 TORUS	· Owner TEMPERATURE ELEMENTS, THERMOWELLS AND TRANSMITTERS			Document No.	INS-DS-002
				Revision / Date	A · September 29, 2026
				Issue purpose	Issued for Review
INSTRUMENTATION AND CONTROLS · TEMPERATURE ELEMENTS, THERMOWELLS AND TRANSMITTERS					
Rev.	Date	Revision description	Prepared	Reviewed	Approved
A	2026-09-29	Issued for Review			

NOTES

1. This datasheet covers the RTD elements, head-mounted temperature transmitters and flanged thermowells for control system service. The custody elements and wells TT/TW-111 and TT/TW-121 and the test wells TW-112 and TW-122 are specified on the Volume 2 measurement datasheets.
2. Controlling documents:  GEN-DB-001, Basis of Design;  INS-LST-001, Instrument Index;  INS-LST-002, I/O List;  INS-LST-003, Alarm and Trip Setpoints;  INS-DWG-004, Instrument Installation Hook-up Typicals (HU-T).
3. Values marked typical are budgetary. The vendor shall confirm them with its proposal and final data (HOLD H-15).
4. Units are US customary. Pressures are gauge unless stated as absolute. Operating cases C1 to C7 are defined in  GEN-DB-001, Section 6; normal conditions are case C2, maximum operating conditions the envelope of C1 to C7, and design conditions those of  GEN-DB-001, Section 7.
5. TT-135 is the process variable of the cascade master TIC-135, whose setpoint (42.3 to 51.6 °F) is compensated for pressure per  PRO-CAL-003. TT-135 sees 19.4 °F in the heater-off upset case C6; its -20 to 150 °F range covers this. It has a dual element so that sensor drift is detected.
6. TT-151 (bath temperature), TSHH-155 and TI-151A are heater vendor connections. The heater vendor shall provide a separate well for each.
7. TT-208A is an air sensor on the B-101 wall away from the heater outlet, without a thermowell.
8. The NPS 12 wall is taken as 0.375 in pending the Volume 4 wall thickness calculation. The wake frequency check shall be repeated if the final wall differs by more than 0.1 in.

GENERAL

Table 1-1: General Data

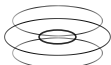
Item	Value	Item	Value
Project	 County, 	Service	120 MMSCFD gas receipt into the receiving pipeline operator's 
Form content	ISA-20; tag numbers to ISA-5.1	Electrical codes	NFPA 70 (2023) Articles 500 and 501; API RP 500
Safety instrumented tags	IEC 61511 and IEC 61508	Sour service	Not required; sweet gas, H2S 4 ppmv maximum (NACE MR0175 not applied)

SITE CONDITIONS

Table 1-2: Site and Environmental Conditions

Item	Value	Item	Value
Ambient design temperature	-5 °F to 110 °F	Electronics rating	-40 °F to 158 °F (-40 °C to 70 °C)
Solar radiation	1,000 W/m ² ; sunshades where exposed	Elevation and atmosphere	1,150 ft MSL; 14.10 psia



 TORUS	· Owner TEMPERATURE ELEMENTS, THERMOWELLS AND TRANSMITTERS	Document No.	INS- DS-002
		Revision / Date	A · September 29, 2026
		Issue purpose	Issued for Review
		INSTRUMENTATION AND CONTROLS · TEMPERATURE ELEMENTS, THERMOWELLS AND TRANSMITTERS	
Item	Value	Item	Value
Wind and ice	108 mph (ASCE 7-22, Exposure C); 0.5 in radial ice (HOLD H-06)	Area classification	Class I, Division 2, Group D in process areas; Division 1 within 5 ft of vents and relief outlets (Volume 6 area classification drawing)
Temperature class	T3 minimum (natural gas autoignition about 900 °F)	Enclosure	NEMA 4X (IP66) minimum; 316 SS or copper-free aluminum (below 0.4 % Cu), epoxy coated
Instrument power	24 VDC from the station UPS (GEN-DB-001, Section 9.8) unless noted		

TAG SCHEDULE

Table 1-3 lists every tag in  INS-LST-001 that references this datasheet, and Table 1-4 gives the process conditions at each tag.

