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Success Story Collection

Power

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Success Story Collection

Power

This is a showcase of success stories from our customers worldwide.
Many leading companies are using
Yokogawa products to manage their plants and processes.

Contents

Plant Information

- Location: Traralgon, Victoria, Australia
- Plant type: Coal-fired (Brown coal)
- Capacity: 4 x 550 MW
- Project type: Revamping
- Completion: 2014

Loy Yang A (Coal, 4 x 550 MW)

AGL Loy Yang Replacement Integrated Control and Monitoring System including Turbine Control & Protection system and Training Simulators

Executive Summary

AGL Energy Limited (AGL) has completed the refurbishment of all four generating units at its Loy Yang A facility as part of a total upgrade of the power station's control system and generating units.

The Unit 4 generator at AGL's Loy Yang A power station successfully passed its full load rejection test in late 2014, signifying the end of Unit 4's major outage activity. The total refurbishment started in 2006. The upgrade featured co-ordinated control system for each boiler/turbine unit incorporating the latest Yokogawa model based on "set and forget" modulating control with extensive integrated plant sequencing and plant automatic run up systems.

The Challenges and the Solutions

Loy Yang's iconic cooling towers and flue stacks near Traralgon in the Latrobe Valley have become local landmarks ever since the plant was commissioned over 30 years ago in 1982. Loy Yang is a 2,210- megawatt power station that supplies approximately 30% of Victoria's power requirements. It is Victoria's largest power station.

More than 30 years on, continuing efficiency initiatives in the face of rising coal costs and tougher environmental controls and the aging of many disparate control and protection systems meant that there was a need to refurbish the integrated control and monitoring systems on the 4 boilers and generators.

The contract to do this refurbishment was awarded to Yokogawa in 2006 with a scope that included creating a common station plant control system, a coal handling system (from the raw coal to the power station bunkers including the auto bunkering system), changing out all the boiler control protection & monitoring systems and the replacement of the original Kraftwerk Union (KWU) turbo generator control and protection systems with Yokogawa CENTUM VP turbo-machinery controllers and ProSafe-RS SIL3 rated safety systems.

The scope also included the development and supply of a high fidelity operator training simulator. This simulator was delivered before the first installation of the CENTUM VP distributed control system. Having the simulator prior to the cutover allowed the operators to become experienced in the new operator interfaces and control logic. The operators being familiar with the interfaces and logic helped with a reduction in operator error during the initial plant recommissioning.

The simulator was also used to pre-test and pre-tune the control system logic prior to commissioning. A second simulator was supplied to offer more operator training opportunities.

Loy Yang's source of brown coal that sometimes contains 66% water

Over the time that this project took to complete, Yokogawa did not miss the opportunity to learn how to be more efficient, timely and ultimately provide more value to Loy Yang's owners. Every unit outage was quicker than the previous one. Yokogawa successfully completed Unit 4's outage early and importantly without any lost time Incidents even though at the project's peak there was an additional 800 workers on site.

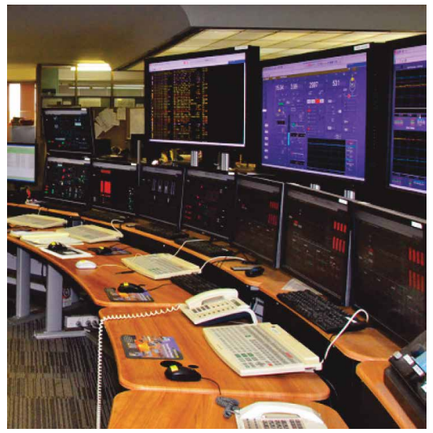
Benefits are already flowing from the new integrated control and monitoring system with one of the units having their longest continuous runs since they were built. Also according to feedback from the plant's operators, the new control system allows more precision in the operation of the steam boilers to better cope with variations in coal quality and moisture content from the adjacent mine. The coal sometimes contains 66% water.

Details of the Upgrade

The Yokogawa CENTUM VP distributed control system installed in Loy Yang 'A' has over 40,000 inputs and outputs and is equipped with a total of 48 operator stations and screens in the central control room.

The co-ordinated control system for each boiler/turbine unit incorporated the latest Yokogawa model based "set and forget" modulating control with extensive integrated plant sequencing and plant automatic run up systems including:

- Superheater steam temperature controls use an enthalpy balanced advanced model-based control, controlling spray flow to steam flow ratio to achieve desired spray stage outlet temperatures with spray valves reacting to firing and steam flow changes before steam temperatures are affected.
- Feedwater and condensate controls operate "unattended" from initial firing pressure raising to rated load with economizer steaming protection using "set and forget" features.
- The firing controls now automatically compensate for the rapid large changes in fuel quality typical of brown coal with very high moisture content.
- A control system featuring fault tolerance, with "graceful degradation" to standard cascade system in the event of faulty inputs to advanced control algorithms.
- Automatic Generation Control with "SMART" sliding pressure feature.
- Sequence of events reporting to 1-millisecond resolution.
- Advanced "Intelligent" alarming software incorporated in the ICMS to prevent alarm flooding during periods of major plant activity.
- A Yokogawa ProSafe-RS safety instrumented system ensures boiler and turbine plant integrity.
- The control of the extensive coal handling plant was refurbished using the Yokogawa FA-M3 family of high speed versatile programmable logic controllers.
- The Yokogawa CENTUM VP distributed control system for the Loy Yang 'A' project is integrated with an extensive suite of plant performance reporting and management packages.
- Yokogawa Exaquantum plant information management system (PIMS).



Part of the new Loy Yang control room layout

Customer Satisfaction

AGL Loy Yang's previous engineering and maintenance manager, Ron Tomasetti, said during the initial implementation phase Loy Yang was already seeing yield improvements in running the automated control system which required less operator input but gave tighter control of the system. "From what we've seen to date, thermal efficiency improvements of 2-3% across the plant are possible."

Mr. Tomasetti said this was a 'win-win' for the power station, electricity users, and the environment. "Efficiency and environmental benefits are one and the same thing. If you run the plant efficiently, you burn less fuel and also avoid spikes in steam temperature. This preserves the life and integrity of the whole steam circuit (comprising boiler, valves etc.) and also results in a higher level of plant safety."

With the ICMS conversion project complete, it marks the end of an eight year project between AGL Loy Yang and Yokogawa Australia but our cooperation continues with Yokogawa providing a long term service & support agreement. Pictured below is the ceremonial completion of the project with the "filling in" of the last eye on the daruma doll.

Plant Information

- Location: Nigrie, Madhya Pradesh, India
- Plant type: Coal-fired (Supercritical boiler)
- Capacity: 2 x 660 MW
- Project type: New
- Completion: March 2014

Jaypee Nigrie (Coal, 2 x 660MW)

Comprehensive Solution for Safe and Efficient Operation of Supercritical Coal-fired Power Plant

Executive Summary

The Jaypee Group is a diversified infrastructure conglomerate in India with interests in Civil Engineering and Construction, Cement, Power, Fertilizers, Real Estate, Expressways, Hospitality, Golf Courses, Sports and Education (not-for-profit). The Group has vast experience in the conceptualization, design, development, construction and operation of hydroelectric power plants and is able to manage multiple aspects of power projects, from front-end engineering design to completion, operation and maintenance.

The Jaypee Nigrie supercritical coal-fired power plant consists of two units with generation capacity of 660 MW each. The plant was set up by Jaiprakash Power Ventures Ltd. (JPVL) at a site in Nigrie Village, Deosar Tehsil, Singrauli District in Madhya Pradesh, India. The commissioning for units I and II were carried out in 2014 and 2015, respectively.

Yokogawa India successfully installed CENTUM VP production control systems and a high-fidelity operator training simulator with requisite project engineering and management, installation and commissioning services.

Central control room

The Challenges and the Solutions

Due to India's rapid economic growth, power companies have not been able to keep pace with the country's rising demand for electricity. To ensure a stable supply of electric power, the Indian government is planning as part of a comprehensive energy initiative to construct numerous large coal-fired power plants which operate at a temperature and pressure above the critical pressure point to generate steam for turbines with high thermal efficiency, consume less fuel, and emit less greenhouse gases. Such large supercritical pressure coal-fired power plants are also called super thermal power plants. Proven, unsurpassed reliability of Yokogawa's control and monitoring systems help success of this government's program.

The JPVL's Jaypee Nigrie supercritical pressure coal-fired power plant consists of boiler-turbine-generator units employing supercritical sliding-pressure boilers supplied by L&T MHPS Boilers Private Limited*, steam turbines and generators by L&T, and the balance of plant (BOP) such as water treatment, ash handling and coal handling processes supplied and installed by various contractors including Ion Exchange, Macawber Beekay and L&T.

Stabile operation by agile control

Despite less environmental impacts, this type of plant has complex dynamic characteristics requiring quickly responding control actions. Whenever the demand changes, the boiler combustion air, coal feeder speed and feedwater flow need to be modulated quickly in a correlated way in response, and the steam turbine also needs to respond in a coordinated manner. The CENTUM VP controls and monitors boilers and steam ensures that these controls work smoothly at all times whatever mode each unit is in.

High-fidelity operator training simulator for safe and efficient operation

The comprehensive solution supplied by Yokogawa included proprietary full-replica operator training simulator in which the supercritical boiler (circulating corner firing with twin fire-vortexes design) and turbines used are modeled precisely to contribute to efficient operations throughout the lifecycle of this power plant.

Comprehensive solution

Also supplied by Yokogawa include:

- Field Instruments
- Continuous emissions monitoring systems (CEMS)
- Steam and water analysis systems (SWAS)
- Ambient air quality monitoring stations (AAQMS)
- Performance analysis diagnostic optimization (PADO) software packages
- Uninterruptible power supply units (UPS)
- DC power supplies

* L&T MHPS Boilers Private Limited, India is a joint venture formed by Mitsubishi Heavy Industries (MHPS) and Larsen & Toubro (L&T) and designs, manufactures and sells supercritical pressure boilers used in coal-fired power generation plants.

Customer Satisfaction

"Commencement of commercial operation was enabled thanks to exceptional support by the highly motivated and dedicated team of Yokogawa engineers at the Nigrie site, the engineering office, and other sites who untiringly worked round the clock. We highly appreciate and acknowledge the tremendous effort made by the Yokogawa team during the test run."

Plant Information

- Location: Hai Duong, Vietnam
- Plant type: Coal-fired (Anthracite)
- Capacity: 2 x 300 MW
- Project type: New
- Completion: 2002

EVN Pha Lai 2 (Coal, 2 x 300 MW)

Yokogawa CENTUM CS 3000 Ensures a Stable Supply of Power to Vietnam's National Grid

Executive Summary

With a power generating capacity of 600 MW, Pha Lai 2 is the largest coal-fired plant in Vietnam. As part of a master plan by the Vietnam Ministry of Industry to meet rapidly rising demand for power by doubling the country's generating capacity, the power station was constructed at a cost of $540 million by Electric of Vietnam (EVN). Located approximately 65 km northeast of Hanoi, Pha Lai 2 and the adjacent Pha Lai 1 power station (a Russian-built facility with eight 220 t/h coal-fired boilers and four 110 MW turbines) are owned and operated by a wholly owned EVN subsidiary, Pha Lai Thermo Power Joint Stock Company. (PPC).

