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THE ROLE OF INFORMATION TECHNOLOGY PROCESS CONTROL NETWORK IN SUPPORTING THE SURVEILLANCE SYSTEM ON GEOTHERMAL SALAK AND DARAJAT OPERATION

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ABSTRACT

Star Energy Geothermal Salak and Darajat asset have been operated for many years of operation. To ensure reliability and availability of the steam field and power plant, the company had been implementing surveillance system technology. The benefits achieved by implementing the surveillance system have been numerous. This surveillance system enables all stakeholders to monitor, collect and analyze historical data of steam field and power plant critical parameters also established information sharing at the highest level as well as enhanced company productivity, secure collaboration, operational transparency and reliability, and create image of integrity and safety to the stakeholders. This paper will discuss in brief the role of Information Technology Process Control Network in supporting the implementation of surveillance system in Star Energy Geothermal Salak and Darajat operation.

Keywords: Geothermal Operation, Information Technology, Process Control Network, Surveillance System

INTRODUCTION

Geothermal energy is another alternative solution to solve the power shortage in Indonesia, which is a fast growing economy and its energy demands are growing rapidly. Geothermal is a clean and renewable energy that could help Indonesia to reduce greenhouse gases emissions. Indonesia is a country that has a lot of geothermal resources and enormous geothermal energy potential with approximately 40% of the world geothermal energy resources (Munandar and Widodo, 2013).

Geothermal resources potential spreads along the entire trajectory of volcanoes in Indonesia which is usually found only in remote locations, therefore requires adequate facilities as well as infrastructure development. Steam field and power plant performance monitoring for all production areas and company-wide daily information and reporting systems in geothermal industry is one of the critical aspects to supporting company's vision, mission and performance measures (Rozaq *et al.*, 2015).

Salak geothermal field is located about 70 KM south of Jakarta (Nordquist *et al.*, 2010) and Darajat geothermal field is located about 150 KM southeast of Bandung in West Java, Indonesia (Intani *et al.*, 2015). Both of the geothermal field is located along the Sunda Volcanic Arc in West Java Province (Stimac *et al.*, 2010). Currently, Star Energy Geothermal Salak and Darajat are the largest geothermal field in Indonesia and the sixth largest in the world (Pasikki *et al.*, 2011). The location map Star Energy Geothermal Salak and Darajat fields in West Java Province, Indonesia as shown in Figure 1.

Figure 1. Location map Star Energy Geothermal Salak and Darajat fields in the West Java Province, Indonesia

As one of the biggest steam field and power generation geothermal company in Indonesia, thus the stakeholders need easy tools to monitor or visualize the real-time or historical operations data of the facilities, especially during critical operation periods. With the tools, the critical to the success of the geothermal operation is the ability to collect and analyze real-time information throughout the entire process, from steam field to power plant. As part of the power generation, company also require to provide ongoing reports on steam field and power plant operations to several stakeholders, to ensure that comply with all compliance and regulation. Use of collaboration tools has also provided an improvement in ensuring data quality and the ability to spot discrepancies for troubleshooting purposes and optimizations process.

Previously, the surveillance activity has been relying on operator report and operator routine duty check list. The monitoring activity was facing many obstacles such as administrative task, weather condition, road condition or interruption by other more important job. There is also gap in quality of facilities performance data in term of its accuracy, interval time, availability and accessibility which lead to inability to detect the declining of plant performance as well as to perform accurate and timely evaluation of any facility problem or discrepancy. The benefit includes early warning system for facility down or any discrepancy which enables operator to recognize the critical parameters problem and take appropriate action in timely manner so that the loss production opportunity impact will potentially be reduced, and the, objective to operate wells safer more efficient, and more reliable will potentially be achieved.

Gunnarsdóttir (2013 and 2015) said that in many cases geothermal data are not yet stored in computerized file form and may only be preserved in word or text processed reports in computers. Geothermal data that has been computerized may then not be stored in central computers as yet, but different parts of the information only kept in computers of individual employees. It can be said that proper data storage is lacking far and wide, which puts it at great risk of time consuming data recovery and even permanent data loss. The benefits of implementing relational database management system is to make the most use of the data, to get benefits as to maximize data security, ensure data consistency, avoid duplication of data, minimize human error, and to increase the accessibility of the data.

