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# The Development of Dispatcher Training Simulator in a Thermal Energy Generation System

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**Abstract**. A dispatcher training simulator (DTS) is a real-time Human Machine Interface (HMI)-based control tool that is able to visualize industrial control system processes. The present study was aimed at developing a simulator tool for boilers in a thermal power station. The DTS prototype was designed using technical data of thermal power station boilers in Indonesia. It was then designed and implemented in Wonderware Intouch 10. The resulting simulator came with component drawing, animation, control display, alarm system, real-time trend, historical trend. This application used 26 tagnames and was equipped with a security system. The test showed that the principles of real-time control worked well. It is expected that this research could significantly contribute to the development of thermal power station, particularly in terms of its application as a training simulator for beginning dispatchers.

## 1. Introduction

A SCADA (Supervisory Control and Data Acquisition) system supervises and controls a system from a remote control system. In practice, a SCADA system is an industrial control system consisting of HMI (Human Machine Interface), computer system monitoring, data acquisition and processing, and sophisticated visualization that can be viewed from different angles. A SCADA system works by acquiring data from a plant, which are in turn sent to the control center. The data contains status information of the equipment's monitored by the SCADA system. Therefore, in a complex industrial system, the SCADA system becomes a necessity to facilitate the operators or technicians in performing maintenance and automation process [1].

In a thermal power station, the SCADA system is used to perform various processes at the power plant. The SCADA system functions as a tool monitor, real-time data recorder, and control of power plant equipments [2]. One of important components of a thermal power plant that can be control by the SCADA system is the boiler. A boiler generates high-pressure steam used to drive turbines. The turbine rotation is converted into a mechanical energy, which is in turn converted into electrical energy by a generator. It is necessary to control the boiler so as to facilitate the operating system of the power plant and reduce human intervention. Thus, the SCADA system needs developing [3]. One of software systems that can support the SCADA system is a third-party software like Wonderware Intouch [4].

This research describes a dispatcher training simulator (DTS) prototype in a thermal energy generation system, particularly in a boiler control system. The software used to visualize the energy flow was Wonderware Intouch [5]. The resulting tool in this study was still a prototype that could be used as a training tool for the entry-level dispatchers. These dispatchers need training using a virtual SCADA system simulator so that they can avoid making operational errors once they are employed in real work situation.

## 2. Method

The research procedure is illustrated in Figure 1.

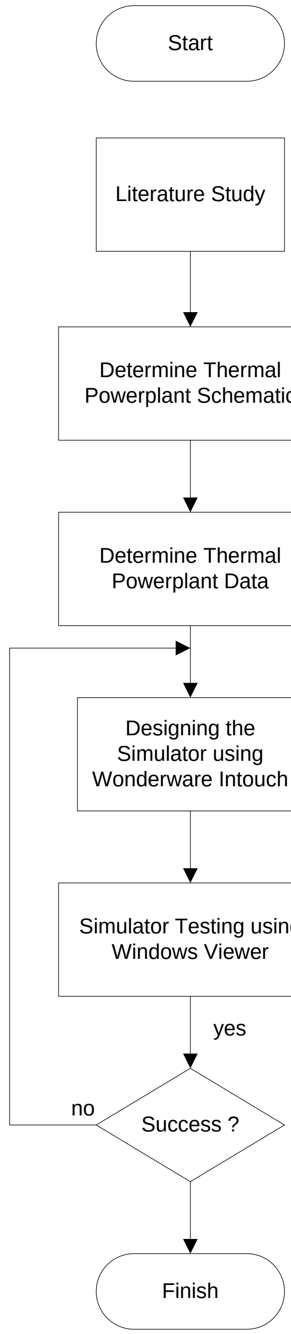


**Figure 1.** Research procedure

As illustrated in Figure 1, the first stage was reviewing literature from reliable sources such as the international journal of the Institute of Electrical and Electronics Engineers (IEEE), books, and articles on the SCADA system and thermal power station. The second stage was determining the generation

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schematic of the thermal power station to be used as reference for designing the simulator. The third stage was determining the technical data and reports from the Cirebon Thermal Power Station to set up the parameter for every object in the simulator [6].

