MAGNETROL®

LEVEL AND FLOW INSTRUMENTS FOR MODULAR SKID SYSTEMS

Level

ACTUATED

SPECIAL APPLICATION SERIES

WHY A SKID?

• Cost-effective • Less On-site Impact • Flexible • Compact, Efficient Footprint • Reduced Installation and Start-up Times • Reduced Transportation Costs

Throughout the process industry, modular fabrication has increasingly become a viable option to field construction for owner/operators, OEMs, and plant engineers. From zero site disruption during fabrication to plug-and-play commissioning, single- and multiple-skid systems have become popular options in recent years.

Nearly any unit operation can be fabricated as a self-contained, modular skid system. While most skids are housed within an open structural framework, a skid maker can fabricate the skid system inside a standard shipping container.

In the pages ahead, we feature 12 process operations that can be fabricated as modular skid systems. The schematics shown on each page portray the typical components of the featured skid application. The level and flow controls found in these applications are listed.

Mobility and Transportability A filtration skid on wheels (left) brings filtration to the individual process as needed. A completely containerized pump skid (right) simplifies shipping and installation, brings security and weather protection to an outdoor field installation, and dampens sound.

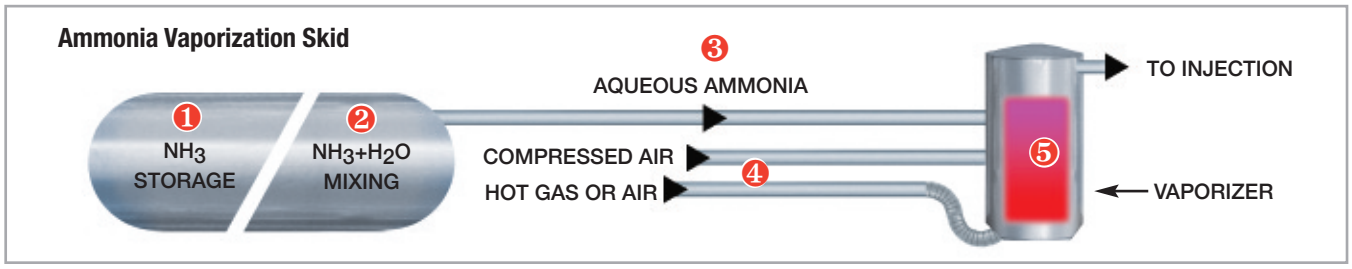
Ammonia Skid

Anhydrous and aqueous ammonia are skid-configured for unloading, storage, transfer, vaporization, stripping, metering, injection, and urea-to-ammonia (U2A) conversion. Skids range from compact, single-process systems to multi-unit utility systems.

Featured Application: Aqueous Ammonia Vaporization Ammonia vaporization changes the state of ammonia from a liquid to a gas. Vaporized ammonia is important for use in industrial refrigeration and in pollution abatement technology, such as selective catalytic reduction (SCR) systems used to neutralize nitrogen oxides from large electric utility and industrial boilers.

Process Schematic Aqueous ammonia vaporization uses heat to evaporate an ammonia and water mixture. The liquid is mixed with atomizing air and dispersed into the vaporization chamber as a fine mist where it is heated until it vaporizes. The air, ammonia, and water vapor mixture is then transferred to the injection grid.

Ammonia Vaporization Skid



Level and Flow Applications

1. Ammonia Storage Tank Pure ammonia is stored in a pressure vessel rated at 250 to 300 psig. Aqueous ammonia (70 to 80% water) is stored in a tank rated at 25 to 30 psig.
Continuous Level: **Eclipse® Model 706 Guided Wave Radar Transmitter or Atlas™ or Aurora® Magnetic Level Indicators**
Point Level: **Model A10/A15 Single Stage Displacer Switch**

2. Mixing Tank The mixing tank uses an agitator for blending. Level controls trigger alarms in underfill and overfill incidents.
Continuous Level: **Pulsar® Model R86 Radar Transmitter or ATLAS or AURORA Magnetic Level Indicators**
Point Level: **Echotel® Model 961 Ultrasonic Switch or Model T20 Single Stage Float Switch**

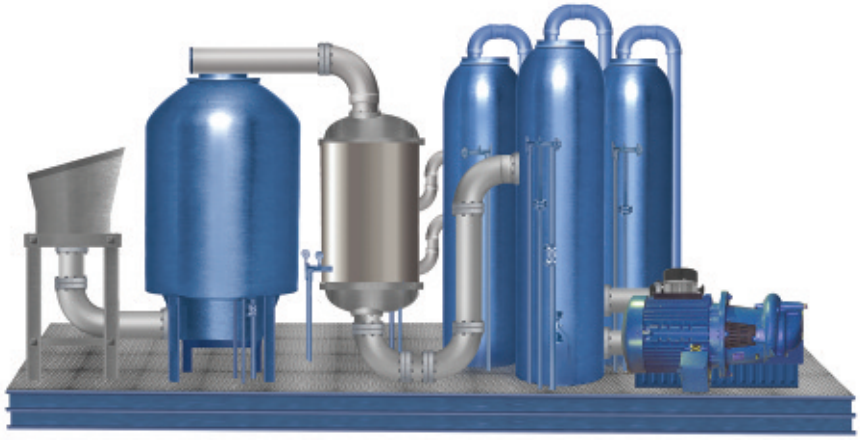
3. Pump Protection A flow switch along a pump's discharge piping will actuate an alarm and shut down the pump when liquid flow drops below a minimum flow rate.
Flow Alarm: **Thermatel® Model TD1/TD2 Thermal Dispersion Switch for low-flow cutoff**

4. Air Flow Monitoring Flow meters help ensure efficient operation at rated SCFM output and detect air leaks. A flow meter with a totalizer provides an accurate measurement of compressed air consumption.
Flow Alarm: **THERMATEL Model TD1/TD2 Thermal Dispersion Switch for low-flow cutoff**
Flow Transmitter: **THERMATEL Model TA2 Thermal Dispersion Mass Flow Meter**

5. Vaporizer Liquid Level Functioning as an essential safety measure, a level switch in a vaporizer can provide high liquid level alarm, overfill tank alarm, leak detection alarm, or low level alarm.
Continuous Level: **PULSAR Model R86 Radar Transmitter; ECLIPSE Model 706 Guided Wave Radar Transmitter or ECHOTEL Model 355 Non-Contact Ultrasonic Transmitter**
Point Level: **THERMATEL Model TD1/TD2 Thermal Dispersion Switch for high/low alarm**

Biomass Gasifier Skid

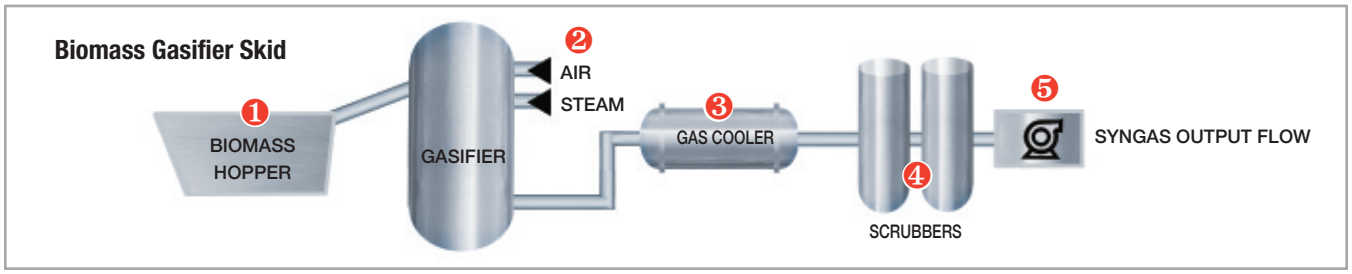
Biomass is cultivated and waste forms of biological material, including: crops, forest residue, waste from livestock, food processing, and municipal sources. When biomass is heated in the absence of oxygen, it decomposes into a mixture of hydrogen and carbon monoxide gases known as synthesis gas or 'syngas.' Like natural gas, syngas is a valuable energy asset that can fuel boilers, generators, and furnaces, or serve as a feedstock.



