Process Instrumentation

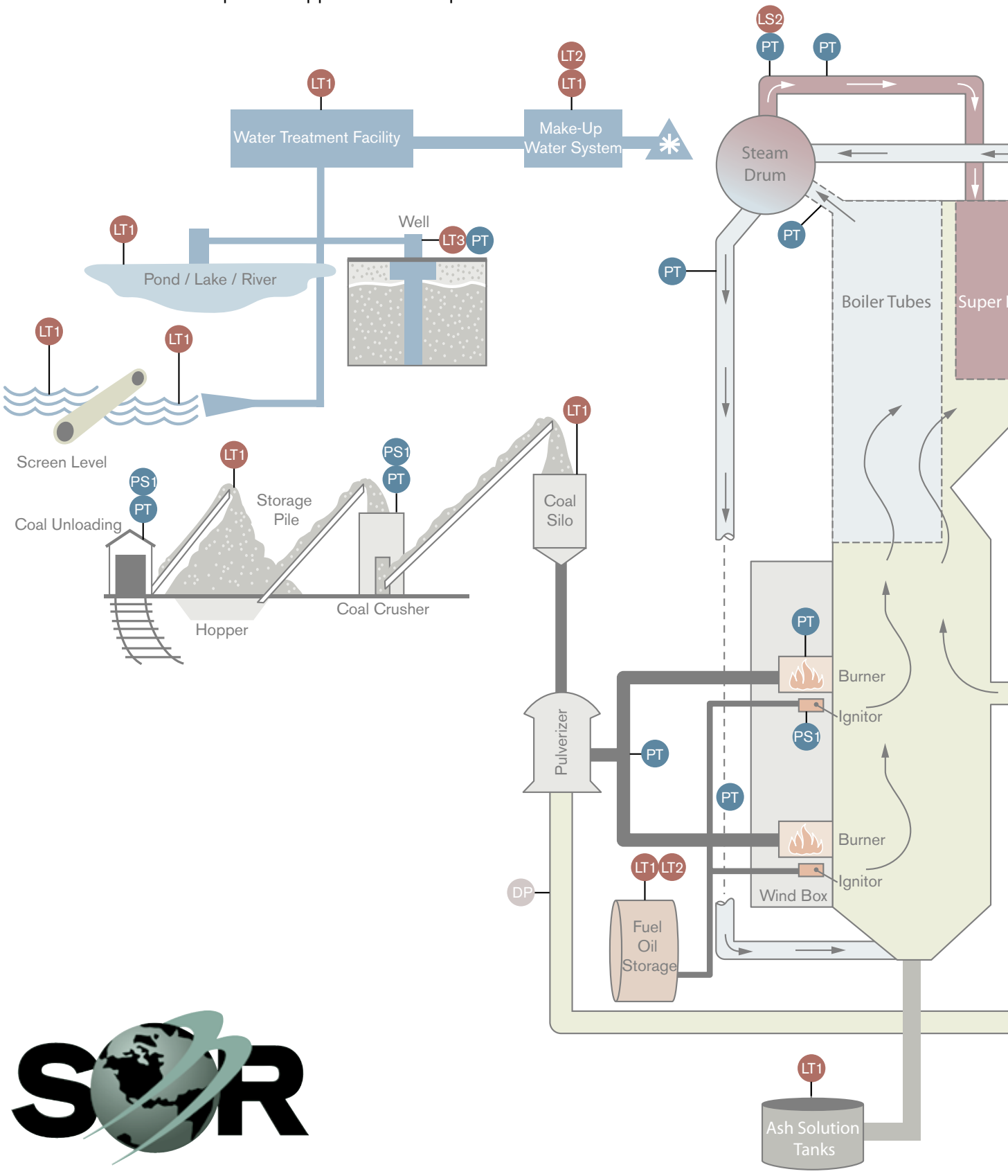
Power Generation

Product Application Notes

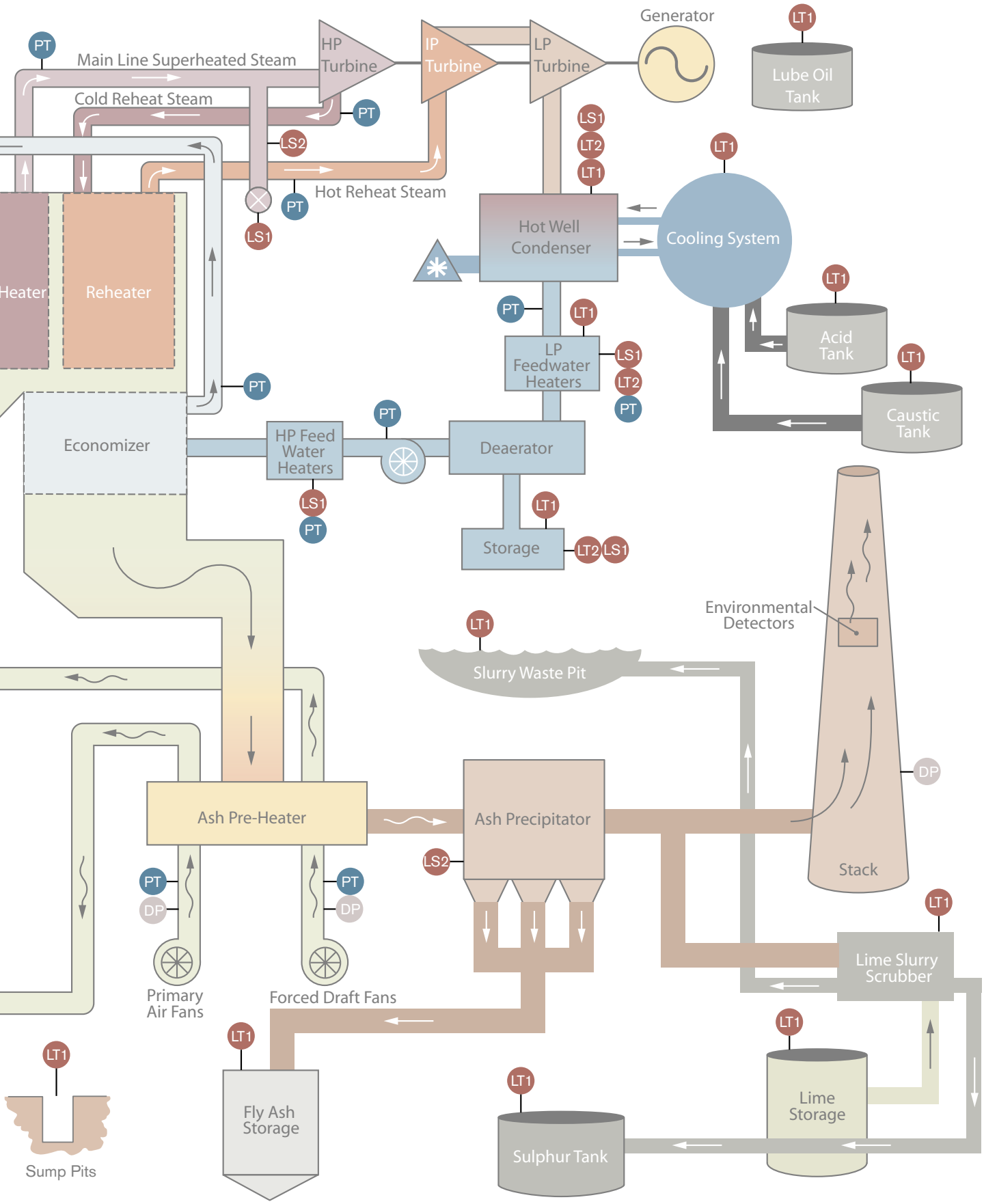
Typical

Coal-Fired Steam Power Plant

Refer to table on left for product application descriptions.



Process Instrumentation


Generator
LT1
Lube Oil Tank
PT
Main Line Superheated Steam
HP Turbine
IP Turbine
LP Turbine
Cold Reheat Steam
PT
LS2
LS1
LT2
LT1
Hot Reheat Steam
PT
LS1
Heater
Reheater
Hot Well Condenser
Cooling System
LT1
PT
LT1
LP Feedwater Heaters
LS1
LT2
PT
Acid Tank
LT1
Caustic Tank
PT
Economizer
HP Feed Water Heaters
PT
Deaerator
LS1
PT
LT1
Storage
LT2
LS1
Environmental Detectors
LT1
Slurry Waste Pit
DP
Stack
Ash Pre-Heater
Ash Precipitator
LS2
PT
DP
PT
DP
LT1
Lime Slurry Scrubber
Primary Air Fans
Forced Draft Fans
LT1
Fly Ash Storage
LT1
Sump Pits
LT1
Sulphur Tank
LT1
Lime Storage

