Royal Thai Navy

PM Control Increases Reliability of Gas Turbine Control System with Retrofit of Woodward MicroNet Plus

Application Bulletin
PMCS-SG-0011

Solutions

- Military marine grade cabinet
- Woodward MicroNet Plus Digital Control System
- Moore Industries PLA driver
- Allen Bradley XM-123
- Imtech converter (WAGO
- Human Machine Interface (HMI)
- Eaton Powerware 9155 UPS

Results

- A system that reduces the risk of maintenance issues and unavailability of high speed sailing on its gas turbines,
- A simpler, faster, more reliable and easier to maintain control system,
- A more knowledgeable operation and maintenance crew.

Background

Established in the late 19th century, the Royal Thai Navy is part of the Royal Thai Armed Forces and operates out of the Sattahip Naval Base, close to the tourist destination Pattaya. Thailand is the only Southeast Asian country that operates an aircraft carrier, which is currently solely used as a helicopter carrier.

This aircraft/helicopter carrier, named the HTMS Chakrinaruebes, was in need of changing its legacy gas turbine control systems for the ship propulsion as some parts were damaged and many spares had become obsolete.

The ship propulsion consisted of two propellers in CODOG (combination of diesel engine or gas turbine) configuration. In this CODOG the ship typically runs on its MTU diesel engines. When high speed is required, the captain switches to gas turbine mode and the two ship's propellers are then each driven by a General Electric LM2500 gas turbine.

Before the retrofit, the control system consisted of a local operator panel (LOP) with a sequencer control unit and a free standing electronic enclosure (FSEE) with an advanced engine control module (AECM). The AECM provided the dynamic control and protection of the gas turbine, while the LOP provided sequencing, protection and monitoring of the gas turbine and the interface to the ship's integrated propulsion management system (IPMS).

Challenge

PM Control was asked to retrofit the old control system with a Woodward MicroNet Plus Digital Control System. The purpose of this retrofit was the following:

- Increase the reliability of the gas turbine control system,
- Address the issue of obsolete spare parts,
- Allow the Navy to be familiarized with the control system.

The limited site information available proved to be an obstacle during the execution of the project. This made the design and configuration of the new system a challenge

PM CONTROL

as it needed to seamlessly integrate with the existing fire/gas system, IPMS and field IOs.

Although most of the field IOs complied with standard industry ranges, some of the field signals operated in ranges that required special signal conditioning. This was the case for the power lever angle (PLA) actuator, an integrating type fuel metering valve with a resistive feedback that operates to a command of about 23 VDC control range.

There were two primary concerns with regard to the integration between the new system and the ship's IPMS:

1. The difference in communication protocol. While Woodward MicroNet communicates in Modbus protocol, the IPMS communicates in proprietary Binary protocol – two non-compatible systems. Conversion between the two protocols was therefore needed.
2. Functional integration with the ship's IPMS was challenging as there were no logic diagram references. Therefore, the functionality interaction between the new system and the existing IPMS during FAT could not be tested and had to be done on site.

Signing of the Contract

Solution

The following solutions were supplied, commissioned and installed by PM Control:

- Military marine grade cabinet
- Woodward MicroNet Plus Digital Control System
- Allen Bradley XM-123
- Imtech converter (WAGO)
- Human Machine Interface (HMI)
- Eaton Powerware 9155 UPS

Woodward Cabinet

Woodward Cabinet

Due to its critical position in both military and humanitarian missions – the Chakrinaruebes played a key role in the support of the 2011 flood relief – high reliability requirements needed to be met under all circumstances. In addition to a Battle-Override functionality, which overrides all non-critical turbine protection systems when the ship is in battle, a military marine grade enclosure was supplied, capable of withstanding high shock/vibration levels and EMI exposure. To facilitate on-board installation, the cabinet was installed with military mating connections allowing plug and play connections for the ship's field wiring.

Woodward Cabinet

Woodward MicroNet Plus Digital Control System

In line with major European and North American navies, the Royal Thai Navy chose the Woodward MicroNet Plus to control and protect the LM2500 gas turbines. The MicroNet's deterministic rategroup structure, guaranteeing execution of critical turbine control and protection code every 5 milliseconds, continues to prove its value for low inertia high power gas turbines like the LM2500. The MicroNet Plus also supports dedicated gas turbine I/O modules such as dedicated Compressor Discharge Pressure inputs, MPU inputs, Thermocouples and RTD inputs.