Biomass-to-Syngas Skid

Featured Skid Configuration: BioMass-to-Syngas Skid
In this entrained-flow type of gasifier, the steam and oxygen reactants flow uni-directionally upwards through the gasifier until high temperature finished syngas exits the reactor.

Process Schematic The biomass feedstock enters the gasifier for conversion into synthesis gas. The syngas exits the gasifier and is routed to a gas cooler to recover useable thermal energy. The gas is then cleaned and routed to an application or to storage.



Level and Flow Applications

1. Hopper Level Solid biomass feedstock is ground into small particles and fed into a biomass hopper from where it is conveyed to the gasifier. High and low level detection in the hopper maintains correct hopper level.
Continuous Level: **ECLIPSE Model 706 Guided Wave Radar Transmitter**
Point Level: **Solitel® Vibrating Rod Level Switch**

2. Input Air Flow Many gasification systems use nearly pure oxygen to facilitate the reaction in the gasifier. Typically, the oxygen is generated in an off-skid plant using cryogenic technology. The oxygen flow is monitored by mass flow transmitters.
Continuous Gas Flow: **THERMATEL Model TA2 Thermal Dispersion Mass Flow Meter**

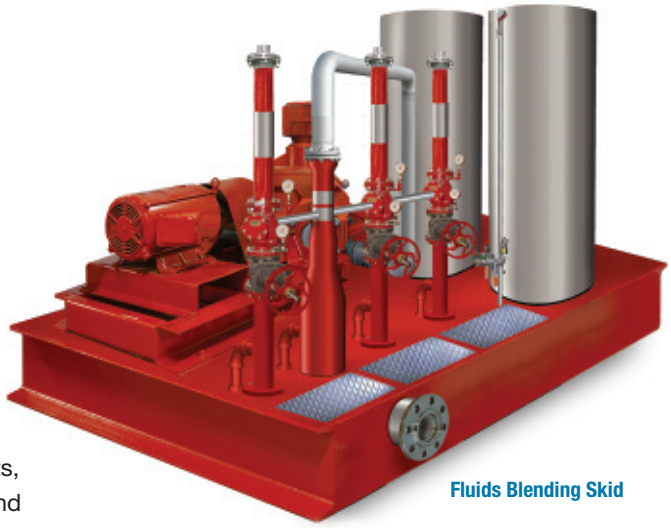
3. Gas Cooler The raw syngas leaving the gasifier enters a gas cooling unit to reduce the gas's temperature. Level controls monitoring the coolant within the cooler body serve as a leak detection system for the gas cooler.
Continuous Level: **ECLIPSE Model 706 Guided Wave Radar Transmitter**
Point Level: **Model B35 External Cage Float Switch or ECHOTEL Model 961 Ultrasonic Switch**

4. Scrubbers Impurities in the syngas—including trace minerals, particulates, sulfur, mercury, and unconverted carbon—are reduced to very low levels by using gas scrubbers. Accurate level monitoring maintains correct amounts of scrubber make-up water.
Continuous Level: **ECLIPSE Model 706 Guided Wave Radar Transmitter**
Point Level: **Model B35 External Cage Float Level Switch or ECHOTEL Model 961 Ultrasonic Switch**

5. Output Syngas Flow Clean syngas is routed to storage or to its application, including: fuel for heat or electricity generation, or to serve as a chemical or petrochemical feedstock. The mass flow of the syngas is monitored by a mass flow transmitter.
Continuous Gas Flow: **THERMATEL Model TA2 Thermal Dispersion Mass Flow Meter**

Blending & Batching Skid

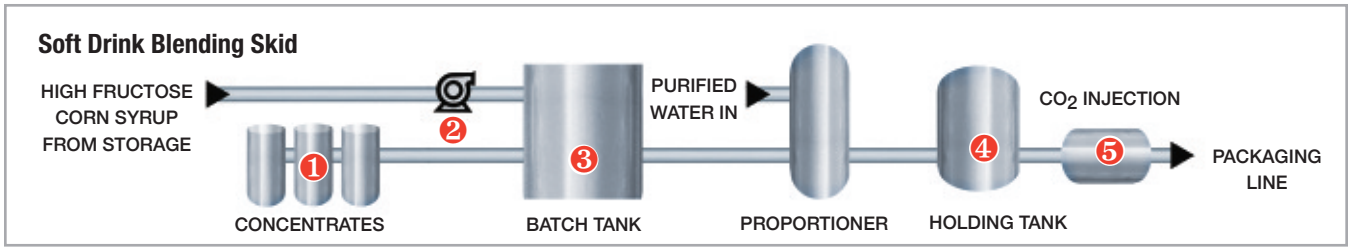
Blending & batching skids are used in all forms of liquids processing. The largest users are food & beverage, chemical, petrochemical, pharmaceutical, and paints & coatings industries. 'Blending' refers to the in-line combining of ingredients into a single output stream. 'Batching' is the dispensing of controlled quantities of process fluids into one or more vessels.



Fluids Blending Skid

Featured Skid Application: Soft Drink Blending & Batching Skid Nearly 35 billion gallons of soft drinks and allied products are consumed annually. Blending and batching units that combine ingredients to produce soft drinks of consistent quality are at the heart of every beverage maker.

Process Schematic Blending skids consist of vessels for ingredients, mixing, surge protection, and finished product storage. Syrups and concentrates are blended in a batch-mixing tank, then pumped to a proportioner to mix regulated fluid ratios, and are stored in a holding tank that feeds the carbonizer. The finished stream is then routed to filling, capping and packaging. Pumps, valves, and blend manifolds are also included on a skid.



