

# *Special Applications Series:* **Critical Ethylene Level and Flow Applications and Case Studies**



## **Maintaining Safety, Reliability and Productivity**

In ethylene plants, balancing environment, health, and safety is essential while maximizing productivity.

Level and flow instrumentation will assist in preventing loss of primary containment and maintaining a safe environment inside of the tank. That's critical, because incident consequences are significant, with the direct cost of a work-related death of \$1M and indirect costs approximately 4 times greater.\* In addition, there is the lasting damage to your brand reputation and the compromised safety of the local community. Instrumentation can also assist in maximizing productivity, including interface type measurement in some of the harshest environments.

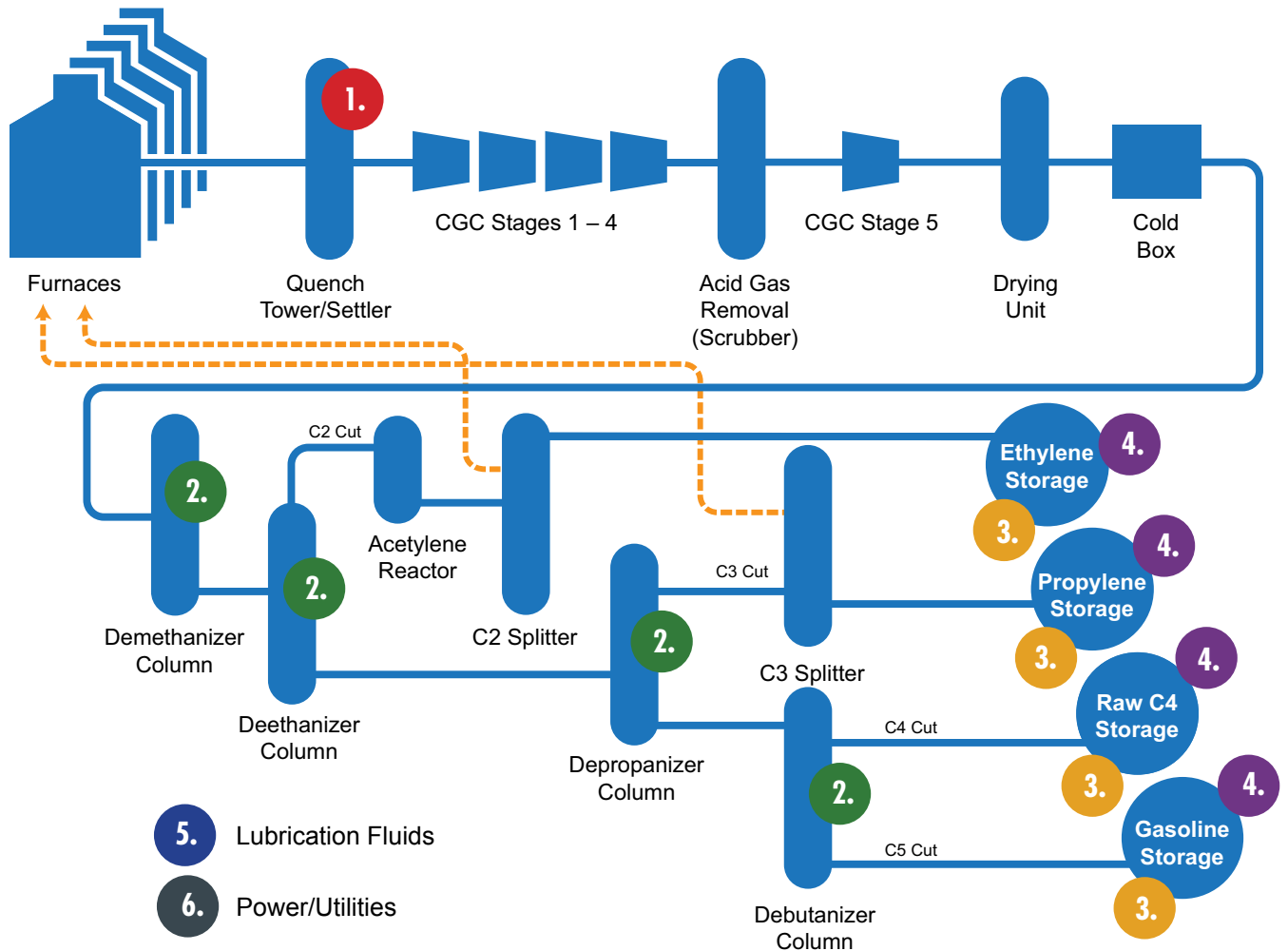
Today, conformance to IEC 61508 is the standard for reliability. Instruments with the appropriate SIL requirements are suitable for use in SIL 1, SIL 2 or SIL 3 safety loops as a single device or with redundancy.