The CPU of the Woodward MicroNet Plus is loaded with specific control application software for the Navy's LM2500 gas turbines. It is tightly integrated into one software system, consisting of two segments:

- Core Fuel Control Software, providing basic control of the turbine and replacing the AECM. It includes the dynamic control, acceleration/deceleration limiters, exhaust gas temperature limiter, torque calculation limiter and overspeed protection and has been designed specifically for GE LM2500 gas turbines.
- 2nd Ring Control Software, providing sequencing, monitoring, protection, alarming, auxiliary controls and interfacing with external systems. The 2nd ring software replaces the LOP sequencer.

Woodward MicroNet Plus Digital Control System

Allen Bradley XM-123, XM-220, XM-441

The LM2500 turbine is equipped with vibration sensors that monitor the vibration of the two turbine shafts at two locations. Monitoring the turbine vibration provides a good indication of the turbine's health conditions. When the turbine encounters high vibrations, the control and protection system shuts down the turbine operation, unless the battle-override mode is activated. PM Control supplied and commissioned XM123 aero derivative vibration modules which monitor the vibration levels. Other XM modules were supplied for protection of the fuel shut off system, avoiding

uncontrolled supply of fuel into the turbine and providing independent overspeed protection. The multiple XM modules that were supplied formed a key part of the master protection loop which provides turbine protection in addition to and independent from the MicroNet.

Allen Bradley XM-123

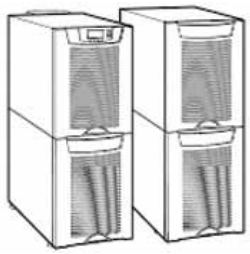
Imtech Converter (Wago)
To interface the ship's IPMS monitoring and control system with the MicroNet, PM supplied protocol converters that were developed by the IPMS supplier. These protocol converters are based on a separate PLC and ensure seamless integration of the gas turbine control to the ship.

Imtech Converter (Wago)

Human Machine Interface (HMI)
To allow easy control and monitoring of the turbine control, an extensive Human Machine Interface (HMI) was supplied. The HMI had to have the functionality to start, operate and stop the turbine as well as to monitor and control its auxiliary systems. The HMI was developed with the iFIX Intellution HMI software and runs on a flush mounted, marine grade, industrial touchscreen PC. Consisting of various screens ranging from turbine overview to the auxiliary systems, it gives operators easy access to relevant process values and can be used to startup or shutdown the turbine. In addition, the HMI has real time/historical trending and event and alarm logging, which can be exported and download for analysis.

Page on Human Machine Interface (HMI)

Eaton Powerware 9155 UPS
Due to the stringent availability requirements on the ship's propulsion system, PM Control supplied an uninterrupted power supply (UPS) to the control panel. An Eaton 8KVA Marine UPS was provided together with each control cabinet to ensure uninterrupted power supply to the controls. Additionally, the UPS filters and regulates the incoming AC power supply providing clean AC power. The UPS was sized with the intention to allow the controls to continue running for at least 30 minutes should a blackout occur.



Eaton Powerware 9155 UPS

Installation & Commissioning
Installation of the new system was done by Royal Thai Navy engineers. They were also responsible for the termination of the wiring. PM Control conducted various checks and tests including:

- IO loop checks to guarantee all signals were correctly terminated,
- Interface checks with the ship's IPMS to ensure that communication between the systems was working,
- Functional checks of the auxiliary systems,
- Trip tests to ensure the gas turbine could trip in abnormal or dangerous operating conditions,
- A harbour acceptance test to demonstrate that both the gas turbine and the control system were fit for sea.

Prior to the Harbour Acceptance Test, the gas turbine was started and stopped several times at low load to verify the start and stop sequence. The lube oil system, fuel manifold systems and vibration were monitored closely to confirm everything was operating within normal process values. After the low load test, the PLA demand was eventually increased to monitor the gas turbine at higher loads.

The final test was a sea trial, which involved the ship sailing out of the harbour and into the test area for manoeuvre testing. It tested the gas turbines actual performance during operation and it was also a good time to fine-tune the controls. The results of all these tests, including the sea trial, were very satisfactory and the Navy was pleased with the end-result.

Finally, PM Control provided on-site training for the Royal Thai Navy operation and maintenance crew. Basic gas turbine knowledge was also taught during this training and experiences were exchanged.

Results

- A system that reduces the risk of maintenance issues and unavailability of high speed sailing on its gas turbines,
- A simpler, faster, more reliable and easier to maintain control system,
- A more knowledgeable operation and maintenance crew.

