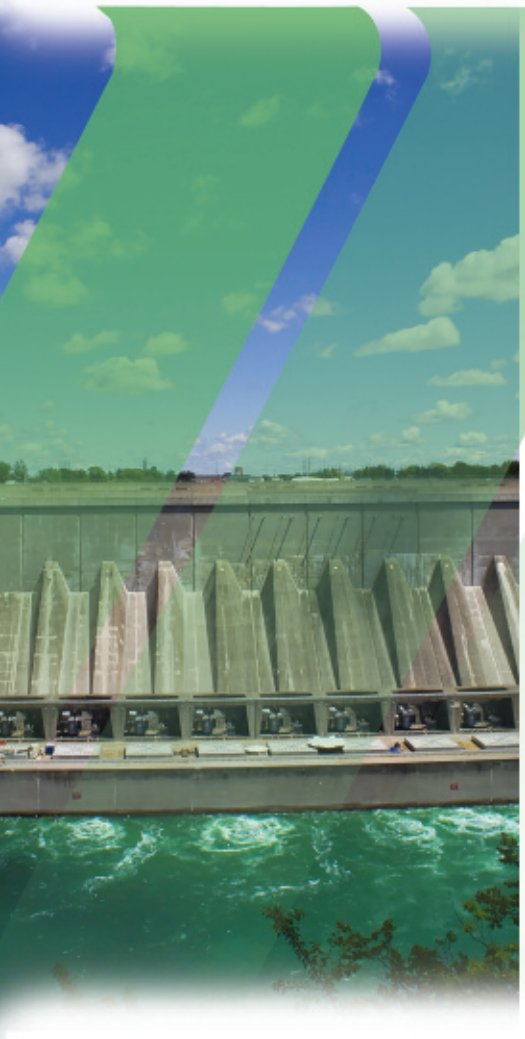
MAGNETROL®

LEVEL AND FLOW

INSTRUMENTS FOR RENEWABLE ENERGY

BIOFUEL | BIOGAS | HYDROELECTRIC | GEOTHERMAL | SOLAR | WIND



SPECIAL APPLICATION SERIES

BIOFUEL

Biofuel is produced from biomass resources to make liquid fuels like ethanol, methanol, and biodiesel, and gaseous fuels such as hydrogen and methane (see Biogas). Biofuels are primarily used to fuel transportation vehicles, but they can also fuel engines or fuel cells for electricity generation.


An ethanol plant in the U.S.

ETHANOL: Ethanol is produced by converting the carbohydrates from biomass into sugar, which is then converted into ethanol in a fermentation process. Ethanol produced from cellulosic biomass is a newer, viable alternative to traditional corn-based ethanol.

BIODIESEL: Biodiesel is produced through a process in which organically derived oils are combined with alcohol (ethanol or methanol) in the presence of a catalyst to form ethyl or methyl ester. Biodiesel can be made from vegetable oils, animal fats, or microalgae oils. Soybean and canola oils are most commonly used.

BIO-OIL: Biomass can be converted into a diesel-like fuel known as bio-oil that is suitable for use in boilers for electricity generation but not as a transportation fuel. Bio-oil is produced through flash pyrolysis, which is where finely divided feedstock is heated at very high temperatures for less than 2 seconds.

BIOFUEL LEVEL APPLICATIONS (Abbreviations: GWR = Guided Wave Radar; TAR = Thru-Air Radar)

❶ Fermentation: In ethanol production, fermentation provides a series of chemical reactions that convert sugars to ethanol. Ethanol and carbon dioxide are produced as the sugar is consumed by yeast or bacteria. Level control of the fermentation tank must tolerate agitation, aeration, and the presence of froth or foam.
Continuous Level: Eclipse® Model 706 GWR Transmitter or E3 Modulevel® Displacer Transmitter.
Point Level: Top Mounted Displacer Switch or External Cage Float Switch.

