

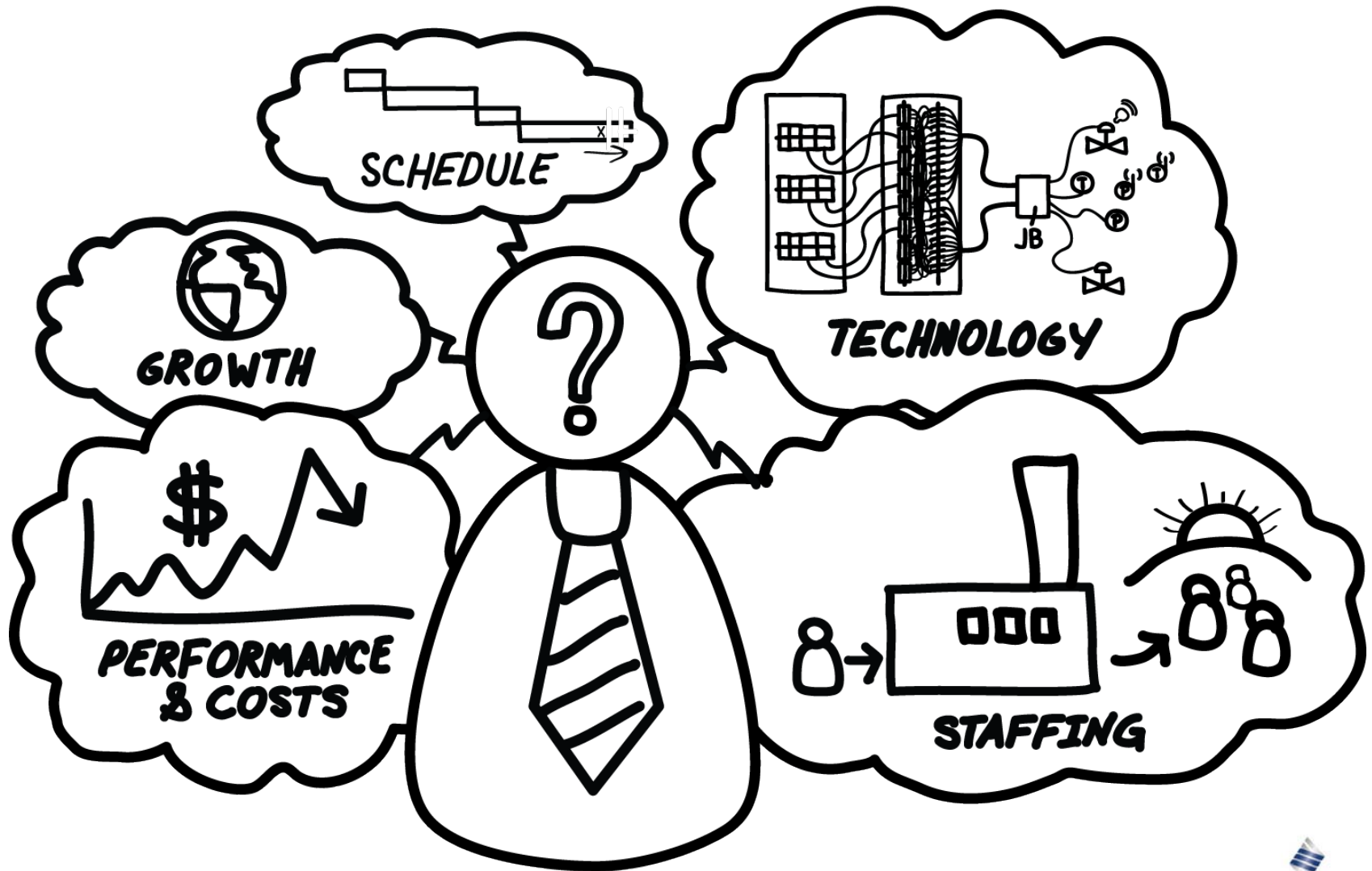


Emerson Solution for Power Industry

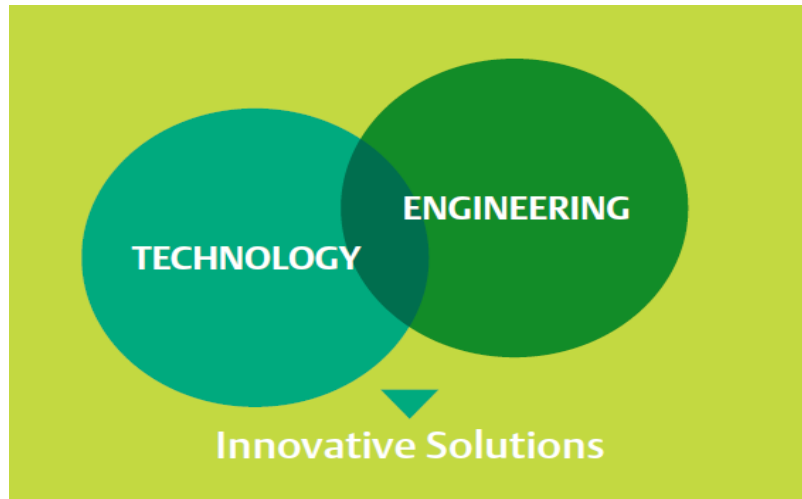


EMERSON
Process Management

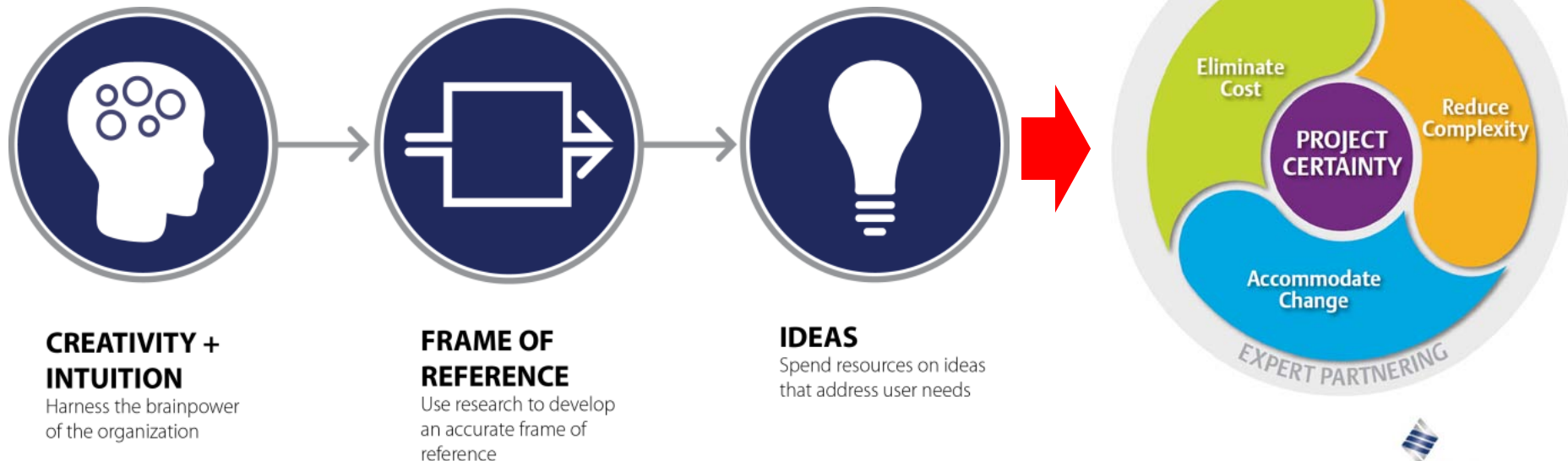
Taking On Your Toughest Challenges



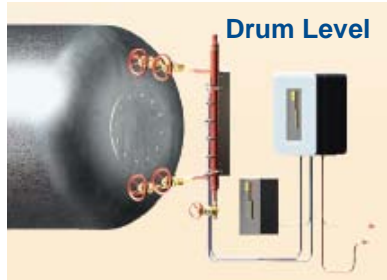
The Answer is: Specialist Solutions



Technology and engineering come together to create solutions for the benefit of customers, driven without compromise for a world in action.



Specialist Solutions for Power Plant

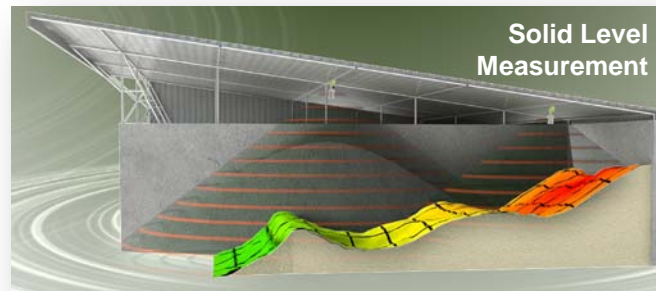


Asset Management

Emerson's CS 6500 Machinery Health Monitor



Fuel Flow Measurement

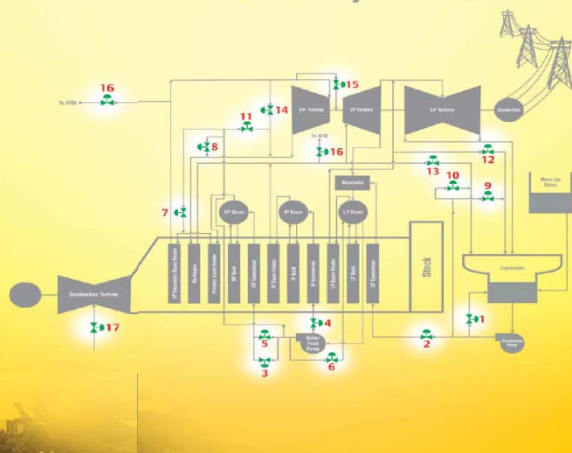


Emerson Proprietary

Final Control & Regulate

Actuation	Control Valves	Pressure Regulators
Valve Instrumentation	Severe Service Products	

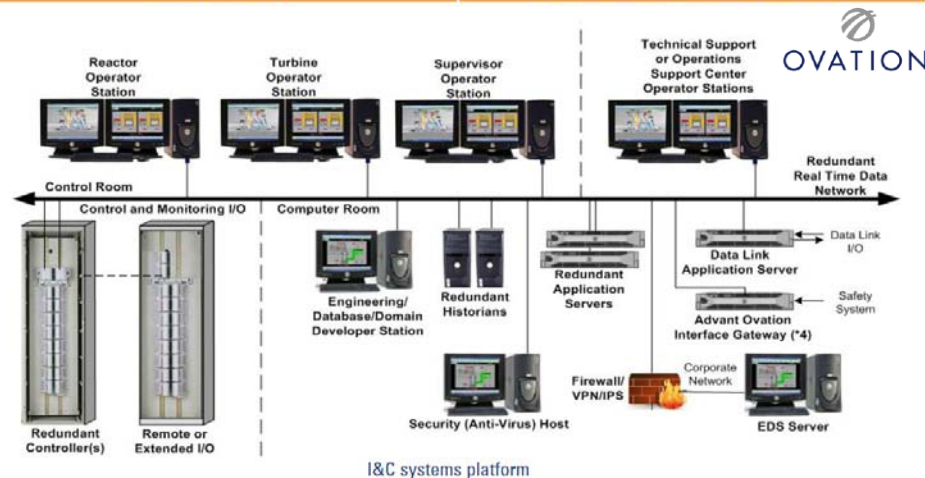
Combined Cycle Power Plant



1. Condensate Pump Recirculation
2. Economizer Level Control
3. Boiler Feed Water Start-up
4. IP Drum Level
5. HP Drum Level
6. Boiler Feedwater Recirculation
7. Superheat Attenuator Spray
8. Reheater Attenuator Spray
9. LP Turbine Bypass Spray
10. IP Turbine Bypass Spray
11. HP Turbine Bypass Spray
12. LP Turbine Bypass
13. IP Turbine Bypass
14. HP Turbine Bypass Valve
15. Gland Steam Seal
16. Sky Vent
17. Fuel Control

Operate & Manage

Process Control	SCADA	Safety & Compliance	Operations Management
Asset Reliability		Decision Support & Data Management	



Measure & Analyze

Pressure	Temperature	Level	Flow	Analytical
Safety & Reliability Monitoring		Tank Gauging	Fiscal Metering	

Superheated Steam Flow



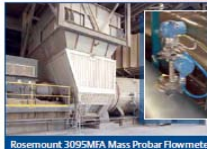
Main Steam Temperature



Emission Analysis (CEMS)



Total Air Flow



Drum Level



OPM 3000 opacity/Dust density



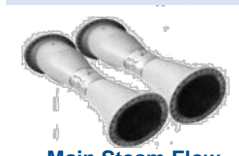
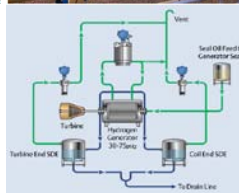
Furnace Pressure



