Sabah Electricity

PM Control Successfully Retrofits General Electric LM2500 Gas Turbine Application with Woodward GTC250A Control

Application Bulletin
PMCS-SG-0014

Solutions

- Woodward GTC250A Digital Gas Turbine Control
- Woodward GAP and Ladder Logic software
- Woodward SPM-D synchronizer
- Allen Bradley Flex IO
- ProFace 15" TFT touchscreen PC
- Human Machine Interface (HMI)
- Mounting plates

Results

- Easy to operate control system
- Increased productivity of Tawau power plant
- Robust and reliable system with decreased risk of downtime

Background

Sabah Electricity Sdn. Bhd. (SESB) is a utility company that generates, transmits and distributes electricity mainly in Sabah and in the Federal Territory of Labuan. SESB's main stakeholders are Tenaga Nasional Berhad (TNB) (80%) and the Sabah State Government (20%). The only power utility company in Sabah, it supplies electrical power to over 400,000 customers distributed over a wide area of 74,000 km2. The company's total generating capacity is 866.4 MW.

With a generating capacity of 40 MW, the Tawau plant is one of the company's major power stations. Just like some of the other SESB power plants, the Tawau plant has had to expand in order to support the region's growing power demand.

Challenge

To cope with the high electricity demand during the daytime, a General Electric LM2500 gas turbine was used for power peak shaving. It was generally started in the morning and shut down again in the late afternoon. The gas turbine was driving a Brush generator and was installed by Stewart & Stevenson in 1993. The turbine and generator were controlled by two Woodward 501 digital controls. One was used as the fuel controller and the other one as the sequencer.

SESB regularly had maintenance and reliability issues with the system at the Tawau plant. To increase productivity and reduce downtime of the system, SESB decided to retrofit these Woodward controllers and therefore consulted PM Control.

PM Control advised replacing the two 501 controls with a Woodward GTC250A control, which is based on the Woodward Atlas II hardware. To expand the Atlas-II onboard I/O additional Allen Bradley extended I/O modules were used.

System and site information was limited, which made it a challenge to design and configure the new system. Moreover, due to limited space available in the existing cubicles, a smart design of the new system was required. It had to be seamlessly

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integrated with the existing fire/gas system, the generator control system, the vibration protection system and all the field wiring.

Sabah, Tawau District

Solution

To comply with SESB's requirements PM Control and its local agent Automatic Control Solutions (ACS) proposed the following products:

- Woodward GTC250A Digital Gas Turbine Control
- Woodward GAP and Ladder Logic software
- Woodward SPM-D synchronizer
- Allen Bradley Flex I/O
- ProFace 15" TFT touchscreen PC
- Human Machine Interface (HMI)
- Mounting plates

Woodward GTC250A Digital Gas Turbine Control

The GTC250A control system is designed to control two-shaft gas turbines for compressor or generator applications. It produces a fuel valve demand output to control speed, load, pressure, and temperature. The GTC250A is based on Woodward Atlas II hardware. It has onboard specialized I/O for turbine control and comes preprogrammed with application software. Additional I/O modules and ladder logic programming are available.

Woodward GTC250A Digital Control

Woodward GAP and Ladder Logic Software

The application software was designed using Woodward's Graphical Application Program (GAP). The GTC250A application was designed as a fuel control for a two-shaft gas turbine and provides fuel demand control from the initial 'Fuel On' to the final 'Fuel Off' signal.

Woodward Ladder Logic Software

A unique feature of the Woodward GAP is its ability to combine multiple source GAP programs into one comprehensive program. The GTC250A has a software structure as follows:

- CORE Software, containing the main control loop functions for controlling the turbine fuel-metering valve. This file was designed and engineered by Woodward specifically for two shaft aero derivative gas turbines.
- Second-Ring Software, incorporating the control system's I/O points, interfacing to the CORE and all communication possibilities of the system. This file was initially designed and supplied by Woodward. Modifications are allowed to interface with distributed I/O and communications to customer devices.
- Third-Ring Software which includes a built-in programming tool named Ladder Logic. This allows PM Control to design and develop a customized program for programming and monitoring sequencing logic in Woodward GAP-based controls.