It is estimated that the two power stations supply approximately 80% of Hanoi's power. In accordance with the Ministry of Industry's master plan, no more than 20% of their power is allotted to private power companies, and the remainder goes to EVN.

In 2002, Yokogawa successfully designed, installed, and commissioned a CENTUM CS 3000 distributed control system (DCS) for the Pha Lai 2 power station, and it has operated to date without any significant problems. Along with the Yokogawa DCS, a full replica plant simulator was installed to provide plant operator training. The DCS and all related systems are maintained by Yokogawa Vietnam under the terms of an annual maintenance contract.

The Challenges and the Solutions

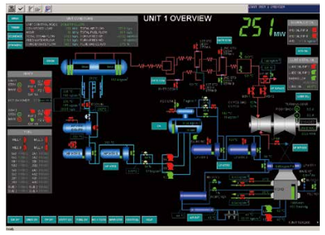
Steady power supply and safe operation

Power demand from the national grid is high, and the Pha Lai 2 power station covers a significant percentage of that. It needs to provide a very steady supply of power 24 hours a day, 7 days a week, all through the year. Yokogawa's highly reliable CENTUM CS 3000 DCS makes this possible.

In addition, Yokogawa transmitters installed in the power island area are contributing to the high overall reliability of this power station.

The CENTUM CS 3000 provides integrated control of the power station's steam turbine control system, water treatment PLC, wastewater treatment PLC, ash handling PLC, burner management system, and coal handling system, enabling the data from these systems to be monitored in real time on graphic displays. This gives plant operators all the information they need to take quick and effective action whenever needed, thus ensuring the safe operation of the plant and the stable supply of power to the national grid at all times.

Central control room

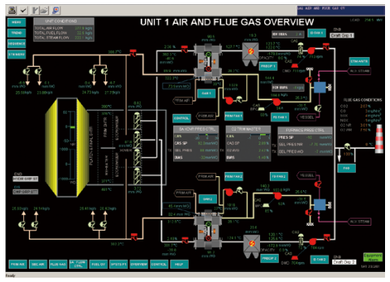


Unit 1 overview graphic display

Steam turbine unit 1

Environmentally optimized operation

Coal-fired power plants produce significantly more greenhouse gasses than plants that rely on natural gas and other fuels. Thanks to the fine-tuned boiler combustion control configured in the CENTUM CS 3000 system and the use of an oxygen monitoring system that can precisely track the oxigen concentration in the flue gas, it has been possible to optimize the combustion process under varying load conditions and keep CO_2 emissions at this plant well within regulatory guidelines. In addition, a Yokogawa solution has made it possible to monitor and strictly control the CO, NOx, and SOx values in the flue gas and the pH value of the water from the plant's cooling towers. In these ways, the Pha Lai 2 power station is maintaining a sustainable operation.



Unit 1 air and flue gas overview graphic display

High fidelity power plant training simulator

For effective operation and engineering staff training, the training simulator uses the test features of the CENTUM CS 3000 to simulate the power plant. The operator training interface accurately replicates the plant control console and graphical interface.

Station staff training on the simulator

Customer Satisfaction

Nguyen Khac Son, PPC's Chief Executive Officer, said, "We are very happy to be using the Yokogawa CENTUM CS 3000 process control system. We are now operating nonstop without any major problems, using Yokogawa's system and field transmitters. We are operating near capacity almost every day and are sending this power to the national grid. Continuous operation is a very important point." He continued, "The CENTUM CS 3000 is the brain of this power station and the field transmitters are important sensors for monitoring all power plant equipment and processes. We have a good relationship with Yokogawa Vietnam and look to working with them in the future."

Plant Details

Type of boiler:	Down-shot coal-fired
Boiler:	922 t/h, Mitsui Babcock Energy Ltd., UK (Doosan Babcock)
Steam turbine:	General Electric, USA
Steam temperature:	541°C
Steam pressure:	17.0 MPa
Gross unit output:	600 MW (300 MW x 2 units)

Systems Delivered

Distributed control system for boiler control, burner management, balance-of-plant control, etc: CENTUM CS 3000

Human-machine interfaces: 10 screens per unit

Field control stations: 15 controllers per unit

Total hardwired I/O: 16,400

Field devices: Yokogawa transmitters

Plant Information

- Location: Ulaanbaatar, Mongolia
- Plant type: Coal-fired (Lignite)
- Capacity: 8 x 420 t/h
- Project type: Revamping
- Completion: 2001 (Phase I), 2007 (II)

Ulaanbaatar Thermal Power Plant No.4
(Coal, 8 x 420 t/h)

Modernization of Large Thermal Power Plant Maintains a Key Lifeline for the People of Mongolia

Executive Summary

In Mongolia, temperatures fall as low as -40℃ in mid-winter. The heat and electricity generated by Thermal Power Plant No. 4 (TPP4) in the capital city of Ulaanbaatar is an important lifeline for the people living there. This is the largest coal fired power plant in Mongolia and it generates 70% of the electricity for Mongolia's central energy system and 65% of the heat energy used by the Ulaanbaatar district heating system.

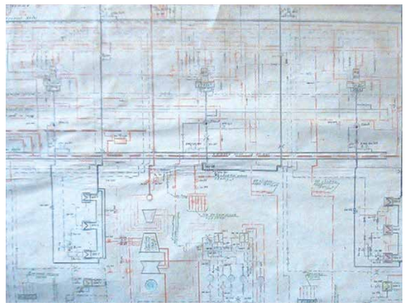
TPP4 was built many years ago and has been severely affected by the scarcity of spare parts for its legacy systems. Plant shutdowns were a frequent occurrence due to equipment malfunctions and accidents, disrupting the supply of heat and power. In addition, the plant caused severe air pollution due to inefficient control of coal combustion. Efforts to correct these problems were also hampered by the loss of many of the plant's original blueprints and other design related documents.

To solve these problems, the Mongolian government decided to execute a plant revamping project in two phases using an official development assistance (ODA) loan. Phase one for boilers one to four started in 1998 and was completed in 2001. Phase two for boilers five to eight started in 2001 and was completed in 2007. For this project, Yokogawa delivered control systems and field instrumentation for all eight boilers.

TPP4 in winter

TPP4, lifeline for Mongolia

Original boiler control panel



Old plant drawing

The Challenges

The original combustion system used indirect firing, with pulverized coal being transferred from a storage silo whenever the boiler was started up. With the exception of feed water control, all the boilers and mill burners were manually controlled by operators. There were many equipment problems and a high risk of explosions, and combustion was extremely low.

In addition, there were just a few of the original blueprints dating back to when the plant was built in the 1980s, and none showed the boiler design in detail. As a result, no one completely understood the actual workings of the plant.

However, the Mongolian government had an urgent need to rehabilitate this large plant and thereby secure this major lifeline for its people. The customer's specific requirements were as follows:

- Full automation of the boilers, burners, and balance of plant facilities
- Change from an analog control system to a modern digital control system
- Use of a power plant simulator to train operators and achieve a smooth transition to screen-based operations.

The Solutions

First of all, information had to be gathered that would provide a starting point for the automation design. This was followed by conversion to a direct firing boiler combustion system in which pulverized coal is directly loaded into the boilers and the replacement of the old mill burner control systems with a Yokogawa DCS.

- **Automation of boilers, burners, and balance of plant facilities and changeover to a new boiler combustion system**

To meet the customer's requirements for changing the old indirect combustion system to a direct combustion system, a Yokogawa project team of Russian, English, Mongolian, and Japanese speakers conducted a detailed investigation of the original boiler combustion control system and coordinated its activities with a new burner vendor. They had to crawl around every nook and cranny of this plant to create a piping & instrument diagram (P&ID) and a cabling drawing that accurately described the plant configuration. This was dirty and challenging work and it took many days to complete. Finally they succeeded in bringing together the documentation needed to design the automation for the plant's boilers, burners, and balance of plant facilities and change to a direct firing boiler combustion system.

New central control room

Ulaanbaatar Thermal Power Plant No.4
(Coal, 8 x 420 t/h)

▸ Replacement of conventional analog control system with state-of-the-art digital control system

With the completion of both phases of this project, the control of all eight boilers has been integrated with a Yokogawa CENTUM CS 3000 DCS. The operator stations were changed over from conventional analog panels to a modern graphical user interface, and this has improved the efficiency and safety of plant operations. In addition, a Yokogawa Exaquantum Plant Information Management System was installed to enable remote monitoring of all boiler operations from the administration building, which contributes to correct and prompt plant operation management. As for the system architecture, a redundant remote optical network was used for the I/O system to reduce the cabling cost and improve safety and reliability.

▸ Power plant simulator improves skills and eases transition to screen-based operations

Together with a state-of-art DCS, a power plant simulator was provided that operators can use to upgrade their skills. This made possible a smooth transition from the conventional analog control panels to an all-new graphical user interface.

Results

▸ Reduction of boiler trips and accidents

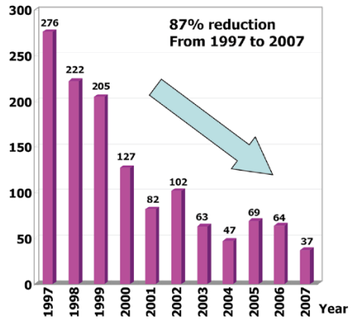
One by one, the eight boilers were changed over to the new control system and resumed operation, starting at the end of 1998. Reliability and safety have both been dramatically improved as a result of a steady decline in the number of boiler trips and accidents. With production up and oil consumption down, it has been possible to significantly reduce energy imports from Russia.

▸ Reduction of CO_2 emissions through improved combustion efficiency

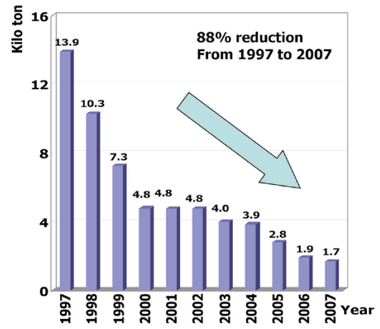
With the reduction of boiler trips and plant accidents, boiler combustion efficiency has been dramatically improved. In addition to ensuring a stable supply of heat and electricity to the city of Ulaanbaatar, this has made it possible to generate more electricity from the same amount of coal. The amount of oil consumed for plant restarts has also been decreased, further reducing CO_2 emissions.

