

CHAPTER 6

IMPLEMENTATION AND RESULT

6.1 Implementation

6.1.1 Introduction

The implementation of the quality assurance for design substation project within XYZ company was started to the project named "PEA 5-11" (Provincial Electricity Authority of Thailand, PEA). The scope of this project is the supply goods and construction of 22kV Indoor Switchgear Substations in Sakon Nakhon and Khon Kaen province. This project was implemented the quality assurance from the beginning in March 1999 until complete project in May 2000.

Before implementation of the quality assurance for design substation in PEA 5-11 Project and next projects, the design staffs were explained about the detail of design procedures, design instruction manuals and control document. The purpose is to make sure that all design staffs can understand and apply the quality assurance to the project very well.

6.1.2 Implementation of the Proposed Quality Assurance in PEA 5-11 Project

The Provincial Electricity Authority of Thailand (PEA) awarded this project to XYZ company to supply of goods and construction of 22kV Indoor Switchgear Substation in Sakon Nakhon and Khon Kaen province. The scope of supply and work for each substation are as below:

1. Supply and installation 22kV indoor switchgear 2 incoming and 10 outgoing feeders including cable work.
2. Supply and installation the Computer Base Substation Control System (CSCS)
3. Construction of 12m x 24m buildings including cable trenches, fence, road and etc.

The design work of this project was implemented according to the quality assurance system. The procedure of design work are followed as the flowchart diagram in appendix II. This included that the standards check list, form, document control and design working manuals were applied to this project under supervised by design manager.

6.2 Results

6.2.1 Time Schedule and Technical Aspect

The percentage of delay time of this project comparing with the last five projects was decrease. The main reason is that the design engineer had many document to guideline and follow during handling the design work for example the design check list and working manuals. This included the design review process which help the design manager to be close to control the status of the design work. The percentage of delay time compare with planning time schedule are shown in **table 6.1** as below

| | Before Implemented QA Average of past five projects | After Implemented QA PEA 5-11 |
|--------------------------|--|----------------------------------|
| Design planning | 5% | -1% |
| Primary circuit design | 5% | 0% |
| Secondary circuit design | 6% | 2% |
| Customer approval | 2% | 1% |
| As built | 8% | 2% |

Table 6.1 Percentage of the over time for each design stage of the project before/after implemented the quality assurance

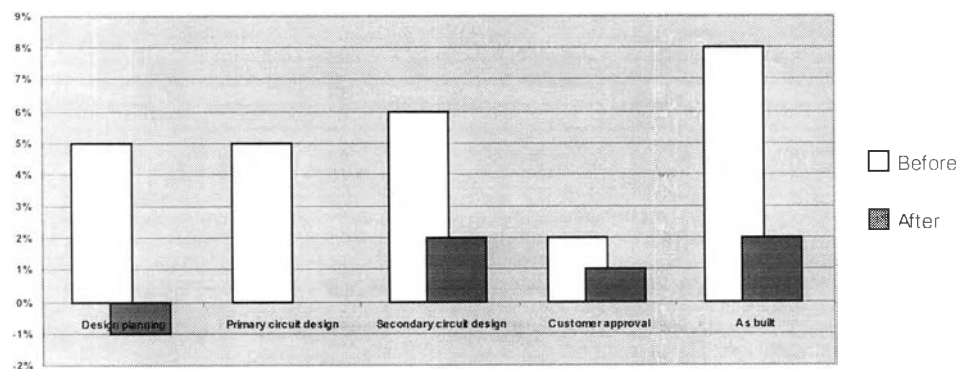


Figure 6.1 Percentage of the over time for each design stage of the project before/after implemented the quality assurance.

The number of design changes in this project was less than the past project. This includes the effect of design changes was also reduced (project time schedule and additional cost) because the additional review for design change procedure will be held to discuss about the effect of such change to project. There are extension of time schedule and/or additional cost if such change effect to project work. **The table 6.2** are shown the design changes record for PEA 5-11 project (after implemented the quality assurance) compared with the average of past five projects before implemented the quality assurance.

