TillQUIST

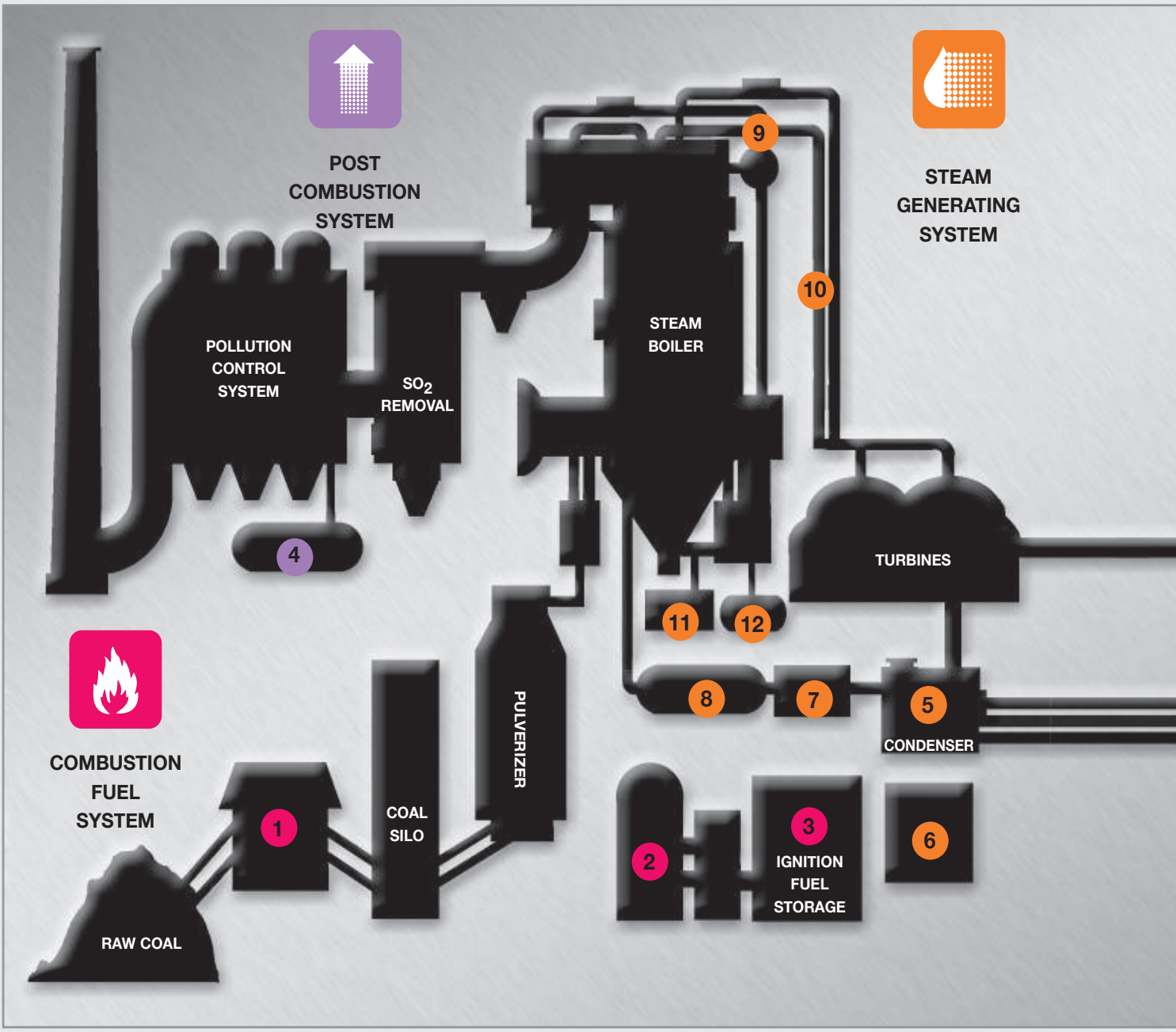
Magnetrol®

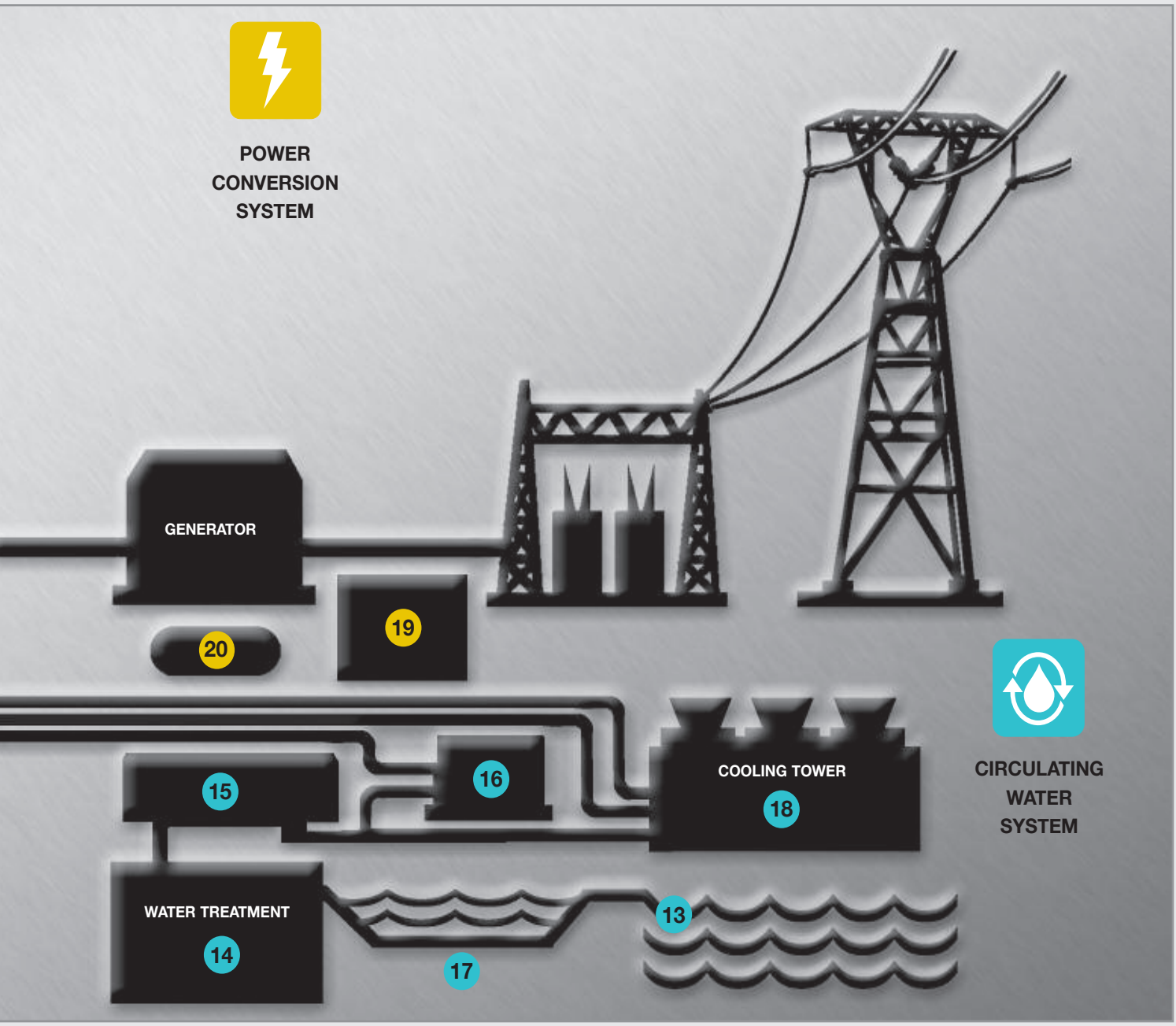
INDUSTRY APPLICATIONS SERIES

POWERGEN

A Guide to Level Instrumentation for Power Generating Plants

