Final Project Report

Emergency Response and Unified Command System

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Abstract

Although the performance calculation software package is quite something new in the power generation business, it plays a major role in contemporary power generation control, electricity grid control and monitoring via SCADA system. Every power plant construction contract nowadays always requires bundling power performance calculation as its minimum requirement because the major player in the electricity generating business realizes that the fossil fuel, the major power source nowadays, is going to extinct from the world and also the nuclear fuel is still the major public concern and dangerous for using. The way to operate power plant efficiently at low fuel gas or fuel oil consumption will be an answer and major role of the contemporary power generating player.

The power performance calculation does not only perform a real – time monitoring, but it also provides a sophisticated power plant simulation analysis such as what – if analysis with varying power plant loads in different ambient conditions. This module provides an advantage on the worst case scenario and best case scenario simulation. It can simulate in on-line mode, connect to power plant control system, or off – line mode for power plant analysis team.

The power plant simulation will give a clear picture of the power plant react characteristic on the unwanted situation such as electricity blackout. This information will give a clear picture of emergency plan, preventive power plant maintenance, and how to prevent the electricity blackout.

Whereas the SCADA network is used to be the media of the performance real – time monitoring is vulnerable from the hacker, I will discuss power plant performance software in terms of power plant performance calculation, power plant simulation and security issue.
Also, I will address the future direction with suggestion.

♦ **Review**

We had a lecture related to Power Plant performance calculation software about “TCIP (Trustworthy cyber infrastructure for the Power Grid)” and Emergency Response and Unified Command System. Roy Campbell, the guest speaker in TCIP topic, pointed out many vulnerabilities and risk of information transfer via SCADA system whereas Richard Jaehne, the guest speaker in Emergency Response and Unified Command Systems, pointed out the procedure, code of conduct and emergency command hierarchy.

I will address several aspects of power plant performance calculation and power plant simulation software package such as power plant performance calculation software architecture and simulation, how it works and what kind of managerial issues we have as well as any benefits and business risk.

♦ **Introduction**

Trace back to 16th century, the first steam engine was little more than a toy, the classic Aeolipile made by Heron of Alexandria. Another steam turbine devise was created by Italian Giovanni Branca in year 1629. The modern steam turbine was invented in 1884 by English engineer, Charles A. Parsons, whose first model was connected to a dynamo that generated 7.5 kW of electricity. His patent was licensed and the turbine scaled up shortly after by an American, George Westinghouse. A number of other variations of turbine have been developed that work effectively with steam.

Whereas the fossil fuel price increases every day and the new power station is
difficult to construct because of an environment concern, to squeeze the hiding performance and improve the power plant reliability of an existing power station will play an important role today. Because of an enormous variation in power generating such as ambient temperature, ambient pressure, and performance calculation difficulty and so on and so forth, the way to achieve performance and power generating reliability improvement is the real-time performance calculation and monitoring. Whereas power plant calculation tries to exploit power station, simulation software on the other hand gives a clear picture of the worse case scenario and power station system react to a disturbance such as fault in the power transmission line, control system failure at substation, power production environment change. Moreover the reliable, performance calculation contributes to the power station longer life and saving maintenance cost per year. Thus during 1980 most of the machine supplier such as General Electric, ABB acquired the sophisticated performance calculation and simulation company such as ABB took over Combustion Engineering and GE took over GateCycle for expanding investment arm in this field and also encouraged real-time performance calculation and monitoring via IT network.

On the other hand, the different standard and unit that machine manufacturer uses may encourage the human error in real-time power calculation. Most of power stations are in the rural area and proliferate across the country, they encourage a geographic IT connection investment and security concern.

Online Power Performance Calculation and simulation is designed to operate within a distributed system environment and interface with most major Distributed Control Systems (DCS) or Data Acquisition Systems (DAS) via the Online Performance Calculation software Process Information as indicated in Fig 1. It uses real-time plant data to carry out calculations. Its design provides for maximum flexibility in reconfiguring or dynamically modifying system parameters, also during system operation.
The construction of a calculation is an interactive process that allows engineer to create, modify, test, and delete calculations without disturbing or interrupting others already in progress.