Level and Flow Applications

1. Concentrate Tanks Syrup concentrates and additives to be blended with high fructose corn syrup (HFCS) are typically stored in stainless steel tanks with level controls that maintain safe tank levels.
Continuous Level: **ECLIPSE Model 706 Guided Wave Radar Transmitter; E3 Modulevel® Displacer Transmitter; ECHOTEL Model 355 Non-Contact Transmitter or Model R82 Radar Transmitter**
Point Level: **Models A15 or B15 Top-Mounted Displacer Switch**

2. Pump Protection Pumps move the liquid product throughout the skid and to the packaging line. A flow switch along a pump's discharge piping will actuate an alarm and shut down the pump when liquid flow drops below a minimum flow rate.
Flow Alarm: **THERMATEL Model TD1/TD2 Thermal Dispersion Switch for low-flow cutoff**

3. Batch Mixing Tank HFCS, syrup concentrates, and additives are blended in an agitator-equipped stainless steel batch mixing tank. Level controls in the tank maintain the proper level of incoming ingredients and the outgoing process stream.
Continuous Level: **ECLIPSE Model 706 Guided Wave Radar Transmitter or E3 MODULEVEL Displacer Transmitter**
Point Level: **Models A15 or B15 Top-Mounted Displacer Switch (in stilling well) or ECHOTEL Model 961/962 Ultrasonic Switch**

4. Product Holding Tank The process stream from the proportioner is pumped into a holding tank that feeds the carbonization unit. Level in the holding tank is maintained by level switches or a level transmitter.
Continuous Level: **ECLIPSE Model 706 Guided Wave Radar Transmitter; E3 MODULEVEL Displacer Transmitter or ECHOTEL Model 355 Non-Contact Ultrasonic Transmitter**
Point Level: **Model B35 External Cage Float Switch or ECHOTEL Model 961/962 Ultrasonic Switch**

5. CO_2 Injection Gaseous CO_2 is used for carbonation of soft drinks. Carbonator flow switches guard against no-flow conditions of the gas, whereas a flow transmitter will provide direct mass flow measurement.
Flow Alarm: **THERMATEL Model TD1/TD2 Thermal Dispersion Switch for low-flow cutoff**
Continuous Gas Flow Only: **THERMATEL Model TA2 Thermal Dispersion Mass Flow Meter**

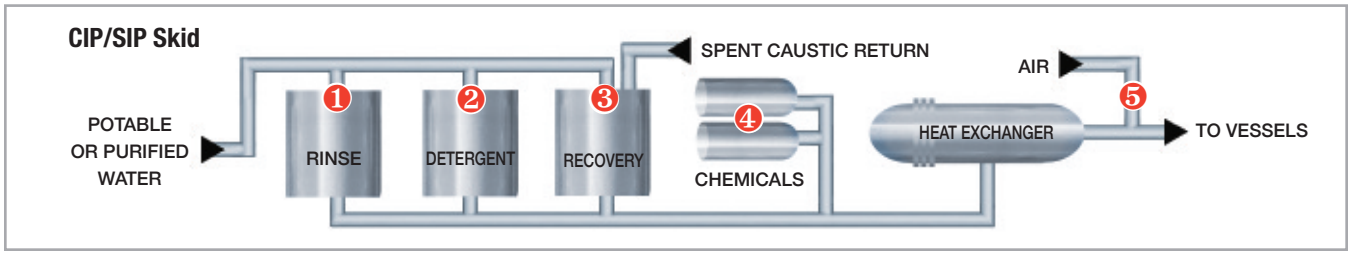
Clean-In-Place Skid

Clean-in-Place (CIP) is a method of cleaning the interior surfaces of pipes, vessels, process equipment, filters, and associated fittings without disassembly. Industries that rely heavily on CIP are those requiring the highest levels of hygiene, and include: dairy, beverage, brewing, processed foods, pharmaceutical & biotech, and cosmetics.

Clean-in-Place (CIP) Skid

Featured Skid Application: Pharmaceutical CIP/SIP Skid
CIP skids clean and sterilize process systems to the highest hygienic standards. A Sterilization-in-Place (SIP) process (attained by steam, hot water, or chemical means) is typically included as is a chemical dosing system, tubular heat exchanger, chemical reclamation, and rinse water recovery system.

Process Schematic Water is pumped into rinse and detergent tanks, is dosed with detergent and chemicals, then heated and pumped to applications. Spent wash returns to the recovery tank for caustic reclamation. Typical CIP/SIP phases are: 1. Pre-rinse; 2. Alkaline wash; 3. Primary air-blow; 4. Rinse; 5. Acid wash; 6. 2nd air-blow; 7. WFI rinse; 8. Sterilization; and 9. Final air-blow.



Level and Flow Applications

1. Rinse Tank Water is pumped from the rinse tank in pre-rinse and subsequent rinse phases that follow the wash cycles. Level controls maintain water level in the rinse tank.
Continuous Level: **ECLIPSE Model 706 Guided Wave Radar Transmitter**
Point Level: **ECHOTEL Model 961/962 Ultrasonic Switch**

2. Detergent Tank The bulk cleaning liquid and water are pumped to the detergent tank before each cleaning cycle to make up a batch of detergent. The detergent is typically pumped through a plate heat exchanger for more effective cleaning.
Continuous Level: **ECLIPSE Model 706 Guided Wave Radar Transmitter**
Point Level: **ECHOTEL Model 961/962 Ultrasonic Switch**

3. Recovery Tank A CIP caustic recovery system reclaims useable caustic solution from spent caustic streams. The spent CIP caustic solution is collected in a recovery tank and is processed through a membrane system in batch or continuous modes.
Continuous Level: **ECLIPSE Model 706 Guided Wave Radar Transmitter**
Point Level: **ECHOTEL Model 961/962 Ultrasonic Switch**

4. Chemical Tanks The most common basic cleaners metered from storage tanks are potassium hydroxide and sodium hydroxide. A base wash is often followed by an acid wash of phosphoric acid, acetic acid, or citric acid.
Continuous Level: **ECLIPSE Model 706 Guided Wave Radar Transmitter**
Point Level: **ECHOTEL Model 961/962 Ultrasonic Switch**

5. Air Flow Air blowing clears alkaline and acid solutions from the CIP lines and reduces rinsing time, and the amount of water required to clear the circuit of chemicals. Flow controls detect low-flow conditions and the presence or absence of air flow.
Flow Alarm: **THERMATEL Model TD1/TD2 Thermal Dispersion Switch for low-flow cutoff**
Continuous Gas Flow: **THERMATEL Model TA2 Thermal Dispersion Mass Flow Meter**

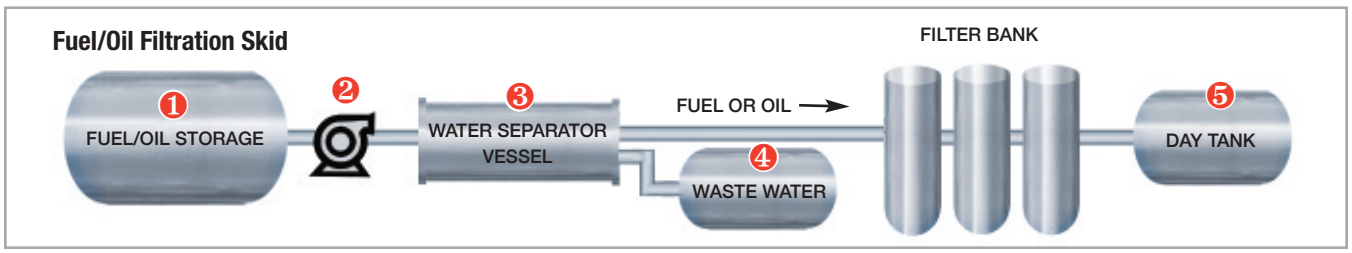
Filtration Skid

Filtration is the process of removing contaminating components from process media. Filtered media include air, steam, compressed air, gas, and liquids in a broad range of viscosities. Liquids commonly filtered include water, solvents, heat transfer fluids, hydrocarbons, paints and coatings, pulp slurry, beverages, pharmaceuticals, edible oils, food products, fuels, and lubrication oils.