This brochure contains a wide spectrum of Magnetrol® and Orion Instruments® level and flow products that conform to the latest safety standards, including SIL requirements, to assist in the most critical applications in ethylene plants.

\*National Safety Council's "Injury Facts" via Chemical Processing Magazine

# Ethylene Process Flow Diagram

This diagram depicts a typical ethylene plant and indicates key applications.



## Key Applications

- 1.** Quench Tower/Settler
- 2.** Fractionation Towers
- 3.** Liquefied Gas Storage/Cryogenic
- 4.** Tank Blanketing
- 5.** Lubrication Fluids
- 6.** Power/Utilities

# 1. Quench Tower/Settler



## Application:

- Feedstock comes into the plant and goes through the ethylene furnaces (pyrolysis)
- Once cracked into a variety of hydrocarbons and hydrogen, it immediately begins to recombine into larger molecules
- To prevent these reactions, the cracked vapor goes through the quench towers to cool using oil or water
- The largest hydrocarbons are carried with the water into the quench settler or the quench water separation drum (QWSD)

## Challenges:

- Loss of control of interface will reduce ethylene production due to inefficient quench tower operation
- As feedstock is increased, more cooling fluids are required
- The residence time in the settlers needs to be minimal to maintain composition and prevent secondary reactions
- A quench settler or QWSD that catches the hydrocarbon liquids and water from the quench tower creates an interface in the QWSD and possibly an emulsion layer if too much caustic is added
- The interface is important to recirculate the quench water from the settler to the tower and not recirculate the hydrocarbons which will reduce productivity and potentially cause fouling of equipment; also applies to quenching oil versus tars and other heavy hydrocarbons
- If fluid composition negatively changes in the quench tower, less ethylene is produced from the feedstock reducing efficiency and productivity.
- Regulating an interface level can also aid in using less caustic if quench water is used



## Instrumentation Solutions:

- Eclipse® Model 706 Guided Wave Radar Transmitter
- Jupiter® Model JM4 Magnetostrictive Level Transmitter

## 2. Fractionation Towers

### TOWER

#### Application:

- Separating substances based on differences in volatilities/boiling points

#### Challenges:

- Level measurement at the bottom of a distillation tower controls the “bottoms” product rate
- Poor level control could allow liquid to back up over the stripping trays causing damage and reduced yields
- Level that’s too low may cause pump cavitation

#### Instrumentation Solutions:

- Eclipse® Model 706 Guided Wave Radar Transmitter
- Digital Displacer E3 Modulelevel® Liquid Level Transmitter
- Aurora® or Atlas™ Magnetic Level Indicator



### REBOILER

#### Application:

- Provides heat to the bottom of a distillation tower to drive the separation process

#### Challenges:

- Excess reboiler liquids (bottoms or blow-down) overflow a baffle where level is controlled by means of a level controller
- When level becomes too low, it will affect the maximum flow rate of bottoms product that can be drawn off
- Inaccurate reboiler level can also degrade composition control for material balance

#### Instrumentation Solutions:

- Eclipse® Model 706 Guided Wave Radar Transmitter
- Digital Displacer E3 Modulelevel® Liquid Level Transmitter
- Aurora® or Atlas™ Magnetic Level Indicator



### CONDENSER

#### Application:

- Changes a gas or vapor to a liquid; condensation is employed in the reflux process to improve the efficiency of distillation

#### Challenges:

- Tower vapors are condensed prior to entering an accumulator (reflux drum) where level can assist controlling tower pressure