INFORMATION TECHNOLOGY

Definition, Role, and Function

Nowadays, Information Technology (IT) touches nearly every aspect of modern life. IT enables seamless integration and communication between businesses anywhere in the world. To keep IT systems running, a large workforce is needed to maintain networks, create new software, and ensure information security (Matthews, 2012). Information Technology is considered a subset of information and communications technology (ICT). ICT hierarchy level contains some degree of commonality in that they are related to technologies that facilitate the transfer of information and various types of electronically mediated communications (Zuppo, 2012).

IT is helping companies simply to survive and support their operations. IT has become the major facilitator of business activities in the world today (Tapscott *et al.*, 2000, Dickson and DeSancis, 2001; and Huber, 2004). IT is also a catalyst of fundamental changes in the strategic structure, operations, and management of organizations (Carr, 2001). According to Wreden (1997), IT capabilities may support the five business objectives, such as improving productivity, reducing costs, improving decision making, enhancing customer relationship, and developing new strategic application. Indeed, IT is creating a transformation in the way business is conducted, facilitating a transition to a digital economy. Brynolfsson *et al.*, (2003) and Liebowitz (2002) said, the digital economy refers to economy that is based on digital technologies, including digital communication networks, computers, software, and other related information technologies.

The business model in the digital economy, companies need to react frequently and quickly resolve the problem and opportunities resulting to new business environment (Arens and Rosenbloom, 2003 and Drucker, 2001). Because the pace of change and the degree of uncertainty in tomorrow's competitive environment are expected to accelerate, organizations are going to operate under increasing pressure to produce more, using fewer resources. Boyett and Boyett (1995) emphasize this dramatic change and describe it with a set of what they call business pressure or drivers.

These business pressures are forces in the organization's environment that create pressures on the organization's operations. In order to succeed in this dynamic world, companies must not only take traditional actions such a lowering costs, but also undertaken innovative activities or devise a competitive strategy. According to Simpson (2003) and Aren and Rosenbloom (2003), IT is the only solution to face these business pressure.

The world is moving faster and faster. Decisions need to be made very quickly, and speed is needed to remain competitive. To mitigate, the business pressure so that company need to leverage real-time operations (Gates, 1999; Davis, 2001; and Huber, 2004). According to Huber (2004), the schematic view or relationships among business pressures, organization responses, and activities supported by IT are shown in Figure 2.