❷ Reactor Tank: Biodiesel and cellulosic ethanol production use reactors for chemical addition and mixing. In a Continuous Stirred-Tank Reactor one or more fluid reagents are introduced into a tank reactor equipped with an impeller that stirs the reagents to ensure proper mixing. The reactor tank requires level monitoring and alarms.
Continuous Level: ECLIPSE 706 GWR Transmitter; E3 MODULEVEL Displacer Transmitter or Pulsar™ R86 TAR Transmitter.
Point Level: External Cage Float Switch.

❸ Reagent Tank: A reagent is a compound that is added to a system in order to bring about a chemical reaction. In biodiesel production, an alkali reagent is used in titration, a test used to determine how much catalyst is needed to achieve a reaction. Reagents are stored in tanks equipped with level controls.
Continuous Level: ECLIPSE 706 GWR Transmitter or E3 MODULEVEL Displacer Transmitter.
Point Level: Echotel® Model 961/962 Ultrasonic Level Switch.

❹ Sumps: Liquids are collected in sumps and pits during hydrolyzation, fermentation, distillation and glucose processing of biofuels. As the liquid level rises or falls in a sump, a level switch can actuate or deactuate a pump or activate an overfill alarm.
Continuous Level: ECLIPSE GWR Transmitter; E3 MODULEVEL Displacer Transmitter; R86 or R82 TAR Transmitters or ECHOTEL 355 Non-Contact Ultrasonic Transmitter.
Point Level: Top Mounted Displacer; Model B10 Displacer Switch or ECHOTEL 961/962 Switch.

❺ Liquid Storage: A wide array of liquids are stored at biofuel plants including water, biodiesel, methanol, ethylene, catalysts, and waste liquids. Level instruments monitor inventory levels and protect against overfills and underfills that cavitate pumps.
Continuous Level: ECLIPSE GWR Transmitter or R86 or R82 TAR Transmitters.
Point Level: Tuffy® II Float-Actuated Level Switch.

BIOGAS

Biogas from digesters is typically 60–70% methane and 30–40% carbon dioxide. Biogases fuel engine-generators or gas turbines to produce electricity. They also fuel boilers to produce heat or steam. Biogas utilization has increased in industrial processing, wastewater treatment plants, municipal landfills, and livestock farms.

ANAEROBIC DIGESTION: Biogas is primarily produced by the biological breakdown of organic matter in the absence of oxygen—a process known as anaerobic digestion. Feed materials include biomass, manure, sewage, plants and plant waste, grease trap contents, and the organic fraction of municipal solid waste (MSW). This type of biogas is composed of methane and carbon dioxide.

BIOMASS GASIFICATION: Another type of biogas, syngas, is created using biomass feed materials in a process known as gasification. The resulting synthesis gas is composed primarily of hydrogen, nitrogen, and carbon monoxide with trace amounts of methane. Biomass gasifiers are reactors that heat biomass in a low-oxygen environment. The gas produced can drive highly efficient devices such as turbines and fuel cells to generate electricity.

LANDFILL GAS RECOVERY: Gas recovery from landfills is a third means of producing biogas. In the U.S., over 400 landfills presently recover methane, which forms as waste decomposes in low-oxygen conditions. A landfill gas-to-energy system consists of a series of wells drilled into the landfill. A piping system connects the wells and collects the biogas.

BIOGAS LEVEL and FLOW APPLICATIONS

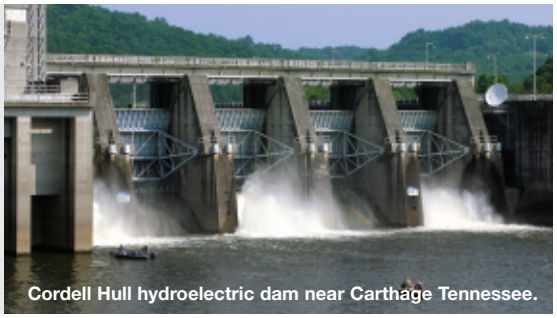
❶ Biogas Flow: In all forms of biogas production, safe and reliable gas flow measurement is essential in the collection, disposal or re-use of biogas. Thermal mass flow meters are widely used in landfill, anaerobic digestion and gasification processes. A flow meter measuring biogas must provide low flow sensitivity, low pressure drop, and tolerate temperature and pressure changes.
Continuous Flow: Thermatel® TA2 Thermal Mass Flow Meter.
Flow Alarm: F10 Flow Switch or THERMATEL TD1/TD2 Flow Switch.

