Steam and Water Analysis System (SWAS)
An Overview
For over six decades, Forbes Marshall has been building steam engineering and control instrumentation solutions that work for process industry. Today we have evolved into a leader in process efficiency and energy conservation through technology tie-ups and focused investments in manufacturing and research. Our joint ventures with the world's leading names enable us to deliver quality solutions in 14 countries, Forbes Marshall is probably the only company in the world to have extensive expertise in both steam and control instrumentation. The dual expertise has allowed us to engineer industry specific systems that focus on energy efficiency and utilities management for sectors as diverse as textiles, food processing, paper, power and chemicals.

We have also been adjudged one of India's top “25 Best Places to Work - 2008” by Economic Times and the Great Places to Work Institute, Our teams are peopled by some of the finest engineers in the land. These highly trained professionals have developed innovative solutions and saved millions of rupees in process costs for our clients. Our business practices and processes have combined into a singular philosophy of being trusted partners who provide innovative solutions. It’s a philosophy we are proud to live up to.

Today in the power plants, high pressure boilers and steam turbines are under constant attack from erosive and corrosive elements such as Silica, Sodium, Dissolved Oxygen, Calcium, Chloride and Phosphates. Without accurate measurement and monitoring, the plant may suffer heavy mechanical damages that can be caused due to imbalance of turbines, reduced efficiency, deposition on turbine blades, corrosion of steam pipe work and so on.

We have designed our Steam and Water Analysis System (SWAS), to keep you in power, SWAS assures safety of your boiler and turbines, by taking along and analyzing up to a dozen samples from all your water and steam circuits. In today's supercritical power plants, sample conditions as high as 600 Degree C and 300 bars are quite common. Forbes Marshall SWAS can easily take care of these samples. To protect your equipment our SWAS works in two stages:

1. Sample Conditioning
2. Sample Analysis

1. Sample Conditioning

First section of any SWAS is the Sample Conditioning section or Wet Panel

Enclosed type Wet Panel

Open frame-free standing Wet Rack

Here the sample is first cooled in Sample Coolers, de-pressurized in pressure regulators and then fed to various analyzers while keeping the flow characteristic constant by means of a Back Pressure Regulating device. There are lots of safety equipment provided in wet panels, so that the operators feel safe while working with these systems.
The schematic diagram here shows how this happens:

- **Line 1**
  - Boiler Feed Water Sample Inlet
  - Blowdown Header
  - Cooling Water Outlet Header
  - Cooling Water Inlet Header

**Legend**

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Description</th>
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<tbody>
<tr>
<td>01a</td>
<td>HT Sample Isolation Valve (Globe Type)</td>
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<tr>
<td>01b</td>
<td>LT Sample Isolation Valve (Needle Type)</td>
</tr>
</tbody>
</table>
| 02      | Sample Cooler
d| Refer Sample Cooler Sizing |
| 04      | Coolant Flow Indicator                           |
| 05a     | Coolant Isolation Valve                           |
| 06      | Sample Filter                                    |
| 08      | Pressure Regulator                                |
| 09      | Sample Relief Valve                              |
| 10      | Temperature Gauge                                |
| 11      | Pressure Gauge                                   |
| 12      | Temperature Switch                                |
| 13      | Pressure Switch                                   |
| 14      | Solenoid Valve                                   |
| 15      | Regulating Valve                                 |
| 16      | Rotameter                                        |
| 17      | Tundish (for Grab Sampling Facility)             |
| 22      | Back Pressure Regulator                           |
| 23      | Three Way Ball Valve                              |
| 27      | Bulkhead Union (1/2" NB 3/4" x 1/4" OD)          |

- Any of analyser given below
- CE Cond. Cell with Flow Through Chamber
- CT Single Conductivity Transmitter
- PHE PH Electrode
- PHT PH Transmitter
- DOE Dissolved Oxygen Sensor
- DOT Dissolved Oxygen Transmitter
- HZ Hydrazine Analyzer
- SI Silica Analyzer (Multichannel)
- NA Sodium Analyzer (Multichannel)

**Note:**

1. Sample tubing: 1/4" OD, 16 SWG, ASTM A 213, TP 316, Seamless Tube
2. Blowdown Header (default): 2" NB, ASTM A106, GR.B, SCH.40, Pipe Flanged To 2" NB, ANSI B16.5, Class 300 RF
5. Cooling Water Piping: 3/4" NB, SCH.40 Pipe
6. Sample Inlet Connections: Bulkhead Union for 3/4" NB, 27
Some of the Important Components of Sampling Systems (Wet Rack)

Sample Cooler

Forbes Marshall Sample Coolers are coil-in-shell type contra-flow heat exchangers. Validated by a premier institute like IIT, we are one of the few sample cooler manufacturers in the world who can offer guaranteed performance. With in-house test set up for performance testing, world-class manufacturing and welding facilities, we offer one of the most trusted sample coolers in the power sector. Various options of coil materials are available such as Stainless Steel AISI 316, Monel 400, and Inconel 625 and so on.