Oil Filtration Skid

Featured Skid Application: Fuel & Oil Filtration Hydraulic oil, turbine oil, lubrication oil, gear oil, transformer oil, and diesel fuel are commonly filtered. Maintaining fluid cleanliness increases the life of critical components on all rotational equipment.

Process Schematic A fuel or oil filtration skid typically incorporates a sequential, multifunction filtration system for dehydration, degassing, particle removal, and removal of volatile matter. Fuel and oil skids are developed for specific types of kinematic viscosities and flash points. Stored fuel or oil passes through the filtration process and on to a day tank for storage.



Level and Flow Applications

1. Fuel/Oil Storage Tank Large tanks are typically not included on a filtration skid; though smaller, holding tanks for separator feed may be included. Safety-certified level switches and transmitters are required for fluids with low flash points.
Continuous Level: **ECLIPSE Model 706 Guided Wave Radar Transmitter; E3 MODULEVEL Displacer Transmitter or PULSAR Model R86 Radar Transmitter (if large tank)**
Point Level: **Tuffy® II Float Level Switch**

2. Pump Protection Pumps operating in a reduced or no-flow condition can overheat and rupture the pump's seal. A flow switch along a pump's discharge piping will actuate an alarm and shut down the pump if flow drops below the minimum flow rate.
Flow Alarm: **THERMATEL Model TD1/TD2 Thermal Dispersion Switch for low-flow cutoff**

3. Water Separator Vessel The first step in filtering an oil or fuel stream is to separate the oil or fuel and the water into separate streams. Interface level measurement will actuate a valve to adjust vessel level.
Continuous Level: **ECLIPSE Model 706 Guided Wave Radar Transmitter or E3 MODULEVEL Displacer Transmitter**
Point Level: **External Cage Float Level Switch**

4. Wastewater Tank Wastewater from the separation process is collected in a dedicated collection tank monitored for level. At high level, a level control actuates a dump valve to route the water to a drain or to additional processing.
Continuous Level: **ECHOTEL Model 355 Non-Contact Ultrasonic Transmitter or Model R82 Radar Transmitter**
Point Level: **ECHOTEL Model 910 Ultrasonic Switch**

5. Day Tank for Fuel or Oil The day tank is typically a cylindrical steel vessel with a capacity for storing a four- to eight-hour supply of fuel oil. Level controls ensure proper liquid level.
Continuous Level: **ECLIPSE Model 706 Guided Wave Radar Transmitter E3 MODULEVEL Displacer Transmitter; PULSAR Model R86 Radar Transmitter or Model R82 Radar Transmitter**
Point Level: **Models A15 or B15 Top-Mounted Displacer Switch or ECHOTEL Model 961/962 Ultrasonic Switch**

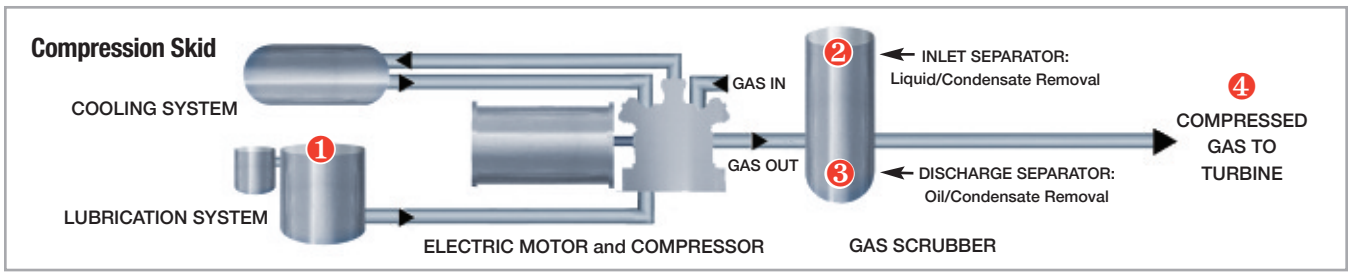
Gas Compression Skid

Gas compressors are used wherever higher pressures or lower volumes of a gas are required, including: natural gas pipeline transport, refrigeration, combustion air, gaseous fuels, and process gas compression. Gas compression systems are typically used in petroleum refineries, natural gas plants, petrochemical plants, and chemical facilities.

Featured Skid Application: Gas Compression Skid
Commonly found in power generating, steel making, and boiler plants, this compression system increases the pressure of the fuel gas to a level suitable for optimum combustion in a gas turbine, furnace, or boiler. Natural gas and biogas are frequently compressed.

Diesel Powered Gas Compression Skid for Field Service

Process Schematic Supported by a lubrication and cooling system, an electric motor drives the fuel gas compressor. After the gas is compressed, it is scrubbed in a separator and routed to the application.



Level and Flow Applications

1. Lube Oil System The skid's integral lubricating system prevents damage to the skid motor and compressor caused by excessive friction. Lubricating oil stored in larger integral stainless steel or carbon steel tanks is monitored for level.
Continuous Level: **ECLIPSE Model 706 Guided Wave Radar Transmitter or E3 MODULEVEL Displacer Transmitter**
Point Level: **TUFFY II Float Switch; Model B35 External Cage Float Switch or ECHOTEL Model 961/962 Ultrasonic Switch**
Flow Alarm: **THERMATEL Model TD1/TD2 Thermal Dispersion Switch**

2. Inlet Separator The gas inlet separator vessel provides liquid/condensate removal prior to gas compression. A level switch actuates a high level alarm, shutdown protection, or opens a dump valve for disposal of accumulated liquid.
Point Level: **TUFFY II Float Switch; or ECHOTEL Model 961/962 Ultrasonic Switch**

3. Discharge Separator A dual-chamber discharge separator for oil/condensate removal features high-efficiency coalescing filter elements to limit oil carry-over. Level switches in the separator's lower and upper chambers provide high level alarm and shutdown capabilities. Point Level: **TUFFY II Float Switch; Model B35 External Cage Float Switch or ECHOTEL Model 961/962 Ultrasonic Switch**

4. Gas Flow To Turbine Movement of skid gas destined for the turbine—be it natural gas, methane, syngas, or biogas—is frequently monitored for mass flow. A flow switch offers alarm or shutdown protection in the event of gas flow interruption.
Continuous Gas Flow: **THERMATEL Model TA2 Thermal Dispersion Mass Flow Meter**
Flow Alarm: **THERMATEL Model TD1/TD2 Thermal Dispersion Switch**