❷ Scrubber Vessel: Essential in gasification processes, scrubbers remove odors, pollutants, acid gases and chemical wastes from biogas. Accurate level monitoring of the scrubbing water necessitates a control to automatically feed the correct amount of make-up water to the recycle reservoir either continuously or on a periodic basis. The level monitoring device for water-out control should be equipped with a level alarm.
Continuous Level: ECLIPSE 706 GWR Transmitter or ECHOTEL 355 Non-Contact Ultrasonic Transmitter.
Point Level: TUFFY II Float Level Switch or ECHOTEL Model 961/962 Switch.

❸ Biogas Dehydration: As biogas emerges from a digester or a landfill it is saturated with water that causes corrosion problems upon condensation. Dehydration systems using air, vacuum and desiccant processes to remove water typically include a holding tank for water drawn off the gas with a level control actuating a valve to vacate the tank at high level. Biogas is dehydrated according to the customer's specifications for maximum water content. Some uses, such as boiler fuel, require an extremely dry gas.
Continuous Level: ECLIPSE 706 GWR Transmitter or E3 MODULEVEL Displacer Transmitter.
Point Level: Model A15 Top Mounted Displacer Switch.

HYDRO ELECTRIC

Hydropower is electricity produced from flowing water. Hydropower produces approximately 7% of U.S. energy (19% of world energy) and accounts for 45% of total renewable energy in the U.S. Newer technologies harness energy in ocean tides, waves, and currents.



Cordell Hull hydroelectric dam near Carthage Tennessee.

HYDROELECTRIC POWER GENERATION

The main components of a hydroelectric power plant are: **The Reservoir**, where water from a natural water body is stored; **The Dam**, its containment walls prevent the water from flowing and help harness the energy present in it; **The Penstock**, enclosed piping that connects the reservoir with the turbine's propeller; and **The Power Station**, which contains the Power Generating Equipment. (The many level and flow applications associated with power generation are covered in the Magnetrol® PowerGen Industry Applications Brochure 41-175.) Not all hydroelectric power generation requires a dam; a run-of-river project only uses part of the stream flow and is a characteristic of smaller hydropower operations.

OTHER HYDROPOWER TECHNOLOGY

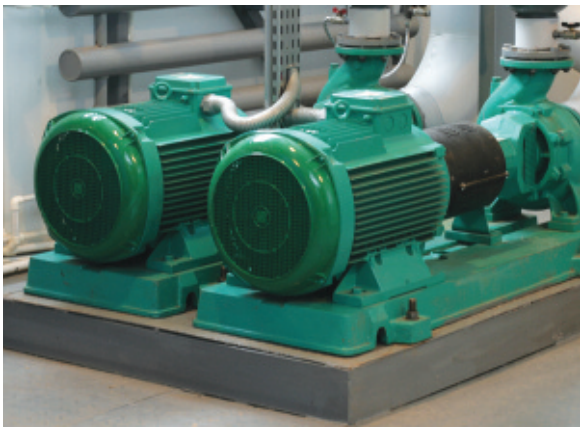
Prior to the widespread availability of commercial electric power, hydropower was used for irrigation, and the operation of water mills, textile machines, sawmills, dock cranes, and domestic lifts. There are several forms of water power currently in use or under development. These include: **Waterwheels**, used to power mills and machinery; **Vortex power**, which creates vortices that can be tapped for energy; **Tidal power**, which captures energy from the tides; **Wave power**, which uses the energy in waves; and **Osmotic power**, which is the energy retrieved from the difference in the salt concentration between seawater and river water.