Woodward SPM-D Synchronizer

Woodward SPM-D Synchronizer

The SPM-D synchronizer compares the generator's frequency and voltage with that from the bus. To bring the offset between the generator and the bus within a predefined window, the SPM-D sends signals to the GTC250A and the AVR to adjust the frequency and the voltage of the generator. If the frequency and the voltage are within the window, the SPM-D will send a signal to close the breaker.

Allen Bradley Flex I/O

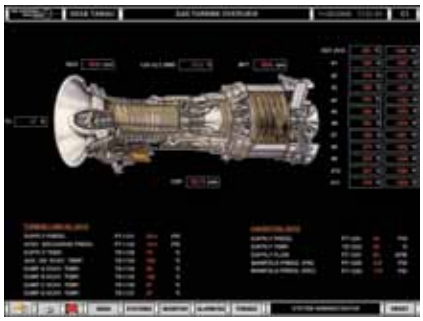
To expand the GTC250A I/O capabilities, Allen Bradley Flex I/O modules were used to increase the number of I/O points interfacing with the field instrumentation.

The Allen Bradley Flex I/O modules communicate with the GTC250A through a ProfiBus network.

Allen Bradley Flex IO

Human Machine Interface (HMI)
An extensive Human Machine Interface (HMI) was part of the scope of supply. The HMI had to have the functionalities to start, operate and stop the turbine as well as to monitor and control the turbine, the generator and its auxiliary systems. PM Control developed the HMI in iFix Intellution software that runs on an industrial, flush mounted PC with touchscreen.

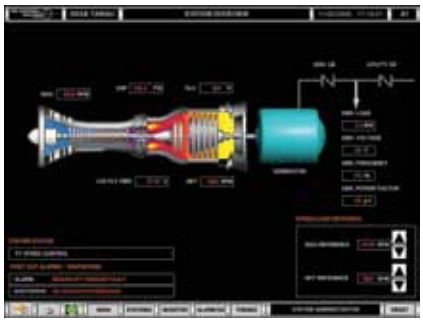
The HMI gives operators easy access to relevant system parameters and is a great asset during the start and stop sequences of the turbine. The system has various screens displaying information. Additionally, the HMI has real-time and historical trending and event logging, which are downloaded onto the PC's hard drive for system analyzing and troubleshooting. Other features include alarm and shutdown monitoring and reset.



HMI - Main Page

Mounting Plates
One of SEBS' requirements was to install the new system into the cubicle that housed the initial control system. Because of that, the new control system had to be mounted on three separate mounting plates. Interconnecting wiring interfaced the three mounting plates with the existing terminal strips.

Installation & Commissioning
ACS engineers installed the new system. They were responsible for the termination of the interconnection wiring and the replacement of all the field wiring. To ensure that all I/O was terminated to the new system, both PM Control and ACS carried out thorough loop checking of all signals.



HMI - System Overview

After the I/O checks, all separate turbine and generator auxiliary systems, such as the turbine and generator enclosure fans and the hydraulic starter skid were tested for proper operation. Furthermore, prior to the actual test runs, several dry and wet starts were conducted to verify the start sequence, proper functioning of the turbine lube oil system and liquid fuel system.

During the first test run the control system's functionalities were studied and verified for correct operation. At the same time, all of the turbine's parameters were tested and verified due to the fact that the turbine was overhauled and this was the initial run at site.

While the generator breaker was closed, the turbine and generator load control routines were checked and the load was gradually increased to full load. Official test runs were made while SESB verified the performance of the system. They were satisfied with the performance and the system was handed over on November 25, 2008.

As a final stage in the project, PM Control trained SESB technical personnel and operators in classrooms and on-site on how to maintain and operate the control system and the HMI.

