CHAPTER 4
THE PROPOSED QUALITY ASSURANCE SYSTEM

This chapter is intended to review the current design process of substation project execution in XYZ company. This includes to collect the past data of the previous projects. This data will be analyzed by using a systematic method called the Failure Mode and Effect Analysis (FMEA) .

4.1 The Analysis of the Current Substation Design Execution Processes

1.) Project Transfer

After Sales team receive the ordered project from customer, they will transfer the information to project manager . Then the Project Manager will inform all related parties including design department about the contract's award via the design manager. The design manager has to study the scope of work, technical requirement, delivery time and etc. before assign the design engineer to handle this project by considering workloads of design staffs as well as complexity of such project. The assigned engineer and design manager must attend the internal kick off meeting held by project manger after a period of time. Normally the project manager will request all related parties such as project staffs, design staff, civil staffs and etc. to attend the internal kick off meeting about one week after job assignment.

The purpose of the meeting is not only presentation of the project in general to Project Teams but also to reach mutual agreement on project schedule and allocation of responsibilities for the activities among all parties. The meeting will go through the following matters to ensure common understanding and reach agreement in scope, duration and budget of each work package:

Technical Aspect

- Scope of supplies
- Deviation List, if any
- Documents and drawings for submission
- Documents from customer

This means that the engineering work start in this stage, the main topic discussed is the contract review and clarify the scope of work. Normally, the engineering staff attend this meeting without the guideline or document to help them for checking which items should be clarified during meeting for example the main project schedule, preliminary design schedule, the customer meeting requirement, interfacing with civil work and etc.

2.) Design Planning

After attend the internal kick off meeting with the related parties, the design engineer together with the design department must find out the scope of delivery by studying deeply in detail through the document submitted during meeting below;

- Customer specification with drawing
- Additions/deductions form the specification
- Our offer with a list of deviation
- Letters, fax, meeting protocols
- The internal technical quotation
- Etc.

Actually, the design engineer will find out the scope of delivery by no guideline or check list to assure that all of items were clarified. If any items which is important to the delivery time or cost the project were neglect to clarified, the damage can be occur to the project later.

Then, it is important to prepare a filing system for all papers that has to be gathered. The design engineer should prepare the working file in order to be easy to manage the document such as correspondence to supplier and customer, project minute of meeting, design input and output, quotation from suppliers and etc.

After that a list of design document and drawings must be prepared including the schedule which will be submitted to customer for approval. The document and drawing prepared in each project must be identified by using the different number for each kind of document.

Nowadays, there is no standard to make a filing system, list of document and drawing and identification number in design department. It will be done by each individual and different way.

3.) Design Input

The stage of design input which will be described below are given as the general understanding of the design in process. Normally, there is no fixed scope between the stages which will be described but some of the documents are prepared during several of the stages.

During the stage of preliminary conceptual design, the scope of equipment supply and the function of substation is defined. These activities start during tendering work and are at that time sufficiently complete to create a basis for the tender and are later continued after award of contract. The preliminary conceptual design is based on design criteria and the customer's specification and the main activities including system studies and substation engineering work are result in as below;

- System study reports.
- Basic block diagrams.
- Preliminary layout drawings.
- Basic System diagram.

As one of the first activities during the preliminary conceptual design the scope and schedule of the system studies is defined. This is the task of the project team.

Design input data is crucial and influenced to design work directly, this means that the document control must be established to ensure whether the design input is enough for generate the design output. At the present, there is no the document control and process to review this information.

4.) Design Process

The design process stage is initiated by following the award of contract and based on the results from the preliminary concept design. Design engineer must study the customer requirement and all technical data related, this includes to study the equipment used in project. This means that there are sometimes meetings with customer and suppliers to discuss and clarify some technical matters. The master design of the design output results in the following documents;

- System study report
- Final technical provisions
- Preliminary outline drawings of equipment used as input to civil design foundations
- Plant documentation requirements
- Plant system diagram
- Lists of equipment

- Complete block diagram and drawings, such as measuring and protection scheme, alarm list and event recorder list

The detailed design includes detailed design of switchyard, switchgear, control equipment and building results in documents such as;

- Detailed layout drawings.
- Switchyard drawings
- Technical specifications of switchyard material
- List of apparatus
- Cabling concept
- Cable connection schedule
- Etc.

