MEASUREMENT AND CONTROL

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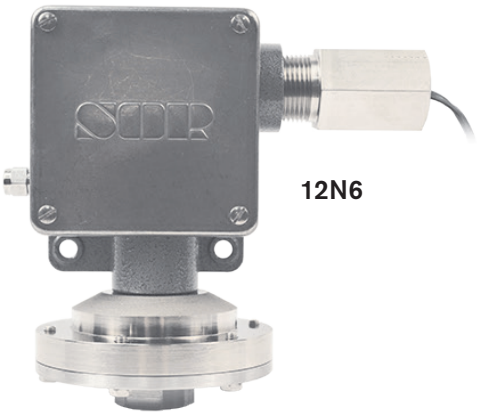
Switches for the Nuclear Power Industry

SOR® Pressure, Vacuum and Temperature Switches

are qualified by a combination of testing and analysis per IEEE-323-1974 & 1983 and IEEE-344-1975 & 1987. See SOR Test Report, 9058-102, 9058-105, and 8923-306 for qualification testing and explanations. (Note: for nuclear qualified differential pressure switches, see SOR catalog 1291.)

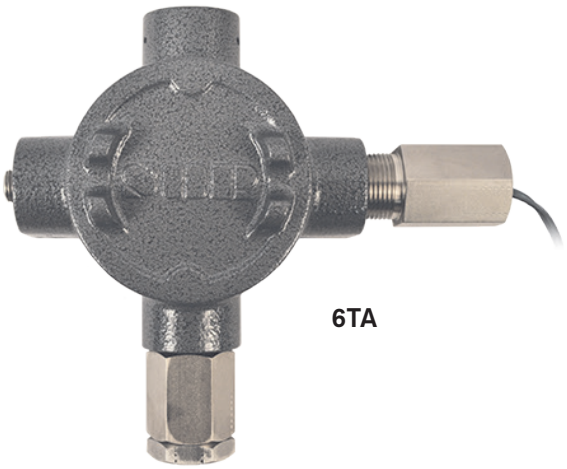
Qualification testing included

- Thermal Aging
- Irradiation
- Mechanical/Electrical Cycling
- Sine Beat
- Random Multifrequency
- LOCA
- HELB



12N6

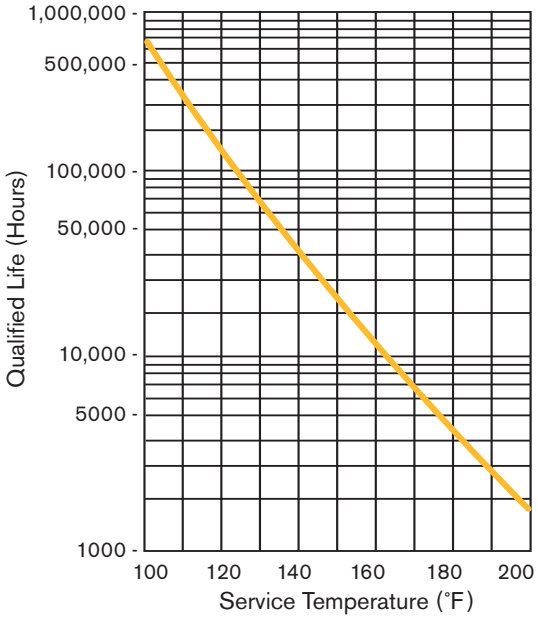
9RT



6TA

SOR maintains a quality program committed to compliance with the applicable elements of 10CFR50, Appendix B, ANSI N45.2 and NQA-1, including the reporting requirements of 10CFR21. The products in this catalog are manufactured under this quality program which is audited by the Nuclear Procurement Issues Committee (NUPIC), and Nuclear Industry Assessment Committee (NIAC).

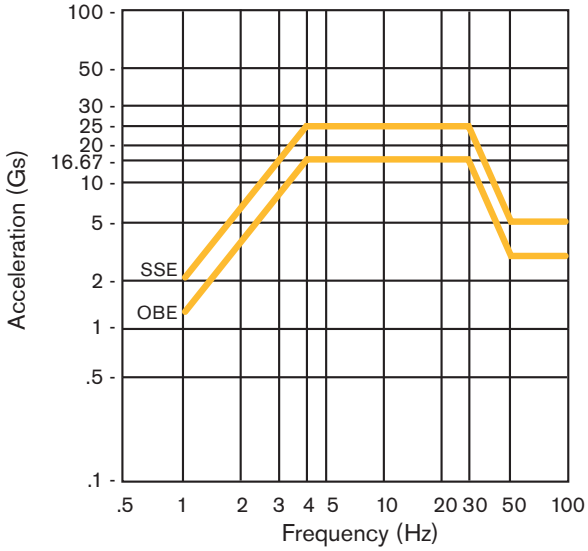
Figure 1: AGING



This graph is based on the Arrhenius equation and may be used as a general guideline in determining the qualified life if the service temperature is greater than or less than 119.257°F.

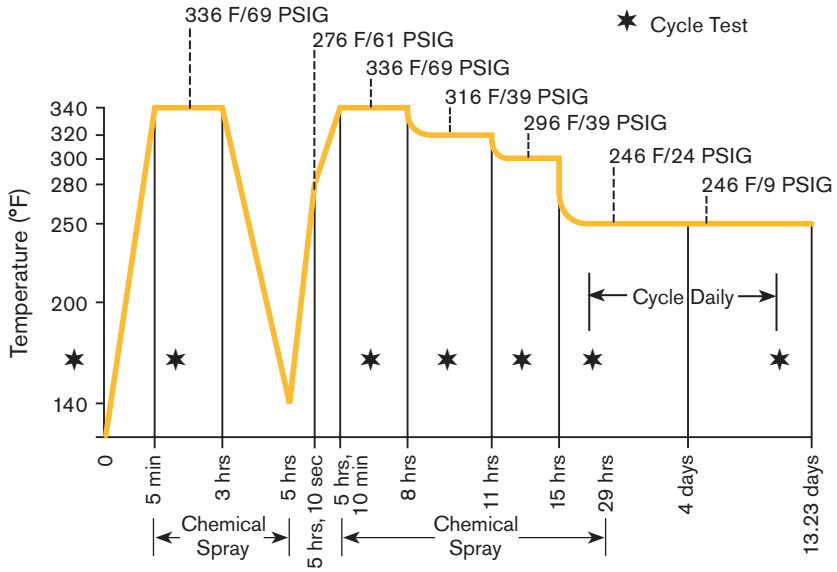
Figure 2: SEISMIC

100% RRS Curves at 1% Damping



This is the RRS (Required Response Spectrum) at 1% damping to which all switches were seismically tested. All TRS (Test Response Spectrum) plots are contained in test report 9058-102. Seismic damping analysis to 0.5%, 2%, 3%, 4%, and 5% is also available upon request.

Figure 3: LOCA



This graph shows the combined environmental conditions to which certain switches were subjected at end-of-life conditions to simulate a LOCA (Loss Of Coolant Accident). The two thermodynamic transients were generated by injecting superheated steam into the autoclave in a controlled manner. The chemical spray consisted of 0.28 molar boric acid and 0.064 molar sodium thiosulfate buffered to pH 10.5 with sodium hydroxide.

Note: Time values have been rounded. See test report 9058-102 for exact values.