▸ Technical transfer to TPP4

The Yokogawa project team worked together with TPP4's engineers from start to finish of this project, providing them the opportunity to improve their skills in such areas as engineering design and commissioning. A number of the boiler control systems were successfully replaced by the TPP4 engineers. This transfer of power plant engineering expertise was one of the main aims of this ODA project, and this ensures that the skills and know-how are in place to sustain operations at this plant.



Number of hot starts



Heavy oil consumption (kilo ton)

Fuel consumption : Electricity (g/kWh)

Fuel consumption : Hot water (kg/Gcal)

Fuel consumption ratio: Hot water (g/Gcal)

Customer Satisfaction

More than a year after phase one was fully completed, one of the four boilers caused a trip. Yokogawa dispatched engineers immediately and made every effort to solve the problem. The investigation found that the boiler trip was caused by a malfunction in one of the conventional components left over the old plant control system. Even though a Yokogawa product was not at fault, the company's engineers provided the TPP4 engineers the support they needed to get the plant safely operating again.

Mr. J.Osgonbaatar, Executive Director of TPP4, says, "Seeing is believing. Whatever beautiful things sales people say, I will not believe until I see them at work. When we experienced the plant trip, I learned what makes Yokogawa different from others. I admire their sincerity and devotion toward customers."

Mr. J.Osgonbaatar

Plant Information

- Location: Springfield, MO, USA
- Plant type: Coal and gas-fired
- Capacity: 253 MW
- Project type: Revamping
- Completion: April 2007

James River (Coal/Gas, 253 MW)

James River Power Plant Replaces Legacy Control System

Background

In 1957, the City Utilities of Springfield, MO, commissioned a pneumatic distributed control system for its James River Power Plant. At that time, the plant was considered very advanced because it utilized a centralized control room for operations, instead of a series of separate control stations located throughout the facility.

"Through the years since," explained Maintenance Manager Steve Stodden, "we had attempted to keep the existing systemfunctional, but maintaining a 50-year-old system has proven difficult.

Several years ago we started discussions with all plantpersonnel involved about upgrading the old control system to improve the safety of the plant and to take advantage of modern digital technology. The result is that we now operate our five generating units with varying stages of a new CS 3000 control system from Yokogawa."

Evaluating the Choices

"Our evaluation of competing vendors was based on consideration of a combination of factors with the awareness that the new system will probably be in place for decades until the current facility is retired," said Stodden. "We had to be confident of the vendor's support during this extended future time period."

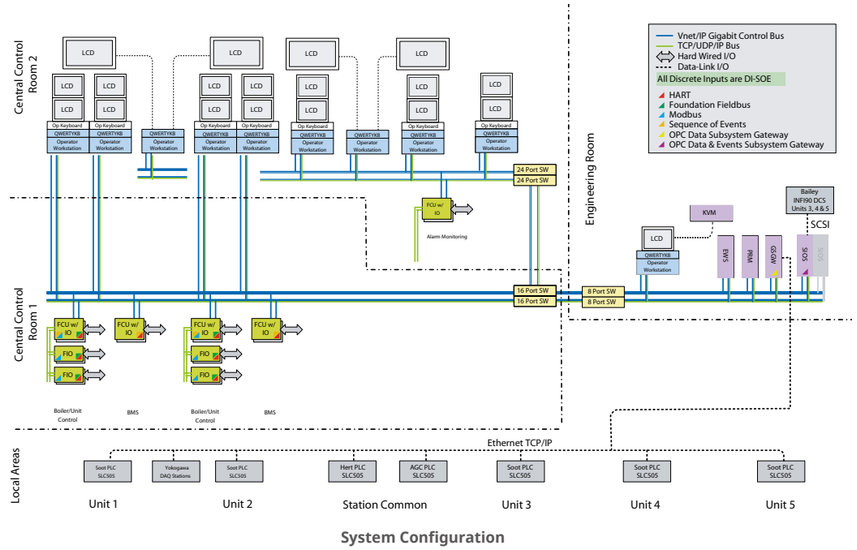
With the vendor selected, system details were then examined. The initial bid was based on 4-20 mA protocol but replaced by FOUNDATION™ fieldbus (FF) as advantages of FF emerged. The plant has five generating units with a total capacity of 253 MW (two 22 MW, one 44 MW, one 60 MW, and one 105 MW).

Scope

"We decided to handle all the new-system installation in-house," said Stodden. "That way our personnel would be very familiar with everything involved. We were delighted with how smoothly the entire procedure went, and we completed installation in only six weeks. We had virtually no problems with the CS 3000 hardware or software. Our biggest obstacle was moving the electrical interlocks required to combine the two control rooms into one. If the Yokogawa system had not worked so well, we would never have made our startup dates."

"Originally," he continued, "Units 1 and 2 were housed in one control room, while Units 3, 4 and 5 were housed in a separate control room. As part of this project, we combined these into one. The new system has worked so well, that we now utilize one control operator to run both Units 1 and 2, where before each unit had a dedicated control operator assigned to each unit."

CENTUM CS 3000



System Configuration

"Units 3, 4 and 5 use a 'hybrid' configuration. These units are equipped with an older control system platform, utilizing Hand-Auto Stations for operator interface. This control system, while dated, is still supported. Therefore, as a step toward uniformity among the units, we utilize the Yokogawa Operator Console Platform to communicate with the older control system hardware already in place. The operators see the same style of operator screens as Units 1 and 2, without realizing that it is utilizing a completely different control system. Annunciators and selected other functions work directly from the CS 3000 control; control loops are displayed on the CS 3000 screens but are processing existing control loops through an interface."

When asked about acceptance by operators of the new electronic system, Stodden illustrated by quoting one of the men who initially said he thought the "...new system was the worst decision we had ever made." But within two months after startup, the same operator asked 'When are we going to do the other three units?' Suffice it to say that by now our operators are very comfortable and pleased."

The CS 3000 system has provided the ability for automatic control sequences not previously practical. For example, shutting down a coal feeder used to require many control manipulations to maintain safe operation of the boiler. The entire sequence is now automatic. "We just hit a key and sit back to watch everything progress through the control sequence," said Stodden with a satisfied smile.

Notes on James River Power Plant

The plant, which celebrated its 50th anniversary in 2007, consists of five coalfired boilers equipped with steam turbines and two natural-gas-fired turbines. The plant initially was designed to utilize natural gas as its primary fuel, with coal as a winter backup fuel. This switched during the late 1970's driven by the Power Plant and Industrial Fuel Use Act of 1978. The station now utilizes less than 1% natural gas for fuel for the steam boilers.

Ultra low-NO_x burners and overfire air(OFA) were introduced later to greatly reduce nitrogen oxide emissions in preparation for EPA standards that went into effect in 2009. All units of the James River Power Station remain capable of burning either 100% coal or 100% natural gas in order to produce electricity.

The plant currently supplies slightly more than half of the electricity generated by City Utilities. Forced outages at the plant have averaged slightly more than 1%, which is approximately one-fifth of the national average.

System Details

System:	CENTUM CS 3000
Total I/O:	Approximately 1,400
System configuration:	9 x HIS, 1 x EWS, 1 x SIOS, 1 x GSGW
Other:	PRM (Plant Resource Manager), FF, Bailey INFI90 interface
Scope:	System, project management, design, configuration engineering, commissioning services

Plant Information

- Location: Tokushima, Japan
- Plant type: Coal-fired
- Capacity: 2 x 1,050 MW
- Project type: New
- Completion: 2000

Tachibanawan Thermal Power Plant
(Coal, 2 x 1050 MW)

Control Solutions for Environmental Control Facilities

Executive Summary

- **One of Japan's largest coal-fired power plants, with advanced environmental protection measures**

- Supplies electricity to a wide area in western Japan (Kansai, Chugoku, Shikoku, and Kyushu)
- Has the largest coal-fired generation units in Japan, each with an output of 1,050 MW
- Protects environment by removing NOx/SOx emissions and ash dust, and recycling fly ash
- Integrated control and monitoring of the environmental facilities, supported by Yokogawa's highly-reliable CENTUM system and state-of-art large displays

Background

The Tachibanawan Thermal Power Station is owned by Electric Power Development Co., Ltd. and is located in Anan City, Tokushima Prefecture. With two 1,050 MW generating units, it is one of the largest coal-fired power plants in Japan.
The station entered commercial operation in 2000 and supplies electricity to a wide area in western Japan through four power utilities that serve the Kansai, Chugoku, Shikoku, and Kyushu regions.

The plant is well known not only for its stable electricity supply but also its environmental protection measures. The plant layout was optimized to keep the site size to a minimum, and colors were selected that matched the scenic surroundings of the Seto Inland Sea area. Part of the fly ash from the combustion process is recycled to make cement. To prevent air pollution, state-of-art environmental control facilities such as Flue Gas Desulfurization (FGD) systems were installed, removing NOx, SOx and ash dust. In 2004 this plant received ISO14001 certification, demonstrating that its environmental protection measures meet international standards.

The Challenges and the Solutions

- **Integrated operation of large environmental control facilities**

  The environmental control facilities at this plant consist of FGD, electric precipitator, coal handling, ash handling, and waste water treatment systems. This large application with more than 30,000 data items is monitored and controlled by Yokogawa's CENTUM CS integrated control system. With a remote I/O architecture that minimizes cabling, highly reliable dual-redundant fiber-optic cables, and communication links with plant auxiliary sub-systems, the CENTUM system achieves highly-reliable, single-architecture monitoring of all facilities.

- **Mouse operation and large displays**

  For safety and efficiency, plant operators can perform input with a mouse and monitor operations on two 100-inch displays. Yokogawa has optimized the operation of these large displays through the development of individual screens, frames, and alarm functions. For example, in an emergency, a guidance message pops up on a screen and easy-to-understand video/audio prompts enable operators to quickly verify associated systems and instruments. This customized operator interface helps to ensure that the plant operates smoothly and safely.

- **Calculation system for environmental management system**

  For the effective management of the FGD and waste water treatment facilities, a calculation system was embedded in the CENTUM control system. The system also includes an operation management function that reduces operating costs and extends equipment life, a forecast calculation function, and a reporting function. This supports highly-reliable and efficient management of the environmental control facilities.

  Since entering commercial operation in 2000, the environmental control facilities at the Tachibanawan Thermal Power Station have been managed effectively by the CENTUM control system, achieving a stable electricity supply with minimal impact on the environment.

Mouse operation and large displays (8 screens)

System Details

Output: 2 x 1,050 MW
Control system for environmental control facilities: CENTUM CS

Plant Information

- Location: Turceni, Romania
- Plant type: Coal-fired
- Capacity: 7 x 330 MW
- Project type: Revamping
- Completion: February 2013

Turceni Thermal Power Plant (Coal, 4 x 330 MW)

Yokogawa's Integrated Solutions Control FGD Processes at Romania's Largest Power Plant

Executive Summary

The Turceni thermal power plant (TPP), located in southwest Romania's Gorj county, is this country's largest coal-fired power plant, belonging to the Romanian state-owned coal energy producer Complexul Energetic Oltenia S.A. With a total installed capacity of 3,900 MW (9 units x 330MW,2 units x 315MW, 2 units x 150 MW spread across 4 power plants), it generates approx. 30% of the country's electricity.