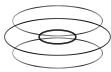
Table 1-3: Tag Schedule

Tag	Service	P&ID	Range or set	System	JB	Area classification
TT-101	Station inlet temperature (TW-101)	 PRO-DWG-101	-20 to 150 °F	BPCS RTU/ PLC	JB-101	Class I, Division 2, Group D
TW-101	Thermowell for TT-101	 PRO-DWG-101	None	Local, no I/O	None	Class I, Division 2, Group D
TT-151	H-101 bath temperature	 PRO-DWG-105	0 to 250 °F	BPCS RTU/ PLC	JB-150	Class I, Division 2, Group D
TT-156	H-101 gas outlet temperature (TW-156), PV of TIC-152	 PRO-DWG-105	-20 to 250 °F	BPCS RTU/ PLC	JB-150	Class I, Division 2, Group D
TW-156	Thermowell for TT-156	 PRO-DWG-105	None	Local, no I/O	None	Class I, Division 2, Group D
TW-161C	Thermowell for TI-161C	 PRO-DWG-106	None	Local, no I/O	None	Class I, Division 2, Group D
TT-135	Control valve outlet temperature (TW-135), hydrate monitoring, cascade master PV	 PRO-DWG-107	-20 to 150 °F	BPCS RTU/ PLC	JB-130	Class I, Division 2, Group D
TW-135	Thermowell for TT-135	 PRO-DWG-107	None	Local, no I/O	None	Class I, Division 2, Group D
TT-173	Station outlet (delivery) temperature (TW-173)	 PRO-DWG-108	-20 to 150 °F	BPCS RTU/ PLC	JB-170	Class I, Division 2, Group D
TW-173	Thermowell for TT-173	 PRO-DWG-108	None	Local, no I/O	None	Class I, Division 2, Group D
TT-208A	B-101 shelter temperature	 PRO-DWG-113	0 to 150 °F	BPCS RTU/ PLC	JB-140	Class I, Division 2, Group D (B-101 interior)

Table 1-4: Process Conditions

Tag	Normal P and T	Maximum operating P and T	Design P and T
TT-101	1,050 psig / 70 °F	1,150 psig / 45 to 120 °F	1,440 psig / -20 to 150 °F
TW-101	1,050 psig / 70 °F	1,150 psig / 45 to 120 °F	1,440 psig / -20 to 150 °F
TT-151	Atmospheric bath / 150 to 190 °F	Atmospheric / 200 °F (TSHH-155)	Vendor bath design / 250 °F
TT-156	1,030 psig / 68 °F (C1) to 130 °F	1,150 psig / 140 °F	1,440 psig / 250 °F
TW-156	1,030 psig / 68 to 130 °F	1,150 psig / 140 °F	1,440 psig / 250 °F



 TORUS	· Owner TEMPERATURE ELEMENTS, THERMOWELLS AND TRANSMITTERS	Document No.	INS- DS-002
		Revision / Date	A · September 29, 2026
		Issue purpose	Issued for Review
		INSTRUMENTATION AND CONTROLS · TEMPERATURE ELEMENTS, THERMOWELLS AND TRANSMITTERS	
Tag	Normal P and T	Maximum operating P and T	Design P and T
TW-161C	25 psig / ambient	PSV-161 set (Class 150) / 110 °F	285 psig (Class 150 at 100 °F) / -20 to 150 °F
TT-135	950 psig / 45 °F (heater on) to 65 °F	1,180 psig / 19 °F heater-off C6 upset to 120 °F	1,440 psig / -20 to 150 °F
TW-135	950 psig / 45 to 65 °F	1,180 psig / 19 to 120 °F	1,440 psig / -20 to 150 °F
TT-173	950 psig / 45 to 70 °F	1,180 psig (PIC-134 clamp); 1,225 psig OPSS trip / 19 to 120 °F	1,440 psig / -20 to 150 °F
TW-173	950 psig / 45 to 70 °F	1,180 psig (PIC-134 clamp); 1,225 psig OPSS trip / 19 to 120 °F	1,440 psig / -20 to 150 °F
TT-208A	Shelter air / 60 to 90 °F	Atmospheric / 110 °F	Not applicable