HYDROELECTRIC LEVEL and FLOW APPLICATIONS

❶ Surge Tank: The main function of a surge tank is to control pressure variations due to rapid changes in the velocity of water. When the power turbine is running at a steady load, there are no surges in the flow of water since the quantity of water flowing through the conduit is sufficient to meet the turbine's requirements.

When turbine load decreases, a governor closes the gates of the turbine to reduce water supply. The water is routed for storage in the surge tank—an action that prevents the conduit from bursting. When turbine load increases, additional water is drawn from the surge tank to meet the increased demand.

A surge tank's internal diameter may range from a few feet to several dozen feet. The tank relies on a level sensor to determine whether or not water stored in the tank should be removed.
Continuous Level: ECLIPSE 706 GWR Transmitter or R86 TAR Transmitter (for closed tanks only).
Point Level: ECHOTEL Model 961/962 Ultrasonic Switch.



❷ Pump Protection: Flow Switches protect pumps from damage due to leaks or if a valve is accidentally closed downstream. A switch will actuate an alarm and shut down the pump when flow drops below the minimum rate.
Flow Alarm: THERMATEL TD1/TD2 Flow Switch for High/Low Alarm; or F10/F50 Flow Switch.

GEO THERMAL

Geothermal reservoirs located deep underground provide powerful sources of heat energy. Drilling a geothermal well to a reservoir brings hot water and steam to the surface where it can be put to many uses. The three principal uses are (1) Electricity Generation, (2) Geothermal Heating, and (3) Geothermal Heat Pumps.


Iceland's Nesjavellir Geothermal Power Station

GEOTHERMAL ELECTRICITY GENERATION

(1) ***Dry Steam Plants*** use steam piped directly from a geothermal reservoir.
(2) ***Flash Steam Plants*** take high-pressure hot water and convert it to steam. As the water rises, the pressure is reduced and the water flashes to steam.
(3) ***Binary Cycle Plants*** take heat from the geothermal water and transfer it to an organic fluid (a butane or pentane hydrocarbon) with a low boiling point in a high pressure heat exchanger known as a vaporizer. The heat transfer causes the second (or "binary") liquid to turn to steam.

OTHER GEOTHERMAL USES: Geothermal Heating is the direct use of geothermal heat for space and process heating applications. Industrial applications include food dehydration, zinc and gold mining, desalination, milk pasteurization, and food dehydration. Geothermal Heat Pumps use the Earth's constant temperatures to heat and cool buildings by transfering and removing heat into buildings according to seasonal needs.

GEOTHERMAL LEVEL APPLICATIONS

❶ STEAM/BRINE SEPARATOR: To achieve better conditions for turbine operation, a reservoir's steam and brine (salt water) is separated into streams where the brine water and particulate matter settle out and the steam vapors rise. The steam collects at the top of the separator where it is removed. Liquid level control modulates the amount of water that is drawn off.
Continuous Level: ECLIPSE Model 706 GWR Transmitter or E3 MODULEVEL Displacer Transmitter.
Point Level: External Cage Float Switch or THERMATEL TD1/TD2 Switch.