The new system integrates the former FSEE and the LOP into one package with the functionalities of dynamic control, protection, sequencing, monitoring and IPMS interfacing. This integration has made the system simpler, faster, more reliable and easier to maintain.

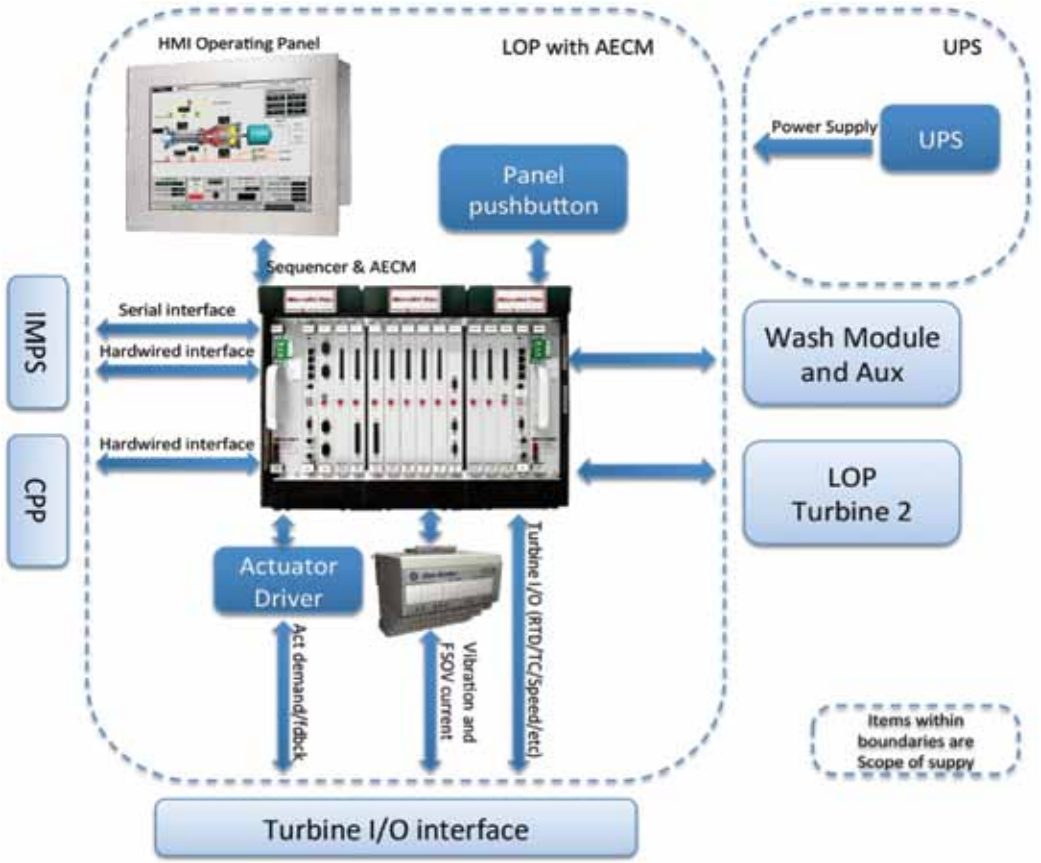
Thanks to the on-site training, the Navy's operators and maintenance crew gained more knowledge of the new control system as well as about gas turbines in general.

All in all, Royal Thai Navy was pleased with the results for both gas turbines.

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



Singapore
PM Control Systems Pte Ltd
No. 8 Joo Koon Crescent, Singapore 629011
Tel.: +65 6779 2822 | singapore@pmcontrol.com

New Delhi, India
PM Control Systems (India) Pvt Ltd
14/3 Mathura Road, Plot No. 4
Faridabad 121003 | Haryana, India
Tel: +91 129 6543114-29 | delhi@pmcontrol.com

Sydney, Australia
PM Control Systems (Aust) Pty Ltd
Unit 1, 1 Wirega Avenue
Kingsgrove, NSM 2208, Australia
Tel: +61 (0)2 9758 2322 | sydney@pmcontrol.com

Batam, Indonesia
PT PM Control Systems
Komp. Taman Niaga Sukajadi | Blok H1 No. 1 Batam 29400
Kepulauan Riau, Indonesia
Tel: +62 778 737 2221 | batam@pmcontrol.com

Jakarta, Indonesia
PT PM Control Systems
Sentra Bisnis Artha Gading | Blok A 7C/25 Kelapa Gading
Jakarta Utara 14240, Indonesia
Tel: +62 21 4585 7266 | jakarta@pmcontrol.com