Design input data is crucial and influenced to design work and overall project performance because some document of design output must be submitted for customer approval before initiate the installation and construction. This means that the document control must be established to ensure whether the design out is generate from the design input and meet to the customer's specification. At the present, there is no the document control and process to review this stage.

5.) Design Review

The design review process is to review the design work at appropriate stage such as design progress, design document and drawing. Actually, the design review will be done by design manager or design supervisor only when the design output are going to be submitted to customer for approval. There is no standard method of review process, normally the visual check is most often used. This includes that there is no standard format and check list to help during review process. Most problems with this result are the delivery time to submit design drawing because there are many drawings used for different purpose and different period of project execution.

6.) Approval

This stage is to submit the design document and drawing for customer approval. Then they will return the approved document and drawing with comment (if any) to us for further process. After that the design engineer will check for customer comments and discrepancies.

7.) Distribution for end users

This stage is to distribute the approved document and drawing for end users. The end users normally are both internal and external staffs. For internal staff are site, commissioning, project staffs and etc. While the external parties may be civil subcontractors, suppliers, There are many purpose of such drawing as below;

- For manufacturing such as relay and control panel
- For construction such as cable trench, equipment foundation
- For installation such as switchgear, transformer
- For commissioning such as relay protection and control system, auxiliary supply

The distribution of document to the end users are not the same criteria, sometimes these drawing was sent directly from design department instead of project staffs.

The number copies of drawing and/or document are different for each user.

8.) Project Execution

The project execution is the stage of manufacturing, construction, erection and commissioning work.

The manufacturing work of some equipment can be start after the customer approve calculation, concept and/or detail design such as control and relay panels, transformer, medium voltage switchgear and etc.

The construction of civil work such as site preparation, building, foundation of equipment, cable trench and etc.

The erection of equipment can be started by following the lay-out drawing after the construction work finished. This

After all equipment are installed and cable work is finished, the commissioning of the individual equipment and whole system will be done in order to ensure the work will be operate completely without any problems.

9.) As built drawing

The drawing sent from design department both mechanical and electrical drawing for erection and commissioning work must be corrected again after complete work in order to up date according to the actual condition at site. The drawing with mark RED/GREEN for modification made during testing and commissioning from site will be corrected and submitted to the customer after complete work in order to finish the design work.

Normally, this stage is not much concerned carefully by design staffs. The drawing are often revised and sent to customer by no review and verified the affect to other document such as final material lists and catalogue, specification, related drawing, and etc. This includes to issue and distribute As built drawing and document to whom may concerned.

4.2 Feedback Information from the past projects

The feedback information from the past projects execution was collected during last three years starting from 1998 to 2000. However, it must be noted that the characteristic of each project was unique. Because there were various types of substations and also the different of the number of feeders within substation such as indoor or outdoor substation, types of control and protection system, location of substation, voltage level, types of customer, normal or automation system and etc. For example the utilities' substation has several feeders and also their complexity is higher than the industries' substations. This means that the project schedule of utilities substation in much higher than the industries substation. However, the information collected from such projects can be used as the picture for comparing how the proposed quality assurance of design work can improve the way to design the substation project.

The past project which we selected to collect to data consists of five substation projects are as below;

- ❑ IPCO I 115/22kV Outdoor substation, 6 feeders
- ❑ IPCO II 115/22kV Indoor substation, 8 feeders
- ❑ IPT 230/115kV Outdoor substation, 10 feeders
- ❑ Toray 115/22kV Outdoor substation, 4 feeders
- ❑ RAT 500/230kV Outdoor substation, 12 feeders

4.2.1 Time Schedule and Technical Aspect

The time schedule of substation design is separated into four parts as belows;

- Design Planning
- Primary circuit design
- Secondary circuit design
- Customer Approval
- As built

As discussed above, the time schedule of design work for one project cannot be used for another project. For this study, the planning time schedule before start the project by design manager and the actual time schedule after project was closed are used to compare together. These are shown in percentage (%) of delay time compare with planning time schedule as shown in **table 4.1**