The fourth stage was designing the simulator of the Cirebon Thermal Power Station SCADA system using Wonderware Intouch. It began with creating a generation flow with reference to the generation schematic. The next steps were adding tagname and inserting animation links into every object in the simulator, creating real-time and historical trends to display graphs of past events occurring in a particular time period, and creating alarm and security systems.

The fifth stage was simulation and trials of the security system, generation flow, real-time trend, historical trend, and alarm system. When there was any malfunction, the procedure went back to the fourth stage to redesign the simulator so as to meet the desired results.

This study used various software such as Microsoft Visio used to create the research flowchart, CorelDraw and Photoshop, used to draw objects not found in the factory symbol in Wonderware Intouch, and Microsoft Access used to store the database of simulating design of the thermal power station SCADA system.

### *2.1. Factors controlled in the SCADA system*

A control system is the most important component to control and supervise a power plant when operating. Prior to design making, the first thing to be done is understanding the conceptual design of the boiler at the Cirebon Thermal Power Station. There are three parameters in the boiler SCADA system that need paying attention to; they are as follows:

*2.1.1. Pressure.* The water pressure affects the resulting steam. The data shows that the boiler at the Cirebon Thermal Power Station is capable of producing steam as much as 2100 tons per hour. To produce steam, the pressure of water passing through the pipes in the boiler should be raised. There are seven types of pipes in the boiler the water should pass through as follows:

a. Economizer: Economizer is the first pipe to be traversed by water. However, the water entering the pipe economizer is already high pressure it has been heated using residual heat generated by the exhaust gas.
b. Furnace: This is the second pipe located in the boiler's combustion chamber. As a result of combustion process, the water turns into steam in this pipe.
c. Separator: It is a tubular drum that separates steam from condensed water.
d. LT SH (Low Temperature Super Heater): LTSH pipe is the fourth pipe. At this stage, the water has been converted into steam, yet still in low pressure.
e. SH (DIV. PANEL): It consists of several small heating pipes.
f. FSH (Final Super Heater): This is where the work steam is generated. The pressure in this pipe is 246 kg/cm$^2$. At this stage, the steam is channeled into the high-pressure (HP) turbine blades that are coupled with the intermediate-pressure (IP) turbine blades.
*g.* Reheater: It is to reheat the the residual steam that experiences a decrease in pressure and temperature in the HP turbine. The reheated steam is reused to drive the IP turbine blades. The IP turbine drives the low-pressure (LP) turbine A and LP turbine B whose axes are connected to the generator.

*2.1.2. Temperature.* The temperature that should be controlled is the temperature of economizer, furnace wall, LT SH, SH (DIV. Panel), reheater, and Final SHTable 1 shows the pressure and temperature noted from the Cirebon Thermal Power Station.

**Table 1.** Pressure and temperature of pipes

| No. | Component | *Pressure* ($kg/cm^2$) | *Temperature* (°C) | Water (t/hr) |
|---|---|---|---|---|
| 1 | Economizer | 305 | 358 | - |
| 2 | Furnace | 274 | 414.3 | - |
| 3 | Low Temperature Super Heater | 265 | 482.4 | - |
| 4 | SH (DIV. PANEL) | 258 | 529.6 | - |
| 5 | Final Super Heater | 246 | 569 | - |
| 6 | Reheater | 50 | 569 | - |
| 7 | Feedwater Economizer Inlet Flow | - | - | 440 |

*2.1.3. Steam Flow.* As shown in Figure 2, it is necessary to visualize the steam generation process because the visualization can facilitate our understanding about the conversion process from water into steam.

