ASCOb pressure and temperature radiation resistant construction switches are designed to be used outside the containment area of nuclear power plants to monitor pressure and temperature. Selection of the proper pressure/temperature switch for a specific application is of paramount importance. This engineering information section describes principles of operation, types of switches, types of enclosures, and materials to assist in the proper selection.

I. Principle of Operation
The pressure/temperature switch will control electrical circuits in response to changes in pressure or temperature.

The pressure transducers are generally of the diaphragm piston type pressure sensor. The exceptions are in the higher pressure ranges, which use a piston with an o-ring seal. The piston defines the area that the pressure is applied to, converting the pressure to a mechanical force.

The temperature transducer is also a diaphragm piston type pressure sensor converting pressure to a mechanical force. The internal pressure is the vapor pressure of a chemical in a contained volume that is in direct relation to the temperature.

The switch incorporates an adjustable spring force that opposes the transducer piston force. When the transducer force is greater than the spring force, the piston rod mechanism moves to operate an electrical snap switch. When the transducer force is less than the spring force the piston rod mechanism moves to restore the electrical snap switch to the normal position.

The switch units incorporate a unique ASCO TRI-POINT® balance plate and operates on an alternating fulcrum principle. This converts a single motion/force of a transducer piston to a two-step motion controlling one or more electrical snap switches. The spring forces of the two-step motion are independent of each other.

II. Types of Switch Units
There are three types of switch units: adjustable deadband, fixed deadband, and two-stage fixed deadband.

The adjustable deadband (SA) model has one electrical snap switch with two separate independent adjusting nuts to set the trip point on increasing pressure/temperature signal and the reset trip point on decreasing pressure/temperature signal over the range of the switch.

The fixed deadband (SB) model has one electrical snap switch with one adjusting nut to set the trip point over the full range of the switch. The reset trip point is fixed relative to the set point and cannot be adjusted.

The two-stage (SC) model has two electrical snap switches with independent adjustment by two separate adjusting nuts. Each may set the trip point over the full range of the switch. The reset point of each electrical snap switch is fixed with respect to the set point for that switch.

III. Electrical Enclosure
All pressure/temperature switches in this catalog are supplied with either a watertight or combination explosionproof/watertight electrical enclosure to withstand the environmental conditions of a Loss of Coolant Accident and Main Steam Line Break. Watertight models have a deep drawn aluminum cover secured by locking tabs and screws. Explosionproof/watertight models have a die cast aluminum cover that threads onto the body. Both enclosures have two 3/4” NPT conduit hubs for wiring.

Two types of electrical enclosures are available to satisfy the following (NEMA) classifications:

Watertight Types 3, 3S, 4

Explosionproof/Watertight Types 3, 3S, 4, 4x, 7, and 9

ASCO’s qualification has not included simulation of any outdoor or explosive atmosphere conditions.

Connections to the switch should be such that any accumulated moisture or LOCA spray will not run into the enclosure. During qualification testing, wiring was run through conduit to a vented electrical junction box located outside the test chamber. (Wiring must comply with all applicable electrical codes).

IV. Transducer Construction
Pressure Internal parts in contact with the fluid are comprised of a pipe fitting (process connection) and elastomer or metallic diaphragm. The pipe fitting is available in aluminum, brass, stainless steel type 303 or 316 in both 1/4” and 1/2” NPT. Diaphragms are available in Viton/fluoroelastomer, ethylene propylene, or 316 stainless steel. Temperature Transducers are available with a direct mount or a remote-probe 316 stainless steel sensing bulb. The direct mount is a 4” long bulb with an integral 1/2” NPT connection for direct mounting to the process. The remote probe is a 3/8” OD probe at the end of a 6’- 80’ stainless steel armored capillary.

V. Definitions & Terminology
Accuracy is the maximum deviation from the base set point under specified operating conditions. The value given by ASCO includes all the qualification life conditions. Accuracy is specified as a percent or the upper limit of the adjustable operating range.

Repeatability is the closeness of agreement among a number of consecutive measurements of output, for the same value of input, under the same operating conditions approaching from the same direction. Repeatability is specified as a percent of the upper limit of the adjustable operating range.

Deadband is the difference between the set point and reset point readings either increasing or decreasing. The values in this catalog are nominal, representative of the deadbands of units at the middle of the range.

Separation (on the two stage unit) is the minimum difference between the two set points increasing or two set points decreasing that may be set.

Proof Pressure or Rated Overrange Temperature is the sensing maximum medium value that a device can be subjected to for extended periods of time without changes to its operating characteristics. Adjustable Operating Range is the set point limits between which the instrument can be adjusted to operate.
ASCO® Pressure and Temperature Switches

IEEE Qualified Switches for Pressures to 8000 psig, Vacuum, Differential or Level Control; Temperature Switches from -30˚ F through 510˚ F (-32˚ C through 265˚ C), with Watertight or Explosionproof Enclosures.

Photos (left to right): Pressure Switches with watertight and explosionproof housing. Temperature Switches (capillary and bulb), with watertight and explosionproof housing.

