closed, manual override	Control	24 VDC or 120 VAC from the safety PLC
Enclosure	Class I Division 1 Group D	Position	Open and closed limit switches
Body	Floating ball, LF2, Class 600 RF, API 6D or API 608	Tests	As the SDVs
Weight	140 lb with actuator, typical	Hold	H-15

MOV ACTUATORS

Each meter-run MOV shall have a rated torque at 90 % supply voltage of at least $1.25 \times 77,945 = 97,431$ lbf-in (8,119 lbf-ft). The lower factor of 1.25 applies because an MOV is not a safety device and a stall only delays run switching.

Table 9: MOV Actuator Requirements

Item	Requirement	Item	Requirement
Type	Multi-turn electric with part-turn worm gearbox, or part-turn electric	Supply	480 V 3-phase, fail as-is
Rated torque	8,119 lbf-ft minimum at 90 % voltage	Stroke time	60 to 120 s, so run switching does not disturb measurement
Controls	Integral starter, torque and position limits, local / remote selector	Signals	4-20 mA position feedback, Modbus to the RTU
Handwheel	Auto-declutch	Enclosure	Class I Division 1 Group D
MOV-115	Padlockable closed, with software lockout	Seat proof	Body bleed valve and gauge connection on each MOV

MANUAL GEAR OPERATORS

Gear operators were sized for a maximum rim pull of 80 lbf, an overall gearbox efficiency of 0.35 and a sizing torque of 1.25 times breakaway, as set out in Table 10.



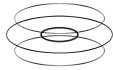
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Table 10: Gear Operator Sizing

Valve size	Sizing torque (lbf-in)	Handwheel (in)	Mechanical advantage	Gear ratio	Turns for 90°
NPS 12	155,359	24	161.8	462:1	About 116
NPS 10	97,431	24	101.5	290:1	About 72
NPS 8	54,497	18	75.7	216:1	About 54

Gearboxes shall be weatherproof and grease filled, with a position indicator, adjustable stops, and a padlock facility for locked-open, locked-closed and car-sealed duty. HV-103B sits in a vertical line with its handwheel about 6.5 ft above grade, so it shall have a chainwheel or a 45° extension (confirm on  PIP-DWG-001). For NPS 2 Class 600 floating ball valves, a lever giving 1.25 times breakaway at 80 lbf would be 41.6 in long, so all NPS 2 Class 600 ball valves shall be gear operated.

SDV AND MOV SUMMARY

Table 11: SDV and MOV Datasheet Summary

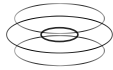
Item	SDV-101, SDV-102, SDV-103	MOV-111, 112, 121, 122, 115
Size and class	NPS 12, Class 600 RF	NPS 10, Class 600 RF
Type	Trunnion, full bore, double block and bleed, self-relieving seats	Trunnion, full bore, double block and bleed with body bleed
Face-to-face	33.0 in	31.0 in
Body, ball, stem	A350 LF2 Class 1; F52 with electroless nickel; 17-4PH	Same
Seats and seals	PEEK insert; decompression-resistant HNBR or FKM; graphite fire-safe	Same
Actuator	Electro-hydraulic spring return, fail closed	Electric, fail as-is
Design	1,440 psig at -20 to 133 °F; 1,420 psig at 150 °F	Same
Tests	Shell 2,225 psig; seats 1,628 psig, 80 psig gas and high-pressure gas	Same
Weight, valve and actuator	3,650 lb typical	2,070 lb typical

SMALL-BORE VALVES

Table 12: Small-Bore Valves, NPS 1-1/2 and Smaller

Item	Requirement
Gate (root, vent, drain, test)	API 602, Class 800, A105N with Charpy at -20 °F, socket weld × socket weld or socket weld × NPT outboard, bolted bonnet, 13 % Cr trim with Stellite seats, outside screw and yoke; vent, drain and hydrotest valves plugged with Class 6000 hex plugs
Ball (HV-133D, DBB bleeds)	ASME B16.34 Class 800, A105N or LF2, socket weld, 316 ball, PEEK seats, lever
Stainless (HV-180A, HV-180B)	ASME B16.34, CF8M or F316, seats rated to -150 °F, class S1
Instrument manifolds	316 stainless steel, 6,000 psig, per the instrument specification
Testing	API 598 shell and seat



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GLOBE VALVES

Table 13: Globe Valves

Tags	Size and class	Requirement
HV-101D, HV-101F, HV-104C, HV-104E	NPS 2, Class 600 RF	ASME B16.34 and API 623; face-to-face 11.25 in (ISA-75.08.01, confirm with vendor); LF2 or LCC body; Stellite plug and seat; handwheel; API 624 fugitive emission type test; API 598 test
HV-101H (SDV-101 equalizing bypass, line 1103)	NPS 1, Class 800 SW	ASME B16.34; A105N or LF2 body; handwheel; Cv 5 ( PRO-CAL-002); API 598 test
HV-102H, HV-103H (SDV-102 and SDV-103 equalizing bypasses, lines 1162 and 1171)	NPS 1, Class 800 SW	As above with needle trim, Cv 1 ( PRO-CAL-002)

Note 1: Each equalizing bypass lets the operator balance pressure across its SDV before opening, so the actual opening differential is near zero and the 1,440 psi torque basis is conservative.

HOLDS

Table 14: Open Items

Hold	Item	Responsible
H-15	Certified valve torques, bores and weights; actuator torque curves, stroke times, oil volumes; SIL certificate	Vendors
TBV	Area classification at valve locations; power supply and cabling for hydraulic pumps and MOVs	Electrical
TBV	SDV-102 trip solenoid architecture and partial-stroke test per the safety requirements specification and LOPA	Instrumentation