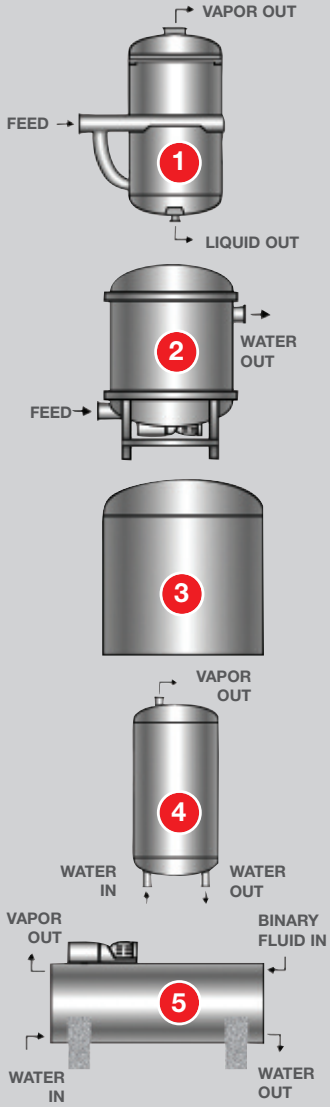
❷ DEGASSER TANK: Geothermal hot water is often routed through a degasser—a large insulated tank equipped to remove organic gases and provide displacement with air or nitrogen. Degassing operations provide treatment by way of carbon adsorption, thermal/catalytic oxidization, combustion, vacuum induction, or by a series of condensers.
Continuous Level: ECLIPSE Model 706 GWR Transmitter or E3 MODULEVEL Displacer Transmitter.
Point Level: External Cage Float Switch; THERMATEL TD1/TD2 or ECHOTEL 961/962. Switch.

❸ WATER STORAGE TANK: Water tanks include those for heated water, cooling water, and wastewater. Direct heat use applications require heated water storage. Spent geothermal fluids with high concentrations of chemicals are stored prior to treatment and reinjection into the reservoir. Hot water can be cooled in special storage tanks to avoid modifying the ecosystem of natural bodies of water prior to reinjection.
Continuous Level: ECLIPSE 706 GWR Transmitter; E3 MODULEVEL Displacer Transmitter; R86 or R82 TAR Transmitters or ECHOTEL 355 Non-Contact Ultrasonic Transmitter.
Point Level: TUFFY II Float-Actuated Level Switch or ECHOTEL Model 961/962 Switch.

❹ FLASH TANK: Hot water from the geothermal well enters a flash tank where the reduced pressure causes the water to boil rapidly, or "flash" into vapor. Water that remains liquid in the tank is returned to the groundwater pump to be forced down into the reservoir again. The vapor from the flash tank drives the steam turbine.
Continuous Level: ECLIPSE 706 GWR Transmitter.
Point Level: Displacer Switch or THERMATEL TD1/TD2 Level Switch.

❺ VAPORIZER: In these special heat exchangers, the geothermal fluid heats and vaporizes a secondary "binary" fluid, which is typically an organic liquid with a low boiling point. The organic vapor drives the turbine. The level of water in the tank must be monitored.
Continuous Level: ECLIPSE 706 GWR Transmitter or E3 MODULEVEL Displacer Transmitter.
Point Level: External Cage Float Switch or ECHOTEL Model 961/962 Switch.

Vessels & Tanks



SOLAR

Solar Technologies use the sun's energy to provide electricity, hot water, process heat and cooling. Solar power presently provides less than 1% of U.S. energy needs but this is expected to increase with the development of more efficient solar technologies.

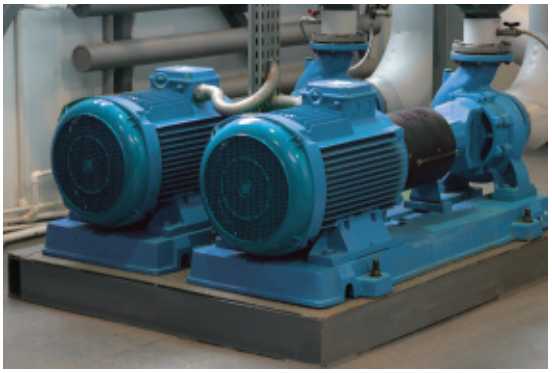
TYPES OF SOLAR COLLECTORS

Different solar collectors meet different energy needs. **Passive Solar** designs capture the sun's heat to provide space heating and light. **Photovoltaic Cells** convert sunlight directly to electricity. **Concentrating Solar Power** systems focus sunlight with mirrors to create a high-intensity heat source, which then produces steam or mechanical power to run a generator that creates electricity. **Flat-plate Collectors** absorb the sun's heat directly into water or other fluids to provide hot water or space heating.