#### Instrumentation Solutions:

- Eclipse® Model 706 Guided Wave Radar Transmitter
- Aurora® or Atlas™ Magnetic Level Indicator



### REFLUX DRUM

#### Application:

- Uses reflux system to achieve a more complete product separation where condensate is cycled back to the tower to provide cooling and condensation of upward flowing vapors

#### Challenges:

- Condensed liquid leaves reflux drum under level control. Poor liquid level can cause expensive operating problems and product degradation if the proper amount is not returning to towers

#### Instrumentation Solutions:

- Eclipse® Model 706 Guided Wave Radar Transmitter
- Digital Displacer E3 Modulelevel® Liquid Level Transmitter
- Aurora® or Atlas™ Magnetic Level Indicator



3.

## Liquified Gas Storage/Cryogenic



### Application:

- Many liquids are cooled at normal atmospheric pressure while others require pressurization
- Feedstock to an ethylene plant's fractionation towers contains a liquid cryogenic hydrocarbon mixture as a result of going through compression and refrigeration trains after the quench tower

### Challenges:

- Above or below-ground insulated storage tanks are built to specifically hold liquefied gases and minimize evaporation
- Instruments contend with pressurization, extreme low temperatures and low dielectric media

### Instrumentation Solutions:

- Eclipse® Model 706 Guided Wave Radar Transmitter
- Pulsar® Model R86 Pulse Burst Radar Transmitter
- Echotel® 961 and 962 Single and Dual Point Ultrasonic Level Switches
- Aurora® or Atlas™ Magnetic Level Indicator



4.

## Tank Blanketing



### Application:

- Nitrogen is the ideal tank blanketing gas when injected into the vapor space of a storage tank to prevent ignition of flammable liquids, inhibit vapor loss, and possibly protect the products from oxygen degradation

### Challenges:

- Extreme low flows and pressures
- Economical mass flow totalization

### Instrumentation Solutions:

- Thermoel® Model TA2 Thermal Mass Flow Meter



## 5. Lubricating Fluids



### Application:

- Liquids used for barrier or buffer fluids are essential in maintaining proper operation of equipment requiring mechanical moving parts, such as pumps

### Challenges:

- At a minimum, low level indication is required to ensure there is liquid in the vessel or seal pot
- Newer standards, such as API 682 Revision 4, are moving towards continuous measurement utilizing transmitters

### Instrumentation Solutions:

- Eclipse® Model 706 Guided Wave Radar Transmitter
- Echotel® 961 and 962 Single and Dual Point Ultrasonic Level Switches



## 6. Power/Utilities



### Application:

- Heat Recovery Steam Generator (HRSG) from cracked gases for additional steam and power generation

### Challenges:

- Improving heat rate efficiency through feedwater heater level control
- Utilities steam and condensate recovery system
- Optimizing makeup water treatment, energy management, steam generation cycle, condensate and waste heat recovery

### Instrumentation Solutions:

- Eclipse® Model 706 Guided Wave Radar Transmitter
- Aurora® or Atlas™ Magnetic Level Indicator



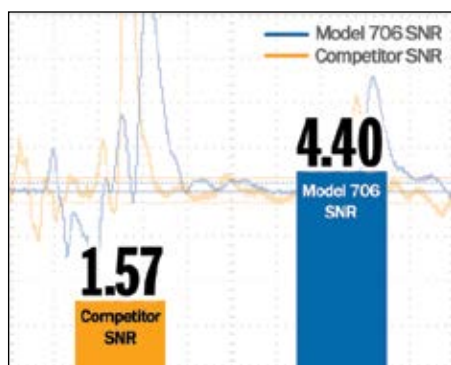
# Case Studies

## Case Study 1

**Company:** One of the world's largest oil & gas and petrochemical companies headquartered in Europe

**Challenge:** Problems occurred with multiphase applications involving hydrocarbon level with water bottoms and gas vapor space. Guided wave radar was being used, but it did not produce a reliable signal throughout the length of the probe and the interface made it difficult to distinguish between upper level and water below. This threatened LOPC due to error in measurement.