	IPCO I	IPCO II	IPT	Toray	RAT	*Average*
Design planning	10%	4%	5%	2%	4%	5%
Primary circuit design	8%	5%	3%	3%	4%	5%
Secondary circuit design	12%	2%	4%	6%	5%	6%
Customer approval	2%	1%	2%	1%	2%	2%
As built	5%	4%	10%	8%	12%	8%

Table 4.1 Percentage of the over time for each design stage

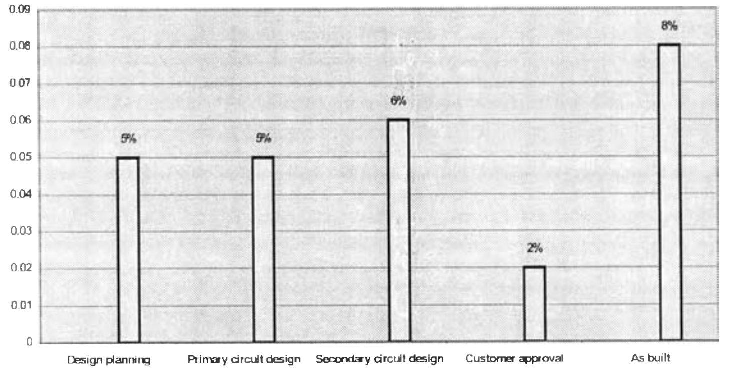

Figure 4.1 Average Percentage of over time for each design stage

For the technical aspect, the design changes occurred during design period will be used and discussed. The effect of design changes criteria can be separated into four groups as belows;

Major Effect Major effect on equipment and/or design process occurring after design stage

Moderate Effect Moderate effect on equipment and/or design process occurring during design stage

Minor Effect Minor effect on equipment and/or design process during conceptual design stage

No Effect No effect on equipment or subsequent design process

The effect of design changes are different depend on many factors such as when the design changes occurred and how such change affect to main equipment or system design. So the above criteria effect of design changes is used.

For this study, the number of design change will be recorded by considering the effect of such design changes according to the above criteria before fill it in the data sheet. **The table 4.2** are shown the design changes record for five projects before implement the quality assurance of design work.

	IPCO I	IPCO II	IPT	Toray	RAT	*Average*
Major Effect	8	2	6	4	4	*5*
Moderate Effect	10	6	8	6	9	*8*
Minor Effect	16	10	15	12	15	*14*
No Effect	28	21	26	18	32	*25*

Table 4.2 Number of design change records

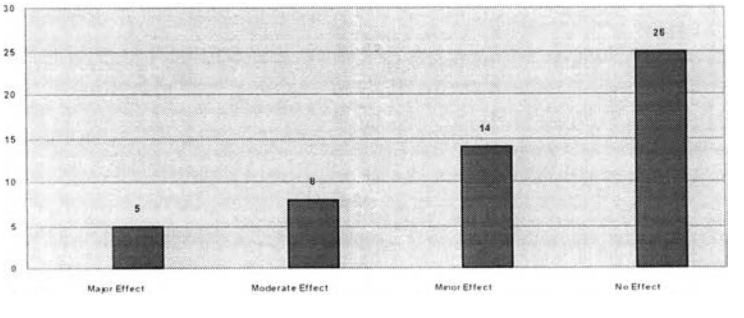

Figure 4.2 Average Number of design change records

4.2.2 Financial Aspect

The financial aspect for design work can be occurred in many cases, for example when design change, design mistake, design delay and etc. These effect can be an additional cost such as overtime payment, cost of re-work, cost of wrong ordered material, travelling cost, re-commissioning cost, and etc.

In this study, the financial aspect of design work can be classified into two groups as below;

1) Additional Man hours charge (% compare with the planning man hours for design work) which are overtime, re-design work, re-commissioning work, and administrative design work.

2) Material and other cost (% compare with booking order) which are the additional material cost, mobilized cost, paper cost (resubmitted drawing), and etc.