Heater Vessel Level



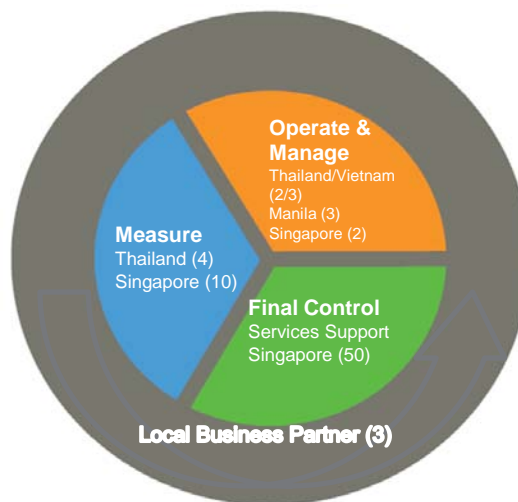
Oxymeter 4000 SMART Insitu



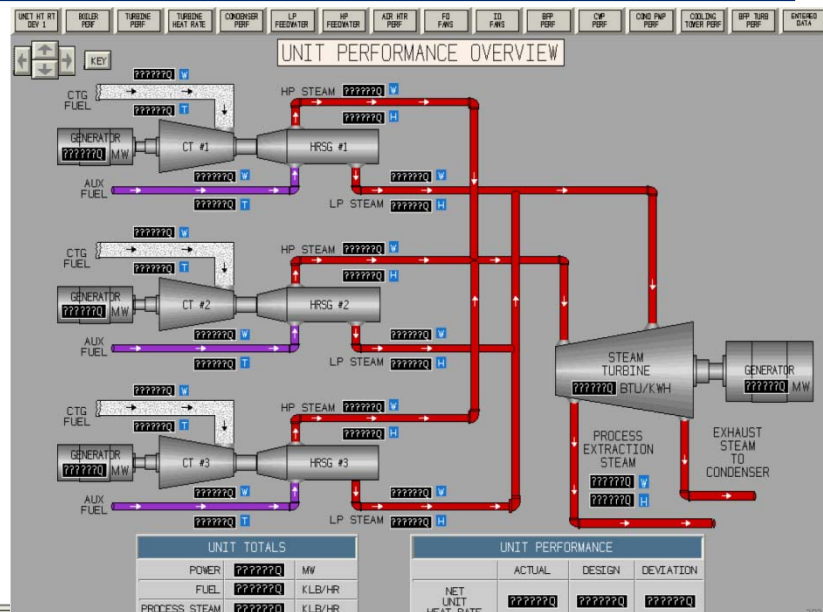
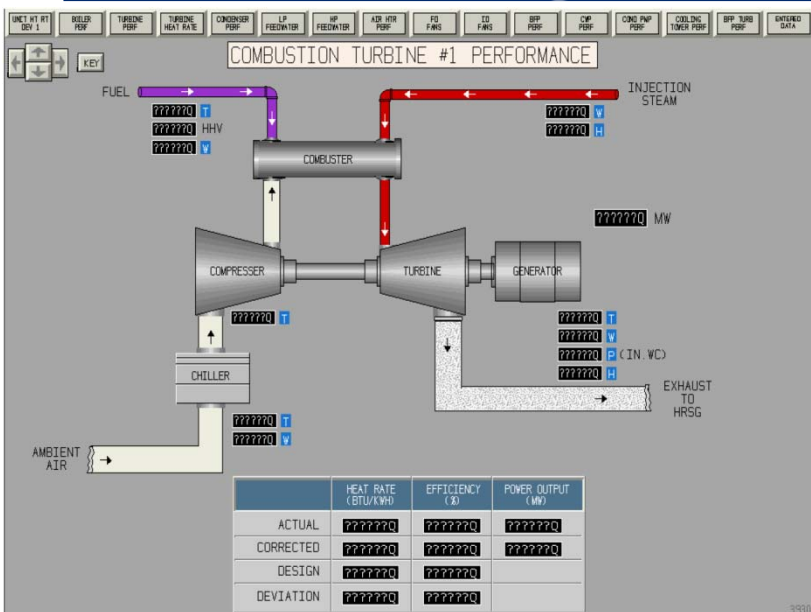
Main Steam Flow

Solve & Support

Plan & Design	Implement & Build	
Improve & Modernize	Operate & Maintain	Train & Develop



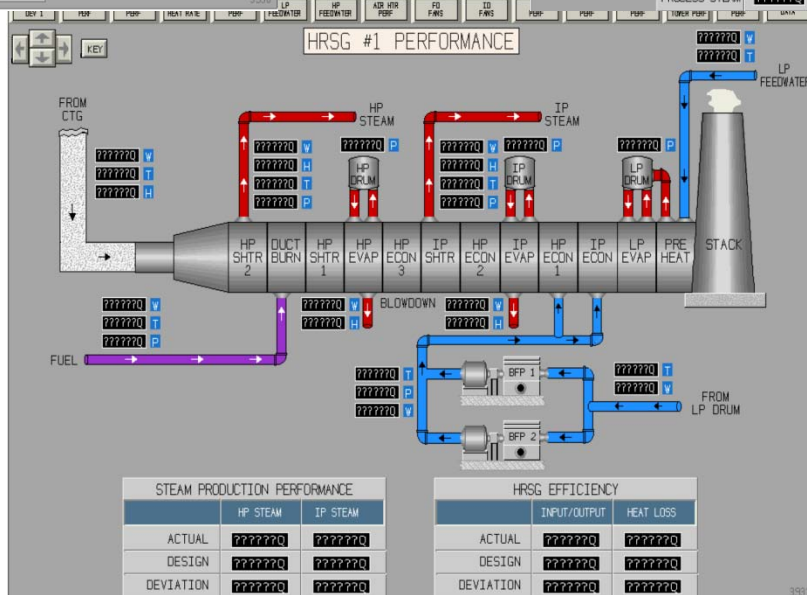
Intuitive Operational Control – Gas Fired



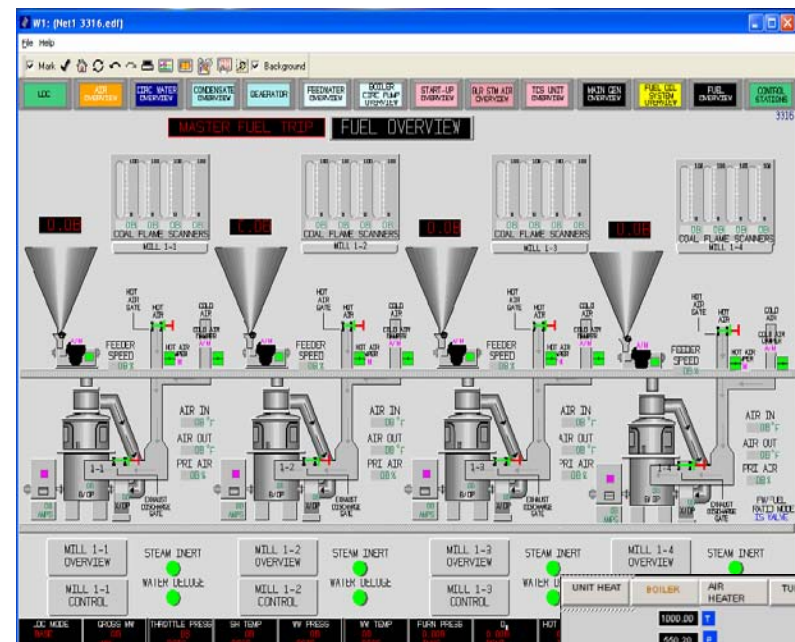
Simple Cycle

Combined Cycle

HRSG Control

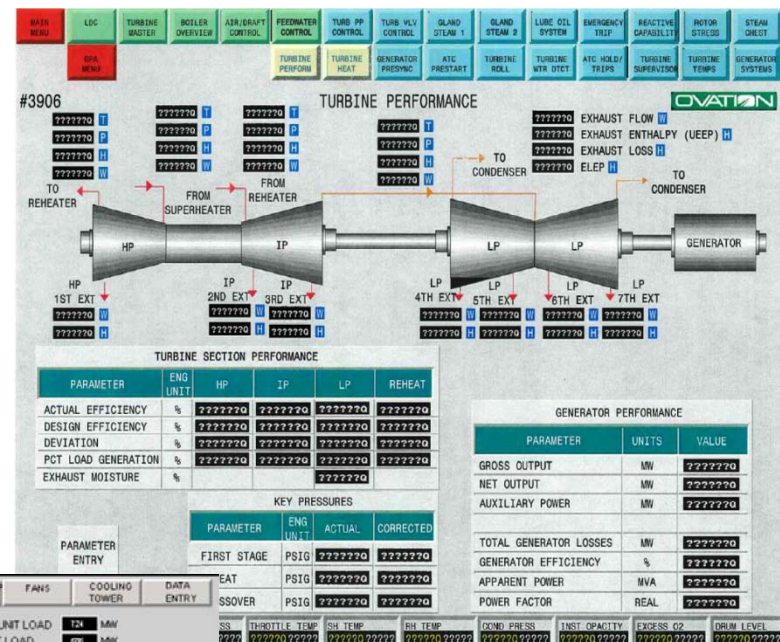


Intuitive Operational Control – Coal Fired

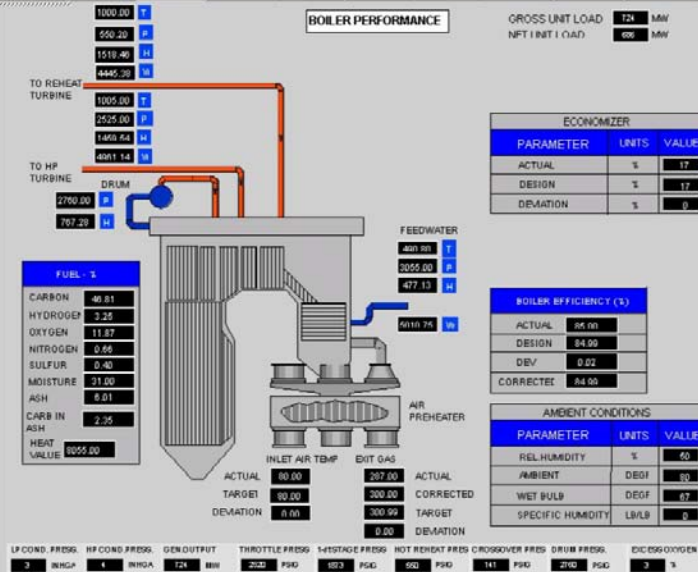


Burner / Mill Control

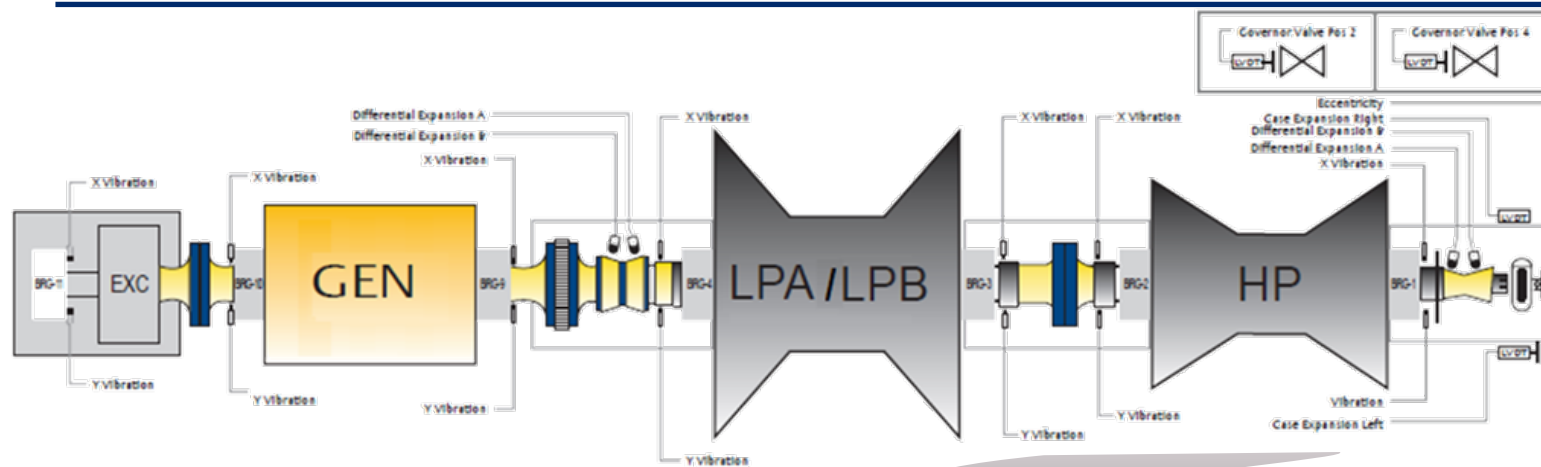
Boiler Control



Steam Turbine Control



Machinery Health Monitor for Turbomachinery



2-Ch, Micro-processor based Monitors

- Independent monitors
- Extensive self-checking
- Self-temperature monitoring

Rack Interface Communication Module

- Modbus
- Dual-path Serial
- Ethernet

Relay Module

- 2-out-of-3 Voting
- Flexible Voting Logic
- Alert, Danger, OK and System relays
- Time Delay
- Trip Multiply

Prediction Ready

- All Racks easily upgrade to complete Protection and Prediction solution

Buffered Outputs

- Raw vibration waveform
- Connectivity with any data collector for balancing, recording or machine diagnostics

Hardware

- 19" rack mount
- Hot swappable protection cards

4-20mA Outputs

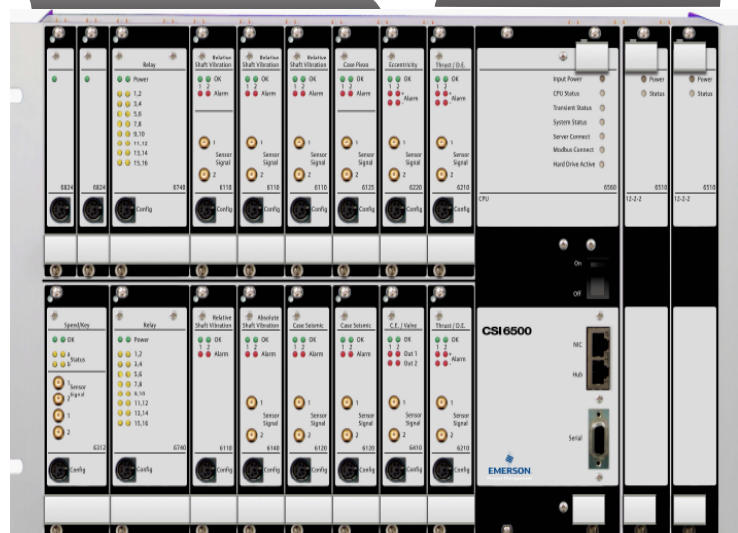
- Provides analog input to PLC's or process control proportional to vibration

Full TSI

- Case Expansion
- Differential Expansion
- Eccentricity
- Thrust position
- Relative Vibration
- Temperature
- Speed
- Zero speed
- Absolute Vibration