**Solution:** ECLIPSE® Model 706 was found to be best-in-class guided wave radar when tested side-by-side. It tracked level up to the device's flanged process connection (above 100% level point), even with water bottoms. There were no dead zones or blind spots at top of probe. The ECLIPSE prevented LOPC and the superior signal strength went through the hydrocarbon level down to the water level.

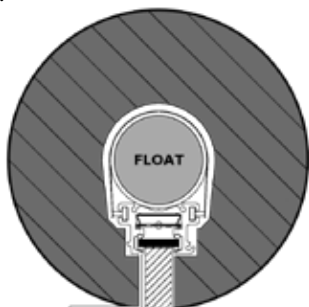


## Case Study 2

**Company:** Ethylene plant in China requiring clear visual indication of level

**Challenge:** Required clear visual indication of level from challenging cryogenic applications including methane, ethane, ethylene and propylene. SGs ranged from 0.3–0.8.

**Solution:** The Orion Instruments® Atlas™ Magnetic Level Indicator (MLI) has physical floats in the MLI chamber that can simultaneously meet cryogenic and low SG requirements. The careful float design allows level to be tracked accurately even as temperature and SG shifts. Cryogenic visual flags or indicators (frost shield) prevent frosting to provide a clear visual indication of liquid level.



## Case Study 3

**Company:** Oil & gas and petrochemical company in China

**Challenge:** The company required tank blanketing for their flammable liquid tanks to create an inert environment in the vapor space. Nitrogen was commonly utilized and required monitoring to account for leakage and verify flow. Users wanted to limit gas to an as-needed basis. They needed to monitor not only pressure, but the flow, in order to find balance of gas usage and cost savings.

**Solution:** Thermatel® TA2 thermal mass flow meters came fully calibrated and configured so the company could simply install and power up. THERMATEL TA2 is also effective in extreme low pressures. In addition, total cost of ownership was reduced with calibration verification procedures that could be performed in the field. Recalibrations can cost tens of thousands of dollars and cause process downtime or loss of measurement.



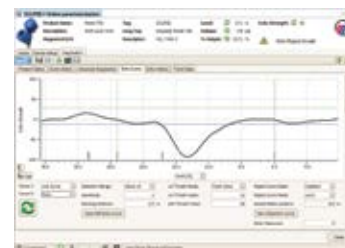
## Case Study 4

**Company:** Refinery and petrochemical facility in Canada that primarily produces ethylene

**Challenge:** The facility's reliability and safety groups needed level devices that met SIL requirements for emergency shutdown (ESD) and safety systems. Both SIL 1 and SIL 2 applications exist at this site.

The facility needed to implement proof test procedures for their instrumentation and control devices to meet safety loop requirements. One proof test requirement was for the mA output to be set below 4 mA and above 20 mA; this was the necessary output range to meet the NAMUR NE43 recommendation.

**Solution:** The Orion Jupiter® JM4 magnetostrictive transmitter was chosen. It allowed current output to be taken low or high per NAMUR NE43. The advanced diagnostics of the JM4 allowed users to pull echo curves from the transmitter display or access them externally using a PC by wiring into the current loop.



# The Right Solutions for Every Application



## Radar

Eclipse® Model 706 Guided Wave Radar Transmitter  
Pulsar® Model R86 (26 GHz) Pulse Burst Radar Transmitter  
Pulsar® Model R96 (6 GHz) Pulse Burst Radar Transmitter

## Thermal Dispersion

Thermatel® Model TA2 Thermal Mass Flow Meter  
Thermatel® Models TD1 and TD2 Flow/Level/Interface Switches

## Ultrasonic

Echotel® 961 Single Point Ultrasonic Level Switch  
Echotel® 962 Dual Point Ultrasonic Level Switch

## Buoyancy

Digital E3 Modulelevel® Liquid Level Displacer Transmitter  
Model A10 Single-Stage Displacer Switch

## Magnetostrictive

Jupiter® Model JM4 Magnetostrictive Level Transmitter

## Magnetic Level Indicators

Aurora® Magnetic Level Indicator  
Atlas™ Magnetic Level Indicator



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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.