Results

- Easy to operate control system
- Increased productivity of Tawau power plant
- Robust and reliable system with decreased risk of downtime

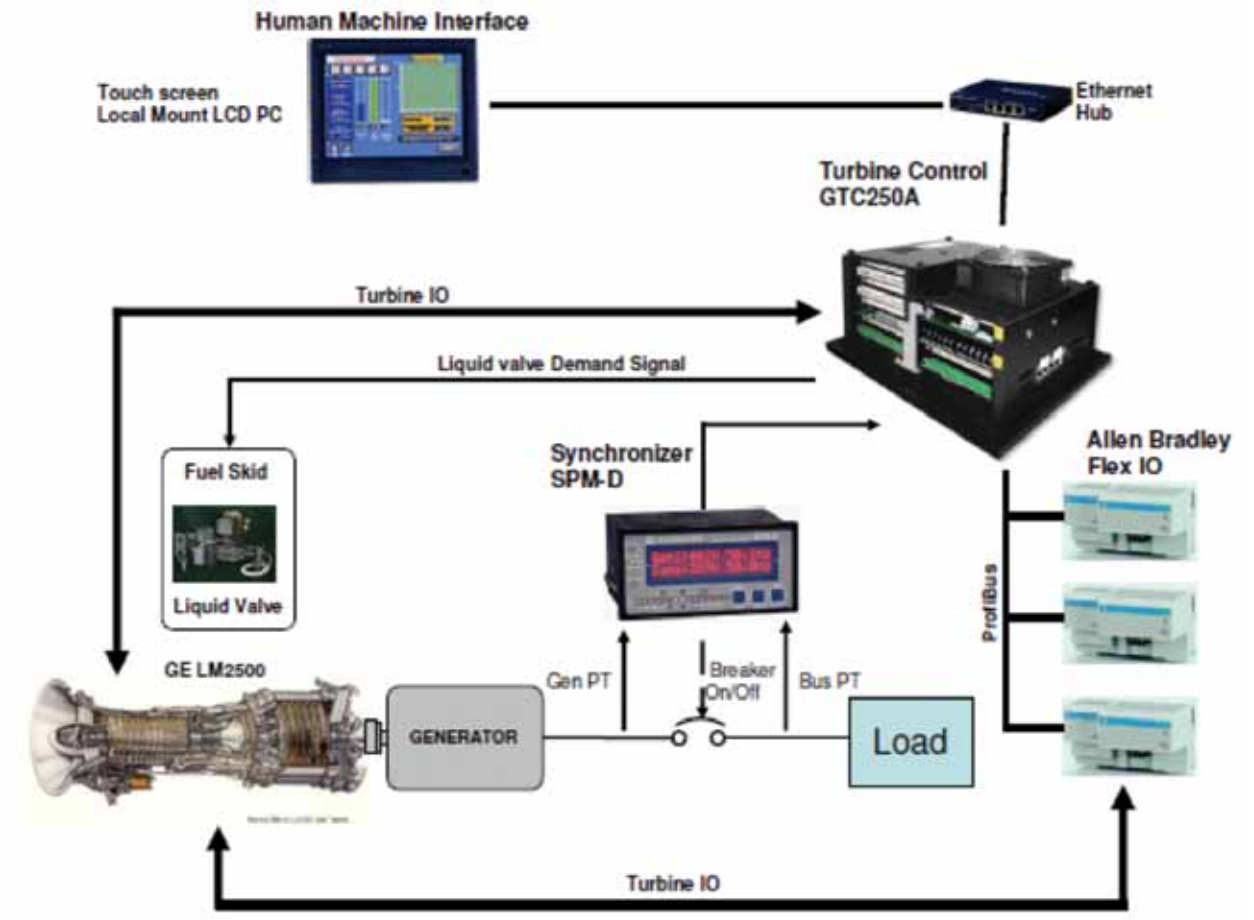
Since the official handover of the system SESB daily operates the system to generate power to the utility when there is a peak in consumption. Feedback from SESB indicates that the system is robust, reliable and easy to operate. The HMI gives operators easy access to relevant system parameters and is a great asset during the start and stop sequences of the turbine.

Due to the success of the gas turbine control retrofit in SESB power station in Tawau, SESB is considering carrying out similar retrofits on more GE LM2500s in other power stations.

About PM Control

PM Control delivers energy optimisation solutions that increase efficiency while lowering emissions. Serving the energy, process and transportation markets, PM Control is the appointed distributor and recognized retrofit partner for Woodward Inc., Regional Technical Center for ABB Switzerland and Value Added Reseller for L&S Electric. Through our activities PM Control is having a positive impact on the lives of people across SE Asia, Australasia, India and beyond.

System Overview



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