General Description
Pressure and temperature switches for Class 1E service are modified versions of the industrial ASCO TRI-POINT product line. Special features include radiation resistance and high-temperature construction. Class 1E switches are available only as factory assembled units consisting of a single switch and transducer assembly, factory set at operating points, and tested as a single unit before shipping from ASCO.

Applications
ASCO TRI-POINT pressure and temperature switches are available for safety-related (Class 1E) applications outside containment in nuclear power plants. They are also suitable for the less stringent balance-of-plant requirements.

Test Program
The Qualification Test Program consists of subjecting representative units to the following tests:

- **Thermal Aging** Short-term representation of an installed life.
- **Radiation Aging** Exposure to gamma radiation.
- **Wear Aging** Operating cycle testing at full electrical load.
- **Vibration Endurance** Exposure to low-level multiaxial vibration simulating installed condition.
- **Accident Simulation** Operating basis and design basis events — including both seismic shaker testing and high-level radiation dosage.
- **Environmental Simulation** Exposure to high temperature and humidity.

Qualification
The ASCO Qualification Specification (AQS-21623) has been prepared in order to provide generic qualification of pressure and temperature switches. It is based on the suggestions and requirements of IEEE 323-1974—“IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations” and IEEE 344-1975—“IEEE Recommended Practices for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations.”

The current ASCO qualification reports are:
- AQR-101083/Rev. 1 - pressure switch
- AQR-020184/Rev. 1 - temperature switch

Operation
Pressure Switches
When pressure is applied to the transducer it is converted into movement of the piston. This piston movement is then used to control the operation of the electrical snap action switch(es) in the switch unit.

Temperature Switches
Temperature sensed by the bulb creates an internal pressure within the transducer. This pressure is then converted into movement of the piston. This piston movement is then used to control the operation of the electrical snap action switch(es) in the switch unit.

Features
- Set point repeatability of ± 3% of operating range.
- Accuracy of ± 10% of operating range for qualified life of the unit.
- Choice of watertight or explosionproof enclosures.
- Mounts in any position.
- Visual adjustment scales of pressure switches in psi and bars; of temperature switches in °F and °C.
- External adjusting nuts.
- Separate electrical, pressure, and adjusting chambers.
- Wide selection of pressure switch transducer wetted material suitable for air, water, oil, or corrosive fluids.
- 316 stainless steel temperature switch transducers available in direct-mount or armored capillary and bulb in standard 6 and 12 foot lengths, and optional lengths to 80 feet.
Switch/Transducer
ASCO® qualified switch units incorporate the unique ASCO TRI-POINT® alternating fulcrum balance plate to control the operation of one or more electrical snap-action switches. Pressure switch transducer units incorporate a diaphragm piston-type pressure sensor.

Temperature transducer units use a vapor pressure principle where the internal pressure within the unit is generated by the vapor pressure of a chemical within a sealed system. Switch and transducers (both pressure and temperature) are factory assembled and fully tested and supplied as a complete switch and transducer unit only.

Specifications:
Types of Operation: Adjustable deadband, fixed deadband, and two-stage fixed deadband
Pressure Switches: Vacuum to 30" Hg, pressure levels to 8000 psig.

Process Connection: 1/4" NPT, optional 1/2" NPT.
Temperature Switches: Temperature ranges -30°F to 510°F (-32°C to 265°C).
Process Connection: Direct-mount 316 stainless steel probe or remote-mount 316 stainless steel armored capillary.
Electrical: Standard: 5 amp, 250 VAC switch; Optional: 10 amp, 125 VDC switch.
Types of Enclosures: Watertight or Explosionproof/Watertight.

Standard Electrical Ratings
SA, SB, SC Series
5 Amp Res., 125, 250 VAC
1/8 HP 125 VAC
1/4 HP 250 VAC
1/2 Amp Res., 125 VDC
1/4 Amp Res., 250 VDC

Optional High DC Rated Switches
(See optional features page 39)
10 Amp Res., 125 VAC or VDC
1/8 Horsepower, 125 VAC or VDC

Environment of Service Conditions
Temp: 50°F to 104°F (10°C to 40°C)
Fluid: Pressure Switches—
Ethylene propylene diaphragm:
-4°F to 180°F (-20°C to 82°C)
Viton/fluoroelastomer diaphragm:
-4°F to 250°F (-20°C to 121°C)
316 S.S. diaphragm:
-50°F to 300°F (-45°C to 149°C)
Fluid: Temperature Switches—See specification table for rated overrange temperature.