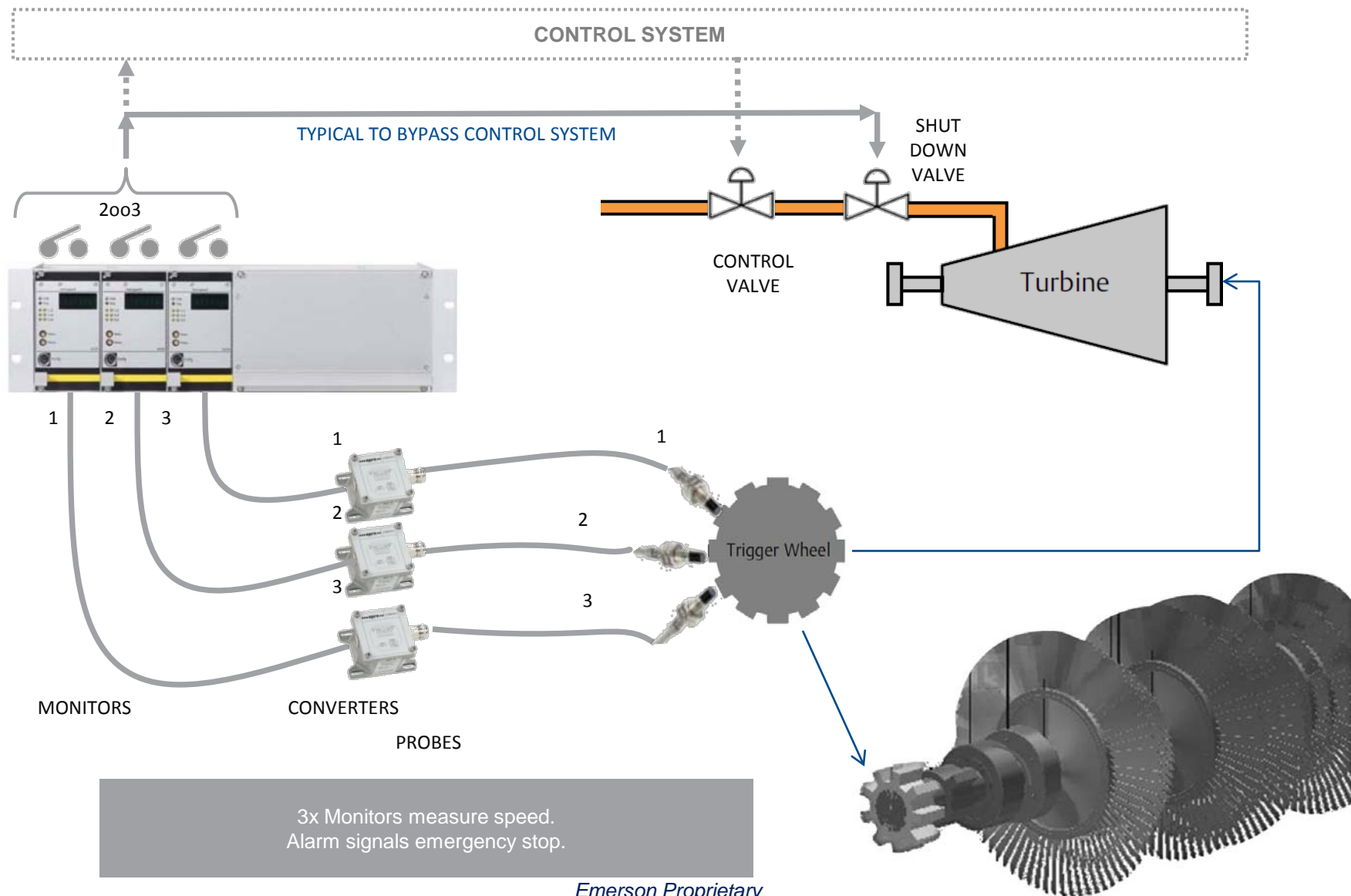
Dual,
Redundant 24
VDC Power

API 670 compliant



TSI = Turbine Supervisory Instrumentation

SIL 3 Over speed Protection



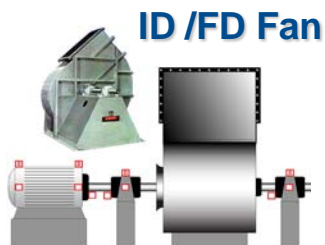
Asset Reliability Improvement



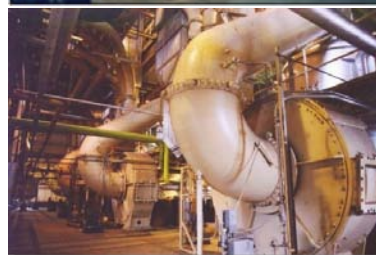
**Cooling Pump for
Boiler Feed Pump**



Cooling Tower Fan
(long distance – Far away)



ID /FD Fan



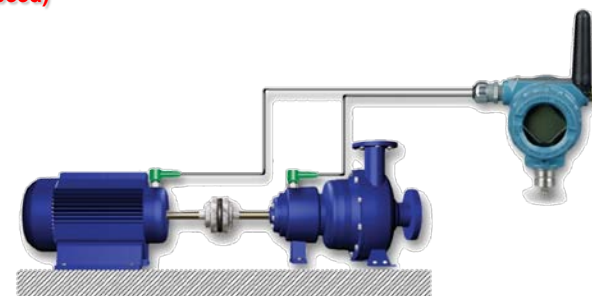
Coal Pulverizers
(Low Speed)



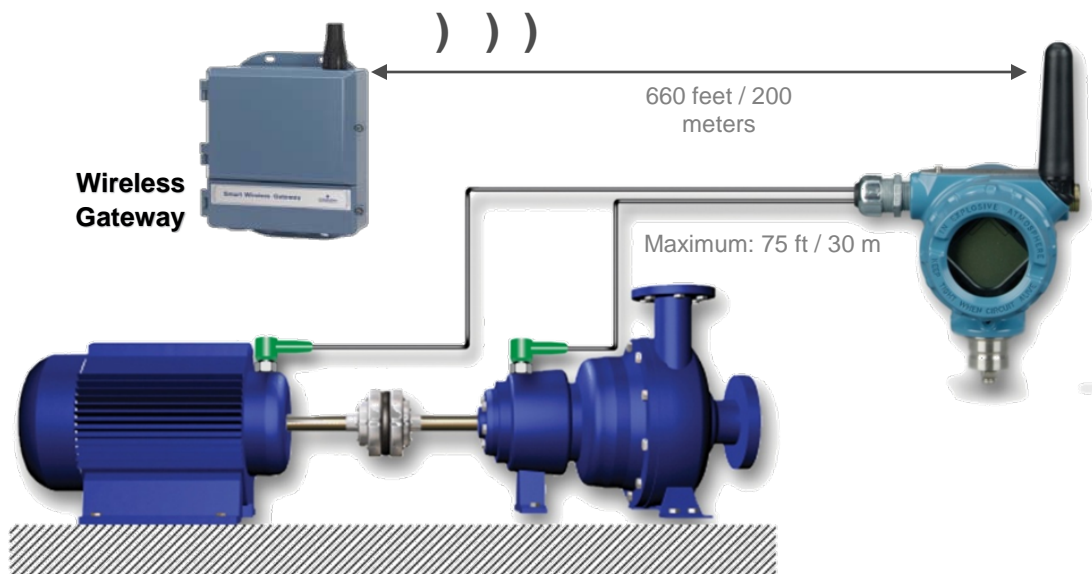
Sea Water Cooling Pump
(long distance – Far away)

Issues to provide Asset Reliability Technology

- Cost of On Line Asset Monitoring System
- Long Distance
- Sensor Mounting
- Switch Technology

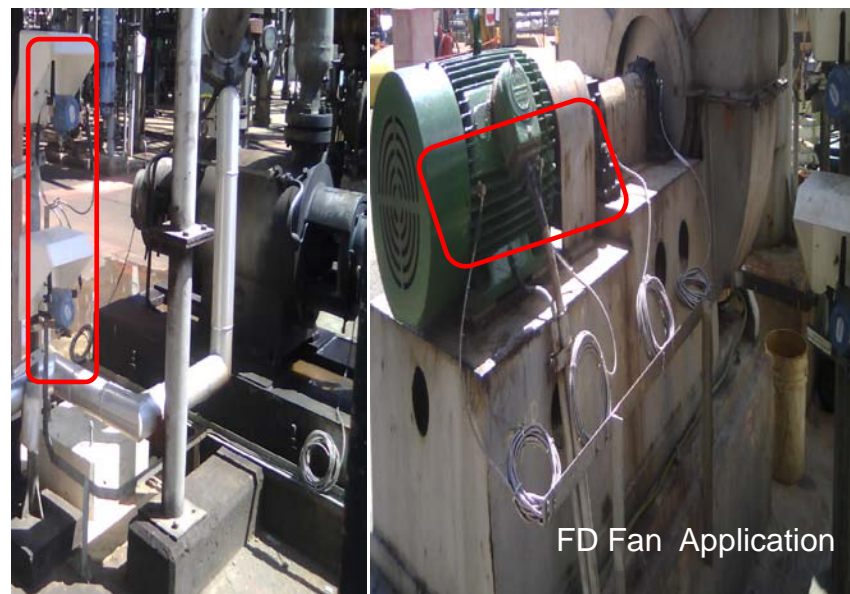
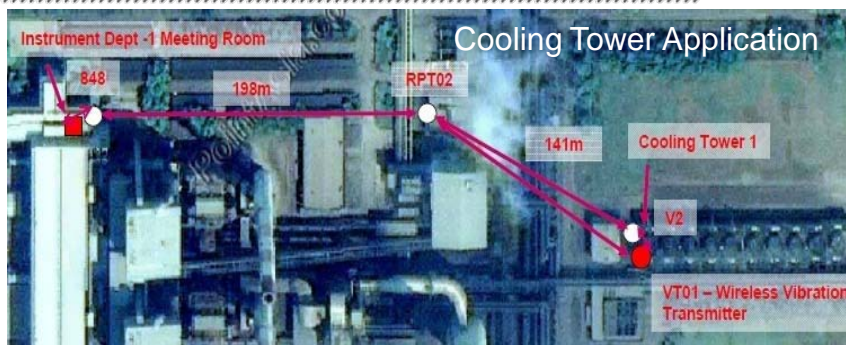


Asset Reliability Improvement

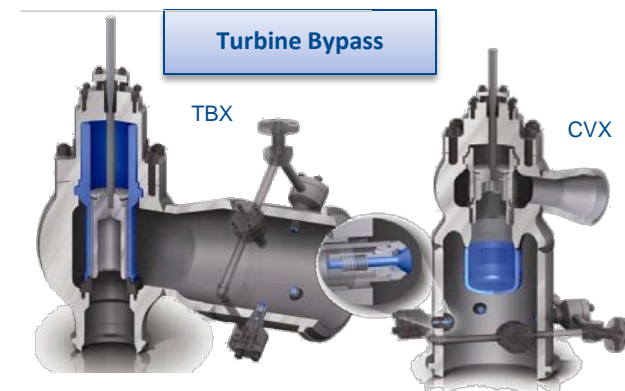
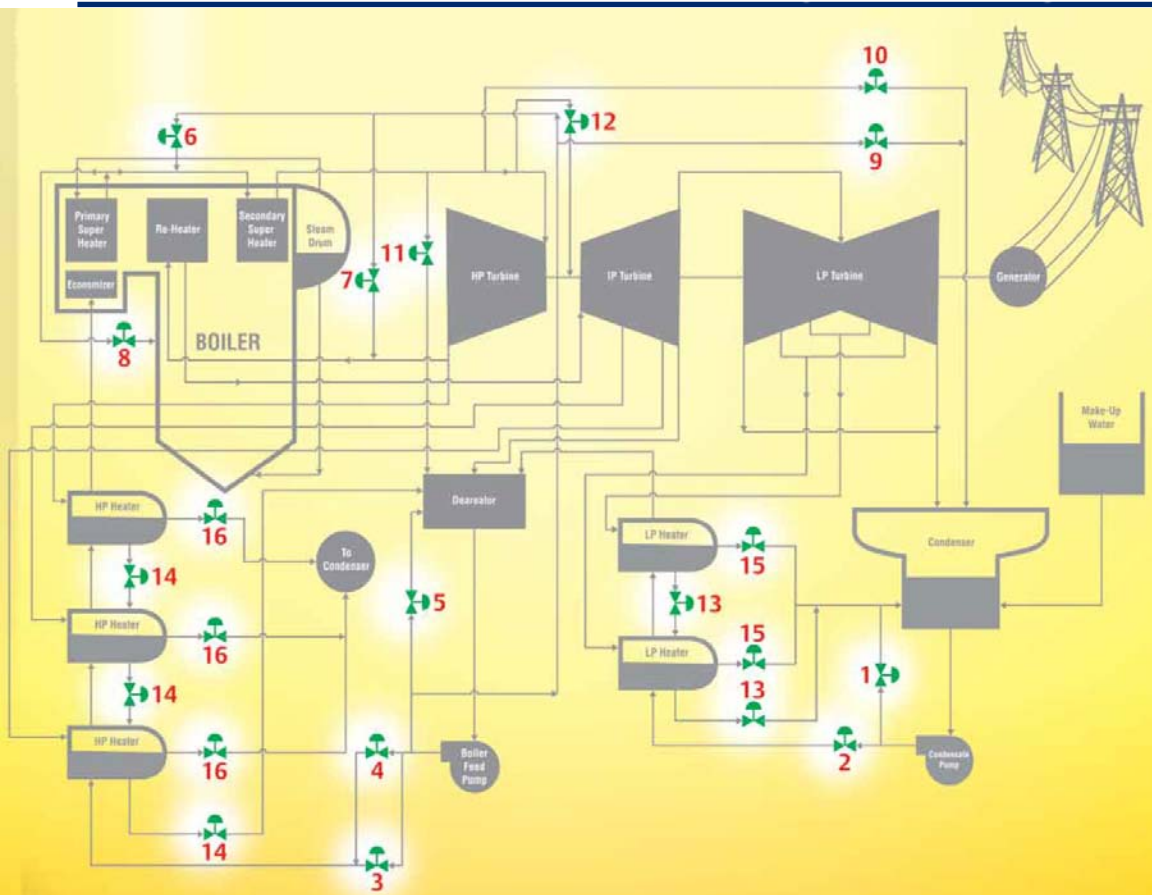


Outputs (scalar values)

1. **Overall Vibration**
Units: Velocity (in/sec or mm/sec)
Range: 2 Hz – 1000 Hz (per ISO 10816 standard).
2. **PeakVue™ Vibration**
Units: G's Peak
Range: 1,000 Hz – 20,000 Hz
3. **Temperature**
Range: -30 to +250 F / -34 to +120 C
Comment: Embedded temperature sensor in BLUE accelerometer



Critical and Serve Service Control Valve (Coal Fired)



The Condensate System

- 1 Condensate Pump Recirculation Valve.
- 2 Deaerator Level Control Valve..

The Feedwater System

- 3 Boiler Feedwater Startup Valve
- 4 Boiler Feedwater Regulator Valve.
- 5 Boiler Feedpump Recirculation Valve.

