Chapter 1 Introduction

1.1 Introduction

Any industrial plants consist of so many machines and equipment, which are operated to change raw materials into final products. The way to change the raw materials into final product can be called an industrial process. In order to achieve the objective of any business, which is making a profit, the industrial process has to manage on the right and best possible way to keep the results into the target. What does it mean? It does mean that the industrial process has to be controlled, monitored and responded to any changes to achieve the best result of the industrial process. This shall be done by a control system.

Control system is a way to manage all machines and equipment in an industrial plant to do the activities to transform raw materials into final products. In the old day, the control system for any industrial processes was done by manual control concept. At that time solid state devices and electrical magnetic contacts were applied to perform the control system, which can be called conventional control system. Cabling technique was used to perform this conventional control system, based on direct hard-wired technique.

Because the conventional control system consists of a lot of solid state devices, electrical magnetic contacts and a huge number of cables for connecting the entire control system, it is difficult to build and hard to modify. Moreover, it takes a long time to perform the control function. However, nobody doubts about its reliability and availability, because the conventional control system a robust and physical system and can be used until the end of plant lifetime without any fatal failure.

Rapid development of electronic and computer technologies in the past ten years has caused the prices of the electronic and computer equipment to decrease rapidly, while the capabilities and performance increase. The application of electronic and computer technologies were applied to the control system to replace the conventional technique. It changes the design concept of the control system for any industrial plants. The impact of the application of electronic and computer technologies in the control system results in decreasing of erection cost, installation complexity of control equipment, labor cost and erection schedule.

The operation of a power plant is the same as any industrial plants. It needs a control system to control, monitor and manage its process to change the raw material which is fuel resource such as oil, gas, coal, hydro, wind, wave or nuclear into the final product which is electricity. The concepts, which are most relevant in the control system of the power plant, are reliability and availability. The quality of the electricity, which is the final product of the power plant, depends on its reliability and pricing. So the reliability concepts shall be strongly considered during the engineering stage of any power plant projects.

1.2 Background History

Electricity is a basic energy resource for every industrials and businesses. The quality of the electricity depends on its reliability and pricing. The reliability of the electricity can be claimed that every time you turn on your electrical equipment, you will have it at the same standard of frequency and voltage (50 Hertz for the frequency and 220 Volts for the voltage in Thailand). For the pricing of the electricity, it depends on Thai Government policy. By the law of the Kingdom of Thailand, the Electricity Generating Authority of Thailand (EGAT) is only one organization who has an authority to do the power business in this country. However, the privatization policy has a strong trend to apply to the power business in Thailand. Anyway the electricity price is under controllable of Thai Government.

The reliability of the electricity depends on the power plant reliability. Power plant composes of so many mechanical, electrical, and control & instrument equipment. In order to achieve the highest reliability of the power plant, designed engineers have to design every system of the power plant on the highest reliability basis. Along the past ten years, the electricity demand of Thailand was increasing rapidly. The reserve of the electricity of the country along the past ten years was on the critical situation, which was less than 15% of the overall installed capacity. What does it mean? It means that if we loose one power plant in EGAT power system, some area of Thailand will have not the electricity.

Hence along the past ten years, the design engineers of EGAT who have a responsibility to design the new power plant must consider on the reliability and availability basis during their design. The control system is only a part of the whole power plant system. Anyway, it can be claimed that it's a heart of the power plant.

Power plant consists of mechanical equipment (such as piping, valve, pump, fan, boiler, turbine, etc.), electrical equipment (such as transformer, switch-gear, motor, etc.), and control & instrumentation equipment (such as field instruments, final control elements, distributed control and information system, programmable logic controller, etc). All of this equipment is constructed under the plant building. In order to manage all equipment to generate the electricity, it must be controlled by the control system.

Today power plant is controlled by automatic control equipment. This automatic control equipment is a Distributed Control and Information System (DCIS) plays this important role. The DCIS of the power plant is also designed based on the reliability basis in order to keep the highest reliability and availability of the power plant operation.

DCIS can be claimed to be the heart of the power plant. Because all activities in every process of power plant are monitored and controlled by DCIS. If we loose DCIS, it does mean that we loose the power plant. **So that DCIS is the critical equipment for the designing and engineering work for the power plant project.**

The Field of Engineering for power plant of EGAT has so many parts such as Civil, Mechanical, Process, Electrical and Control & Instrumentation (C&I). C&I is one important part of EGAT's power plant design & engineering. The most important concept of power plant design & engineering work of EGAT, is the reliability of power plant. Because the quality of EGAT power business depends on one important key that is reliability of EGAT's power system as I explain in the previous paragraph.