Level Controls in a Coal-Fueled Plant





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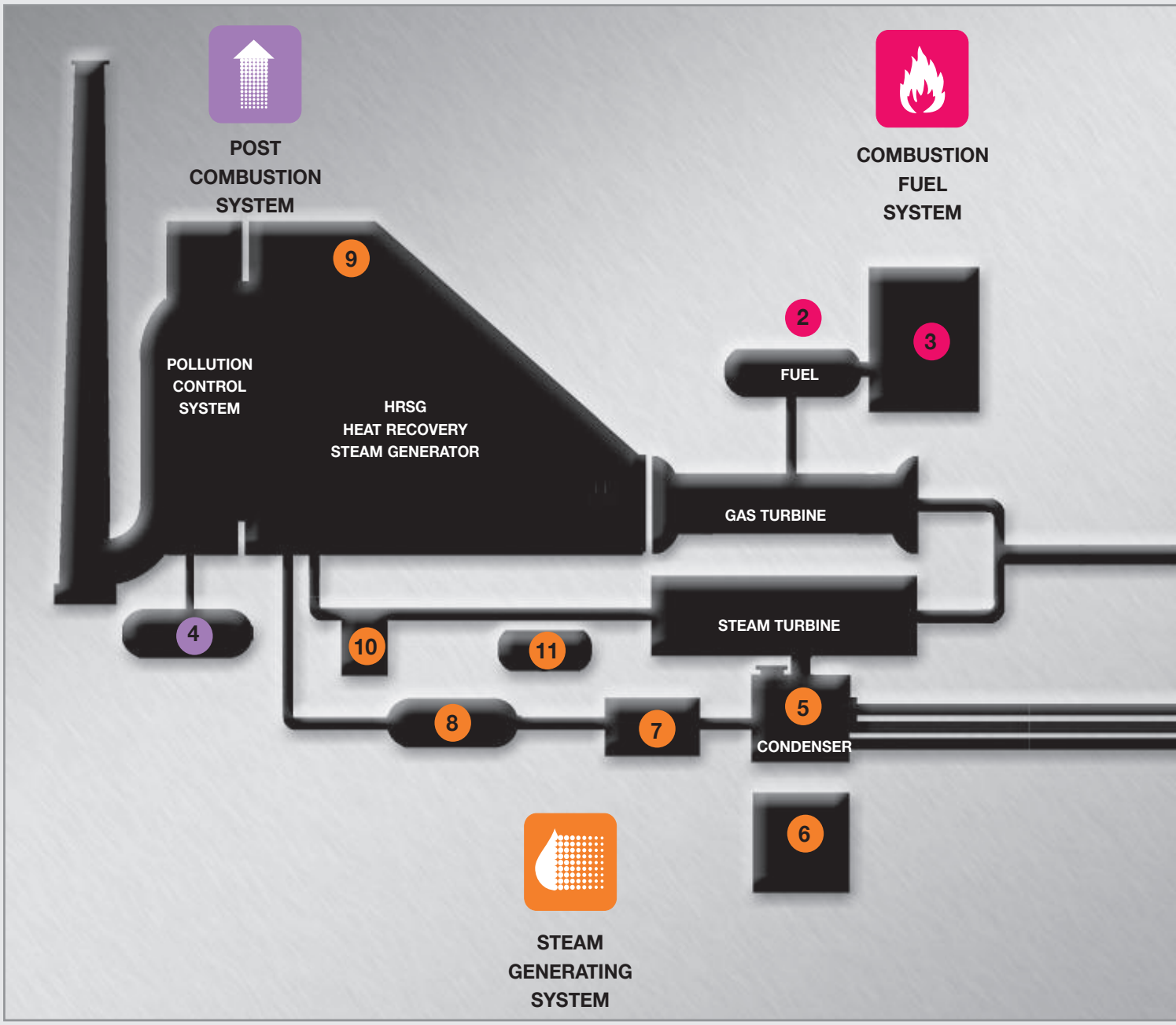
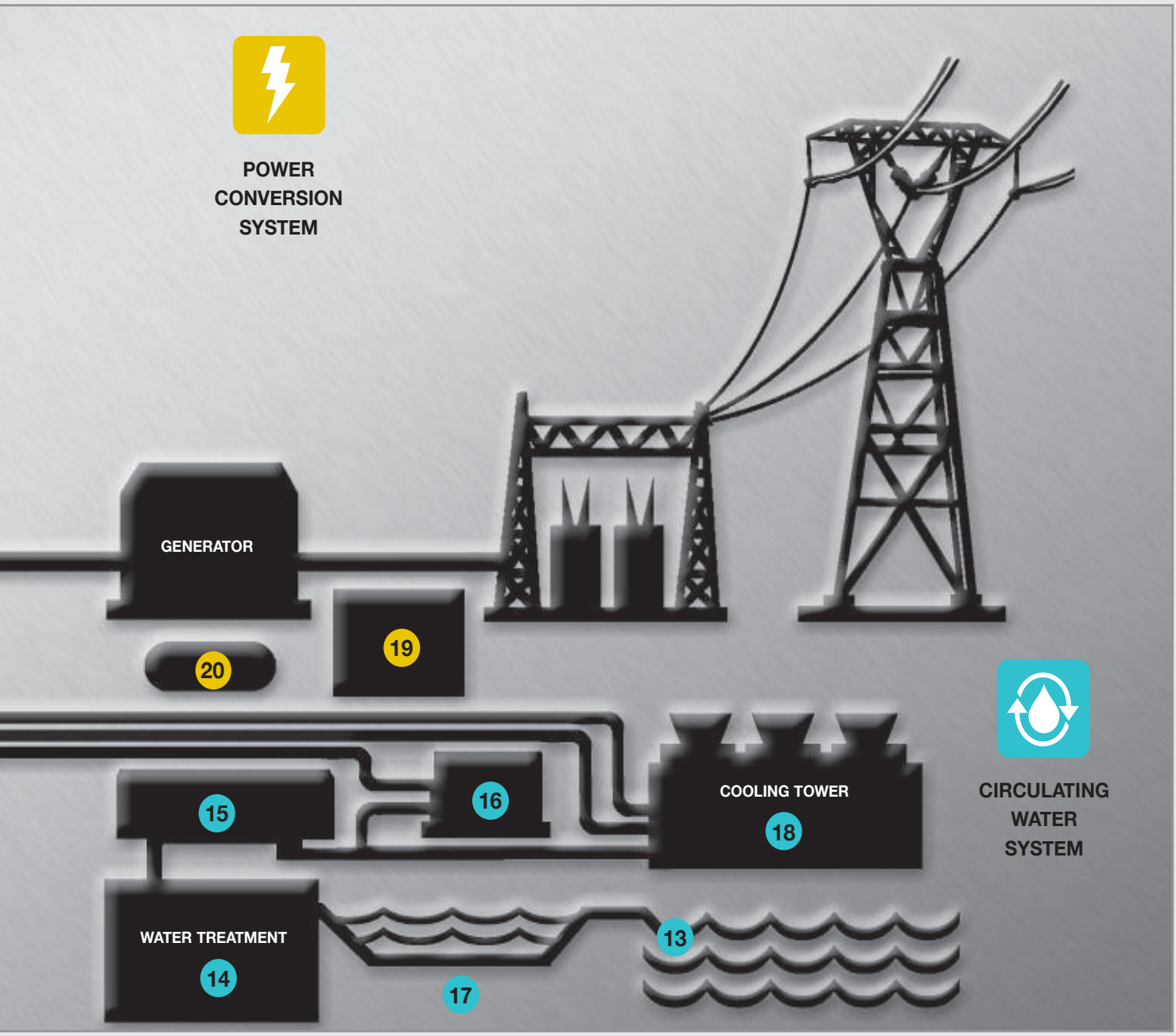
Please Note: The level instruments recommended in this guide are based on field experience with similar applications and are included as a general guide to level control selection. Because all applications differ, however, customers should determine suitability for their own purposes.