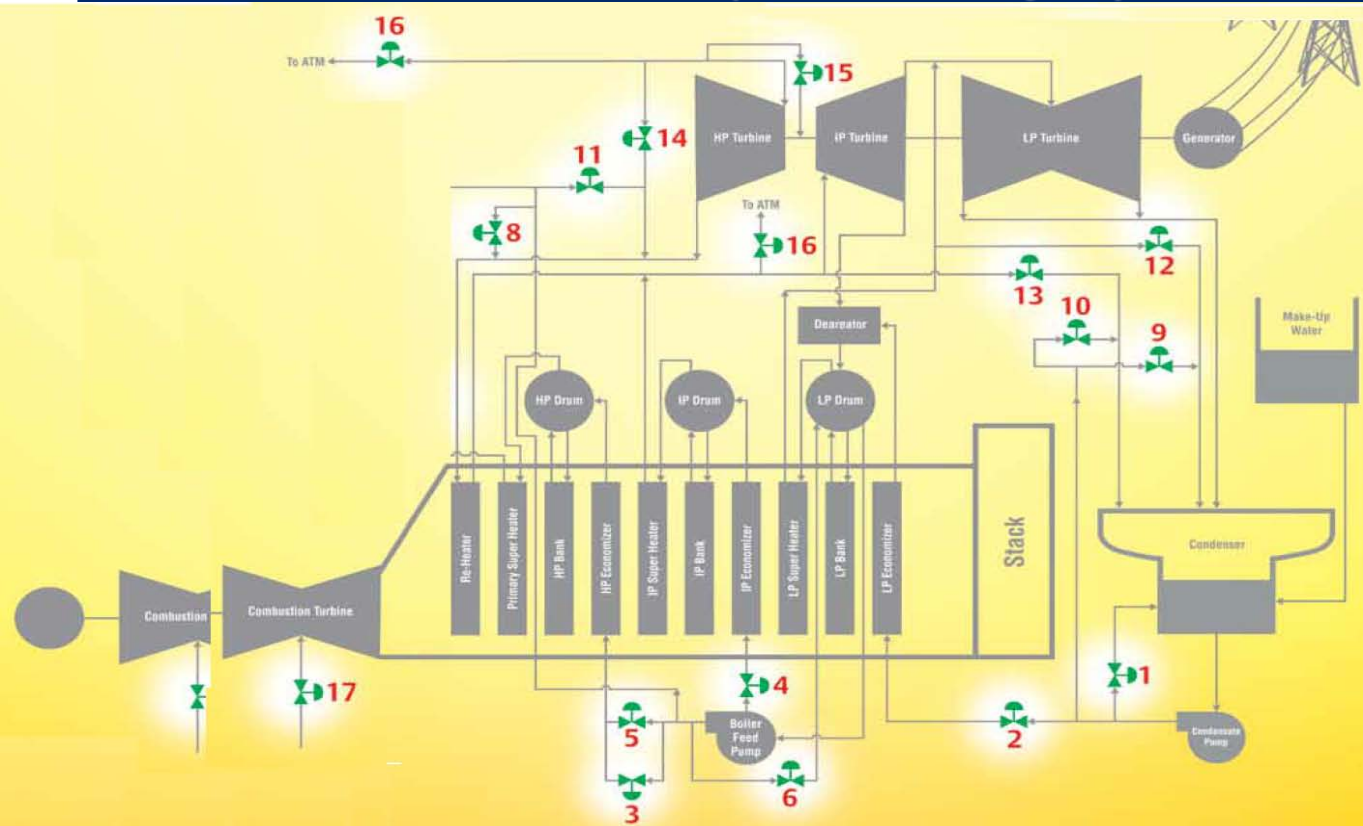
The Main Steam System

- 6 Superheat Spray Valve (and Attemperator)
- 7 Reheat Spray Valve (and Attemperator)
- 8 Sootblower Valve
- 9 HP Turbine Bypass Spraywater Valve
- 10 HP Turbine Bypass Valve
- 11 Deaerator Pegging Steam Valve.
- 12 Steam Seal Regulator Valve

The Heater Drain System

- 13 LP Feedwater Heater Normal Drain Valve
- 14 HP Feedwater Heater Normal Drain Valve
- 15 LP Feedwater Heater Emergency Drain Valve.
- 16 HP Feedwater Heater Emergency Drain Valve

Critical and Serve Service Control Valve (Combined Cycle)



The Condensate System

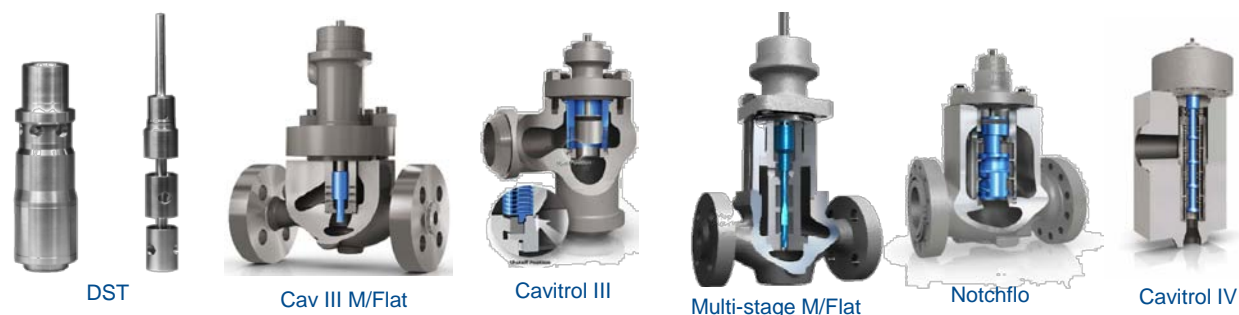
- 1 Condensate Pump Recirculation Valve.
- 2 Deaerator Level Control Valve

The Feedwater System

- 3 Boiler Feedwater Startup Valve
- 4 IP Drum Level Control Valve
- 5 HP Drum Level Control Valve
- 6 Boiler Feedpump Recirculation Valve

The Main Steam System

- 7 Superheat Spray Valve (and Attemperator)
- 8 Reheat Spray Valve (and Attemperator)
- 9 LP Turbine Bypass Spraywater Valve
- 10 IP Turbine Bypass Spraywater Valve
- 11 HP Turbine Bypass Spraywater Valve
- 12 LP Turbine Bypass Valve
- 13 IP Turbine Bypass Valve
- 14 HP Turbine Bypass Valve
- 15 Steam Seal Regulator Valve
- 16 Sky Vent Valve



Anti-Cavitation Trims

Emerson Proprietary



Noise Attenuation Trims

Fisher Severe Service Valve Solution

Reheat Spray Valve

Boiler Feedpump Recirculation Valve

Application

- Reheat Spray Valve at subcritical coal fired power plant in India

Challenge

- Existing Reheat Spray Valve was leaking, causing poor heat control and excessive thermal cycling.
- Upon analysis, the valve trim seating surface had eroded due to insufficient cavitation protection at low opening positions, eliminating shutoff integrity and resulting in leaks.

Solution

- A customized characterization of the Fisher Cavitrol III Micro-flat trim to enable reliable and constant low flow operation of the valve.

Eliminated leaks and excessive thermal stresses while improved temperature control and thermal efficiency



Customer

- Coal Fired Plant in Colorado

Application

- Boiler Feedpump Recirculation Valve

Challenge

- Experiences some of the toughest process conditions with extreme pressure drops and high temperatures.

Solution

- FISHER CAV4 Control Valve with Cavitrol™ IV multi-stage trim features uneven pressure staging with an expanding flow area design, which allows over 90 percent of the overall pressure drop to be taken in the initial stages. As a result, the final stage will experience a relatively low inlet pressure, hence effectively preventing damaging cavitation.

Customized product designs to meet critical application requirements for increased plant efficiency and capacity.



Vent, Drain and Isolation Valve Alternative

Isolation

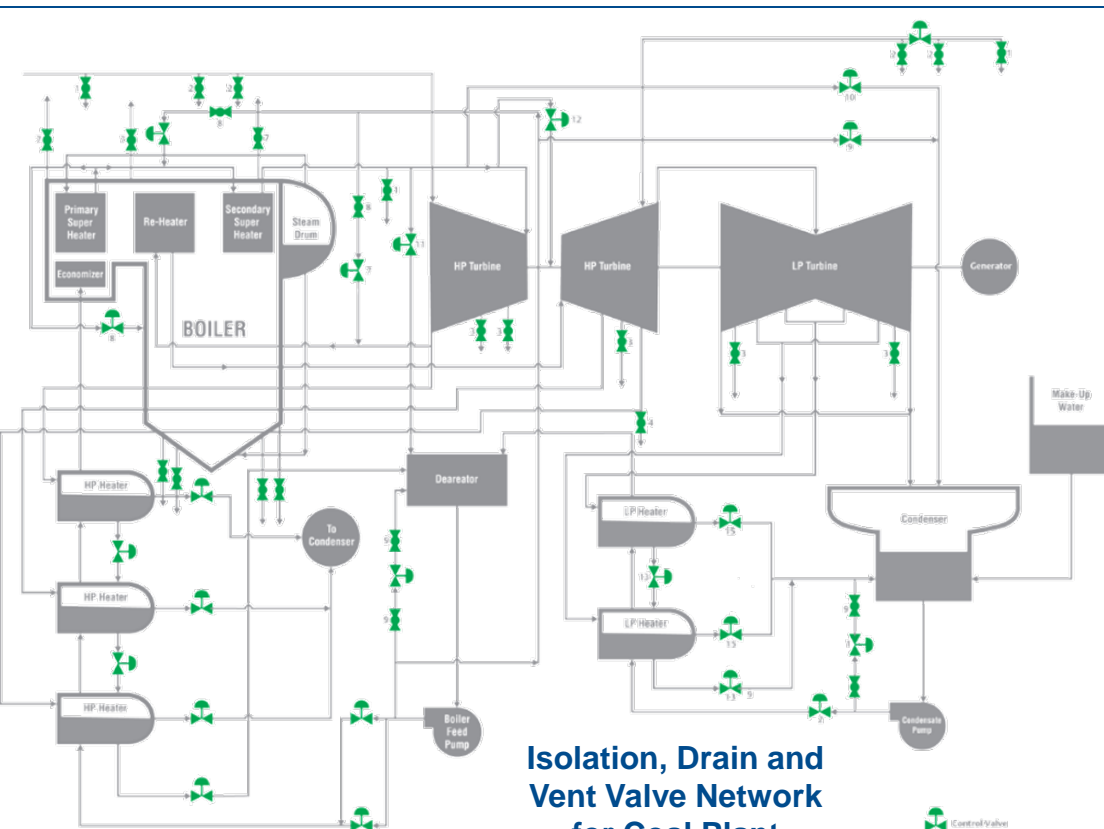
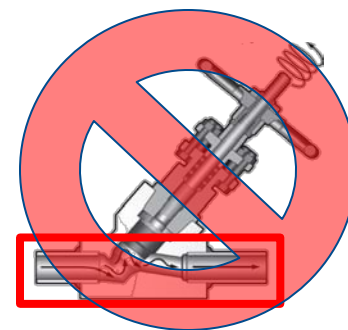
- Superheat Spray Block Valve
- Economizer/Feedwater Heater Isolation
- Feedwater Isolation Bypass Block Valve
- Steam Glass Sight Glass Isolation
- Reheat Spray Control Valve Isolation
- Sootblower Isolation
- Sootblower Control Valve Isolation
- Sootblower Bank Isolation
- Main Steam Turbine Isolation
- Extraction Steam Isolation
- HRSG Hot Reheat & main Steam Isolation

Drain

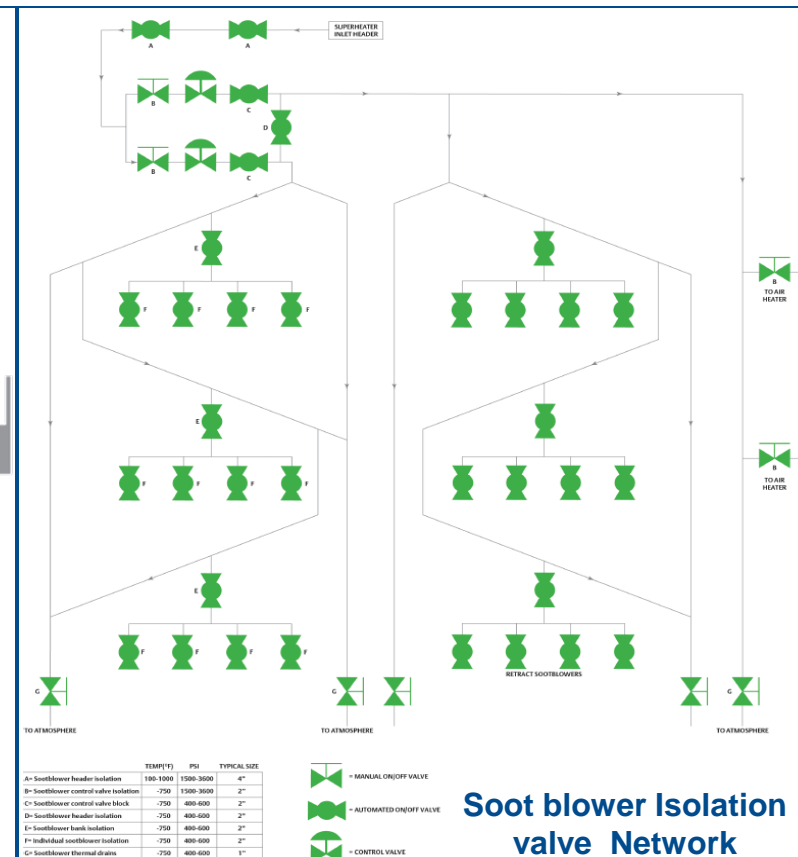
- Main Steam, Hot Reheat & Cold Reheat Drip Leg Drain
- Turbine Bowl Drain
- Extraction Line Drain
- Mud Drum Blowdown Drain

Vent

- Steam Drum Emergency Blowdown Valve
- Economizer/Feedwater Heater Vent
- Superheater Vent
- Main Steam Startup vent



Isolation, Drain and Vent Valve Network for Coal Plant

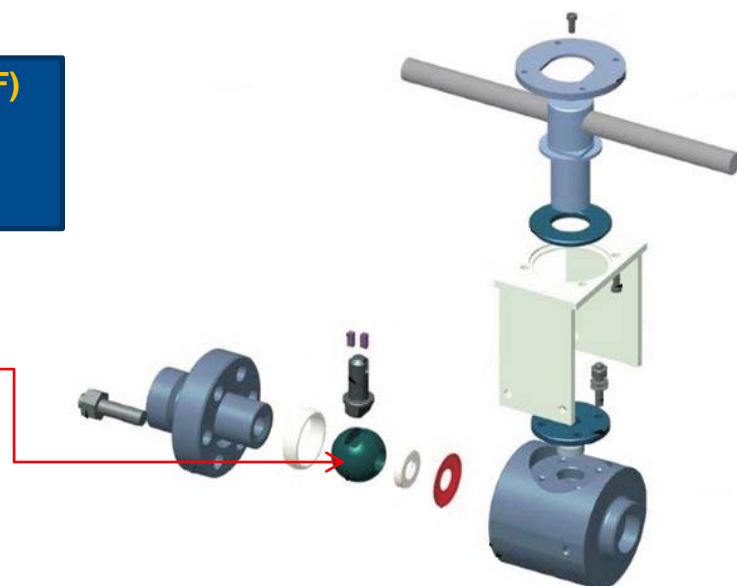
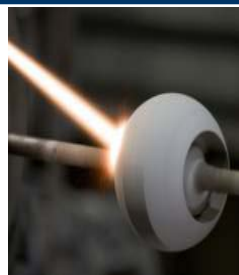