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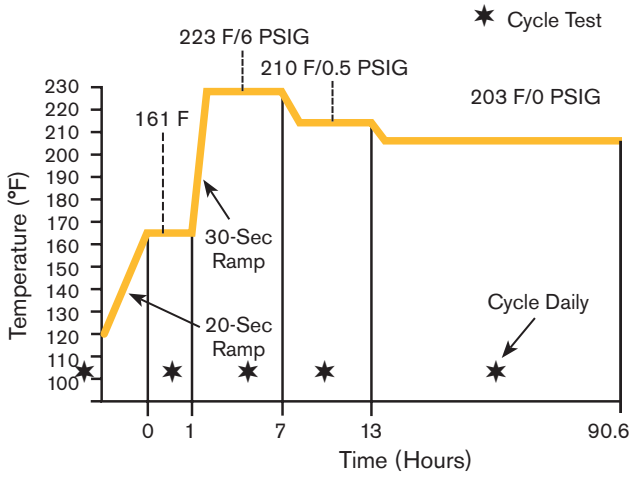
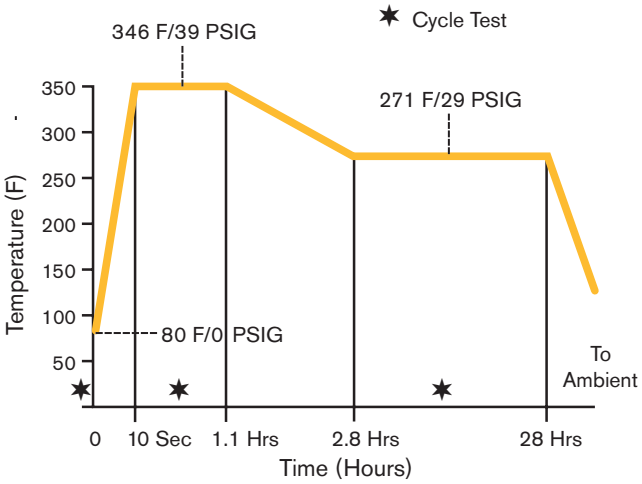
Figure 4: HELB 1



This graph shows the combined environmental conditions to which certain switches were subjected at end-of-life conditions to simulate a HELB (High Energy Line Break). The HELB 1 profile shown here was generated by injecting superheated steam into the autoclave in a controlled manner.

Note: Time values have been rounded. See test report 9058-102 for exact values.

Figure 5: HELB 2



This graph shows the combined environmental conditions to which certain switches were subjected at end-of-life conditions to simulate a second more severe HELB (High Energy Line Break). The HELB 2 profile shown here was generated by injecting superheated steam into the autoclave in a controlled manner.

Note: Time values have been rounded. See test report 9058-102 for exact values.

Qualification Program Explanation

- **Thermal Aging** to simulate a 20-year life at a service temperature of 119.257°F (see Figure 1). Switches were subjected to accelerated thermal aging according to the Arrhenius model and based on the lowest activation energy of all of the safety related, non-metallic materials of construction.

- **Radiation** Aging to 31 or 186 megarads minimum. Switches were subjected to various amounts of gamma irradiation (see test report) to simulate that amount of radiation the switch might be exposed to during its qualified life, plus the amount of radiation it might see during an accident plus margin.

- **Mechanical/Electrical Cycling** to 30,000 cycles at full-scale pressure/temperature and rated electrical load. Pressure and vacuum switches were cycled either pneumatically or hydraulically from the low end to the high end of the adjustable range. Temperature switch sensors were thermally cycled from 20°F below set point to 20°F above set point. All cycling was conducted with full rated voltage and current applied to the switch contacts.

- **Sine Beat** testing at 1-50 Hz, 4.5g on line-mount temperature switches. This test was performed to age the switch and determine its response to these conditions. Only the direct mount temperature switch was chosen for this test as it is the only switch that may be line mounted.

- **Random Multifrequency** testing including five OBEs (Operating Basis Earthquake) and one SSE (safe shutdown earthquake) in each of four orientations (see Figure 2). This test was performed to age the switch and determine its response to these conditions.

- **LOCA** (Loss Of Coolant Accident) testing on selected models (see Figure 3). This test simulated LOCA conditions and established the switch's response/condition before during and after the test.
- **HELB** (High Energy Line Break) testing to two different profiles on selected models (see Figures 4 and 5). This test simulated two different HELB conditions and established the switch's response/condition before during and after the test.

The above testing brought the switches to end-of-life conditions as required by the IEEE standards and then subjected them to accident conditions. Please note that none of the qualification levels were established based on a specific application. Rather, they were chosen generically with the intent to be suitable for the majority of possible applications in nuclear power stations. It is the responsibility of the end user to establish if the qualification levels are suitable for the intended use.

Specifications

Repeatability of SOR Switches

Pressure Switch	±1% of Span
Temperature Switch	±1.5% of Span
Vacuum Switch	±1% of Span (±1.5% Post-LOCA)

Repeatability, as defined by ISA/ANSI S51.1, is the closeness of agreement among a number of consecutive measurements of the ouput (set point) for the same value of the input under the same operating conditions, approaching from the same direction, for full range traverses.

Drift Maximum Annual Drift for all qualified models (except #9 & #29 pistons with U8 diaphragm) is 2.5% of span. The Maximum Annual Drift for #9 & #29 pistons with U8 diaphragms is 4.0% of span.

Temperature Influence Formulas
for Pressure and Vacuum Switches

The formulas given below represent a general guideline for the expected influence of temperatures on the set points of the pressure and vacuum switches in this catalog.

Housing

Sealed - △ SP = [0.027 (psi/°F) - (SP x 0.0003 / °F)] x (Tf - Ti)
Vented - △ SP = - (SP x 0.0003 / °F) x (Tf - Ti)

Where: △ SP = The change in the set point in (psi) from the intial value.
SP = The initial set point in (psi).
TI = The initial ambient temperature in °F
Tf = The final ambient temperature in °F

Test Reports
for SOR Pressure, Vacuum and Temperature Switches

9058-102	Qualification Test Report.
9058-103	DC rating on "W" switch element.*
9058-105	"U1" diaphragm option for improved long-term drift and dead band. *Affects qualification levels. Contact SOR.*
9058-119	Terminal Block option in R-series housing.*
9058-120	R-series housing with M20x1.5 conduit connection.*
8923-306	Switch without "JJ" conduit seal. *Affects qualification levels. Contact SOR.*
8923-340	N6 housing.

**Contact SOR for ordering information*

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Model Number System

12N6-B45-U8-C2A-JJTTNQ

Piston (Designator 1)	Housing (Designator 2)	Switching Element (Designator 3)	Range Spring (Designator 4)	Diaphragm (Designator 5)	Pressure Port (Designator 6)	Accessories (Designator 7)

To specify a **Pressure Switch, begin with Step 1a.**
Vacuum Switch, begin with Step 1b.
Temperature Switch, begin with Step 1c.

Use the sample model number above each table to position selected designators within the model number.

Important Note: *Some options may reduce the qualification level of a given model. The qualification of a switch is only as good as the weakest link. See SOR Qualification Test Reports 9058-102, 9058-105, and 8923-306 for further details. Also, reference qualification levels given in Steps 2, 4, and 6 of this catalog.*

Step 1a: Pressure Switch

12N6-B45-U8-C2A-JJTTNQ

Place designators in positions 1 and 4.

Piston (Designator 1)	Spring (Designator 4)	Adjustable Range		Overrange[1]	
		psi	bar [mbar]	psi	bar
12	4	0.5 to 6.0	[35 to 415]	200	14
12	5	0.75 to 12	[50 to 830]		
12	45	1 to 16	[70 to 1100]		
4	4	2 to 25	0.14 to 1.7	750	50
4	5	3 to 50	0.2 to 3.5		
4	45	4 to 75	0.3 to 5		
6	2	7 to 30	0.5 to 2	1500	100
6	3	12 to 100	0.8 to 7		
6	5	20 to 180	1.4 to 12		
6	45	25 to 275	1.7 to 19		
5	3	25 to 240	1.7 to 16		
5	5	35 to 375	2.4 to 26		
5	45	45 to 550	3.1 to 38		
29	4	80 to 400	5.5 to 28	2500	170
29	45	150 to 1350	10 to 93		
9	4	100 to 500	7 to 35		
9	5	200 to 1000	14 to 70		
9	45	200 to 1750	14 to 120		

1. The maximum input pressure/temperature that can be continuously applied to the switch without causing a permanent change of set point, leakage or material failure.
2. Dead Bands: Please contact SOR with model and increasing/decreasing set point value to obtain dead band information.

Step 1b: Vacuum Switch

54N6-B118-M9-C2A-JJTTNQ

Place designators in positions 1 and 4.

Piston (Designator 1)	Spring (Designator 4)	Adjustable Range (Vacuum - 0 - Pressure)		Overrange	
		in. Hg	mbar	psi	bar
54	118	30 - 0 - 1	1000 - 0 - 35	750	50

Step 1c: Temperature Switch

Place designators in positions 1 and 4.