Dimensions (inches)
### Pressure, Vacuum and Differential Switches

#### Adjusted Deadband

<table>
<thead>
<tr>
<th>Adjustable Operating Range</th>
<th>Proof Pressure</th>
<th>Maximum Mid-Range °F</th>
<th>Watertight Enclosure</th>
<th>Explosionproof Enclosure</th>
<th>Adjustable Deadband</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 25° W.C.</td>
<td>25</td>
<td>2.5° W.C.</td>
<td>SB31AR</td>
<td>SB31BR</td>
<td>TA31BR</td>
</tr>
<tr>
<td>0 - 50° W.C.</td>
<td>50</td>
<td>5° W.C.</td>
<td>SB31AR</td>
<td>SB31BR</td>
<td>TA31BR</td>
</tr>
<tr>
<td>0 - 100° W.C.</td>
<td>100</td>
<td>10° W.C.</td>
<td>SB31AR</td>
<td>SB31BR</td>
<td>TA31BR</td>
</tr>
<tr>
<td>25 - 400° W.C.</td>
<td>40</td>
<td>10° W.C.</td>
<td>SB31AR</td>
<td>SB31BR</td>
<td>TA31BR</td>
</tr>
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</table>

#### Fixed Deadband

<table>
<thead>
<tr>
<th>Adjustable Operating Range</th>
<th>Proof Pressure</th>
<th>Maximum Mid-Range °F</th>
<th>Watertight Enclosure</th>
<th>Explosionproof Enclosure</th>
<th>Adjustable Deadband</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 25° W.C.</td>
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<td>2.5° W.C.</td>
<td>SB31AR</td>
<td>SB31BR</td>
<td>TA31BR</td>
</tr>
<tr>
<td>0 - 50° W.C.</td>
<td>50</td>
<td>5° W.C.</td>
<td>SB31AR</td>
<td>SB31BR</td>
<td>TA31BR</td>
</tr>
<tr>
<td>0 - 100° W.C.</td>
<td>100</td>
<td>10° W.C.</td>
<td>SB31AR</td>
<td>SB31BR</td>
<td>TA31BR</td>
</tr>
<tr>
<td>25 - 400° W.C.</td>
<td>40</td>
<td>10° W.C.</td>
<td>SB31AR</td>
<td>SB31BR</td>
<td>TA31BR</td>
</tr>
</tbody>
</table>

#### Two-Stage Fixed Deadband

<table>
<thead>
<tr>
<th>Adjustable Operating Range</th>
<th>Proof Pressure</th>
<th>Maximum Mid-Range °F</th>
<th>Watertight Enclosure</th>
<th>Explosionproof Enclosure</th>
<th>Adjustable Deadband</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 25° W.C.</td>
<td>25</td>
<td>2.5° W.C.</td>
<td>SB31AR</td>
<td>SB31BR</td>
<td>TA31BR</td>
</tr>
<tr>
<td>0 - 50° W.C.</td>
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<td>5° W.C.</td>
<td>SB31AR</td>
<td>SB31BR</td>
<td>TA31BR</td>
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<tr>
<td>0 - 100° W.C.</td>
<td>100</td>
<td>10° W.C.</td>
<td>SB31AR</td>
<td>SB31BR</td>
<td>TA31BR</td>
</tr>
<tr>
<td>25 - 400° W.C.</td>
<td>40</td>
<td>10° W.C.</td>
<td>SB31AR</td>
<td>SB31BR</td>
<td>TA31BR</td>
</tr>
</tbody>
</table>

### Temperature Transducers

#### Specifications

<table>
<thead>
<tr>
<th>Adjustable Operating Range</th>
<th>Rated Overrange Temperature °F</th>
<th>Adjustable Deadband</th>
<th>Fixed Deadband</th>
<th>Two-Stage Fixed Deadband</th>
<th>Temperature Transducers</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 60° F</td>
<td>60</td>
<td>3.8</td>
<td>SB11AR</td>
<td>SB12BR</td>
<td>TA11BR</td>
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<tr>
<td>60 - 300° F</td>
<td>300</td>
<td>10</td>
<td>TA12BR</td>
<td>TB12BR</td>
<td>-</td>
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</table>

#### Adjustable Deadband

<table>
<thead>
<tr>
<th>Adjustable Operating Range</th>
<th>Rated Overrange Temperature °F</th>
<th>Adjustable Deadband</th>
<th>Separation Deadband</th>
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</thead>
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<tr>
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<td>3.8</td>
<td>5</td>
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<tr>
<td>60 - 300° F</td>
<td>300</td>
<td>10</td>
<td>10</td>
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</tbody>
</table>

### Pressure, Vacuum, and Differential Transducers

<table>
<thead>
<tr>
<th>Stainless Steel</th>
<th>316 SS</th>
<th>316 SS (SA)</th>
<th>All 316 SS **</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5 - 25° W.C.</td>
<td>25</td>
<td>TA31BR</td>
<td>TA31BR</td>
</tr>
<tr>
<td>0.5 - 250° W.C.</td>
<td>250</td>
<td>TA31BR</td>
<td>TA31BR</td>
</tr>
</tbody>
</table>

**NOTE:** ASCO stainless steel & EPDM or stainless steel & Viton® transducers are only available in transducer construction listed in table. For other special transducer materials contact ASCO.

**For all 316 stainless steel construction increase deadband by 50%.

† Deadband values are nominal.