**Fig. 1:** The *Online Performance Calculation Software* functional structure

- **Online Performance Calculation Software Process Information System**

  Online Performance Calculation Software Process Information (PI) is based upon a distributed, open, client/server architecture that takes advantage of distributed servers for data management and display/report generation.

  The four primary components of Online Performance Calculation Software are:

  - History services for distributed data collection, storage, and archiving.
  - Display services for distributed graphical user interface.
  - DCS/PLC connections for the consolidation and historization of process information from power plant control system.
• Interfaces to plant management applications e.g. Online Performance Calculation Software Performance Module

Online Performance Calculation Software Performance and Simulation applications are constructed as sequences of mathematical functions, steam/gas table references and thermodynamic functions (Tools). The combined sequences determine the performance of a plant component or group of related components. The Application Tool Library provides the users with tools so that they can define their own performance calculations if desired.

On the other hand, simulation software application in performance calculation package plays a major role in worse case simulation scenario for supporting system operator information and gives a clear picture to an emergency planning team for planning an emergency plan to handle an incident that may occur not only in the power plant but also in the power grid.

The sophisticated performance calculation and simulation nowadays also buddle alarm management system to encourage an incident investigation and record in electronic documentation form. Moreover, an additional application on top of performance calculation can perform power plant asset optimization and asset maintenance prediction according to the exact machine condition.

♦ Application and case

Why performance calculation and simulation software is important? Because of “Time, Money, consequences of the black out and environment concern” The performance calculation software and simulation can calculate the power plant on real – time basic according to ASME, JIT or machine manufacturer formula. The performance calculation
plays a major role in the power acquired bidding and also gives plentiful information to plant owner in preventive maintenance planning with low maintenance budget and low environment impacts to the local community.

Before an emergence of performance calculation software, the power plant maintenance made a routine maintenance based on time interval. Sometimes the time interval maintenance did not reflect the real machine maintenance needed or lack of the maintenance in some case. Because of the difficulty of the performance calculation formula and the lack of performance specialist, it made the power plant owner incur the waste maintenance budget.

First of all, the performance calculation emerged in form of stand alone application. Because of a small group of performance expertise and dot com era, the major players in this field such as GE, ABB and OSI soft Inc. try to encourage the solution that can integrate the local stand alone performance calculation server to form a power performance monitoring in real – time basic with standardize database such as PI server database system. Because of centralizing the power performance calculation and simulation, the system operator at the center can get a clear picture of the overall system and the simulation software package is fully utilized by the system operator in the what – if scenario application. The what – if scenario can perform a clear picture of the a high potential event that occurs to the system and how the system reacts to those event such as when the hacker gets access to the SCADA network and tries to trip an important breaker at local substation. The simulation software package can simulate not only the power plant reaction but also the transmission line equipment reaction to those events by sophisticated mathematic formula. This pros side of the performance calculation and simulation also gives the sufficient improvement in fuel combustion by decreasing the pollution gas and releasing the hiding power plant capacity.

According to New York City electricity black out in 2003 and President George W. Bush Junior announcement in Power Grid upgrading fund, it made a consequence in power
plant performance business. In New York City electricity black out in 2003, there was also the lack of the procedure to bring the electricity distribution system back to normal. It took almost one day and a half to restore the system back to normal operating. Because of lacking the restore system procedure, it took a lot of energy and wasting time in bring back the Northern and the Western edge of electricity grid whereas the cause of New York city black out is still unknown as the following report from CNN.

“The outage occurred quickly and rippled across a large area. Cities affected included New York, Cleveland, Ohio, Detroit, Michigan, and Toronto and Ottawa, Canada.

In just three minutes, starting at 4:10 p.m., 21 power plants shut down, according to Genscape, a company that monitors the output of power plants.

It was unclear what caused the outage, although state and federal officials agreed that it was not terrorism.