201N6-B125-U9-C7A-JJTTNQ

Probe (Designator 1)	Range (Designator 4)	Mounting Type	Capillary Length		Adjustable Range		Overrange Temperature		Max Process Pressure	
			ft.	m	°F	°C	°F	°C	psi	bar
201	125	Direct	-	-	40 to 225	5 to 107	360	182	2300	158
203	125	Remote	6	1.8						
205	125	Remote	10	3.0						
207	125	Remote	15	4.5						
209	125	Remote	20	6.0						
201	115	Direct	-	-	150 to 375	66 to 190	520	270		
203	115	Remote	6	1.8						
205	115	Remote	10	3.0						
207	115	Remote	15	4.5						
209	115	Remote	20	6.0						

Step 2: Select Housing

12N6-B45-U8-C2A-JJTTNQ

Replace N6 in the sample model number with the appropriate housing designator.

Housing (Designator 2)	Specifications		Qualification	
	Material	Conduit	DBE	Radiation[3]
N6	Carbon Steel	3/4" NPT (F)	HELB[1]	31 Mrad
RT	316SS (CF8M)			
TA[4]	Ductile Iron		HELB[2] & LOCA[2]	186 Mrad

1. Reference Page 3, Figures 4 & 5.
2. Reference Page 2, Figure 3.
3. The noted values represent the minimum irradiation aging dose applied during qualification testing.
4. Temperature switches in the TA housing are qualified for 31 Mrad and HELB only.

Step 3: Select Switching Element

12N6-B45-U8-C2A-JJTTNQ

Replace B in the sample model number with the appropriate switching element designator.

Switch (Designator 3)	AC Rating		DC Rating Resistive		Contact Form
	Volts	Amps	Volts	Amps	
B	250	5	125	0.3	SPDT
W*	250	5	-	-	SPDT
BB	250	5	125	0.3	DPDT

**DC rating is optional. Contact SOR.*

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Step 4: Select Diaphragm System

Replace U8 in the sample model number with the appropriate diaphragm system designator.

12N6-B45-**U8**-C2A-JJTTNQ

NOTE: If the designator 1 (chosen in step 1) does not appear under Compatible Designators, the line item is not available.

Diaphragm (Designator 5)	Diaphragm Material	Diaphragm System		Qualification			Compatible Designators (Designator 1)
		Welded	O-Ring	DBE[7]	Radiation[3]	Cycles	
U1[4]	316SST	Yes	None	HELB[1] & LOCA[2]	31 Mrad	5,000	9, 29 Standard (5, 6 Optional)
U8[5]					31 Mrad or 186 Mrad[6]	30,000	4, 5, 6, 12 Standard (9, 29 Optional)
U9				HELB[1]	31 Mrad		201, 203, 205, 207, 209
M4		No	Viton				54
M9			EPR	HELB[1] & LOCA[2]	31 Mrad or 186 Mrad[6]		

1. *Reference Page 3, Figures 4 & 5.*
2. *Reference Page 2, Figure 3.*
3. *The noted values represent the minimum irradiation aging dose applied during qualification testing.*
4. *The U1 is standard on the 9 & 29 Piston and it is optional on the 5 & 6 Piston. The U1 has significantly better dead band and long term drift for the 9 & 29 Piston. The U1 has marginally better dead band and drift on the 5 & 6 Piston. Refer to Test Report 9058-105.*
5. *The U8 is standard on the 4, 5, 6 & 12 Piston and it is optional on the 9 & 29 Piston. If higher cycles or radiation levels are needed for the 9 & 29 the U8 can be specified, but this will increase the dead band and long term drift.*
6. *The TA Housing selection is required for the 186 Mrad radiation level.*
7. *The JJ Conduit Seal Accessory Option selection is required for HELB & LOCA applications.*

Step 5: Select Process Connection

Replace C2A in the sample model number with the appropriate process connection designator.

12N6-B45-U8-**C2A**-JJTTNQ

NOTE: If the designator 1 (chosen in step 1) does not appear under Compatible Designators, the line item is not available.

Process Connection (Designator 6)	Connection Material	Connection Size/Type		Compatible Designators (Designator 1)
C1A	316SS	1/4	NPT(F)	12, 4, 5, 6, 9, 29, 54
C2A		1/2	NPT(F)	
C7A		1/2	NPT(M)	201, 203, 205, 207, 209

Step 6: Select Accessories

12N6-B45-U8-C2A-**JJTTNQ**

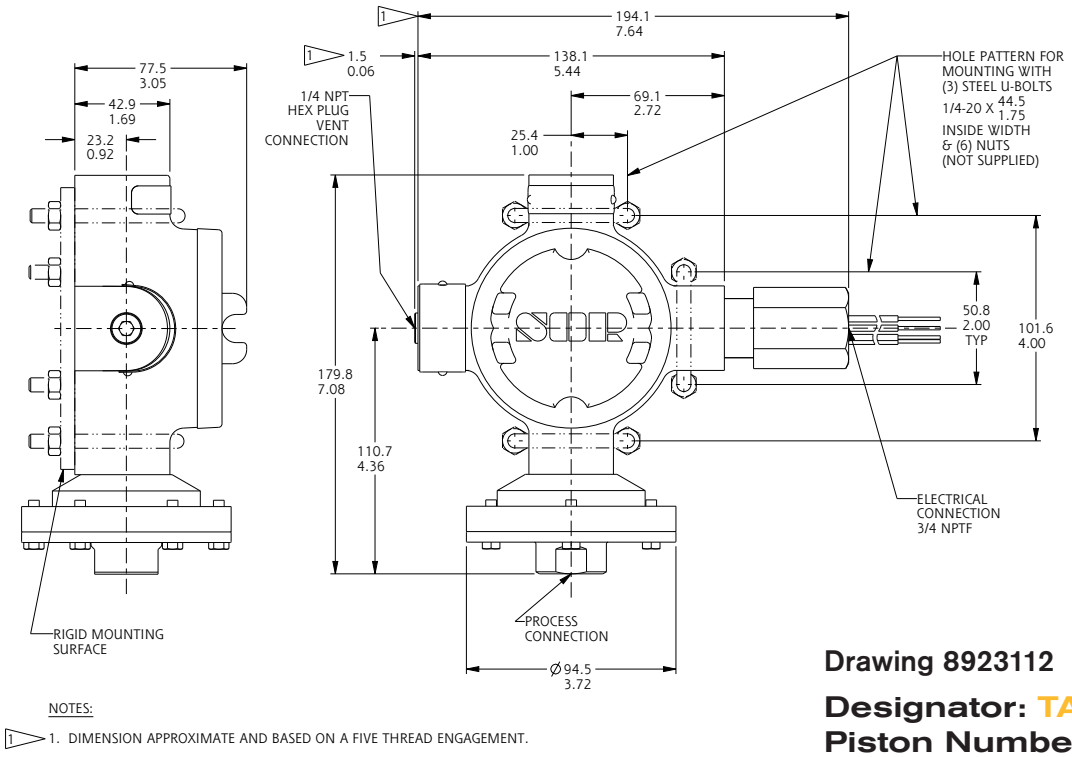
Accessories (Designator 7)	Description
JJ	Conduit seal with 17 ft. lead wire length. *Optional.* *This designator must be used for HELB and LOCA applications.*
RR	Stainless steel tag attached with stainless steel wire to housing.
TT	Oversized nameplate for tagging information. *Required designator.*
NQ	Nuclear-qualified model. *Required designator.*

Approximate Weights

Housing Designator	Piston/Probe	Weight	
		lbs	kg
N6	12	5.63	2.55
	4, 54	3.94	1.79
	5, 6, 9, 29	3.56	1.62
	201	3.88	1.76
	203, 205, 207, 209	3.75	1.70
RT	12	7.13	3.23
	4, 54	5.50	2.49
	5, 6, 9, 29	5.06	2.30
	201	5.38	2.44
	203, 205, 207, 209	5.25	2.38
TA	12	8.81	4.00
	4, 54	7.19	3.26
	5, 6, 9, 29	6.75	3.06
	201	7.06	3.20
	203, 205, 207, 209	6.94	3.15

1. Includes weight of "JJ" conduit seal.
2. Excludes weight of external wire leads.
3. Excludes weight of armored capillary, bulb extension, and sensing bulb on remote mount temperature switches.