As Romania joined the EU in 2007, it was required to bring its power plants' sulfur dioxide (SO_2) and dust emissions into compliance with the EU environmental standards by 2011. Thus the power plants had a very tight deadline for achieving this reduction, and would not be allowed to continue the operation if they failed to comply. Given this situation, the Turceni TPP pollution abatement project chosed to make use of a yen-denominated official development assistance (ODA) loan from the Japan Bank for International Cooperation (JBIC) to finance the installation of flue gas desulfurization (FGD) systems for units 3, 4, 5, and 6 at the Turceni power plant.

The FGD systems are designed to remove 96.4% of the SO_2 and up to 80% of the fly ash from the boiler flue gas. Each boiler of units 3 through 6 is equipped with an absorber unit, and there is a total of two limestone slurry preparation lines for the four boilers. The flue gas SO_2 absorption process produces a gypsum slurry that is pumped out to a subsequent dehydration process. 15,000 tons/year of commercial grade gypsum are produced. This technology is the one of the former Austrian Energy & Environment (AE&E), actually Andritz Energy & Environment.

For the Turceni TPP, Yokogawa provided its CENTUM VP integrated production control system (PCS); field devices such as DPharp EJX pressure/differential pressure transmitters, pH analyzers, and temperature transmitters; the Plant Resource Manager (PRM) integrated device management tool; the Exaquantum plant information management system (PIMS); the eLogBook tool for shift operator logging; and paperless recorders for environmental emissions tracking and the monitoring of large motors. Following the delivery of all of these products and systems between 2009 and 2012, the FGD systems for all four units have been operating to the customer's complete satisfaction.

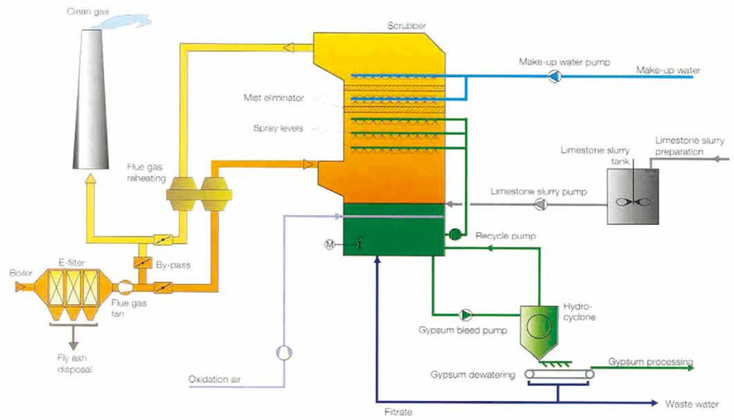
The Challenges and the Solutions

Integration with subsystems

The Turceni TPP has to run 24/7/365 for a steady supply of electricity to the national grid while meeting the strict requirements of the new EU environmental standard, which provides that the SO_2 content in the flue gas must never exceed 200 mg/Nm³. To promptly make the necessary adjustments, the operators in the FGD control room need to see in real time what is happening in each of the FGD processes. Yokogawa made this possible by achieving complete integration between its CENTUM VP PCS with FGD subsystems such as the gas monitoring and recording system (GMRS), vibration monitoring and recording system (VMRS), asset management package (PRM), and the closed circuit television system (CCTV).

From their human machine interface (HMI) stations in the FGD control room, operators can view live feeds from CCTV cameras installed in various plant locations, and are able to zoom in/out and pan left/right. Also at the HMI stations, operators have access to a PRM screen that gives the status information for all field devices and a VMRS screen that displays a continuous stream of data as well as data logged by paperless recorders that can be used to identify when preventive maintenance is required for any of the large motors in the FGD facility, thereby minimizing the possibility that a failure can lead to an unscheduled plant shutdown.

Thus operators can stay on top of what is happening in the process at all four units and they are provided with the right information at the right time to ensure that they can promptly take the right action to ensure safe and efficient operations.



Flue gas desulfurization processes

Optimum FGD absorber control

The FGD absorber has three main processes that must be precisely controlled to meet the government's environmental standard and to ensure the efficient production of a high quality gypsum by-product:

- Limestone: the storage of limestone and preparation of limestone slurry
- Absorption: the supply of limestone slurry and air to remove SO_2 and produce a gypsum slurry
- Gypsum: the recovery of commercial-grade gypsum from the gypsum slurry

The flue gas enters the absorption unit after passing through an electrostatic precipitator that removes fly ash. Based on the type of coal that is being used and the data on the flue gas flow rate, the CENTUM VP system automatically controls how much slurry is sprayed inside the absorber unit by controlling pumps on or off, thereby ensuring the optimum desulfurization rate required to meet EU environmental standards. The reaction between the SO_2 and limestone slurry produces calcium sulfite, which undergoes a further conversion to gypsum through the introduction of oxidation air. After the pH level is adjusted to 7.0 through the addition of $CaCO_3$, the gypsum slurry is transferred to a gypsum separator. Here, through some processes, such as filtration and dehydration that necessitate the operation of numerous motors and pumps, a saleable gypsum by-product is produced and it is over 95% pure.

All strategies for the automated control of the above processes are configured in the CENTUM VP system, using a combination of sequential and feedback control functions. By means of graphic displays and guidance messages at the HMI stations, operators at the Turceni TPP are able to interact with CENTUM VP and stay on top of what is happening in these processes.

Reporting and information transferring

The Turceni TPP must regularly submit reports showing that it is in compliance with the new EU environmental standard. The Exaquantum plant information management package collects all the necessary operational data for these reports, which are automatically generated on a daily, weekly, and monthly basis by the CENTUM VP system. The amounts of water, electricity, limestone, and steam used in the processes are also calculated so that the overall efficiency can be determined. This information can be used to further improve the operation.

The eLogBook tool allows the operators on each eight hour shift to record and transfer information on any significant activities, operation changes, problems, and so on to the operators working the next shift, ensuring greater safety and efficiency in plant operations.

Customer Satisfaction

Marian Motocu, the former general manager of Complexul Energetic Turceni S.A.(at this moment, being the manager of Craiova II TPP): "Yokogawa's fully integrated control solution and competence came with a great contribution to the success of this pollution abatement project, opening a new phase in the Romanian energy power sector."

Laviniu Danciu, complex project manager Turceni TPP, said, "Yokogawa's systems and products, including the CENTUM VP PCS, Exaquantum PIMS, PRM plant asset management package, instrumentation, the eLogBook tool, sequence event recording (SER), and integrated 3rd party subsystems such as a vibration monitoring system, emissions monitoring system, and CCTV system have all demonstrated their strong capabilities over a one year period at all four units. Yokogawa is one of our best partners."

The FGD control room

Plant Information

- Location: Niigata, Japan
- Plant type: Coal-fired (CFB boiler)
- Capacity: 149 MW
- Project type: New
- Completion: 2000

Itoigawa Power Plant (Coal CFB boiler, 149 MW)

Flexible Control Solution for IPP Generation Facility with CFB Boiler

Executive Summary

- **Flexible operation of circulating fluidized bed (CFB) facility by independent power producer (IPP)**
  - 149 MW coal-fired power plant operated by IPP
  - First use of circulating fluidized bed (CFB) boiler by IPP in Japan
  - Fly ash recycled at adjacent cement plant
  - Daily operation in swing mode and shutdown/startup responding to shifts in electricity demand
  - Controlled by Yokogawa's CENTUM system

Background

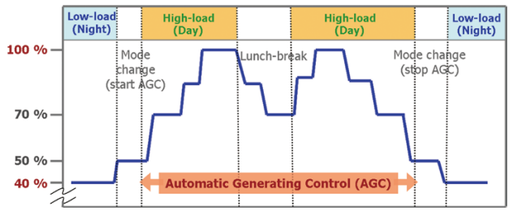
The Itoigawa Power Plant was constructed adjacent to a cement plant in Itoigawa City, Niigata Prefecture, and is operated by an IPP that supplies electricity to Tohoku Electric Power, one of Japan's major power companies. The use of a 149 MW coal-fired CFB boiler in this power plant is a first for an IPP in Japan, and this effectively reduces NOx emissions. This power plant also recycles at an adjacent cement plant the fly ash that is the byproduct of coal combustion.

Control room

The Challenges and the Results

- **Flexible response to shifts in electricity demand**

To adjust to shifts in electricity demand, the customer runs the Itoigawa Power Plant in swing mode. During the daytime hours of high electricity demand, the plant is run at up to 100% of its capacity, with output being adjusted flexibly in response to commands from a central load dispatching center. At night the plant is operated at just 40% of its capacity.

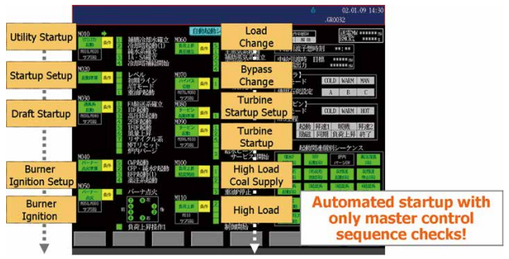


Daily operation example in swing mode

- **Automatic shutdown/startup capability**

Yokogawa fully implemented the operation logic for its highly-reliable CENTUM CS control system to match frequent load changes and provide a high degree of flexibility in the system's operation.

The CENTUM control system also supports automatic shutdown/startup to keep to a minimum the manual checks performed by operators. They are only required to check the master control sequence for stopping and starting the plant facilities, which ensures a safe, smooth shutdown and startup.



Plant automatic sequence monitoring

Since commencing commercial operation in July 2001, the Itoigawa power plant has been operating reliably and efficiently under its Yokogawa CENTUM control system while employing CFB technology to generate environmentally friendly electricity.

System Details

System:	CENTUM CS
Total I/O:	Aprox. 1,500
System configuration:	4 x HIS, 1 x EWS, 4 x FCD
Scope:	System, project management, design, configuration engineering, commissioning services

Plant Information

- Location: Yonghung, South Korea
- Plant type: Coal-fired (Supercritical boiler)
- Capacity: 2 x 800 MW
- Project type: New
- Completion: 2004

Yonghung Thermal Power Plant
(Simulator, Coal, 2 x 800 MW, Supercritical)

800 MW Supercritical Coal-fired Power Plant Achieves Smooth and Rapid Plant Commissioning Using a Full-replica Plant Simulator

Executive Summary

Faster, smoother plant commissioning

The customer has successfully brought online a greenfield 800 MW supercritical power plant using a Yokogawa full-replica plant simulator to ensure a fast and smooth plant commissioning process.