Level Controls in a Combined-Cycle Plant





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Magnetrol®

Level Controls for Power Generation since 1932.

One hundred years ago, electric power was over 20 cents a kilowatt-hour—more than twenty times today's cost. Back then electricity was used primarily in cities for lighting streets and powering streetcars. The cost of electric power was well beyond the means of most families. Even rudimentary appliances were absent from American homes.

But the 20th century brought *Power to the People* through improved power-generating technology. By century's end, affordable electricity was available to all Americans.

As the power industry matured, a Chicago company that first marketed its level controls for steam boilers in 1932 would grow along with it. The young firm would become Magnetrol® International, Incorporated, and its people would build a worldwide reputation for durable controls able to withstand the stresses that are routinely found in modern coal-fired or combined-cycle operations.

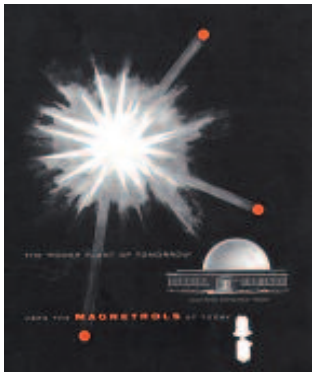
Today the power industry is evolving still further—from a highly regulated, monopolistic industry with traditionally structured electric utilities to a less regulated, competitive industry where rates will become more and more dynamic to reflect the cost of providing electrical service. Deregulation will also provide new impetus for improvements in power generation and allied technologies.

With its introduction of Eclipse® Guided Wave Radar in 1998, Magnetrol® has brought leading-edge level control to the power industry at reduced capital cost. Other recent innovations at MAGNETROL have advanced the abilities of ultrasonic, thermal dispersion and air sonar technologies to provide more accurate and reliable controls while reducing product operating costs by replacing electro-mechanical systems with electronic ones. Where application demands favor buoyancy level controls, advanced Modulevel® transmitters lead the industry. MAGNETROL has also re-invented visual indication technology with its founding of Orion Instruments® and the introduction of its Magnetic Level Indicators, or MLIs, in 2001.

The pages ahead serve as an introduction to MAGNETROL level sensing and control products for Power Gen applications. To empower your process with the leading edge, contact your MAGNETROL representative. ■

POWER PIONEER

Magnetrol® products were selected for Argonne National Laboratory's Boiling Water Reactor in the 1950s—one of the earliest experiments in Nuclear Power Generation.



Combustion Fuel • Circulating Water • Steam Generation • Particulate Removal • Power Generation

COAL YARD STORAGE

PLANT AREA:
Combustion Fuel

Application: Raw coal is delivered to a coal yard in aggregate pieces of approximately 6" that are later reduced in size by a crusher to approximately 1.5". Enclosed storage of crushed coal is common in frigid climates and where containment of coal dust is controlled to protect populated areas. Hoppers and silos store active and reserve crushed coal prior to its pulverization into the powdered form suitable for boiler combustion.

Challenges: Some severe power plant accidents in years past have been traced to coal dust ignition, and the atmospheres of contained coal storage areas are highly congested with explosive dust. For safe coal yard operation, explosion proof, air tight level instrumentation is absolutely essential.