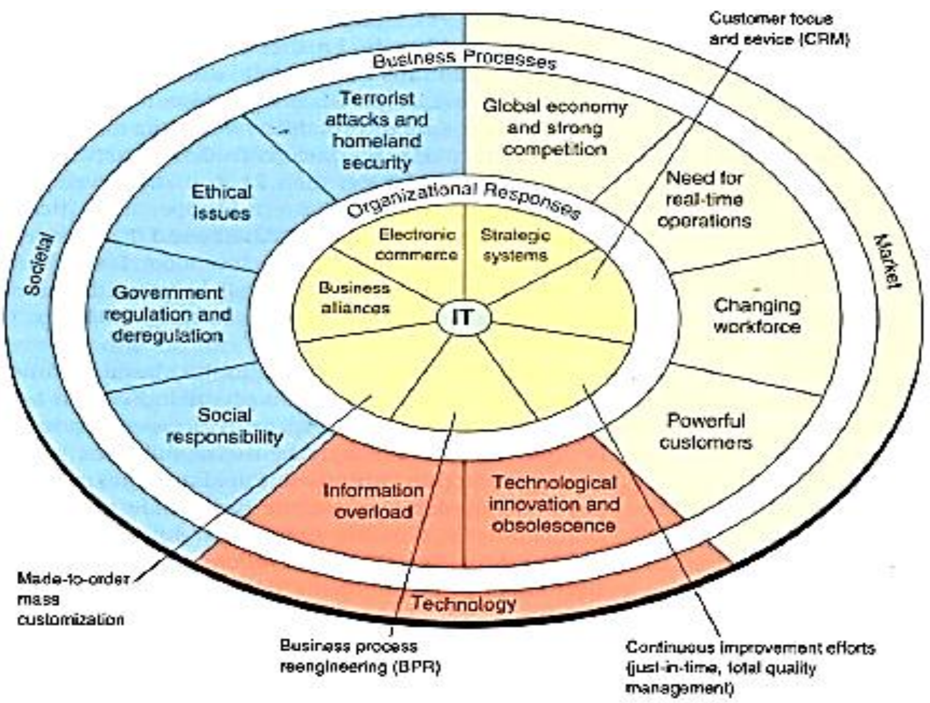

Figure 2. Business pressure, organizational responses and IT support

Process Control Network

Process Control Network (PCN) is a communications network that is used to transmit instructions and data between control and measurement units and Supervisory Control and Data Acquisition (SCADA) equipment (Byres *et al.*, 2005). According to terminology definition where PCNs are networks that mostly consist of real-time industrial process control systems used to centrally monitor and (over the local network) control remote or local industrial equipment such as motors, valves, pumps, relays, etc.

Process Control Systems are also referred to as Supervisory Control and Data Acquisition (SCADA) systems or Distributed Control Systems (DCS) (Peerlkamp and Nieuwenhuis, 2010). SCADA systems have been common used in the geothermal industry. These systems are used to monitor critical infrastructure systems and provide early warning of potential disaster situations. One of the most important aspects of SCADA has been its ability to evolve with the ever-changing face of technology that is now referred to as Information Technology systems. SCADA has evolved from a monolithic architecture to a networked architecture (Stouffer *et al.*, 2006).

In recent years, SCADA, PCN systems have increasingly relied on commercial information technologies such as Ethernet, TCP/IP and Windows for both critical and non-critical communications. The use of these common protocols and operating systems has made the interfacing of industrial control equipment much easier, but there is now significantly less isolation from the outside world. Network security problems from the enterprise network and the world at large can be passed onto the SCADA and process control network, putting industrial production and human safety at risk (Antal and Maghiar, 2008).

THE SURVEILLANCE SYSTEM

System Requirement

The geothermal stakeholders are requiring a high level confident of surveillance integrated in steam field and power plant systems to measure and understand the critical parameters and its characteristic. The surface facility monitoring, data collection and surveillance system is designed to ensure a successful of geothermal operation by collecting key important surface facility and turbine performance data. Achieving this objective is also the main goal of having surveillance system. Another key objective of the surveillance system is having a reliable data for both subsurface and surface production aspects to obtain a reasonable power generation baseline.

The surveillance systems installed on Star Energy Salak and Darajat operation must have at least two functionalities, such as operational and managerial functionalities. Users working in the operation section have capability to use the data for analysis by generating graphical user interface and trending as well. Users in managerial section use real time web-based application as the main application. Managerial section is using a thin client technology that works within a web-based environment to provide access to real-time and historical data via company intranet. Additionally, with the use of add-in functions to the spreadsheet menu bar and dialog boxes, users can quickly populate the spreadsheet with both real-time and historical data without need to use complex import functions.

The surveillance system must formed by a three-tier Information Technology architecture that is based on the server/client networking and information management concept dominating most business applications today. This combined with the use of web-based technology, Industrial Ethernet communications, and a component-based software structure. The ultimate goal of surveillance system is to develop supervisory and data acquisition monitoring system with the following purposes i.e. collecting the real-time and historical data from steam field and power plant parameters, saving the data in the application server that can be withdrawn anytime for the performance review and further evaluation, and monitoring/viewing the data from the control room and remote offices.

Together with all stakeholders involve, the functional team was carefully reviewed the products selection that were available on the market using following criteria, i.e. ability to sustain 24/7 operation, robust data processing capable of producing around 20K data items per second, easy to install and maintain, a reliable system from a well-established company. The steam field and power plant facilities better decision-making and reporting for operator, engineers and supervisors, while optimizing the costs for operation and maintenance. It can integrate all of the available data for the steam field and power plant operations group into a user friendly, consistent interface to better predict future events, and adapt to all systems in order to make them as efficient as possible.

