Chapter 6

Conclusion, Discussion and Recommendation

6.1 Conclusion of the Thesis Research

This Chapter has an intention to do a conclusion, discussion and recommendation for this thesis research. The problem, which is an initiate idea to do this thesis research, is the problem of the partitioning of the DCIS controller. The partitioning of the DCIS controller is a part of the DCIS configuration design. The DCIS configuration composes of the human machine interface, communication network, controller, input / output part and data logging devices. This thesis research considers to the controller area where the problem occurs. The reliability plays important role for the study area of this thesis research.

The reliability modeling for system prediction is the reliability analysis theory, which is used to measure and predict the system reliability of the DCIS configuration. The study concentrates to the consideration of controller allocation. The problem of controller allocation, process allocation, controller partitioning are identified and measured the reliability of each case of problem by using the reliability modeling for system prediction technique in order to find a good fit result for the DCIS configuration.

The problem of DCIS configuration which base on reliability in this thesis research is the problem between the contractor who does the DCIS for EGAT and EGAT engineers who do the design concepts of the DCIS configuration for power plant control system. The major problem is the different number of the DCIS controller, which is used to perform the entire DCIS between EGAT engineers and the contractor. The reliability modeling for system prediction is used to ensure the way to do the DCIS configuration and find the good fit configuration for both parties.

From the result of the analysis of the case study in Chapter 4, it indicated that the way to distribute the software control into many DCIS controllers causes the decreasing of the DCIS system reliability. However, even the using of the small amount of DCIS controller can increase the DCIS system reliability, it may causes a wide failure area in power plant process control when the controller failure occurs. Hence, the design engineers must consider and evaluate their design between the high reliability of the DCIS controller and consequence of failure if the DCIS controller fails its operation.

The believe among the design engineers about the support reason that the way to distribute power plant process control tasks into many DCIS controllers can increase the system reliability, it should be changed to increase the availability of the power plant operation. From the result of the study, the way to implement the control software may also cause a wide failure area even it can increase the system reliability of the DCIS controller. The design engineers must consider and evaluate that what do they want?

The design criteria of the DCIS configuration, which is performed in this thesis research, is a guideline for the design engineers to do their evaluation between the system reliability of the DCIS controller which is used to implement the control software and the power plant process operation. Some impacts, which are not reliability factors, are concerned to the design criteria of the DCIS configuration because it has an effect to the performing of DCIS configuration.

These impacts are the capability of the DCIS controller, the concept of the partitioning of the DCIS controller, the concept of dual design equipment, the concept of standby equipment, the concept of the control system hierarchy, the concept of the plant protection system, the interfacing to other system, the safety factor which is used to limit the usage of DCIS controller capability and the response time of control software which is implemented into the individual DCIS controller.

The criteria for configuration design of a DCIS system for power plant in terms of reliability can be listed as follow:

6.1.1. The system reliability of each drop of DCIS controller shall not be less than 0.95.

6.1.2. The redundancy of the power supply module shall be provided.

6.1.3. The redundancy of the network communication module shall be provided.

6.1.4. The redundancy of the processor module shall be provided.

6.1.5 The partitioning of DCIS controller for the power plant control system shall be done based on the following design concept:

- **The control software of main equipment that may cause a single failure trip to the power plant operation must be implemented into a different DCIS controller.**
- **The control software of the same power plant process shall be grouped into the same DCIS controller as many as possible.**
- **The opened-loop control and closed-loop control of the same power plant process shall be implemented into the same DCIS controller.**
- **In the case of power plant process control that may be used only 1 DCIS controller is enough, at least 2 DCIS controllers shall be provided for each major power process control in order to support the dual design and standby concepts for the main equipment.**

6.1.6 The MTTR of the DCIS Controller and its peripheral devices shall not be more than 30 minutes

6.1.7 The safety factor of the software implementation into the each individual DCIS controller shall be not exceed 60% of its capacity.

6.1.8 The DCIS controller for the interfacing signal shall be provided at least one set of the DCIS controller and its peripheral devices with the redundancy application.

6.1.9 The DCIS controller for the plant protection concept shall be provided in three sets of the DCIS controllers and its peripheral devices with the redundancy application.

6.1.10 The DCIS controller for the off-line modification work and maintenance purposes shall be provided at least one complete set of the DCIS controller and its peripheral device with redundancy application.

Anyway, this design criteria still has some limitations, because "EGAT can not specify the exact DCIS vendors into the bidding document" and "EGAT doesn't own their power plant process technology". Both limitations are external factors, which affect on the criteria of the DCIS configuration design. Therefore, we can not do the exactly right estimation of the amount of the DCIS controller and the specific power plant process. However, the way to do the system reliability prediction and analysis in Chapter 4 can be used to evaluate the good fit reliability and the practical amount of the DCIS controller for the DCIS configuration.

6.2 Discussion

In the real situation of the working place in the Engineering Business Unit of EGAT, the engineering staffs of EGAT were familiar with the word "reliability". But actually, they had very little knowledge about the reliability technique. Generally, every DCIS vendors implemented the redundancy concept into an important part of their DCIS products to increase the system reliability. Hence, the engineering staffs who have a long experience with the performing of the entire DCIS knew very well about the application of redundancy. However, only some engineering staffs of the Engineering Business Unit knew about how redundancy technique can increase the system reliability and how to measure the system reliability of the considered system.