INSTRUMENTATION

▲ **Point Level:**
Solitel® Vibrating Rod Level Switch available with an Extended Rigid Probe up to 100 inches (254 cm) or an Extended Flexible Probe up to 65 feet (20 meters)

NATURAL GAS SEPARATOR

PLANT AREA:
Combustion Fuel

Application: Natural gas separators remove solid particles and liquids from a continuous gas stream supply. Dust, dirt, sand and pipe scale as well as water, natural gas liquids and light hydrocarbons can be removed. In a typical system, an inlet separator allows particles and liquids to settle out and the gas to rise. The gas collects at the top of the separator where it is removed by means of a gas compressor. The collected particles and liquids are then dumped into a water tank.

Challenges: Liquid level control precisely modulates the amount of water that is drawn off to ensure that the level does not rise too high and enter the compressor inlet.

INSTRUMENTATION

▲ **Point Level:**
Model B35 External Cage Float-Actuated Switch, ASME B31.1 Construction

▲ **Continuous Level:**
ECLIPSE Model 706 or Horizon® Model 704 Guided Wave Radar Transmitters, E3 MODULEVEL or MODULEVEL Pneumatic Transmitters

▲ **Visual Indication:**
Atlas™ or Aurora® Magnetic Level Indicators can be supplied with switches or transmitters

FUEL OIL STORAGE

PLANT AREA:
Combustion Fuel

Application: Fuel-fed ignitors initiate the boiler flame in coal-fed plants using natural gas or atomized fuel oils such as light grade #2 or heavy grade #6. Natural gas and propane can also be used. In combined-cycle plants, gas turbines often use natural gas and liquid fuel oils as ignition fuel. Large gas turbines are designed to operate alternately or simultaneously with both gas and liquid fuels. In dual-fuel plants, a False Start Tank will temporarily hold diesel fuel after an unsuccessful attempt to fire the turbine.

Challenges: Crude oils with lower flash points represent a greater fire hazard and require more extensive fire protection systems. Switches and transmitters should be safety certified.

INSTRUMENTATION

▲ **Point Level:**
Models B10 or B15 Displacer-Actuated Switches

▲ **Continuous Level:**
ECLIPSE Model 706 Guided Wave Radar Transmitter or Pulsar™ Model R95 Pulse Burst Radar Transmitter

▲ **Continuous Level:**
Echotel® Model 300 or 335 Non-Contact Ultrasonic Transmitters

AMMONIA STORAGE

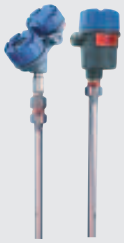
PLANT AREA:
Particulate Removal

Application: Vaporized ammonia is used in catalytic and noncatalytic reduction systems for emissions control. Ammonia is injected into the flue gas stream and acts as a reducing agent. It is also used to enhance precipitator efficiency for particulate control. Pure ammonia is stored in a pressure vessel rated for 250 to 300 psig. Aqueous ammonia (70 to 80% water) is stored in a tank rated for 25 to 30 psig. Storage requirements for aqueous ammonia are three to four times that of pure ammonia.

Challenges: Accidental atmospheric release of pure ammonia vapor can be hazardous, so safety and environmental measures may be required which affect the level control selected.

INSTRUMENTATION

▲ **Point Level:**
Model A15 Displacer-Actuated Switch

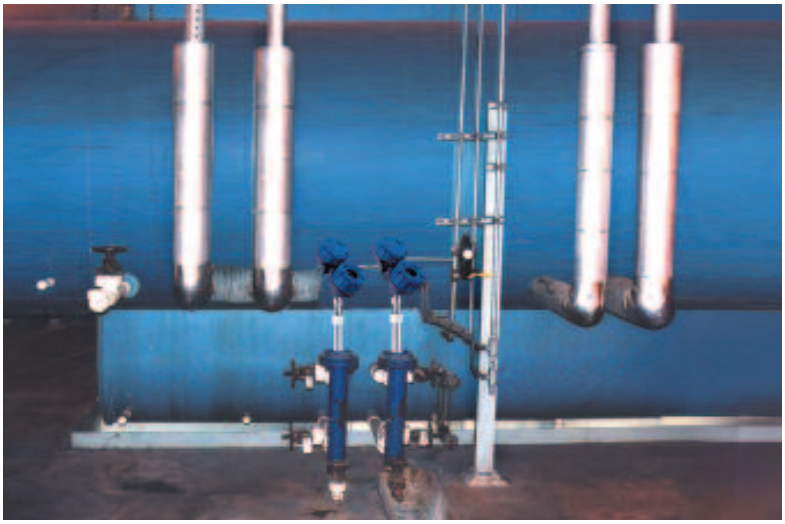


▲ **Continuous Level:**
ECLIPSE Model 706 or HORIZON Model 704 Guided Wave Radar Transmitters with 7XP Coaxial Probe

▲ **Visual Indication:**
ATLAS or AURORA Magnetic Level Indicators can be supplied with switches or transmitters

CONDENSER HOTWELL

PLANT AREA:
Steam Generation



Application: Steam enters the condenser where it cools and condenses into water before being sent to the low-pressure feed-water heater. The condenser hotwell serves as a water reservoir for the turbine cycle. When hotwell level reaches the low point, a valve opens to supply make-up water to the cycle. When hotwell level reaches the high end of the level range, a dump valve opens to move the condensate from the hotwell to a condensate storage tank.