SOLAR LEVEL and FLOW APPLICATIONS

❶ Heat Transfer Fluid Storage: Large-scale solar collectors for electric power generation require a heat transfer fluid (water, thermal oils, or ionic liquids) to absorb the sun's heat for generating steam. Arrays of mirrored panels convert the sun's energy into +750 °F (+399 °C) thermal energy that's hot enough to create steam for turbines. The mirrors focus sunlight onto pipes of heat transfer fluid that run along the mirror's centerline. The fluid then boils water to produce steam. Thermal fluids also help provide hot water and heat. Thermal fluids are typically stored in pressurized tanks that require level monitoring.
Continuous Level: ECLIPSE 706 GWR Transmitter or E3 MODULEVEL Displacer Transmitter.
Point Level: External Cage Float Switch.

❷ Hot Water Storage: High-temperature solar water heaters provide energy-efficient hot water and heat for large industrial facilities. Thermal storage in buffer tanks provide interfaces between collector subsystems and energy-using systems.
The preferred solar storage vessel is a vertical cylindrical tank designed for the maximum pressure of the supply water source, which may be as high as 150 psi.
Continuous Level: ECLIPSE 706 GWR Transmitter or E3 MODULEVEL Displacer Transmitter.
Point Level: External Cage Float Switch.



❸ Pump Protection: Flow Switches protect pumps from damage due to leaks or if a valve is accidentally closed downstream. A flow switch will actuate an alarm and shut down the pump when flow drops below the minimum rate.
Flow Alarm: THERMATEL TD1/TD2 Flow Switch for High/Low Alarm; F10 Vane-Actuated Flow Switch or F50 Disc-Actuated Flow Switch.

WIND

Wind Energy is one of the fastest-growing forms of electricity generation in the world. U.S. wind power market share is expected to reach 3.35% by 2013 and 8% by 2018. More optimistic industry experts predict that wind energy will meet 20% of the nation's energy needs by 2030.