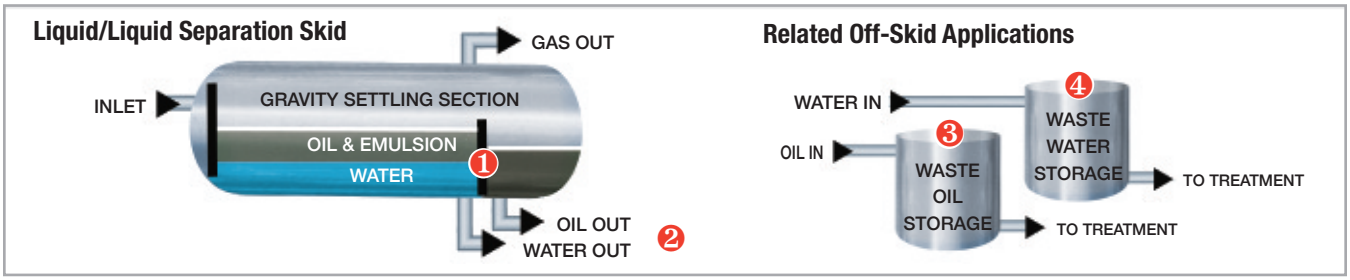
Liquid Separation Skid

Separation is essential to all processing industries. Skids vary according to the separation technology, including: distillation, gravity separation, coalescence, crystallization, adsorption, membrane processes, absorption, and extraction. Pre-separated mixtures can combine two or more states: solid-solid, solid-liquid, solid-gas, liquid-liquid, liquid-gas, gas-gas, or solid-liquid-gas mixtures.

Featured Skid Application: Oil-Water Separation An oil-water separator is designed to separate oil and suspended solids from the wastewater effluents in chemical and petrochemical processing plants and other industrial settings.

Three-Phase Separation Skid

Process Schematic Gravity separator design is based on the specific gravity difference and immiscibility of the oil and the wastewater. The oil will rise to the top of the separator, and the wastewater will settle beneath the oil. Each layer is then drawn off.



Level and Flow Applications

1. Separator The interface level measurement monitoring level within the separator should provide accurate and reliable level control despite the presence of an emulsion layer between the oil and water layers.
Continuous Level: **E3 MODULEVEL Displacer Transmitter**
Point Level: **Float or Displacer Level Switches**

2. Pump Protection Whether caused by a closed valve, a plugged line downstream or by pump cavitation, pumps operating in a reduced or no-flow condition can overheat and rupture the pump's seal causing a dangerous deviation in process pressure and temperature. A flow switch along a pump's discharge piping will actuate an alarm and shut down the pump when liquid flow drops below the minimum flow rate.
Flow Alarm: **THERMATEL Model TD1/TD2 Thermal Dispersion Switch for low-flow cutoff**

Off-Skid Applications:

3. Waste Oil Tank When volumes of separated oil are large, they are collected in a waste oil storage tank. When the collected oil reaches a pre-determined level, it is discharged for transport to treatment facilities for reclamation.
Continuous Level: **ECLIPSE Model 706 Guided Wave Radar Transmitter; PULSAR Model R86 Radar Transmitter or Model R82 Radar Transmitter**
Point Level: **TUFFY II Float Switch or ECHOTEL Model 961/962 Ultrasonic Switch**

4. Wastewater Tank Industrial plants generate water waste from separators, runoff, washing units, sumps, and other processes. When the collected liquid reaches a pre-determined level in waste tanks, it is discharged for transport to the treatment plant or to disposal facilities.
Continuous Level: **ECLIPSE Model 706 Guided Wave Radar Transmitter; PULSAR Model R86 Radar Transmitter or Model R82 Radar Transmitter**
Point Level: **Model B35 External Cage Float Level Switch or ECHOTEL Model 940/941 Ultrasonic Switch**

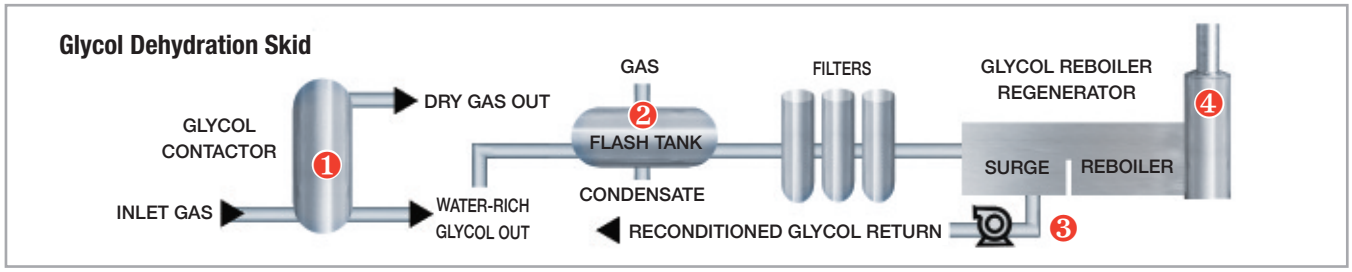
Natural Gas Dehydration Skid

Water vapor is the most common undesirable impurity found in natural gas. The problem of gas hydrate formation results in ice-like hydrates plugging flow lines and natural gas processing equipment to cause severe operational problems. Two methods employed for gas dehydration are expansion refrigeration, or absorption through the use of solid or liquid desiccants.

Glycol Skid for Natural Gas Dehydration

Featured Skid Application: Glycol Dehydration Skid The use of ethylene glycol liquid desiccants is one of the most established and reliable techniques for natural gas dehydration. Liquid desiccants include Diethylene glycol (DEG), Triethylene glycol (TEG), and Tetraethylene glycol (TETRA EG). The dehydration process is sometimes separated into two skids; one for glycol absorption and another for glycol reconditioning.

Process Schematic Ethylene glycol flows downward from the top of a tower and meets a rising mixture of water vapor and hydrocarbon gases. Dry gas exits from the top of the tower while the glycol/water mixture is pumped out of the bottom. The glycol and water are separated, and the glycol is recycled.



Level and Flow Applications

1. Glycol Contactor Wet natural gas first flows through a glycol contactor to remove all liquid and solid impurities. The gas flows upward through the contactor where it is contacted and dried by glycol. The 'pipeline-ready' dried gas passes through a heat exchanger and into the application loop. Water-rich glycol is withdrawn from the bottom of the absorber via a level controller.
Continuous Level: **ECLIPSE Model 706 Guided Wave Radar Transmitter**
Point Level: **TUFFY II Float Level Switch**

2. Flash Tank Skids are often provided with low pressure, three-phase flash separators to separate solution gas from the glycol and hydrocarbon condensate. A flash separator also removes up to 90% of methane emissions. The flash separator is installed on the rich glycol line between first pass of the glycol/glycol heat exchanger and the glycol filter bank.
Continuous Level: **ECLIPSE Model 706 Guided Wave Radar Transmitter**