High Pressure Regulator

Forbes Marshall offers piston type High Pressure Regulators. These are used in primary conditioning where sample pressures are higher than 100 Kg/cm². As these are piston type Pressure Regulators, there is no fear of diaphragm rupture etc.

For lower pressure/temperature rating, Forbes Marshall offers spring loaded diaphragm type Pressure Regulator. To offer safety against a remote possibility of diaphragm rupture, in-built safety valve is a regular feature.

Back Pressure Regulator

Forbes Marshall offers Back Pressure Regulator (BPR) to avoid low flow (or fluctuating flow) conditions to analyzers in the event of grab sample valve operation. In the absence of such a device, the sample would flow to grab sample line when the grab sample valve is opened. This can create low flow alarm conditions in samples going to analyzers.

A Pressure Regulator and Back Pressure Regulator combination provides very stable pressure and flow conditions, thereby ensuring reliable, efficient and accurate analysis.
Sight Glass

Forbes Marshall offers Sample Flow Indicator (Sight Glass) to view the sample flow inside the sample line. A rotating wheel indicates presence of cooling water. The sight glass is made of high grade stainless steel.

Sample Filter

Forbes Marshall also manufactures the Filter which is required to ensure particle-free sample. Any particle of size up to 40 microns size can be filtered out. Forged stainless steel body and hexagonal cap help easy cleaning of filter element.

Pressure Relief Valve

Forbes Marshall Pressure Relief Valve comes fitted with Sample Cooler. Pressure Relief Valve is important as it protects the Sample Cooler in case the coil fails. This is also important for human safety as pressurized cooler may burst due to full sample pressure under coil failure conditions.
Hi-temp Isolation Valve

This valve is an easy to operate & can be used for most high pressure and temperature applications. Its unique plug/seat geometry and stuffing box design allow these valves to operate for extended period of time without gland leakage and passing. Valves are designed for PN 500 (Class 2500), are offered for all ratings upto PN 500 and Class 2500. Body seat integral stellite is hard faced by a special Automatic welding process. Unique non-rotating single piece spindle plug design guarantees long seat life as grinding between plug and seat is eliminated.

Cooling Water Isolation Valve

Cooling Water Isolation Valve is a ball valve. Its stainless steel body makes it corrosion resistant and light weight. Long handle makes it easy to operate. Ball valve type design ensures full flow at open condition.

Cation Column

The duplex type Cation Conductivity Column is a field proven Forbes Marshall design. The Cation conductivity measurements are considered to be more reliable than ordinary conductivity measurements, as this method ensures elimination of masking effects of desired chemicals used in treating the water. This provides a more realistic picture of dissolved impurities in the sample. The Forbes Marshall Cation Column is easy to operate, regenerate and maintain.
Philosophy and importance of boiler parameters

Thermal Power Plant Steam and Water in-line Analytics

Nuclear cycle measurement
pH Analyzer

- **pH**: The steam which goes to the turbines has to be ultra pure. The pH value of the feed water gives direct indication of alkalinity or acidity of this water. The ultra pure water has pH value of 7. In a steam circuit, it is normal practice to keep the pH value of feed water at slight alkaline levels. This helps in preventing the corrosion of pipe work and other equipment. Typically dedicated pH Analyzers are recommended at following locations in a steam circuit: high pressure heaters, DM make-up water, condensate extraction pump discharge.

**Features:**
- Dedicated pH analyzer in each line ensures that pH is getting maintained in specified band
- Two wire Aquamon Smartpro series plus model is the simplest pH and ORP transmitter. These analyzers are directly loop powered by +24V DC supply from DCS and PLC
- Also direct 110-230 V AC powered Aquamon 4000 transmitter is available if alarm contacts required along with 4-20 mA output. For pH measurement both low and high pH alarm contacts can be used to control dosing for chemicals. Separate PT-100 sensor input can be used for temperature compensation for pH measurement

Conductivity Analyzer

- **Conductivity**: Conductivity is an important parameter for detecting any contamination of steam in the boiler circuit. Conductivity of pure water is almost zero (1-2 μ Siemens). Ingress of any kind of dissolved impurity will raise conductivity instantly. Thus conductivity is an important parameter for the detection of leakages.

Typical points in the steam circuit where conductivity should be monitored are: superheated steam, drum water, high pressure heaters, low pressure heaters, condenser, plant effluent, D.M. plant, make-up water to D.M. plant.

**Features:**
- Like pH Analyzers, Aquamon smart pro series is also available for conductivity measurement. This is loop powered through 24VDC power supply. Both 24V DC loop powered and AC powered options are available for this measurement
- These conductivity transmitters can be used with cells with different cell constant. PT-100 temperature sensor in conductivity cell helps to get a compensated reading for conductivity measurement
• **Silica**: The presence of Silica in the steam and water circuits of a power generation plant is associated with a number of problems both in the super heater and turbine sections.

The solubility of silica in steam increases with pressure. Hence there are chances of silica carryover. The presence of silica in the steam can lead to deposition in superheated tubes and on the turbine blades which may lead to loss of efficiency and turbine blade failure. For proper working of turbines, continuous monitoring of silica is highly recommended.

Similarly, the monitoring of anion and mixed bed ion exchanges safeguards and optimizes the operation of demineralization plant.