Metal Seated Severe Service Ball Valve – Z500

- Z500 Severe Service On/Off Ball Valve
 - Design: Floating ball with integral metal seat
 - Sizes:
 - Isolation 8"
 - Drain /Vent 0.65" to 2"
 - NPS ½ to 36
 - **Class VI Shutoff /API 598**
 - **ASME CL150 to 4500**
 - End Connection: BWE, SWE, NPT, RF, RTJ
 - Bore: Full or Reduced
 - Material of Construction: A105, F22, F91, F316
 - (Specials – 304, 347, Duplex, Hastelloy, Inconel are available)
 - Seat Sealing: Uni or Bi-directional
 - Top Works: Lever, Gear, Electric, Pneumatic or Hydraulic actuators

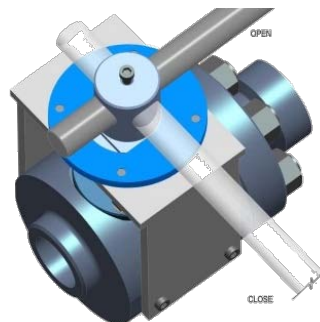
High Tech Coating (HVOF)

- Corrosion & erosion resistance
- Hardness > 68 RC



Integral Travel Stop

Prevents over-rotation



Critical Plant Measurement

Superheated Steam Flow



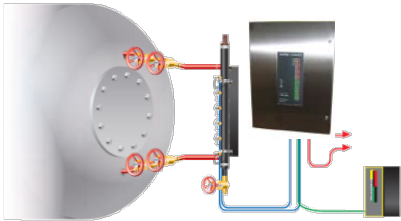
Main Steam Temperature



Furnace Pressure



Hydrastep and Hydratect
Water/Steam Monitoring Systems



Total Air Flow



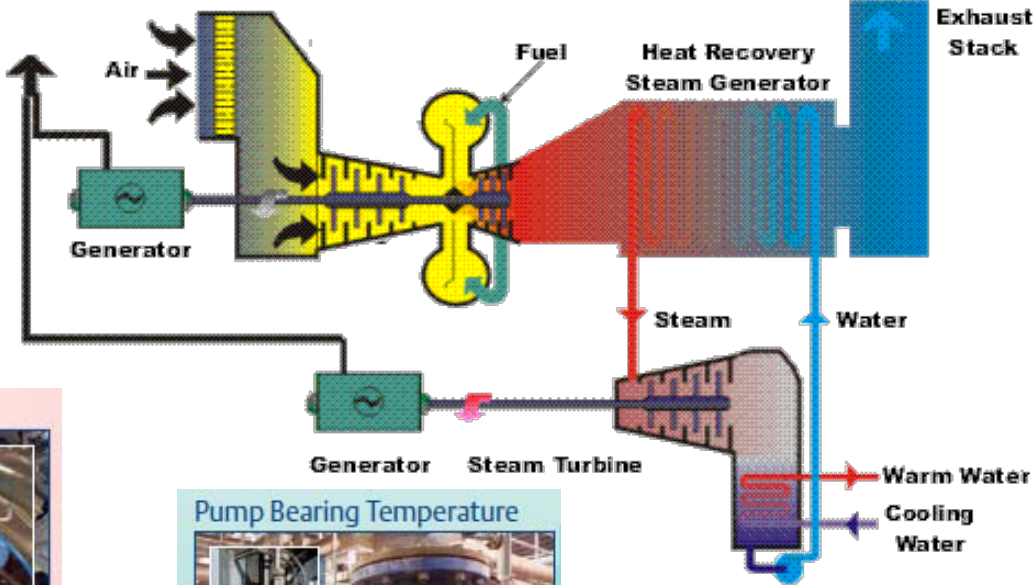
Pump Bearing Temperature



Heater Vessel Level



Drum Level



Flow Measurement in Power Plant

Main Steam (Superheated Steam)



Venturi
• 2" to 72"
• ASME MFC-3M



Nozzle
• 2" to 48"
• ASME MFC-3M



Annular Bar
• 2" to 96"
• ASME B31.1/3/8

Saturated Steam



- Temperature Compensation
- Mass and Volume
- ½" to 12"

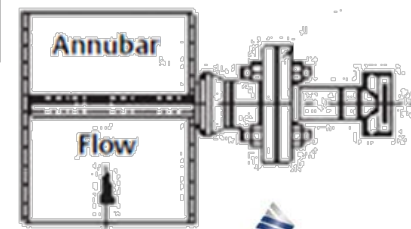
Fuel Flow

(Coriolis for Gas and Liquid)

- No straight Run
- Direct Mass



Air Flow



ID and FD Fan Air Flow
Measurement

Main Steam Flow Solution

Venturi and Nozzle

Challenge:

- Large Size Flow Measurement (2" to 72")
- High Temperature and Pressure Requirement
- ASME PTC 6 Requirement

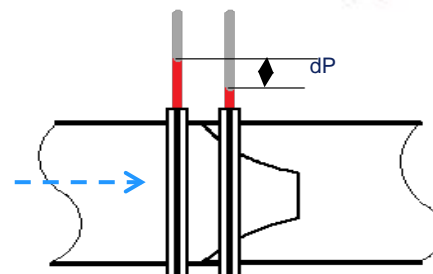
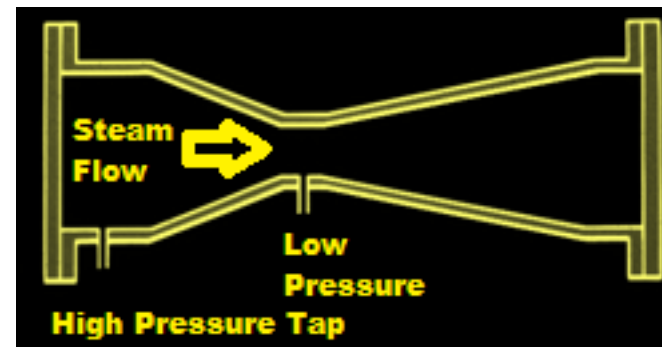
Solution:

Venturi / Flow Nozzles



Customer Benefits:

- ASME PTC-6 compliant flow nozzles for performance testing
- No obstruction
- Low Pressure Drop
- No moving parts, simple configuration, maintenance free



Gas/Liquid fuel flow Solution

Challenge:

Fuel flow meter accurate enough for Gas Turbine Performance Test and robust enough for long periods of operation with little or no maintenance.

Solution:

MMI Coriolis Mass flow meters

Customer Benefits:

- No moving parts design provides reliable service even in dirty hard to handle services
- High accuracy direct mass flow measurement device assures proper combustion control & performance test results
- Field provable calibrations - reduces life cycle costs
- *No straight runs of pipe - saves on installation*



Challenge:

Provide an accurate, flow device certified for fiscal custody transfer to assure that they are getting what they have paid for.

Solution:

Daniel Ultrasonic Liquid and Gas Flow meters

- Industry's most recognized for large capacity custody metering
- Global Metrology approval for custody metering

Benefits:

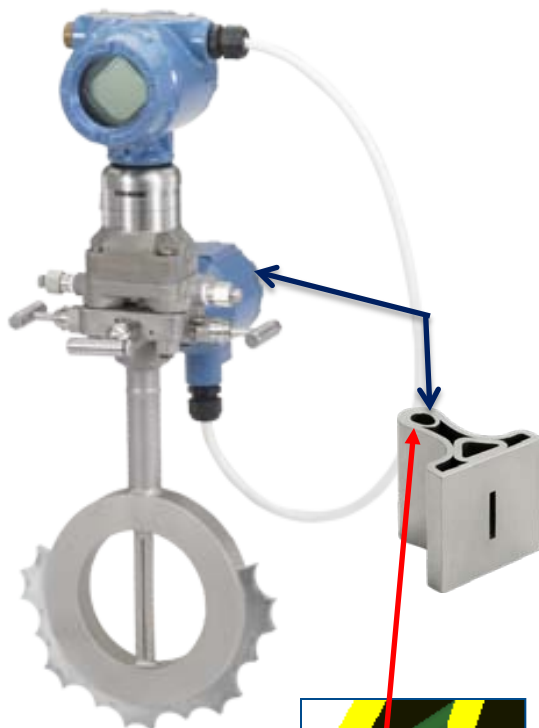
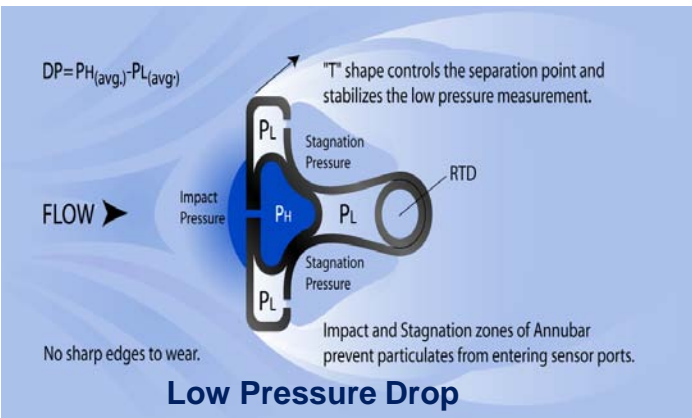
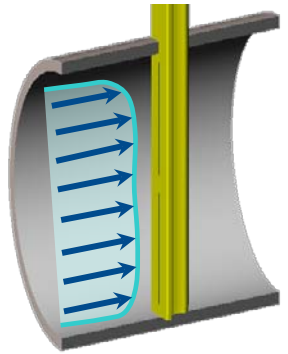
- Assure that you get what you pay for
- Reduced maintenance costs
- Maximized flow capacity



Saturated Steam & Air Flow Measurement

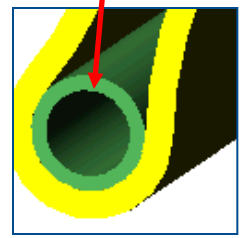


2" to 96"



Integral Temperature Sensor.

RTD in all sensor sizes



MultiVariable (MV) Vortex Design

- MultiVariable Vortex for Saturated Steam

- Wide Rangeability
- Improved Performance
- Simple, Cost-effective Solution
- Supports Existing Temperature Measurement Practices



- Electronics

- Processes two signals – vortex shedding for flow, temperature for density
- Calculates and outputs temperature compensated mass flow for saturated steam
- Can output two simultaneous variables (4-20 and Pulse): Flow, Steam Mass flow, Temperature

- Temperature Sensor

- Type N thermocouple
- Isolated from process like vortex sensor – uses shedder bar as thermowell
- 2-wire, Conserves power for future enhancements

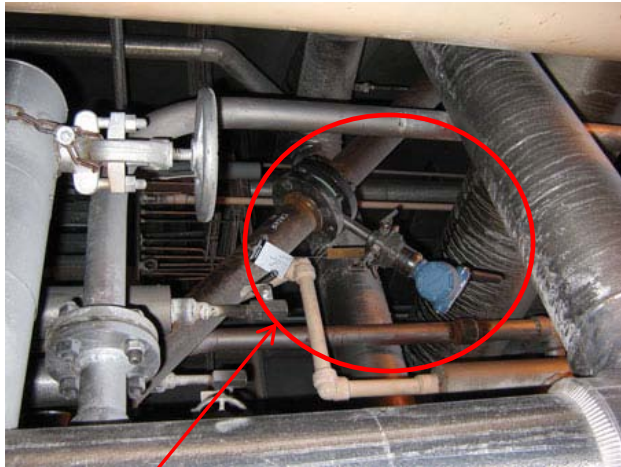
- MV Vortex with temperature & vortex sensor can be replaced independently without exposure to process fluid

- 2% of Mass Flow Rate

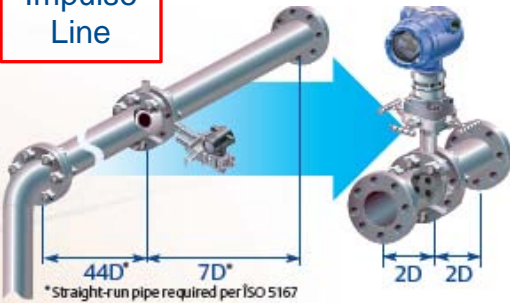


Compact Conditioning Orifice

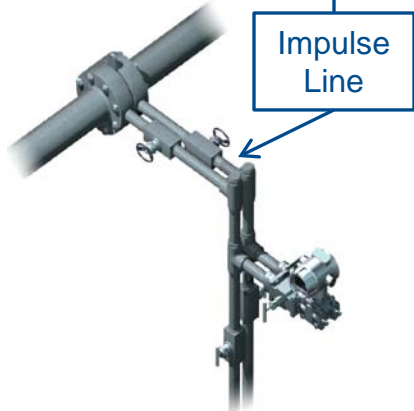
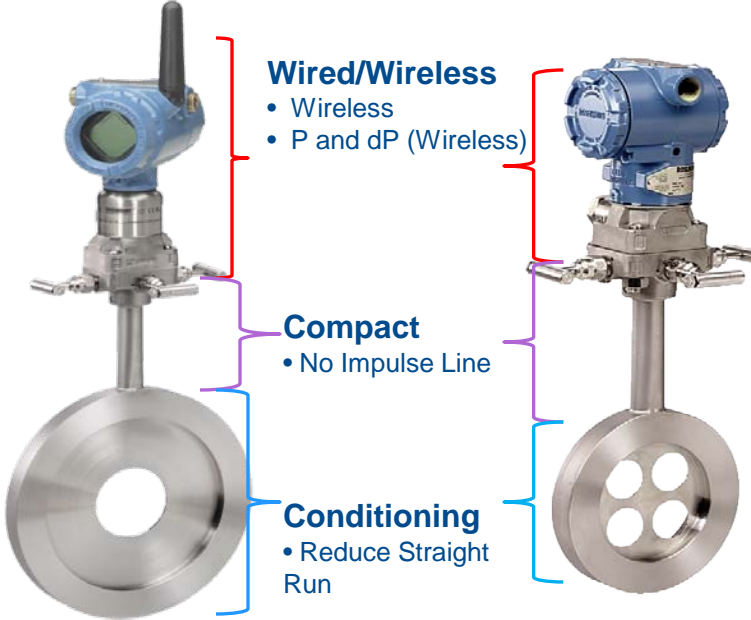
(Simple Installation)