The full-replica plant simulator was used for:
- Control system validation prior to DCS commissioning
- Operator training

Background

In Korea, steadily growing demand for electricity together with limited indigenous energy resources and a heightened environmental awareness have required additional power generation facilities with improved efficiency and environmental performance. Korea South East Power Co., Ltd. (KOSEP), a wholly owned subsidiary of the government-owned Korean Electric Power Company, constructed two new 800 MW supercritical coal-fired units in Yonghung, Korea to generate highly efficient, environmentally friendly electricity.

The Challenges and the Results

To ensure that the commissioning process for its new plant went smoothly, KOSEP turned to Yokogawa and its TechComm Simulation subsidiary for a full-replica training simulator solution.

The purpose of this full-replica training simulator was twofold:
- To conduct a thorough, off-line test and validation of the DCS configuration prior to the control system's actual loading and commissioning at the plant.
- To aid in the initial/refresher training of plant operators, which was conducted in parallel with the plant commissioning.

To achieve these objectives, the simulator was required to fully stimulate DCS functions and emulate turbine, generator, and electrical control functions. Yokogawa's full-replica simulator met the customer's requirements with high accuracy (> 99% steady state; >95% dynamic state), calculation of models at less than 250msec per cycle, and the ability to perform performance tests and a wide variety of simulations including startups, shutdowns, and load changes under normal, abnormal, and emergency operating conditions.

Thorough Off-line Control Validation

The simulator was delivered on-schedule to the site in September 2002, twelve months before the boiler was to be fired up for the first time. In collaboration with the DCS manufacturer and Yokogawa, the customer proceeded to test and validate the DCS configuration on the simulator, conducting an I/O checkout, drive checks, sequence checks, control module checks/tuning, alarm/trip setting, and DCS response checks as well as tests in which malfunctions and other abnormal situations were simulated. This enabled thorough validation of the control configuration prior to DCS installation at the site, thereby minimizing the final tuning work. A significant number of potential plant trips and incidents where there was potential for damage to the plant were identified and resolved before the initial plant startup, ensuring a safe and smooth plant commissioning process.

Custom-made Operator training

The thorough control system validation on the simulator also provided a suitable training environment for plant operators. The simulator aided in the initial training for plant operators and refresher training for experienced operators under a wide variety of normal, abnormal, and emergency operating conditions. In parallel with DCS commissioning, KOSEP plant operators were well trained under the new control environment, reproducing custom-made flexible operating scenarios on the simulator. This avoided mistakes that could have occurred if the operator had not been familiar with the new system, thereby ensuring safe and smooth plant operation.
The simulator also has the flexibility and expandability to accommodate future improvements in plant performance. The simulator continues to be an effective tool for the customer to optimize operational procedures and the plant logic/system.

Central control room

Power plant simulator

Plant Details

Owner:	Korea South East Power Co., Ltd. (KOSEP)
Output:	2 x 800 MW
Plant efficiency:	43.5%
Operation mode:	Base load & cycle operation
Fuel:	Bituminous coal
Boiler type:	Supercritical pressure, once through, single reheat
Turbine:	Tandem compound, HP, IP, and LP turbine, single stage reheat, condensing type
Generator:	Cylindrical rotor, hydrogen and water cooled, three-phase synchronous generator
Simulator system:	Yokogawa full-replica plant simulator (main computer + instructor system + DCS)

Plant Information

- Location: Tuas, Singapore
- Plant type: Gas and oil-fired
- Capacity: 2 x 600 MW
- Project type: New
- Completion: 1999

Tuas Power Station (Gas/Oil, 2 x 600 MW)

Safe and Efficient Power Plant Operation

Executive Summary

The Tuas Power Station and its associated facilities are located on reclaimed land along the western shore of Singapore. The station occupies an area of approximately 75 hectares and is being built in two stages.

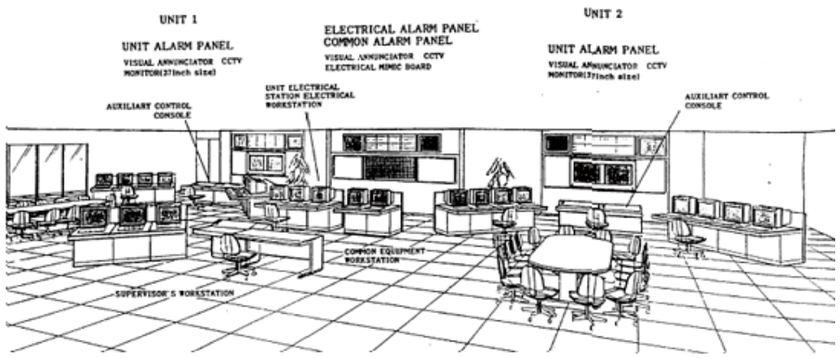
Stage I of Tuas Power Station is comprised of two 600 MW oil-fired steam-generating sets. The power station entered commercial operation in March 1999 when the first of these units was fully commissioned.

As part of its work in stage I of this project, Yokogawa supplied the CENTUM CS integrated production control system (DCS) for the plant's very large power generation units. Yokogawa Electric Asia Pte. Ltd., Singapore produced the control system in Singapore and carried out all engineering work.

In addition to supplying Instrumentation & Control (I&C) equipment, Yokogawa handled system design/engineering, configuration, project management, commissioning services and maintenance.

The Tuas Power Station successfully entered commercial operation on schedule and the plant owner has attributed this in part to Yokogawa's good performance in delivering both products and services.

The development of Stage II comprised of four-block combined cycle power plants was completed in September 2005, which brought the Station to its licensed capacity of 2,670 MW.



Central control room designed by Yokogawa

A full-scope, high-fidelity training simulator supplied by Yokogawa enabled a simulator training in all aspects of operating complex plant systems and has made a significant contribution in raising the skill levels of the highly motivated Tuas Power Station workforce.

Replica simulator showcase

Yokogawa also designed the Tuas Power Station's central control room (CCR), which has won praise from users for its good operating environment. Our CCR design methodology emphasizes the importance of sound ergonomic design in reducing operator errors and facilitating the smooth running and control of processes.

System Details

System:	CENTUM CS
Total I/O:	43,410 (DIO: 37,300, AIO: 5,840)
System configuration:	51 x FCS, 3 x EWS, 29 x operation monitors, 4 x alarm monitors, 2 x CCTV, 3 x sequence-of-events manager/visual annunciator systems, 2 x on-line performance monitoring systems, 3 x historian systems

Plant Information

- Location: Bilbao, Spain
- Plant type: Combined cycle
- Capacity: 800 MW
- Project type: New
- Completion: 2003

BBE and BBG Plants (Combined cycle, 800 MW)

Combined Cycle Power Plant with Regasification Facility Realizes Stable Power Supply

Background of the Project

In Spain, the demand for electricity and imported natural gas has been rapidly increasing, a trend that is anticipated to continue for years to come. To augment the country's energy supply, several new LNG regasification plants as well as combined cycle gas turbine plants have been constructed in Spain.

About the Bahia de Bizkaia Plant - BBE and BBG

To achieve a stable supply of gas and electricity for the country, the Spanish government decided to build the Bahia de Bizkaia Plant. Located in Bilbao, this plant consists of Bahia de Bizkaia Electricidad (BBE), an 800 MW gas fired combined cycle power station, and Bahia de Bizkaia Gas (BBG), a regasification facility with regasificators having a total capacity of 2.7 billion cubic meters.

The Bahia de Bizkaia Plant was one of the most significant power projects to be carried out in this region. The project was led and financed by Ente Vasco de la Energia, Repsol-YPF, British Petroleum, and Iberdrole S.A., with the total investment of approximately 600 million euros.

The Challenges and Results

- **High availability (BBE and BBG)**

  Both facilities aim to have high availability. The field-proven CENTUM CS 3000 distributed control system (DCS) ensures this by enabling the control and monitoring of the entire BBE power station. The BBG regasification facility is designed to operate 24 hours a day, 365 days a year without having to be shut down for maintenance. Yokogawa's highly reliable CENTUM CS 3000 DCS offers a high degree of redundancy that contributes to the entire plant's high availability.

- **Unified operation of multivender control systems (BBE)**

  At the BBE power station, General Electric Company gas and steam turbines have been installed and are controlled by the company's own turbine control system. The electrical equipment of the power station is controlled by another vender's system. With its Unified Operator Interface (UOI), Yokogawa's CENTUM CS 3000 enables the seamless operation of each of these control systems. With the UOI solution, all of the actions required for the operation, management, and maintenance of turbines, the heat recovery steam generator (HRSG), and the balance of plant and electrical controls can be carried out from a single operator interface. The UOI also eliminates the requirement for operators to master the operation of multiple systems.

- **Flexible operation and reduced start-up time (BBE)**

  The BBE power station is capable of working both at base load and at partial loads, which provides flexibility in the plant operation. In addition, to reduce the start-up time, 100-percent-flow by-passes were designed to start the gas turbine and the HRSG individually without starting up the steam turbine. The Yokogawa DCS for which the Spanish engineering company Siemsa Notre S.A. (SIEMSA) fully implemented the above operation logic has steadfastly supported the safe plant operation and smooth startup.

Customer Satisfaction

The SIEMSA engineer commented, "We appreciate CENTUM CS 3000's operationality and system reliability. With the UOI solution, the DCS controls use the same HMI system as the turbine and electrical control system, and there is no need for a dedicated communication gateway and separate screens. This significantly reduces the engineering time and costs."

System Details

System:	CENTUM CS 3000/UOI (BBE) CENTUM CS 3000 (BBG)
System configuration (BBE):	4 x operator stations 1 x engineering workstation 2 x UOI (Cimplicity) servers 4 x field control stations 2,600 inputs/outputs 1,800 communication signals
System configuration (BBG):	1 x engineering stations 6 x operator stations 4 x control stations 1,500 inputs/outputs 2,500 communication signals 1 x OPC Server

Plant Information

- Location: Santa Barbara, Tuscany, Italy
- Plant type: Combined cycle
- Capacity: 400 MW
- Project type: New
- Completion: October 2007

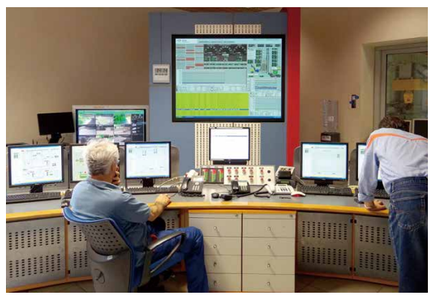
Enel Santa Barbara (Combined cycle, 400MW)

Seamless Integration of Multivendor Control Systems with Field Digital Technology Improves Power Plant Efficiency

Executive Summary

Enel S.p.A. is an Italian electric utility company, the second-largest in Europe by market capitalization. Formerly a state-owned monopoly, it is now partially privatized with Italian government control: the largest shareholder is the Italian Ministry of Economy & Finance (31.244%).