The percentage of the additional man hours charge and material and other cost for five projects are shown in **table 4.3** as below;

	IPCO I	IPCO II	IPT	Toray	RAT	*Average*
Man hours charge	32%	20%	15%	18%	16%	***20%***
Material and other cost	11%	3%	3%	4%	6%	***5%***

Table 4.3 Percentage of the additional man hours charge and material and other cost

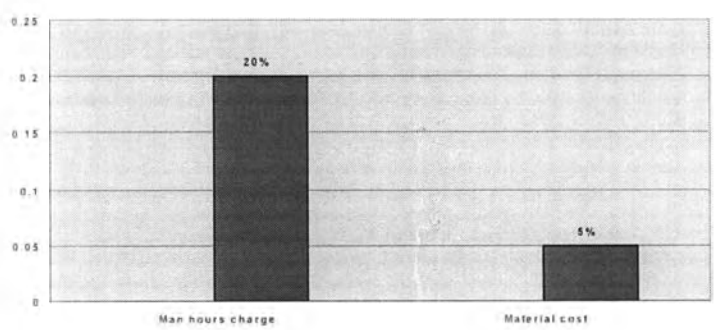

Figure 4.3 Average Percentage of the additional man hours charge and material and other cost

4.2.3 Project Case : Industrial Power Company (IPCO I & II) Project

This project located at the Eastern Industrial Seaboard in Map Ta Phut, Rayong Province in Hemaraj Area. IPCO is Small Power Producer (SPP) which sale electrical power and steam to both PEA and industrial customers locate near that area. This project was separated into 2 stages by the first stage started in March 1997 and delivered in February 1998. The second stage started in February 1998 and delivered in November 1998.

The first stage is the conventional substation (Outdoor Type) while the second stage is the Gas Insulated Substation (GIS, Indoor Type). The difference between these types is that the conventional need more area and spacing for installation while the GIS type can be installed in building with smaller area.

This substation is 115/22kV conventional type 6 feeders and GIS type 8 feeders

A. Time Schedule and Technical Aspect

The design schedule of this project was not tight according to the customer's contract, however, the customer's concept design (Single Line Diagram) has not finalized yet. Because IPCO must export the electrical power to their customer. The concept design of control and protection must be based on their customer requirement. For example, one of their customer is the Provincial Electricity Authority of Thailand (PEA) which has their criteria of control and protection system. Hence, the concept of control and protection was changed from the contract. This results that we must re-design (rework) and made the new relay and control panel to supply this customer which affect to delivery time of equipment and design schedule.

B. Financial Aspect

The final concept design was very delay in this project, then it affected to the detail design both primary and secondary circuit design. Moreover, the design changes occurred many times during design period. So it cause the design engineer to do overtime to complete design work. The additional cost was occurred due to the overtime payment and cost of reworking. This also the cost of traveling to modify at site.

C. Customer Aspect

Although the design schedule in this project was delay but the main reason is that the customer had many changes in their concept design. So the customer did not feel unhappy with the delay of design work.

4.3 Problem Analysis Using the FMEA

4.3.1 The FMEA Types Selection

The type of FMEA as stated earlier comprises of system, design, process, and service FMEA. The substation design execution in XYZ company has both design process function and design function. Hence, we select the process FMEA and design FMEA to apply in our company.

4.3.2 The FMEA Team Selection

An individual person cannot conduct the FMEA because the FMEA is a team function. This team must be conducted the FMEA as appropriate for a specific project and cannot serve as the FMEA company. So the FMEA team must be established to solve the problems in the substation design project. In order to meet a complete job with the best results, the number of design engineers selected to conduct the FMEA team is four persons. All of them has a good knowledge and intensive experiences in substation design work. These include some knowledge of working group, the project on hand and willingness to participate in FMEA team.

4.3.3 The Process of Conducting the FMEA

After the team has been identified, the process flowchart of the design processes of substation project execution in XYZ company shown in section 4.1 was used to explain and discuss in order to make sure that everyone in FMEA team understand the process including the problems associated with each process in the same way. Then the team must collect the data of the failures and classifies them appropriately. At this stage the team began to fill in the FMEA form as shown in Figure 2.4. (The failures identified are the failure modes of the FMEA)

Then the data of failures in each process were analyzed. The analysis method selected in this stage is brainstorming technique which everyone in team can share their own idea related to such problem. Information from this step will be used to fill in the columns of the FMEA form in relationship to the effects of the failure, existing controls, and discussing the estimation of severity, occurrence, and detection.