Design Architecture

Surveillance system and data flow diagram on Star Energy Geothermal Salak and Darajat operation as shown in Figure 3. The architecture design has been followed company policy and procedure by doing risk assessment and getting IT concurrence process from IT management level. In Operating System side, implementation of all PCN-IP technical controls is mandatory and will be part of requirement to be fulfilled by vendors when they install the application. Data historian collectors will be installed in each asset connected to DCS and others SCADA system network to collect data sources and feed to historian server.

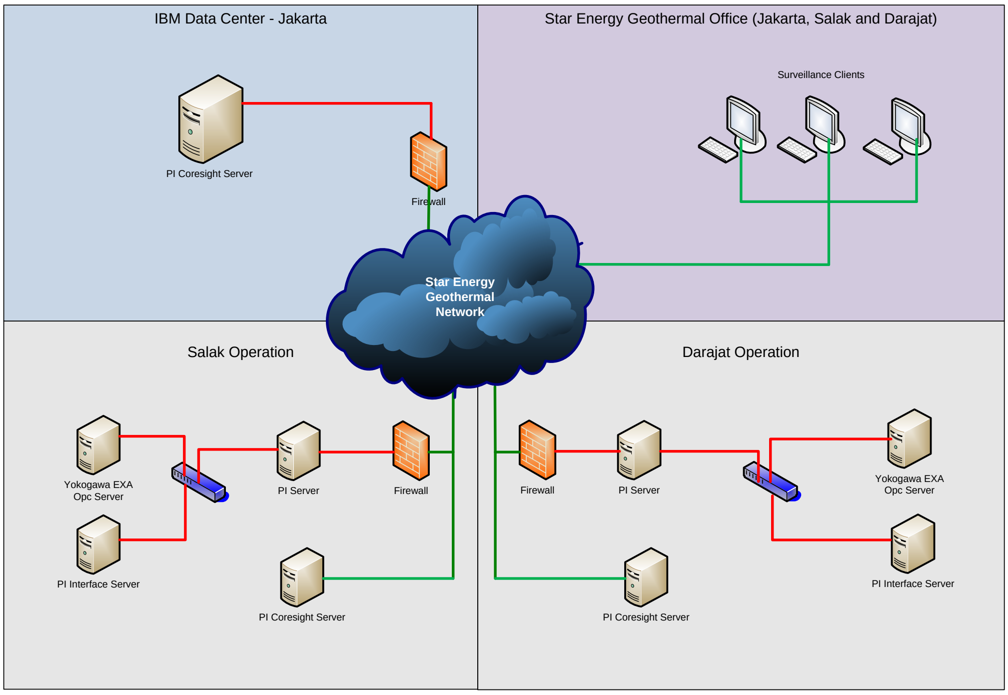

Figure 3. Surveillance system and data architecture flow diagram

The surveillance data architecture adopted the ISA S99 standard provides the SCADA and control systems industry with a model for segmenting networks at levels 2 and above to ensure that SCADA and control systems are isolated from the Enterprise IT networks through a DMZ (demilitarized zone). As the lower levels 0 and 1 typically contain instrumentation, meters, PLCs, RTUs and other field embedded devices move to IP communications, additional considerations for security must be taken into consideration (Djiev, 2002). One commonly suggested security solution is to isolate the SCADA and PCN system from the corporate and Internet systems through the use of firewalls (Byres and Hoffman, 2002).

A firewall is a mechanism used to control and monitor traffic to and from a network for the purpose of protecting devices on the network. It compares the traffic passing through it to a predefined security criteria or policy, discarding messages that do not meet the policy requirements. In effect, it is a filter blocking unwanted network traffic and placing limitations on the amount and type of communication that occurs between a protected network and other networks, or another portion of a site's network) (Mahan *et al.*, 2011).

<u>Technology Solution</u>

Client and Server technology is the next information technology for enabling the implementation. This technology enables for empowering users to access the information directly and timely. In Star Energy Geothermal Salak and Darajat operation, since 2007s we have been leveraging the OSIsoft's PI Systems® as data historian and surveillance system tools to collect real-time data on steam field and power plant operations and integrate with a variety of information sources throughout the steam field and power plant, along with DCS, other supervisory control and data acquisition system.