Dimensions



NOTES:
1. DIMENSION APPROXIMATE AND BASED ON A FIVE THREAD ENGAGEMENT.

Drawing 8923112

Designator: TA
Piston Number 12

Dimensions in this catalog are for reference only. They may be changed without notice. Contact the factory for certified drawings for a particular model number.

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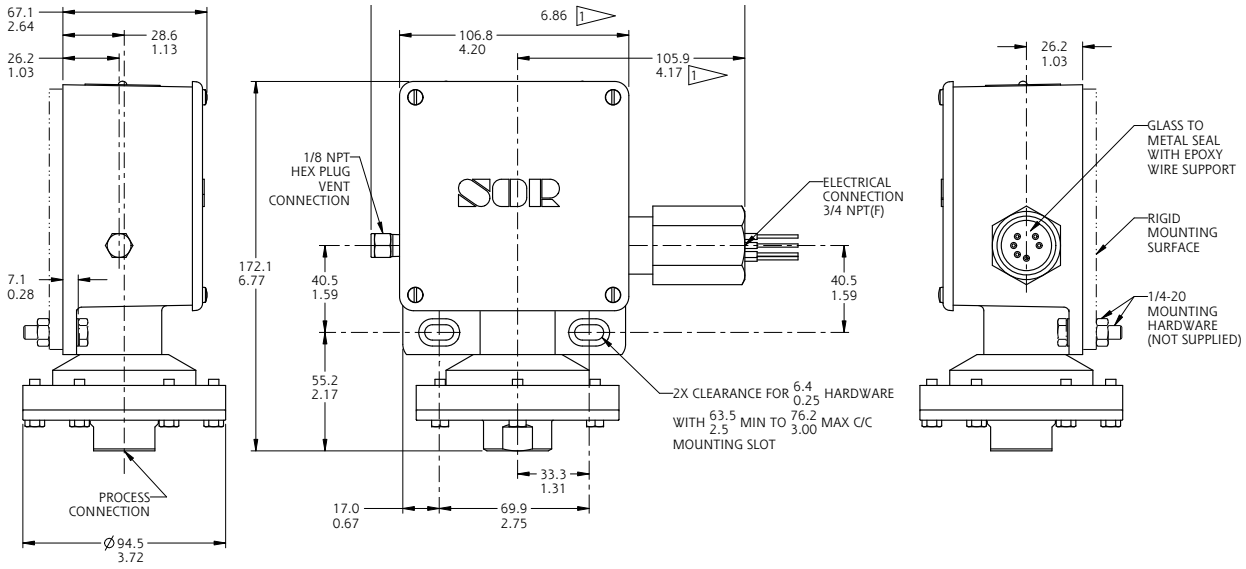
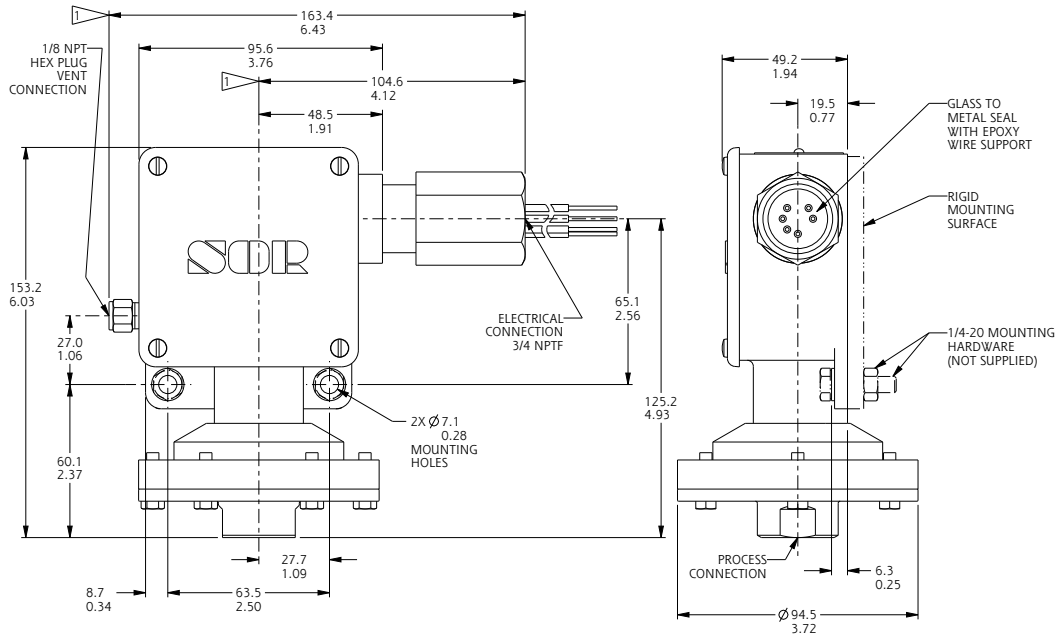


Linear = mm/in.

NOTES:

1 1. DIMENSION APPROXIMATE AND BASED ON A FIVE THREAD ENGAGEMENT

Drawing 8923118
Designator: RT
Piston Number 12

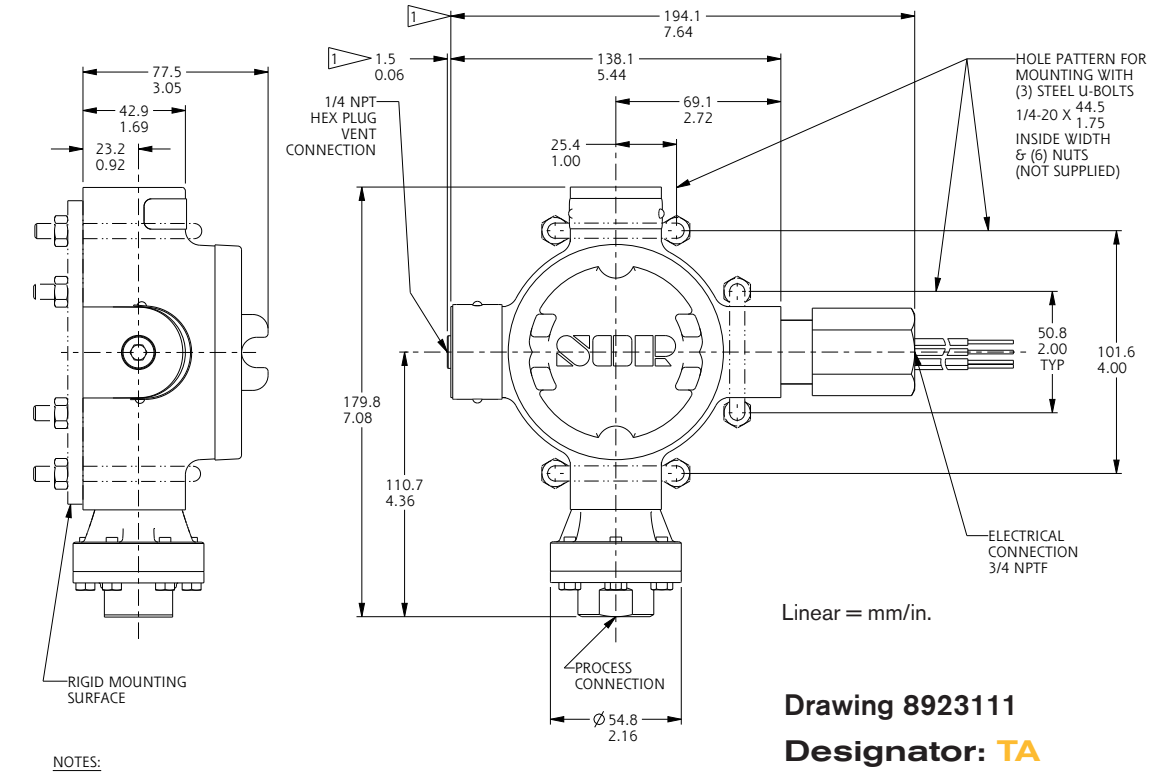


NOTES:

1 1. DIMENSION APPROXIMATE AND BASED ON A FIVE THREAD ENGAGEMENT.

Drawing 8923115
Designator: N6
Piston Number 12

Dimensions in this catalog are for reference only. They may be changed without notice. Contact the factory for certified drawings for a particular model number.