The estimation criteria of severity, occurrence, and detection are based on ranking 1 to 10 scale. Because this is widely used and easy to interpret and precise in the quantification of the ranking. After the value of the severity, occurrence, and detection were quantified by the FMEA team, then the priority of the problems is articulated via the RPN (Risk Priority Number). The RPN are the product of Severity (S), Occurrence (O), and Detection (D) ranking (RPN = (S) x (O) x (D)). This RPN will be used to rank order and measure risk of process and design of substation design execution only, there is no other value or meaning of the RPN.

The threshold of the pursuing failures or problems has been selected by the FMEA team which is based on the 90 percent confidence – 90 percent of all failure must be addressed for very critical process and design on the guideline scale of 1 to 10. Since the maximum number possible for the RPN is 1000 (10x10x10 from occurrence, severity, and detection), ninety percent of 1000 is 900. Then subtract 1000 –900 = 100. Therefore the threshold of examining the failures would be any values equal or greater than a 100 RPN. In other words, the RPN of problems which has the value greater than 100 must be addressed.

There are rules to address the problems (Stamatis, 1995:40) as follow. The problem with high RPN will be address first. If there are more than two failures with the same RPN, then first address the failure with high severity, and then detection. Severity is approached first because it deals with the effects of the failure. Detection is used over the occurrence because it is customer dependent, which is more important than just the frequencies of the failure.

Severity (S) Evaluation Criteria

Effect	Criteria	Ranking
Hazardous Effect	Hazardous effect. Safety-related-sudden failure. Noncompliance with government regulation.	10
Serious Effect	Potential hazardous effect. Able to stop product without mishap; safety-related; time-dependent failure. Disruption to subsequent process operations. Compliance with government regulation is in jeopardy.	9
Extreme Effect	Customer very dissatisfied. Extreme effect on process; equipment damaged. Product inoperable but safe. System inoperable.	8
Major Effect	Customer dissatisfied. Major effect on process; rework / repairs on part necessary. Product / Process performce severely affected but functionable and safe. Subsystem inoperable.	7
Significant Effect	Customer experiences discomfort. Product / Process performance degraded, but operable and safe. Nonvital part inoperable.	6
Moderate Effect	Customer experiences some dissatisfaction. Moderate effect on product / process performance. Fault on nonvital part requires repair.	5
Minor Effect	Customer experiences minor nuisance. Minor effect on product / process performance. Fault does not require repair. Nonvital fault always noticed	4
Slight Effect	Customer slightly annoyed. Slight effect on product or process performance. Nonvital fault noticed most of the time.	3
Very Slight Effect	Customer more likely will not notice the failure. Very slight effect on product / process performance. Nonvital fault noticed sometimes.	2
No Effect	No effect on product or subsequent processed.	1

Occurrence (O) Evaluation Criteria

Occurrence	Criteria	Ranking
Almost Certain	Failure almost certain. History of failures exists from previous or similar designs.	10
Very High	Very high number of failures likely.	9
High	High number of failure likely.	8
Moderately High	Frequent high number of failure likely.	7
Medium	Moderate number of failure likely.	6
Low	Occasional number of failure likely.	5
Slight	Few failure likely.	4
Very Slight	Very few failure likely.	3
Remote	Rare number of failure likely.	2
Almost Never	Failure likely. History snows no failures.	1

Detection (D) Evaluation Criteria

Occurrence	Criteria	Ranking
Almost Impossible	No known controls available to detect the failure	10
Remote	Remote likelihood current controls will detect the failure	9
Very Slight	Very slight likelihood current controls will detect the failure.	8
Slight	Slight likelihood current controls will detect the failure.	7
Low	Low likelihood current controls will detect the failure.	6
Medium	Medium likelihood current controls will detect the failure.	5
Moderately High	Moderately High likelihood current controls will detect the failure.	4
High	Good likelihood current controls will detect the failure.	3
Very High	Very high likelihood current controls will detect the failure.	2
Almost Certain	Current controls almost always will detect the failure. Reliable detection controls are known and used in similar processes.	1