Challenges: Water loss in the turbine cycle due to leakage, steam venting or other usage depletes make-up water. Level control in the hotwell ensures adequate make-up water is supplied to the cycle or diverted to storage.

INSTRUMENTATION

▲ **Point Level:**
Model B40 Float-Actuated Switch

▲ **Continuous Level:**
ECLIPSE Model 706 Guided Wave Radar Transmitter,
E3 MODULEVEL or MODULEVEL Pneumatic Transmitter

▲ **Visual Indication:**
ATLAS or AURORA Magnetic Level Indicators can be supplied with switches or transmitters

CONDENSATE STORAGE

PLANT AREA:
Steam Generation

Application: When the condenser hotwell level reaches the high point, a dump valve opens to drain excess condensate from the hotwell to a condensate storage tank. When loss of condensate from the turbine cycle is reflected in a low level in the hotwell, a make-up valve opens in the storage tank to supply make-up water to the condenser hotwell.

Challenges: Proper functioning of the liquid level control in the condensate storage tank ensures the proper supply of make-up water.

INSTRUMENTATION

▲ **Point Level:**
Models B10 or B15 Displacer-Actuated Switches

▲ **Continuous Level:**
ECLIPSE Model 706 Guided Wave Radar Transmitter or PULSAR Model R95 Pulse Burst Radar Transmitter

▲ **Continuous Level:**
ECHOTEL Models 300 or 335 Non-Contact Ultrasonic Transmitters

DEAERATOR

PLANT AREA:
Steam Generation

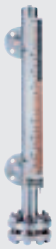
Application: The deaerator is an open-faced water heater which removes non-condensable gases from the feedwater. In addition to the condenser hotwell, the deaerator's storage tank is the remaining reservoir in the turbine cycle. Positioned below the deaerator and before the boiler feed pumps, the deaerator storage tank serves as a surge tank for the boiler feedwater. Tank level is often controlled by a control valve on the condensate supply line to the deaerator.

Challenges: Pressure fluctuations are extensive in the deaerator storage tank and result in flashing. Level controls must contend with the tank's fluctuating temperatures and pressures.

INSTRUMENTATION

▲ **Point Level:**
Model B35 External Cage Float-Actuated Switch, ASME B31.1 Construction

▲ **Continuous Level:**
ECLIPSE Model 706 Guided Wave Radar Transmitter with a 7XS Steam Probe



▲ **Visual Indication:**
ATLAS or AURORA Magnetic Level Indicators can be supplied with switches or transmitters

CONDENSATE DRIP LEGS

PLANT AREA:
Steam Generation

Application: Placed along super heated steam lines, condensate drip legs (or drip traps) collect particles of moisture and drain off the accumulated condensate. Employed as a preventative measure against turbine water induction, drip legs can be placed along main steam lines, hot and cold reheats and steam extraction lines. When a level switch senses the upper level in a drip leg it opens a dump valve to remove the accumulated condensate.

Challenges: If particles of moisture escape condensate collection systems and enter the turbines, significant damage can result. Level controls used in condensate drip legs must contend with the high temperatures and pressures associated with these devices.

INSTRUMENTATION

▲ **Point Level:**
Model B40 Float-Actuated Switch

▲ **Point Level:**
Model B35 External Cage Float-Actuated Switch, ASME B31.1 Construction

FEEDWATER HEATERS

PLANT AREA:
Steam Generation

Application: Feedwater heaters use extraction steam from the turbine to raise the temperature of water destined for the boiler. Water first passes through low-pressure heaters and into the deaerator where excess oxygen is removed. The feedwater then passes into the high-pressure heaters where it is further heated and pressurized. Two separate level control loops should manage each feedwater heater—according to ASME standards.

Challenges: Feedwater heater level is controlled to (1) prevent level from rising into the extraction line; (2) keep the tube surfaces in the condensing zone immersed; and (3) keep the drain cooler flooded. Level instrumentation must withstand moderate to high temperatures and pressures and turbulent conditions.