The MTBF and MTTR have been used for a long time in every power plant project of EGAT. It was asked from many contractors who provided the DCIS for EGAT by the consultant that EGAT hired for the supervision activities of the engineering work for the power plant project. The consultant of EGAT is the world leader engineering firm from European Country or the United State of America. They used both mean times during the evaluation of the bidding period. Anyway, no technologies transfer from these engineering firms to the engineering staff of EGAT about how to use of these mean times.

From the course of the reliability and maintainability module of the Regional Centre for Manufacturing Systems Engineering of the Faculty of Engineering of Chulalongkorn University, there was some comments about the using of MTBF and MTTR that both mean times were calculated from the statistical method and gave us the statistical mean times[18]. Hence, the use of MTBF and MTTR told us nothing about the failure of any components or parts in a system. We never knew that when the failure will occur. We knew only the chance that the failure may be occur. This is a weak point of MTBF and MTTR usage.

The study in this course told us that the system reliability could be improved if we knew the failure rate of the each component and parts, which were used to perform the entire system. By using the failure rate, we can predict the lifetime of the components and parts more accurately. So, the system reliability could be designed to meet the minimum reliability requirement.

Moreover, the reliability program consists of so many activities. The reliability program must be treated along the system life cycle as shown in figure 4.11. in Chapter 4. The using of MTBF and MTTR could tell us about the system reliability prediction at the beginning stage, which is a design concept. **Paul Kales** used reliability modeling for system prediction technique to analyze the system reliability by using both MTBF and failure rate to calculate the system reliability [2].

If we need to improve the overall system reliability of the power plant in order to increase the power plant availability, we can not do the improvement only in the DCIS area. We have to improve the reliability for the whole power plant process. Moreover, we can not do it only at the beginning of the design concept but we have to do it along the whole life cycle of power plant. It has a huge work to do the reliability activities. It takes time and needs skilled persons to do this improvement. Anyway, we have to compare between the reliability improvement and the loose of time and costs during the downtime of the plant operation because of poor reliability.

6.3 Recommendation

6.3.1 MTBF of the DCIS controller and the lifetime of DCIS controller and its peripheral devices

When we look over the MTBF of the case study, this value comes from the DCIS vendors who provide the DCIS systems. The way to calculate MTBF is used the statistical method. Hence, the MTBF does not tell us when the failure of the DCIS will occur. MTBF is the information that EGAT design engineers always ask to the DCIS vendors during the evaluation period of the DCIS. But design engineers of EGAT do not really understand what the MTBF could tell them about the reliability of the DCIS? Anyway, from the result of analysis in Chapter 4, the MTBF can be used to predict of the system reliability of the DCIS configuration, which we consider.

The recommendation is that design engineer should consider to the lifetime of the design components, which will be used to perform the entire DCIS system in parallel with the using of MTBF. By using only MTBF we can do only the prediction of the system reliability. If we need to do any improvement of the reliability of the entire DCIS, we should consider the lifetime of each important component of the DCIS.

The lifetime will be created from the past failure data of the component, which we considered. By using the past failure data, the failure rate of the component can be calculated. Then by using the weibull analysis methodology and the failure rate of the component, the lifetime of the component can be predicted at the accurate and reliable point. The lifetime is more useful than MTBF because the lifetime is calculated from the real failure rate data.

Hence, the design engineer can use the lifetime value to improve their design better than only the using of MTBF. Normally, the design engineer of EGAT never considered the lifetime data of the DCIS and its peripheral components. Hence, it will be very useful if the lifetime value will be used to do the reliability improvement of the DCIS configuration design during the designing process of the DCIS in the future power plant project of EGAT.

6.3.2 Reliability Improvement Program

The study in this thesis research is only a part of reliability program. The reliability theory, which is used in this thesis research, is applied to ensure the reliability of the DCIS configuration for the DCIS controller area. If we need to do the improvement of the reliability for the whole DCIS system, it has some more works to do. Moreover, the improvement of the reliability of the whole DCIS system must consider along its life cycle.

From figure 4.11 in Chapter 4, if we need to improve the reliability of the system which we consider we have to treat reliability for the whole system life cycle. Start from system design, system acquisition, hardware manufacturer, plant integration and operation. For the research study, it indicates that EGAT has some application of reliability program, which is used during their design process. However, EGAT engineering staffs still have not enough experience and understanding about the reliability.

Hence, if EGAT need to do better improvement of the reliability, the reliability must be treated much more concentrates and should be treated along the system life cycle of the interesting system. Moreover, if EGAT should give much more knowledge about the reliability and maintainability to EGAT's engineering staffs. By this way EGAT can improve the quality of the people who must use the reliability and maintainability technique to improve their engineering work for the new power plant project.

In the new power plant project, EGAT should set a team to do the evaluation of the system reliability for the whole power plant process. It concerns a lot of activities to do. Anyway, if EGAT need to improve the way to manage their power business to complete with other international company, EGAT must treat the reliability program as an important part of engineering tasks to do the improvement for the new power plant project of EGAT. By this way, EGAT will have a reliable power plant that can provide the reliable electricity to support the electricity generation and transmission business of EGAT and can stay alive in the current the worst economic crisis which we never met in our history.