The current big concern of the Enel Generation and Energy Management (GEM) division invested plan is to improve plant efficiency and reduce environmental impact. To reach these objectives, a program was started to convert the existing oil-fuelled power plants to gas-fueled combined-cycle plants. The combined-cycle power plant (CCPP) at Santa Barbara was converted and operated in 2007. This CCPP is capable to generate 400MW electricity and it covers the peak demand of electricity within the national grid. The CCPP consists of one gas turbine STG5-400F(V94.3A) from Siemens, one heat recovery steam generator (HRSG) from Ansaldo Caldaie, and steam turbine from Ansaldo Energia.



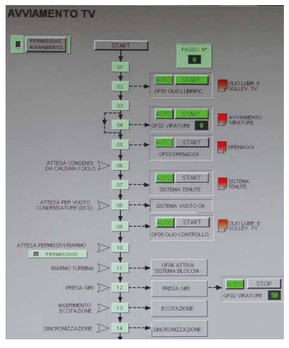
Central control room

Yokogawa successfully installed CENTUM CS 3000 production control system (PCS) to manage nearly 6000 I/Os and 10,000 I/Os from 25 sub-systems through OPC interface. And Enel GEM challenges field digital technology for their predictive maintenance in their asset management system.

The Challenges and the Solutions

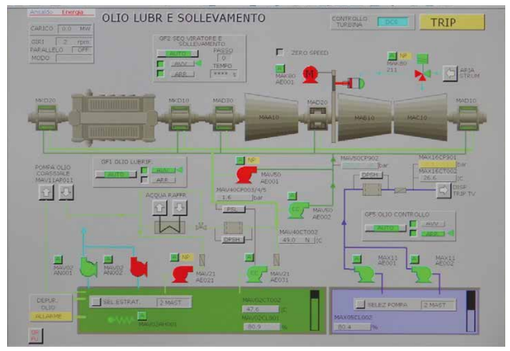
Seamless operation of multivendor control systems

This 400MW CCPP is controlled by the integration system of CENTUM CS 3000 production control system (PCS) and 25 sub-systems such as gas turbine control system, steam turbine control system, emission monitoring system, safety instrumented system (SIS) for emergency shut down (ESD) and fire and gas (F&G)system, and so on through OPC interface.



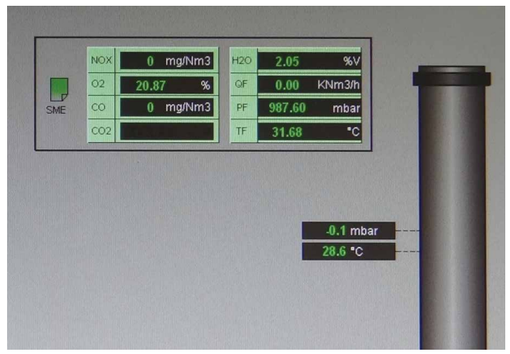
Start-up procedures in graphic display

The many key procedures of this CCPP are preconfigured in the CENTUM system by using both sequence functions and PID control functions with calculation block functions, associated with graphic displays, so the operators can smoothly start-up whole process with minimum time. When this Santa Barbara CCPP receives the demand pattern from ENEL headquarters, the operator can flawlessly supply the demand electricity to the national grid.



Graphic display Steam turbine

Regarding the environmental impact, operators are aware of the importance of the pollution limits. If the plant exceeds the limits, they take immediate countermeasures. The most important limits are about CO average hourly concentration (max. 30 mg/m^3) and NOx average hourly concentration (max. 50 mg/m^3). There are also limits on pH, temperature and chlorine concentration of wastewater. Seamless integration is contributing to improve CCPP efficient operation.



Environmental data in graphic display

Intelligent asset management reduces TCO

6000 I/Os are wired to PCS cabinets and another 10,000 I/Os are connected to sub-systems. It is very tough works for the field operators to check all field devices such as pressure transmitters, flowmeters, level gauges, many kind of control valves, and so on within the limited working time. Once a failure of field devices and shut down the plant, significant loss will be happened. To reduce the field operator work load and to reduce the maintenance fee are mandatory issue in this CCPP. ENEL GEM has to continuously run the CCPP, within the requirement is received.

ENEL GEM decided to use field digital technology, applying FOUNDATION™ fieldbus and Profibus. And asset management system, plant resource management (PRM) package was included in this project.
Through PRM package, the engineers and the operators can see the status and parameters for each device from the engineering work room through a engineering work station quickly and clearly. So the maintenance member can fix a problem before the complete equipment failures.
This reduces the field operator work load drastically and ENEL GEM can reduce total cost of ownership.
Maintenance information immediately notifies the right people, field operator and/or maintenance engineer, depending on the type and criticality of the diagnostic data analysis. The device navigation displays the status of plant-wide assets with a Windows Explorer- like interface. Flexible navigation mechanism enable maintenance personnel to quickly identify areas of the plant that require online diagnosis.

Customer Satisfaction

Mr. Fabio Parigi

Fabio Parigi, automation manager said, " Recent DCS and field instruments are smarter and intelligent because of applying microprocessor technology. So we are always challenging to a new technology to improve our operation and productivity. For this CCPP, we decided to use field digital technology such as FOUNDATION™ fieldbus for field devices and Profibus for motor control. We are challenging predictive maintenance to monitor many field transmitter data through PRM. This will allow us to reduce the maintenance cost through the plant life cycle operation."

Mr. Marco Righeschi

Marco Righeschi, chief operator said, "Our CCPP covers the peak load electricity, so the plant starts working whenever we receive the instruction from ENEL headquarters. We can flawlessly start the CCPP up and generates the electricity in accordance with the required demand curve. We appreciate Yokogawa's reliable system and instrumentation. We are operating this CCPP safely and efficiently at any time."

Plant Information

- Location: Rayong, Thailand
- Plant type: Combined cycle cogeneration
- Capacity: 140 MW
- Project type: New
- Completion: 2002

EGCO Cogeneration (Combined cycle cogeneration, 140 MW)

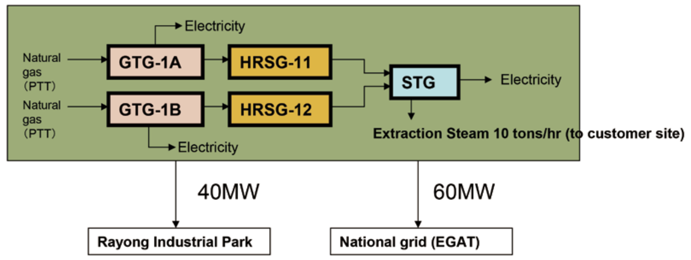
Fully Automated Power Plant Supplies Steady Flow of Electricity to Thai National Grid

Executive Summary

The Electricity Generating Public Company Limited (EGCO) was the first independent power producer (IPP) to be established in Thailand as the result of an initiative by that country's government to allow broader private sector investment in the power sector. EGCO was incorporated on May 12, 1992 by the Electricity Generating Authority of Thailand (EGAT), and over the next three years it became a public company and was listed on the Stock Exchange of Thailand (SET).
Operating as a holding company, it invests in power generation and supply and provides comprehensive operation, maintenance, engineering, and construction services to the power industry and other industries in Thailand as well as other countries. Furthermore, the company searches for good growth opportunities that are related to its core energy business.

EGCO Cogeneration Co., Ltd, an EGCO Group company, operates a combined cycle power generation plant at the Rayong Industrial Park. The plant uses natural gas from PTT to power gas turbines that generate electricity. Heat recovery steam generators (HRSG) use waste heat from the turbines to produce steam for a steam turbine that generates additional electricity. Sixty percent of the generated electricity goes to the national grid (EGAT) and the remaining 40% is utilized by companies at the Rayong Industrial Park.

To control these processes at the EGCO Cogen power plant, Yokogawa Thailand installed a CENTUM CS 3000 process control system in 2002. This facility has operated without any major system failures since then.

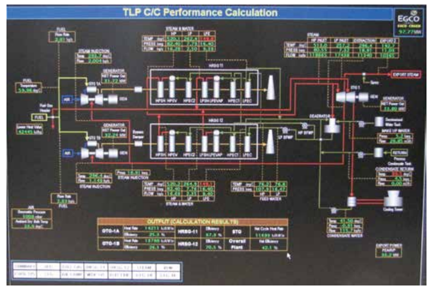


Main process overview

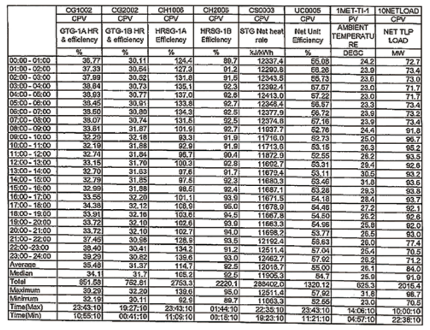
The Challenges and the Solutions

Highly efficient operation

The national grid operated by EGAT needs a steady supply of electricity at all times, and the same is true for the Rayong Industrial Park. The CENTUM CS 3000 plays a core role by controlling and enabling the monitoring of all processes at the EGCO Cogen plant. The gas and steam turbine control systems as well as the PLCs controlling the water treatment and chemical injection facilities are all integrated with the CS 3000 system through a Modbus interface. The CS 3000 system has access to both horizontally and vertically integrated data from throughout the plant, allowing EGCO Cogen to calculate the efficiency of each gas and steam turbine as well as each of the HRSGs in real time. Operators have constant access to plant performance data and a daily report showing the hourly base performance figures can be printed out. The performance data is utilized to plan maintenance and improve control strategy. Currently, the plant's overall efficiency is about 60%.



Plant performance screen

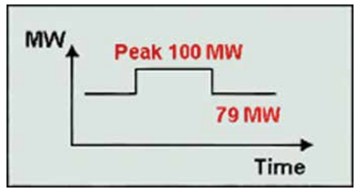


Daily report

Steady and safe operation

Based on monthly requests from EGAT, EGCO Cogen supplies a steady flow of electricity to the national grid. EGCO Cogen also supplies load of 40 MW to the Rayong Industrial Park. To meet these requirements under a variety of circumstances, the CS 3000 system has the following control functions:

- Automatic start-up and shutdown sequences
- Automatic load sharing and plant optimization
- Load shedding control
- Voltage and power factor control
- Island operation when disconnected from the national grid
- Plant performance monitoring



Monthly electricity demand

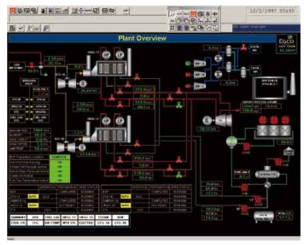
Each operator workstation has function keys that allow quick access to a target process from the plant overview graphic display. With certain sequences, clear and easy-to-understand operation procedures are displayed. Operators thus have all the information needed to take quick and timely action whenever needed, making this a very safe plant.