INSTRUMENTATION

▲ **Point Level:** Model B40 Float-Actuated or Series 3 External Cage Switches

▲ **Continuous Level:** E3 MODULEVEL or MODULEVEL Pneumatic Transmitters; or ECLIPSE Model 706 Guided Wave Radar Transmitter with 7XS Steam Probe

▲ **Visual Indication:** ATLAS or AURORA Magnetic Level Indicators can be supplied with switches or transmitters

STEAM DRUMS

PLANT AREA:
Steam Generation

Drums atop a HRSG

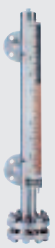
Application: The steam drum is the primary interface between water and steam. In a coal-fired plant, boiler feedwater passes through the economizer and into the drum where the steam separates from the feedwater and is drawn off to the superheater. In combined-cycle operations, a Heat Recovery Steam Generator (HRSG) serves the same purpose as a boiler. It is a gas-to-water heat exchanger that extracts energy from the gas turbine exhaust gases and uses it to create steam for the steam generator. HRSG Drums can be high or low pressure varieties.

Challenges: Maintaining constant liquid level in the upper part of the drum is necessary to provide the proper quality of steam. Instrumentation must withstand high temperatures and pressures.

INSTRUMENTATION

▲ **Point Level:** Model B40 Float-Actuated or Series 3 External Cage Switches

▲ **Continuous Level:** ECLIPSE Model 706 Guided Wave Radar Transmitter with a 7XS Steam Probe



▲ **Visual Indication:** ATLAS or AURORA Magnetic Level Indicators can be supplied with switches or transmitters

BOILER BLOWDOWN TANK

PLANT AREA:
Steam Generation

Application: The concentration of undesirable solids in boiler water can be reduced through the use of a continuous purge or blowdown system. A blowdown tank receives continuous blowdown from the steam drum and blowdowns of variable temperatures and pressures from the steam generator. A blowdown tank can also function as a gravity feed drain for the steam generator when the generator is drained for maintenance.

Challenges: Good boiler blowdown practices can greatly reduce a boiler's water treatment needs and operation costs. Combustible mixtures left in a boiler due to improper purges, however, have been known to cause catastrophic explosions. Proper tank level controls are essential to ensure a safe and effective boiler blowdown system.

INSTRUMENTATION

▲ **Continuous Level:**
ECLIPSE Model 706 Guided Wave Radar Transmitter with 7XS Steam Probe or E3 MODULEVEL Displacer-Actuated Transmitter

FLASH TANK

PLANT AREA:
Steam Generation

Application: A flash tank serves as a collection system for a variety of condensate drain lines. Flash tanks receive high pressure condensate which is then exposed to a low pressure steam source. When this occurs, a certain percentage of condensate will “flash” to steam at the lower pressure. This steam can be “recycled” on other low pressure steam heat transfer devices. Smaller in size than traditional flash tanks, flash separators utilize cyclonic action to instantly separate steam and condensate.

Challenges: Level measurement is necessary to control flash tank level. The challenges are elevated temperatures and pressures.

INSTRUMENTATION

▲ **Point Level:**
Model B40 Float-Actuated Sealed Cage Switch

▲ **Continuous Level:**
ECLIPSE Model 706 Guided Wave Radar Transmitter with a 7XS Steam Probe

▲ **Visual Indication:**
ATLAS or AURORA Magnetic Level Indicators can be supplied with switches or transmitters

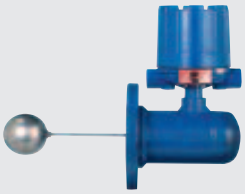
DEMINERALIZATION TANKS

PLANT AREA:
Circulating Water

Application: Because modern high-pressure boilers evaporate several million pounds of water every working hour, the purity of feed-water circulating inside the boiler is essential. Chemical treatment reduces scale-forming materials and corrosive oxygen content. A Feedwater Evaporator can be used as an alternative method to chemicals by removing impurities through evaporating raw water with extraction steam. Most often, the purity of feedwater is achieved by chemical treatment.

Challenges: Because support chemicals for water treatment can include caustics, sodium hypochloride, sulfuric acid or other additives, individual chemistry and storage requirements will dictate the level instrumentation selected.

INSTRUMENTATION



▲ **Point Level:** Models T52 or T62 Float-Actuated Switches

▲ **Continuous Level:** ECLIPSE Model 706 or HORIZON Model 704 Guided Wave Radar Transmitter

▲ **Continuous Level:** E3 MODULEVEL Displacer-Actuated Transmitter

WATER SERVICES

PLANT AREA:
Circulating Water

Application: Service water is utilized for general plant services that include pump and instrument seal water, fire water, demineralization, cooling and make-up water supply. Storage tanks with a capacity to support three days to one week of operation, allow continued plant operations in the event the supply of water is interrupted. Collectors and storage tanks are typically fixed roof, vertical cylindrical steel tanks.

Challenges: Level measurement and flow detection devices are crucial for effective water source management. Typical measurement ranges are from 24 to 50 feet.