Linear = mm/in.

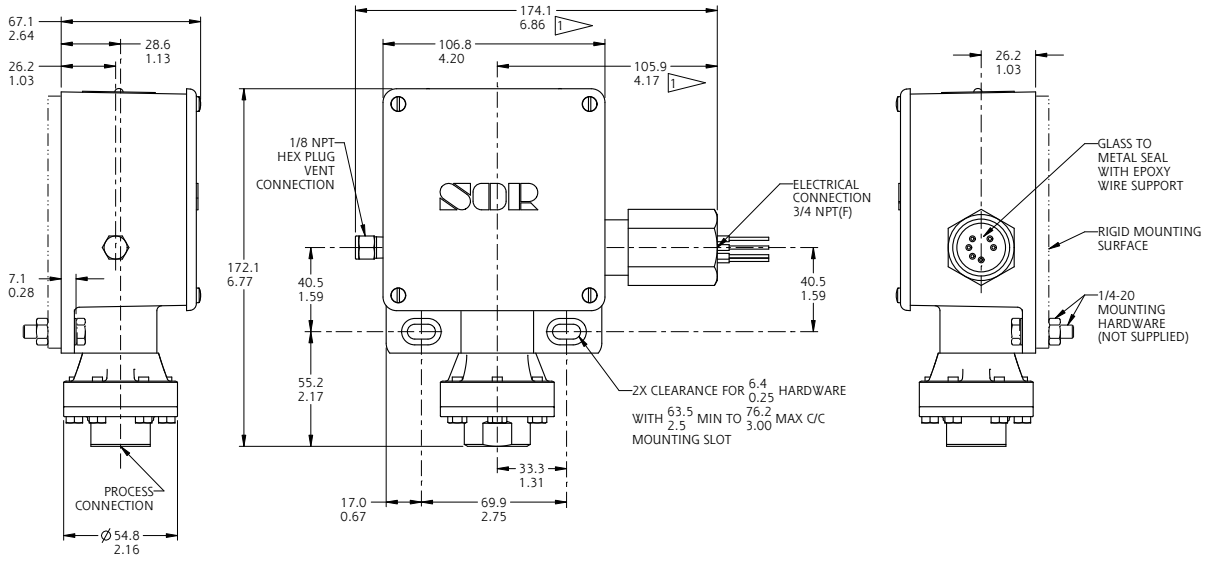
Drawing 8923111

Designator: TA

Piston Numbers 4, 54

NOTES:

1. DIMENSION APPROXIMATE AND BASED ON A FIVE THREAD ENGAGEMENT.



Drawing 8923117

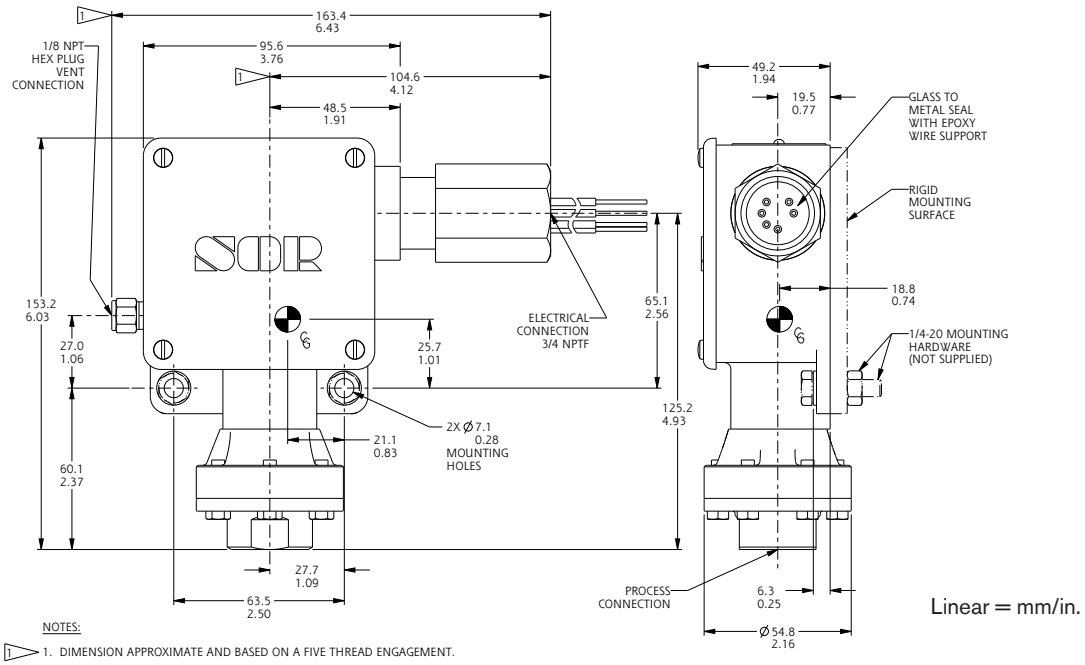
Designator: RT

Piston Numbers 4, 54

NOTES:

1. DIMENSION APPROXIMATE AND BASED ON A FIVE THREAD ENGAGEMENT

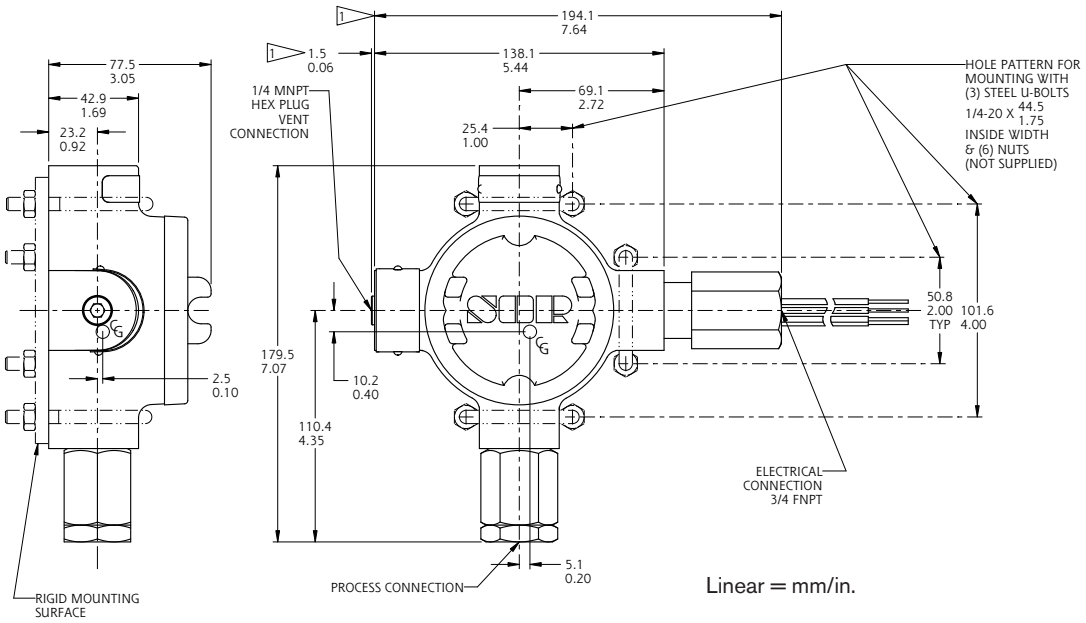
Dimensions in this catalog are for reference only. They may be changed without notice. Contact the factory for certified drawings for a particular model number.