No
Impulse
Line

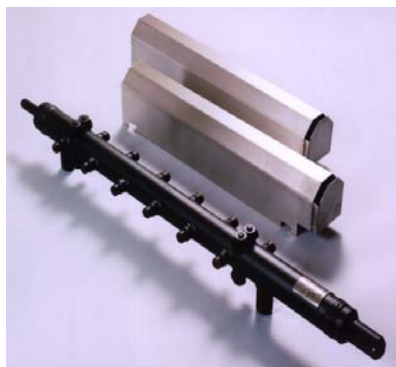
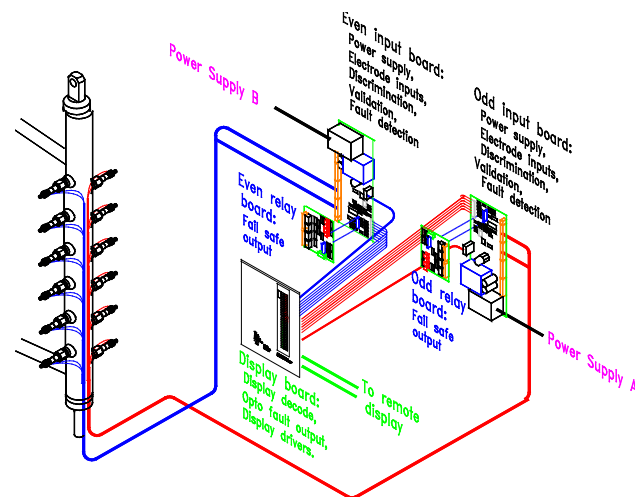
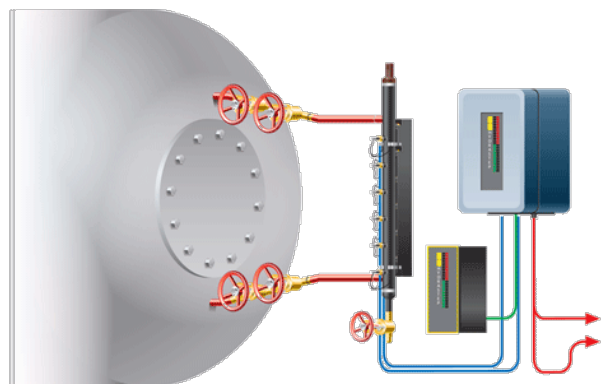
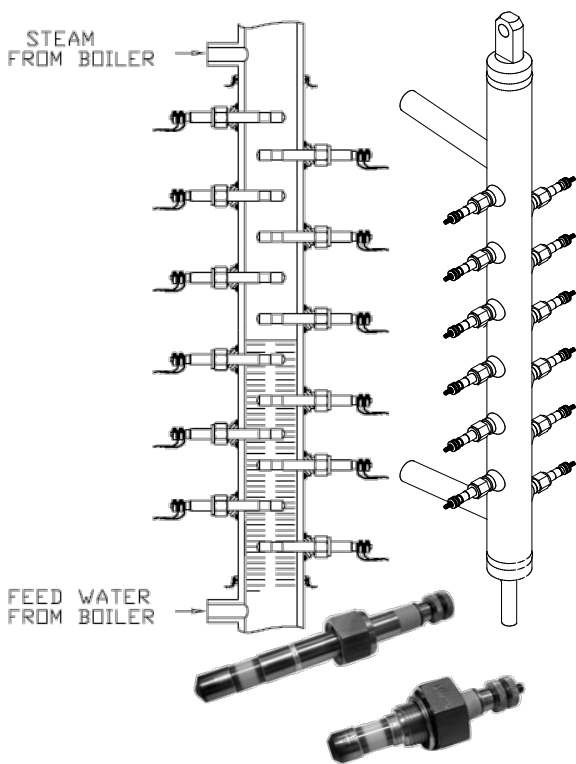


*Straight-run pipe required per ISO 5167



Traditional Orifice Plate Technology

Drum Level Measurement in Power Plant



- Highly reliable Drum Level Measurement(reduce false alarm)
- Target for High and Low Level Drum Protection
- ASME Code PG.60.1.1
- Redundant Configuration available

Steam Temperature Measurement Redundant Sensor & Multi Point Temperature Solution

Challenge

- Faster load maneuverability requires accurate Steam Temperature control within +/-5 degC
- Ensure delivery of Quality Steam to Turbine and minimize Thermal Stress on blades

Solution

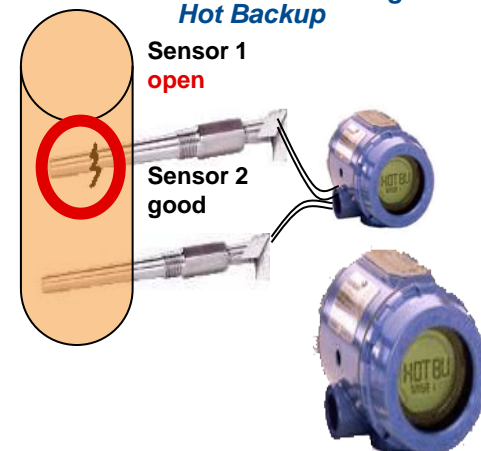
- 3144 P Temperature Transmitter with Dual Thermocouple Input Sensors
- Sensor Drift Monitoring & Hot Backup to detect early failures

Customer Benefit

- Controlled attenuation reduces heat loss and hence improves heat rate
- Tighter set points for steam temperature allows for faster load ramp ups
- Increased availability of Superheater tubes and turbines



3144P Temperature Transmitter With Sensor Drift Monitoring and Hot Backup



High Density Measurement

Eight Independently Configurable Input

- Thermocouple, 2 & 3 wire RTDs, mV, ohm, and milliamp inputs

Field-hardened

- NEMA 4x / IP66 enclosures available

Intrinsically Safe (FISCO)

- Mounts in hazardous areas to limit wire runs



Four Independently Configurable Inputs

- Thermocouple, 2, 3, & 4 wire RTDs, mV, ohms, mA inputs

Output

- WirelessHART™

Power Module

- Six year life at 1 minute update rate

Enclosure

- NEMA 4X, IP66
- Intrinsically Safe Class 1, Div 2



Sapphire Sensor

- Applications up to 1800 °C & 65 bar
- Sapphire tube protects against toxic hydrogen gases
- Single forged housing and dual seals

High Temperature Thermocouple

- Proven performance with DIN standard design
- Ceramic or heat resistant metal protection tubes for abrasive or thermal shock environments

3D Solid Scanner – Coal & Fly Ash

Application

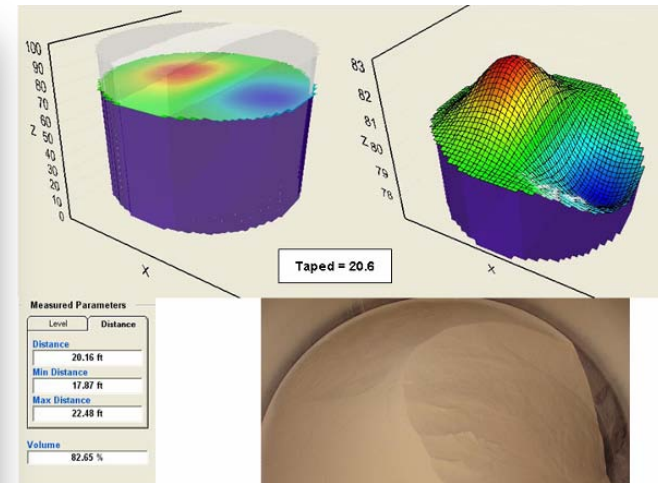
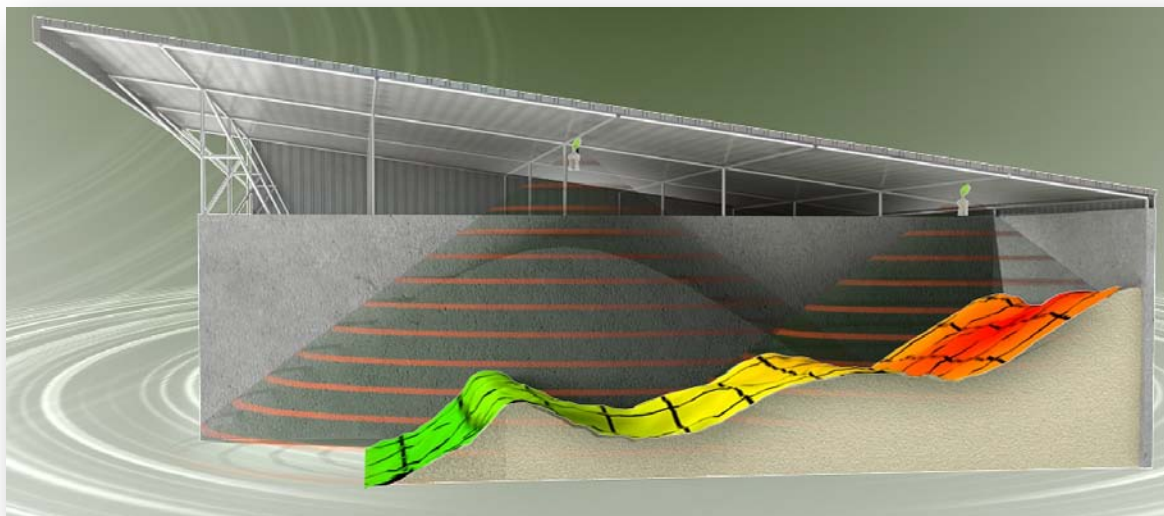
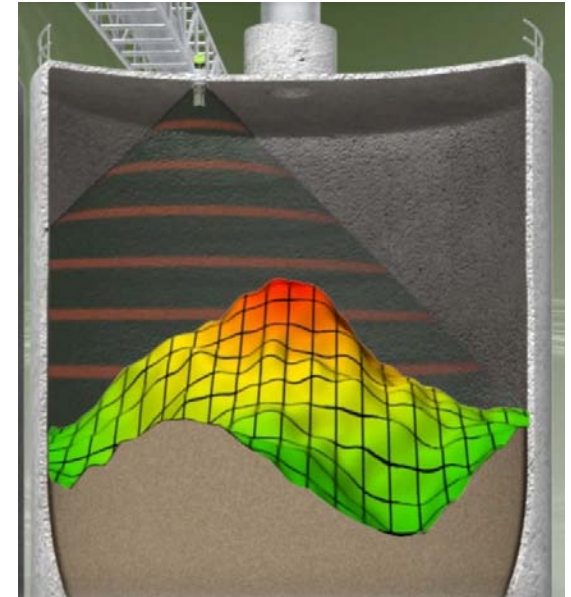
- Determine Volume and Level of Solid

Challenge

- Traditional level measurement devices only measure the distance between the device and one **single point** on the surface.

Solution

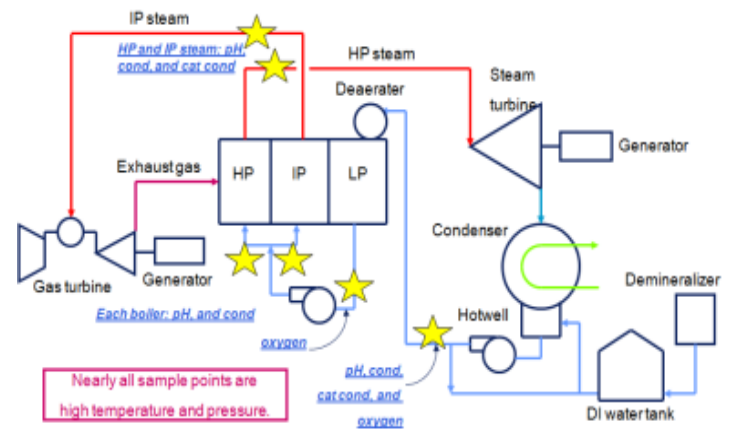
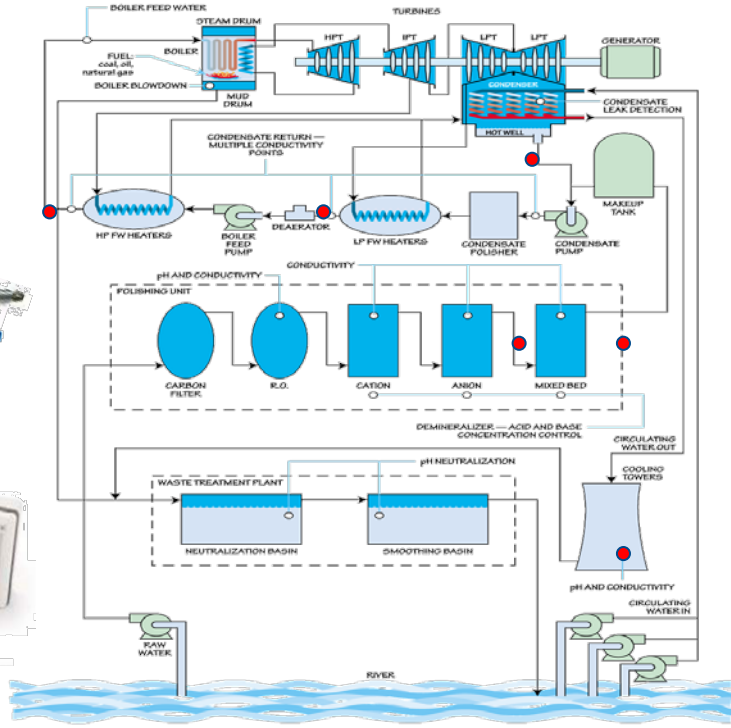
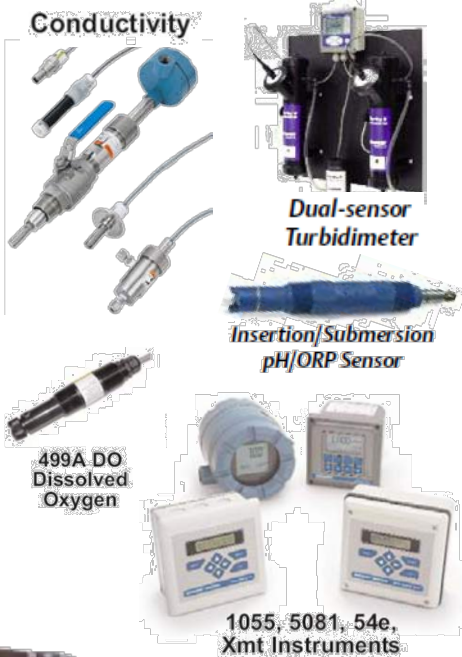
- Measuring Multiple Points along the surface of solid in practically any kind of storage
- Calculate True Volume of material and provide 3D visualization of content



Measured Parameters	
Level	Distance
Distance	20.16 ft
Min Distance	17.87 ft
Max Distance	22.48 ft
Volume	82.65 %



Steam & Water Analysis System (for Condensate Contaminants)



Nearly all sample points are high temperature and pressure.