Central control room

Customer Satisfaction

EGCO COGEN operators

According to the Plant Manager, "The system allows operators to clearly see the plant's status and know what is going on. With this information, our operators can take quick action whenever there is a problem with a gas or steam turbine or with an HRSG. When there is a problem with the transmission lines or some other part of the national grid, the plant is immediately put into island mode and provides electricity only to its local customers. We are very pleased with the performance of Yokogawa's CENTUM CS 3000 at our power plant."



HRSG graphic display

Plant Details

Gas turbine:	2 x 40 MW, GE
HRSG:	2, Alstom
Steam turbine:	60 MW, Alstom

System Details

Distributed control system:	CENTUM CS 3000
Total I/O:	1,500
Field devices:	Yokogawa pH meters, conductivity meters

Plant Information

- Location: Toronto, ON, Canada
- Plant type: Gas-fired cogeneration
- Capacity: 117 MW
- Project type: Revamping
- Completion: 2005

Pearson International Airport
(Combined cycle cogeneration, 117 MW)

Toronto Airport Cogen Plant Focuses on Reliability

Background

Canada's Toronto Pearson International Airport, along with millions of people in Eastern Canada and eight US states, suffered a severe electrical power outage in 2003. This catastrophic failure made it painfully apparent that the airport neededa reliable, independent source of electricity. Round-the-clock reliability was simply an absolute must, but the economics of such a system had also to be carefully considered.

These two factors – reliability and costs – have now been met by a cogeneration power plant design using twin GELM6000PD aero-derivative gas turbines, each capable of producing 42 MW.

Exhaust from the turbines passes through steam generators which run a third steam-driven generator capable of 33 MW output. Remaining plant heat can be used to heat/cool the airport buildings. Economics were addressed in this generous design to allow sale of excess power generated to the Ontario power grid. A Yokogawa CENTUM CS 3000 control system, selected after careful evaluation of system reliability for various vendors, completes the plant.

"Those involved with the Cogen plant have been very pleased with reliability of the Yokogawa control system," states Henry Oberhauser, Senior Manager, Utilities for Greater Toronto Airports Authority (GTAA). "The only substantial system outage occurred due to sub-standard process water supplied by a sub-contractor. We feel Yokogawa's claim of 'seven 9's' reliability – which translates to less than one minute of downtime in 40 years – is well on its way to reality."

The Plant

The airport is owned by the GTAA[1], which hired outside firms to help design, build, and operate the plant. The airport, by meeting the twin requirements of a coincident demand for electricity and thermal power along with access to fuel (natural gas), was an ideal candidate for a Cogeneration system. In early 2001, GTAA had constructed a Central Utility Plant for the airport; it replaced a legacy plant torn down as various airport facilities were being added. The plant supplied steam for heating and chilled water for cooling the airport terminals.This new plant can supply steam needs but also allows the optional operation of the plant's steam boilers in standby mode while using steam from the Cogen system. The plant was constructed in 2003. A year later the Yokogawa control system was commissioned.

An interesting facet of the design is the use of two "once-through steam generators" (OTSGs) supplied by Innovative SteamTechnologies (IST) of Cambridge, Ontario. These units offer several advantages over conventional designs. They are efficient,flexible and capable of full operation from cold starts within less than 30 minutes. They start, run and finish dry. Conventional-pass stacks, diverter valve systems and stack silencers are not needed.An OTSG is basically a heat exchanger composed of a series of tubes whose boiler water is simultaneously heated, evaporated and superheated. Heat recovered in the OTSG supplies the steam turbine at its required temperature and pressure.

[1] GTAA operates Pearson Airport, an international gateway with 65 airlines via 82 gates in three terminal buildings. A fourth terminal is currently beingdesigned. The airport generates $14-billion in annual revenues, $2.8-billion tax revenues and provides 135.000 jobs. It has 16,000 parking spaces.

Yokogawa CENTUM CS 3000 control system

Encompassed by the Yokogawa monitoring and control system is the entire Cogen plant including the two OTSGs. Startup, operation and shutdown of the OTSGs is fully automatic. The complex logic involved was developed by close cooperation of Yokogawa, IST and SNC-Lavalin[2] engineers.

Not shown but also in the control room is an engineering station. It allows access to technical drawings and related information such as applicable codes and standards and other engineering information. It includes a system simulator used in operator training and to examine and test changes in the CS-3000 logic. This logic can be modified through this station. A HART plug-in allows diagnostics for HART I/O. Naturally, access to the station is fully protected and limited to only the plant's certified engineers. A monthly printout – both tabular and graphical – by a companion J.D. Edwards software package, using selected inputs from the Yokogawa files, provides maintenance guidance. Since installation of the Yokogawa system, no major maintenance has been required. Steam fed to the OTSGs must be of ultra-high quality. Steam monitoring and water purification control is included in the CENTUM system.

Steve Sadecki in the Cogen Plant control room with multiple flat-screen displays. Control is provided for plant balance and unit operations. Monitors provide rapid and complete displays of all system assets. Says Sadecki, "The display formats are very well thought out and extremely operator friendly. It took me, and fellow operators, less than a week of training to be completely familiar and comfortable with the system– even though none of us had previous experience withYokogawa equipment."

[2] SNC-Lavalin, one of the leading groups of engineering and construction companies in the world, has office across Canada and in thirty other countries. It is at work in over 100 countries.

Predicted reliability being achieved

The Honourable Donna Camsfield, Minister of Energy, at the Cogen Plant opening on Dec.2, 2005, said in part, "Today's plant opening is another step in Ontario's cogenerational potential and another example of the Greater Toronto Airport Authority's significant record of environmental leadership."
She cited benefits of cogeneration to include:

- Adds more capacity added to the power grid
- Produces high combined fuel efficiency
- Helps control industry costs, mitigates electricity cost increases
- Improves transmission and system reliability
- Helps replace coal thus creating a cleaner environment
- Increases the number of facilities that recover quickly or even continue to operate in the event of power interruption.

Comments by those associated with the plant and echoed by other industry and government groups visiting the Toronto facility – about two such tours per month since installation – attest to the central focus of system reliability. The GTAA facility and its Yokogawa control system qualify on all counts.

System Details

DCS:	CENTUM CS 3000
Total I/O:	Approximately 2,000
System configuration:	Dual LCD operator stations, engineering work stations with virtual test function, field controllers, I/O with HART, sequence of events I/O
Scope:	Distributed control system including control system software, factory acceptance, commissioning assistance

Plant Information

- Location: Samutprakarn, Thailand
- Plant type: Combined cycle cogeneration
- Capacity: 94 MW
- Project type: New
- Completion: 2004

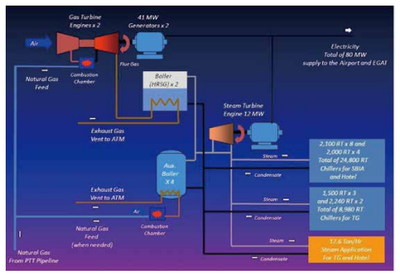
Bangkok's Surarnabhumi Airport
(Combined cycle cogeneration, 94 MW)

CENTUM CS 3000 Ensures Stable Supply of Electricity and Steam to Bangkok's Suvarnabhumi Airport

Executive Summary

District Cooling System and Power Plant Co., Ltd. (DCAP) operates a power plant near Bangkok's Suvarnabhumi International Airport that supplies electricity and steam to the Bangkok International airport main terminal, a hotel nearby and a Thai Airways catering facility. The DCAP plant has two 41 MW gas turbines, two heat recovery steam generators (HRSG, 63 t/h each), and one 12 MW steam turbine. In average, 50 MW electricity is transferred to the Airport of Thailand (AOT), 30 MW is selling to the national grid (EGAT)and total left MW is utilized in this DCAP power plant. The steam is sent to 10 steam absorption chillers located at the airport's main terminal, east and west, about 2 km away from DCAP facility .

To be a steady supply of electricity and steam to Suvarnabhumi International Airport, which operates 24 hours a day / 365 days around a year, is most important issue for DCAP. Yokogawa Thailand successfully installed a CENTUM CS 3000 distributed control system, field transmitters and magnetic flowmeters. The facility is in operation without any problem since 2004.



Process overview

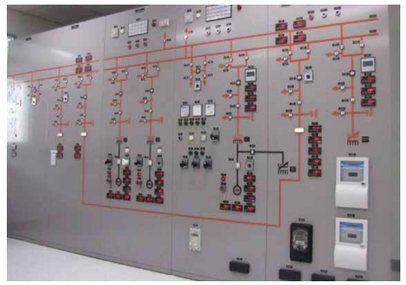
The Challenges and the Solutions

- **Steady and safe supply of power and steam**

DCAP's mission is to ensure a steady supply of electricity and steam to the airport terminal, a hotel nearby, and a Thai Airways catering facility. The steam is supplied to steam absorption chillers at east and west of the airport terminals that drive the cooling systems at the airport complex and the airline catering facilities. The airport receives power over a main line from the DCAP power plant and a line from the Metropolitan Electricity Authority (MEA).

There are four operation modes to meet any cases for power requirement and steam requirement situations.
- Full operation including steam chillers
- Half operation including steam chillers
- Half block + steam chiller operation
- Aux. boiler + steam chiller operation

The operation procedures carefully configured in the CENTUM CS 3000 ensure smooth transfers between these modes. Regarding gas and steam turbine control, the turbine suppliers installed the respective controllers; however, they receive major settings from the CENTUM CS 3000 via a Modbus interface as master setpoints and all process data in the turbine systems can also be monitored by the CENTUM CS 3000. Safe and steady supply of electricity to, and air conditioning at, the entire airport complex is thus assured all year round.



Central control room

- **Environmentally optimized operations**

Natural gas supplied by PTT Public Co., Ltd. powers DCAP's main gas turbines and auxiliary boilers. Even though natural gas is low in emissions, the CENTUM CS 3000 system tracks and displays the relevant process data. The data are linked to a continuous emissions monitoring system (CEMS) through a plant network that is connected to the government's systems. Data on NOx, SO_2, CO, O_2, and opacity are sent twice a day. The water used in this plant is also carefully monitored and controlled to keep it within recommended limits.

Continuous emissions monitoring system

Customer Satisfaction

Seree La-Ongutai, acting general manager, said, "We are producing electricity and steam for the whole airport terminal, adjacent hotel and Thai Airways facilities. It is very hot in Thailand all through the year, so the airport always needs a stable utility. We very much appreciate the reliability of Yokogawa's CENTUM CS 3000, which is the cooling of all our airport facilities here. So far the plant has operated with great stability, availability and safety, and I believe this is due in good part to the integration of the system's sequence logic functions and the dynamic graphic displays on the human machine interface (HMI). We are striving to save energy in the whole facility, so we would like to work together with Yokogawa for continuous improvement."