The PI data engine is used to collect and store all the raw data from the DCS, PLC's, manual logger and the field including pressure, temperature, flow rate, frequency, voltage, wattage, level, and others online analysis, which implement the actual monitoring of the process performance. The PI System provides real-time event management, retrieval, and deep archiving of volumes of data for scalable management of relevant variables and events enterprise wide.

PI System brings all operational data into a single system than can deliver it to users at all levels of the company from the plant floor to enterprise level. The PI System keeps all critical operation data online and available in a specialized time-series database so it is always available. With the help of the PI System's reporting and analytical tools, the wealth of data in our operation can drive meaningful, empowered and informed action.

The OSIsoft's product such as PI DataLink® by Microsoft Excel add-in, PI ProcessBook® and PI Coresight® by monitoring graphs and trends, created by the plant engineers. Statistical Quality Control is applied in order to monitor the process variables efficiently, and maintain operational quality through control charts that have upper and lower control limits. The operators and engineers are able determine the cause-effect relationships between steam field and power plant parameters and determine key process variables. Knowing the cause and effect enables the staff to maintain better (OSIsoft, 2016).

The sample displays PI DataLink real-time surveillance system for Salak and Darajat operations may show in Figure 4.

The PI DataLink established a direct connection the OSIsoft PI System and Microsoft Excel. Users can display real-time as well as historical data in Microsoft Excel so they can create and publish reports and perform complex data analysis. By providing direct access to PI System data, PI DataLink makes the performance of such tasks as data gathering, reporting, modeling, analysis, forecasting, and process planning fast and dependable.

The PI ProcessBook as easy-to use graphical interface makes it possible to efficiently display real-time and historical data reading in the PI System and other sources. User can use PI ProcessBook to create interactive graphical displays that can be saved and shared with others. Users can quickly switch between view and build modes to create dynamic, interactive displays and populate them with live data. They also can write scripts that automate displays and trends by using Microsoft Visual Basic for Applications, which is seamlessly integrated into PI ProcessBook. The sample displays PI ProcessBook real-time surveillance system for Salak and Darajat operations may show in Figure 5.