One possibility was a lightning strike in the Niagara region on the U.S. side of the border, according to the Canadian Department of National Defense. A spokeswoman for the Niagara-Mohawk power grid said the cause was still unknown, but that it was not a lightning strike. “

It is clear that the power calculation software does not provide only the power plant performance real-time monitoring but also the power system monitoring as a whole.

In the case of New York City black out, if the performance calculation software had exited in the system, it would have provided an enormous information and procedure in bringing the system back to normal whereas the additional software on top of this package would have provided an information of the post black out and also pre black out investigation as well.
As I mentioned above, the New York City Black out has had an effect on the power generating and electricity transmission around the world and also the world oil price which has been increasing for example in Thailand since 2002. The State enterprise, Electricity Generating Authority of Thailand (EGAT), recruited internally the performance and simulation expertise for forming the loss control center. The loss control center duty is to monitor EGAT power plant performance and prepare the emergency plan. Especially the loss control department routine duty is to ensure that EGAT whole system is reliable and that EGAT power plant utilizes the fossil fuel effectively.

♦ Issue

As Roy Campbell issued in our class, the technology is a double – sword edge. The performance and simulation relays heavily on SCADA data transferring network. Security is a critical issue in performance real – time monitoring and simulation because of the performance and simulation involve in the power plant control system and grid control system. The vulnerability of the SCADA has lead hacker to get an access to power plant and grid control system.

Software license, difficulty of performance improvement in tangible dollar saving and lack of power plant performance and simulation expertise are also obstacles for power producer companies to adopt performance monitoring and simulation software. There is no standard formula for power performance calculation and simulation because of the variety of power plant type and also variety of power plant machines and power plant configuration. Moreover, SCADA security and trustworthy insurance are really needed for the will to share performance calculation data, power plant process variablility, breaker status, power plant control programming and substation control programming over SCADA networking.
However, adopting the performance calculation and simulation does not guarantee the performance improvement and grid transmission more reliable because actually, the biggest problem is a difficulty of finding the power plant performance and simulation expertise.

Ratchaburi Electricity Generating Company, the biggest power generation of Thailand, is trying to adopt the power plant performance improvement by neural network methodology in its power generating unit. Before the implementation step, Ratchaburi performance department found that the improvement in boiler temperature control by adopting neural network methodology could improve not only overall boiler performance but also boiler and power generating reliability. During the implementation step, they found that the implementation of neural networking and turning the neural network algorithm were very difficult and it needed the supervision of a performance expertise.

♦ Conclusion

Eventually, ABB Optimax®, GE GateCycle® and other performance calculation and simulation are trying to address the benefit of integrating the power performance and simulation in the power generating and power distribution business, the lack of performance and simulation expertise is still the biggest problem in utilizing the performance and simulation software in disaster prevention, maintenance scheduler and improvement of power plant combustion with low environment impact.

Moreover, the US power generating and distribution business are not the same as that in Thailand. The US power generating business and distribution are assembled with many different players. The sharing of power plant process data and substation operating data are the obstacles to achieve the goal of whole system online performance monitoring and simulation the whole system react to the system disturbance, not only the power generating disturbance but also electricity transmission line disturbance.
Nonetheless, some of the process data is a secret or proprietary technology of the machine supplier or power plant owner, it encourages the power plant owner or machine producer to keep it secret for maintaining its advancement in power generating process and their own system reliable.

In conclusion, even though the performance real – time monitoring and simulation has an enormous potential to achieve and feasible technology is existing, every player in Electricity business crucially needs to corporate sincerely just like supply – chain business management, everybody in the supply – chain is encouraged to improve its own performance with low inventory by sharing its information.
Exhibit 1 Performance Calculation and simulation Architecture in combine cycle power plant

INFORMATION BUS (ETHERNET TCP/IP) connected to SCADA network

Interface Computer

Performance Calculation and simulation Server

Computer Transfer unit

SCSI

Power Plant Process Network

Termination

Power Plant Process Network

Termination

Power Plant Process Network
Exhibit 2 ABB Power Cycle (Online Performance Calculation and Simulation from ABB)
Exhibit 3 GE Gate Cycle (Online Performance Calculation and Simulation from GE)
♦ Annotated Reference

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