Table 4.4 Evaluation Criteria Table for the Process FMEA

Severity (S) Evaluation Criteria

Effect	Criteria	Ranking
Hazardous without warning	Very high severity ranking when a potential failure mode affects safe Substation control operation and/or involves noncompliance with government regulation without warning.	10
Hazardous with warning	Very high severity ranking when a potential failure mode affects safe Substation control operation and/or involves noncompliance with government regulation with warning.	9
Very High	Substation control operation inoperable, with loss of primary function.	8
High	Substation control operation operable, but at reduced level of performance. Customer dissatisfied.	7
Moderate	Substation control operation operable, but comfort/convenience item)s) inoperable. Customer experiences discomfort.	6
Low	Substation control operation operable, but comfort/convenience item(s) operable at reduced level performance. Customer experiences some dissatisfaction.	5
Very Low	Small item does not conform. Defect noticed by most customers.	4
Minor	Small item does not conform. Defect noticed by average customer.	3
Very Minor	Small item does not conform. Defect noticed by discriminating customer.	2
None	No effect.	1

Occurrence (O) Evaluation Criteria

Occurrence	Criteria	Ranking
Very High : Failure is almost inevitable	>1 in 2	10
	1 in 3	9
High : Repeated failures	1 in 8	8
	1 in 20	7
Moderate : Occasional failure	1 in 80	6
	1 in 400	5
Low : Relatively few failures	1 in 2,000	4
	1 in 15,000	3
Remote : Failure is unlikely	1 in 150,000	2
	1 in 1,500,000	1

Detection (D) Evaluation Criteria

Detection	Criteria	Ranking
Absolute Uncertainty	Design control will not and/or can not detect a potential cause/mechanism and subsequent failure mode; or there is no design control.	10
Very Remote	Very remote chance the design control will detect a potential cause/mechanism and subsequent failure mode	9
Remote	Remote chance the design control will detect a potential cause/mechanism and subsequent failure mode	8
Very Low	Very low chance the design control will detect a potential cause/mechanism and subsequent failure mode	7
Low	Low chance the design control will detect a potential cause/mechanism and subsequent failure mode	6
Moderate	Moderate chance the design control will detect a potential cause/mechanism and subsequent failure mode	5
Moderately High	Moderately High chance the design control will detect a potential cause/mechanism and subsequent failure mode	4
High	High chance the design control will detect a potential cause/mechanism and subsequent failure mode	3
Very High	Very high chance the design control will detect a potential cause/mechanism and subsequent failure mode	2
Almost Certain	Design control will almost certainly detect a potential cause/mechanism and subsequent failure mode.	1

Table 4.5 Evaluation Criteria Table for the Design FMEA

4.3.4 Quantifying Severity, Occurrence, and Detection of Each Process

The FMEA team has quantified the severity, occurrence, and detection of each process of the substation design work based on the evaluation criteria table for both process and design FMEA shown on the table 4.4 and 4.5 . Since there are many failure modes in the twelve processes of the design substation execution, only two of them will be explained how the FMEA team could get the severity, occurrence, and detection value of the failure mode in the process being discussed. This is because the FMEA process to getting the S, O, and D values of the substation design project is the same.

(1) Design input with a Failure Mode: Insufficient design information.

The design input process is very important to initial the design work. There are many design input used to generate each design drawing, calculation and etc. The design output may be incorrect if there is no some information. Our company had an experience that when we design the sizing of stationary battery. Actually, the standard of calculation based on IEEE standard is spared by 20 percent. However the customer require spare by 30 percent because they have a plan to add future load. As a result, we must revise the previous design not only the stationery battery but also the sizing of battery charger and cable.

Therefore, the severity level is ranked to the score of 6 because the process is still operable and safe although its performance is degraded. Therefore, the occurrence is ranked to medium or score of 8. The detection is ranked to the score of 10 (almost impossible). As a result, the RPN score is equal to 6 x 8 x 10 = 480

(2) Design output with a Failure Mode: Design change from customer

The design change from customer is most often occurred during project execution in XYZ company. There are many reasons that customer inform us to change their concept design. Normally, we don't have any document to check the impact of such change. We usually accept them with lack of verify consequence of such change. We had an experience that the delivery time of the protective relay which customer need to change type required more delivery time than the previous one about 8 weeks. Our company could not install these relay and energize the electrical power to customer as specified in the contract. The consequence (potential effect) of this failure is that the customer feel very dissatisfaction and lost of money to export the electrical power to their customer. therefore, the severity of this failure mode is at Very High level and is ranked to the score of 8 because the substation is inoperable with loss of protection function.