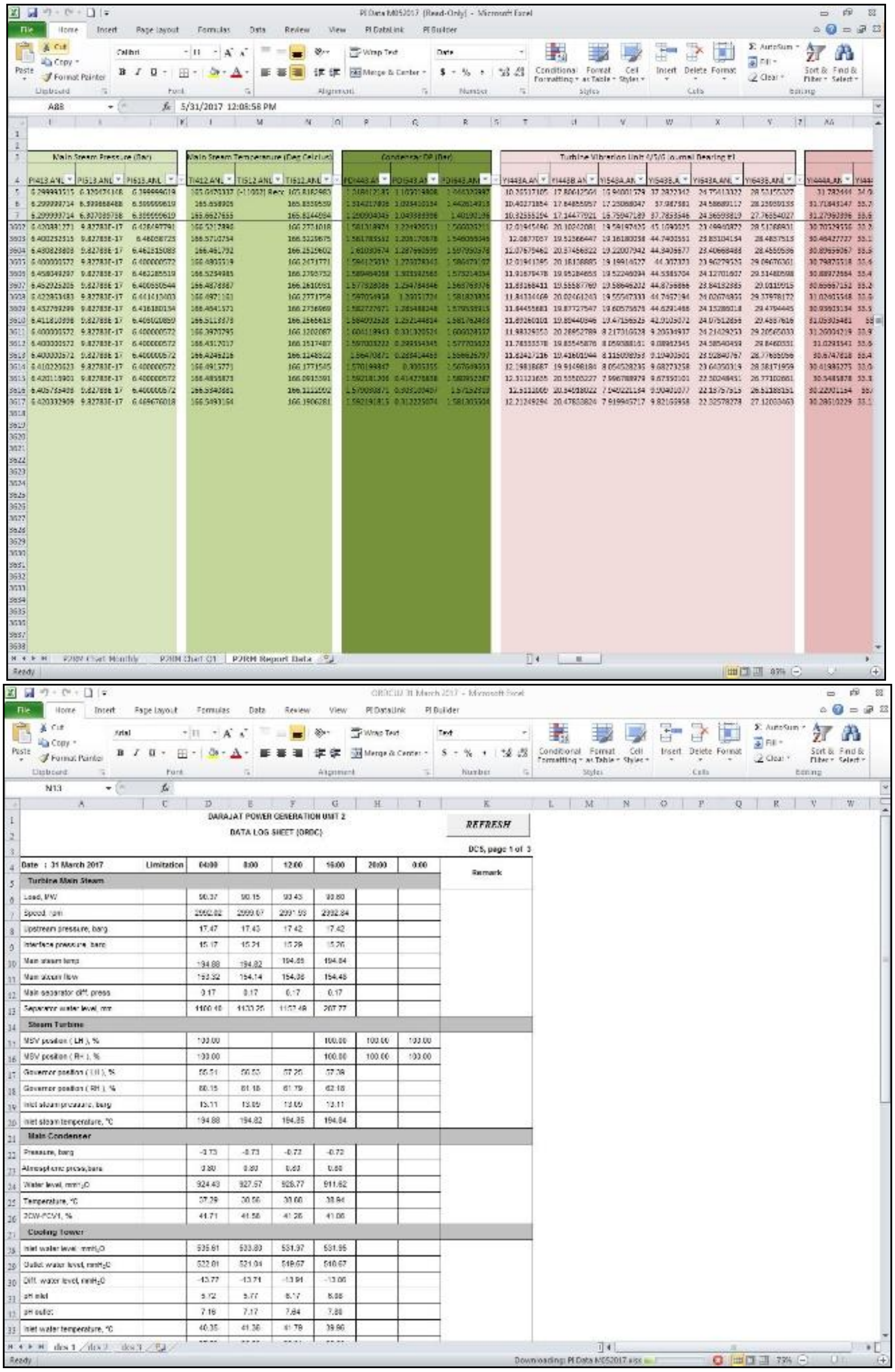

Figure 4. Sample displays of PI DataLink

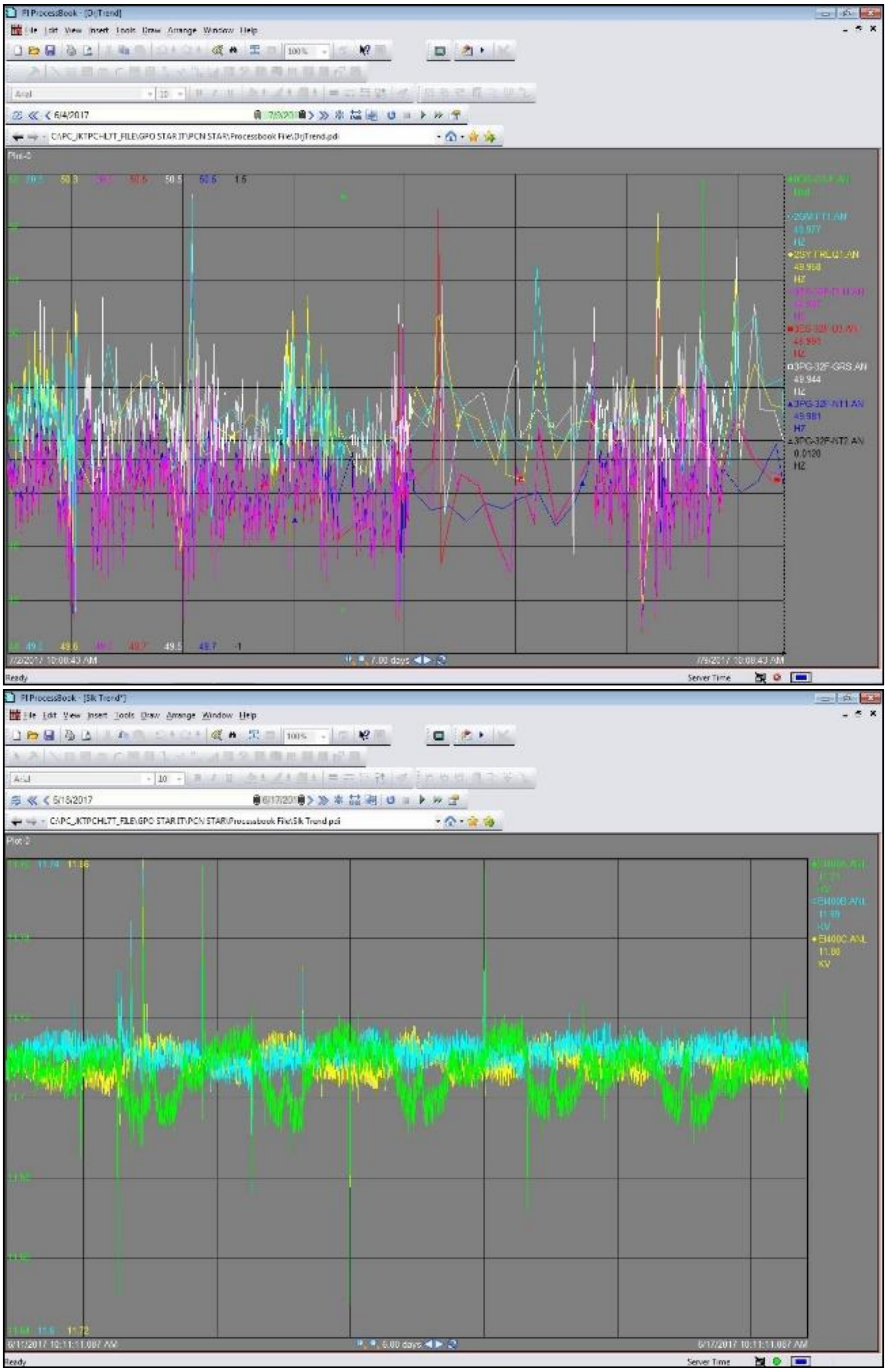

Figure 5. Sample displays of PI Processbook

The web-based real-time surveillance system portal site was developed using OSIsoft's PI Coresight®. While the core portal pages were developed by IT team, users have the ability to create their own customized graphic screens of the field that are incorporated in the portal site to display specific information based on their need. Custom and legacy data was consolidated along with PI System data. The site is also dynamic, allowing users to customize the layout and work with trends. The PI Coresight is thin clients that are integral components to the PI System products suite. The web-based applications allow users to investigate real-time information including time series, relational, and web services information, all within a familiar with internet browser-based environment. The sample displays web-based real-time surveillance system for Salak and Darajat operations may show in Figure 6.