Drawing 8923114

Designator: N6

Piston Numbers 4, 54

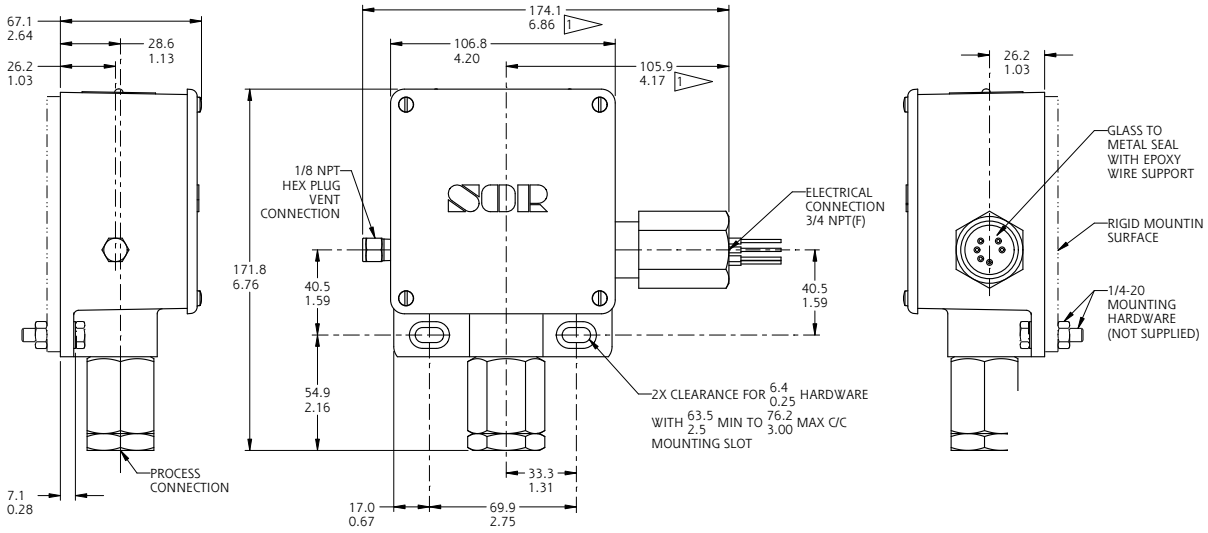


Drawing 8923110

Designator: TA

Piston Numbers 5, 6, 9, 29

Dimensions in this catalog are for reference only. They may be changed without notice. Contact the factory for certified drawings for a particular model number.



Linear = mm/in.

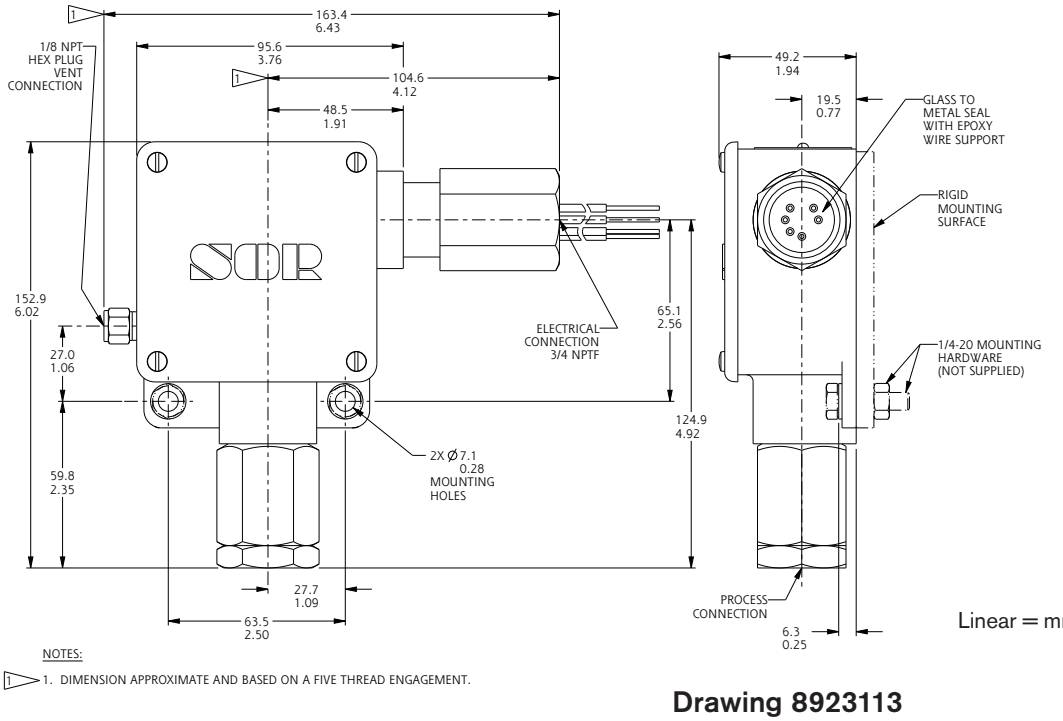
NOTES:

1. DIMENSION APPROXIMATE AND BASED ON A FIVE THREAD ENGAGEMENT

Drawing 8923116

Designator: RT

Piston Numbers 5, 6, 9, 29



Linear = mm/in.

NOTES:

1. DIMENSION APPROXIMATE AND BASED ON A FIVE THREAD ENGAGEMENT.

Drawing 8923113

Designator: N6

Piston Numbers 5, 6, 9, 29

Dimensions in this catalog are for reference only. They may be changed without notice. Contact the factory for certified drawings for a particular model number.

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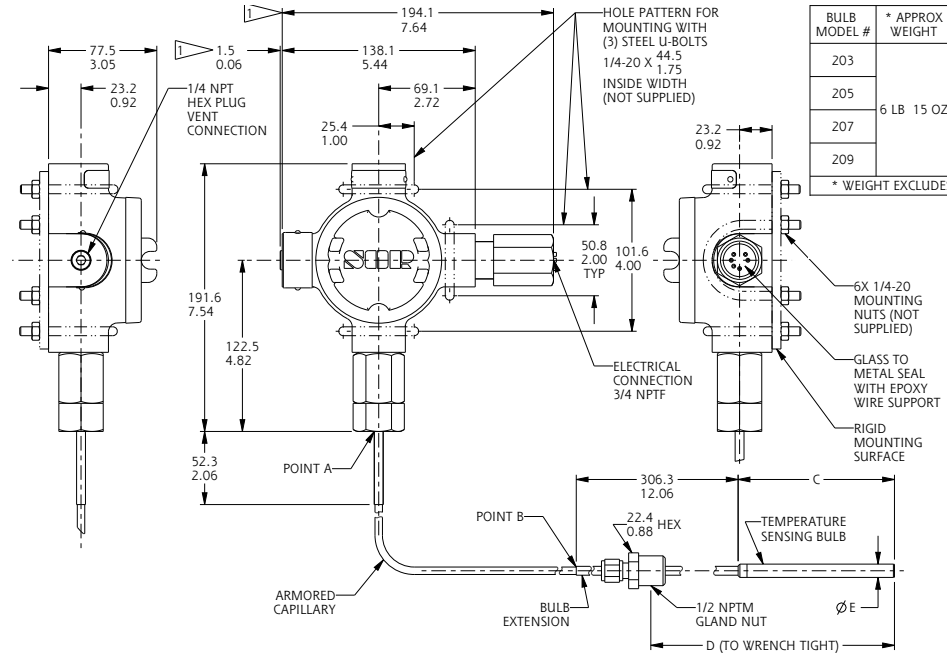


BULB MODEL #	* APPROX WEIGHT	LENGTH A-B	LENGTH C	LENGTH D	ØE
203	6 LB 15 OZ	1829 72	112.0 4.41	125.7 4.95 TO 381.8 15.03	9.7 0.38
205		3048 120	124.7 4.91	138.4 5.45 TO 394.5 15.53	
207		4572 180	162.8 6.41	176.5 6.95 TO 432.6 17.03	
209		6096 240	194.6 7.66	208.3 8.20 TO 464.3 18.28	