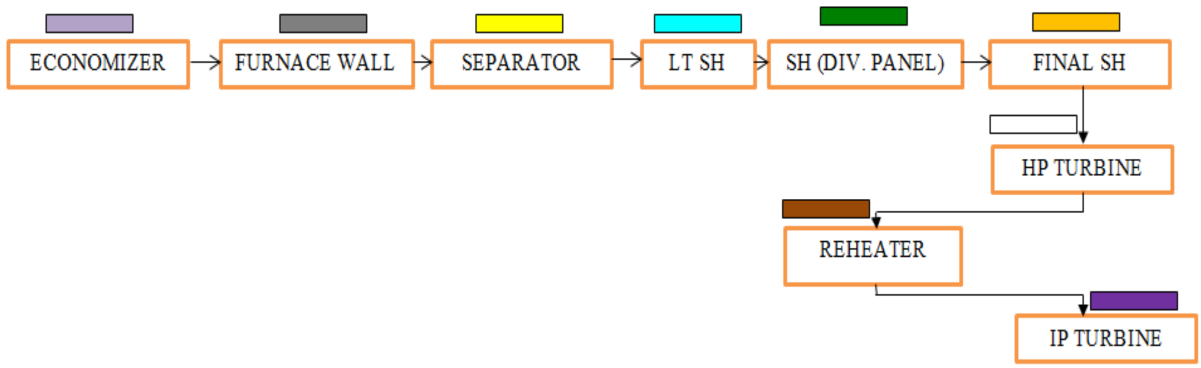


**Figure 2.** The steam flow at the Cirebon Thermal Power Station

## 3. System designing

The next discussion is on the steps of the boiler's SCADA system designing at the Cirebon Thermal Power Station using Wonderware Intouch. 2007. These steps are as follows:

### *3.1. Creating the template maker*

Creating the template maker is the first step in the SCADA system designing [7]. Its function is to classify component types as shown in Figure 3.

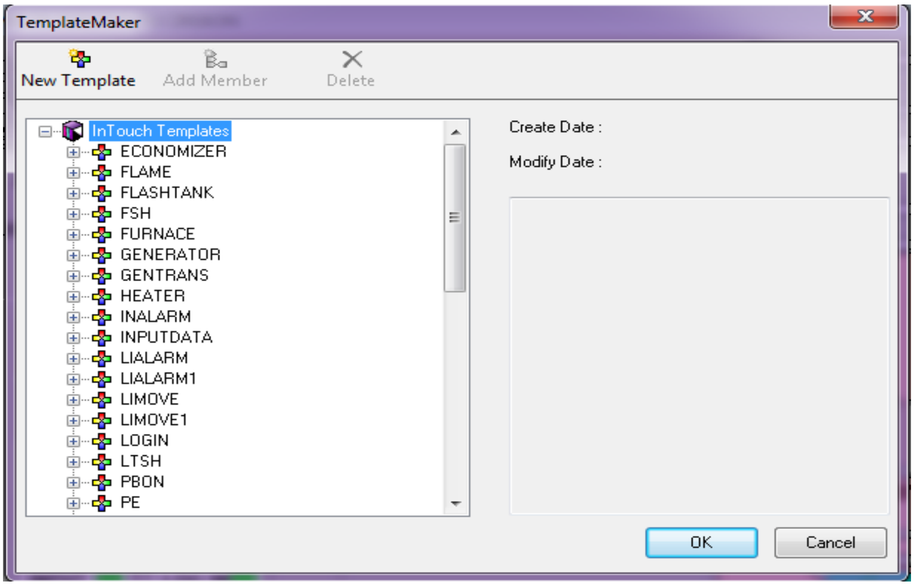


**Figure 3.** Template maker display

This tool is equipped with "add member" feature. This feature is to add names of components to be classified. Take the components of turbine for an example. There are four types of components including HP (High Pressure), IP (Intermediate Pressure), LPA (Low Pressure A), and LPB (Low Pressure B). And discrete refers to the tag types. The details are shown in Figure 4.