Thus the typical points in steam circuits where silica analysis is required are Low Level Silica Measurement in high pressure and low pressure turbines, steam, drum (saturated) steam, CEP discharge, make-up water, D.M. makeup water and high level Silica measurement in drum water.

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**Features:**

- Provision to monitor silica at multiple locations in the stream
- Provision for grab sample analysis
- Inbuilt data logger for analyzing graphical trend
- We offer smallest cycle time (~9 min) that can help you to know your process better and faster
- Micro-piston Pumping avoids cross contamination between two different channels
- Automatic two-point calibration gives best accuracy
- Locally available reagents and low consumption of the reagent ensures lowest cost of ownership
- Auto diagnostic features make our Silica Analyzers easy for maintenance
• **Dissolved Oxygen**: At elevated temperature dissolved oxygen causes corrosion which may cause puncturing and failure of piping and components respectively. Dissolved oxygen also promotes electrolytic action between dissimilar metals causing corrosion and leakage at joints and gaskets. Mechanical deaeration and chemical scavengers additives are used to remove the dissolved oxygen. An analytical check of process efficiency, therefore, is essential. Dissolved oxygen monitoring is imperative in power stations using neutral or combined operating conditions (pH 7.0-7.5 or 8.0-8.5). The typical points in steam circuit where dissolved oxygen monitoring is required are deaerator inlet and outlet.

**Features:**
- Measurement in ppb range
- Better response time
- Built-in temperature sensor for temperature easy compensation
- Sensors can be directly connected to the transmitter through a detachable cable for an easy maintenance

• **Hydrazine**: Hydrazine is used as oxygen scavenger. So it also maintains feed water alkalinity to prevent acidic corrosion. It prevents frothing in the boiler and minimizes deposits on metal surfaces. Hydrazine also helps in maintaining a protective magnetite layer over steel surfaces. Under dosing of hydrazine leads to increased corrosion and overdosing represents a costly waste. Therefore hydrazine monitoring is extremely important. The typical points in a steam circuit where hydrazine monitoring is required are: re-heaters, economizer inlet and L.P. heaters.

As output from Hydrazine analyzer can be used for precise dosing control. Hydrazine analyzer used in Forbes Marshall’s SWAS package offers:

**Features:**
- A response time lower than 60 seconds
- Measurement using 3 electrodes unlike tradition amperometric techniques thus eliminating voltage is due to changes in composition of water
- Reference electrode with pre-pressurized gel electrolyte which facilitates maintenance
- Provision for grab sample analysis- A feature very useful for PLANT CHEMIST
- No moving parts such as pumps or valves that are used to force gases, making the analyzer the most reliable one
**Sodium**: The presence of Sodium signals contamination with potentially corrosive anions, e.g., chlorides, sulfates etc. Under conditions of high pressure and temperature, neutral sodium salts exhibit considerable steam solubility. NaCl and NaOH, in particular, are known to be associated with “Stress Corrosion Cracking” of boiler and superheater tubes. The ubiquitous character of sodium in the environment makes it a useful indication to reveal possible “Leak conditions” within the circuit, particularly in the condenser section where the measurement of sodium detects cooling-water leaks with a much higher sensitivity than conductivity measurements. The typical points in a steam circuit where sodium monitoring is required are, D.M. plant make up water, condensate pump discharge, condenser, drum (saturated steam).

**Features:**

- Unmatched accuracy with 0.01 ppb detection unit
- Provision of grab Sampling, a feature very useful for plant chemist
- Wide range of measurement from 0 to 10,000 ppb, Freely programmable
- Use of Non-Hazardous chemicals for automatic reactivation of electrodes
- Fast Response. Even in multichannel measurement auto-adapted rinsing sequence to reach accuracy in a minimized cycle time (10 minutes possible)
- A reproducibility <1.5% of reading or <0.02 ppb, whichever is greater within 10°C
- An accuracy <5% of the reading or <0.1 ppb, whichever is greater
- Users can go for freely programmable “FULLY AUTOMATIC CALIBRATION SEQUENCE” as an option
Chiller

Chiller Package

Chilled water is required when the cooling water available at site is incapable of cooling the sample to the temperature required by the analyzers.

If cooling water temperature exceeds 40°C, the sample temperature would exceed 45°C, which is higher than the temperature required by the analyzers. To bring down the temperature of the sample chilled water is required.

Chiller package is also required when a sample is to be cooled at 25°C. We manufacture these in our factory and are the only SWAS manufacturers having this capability.

Lab Sampling Module

Forbes Marshall offer Lab Sampling Module for laboratory analysis of steam in process boilers which is designed as per international standards. Its small and compact size and light weight design makes it suitable for continuous lab sample collection. It is easy to operate and fits easily on site.

Wherever there is a Boiler, Lab Sampling Module is required.
Photo Gallery
Forbes Marshall is the only SWAS manufacturer having expertise in Steam Engineering & Control Instrumentation

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<th>All power majors deal with us</th>
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Everything about steam and water analysis
Your local Forbes Marshall representative would be happy to provide you with any help and advice you might need.