SPECIFICATION

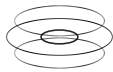
Table 1-5: Specification

Item	Requirement
Element	Pt100 RTD, IEC 60751 Class A, four-wire, spring loaded, 1/4 in mineral-insulated 316 SS sheath; single element, dual on TT-135
Transmitter	Head-mounted, two-wire 4-20 mA with HART 7, sensor-break detection, NAMUR NE43 upscale on sensor failure
Housing	Dual compartment explosion-proof, Class I, Division 1, Group D, T6, NEMA 4X, local LCD
Accuracy	Element and transmitter together ± 0.3 °F over -20 to 150 °F, typical, vendor to confirm (HOLD H-15)
Ranges	Per Table 1-3: TT-151 0 to 250 °F, TT-156 -20 to 250 °F, TT-208A 0 to 150 °F, all others -20 to 150 °F
Thermowell type	Tapered, drilled bar stock, 316 SS, 1-1/2 in Class 600 RF flange (ASME B16.5); bore 0.26 in, root diameter 1.0 in, tip diameter 0.75 in. TT-151 bath well 1 in NPT by the heater vendor
Immersion length	5.5 in unsupported length in NPS 12 lines, placing the tip in the central third of the 12.0 in bore
Thermowell rating	Class 600 flange; pressure rating per ASME PTC 19.3 TW at 1,440 psig and 150 °F (TW-156 at 250 °F)
Wake frequency	Screened in Table 1-6. The vendor shall submit the full ASME PTC 19.3 TW-2016 calculation (frequency, steady and dynamic stress, pressure) for each well
Connection to element	1/2 in NPT, union-nipple-union (typical HU-T)
Diagnostics	Sensor drift alert on the dual element of TT-135; open and short circuit detection
Power	24 VDC loop power
SIL capability	Not required; there is no temperature SIF, and TSHH-155 is a switch on  INS-DS-005
Tagging	316 SS plate, 1/8 in engraved characters, wired to the instrument
Inspection and testing	Element and transmitter matched and calibrated as a loop at three points; thermowell hydrotest at 1.5 times the flange rating, positive material identification and dimensional check
Documentation	Dimensional drawing, wiring diagram, hazardous location certificate, calibration certificate, IEC 61508 certificate and safety manual for safety instrumented tags, installation and maintenance manual and spare parts list, all as searchable PDF

THERMOWELL WAKE FREQUENCY SCREENING

TORUS screened the NPS 12 thermowells (TW-101, TW-135, TW-156 and TW-173) at case C5, 120 MMSCFD at 900 psig and 60 °F, which gives the highest line velocity. Table 1-6 sets out the result. The Scruton number is below 2.5, so ASME PTC 19.3 TW-2016 requires the shedding frequency to stay below 0.4 of the installed natural frequency, which rules out in-line resonance. The ratio is 0.14, and it stays



 TORUS	· Owner TEMPERATURE ELEMENTS, THERMOWELLS AND TRANSMITTERS	Document No.	INS- DS-002
		Revision / Date	A · September 29, 2026
		Issue purpose	Issued for Review
INSTRUMENTATION AND CONTROLS · TEMPERATURE ELEMENTS, THERMOWELLS AND TRANSMITTERS			

below 0.2 even if the support compliance factor falls to 0.6. The Strouhal number was held at 0.22; the Reynolds-dependent value of the code (0.20 at this Reynolds number) would lower the shedding frequency further. Cases C1 and C4 have higher pressure and lower velocity and do not govern.

Table 1-6: Thermowell Wake Frequency Screening, Case C5

Quantity	Symbol	Value	Basis
Gas density and viscosity	ρ, μ	3.59 lb/ft ³ , 0.0125 cP	GERG-2008 at 900 psig, 60 °F
Line velocity, NPS 12 (12.000 in bore)	V	24.1 ft/s	$V = Q / A$
Natural frequency, fixed base	f_a	821 Hz	$(1.875^2/2\pi)\sqrt{EI/mL^4}$, mean diameter
Installed natural frequency	$f_{n,c}$	626 Hz	$f_a H_c H_{a,f} H_{a,s}$ with $H_c = 0.85$, $H_{a,s} = 0.9$
Reynolds number at tip	Re	641,249	$\rho V B / \mu$
Shedding frequency	f_s	84.7 Hz	$N_s V / B$ with $N_s = 0.22$
Scruton number	N_{Sc}	0.30	$(\pi^2/2)\zeta(\rho_m/\rho)(1 - (d/B)^2)$ with $\zeta = 0.0005$
Frequency ratio	$f_s/f_{n,c}$	0.14	Limit 0.4 (in-line)
Longest length meeting the limit	L_{max}	9.5 in	f_n scales with $1/L^2$

Note 1: 316 SS: E = 28.3 x 10⁶ psi, density 0.289 lb/in³. Support compliance and sensor mass factors are bounding values; the vendor's PTC 19.3 TW calculation replaces them.

OPEN ITEMS

Table 1-7: Open Items

HOLD	Item	Responsible party
H-15	Final thermowell dimensions and PTC 19.3 TW calculation	Thermowell vendor
TBV	NPS 12 wall thickness	Volume 4 wall thickness calculation