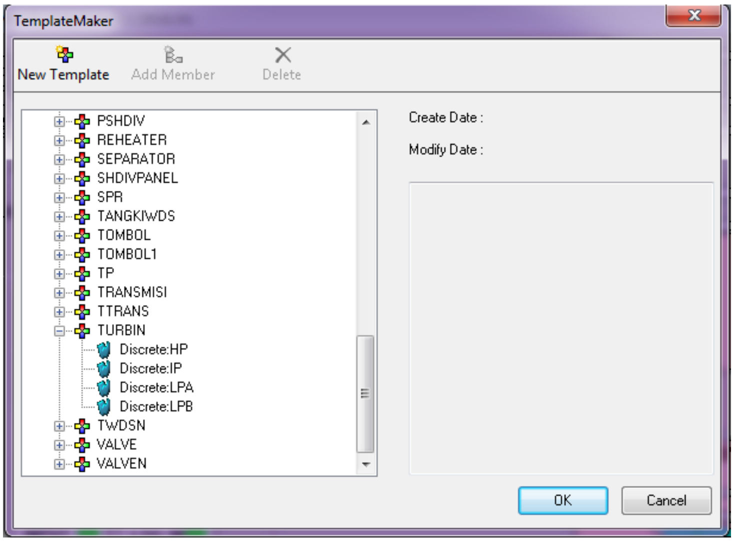


**Figure 4.** Add Member Feature

### *3.2. Creating tagname dictionary*

The second step is arranging tagname dictionary. This tool is used to add identity to each component for easy recognition when inserting animation scripts [8].

### *3.3. Creating animation link*

The third step is creating animation link. This tool is used to give effect to components that have been given a tagname.

### *3.4. Creating real-time trend.*

The next step is creating real-time trend. This tool is to check the status of system when operating. In this tool, there are parameters set up with reference to the datasheet from the Cirebon Thermal Power Station. There are 13 parameters in this tool. They are the parameters of pressure and temperature of economizer, furnace, Low Temperature Super Heater, Super Heater DIV. Panel, Final Super Heater, Reheater, and Feedwater economizer inlet flow.

### *3.5. Creating historical trend*
The next step is creating historical trend. This tool serves as a system past activity recorder [9]. This tool also could monitor the system performance so that every component's life time could be projected. Due to the software limitations, the writers only include 8 parameters in this tool.

### *3.6. Creating real-time alarm.*
The seventh step is creating real-tine trend alarm. This tool is very important to provide information and a warning when the system malfunctions.

### *3.7. Creating security system*
This tool is designed to preseve the right to access so that not every one can access the system. This is done by clicking "Special" on the window maker, then "Security", then "Select security type", and then "InTouch". The details are shown in Figure 5.

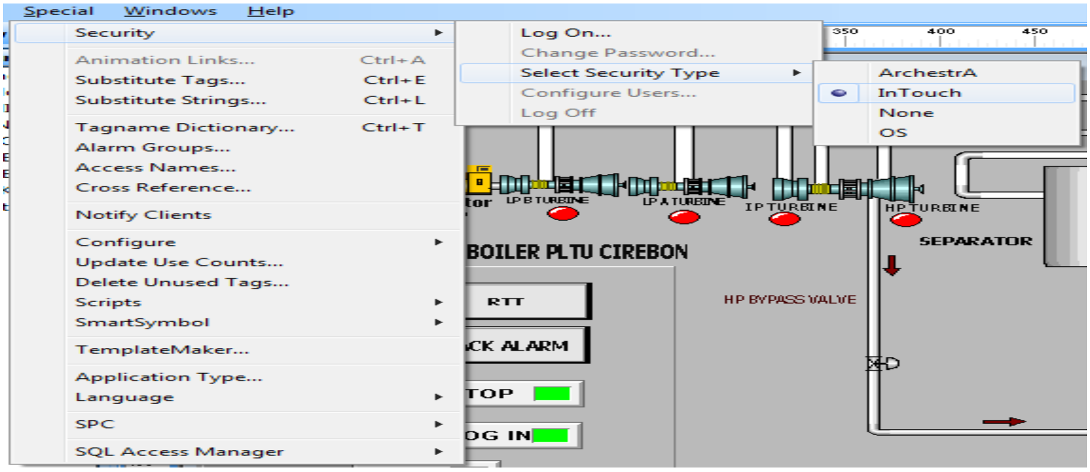

**Figure 5.** Initial phase in creating Security System

And then go back to "Special", then click "Security", and click "Log On". A widow as shown by Figure 6 will appear.