Reliability of power plant depends on so many factors. The reliability of C&I equipment is also concerned many factors. DCIS is a main C&I equipment for power plant. DCIS can be claim that it's a heart of power plant operation. Because every activities in the entire process of power plant are controlled by DCIS. If we loose DCIS, it does mean that we loose power plant operation.

Nowadays EGAT's new power plant projects are turnkey contracts. EGAT provides only the design engineering concepts of every system to the contractor. The design engineering concepts of EGAT are specified in a bidding document (sometime called conceptual design), which has all engineering details of every system including the commercial part of the power project. Although EGAT has these documents, the contractor who wins the bid of a new power project of EGAT still has so many problems. Some contractors try to escape from EGAT's technical specification, some try to follow but still have some conflicts during the engineering stage. The design of DCIS configuration is an area in EGAT's technical specification that conflict always occurs between EGAT's C&I engineer and the contractor who win the bid.

1.3 Statement of Problem

The subject of this thesis is the development of **Criteria for Configuration Design of a Distributed Control and Information System (DCIS) for Power Plant in Terms of Reliability.** In today engineering work for the new power plant of EGAT, we specified our technical specification of the Control and Information System in EGAT's Technical Specification, which was attached in the contract that EGAT made with the contractor who get the turnkey contract of power plant from EGAT.

Normally, the engineering project and construction projects for the new power plant of EGAT almost are **turnkey contract**. EGAT's engineer has a responsibility to supervise the contractor who gets the contract of the new power project from EGAT and keep them to follow EGAT's Technical Specification.

For the Control and Instrumentation (C&I) System, it's a part of power plant. EGAT's Technical Specification is also specified in the technical specification for the Control and Instrumentation System. DCIS is the control equipment, which is in a scope of Control and Instrumentation System. The important part of the technical specification for DCIS is the Configuration of the DCIS system.

Generally, DCIS is composed of four major parts, which are Human Machine Interface, Network Communication, Controller and Its Field Equipment. The controller of DCIS is the heart of the system. The basic idea of any DCIS system is a distribution of the controllers of its system. All major process or mechanical equipment, which are controlled by DCIS, is distributed its software dedicate into these controllers.

Normally, EGAT never specify the number of the DCIS controller in the Technical Specification. In EGAT's technical specification, we mention only the guideline and scope of work that the DCIS vendors have to follow. EGAT specified in the Technical Specification that how to assign the task and its allocation of the controller of DCIS system, the important key of EGAT's technical specification of this part is the system reliability and availability. This part of C&I Engineering Work always has the problem for the DCIS system allocation. This is always a gray area for any contractor.

EGAT always has a number of controllers in their mind; the contractors who get the power plant project from EGAT have a different figure. This number is always a conflict between EGAT's engineer and the contractor.

Hence, this research tries to develop a good tool for EGAT's Control & Instrumentation (C&I) Engineer. The C&I engineer can used the results from this research to develop a **Criteria for Configuration Design of a DCIS for Power Plant in the Terms of Reliability.**

1.4 Objectives of Research

The main objective of this research is to develop **Criteria for Configuration Design of a DCIS for Power Plant in Terms of Reliability.**

The main objective can be expanded as follow:

1. **To identify the problems of controller allocation for DCIS.**
2. **To study the capability of the DCIS from 3 major vendors who snpply the DCIS for EGAT power projects in terms of system reliability.**
3. **To develop Criteria for Configuration Design of a DCIS for Power Plant in Terms of Reliability.**

1.5 Scope of Research

1. Only the case of oil-fired Krabi power plant will be considered.
2. The research will be confined to the partitioning of DCIS's controllers within the configuration design.

1.6 Methodology

The approaches to be used for this research are as follow:

1. Compiling and analyzing of the updated technology of DCIS vendors, which are accepted by EGAT, especially the lifetime and reliability test information of these DCIS equipment.

2. Gathering of power plant engineering information from world leader engineering consultant companies who have worked for EGAT and use them as a basic concept for this research.

3. Take into consideration the opinion of operators and maintenance staffs of the power plant of EGAT in order to get some more data and recommendation from the real case for this research.

4. Compiling information from the documents and publication (journals and magazines) related to reliability of the DCIS configuration, which are used as a reference for this study.

5. Make use of fundamental aspects of the reliability theory to analyze the system.

6. Analysis of postulated failures of DCIS, in order to ensure the reliability of the result of DCIS configuration.

7. Develop appropriate criteria for DCIS configuration design.

1.7 Expected Benefit

The Criteria for Configuration Design of a Distributed Control and Information System (DCIS) for Krabi Thermal Power Plant in terms of Reliability that could be used as a tool for C&I engineers to perform the control system engineering work for any new power plant project.