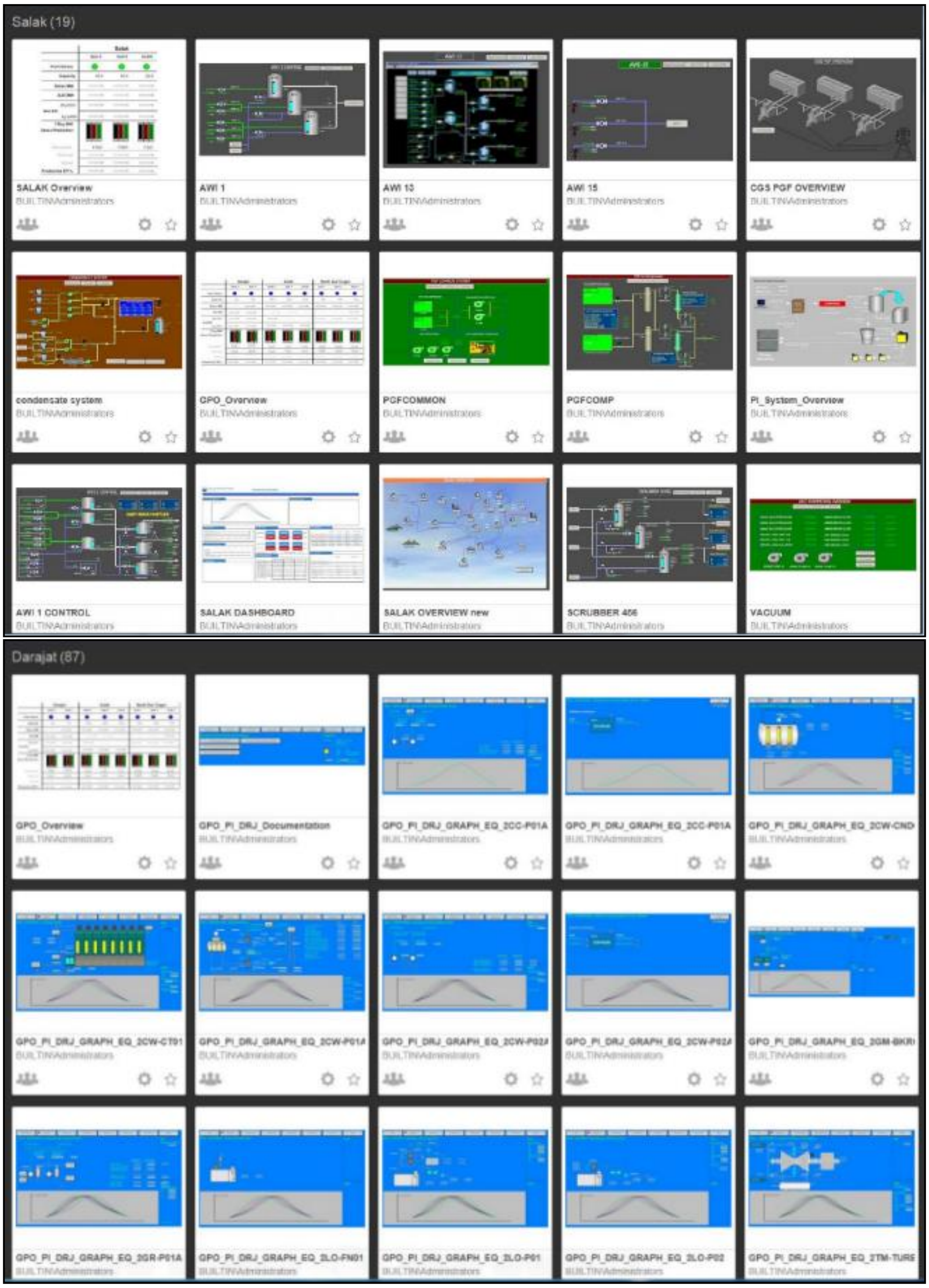

Figure 6. Sample displays of PI Coresight

Enhancing the Portal capability then engineers can drill down to view how the individual systems or equipment are working, to help operators and engineers focus on problem areas, color coded tabs have been incorporated to immediately identify areas of concern. A navigation bar, populated by the module database, is include on all pages to help choose with systems or equipment parameters data that they want to see or investigate. The portal site is Internet Explorer-based so it is very intuitive and easy for end user to use and understand.

CONCLUSIONS

The implementing surveillance system on Star Energy Geothermal Salak and Darajat operation have been numerous such aim of providing a tool for users to assess, improve and optimize the plant operations, allow more than one user to access data from historian database system simultaneously, faster data retrieval into spreadsheet for reporting purpose, provide real time plant performance monitoring tool, a centralized information or database available, extendable archive data files, a better system performance that existing historian system, integrates with existing DCS and other supervisory control and data acquisition, improved accessibility and user friendly (thin client, web server and etc.), on-line notification based on process discrepancy to maintenance personnel to perform necessary repair on certain instrument/equipment, and minimize or eliminate common mistakes in gathering manual operating data.

The surveillance system has been providing economically viable energy generating, establishing information sharing at the lowest and highest level as well as enhanced the productivity tools, secure collaboration, operational data transparency, improve reliability, availability and created an image of integrity and safety to stakeholders. Integration and interconnectivity are creating a new world of opportunities for process control network to support the success of geothermal industry expected gain will be obtained if surveillance system is implemented such as reduction loss production opportunity as result of faster operator response time, and gain production optimization by improved steam field and power plant surveillance system.

The surveillance also can provide information for support decisions and thereby helps to offset negative effects of operational issue and reduce the decision uncertainty by transforming data into information to further manage costs and improve value, significantly reduce clerical function and change into analytical function, and highly secure environment with no interference in regular control room work.

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