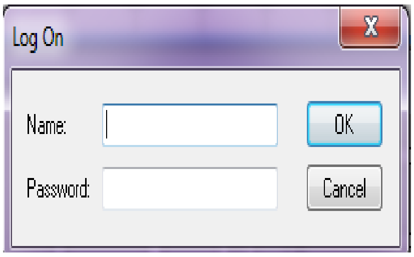

**Figure 6.** Log On Display

Afterward, enter a desired name and password. The access will be restricted to a registered account. Full visualization of SCADA system of Cirebon steam power plant operation using Wonderware In Touch software can be seen in figure 7.

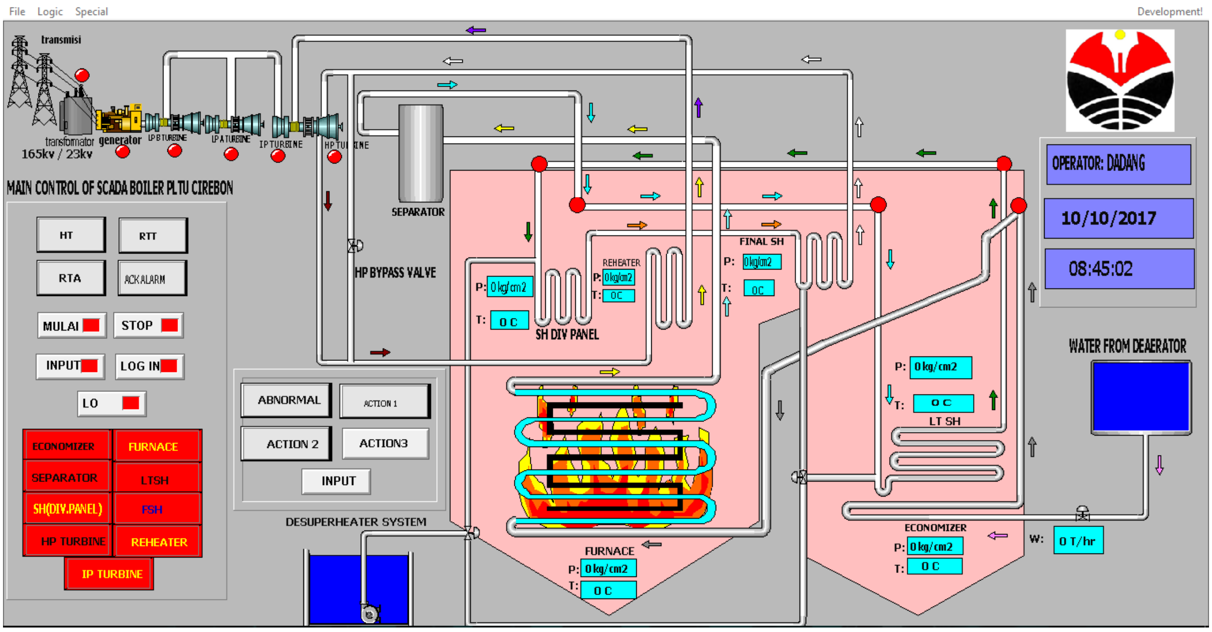


**Figure 7.** Visualization of SCADA system of Cirebon steam power plant operation using Wonderware In Touch

## 4. Conclusion

The development of Dispatcher Training Simulator in the Thermal Energy Generation using Wonderware Intouch could work well and could run the functions of thermal energy generation system virtually.

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