Since the design staffs do not check carefully with the impact of design change from the customer which is occurred often including no check list and procedure to take when it re-occurring. Therefore the occurrence of this failure mode is ranked to high with the score of 8 and the detection of this failure mode is ranked to the score of 8. Then the result of these evaluate lead to the RPN score equal to 8 x 8 x 8 = 512, which is the highest RPN

4.3.5 Results of Conducting the FMEA

After the process of conducting the FMEA were done by FMEA team, the result of the discussion for the evaluation and quantification of the value of the Severity, Occurrence, and Detection of both the process and design FMEA are shown on the appendix III.

From the results of conducting the FMEA, the high-risk areas of the substation design execution which the value of RPN is greater than 100 will be shown on the table 4.6 below;
This table comprises of 20 items that the highest risk of potential failure mode is ***design change from customer*** **of the** ***design change process.***

Item	S/No.	Process	Potential Failure Mode	RPN
1	1.4	Internal KOM	Deviation between the invitation to Bid and the contract is not discussed	480
2	1.4	Internal KOM	Verbal commitments are not fully discussed	420
3	1.4	Internal KOM	Failure to check the customer data/document	480
4	2.1	Find out the scope of delivery	Failure to understand some items in the scope of delivery	400
5	2.2	Arrange filing system	Difficult to find out document	300
6	2.2	Arrange filing system	Loss of some document used in project	480
7	2.3	List of Doc./Dwg. for submission	List of doc./dwg. is not covered all customer required.	240
8	2.3	List of Doc./Dwg. for submission	Design schedule is not related to project schedule.	140
9	2.4	Prepare Design Quality Plan	Quality plan does not apply to the actual project.	300
10	3	Design Input	Insufficient design information	480
11	4	Perform the functions according to the customer's requirement.	Poor design	200
12	4	Perform the functions according to the customer's requirement.	Not fulfil the customer's requirement	210
13	4	Perform the functions according to the customer's requirement.	Design work is based on wrong standard	150
14	4	Perform the functions according to the customer's requirement.	Design work is delay to submit	168
15	5	Design review and verification	Failure to check the design output meet the Design input	336
16	6	Design Change	Design change from customer	512
17	7.2	Approval	Failure to check the revised Doc./Dwg.	150
18	8	Distribution for end users	Incorrect to stamp the purpose of Doc./Dwg.	120
19	11.1	As built Doc./Dwg. preparation	Failure to revise as the red/green marks	288
20	12	Feedback Design Result	Cannot keep this information to use in the future project.	200

Table 4.6 High Potential Failure Mode Area of Substation Design Execution

Then the recommended actions are established and recorded into the process and design FMEA which the RPN is greater than 100 by discussion within the FMEA team.

The table 4.7 show the document control and working manual required in order to prevent errors occurred to the design execution. All document are shown the detail in the appendix IV

Item	S/No.	Process	Process	RPN
1	1.4	Internal KOM check list (D1)	Internal KOM	480
2	2.1	Design planning check list (D2)	Find out the scope of delivery	400
3	2.2	Design Working Manual 01	Arrange filing system	480
4	2.3	Design Schedule(D3) Design Document Status (D4) Design Working Manual 02 Design Working Manual 03	List of Doc./Dwg. for submission	240
5	2.4	Design Quality Plan (D5)	Prepare Design Quality Plan	300
6	3	Design in Progress Check list (D6)	Design Input	480
7	4	Design working Manual 01-20 Design in Progress Check list (D6)	Perform the functions according to the customer's requirement.	210
8	5	Design Review and Verification check list (D7) Design Review report (D8)	Design review and verification	336
9	6	Design Modification Proposal (D9) The summary of additional hours and costs (D10) Design change request form (D11)	Design Change	512
10	7.2	Letter of Transmittal form (D12) Doc./Dwg. for approval check list (D13)	Approval	150
11	8	Letter of Transmittal form (D12) Distribution Design Doc./Dwg. check list (D14)	Distribution for end users	120
12	11.1	As built drawing list (D15)	As built Doc./Dwg. preparation	288
13	12	Feedback design result form (D16)	Feedback Design Result	200

Table 4.7 Document Control for Substation Design Execution

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