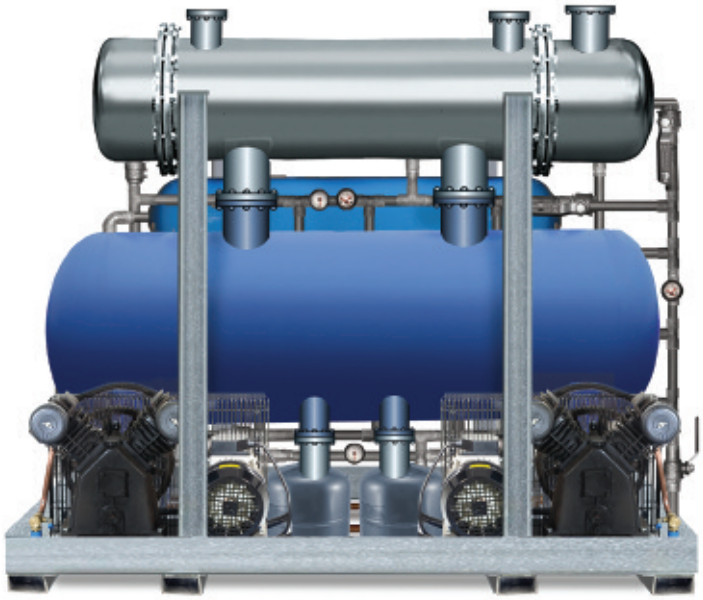
3. Glycol Circulation Pump Protection Glycol recirculation pumps operating in a reduced or no-flow condition can overheat, rupture the pump's seal, and disrupt the glycol reconditioning circuit. A flow switch along the pump's discharge piping will actuate an alarm and shut down the pump when liquid flow drops below the minimum flow rate.
Flow Alarm: **THERMATEL Model TD1/TD2 Thermal Dispersion Switch for low-flow cutoff**

4. Exhaust Gas Flow Monitoring Exhaust gases emitted from the reboiler that are discharged directly to the atmosphere can be monitored by a mass flow transmitter. Because flow rates and gas compositions fluctuate, the mass flow transmitter can be used to obtain relative flow indication.
Continuous Gas Flow: **THERMATEL Model TA2 Thermal Dispersion Mass Flow Meter**

Pump Skid

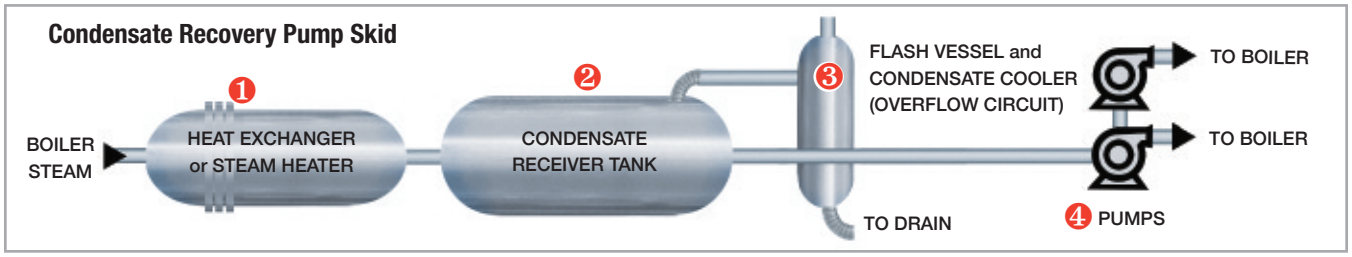
Pump skids for fluid transfer are often found in field and factory processes. Pump skids move a broad range of fluids: from asphalt, cement slurries and drilling mud to potable water, hot condensate and every imaginable liquid chemical. Pump skids typically range from 10 HP electric-powered units to 1500 HP diesel skids with multiple pumps.

Featured Application: Condensate Recovery Pump Skid
Because condensate leaving a steam trap retains up to 25% of its original heat energy, recovery and utilization of condensate reduces feedwater make-up, fuel, and water treatment costs. Pumping is necessary when the condensate return pressure is higher than the process/source condensate pressure.



Condensate Recovery Pump Skid

Process Schematic A condensate recovery pump skid typically has one to four pumps, a condensate receiver tank (15 to 1,500 gallons; 57 to 5,678 liters), control panel, gate valves, drain valves, blowdown valves, condensate piping, and may include a heat exchanger, flash vessel, or condensate cooler.



Level and Flow Applications

1. Heat Exchanger or Steam Heater In steam heaters, steam is condensed while the process fluid is heated. One common control arrangement cascades the temperature controller to a level controller. The controller senses the rise in level due to an increase in process load and opens a fluid valve.
Continuous Level: **ECLIPSE Model 706 Guided Wave Radar Transmitter or E3 MODULEVEL Displacer Transmitter**
Point Level: **Model B35 External Cage Float Switch**

2. Condensate Receiver Tank A receiver tank is placed below the heat exchanger to receive condensate that drains from the bottom. When the control senses the high level in the tank, it will actuate a valve to remove the accumulated condensate.
Continuous Level: **ECLIPSE Model 706 Guided Wave Radar Transmitter; E3 MODULEVEL Displacer Transmitter; PULSAR Model R86 Radar Transmitter; Model R82 Radar Transmitter or ECHOTEL Model 355 Non-Contact Ultrasonic Transmitter**
Point Level: **Model B35 External Cage Float Switch**

3. Flash Vessel and Condensate Cooler Condensate and flash steam enter the flash vessel. The condensate falls to the base of the vessel where it is drained. Level measurement is necessary to control flash tank level. The challenges are elevated temperatures and pressures.
Continuous Level: **ECLIPSE Model 706 Guided Wave Radar Transmitter**
Point Level: **Model B35 External Cage Float Switch**

4. Pump Protection Pumps operating in a reduced or no-flow condition can overheat and rupture the pump's seal. A flow switch along a pump's discharge piping will actuate an alarm and shut down the pump when liquid flow drops below the minimum flow rate.
Flow Alarm: **THERMATEL Model TD1/TD2 Thermal Dispersion Switch for low-flow cutoff**

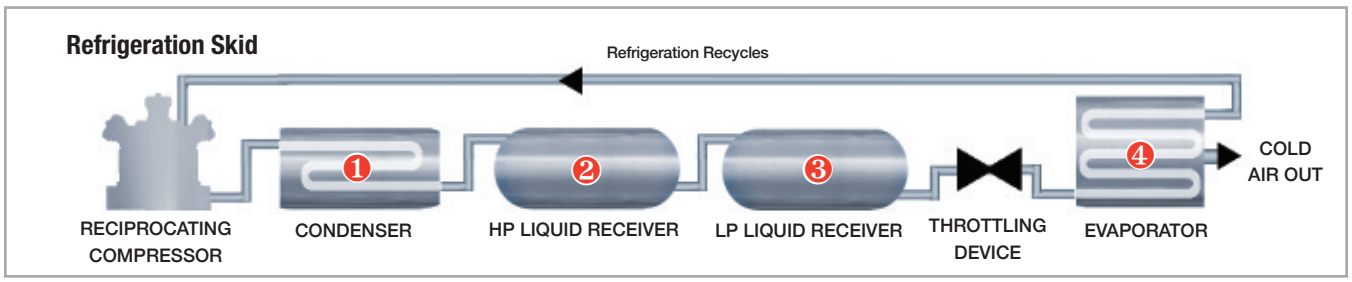
Refrigeration Skid

Aside from the obvious applications, like air conditioning and cold storage, refrigeration is used throughout industry to facilitate processing. It's employed for solvent recovery, liquefaction, gas separation, condensing, and heat exchange. In power generation, it cools inlet air for improved turbine performance. In oil refineries and chemical plants, refrigeration maintains low temperature processes, as in the alkylation of butane. Pharmaceutical refrigeration chills glycol in reactor vessels and immersion chillers, and removes water vapor and CO_2 from preparations.