Plant Details

Gas turbines:
2 x 41MW, IHI

HRSG:
CMI

Steam turbines:
12 MW, Shin Nippon

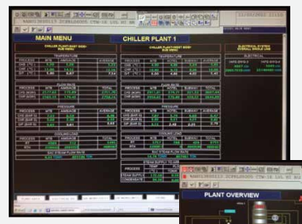
Steam absorption chillers:
21,000 refrigerant tons

Electric chillers:
12,480 refrigerant tons

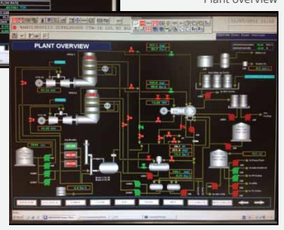
Steam generation:
80 t/h

Steam temperature:
430 deg C

Steam pressure:
60 bar



Chiller overview



Plant overview

Systems Delivered

Distributed control system: CENTUM CS 3000

Total I/O: 1841

Field devices: Yokogawa magnetic flowmeters

Plant Information

- Location: Budapest, Hungary
- Plant type: Gas-fired cogeneration
- Capacity: 34.5 MW
- Project type: New
- Completion: 2005

Füredi Power Plant

(Gas-fired combined heat and power plant, 34.5 MW)

Customized STARDOM & FAST/TOOLS Plant Management Solution Helps Füredi CHP, Hungary Operate Optimally

Executive Summary

The Füredi Power Plant project is a showcase for the use of SCADA and STARDOM in a power sector application, and it posed certain unique operation and control requirements. A FAST/TOOLS SCADA system was seamlessly integrated with a STARDOM automation system, providing the information needed by power plant managers, operators, and maintenance personnel to efficiently monitor the plant's operation and analyze its performance. A history database integrated into FAST/TOOLS collects and stores the measured and calculated parameters.

The system covers approximately 16,000 items, collects data, creates shift/daily/weekly reports, and makes monthly calculations. The collected and calculated data is kept for the lifetime of the plant.

Through this project, Zugló-Therm Energy Supply Ltd. has achieved the following:

- **Easy set point definition for all plant power generation operations**

  The heat produced by the entire plant and the electrical set points for the engines can be defined in an Excel file every 24 hours, with 15 minute resolution, and this data can be easily exported into the FAST/TOOLS system.

- **Stable electric power generation**

  The superior control system can respond flexibly to changing heat demand, focusing on the operational conditions of the gas engines.

- **Power plant optimization**

  The control system supports on-line calculation of both plant and gas engine efficiency, enabling adjustments for optimal operation.

- **Control of electric power generation based on net performance**

  The control application in STARDOM can automatically calculate the in-house power consumption of the power plant. With this function, the plant can more accurately control the required amount of power to be supplied to the national grid operator.

About the Project

The plant is located at Füredi út in Budapest. The main contractor is Kraftszer Kft., a Hungarian engineering company that has built a number of CHP plants, and the plant will be operated by Zugló-Therm Energiaszolgáltató Kft.

The Füredi power plant consists of three (3) Wärstilä 18V34SG gas engines rated for an electrical output of 18 MWe, three (3) heat exchangers for each engine that supply the hot water for the district heating system, and auxiliary systems for such functions as fuel and air supply. Natural gas is the main fuel for the power plant.

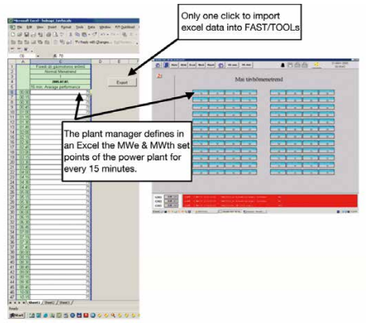
The hot water is distributed by Fötáv Rt., the main district heating utility in Budapest.

Although the emphasis is on the supply of hot water for district heating, the generated electricity is also supplied to approximately 20,000 households on the public power grid. In Hungary this kind of CHP plant is required to have a minimum total efficiency of 65% per month and 75% per year.

The Challenges and the Solutions

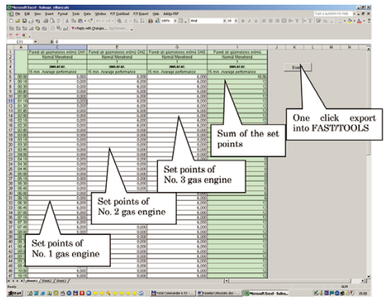
- **Easy set point definition for all plant power generation operations**

  The district heating set points are defined in Excel and sent to the district heating company. As shown below, the Excel data can be imported into FAST/TOOLS with just one mouse click. Plant operators can see the actual daily plant set points on screen.



The plant operator will see the above set point lists on the Fast/Tools screen.

This system is used for the electrical set points as well. In this case the plant manager has to define the set points for each of the three gas engines. Please refer to the Excel sheet below.



Excel sheet

- **Stable electric power generation**

  The automation system realized in STARDOM can also recalculate the set points for each gas engine in the event of a malfunction such as a trip of a gas engine. If one of the gas engines shuts down, the other two gas engines will increase power output to compensate.

- **Power plant optimization**

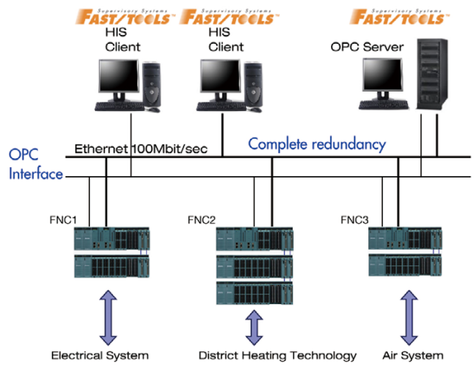
  STARDOM calculates the efficiency factors for each gas engine and for the entire power plant, and provides data that operators can use to make the plant operate economically and efficiently.

Scope/Special Features of the Control System

Three fully redundant STARDOM field control node (FCN) stations control different parts of the plant, including the electrical system, district heating system (including the gas engines connected to the PLCs), and air system.

Redundancy is realized at different levels in the FCN controllers such as the power supply, CPU, communications between the nodes, and I/Os. One of the most important criteria is the 10 msec time stamping of electrical signals.

The STARDOM controllers manage the plant's measuring and supervisory control activities, governing approximately 550 hardwired I/Os. Via serial communication lines (MODBUS, IEC-103), they collect an additional 500 signals; 1500 signals are connected through redundant OPC interfaces.



System Details

Control system:	STARDOM FCN and FAST/TOOLS SCADA system
Number of I/O points:	2,500
Field instruments:	EJA530A x 9, EJA110A x 13, EJA120 x 2, YTA70 x 2, non-Yokogawa products x 116, manometers x 100

Plant Information

- Location: Dushanzi, Xinjian Urghur Autonomous Region, China
- Plant type: Coal-fired (CFB boiler)
- Capacity: 5 x 440 t/h, 3 x 100MW
- Project type: New
- Completion: January 2010

PetroChina Dushanzi Utility

(Coal-fired CFB boiler, 5 x 440 t/h, 3 x 100MW)

Yokogawa's CENTUM CS 3000 and PRM Assure Utility Supply for Dushanzi Refinery & Petrochemical Complex

Executive Summary

At a cost of 30 billion yuan ($4.4 billion), PetroChina, China's largest oil producer, constructed a large refinery and petrochemical complex on a 455 hectare parcel of land in Dushanzi, a city in China's Xinjiang Uyghur Autonomous Region. Using mainly high sulfur crude oil from the Kazakhstan-China pipeline, the complex processes 10 million tons of crude oil and produces 1 million tons of ethylene per year. As such it plays an important role in the China-Kazakhstan energy cooperation strategy.

The utility plant that provides steam, electricity, and water to this complex include five 440 t/h circulating fluidized bed (CFB) boilers, three 100 MW turbines/generators, and chemical and water treatment systems.

The complex's CFB boilers use brown coal as a fuel and are designed to keep CO_2 emissions to a minimum. Normally, four of the complex's five boilers are in use and the remaining boiler is kept on standby and undergoes maintenance. For the utility plant at this important industrial complex, Yokogawa China successfully installed a CENTUM CS 3000 integrated production control system and the Plant Resource Manager (PRM) package.

Refinery

Petrochemical plant

The Challenges and the Solutions

Safe and steady operation

The utility plant operates non-stop throughout the year, ensuring an uninterrupted supply of steam, water, and electricity to the main process facilities. In response to boiler master signals that are issued in real time by the production scheduling center, the four boilers must adjust their output to match shifts in demand for steam by the processes and the turbines that generate electricity for the complex. With its highly reliable dual redundant CPUs and seven 9s availability, Yokogawa's CENTUM CS 3000 production control system maintains steady control of the boilers and ensures that operations can continue nonstop without any major system problems.

Standard process graphics, process overview, trend, operator guidance, and alarm summary displays are all designed with safe operation in mind, and can be accessed quickly and smoothly by operators, giving them a comprehensive overview of operations.

Total integration of information

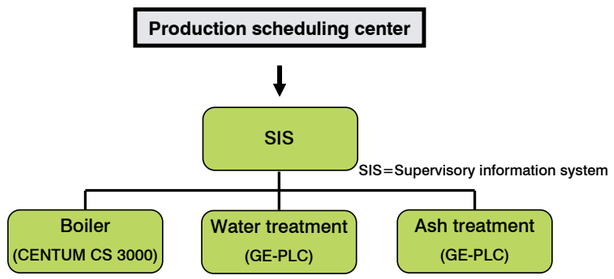
Through an OPC interface, the PetroChina Dushanzi refinery and petrochemical complex uses a supervisory information system (SIS) as its plant information management system (PIMS). All process data from throughout the complex are gathered by the CENTUM CS 3000 system and the GE PLCs used in the water and ash treatment processes. Based on this process data, boiler efficiency, coal consumption, rate of electricity generation, and many other kinds of useful data from the boilers can be accessed by the engineers at their desks, without having to visit the central control room. The CENTUM CS 3000 system is a very steady platform and provides a very convenient process monitoring environment.

The integration of information allows PetroChina Dushanzi to reduce its consumption of water, coal, and other resources. In many different performance statistics, it is ranked number one in the PetroChina Group.

Customer Satisfaction

Liu Jian Ming, Director of the Utility Control and Instrumentation Department said, "Every day we are trying to improve operations at our plant and to reduce both coal consumption and CO_2 emissions, because one of our targets is to achieve sustainable manufacturing. We very much appreciate that Yokogawa supplies very reliable products and systems, and has been working together with us to provide support. Of the many vendors that are supplying products and services for this PetroChina utility plant, Yokogawa is one of the best."

SIS boiler operation display



Total system configuration

OpreX™ Yokogawa achieves operational excellence by providing products, services, and solutions based on the OpreX comprehensive brand that cover everything from business management to operations.

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Represented by:

[Ed:02/d] Printed in Japan, 909(KP)

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