	LS1	LS2	LT1	LT2	LT3	PS1	PT	DP
Instrumentation	Sealed Chamber Float Switches	Condensate Chamber Float Switches and Steam Trap	echOsonix®	RF Transmitter	Submersible Transmitter	Weatherproof, Explosion Proof (pressure, vacuum, compound) Switch	Mini-Hermet Explosion Proof, Adjustable Transmitter	Differential Pressure
Product Features	5-year warranty Temperatures to 1200°F (649°C) ANSI B31.1 construction	5-year warranty Temperatures to 1200°F (649°C) ANSI B31.1 construction	1-year warranty Installation flexibility Immune to steam, condensate, foam, dust	3-year warranty Loop powered Installation flexibility	1-year warranty Loop powered Low cost	3-year warranty Adjustable set point Environmentally sealed contacts	3-year warranty Loop powered 5:1 turndown 4-20 mA output	3-year warranty Low cost Differential ranges down to 12 in. w.c.
Air/Ignition System			Fuel oil storage level Form 1311	Fuel oil storage level			Monitors fuel flow between pulverizers and burners	Differential pressure devices monitor primary air flow
Coal System			Storage pile, conveyer control, coal silos Form 1309				Monitors high-pressure hydraulic or pneumatic coal unloading and crushing systems	
Environmental			Scrubber lime slurry, fly ash storage Forms 1312, 1086, & 1220	Ash levels inside precipitator				
Steam Generation	Feedwater heater high and low alarms	Steam drum safety shutdown		Dearator water storage level				
Steam System	Hotwell condenser level	Dripleg drain automation	Cooling tower Form 1106	Hotwell condenser level				
Water System			Pond/River level treatment plant cooling tower Forms 1310 & 1314	Make-up water system supply	Level transmitters monitor well level		Pressure transmitters monitor pump performance	
Form	912	912	1035	1100	1144	216, 455, 456	456	386, 388, 459, 468

Indicates an SOR® "Unique Solution"

Water Treatment

Boiler water must be pure to eliminate build-up in boiler tubes and on turbine blades causing loss of efficiency and potential damage to equipment and personnel. Power plant water treatment facilities feed pure water into a closed loop system where it is recycled indefinitely.

Various instruments are needed for the entire water treatment facility – please refer to the SOR Water Treatment Product Application Notes brochure for specifics of typical instrumentation.

Purified water flows from the treatment plant to the make-up water system, which feeds into the hotwell condenser, if required. This system is intended to replace expected losses, but proper water supply must be maintained.

Coal System

Raw coal is brought into the plant and unloaded into large storage piles. A coal crusher reduces pieces in size, then feeds into a silo that stores 8 to 12 hours of supply. Pulverizers then reduce the pieces to dust, mix it with primary air and send it to the boiler burners. Catastrophic accidents at power plants typically involve highly volatile coal dust, so explosion proof instrumentation is required in this area.

Air/Ignition

Boiler water is heated by burning pulverized coal and primary air. Oil fired igniters light coal burners which continuously supply heat to generate steam. Forced air is injected directly into the boiler. Combustion by-products and heat move through the boiler and into the environmental system, in continuous one-way flow.

Large fans force primary and draft air through the ductwork, providing a positive pressure flow. For proper operation and safety, this flow must be maintained. Heater controls on the air pre-heater must be monitored to ensure the correct temperatures.

Steam Generation

Low-pressure feedwater heaters use steam from the turbine to heat and pressurize water drawn from the hotwell condenser. A deaerator removes excess oxygen from the water before it flows through the high-pressure feedwater heaters and the boiler economizer. From there, water goes into the steam drum where steam is separated and drawn off to the superheater. The remaining water passes through the downcomer and into the bottom of the boiler tubes. Water returning from the tubes passes back into the steam drum where more steam is drawn off and the remaining water sent back through the boiler. The boiler is essentially a large convection oven with tube bundles for steam generation. It draws water in the bottom and sends it through tubes directly above the burners before going to the steam drum.

Feedwater heaters must be carefully monitored for pressure, temperature and level. Each successive heater has higher temperatures and pressures, so instrumentation must be selected for each specific heater's needs. The economizer is a group of boiler tubes set at the end of the heat path. It absorbs some of the unspent heat from boiler gases to pre-heat water moving to the steam drum. The line feeding from it to the steam drum must be monitored for pressure, temperature and flow.