Auto Oxygen Trimming In Situ Zirconium O2 Combustion Probes Technology

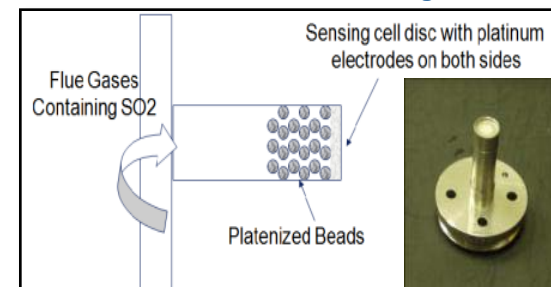
- World Class Accuracy $\pm 0.05\%$ O₂ or 0.75% of reading
- Stoichiometer feature permits a depressed range, Indicating O₂ deficiency during reducing events
- ZrO₂ cell is within Stainless Steel housing. Utilizes Platinum beads to make it resistant to SO₂ and Acids
- Disc-type ZrO₂ cell is guaranteed not to crack Offering the longest life
- Probes are Fully Re-buildable reducing Lifecycle costs
- Built-In Solenoid Valves for Auto Calibration Functions



6888A & 6888Xi

In-situ ZrO₂ Analyzers
4-20mA HART

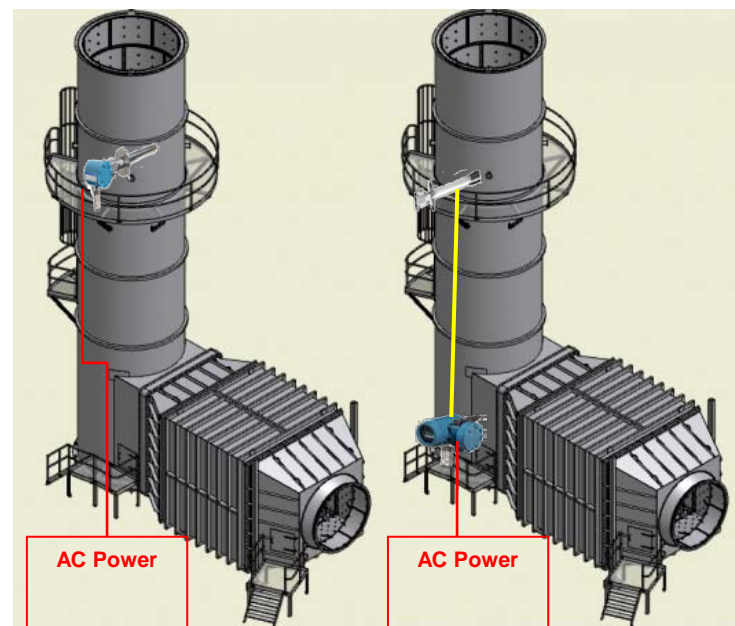
ZrO₂ Cell with Platenized Beads in Stainless Steel Housing



Integrated Auto-cal
Solenoid Valves



Re-buildable Probe



Generator Cooling Solution – H₂ Purity

Improve Generator Safety and Generator Efficiency



- ➔ Specific Gravity
- ➔ Calorific Value/BTU, Wobbe Index
- ➔ Relative Density
- ➔ %H₂ Purity
- ➔ Line Density

Hydrogen Purity Control

- **Turbine Generator Cooling**
Efficient hydrogen-cooling and minimized windage loss through fast-response purity measurement
- **Enhance Refining Efficiencies**
Hydrogen purity control for improved cracking yields and catalyst protection

Specifications

SGM Gas Specific Gravity meter is designed for the Specific Gravity measurement of clean, dry gas.

Accuracy up to $\pm 0.1\%$ (reading)

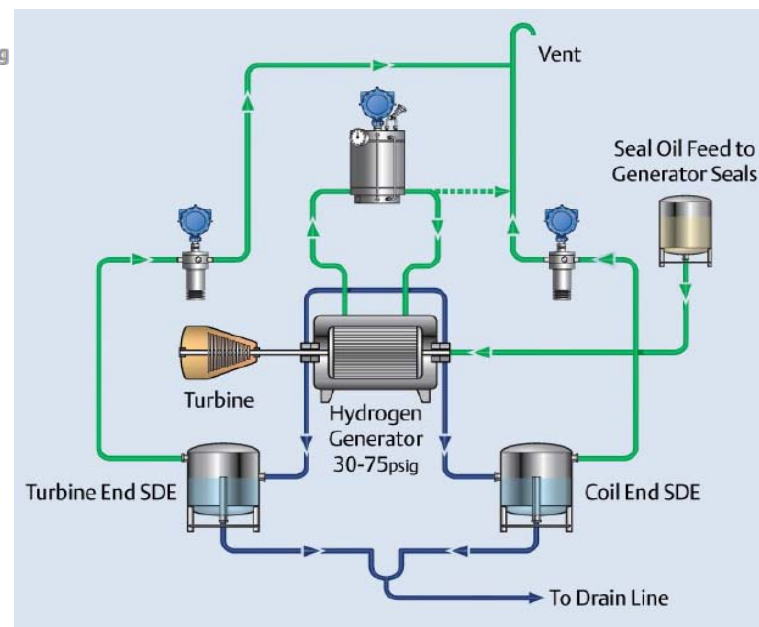
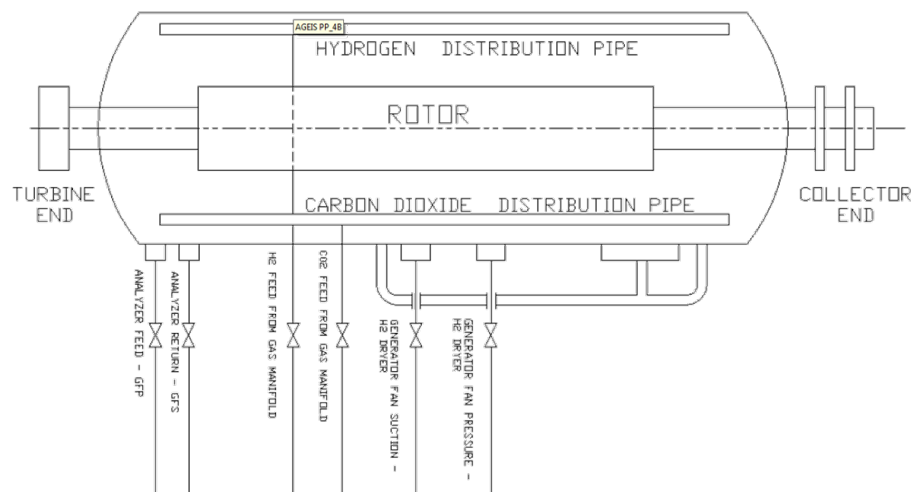
Repeatability $\pm 0.02\%$ (reading)

Wetted materials Ni-span C 902, Aluminium alloy, 316L Stainless Steel

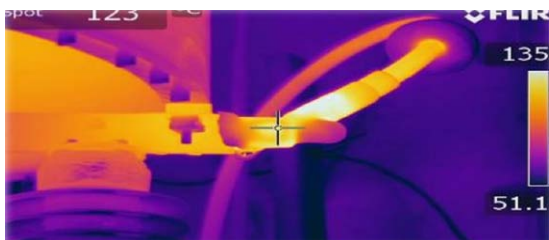
Certification* ATEX II1G EEx ia IIC T5, CSA CUS C1 D1 Grps A, B, C & D, T4

Input pressure up to 125 bar (1812 psi) (Sample Conditioning System)

Typical Generator Arrangement



Electrical Asset Monitoring (Temperature, Humidity & Partial Discharge)

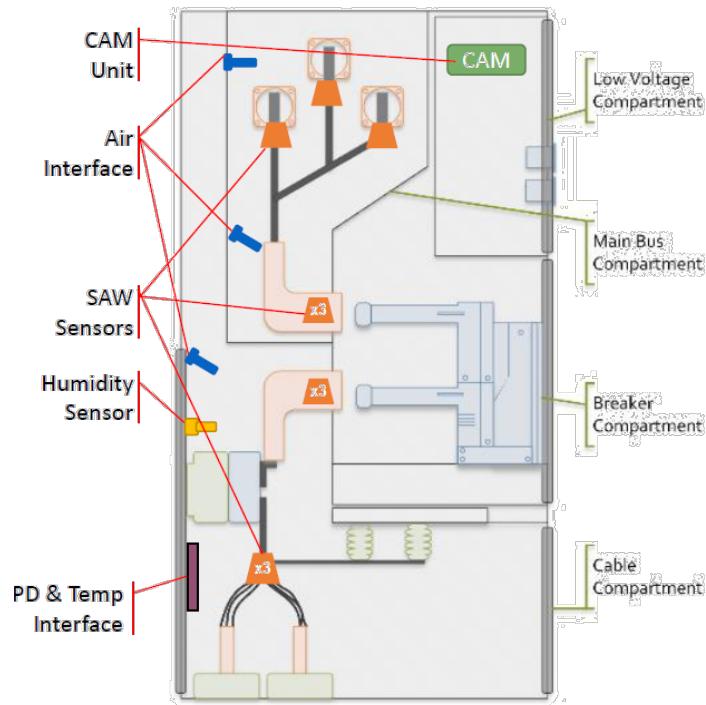


Temperature



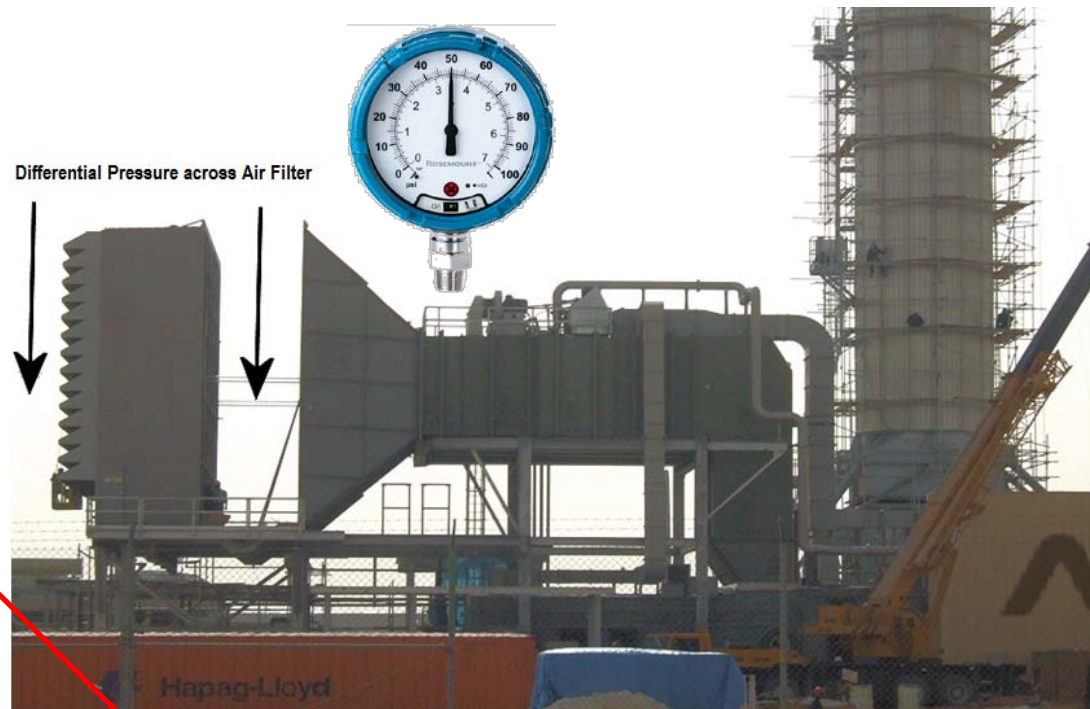
Humidity

Partial Discharge



Emerson Proprietary

Air Filter Monitoring for Gas Turbine



Mechanical Seal Pot Monitoring

API 682 (ISO 21049:2011) 4th Edition

Rosemount
Wireless
Gauge
Pressure



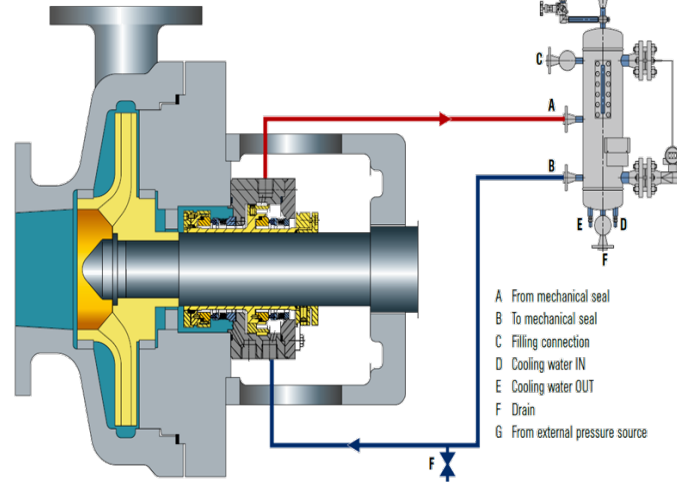
Rosemount
Wireless dP Level



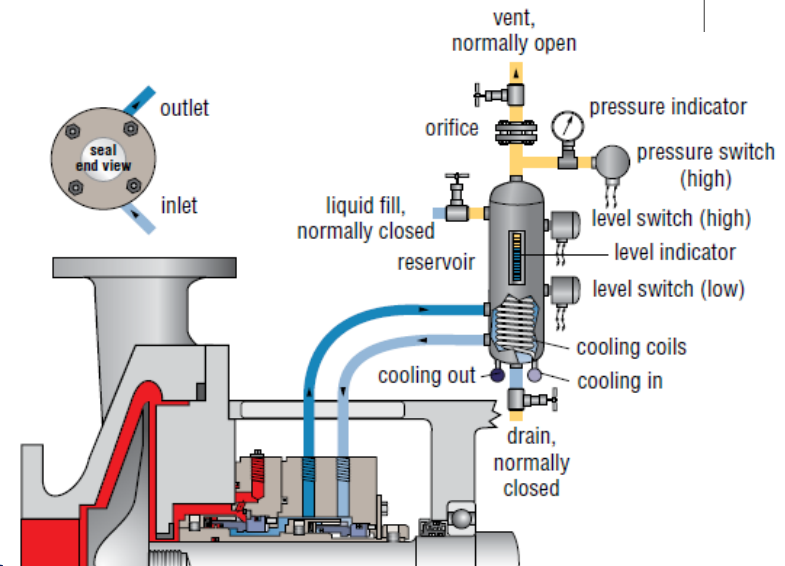
Rosemount
Wireless Level

Improvement

- To monitor the Level of Oil in the Seal Pot
- To monitor the Pressure in the Seal Pot



Pressurized barrier
fluid reservoir
supplying clean fluid
for an arrangement 3
pressurized dual
seal.