Refrigeration Skid

Featured Skid Application: Ammonia Refrigeration Skid With the majority of countries now agreeing to eliminate hydro-chlorofluorocarbon coolants by 2020, absorption refrigeration (or, ammonia refrigeration) has become a leading industrial refrigerant.

Process Schematic The refrigeration process cycles ammonia (refrigerant) and water (absorbent) through a compressor, condenser, high and low pressure receiver tanks, a throttling device, and evaporators, from where the process recycles.



Level and Flow Applications

1. Condenser The condenser transfers heat from the refrigerant to a coolant medium—usually ambient air. Water-cooled condensers continuously circulate water to absorb refrigerant heat. Level controls monitoring the water basin include high and low level alarms.
Continuous Level: **ECLIPSE Model 706 Guided Wave Radar Transmitter or E3 MODULEVEL Displacer Transmitter**
Point Level: **TUFFY II Float Level Switch or ECHOTEL Model 910 Ultrasonic Switch**

2. High Pressure Liquid Receiver A high pressure receiver tank provides a buffer for liquid refrigerant as demand varies, and uses a recirculator to pump the refrigerant to multiple evaporator units. The tank is monitored for level.
Continuous Level: **ECLIPSE Model 706 Guided Wave Radar Transmitter**
Point Level: **Model B35 External Cage Float Switch**

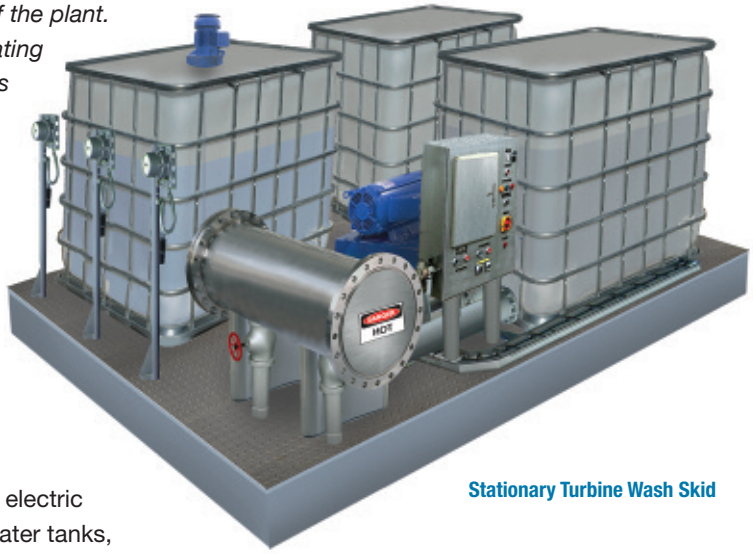
3. Low Pressure Liquid Receiver A low pressure receiver tank provides a buffer for liquid refrigerant as demand varies, and uses a recirculator to pump the refrigerant to multiple evaporator units. The tank is monitored for level.
Continuous Level: **ECLIPSE Model 706 Guided Wave Radar Transmitter**
Point Level: **External Cage Displacer Switch or ECHOTEL Model 940/941 Ultrasonic Switch**

4. Evaporator Water level in the evaporator needs to be controlled close to the setpoint. Higher levels can put the refrigerant compressor in danger due to liquid carryover, while lower levels will result in smaller heat transfer rates.
Continuous Level: **ECLIPSE Model 706 Guided Wave Radar Transmitter or E3 MODULEVEL Displacer Transmitter**
Point Level: **Model B35 External Cage Float Switch or ECHOTEL Model 940/941 Ultrasonic Switch**

Pump Protection Pumps operating on the skid are protected by flow switches that actuate an alarm in the event of no-flow conditions.
Flow Alarm: **THERMATEL Model TD1/TD2 Thermal Dispersion Switch for low-flow cutoff**

Turbine & Compressor Wash Skid

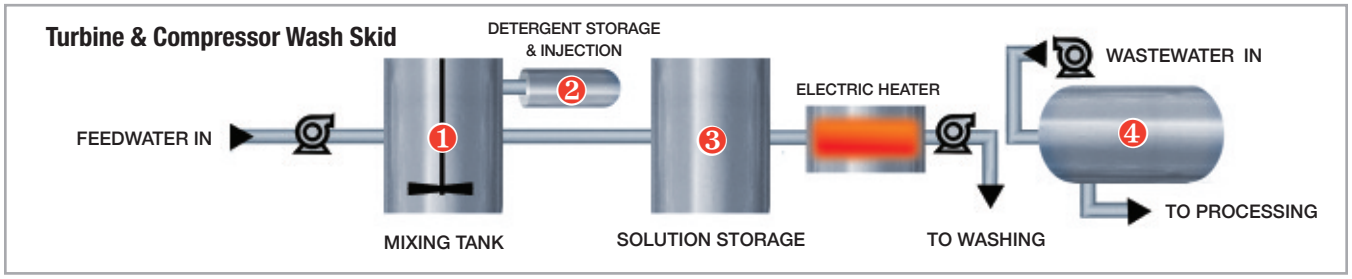
Fouling on the compressor blades of a gas turbine diminishes performance of the turbine and reduces the power output of the plant. The cause of fouling comes principally from dust and lubricating oil leakage from the compressor's main bearings. This results in a buildup of oily dirt and dust that causes increased surface roughness that can result in pitting of the blades. Performance gains of 2 to 4 percent are often achieved by regular cleaning.



Stationary Turbine Wash Skid

Featured Skid Application: Turbine & Compressor Wash Skid
Online/offline wash skids are used to store, pump and heat solutions for cleaning turbine blades and vanes. Skids range from small, wheeled carts to large, fixed-skid installations that clean multiple generators.

Process Schematic Turbine wash skids typically consist of an electric heater, cleaning solution, mixing and storage tanks, wastewater tanks, control system, pumps, instrumentation, valves and interconnects. Updated water wash pumping systems use a variable frequency drive (VFD) to accurately control high pressure water flow.



Level and Flow Applications

1. Cleaning Solution Mix Tank Mixing and blending the detergent concentrate with water is essential to the cleaning operation. An impeller in the mixing vessel accomplishes the blending of water and concentrates. Level controls monitor the mix tank and trigger alarms in the event of tank underfill or overfill incidents.
Continuous Level: **ECLIPSE Model 706 Guided Wave Radar Transmitter; PULSAR Model R86 Radar Transmitter or Model R82 Radar Transmitter**
Point Level: **Model B35 External Cage Float Switch; or ECHOTEL Model 940/941 Ultrasonic Switch**

2. Detergent Concentrate Storage To create the turbine wash solution, precise quantities of detergent concentrates are injected into the mix tank by a metering pump system. Concentrate storage tanks require stringent level monitoring in order to maintain continuous availability of the cleaning solution.
Continuous Level: **ECLIPSE Model 706 Guided Wave Radar Transmitter; E3 MODULEVEL Displacer Transmitter; PULSAR Model R86 Radar Transmitter or Model R82 Radar Transmitter**
Point Level: **TUFFY II Float Level Switch or ECHOTEL Model 910 Ultrasonic Switch**