The steam drum is a long cylinder with baffles to separate water and steam. After separation steam is drawn into the superheater. Water levels, pressure and temperature in the drum and its inlet/outlet lines must be monitored. Pressure instruments on the drum require either a pigtail siphon or diaphragm seal to protect from heat.

Steam System

From the steam drum, steam passes through the superheater and into the turbine, which converts the heat into mechanical energy. The conversion is done in three stages to use as much heat energy as possible. After steam leaves the turbine, it is condensed back to water and recirculated to the boiler.

Steam is drawn from the steam drum and sent to the superheater where pressure, temperature and flow must be monitored. Steam comes out dry and superheated, ready for the turbine. A dripleg is used on superheated steam lines to collect particles of moisture still present in the dry steam which can cause severe damage to the turbine. A level switch senses the liquid level and opens a dump valve.

The reheater takes spent steam from the high pressure (HP) turbine and superheats it again before it goes to the intermediate pressure (IP) turbine. Steam passes directly from the IP turbine to the low pressure (LP) turbine. The turbine, the most expensive and critical component of a power plant, converts heat in the steam to mechanical energy. The turbine shaft turns a generator at high speed to generate electricity.

Spent steam exits the LP end of the turbine and enters the hotwell condenser, where it is cooled and condensed into water. Make-up water is added at the hotwell when required. Cooling systems are typically circulating water, refrigerant or some combination of the two, and require temperature, level and sometimes pressure instrumentation.

Environmental System

By-products of combustion are ash, gases and heat wastes. The heat is dissipated through the cooling system, while the solids and gases are removed through the environmental system. Ash and solids that fall to the bottom of the boiler (bottom ash) are collected in a hopper and removed periodically. Fly ash is entrained in the exhaust flow and collected in the ash precipitator. Pressure and temperature transmitters used at the inlet and outlet of the precipitator protect against clogging and overheating.

Scrubbers are typically used to remove combustion gases by bubbling exhaust through lime slurry. Detectors inside the stack monitor performance of the environmental system for emissions reports to government agencies.

Power Generation

Each coal-fired power plant is unique and has varying instrumentation needs based on the equipment used, regional regulations, fuel, and other factors. This guide presents typical instrumentation in the major sections of a standard coal-fired power plant. Modern plants use many pumps, fans, valves, etc., which typically require instruments for monitoring and for safety shut downs or interlocks.

Fans

Fans must be kept operating properly, monitored for blockage, and equipped with safety shutdowns.

Pressure transmitters monitor for performance	Mini-Hermet Explosion Proof, Adjustable	•Loop powered •5:1 turndown
Draft switches are safety shutdowns	Explosion Proof/ Weatherproof (draft DP switch)	•Low cost •Differential ranges down to 12 in. w.c.

Valves

Instruments are used to sense the presence of liquid (flow) to verify valve operation.

RF switches detect pressure or absence of liquid	Single Point RF Switch	•Low cost •No moving parts

Lubrication Systems

All rotating equipment needs lubrication to avoid excess friction and damage. Lubrication systems typically include a reservoir which must be monitored for loss of lubrication and lube oil pressure.

Level switches monitor reservoirs	Tip Sensitive Ultrasonic Gap Switch	•Low cost •No calibration required
Pressure devices monitor lube oil pressure	Mini-Hermet Explosion Proof, Adjustable	•Loop powered •5:1 turndown
Pressure switches are safety shutdowns	Mechanical Switch	•Low cost •Adjustable set point with calibrated scale

Pumps

To avoid damage caused by cavitating pumps, input and output pressures must be monitored. Pumps also need safety shutdown or interlock instruments in case of loss of liquid.

Pressure transmitters monitor input and output pressures	Mini-Hermet Explosion Proof, Adjustable	•Loop powered •5:1 turndown
Pressure switches are safety shutdowns	Explosion Proof/ Weatherproof (pressure, vacuum)	•Adjustable differential for pump control
Flow switch (pump protection)	T21 Thermal Differential Switch	•Adjustable set point •Fast response

This brochure is intended to provide suggestions for the general application of certain types of instruments. Since each application has unique characteristics, it is recommended that you consult SOR to discuss the specific details of your application to ensure the correct instrument is selected.

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