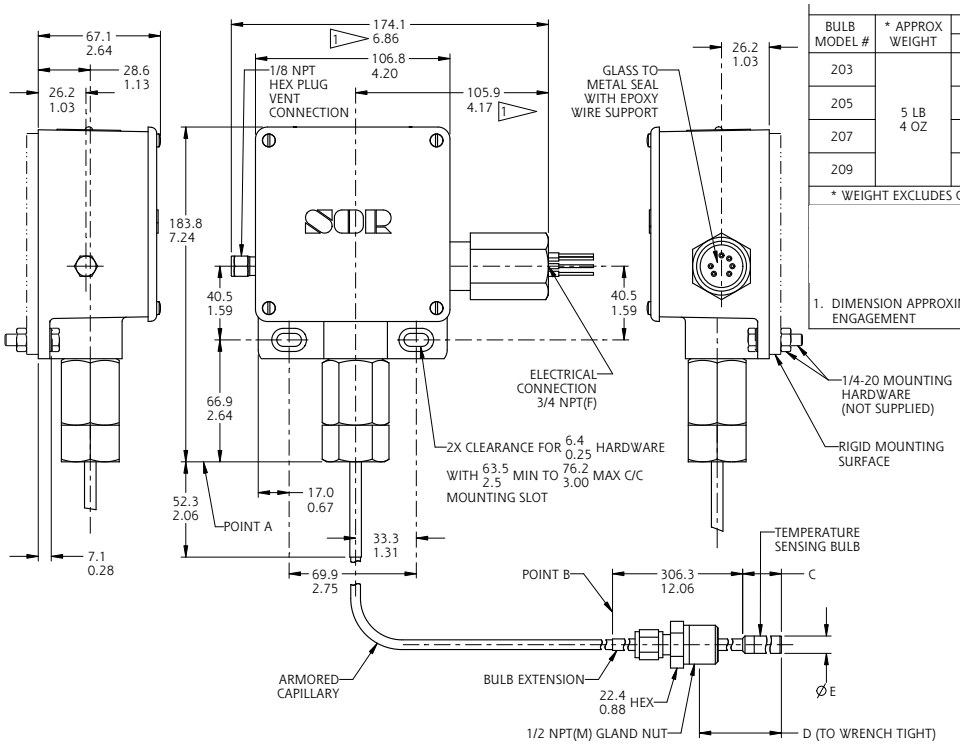
* WEIGHT EXCLUDES CAPILLARY, BULB AND EXTERNAL WIRE LEADS

NOTES:

1. DIMENSION APPROXIMATE AND BASED ON A FIVE THREAD ENGAGEMENT.

Drawing 8923124

Designator: TA Remote Temperature Switch



BULB MODEL #	* APPROX WEIGHT	LENGTH A-B	LENGTH C	LENGTH D	ØE
203	5 LB 4 OZ	1829 72	112.0 4.41	125.7 4.95 TO 381.8 15.03	9.7 0.38
205		3048 120	124.7 4.91	138.4 5.45 TO 394.5 15.53	
207		4572 180	162.8 6.41	176.5 6.95 TO 432.6 17.03	
209		6096 240	194.6 7.66	208.3 8.20 TO 464.3 18.28	

* WEIGHT EXCLUDES CAPILLARY, BULB AND EXTERNAL WIRE LEADS

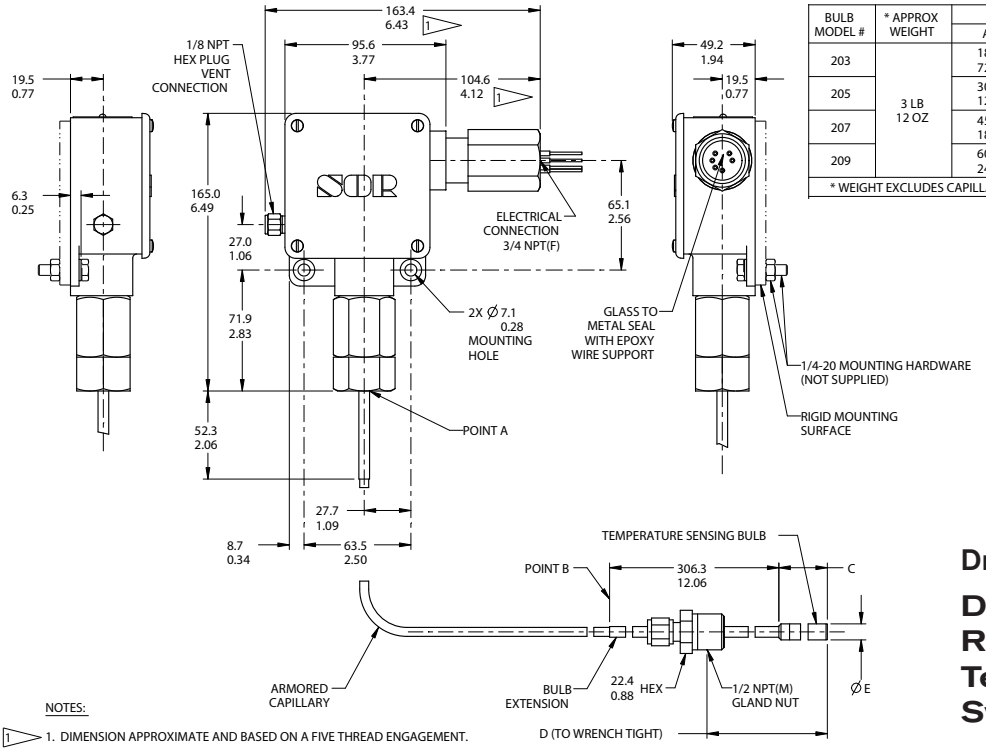
1. DIMENSION APPROXIMATE AND BASED ON A FIVE THREAD ENGAGEMENT

Linear = mm/in.

Drawing 8923126

Designator: RT Remote Temperature Switch

Dimensions in this catalog are for reference only. They may be changed without notice. Contact the factory for certified drawings for a particular model number.



BULB MODEL #	* APPROX WEIGHT	LENGTH A-B	LENGTH C	LENGTH D	Ø E
203	3 LB 12 OZ	1829 72	112.0 4.41	125.7 4.95 TO 381.8 15.03	9.7 0.38
205		3048 120	124.7 4.91	138.4 5.45 TO 394.5 15.53	
207		4572 180	162.8 6.41	176.5 6.95 TO 432.6 17.03	
209		6096 240	194.6 7.66	208.3 8.20 TO 464.3 18.28	

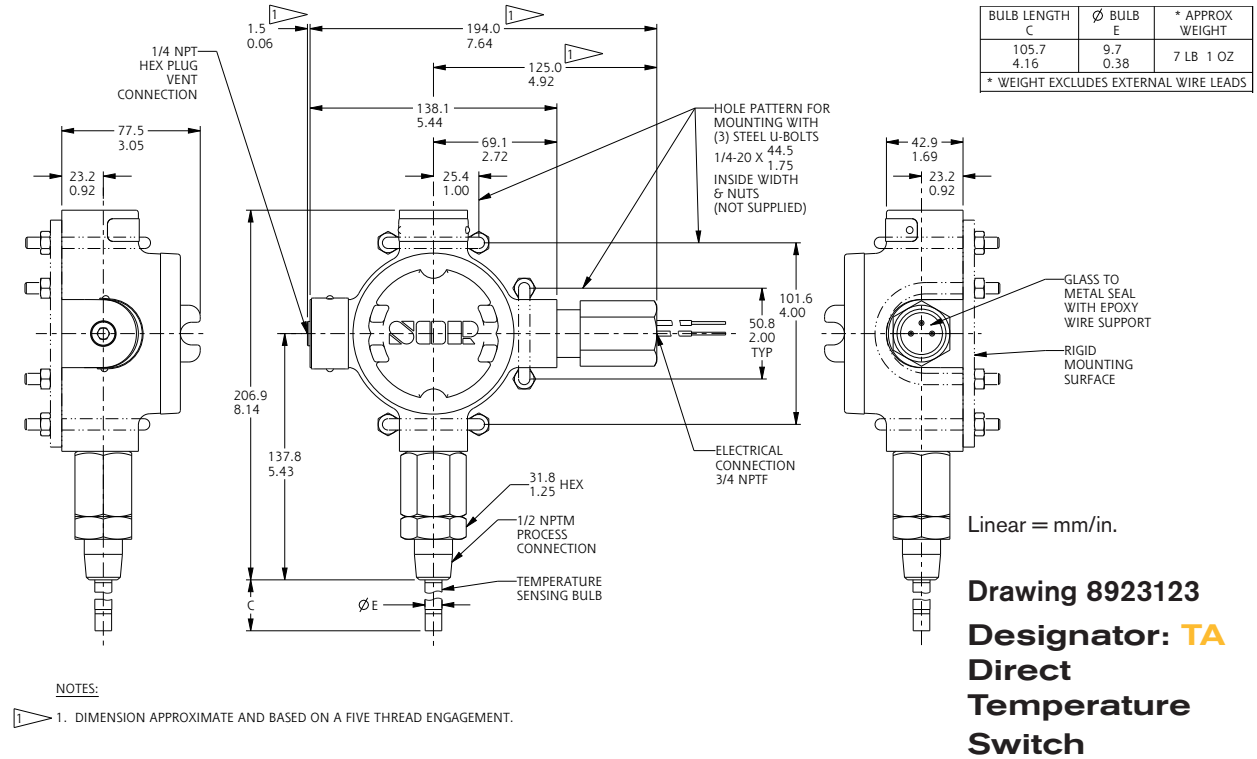
* WEIGHT EXCLUDES CAPILLARY, BULB AND EXTERNAL WIRE LEADS

NOTES:

1. DIMENSION APPROXIMATE AND BASED ON A FIVE THREAD ENGAGEMENT.

Drawing 8923122

Designator: N6 Remote Temperature Switch



BULB LENGTH C	Ø BULB E	* APPROX WEIGHT
105.7 4.16	9.7 0.38	7 LB 1 OZ

* WEIGHT EXCLUDES EXTERNAL WIRE LEADS

Linear = mm/in.