INSTRUMENTATION

▲ **Point Level:** Models B10 or B15 Displacer-Actuated Switches

▲ **Continuous Level:** ECLIPSE Model 706 Guided Wave Radar Transmitter or PULSAR Model R95 Pulse Burst Radar Transmitter

▲ **Continuous Level:** ECHOTEL Models 300 or 335 Non-Contact Ultrasonic Transmitters

OPEN ATMOSPHERE SUMPS

PLANT AREA:
Circulating Water

Lime slurry runoff

Application: Power generating facilities have large, open atmosphere collection basins known as sumps that are usually found in wastewater treatment areas. Often constructed of concrete with depths ranging from four to ten feet, sumps function as collection and treatment sites for waste liquids ranging from storm water runoff to excess make-up water. With many possible uses for sumps, chemical composition and temperatures will vary.

Challenges: Proper level control will help ensure the continuous operation of collection and processing basins. Level controls in these areas must often tolerate corrosive media, harsh chemicals, liquids with high solids content and punishing weather conditions.

INSTRUMENTATION

▲ **Point Level:**
Models A10 or B10 Displacer-Actuated Switches

▲ **Continuous Level:**
ECLIPSE Model 706 or HORIZON Model 704 Guided Wave Radar Transmitter

▲ **Continuous Level:**
ECHOTEL Models 300 or 335 Non-Contact Ultrasonic Transmitters

COOLING TOWER BASIN

PLANT AREA:
Circulating Water

Application: Open-system cooling towers reject waste heat from the steam cycle by exposing the cooling water directly to the atmosphere. The majority of heat removed is due to evaporation and the remaining cooled water drops into a collection basin. Level control applications include a high level switch to avoid overflow conditions in the cooling tower basin. In a once-through cooling system, the water intake structure is often a vertical wet pit pump which requires high and low level sensing and possible pump control.

Challenges: Water infeed and basin levels of the cooling tower require level sensing and control. In frigid climates, a level switch can work in tandem with a resistance heater to protect standing water in the cooling tower basin against freezing.

INSTRUMENTATION

▲ **Point Level:**
Models A15 or B10 Displacer-Actuated Switches

▲ **Continuous Level:**
Kotron® Models 82CE or 805 RF Capacitance Transmitters

▲ **Continuous Level:**
ECLIPSE Model 706 or HORIZON Model 704 Guided Wave Radar Transmitters

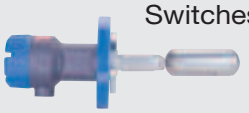
LUBRICATION OIL TANKS

PLANT AREA:
Power Generation

Application: Generators and gas turbines will have integral lubricating systems to prevent damage caused by excessive friction. Often a portion of the lubricating oil is used in the hydraulic oil systems for hydraulic control devices. Lubricating oil is typically stored in integral stainless steel and carbon steel tanks that are monitored for level. A generator gear-box lube oil system may have a reservoir with a capacity of 3,000 gallons and a turbine oil system may have a reservoir with a capacity of 150 gallons.

Challenges: Adequate level monitoring of lube oil reservoirs will ensure the proper functioning of turbines, electrical generators and other equipment with integral lubrication systems.

INSTRUMENTATION



▲ **Point Level:** Tuffy® II Float-Actuated Switches

▲ **Continuous Level:** ECLIPSE Model 706, HORIZON Model 704 Guided Wave Radar Transmitter, or PULSAR Model R95 Pulse Burst Radar Transmitter

▲ **Continuous Level:** ECHOTEL Models 300 or 335 Non-Contact Ultrasonic Transmitters

WATER WASH TANKS

PLANT AREA:
Power Generation

Application: The compressor of a gas turbine ingests a large amount of air containing particulate matter, aerosols of hydrocarbons and other organic compounds and gases. Although the larger particulate matter is filtered out, the other compounds are deposited on the compressor blades. Compressor washing removes this deposited fouling and restores the aerodynamic profile and compressor efficiency. Also used for cleaning generator or other machinery and equipment components, water wash is periodically discharged as waste water.

Challenges: Water wash is collected in a dedicated collection tank monitored for level with typical capacities of 50 to 100 gallons.

INSTRUMENTATION

▲ **Point Level:** Top Mount Float-Actuated Switches

▲ **Continuous Level:** ECHOTEL Models 300 or 335 Non-Contact Ultrasonic Transmitters or ECLIPSE Model 706 Guided Wave Radar Transmitter

▲ **Visual Indication:** Top Mount ATLAS Magnetic Level Indicator

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POWERGEN

AN INDUSTRY GUIDE TO LEVEL MEASUREMENT AND CONTROL FROM ***MAGNETROL***

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- ***Steam Generation***
- ***Tank Bridle Level Measurement***
- ***Tank Overfill Prevention***
- ***Understanding Safety Integrity Level (SIL)***
- ***Water & Wastewater***

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Magnetrol®

Worldwide Level and Flow Solutions[sm]

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