3. Cleaning Solution Storage Tank The process-ready cleaning solution is stored in a metal or plastic tank. Tank level controls actuate tank-filling operations and protect against underfill and overfill conditions.
Continuous Level: **ECLIPSE Model 706 Guided Wave Radar Transmitter; E3 MODULEVEL Displacer Transmitter; PULSAR Model R86 Radar Transmitter; Model R82 Radar Transmitter or ECHOTEL Model 355 Non-Contact Ultrasonic Transmitter**
Point Level: **TUFFY II Float Level Switch or ECHOTEL 910 Ultrasonic Switch**

4. Spent Wash Solution Tank Spent water wash is collected in a dedicated collection tank and is periodically discharged as wastewater. Level monitoring will actuate fill valves and trigger an alarm in the event of an overfill incident.
Continuous Level: **ECLIPSE Model 706 Guided Wave Radar Transmitter; PULSAR Model R86 Radar Transmitter; Model R82 Radar Transmitter or ECHOTEL Model 355 Non-Contact Ultrasonic Transmitter**
Point Level: **TUFFY II Float Level Switch; or ECHOTEL Model 961/962 Ultrasonic Switch**

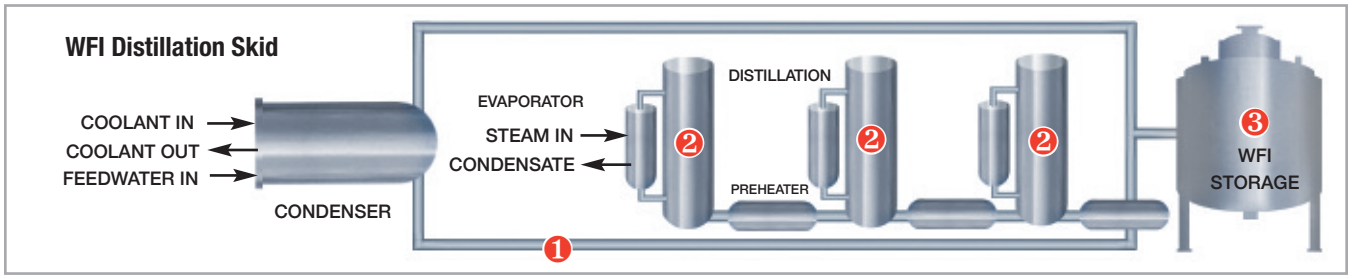
Water Purification Skid

Many industries require water purified beyond the standard municipal water supply. Two industrial purified water standards are U.S. Pharmacopoeia Purified Water (USP PW) and Water-for-Injection (WFI)—the highest purity industrial water. PW and WFI are widely used in food & beverage, cosmetics, pharmaceutical, biotech, and electronics industries.

Featured Skid Application: WFI Distillation Skid
Incorporating a multiple-effect still, this skid generates highly pure Water-for-Injection. The still can be configured to produce pure steam as an option. Level instrumentation should be of a hygienic design.

Water Purification Skid

Process Schematic WFI production consists of a series of interconnected pressure vessels—called distillation columns (or effects). On each column a heat exchanger acts as an evaporator, its upper chamber used to separate pyrogens. The purified water is stored in a dedicated WFI tank.



Level and Flow Applications

1. WFI Pump Protection Whether caused by a closed valve or by pump cavitation, pumps operating in a reduced or no-flow condition can overheat, rupture the pump's seal and cause a dangerous deviation in process pressure and temperature. A flow switch along a pump's discharge piping will actuate an alarm and shut down the pump when liquid flow drops below the minimum flow rate.
Flow Alarm: **THERMATEL Model TD1/TD2 Thermal Dispersion Switch for low-flow cutoff (Hygienic THERMATEL designs are available)**

2. Distillation Column Level Depending upon its configuration, a WFI skid may contain one distillation column (Single-Effect Still); or, four or more columns (Multiple-Effect Still). Level switches in the separation columns provide control for the feedwater supply and provide alarm capabilities to ensure that all columns are operating at correct liquid levels.
Continuous Level: **ECLIPSE Model 706 Guided Wave Radar Transmitter or E3 MODULEVEL Displacer Transmitter**
Point Level: **Model B35 External Cage Float Switch;or ECHOTEL Model 960/961 Hygienic Ultrasonic Switch**

3. WFI Storage Tank Stainless steel WFI tanks typically utilize hygienic clamp-style connections, an aseptic manway, and a spray ball for interior sanitization. The vessel and all components are fabricated to ASME Section VIII, Division 1 requirements. Tank sizes may range from 250- to 10,000-gallons (945- to 37,800-liters). A hygienic level controller monitors the tank level and can activate an alarm in the event of underfill and overfill conditions.
Continuous Level: **ECLIPSE Model 706 Guided Wave Radar Transmitter; PULSAR Model R86 Radar Transmitter or Model R82 Radar Transmitter**
Point Level: **ECHOTEL Model 960/961 Hygienic Ultrasonic Switch**

Guided Wave Radar

ECLIPSE and Horizon® transmitters are two-wire, loop-powered, 24 VDC level transmitters based on Guided Wave Radar (GWR) technology. Available in coaxial, twin rod and single rod probes, these leading-edge transmitters provide measurement performance well beyond that of many traditional technologies. Available with HART®, FOUNDATION fieldbus™ and PROFIBUS® outputs.

Thru-Air Radar

PULSAR Pulse Burst Radar level transmitters are the latest generation of loop-powered, 24 VDC, liquid level transmitters. They offer lower power consumption, faster response time and are easier to use than most loop-powered radar transmitters. PULSAR is available in a dielectric rod or horn antenna style.

Float & Displacer

Float-actuated switches are available in top-mount and side-mount styles for high or low level alarm interface, and pump control applications.Top-mounting displacer type level switches offer the industrial user a wide choice of alarm and control configurations. Displacer based electronic and pneumatic transmitters offer 4-20 mA or HART output.

Ultrasound

ECHOTEL contact and non-contact ultrasonic level transmitters and switches are available in a range of models to provide users with the features and options suitable for their specific application.
The Models 961 single-point and 962 dual-point switches are available with relay or current shift electronics.

Thermal Dispersion

THERMATEL Model TA2 Mass Flow transmitters provide reliable mass measurement for air and gas flow applications. THERMATEL Models TD1 and TD2 switches provide a high level of performance in flow, level and interface applications for air, gas and liquids. A hygienic version of the TD2 switch is available for sterile, Clean-In-Place applications.

Visual Indication

ATLAS, AURORA and Gemini are magnetically coupled liquid level indicators precision engineered and manufactured to provide accurate, reliable, and continuous visual level indication. AURORA provides redundant control with both a float and an ECLIPSE Guided Wave Radar transmitter.

RF Capacitance

Kotron® RF Capacitance level switches and transmitters are available in nine different models to provide a wide range of features to suit a large array of applications and process media.

Vibrating Rod

SOLITEL Vibrating Rod level switches provide reliable level detection of powders and bulk solids. This compact, integral switch is suitable for high or low level detection in hoppers or silos.

Magnetostriction

The Enhanced Jupiter® magnetostrictive transmitter provides a 4-20 mA output proportional to the level being measured or FOUNDATION fieldbus™ output. May be externally mounted to a MLI or inserted directly into the process vessel.

Special Application Series

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- ***Tank Overfill Prevention***
- ***Understanding Safety Integrity Level (SIL)***
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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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