Coal Stack Pile Monitoring – Avoid Fires

Challenge:

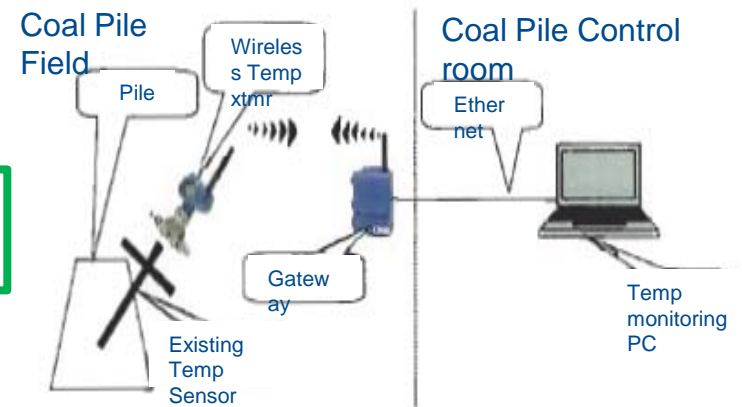
- Infrared cameras are used to detect stack yard fires
- Moving coal feedstock does not allow any permanent wired installations

Solution:

- Portable temperature sensors with head mounted Wireless transmitters
- Discharge water pressure on quench jets

Benefits:

- Monitoring of coal pile temperature in open coal stack yards
- Easy re-positioning of sensors on coal stack piles
- Avoid coal fires by detection of rise in coal temperatures
- Implement early warning system and remote indication



Transformer Monitoring



Auxiliary Power Transformers - WPG

Challenge:

- Insufficient measurements on transformer oil and winding temperatures
- No measurement on oil tank level and transformer pressure
- Wired solutions near transformers have very high electro-magnetic interference

Solution:

- Wireless transmitter to monitor transformer oil/winding temperature, tank level and gas pressure

Benefits:

- Remote real time monitoring of auxiliary transformers
- Reduced transformer failures
- Reduced manual inspection routines



Oil Temperature



EMERSON
Process Management

Steam Turbine Thermal Performance

Determination

- Baseline performance for ST
- Capture and locate deterioration

Measurement Points

- Condenser Vacuum
- Reheat Temperature/Pressure
- Main Steam Temperature/Pressure

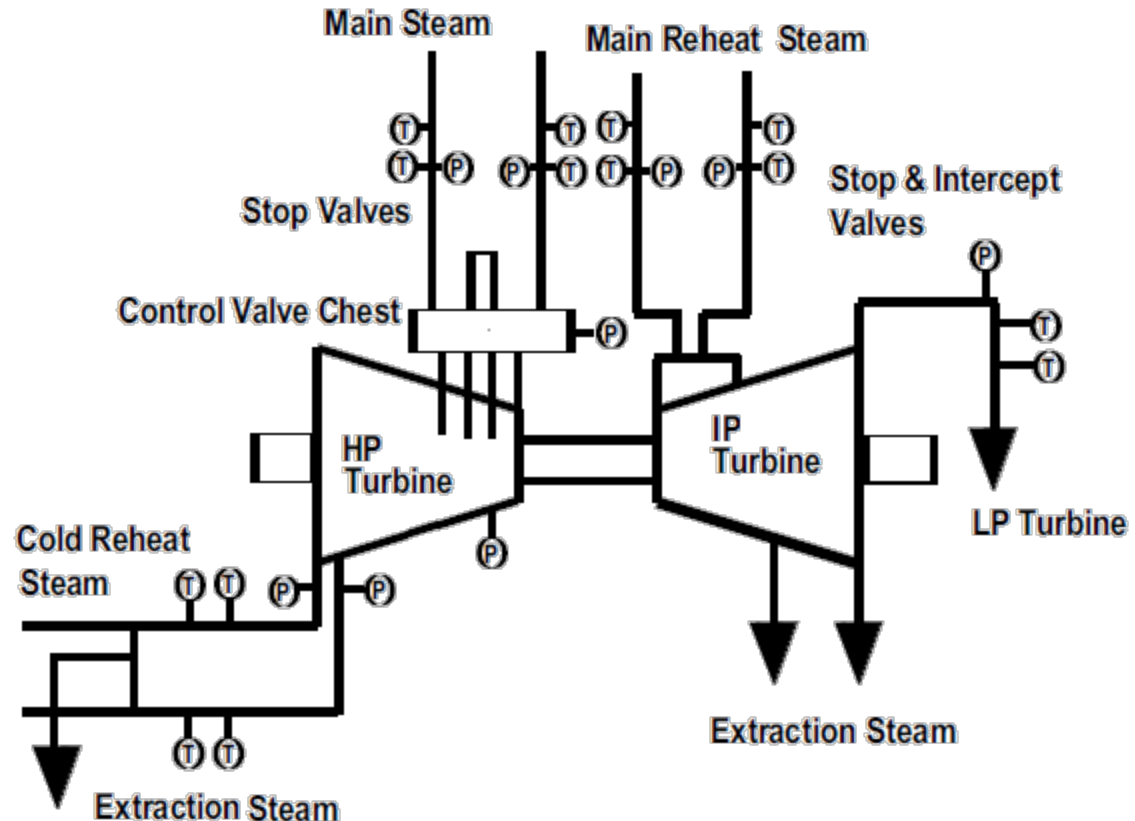
Pressure



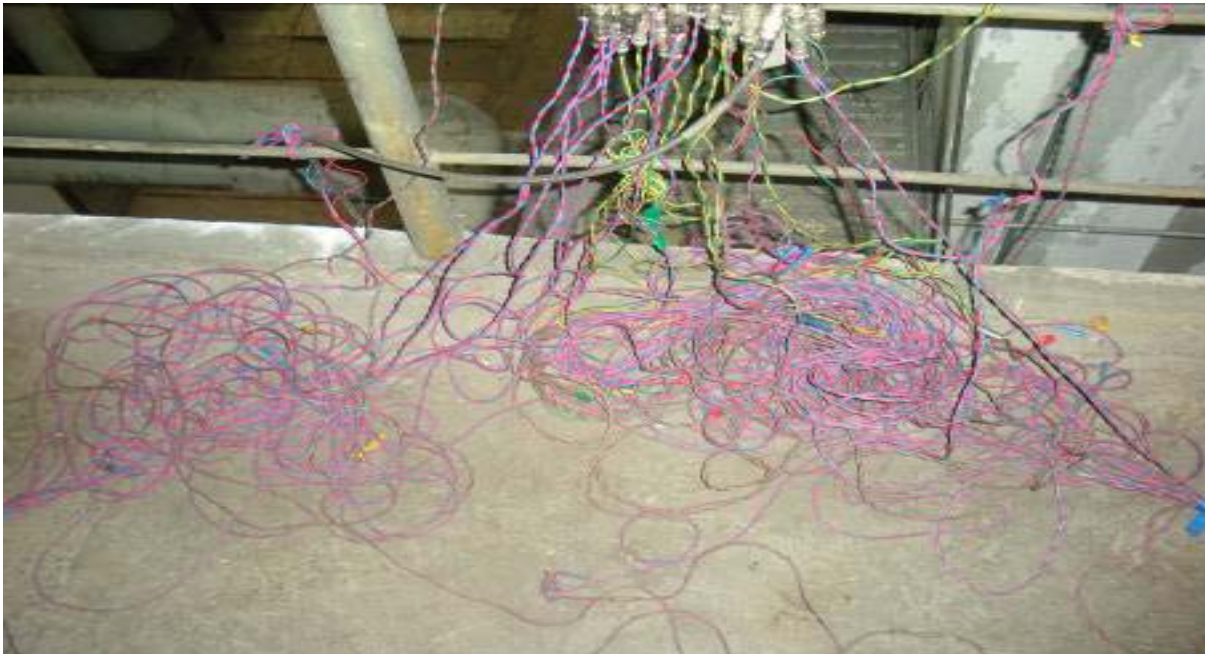
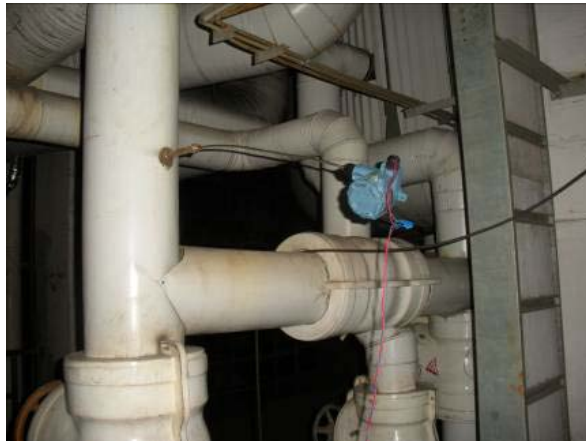
Flow



Temperature



Before – Hard wiring



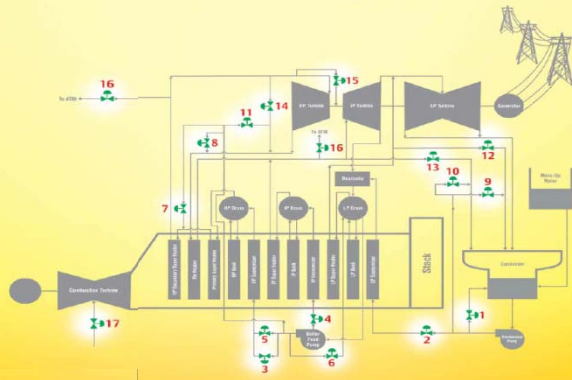
After - Wireless



Final Control & Regulate

Actuation	Control Valves	Pressure Regulators
Valve Instrumentation	Severe Service Products	

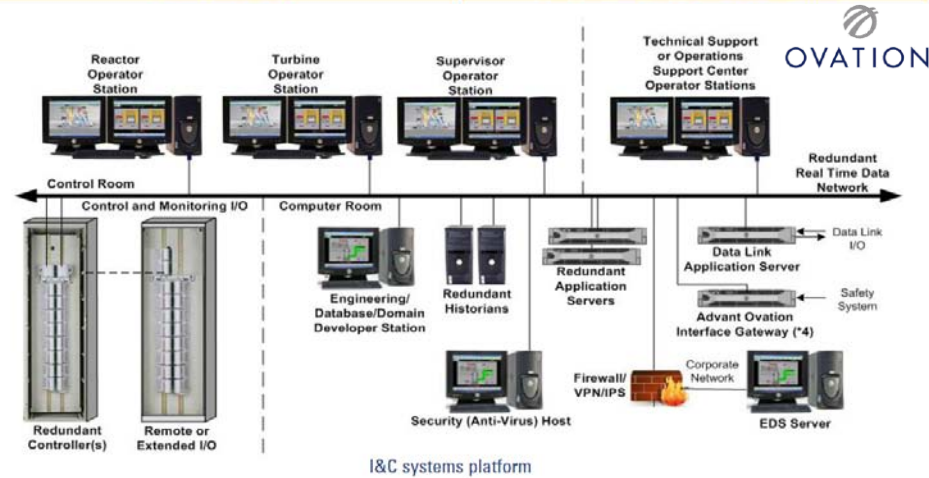
Combined Cycle Power Plant



1. Condensate Pump Recirculation
2. Economizer Level Control
3. Boiler Feed Water Start-up
4. IP Drum Level
5. HP Drum Level
6. Boiler Feedwater Recirculation
7. Superheat Attenuator Spray
8. Reheater Attenuator Spray
9. LP Turbine Bypass Spray
10. IP Turbine Bypass Spray
11. HP Turbine Bypass Spray
12. LP Turbine Bypass
13. IP Turbine Bypass
14. HP Turbine Bypass Valve
15. Gland Steam Seal
16. Sky Vent
17. Fuel Control

Operate & Manage

Process Control	SCADA	Safety & Compliance	Operations Management
Asset Reliability		Decision Support & Data Management	



Measure & Analyze

Pressure	Temperature	Level	Flow	Analytical
Safety & Reliability Monitoring		Tank Gauging	Fiscal Metering	

Superheated Steam Flow



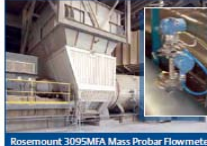
Main Steam Temperature



Emission Analysis (CEMS)



Total Air Flow



Drum Level



OPM 3000 opacity/Dust density



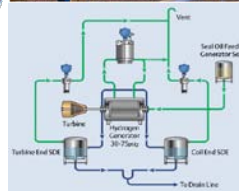
Furnace Pressure



Heater Vessel Level



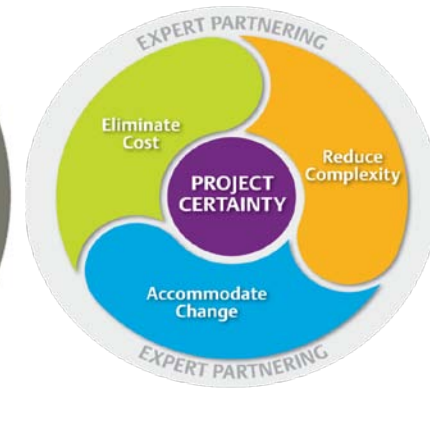
Oxymeter 4000 SMART Insitu



Main Steam Flow

Solve & Support

Plan & Design	Implement & Build	
Improve & Modernize	Operate & Maintain	Train & Develop



Specialist Solutions for Power Plant

Final Control & Regulate

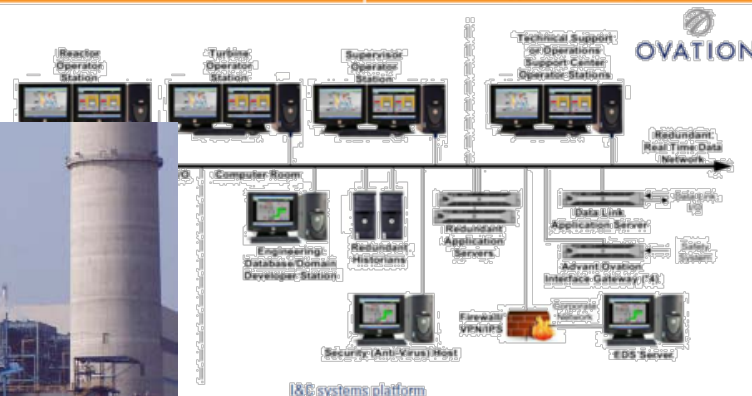
Actuation	Control Valves	Pressure Regulators
Valve Instrumentation	Severe Service Products	

Combined Cycle Power Plant

1. Condensate Pump Recirculation
2. Economizer Level Control
3. Boiler Feed Water Start-up
4. IP Drum Level
5. HP Drum Level
6. Boiler Feedwater Recirculation
7. Superheater Spray
8. Reheat Spray
9. LP Turbine
10. HP Turbine
11. HP Turbine
12. LP Turbine
13. HP Turbine
14. HP Turbine
15. Gland Seal
16. Sky Valve
17. Fuel Control

Operate & Manage

Process Control	SCADA	Safety & Compliance	Operations Management
Asset Reliability		Decision Support & Data Management	



Measure & Analyze

Pressure	Temperature	Level	Flow
Safety & Reliability Monitoring		Tank Gauging	



Solve & Support

Plan & Design	Operate & Maintain	Implement & Build
Commission	Operate & Maintain	Train & Develop