NOTES:

1. DIMENSION APPROXIMATE AND BASED ON A FIVE THREAD ENGAGEMENT.

Drawing 8923123

Designator: TA Direct Temperature Switch

Dimensions in this catalog are for reference only. They may be changed without notice. Contact the factory for certified drawings for a particular model number.

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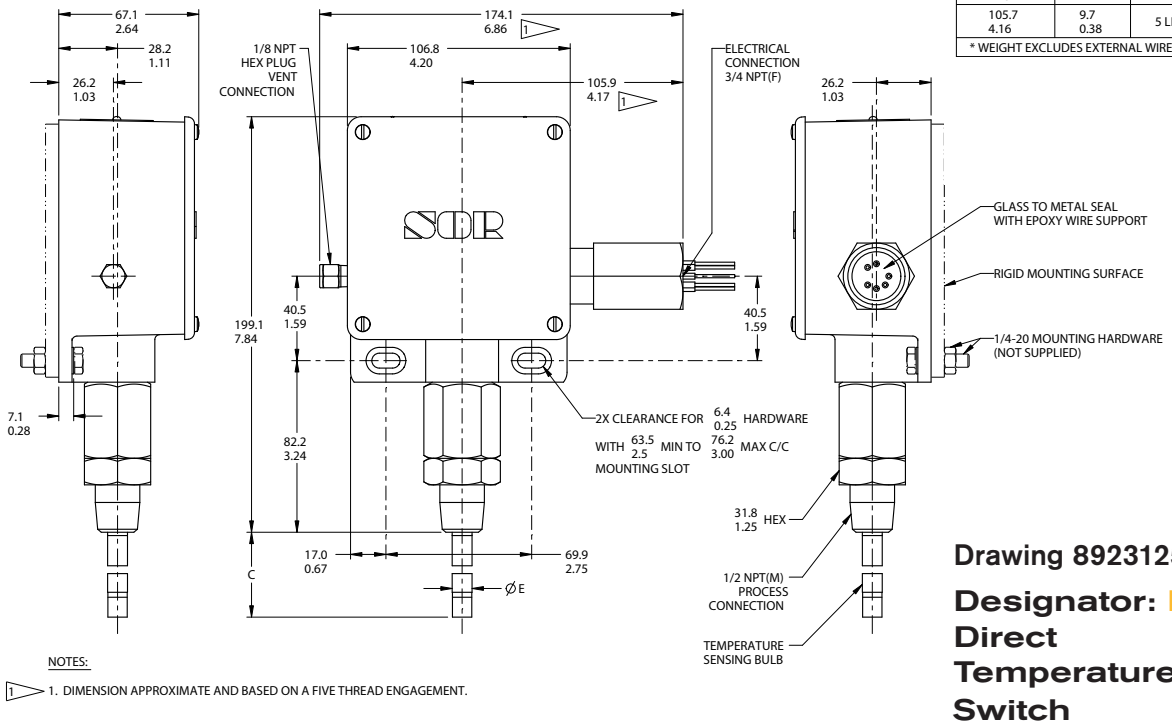
BULB LENGTH C	Ø BULB E	* APPROXIMATE WEIGHT
105.7 4.16	9.7 0.38	5 LB 6 OZ
* WEIGHT EXCLUDES EXTERNAL WIRE LEADS		



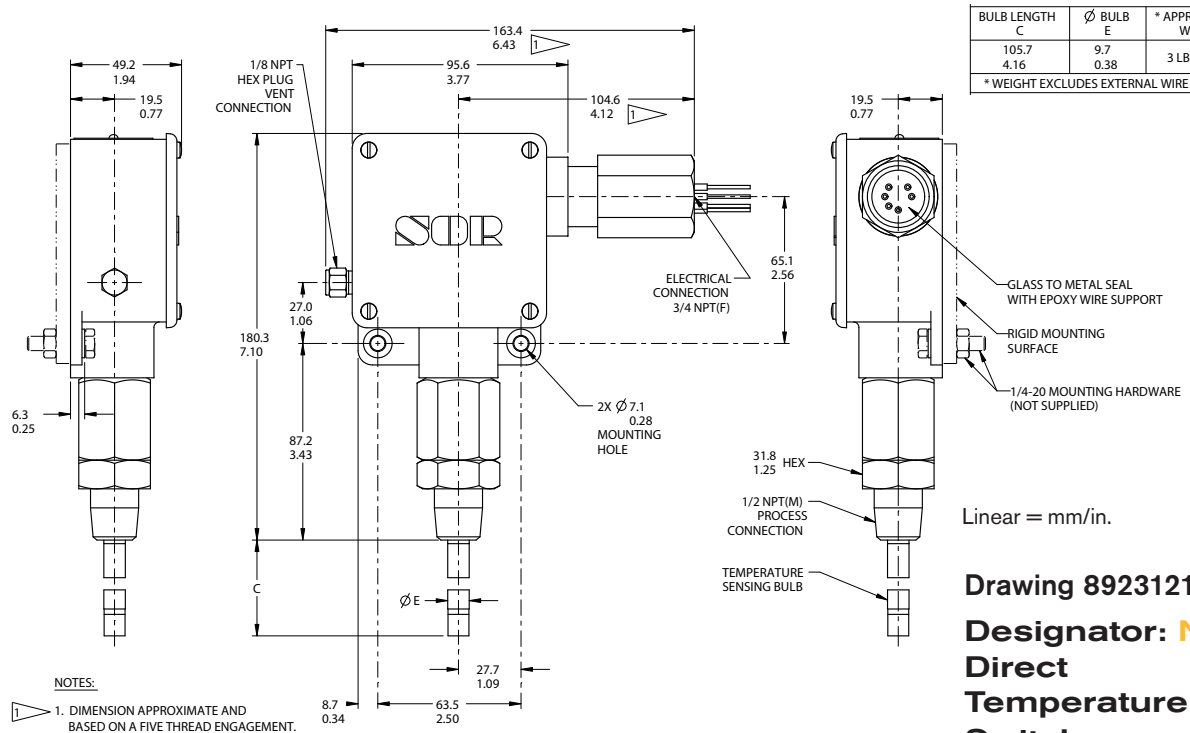
NOTES:

1. DIMENSION APPROXIMATE AND BASED ON A FIVE THREAD ENGAGEMENT.

Drawing 8923125

Designator: RT Direct Temperature Switch

BULB LENGTH C	Ø BULB E	* APPROXIMATE WEIGHT
105.7 4.16	9.7 0.38	3 LB 14 OZ
* WEIGHT EXCLUDES EXTERNAL WIRE LEADS		



NOTES:

1. DIMENSION APPROXIMATE AND BASED ON A FIVE THREAD ENGAGEMENT.

Linear = mm/in.

Drawing 8923121

Designator: N6 Direct Temperature Switch

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SOR Inc. | Lenexa, KS USA | 913-888-2630 | Fax 913-888-0767 | **SORInc.com**

REGIONAL OFFICES

China

SOR China | Beijing, China | china@SORInc.com
+86 10 5820 8767 | Fax +86 10 5820 8770

Middle East

SOR Measurement & Control Equipment Trading DMCC | Dubai, UAE
middleeast@SORInc.com | +971 4 278 9632 | Fax +1 913 312 3596

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