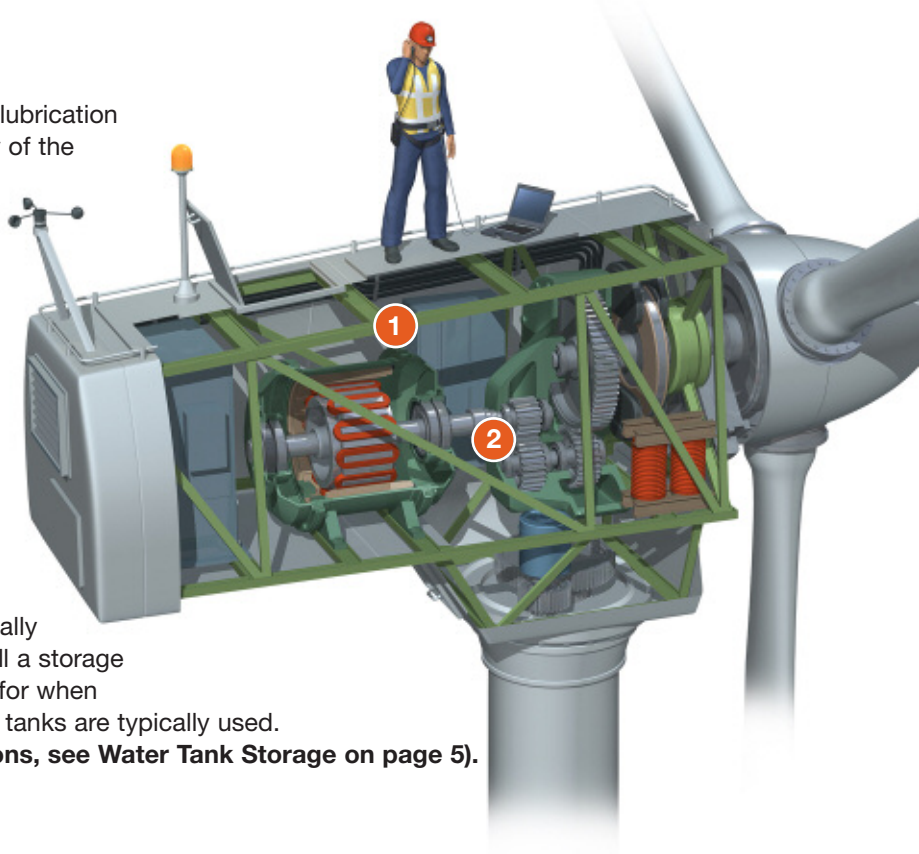
WIND ENERGY SYSTEMS

Large wind conversion systems are most commonly deployed for power grid electricity generation. Smaller systems are used for water pumping. A system of blades mounted on a tower is turned by the wind to either produce mechanical work directly (via a water pump), or to employ a generator to transform mechanical work into electrical energy (wind turbines). Utility-scale wind turbines for land-based wind farms have rotor diameters ranging from 165 to 325 feet (50 to 100 meters).

WIND TURBINE LEVEL APPLICATIONS

❶ Wind Turbine Oil Reservoir: As wind energy technology advances, higher demands are placed on turbine lubrication systems. Lubricant reservoirs of up to 550 gallons (2,000+ liters) serve as oil storage in centralized systems to provide lubrication for the blade bearings, blade tilt, main bearing, azimuth bearing, meshing gears, generator bearings, cylindrical gears, bevel gears, rolling and sliding bearings, worm gear units, and gear couplings. The oil reservoir is monitored for continuous or point level.
Continuous Level: ECLIPSE 706 GWR Transmitter or ECHOTEL 355 Non-Contact Ultrasonic Transmitter.
Point Level: TUFFY II Float-Actuated Switch or ECHOTEL Model 961/962 Ultrasonic Switch.

❷ Wind Turbine Gearbox: Gearbox and bearing lubrication are of particular importance due to the complexity of the gearbox and the high mechanical loads. Gearbox and bearing problems are a common cause of downtime; and loss of oil through a small leak has lead to catastrophic wind turbine failures. Along with vibration, temperature, and flow sensors, a low level gearbox oil alarm is a critical safety control.
Point Level: TUFFY II Float-actuated Switch or ECHOTEL 940/941 Compact Ultrasonic Level Switch.



WATER PUMPING LEVEL APPLICATION

Water Pumping Storage: For industrial and agricultural use, a water pumping windmill is typically placed above a well or near a river. Next to the mill a storage tank is placed to provide a buffer supply of water for when the mill is not operational. Ferro-cement and steel tanks are typically used.
(For point and continuous level recommendations, see Water Tank Storage on page 5).

OTHER WIND ENERGY APPLICATIONS

The number of dedicated industrial applications for wind energy continues to grow. Wind power is currently being used in these applications:

- Municipal and Industrial Water Services
- Mechanical Power Mills
- Telecommunications and Radar
- Pipeline Control
- Navigational Aids
- Cathodic Protection
- Weather Stations and Seismic Monitoring

Special Application Series

*Other industry and special application brochures from **MAGNETROL** include:*

- ***Chemical***
- ***Crude Oil Processing***
- ***Flue Gas Desulfurization***
- ***Food & Beverage***
- ***Interface Level Measurement***
- ***Life Science***
- ***Mass Flow Measurement***
- ***Modular Skid Systems***
- ***Natural Gas Processing***
- ***Nuclear Power***
- ***Petroleum Refining***
- ***Power Generation***
- ***Pulp & Paper Mills***
- ***Steam Generation***
- ***Tank Bridle Level Measurement***
- ***Tank Overfill Prevention***
- ***Understanding Safety Integrity Level (SIL)***
- ***Water & Wastewater***

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

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