The number of reworks in term of design drawing and documentation were also less than the past project because after implement the quality assurance, there were standard procedures, working manuals and control document to keep the standard of design work to be the same.

| | Before Implemented QA Average of past five projects | After Implemented QA PEA 5-11 |
|-----------------|--|----------------------------------|
| Major Effect | 5 | 1 |
| Moderate Effect | 8 | 1 |
| Minor Effect | 14 | 4 |
| No Effect | 25 | 8 |

Table 6.2 Number of design change records before/after implemented the quality assurance

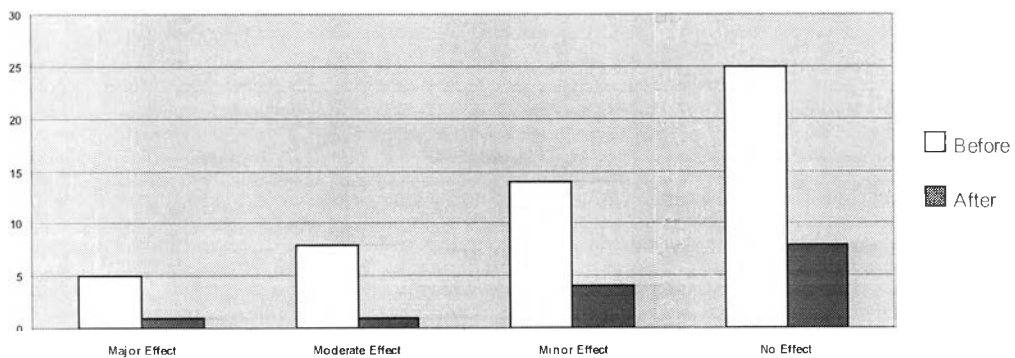


Figure 6.2 Number of design change records before/after implemented the quality assurance

6.2.2 Financial Aspect

The man-hours spent in this project was less than the budget by using the past project to be criteria including no overtime cost spent in this project also. This reason is that there are many document control to be used during handle design project.

The design review of design schedule was used to monitor the progress of design work followed the project time schedule from the starting project until delivery the project.

The number of reworks was reduced, this means the cost of reworks in this project also reduced in term of paper work, redesign time (man-hours) and etc. compares to other projects.

The number of design changes was reduced, the unexpected cost was also reduced. Because there may be errors from estimation to re-order of equipment or from re-design.

| | Before Implemented QA Average of past five projects | After Implemented QA PEA 5-11 |
|-------------------------|--|----------------------------------|
| Man hours charge | 20% | 4% |
| Material and other cost | 5% | 1% |

Table 6.3 Percentage of the additional man hours charge and material and other cost before/after implemented the quality assurance

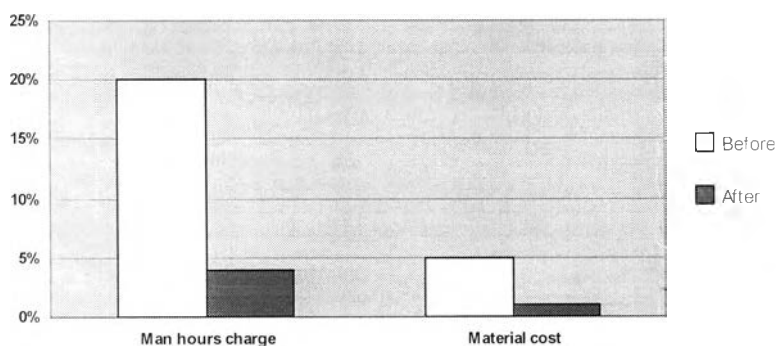


Figure 6.3 Percentage of the additional man hours charge and material and other cost before/after implemented the quality assurance

6.2.3 Customer Aspect

The delivery of design drawing and document for customer approval follows the schedule submitted to customer when starting project. This results the project can be finished as the project schedule. The customer could energize the electrical power to their process on time.

The drawing and document submitted to customer was controlled in the same standard such as drawing number, revision index and etc. This can help the customer when check or operate their process.

The design errors found during the commissioning process is less than the past project. This help the commission team to spend the commissioning time within the schedule and finish their function on time.

6.2.4 Result from the Failure Mode and Effect Analysis

The result of FMEA implementation in PEA 5-11 Project after finished was analyzed by design team. The value of Severity, Occurrence, and Detection of each design process which has its RPN exceed than 100, is evaluated by design staff as in appendix III.

The comparison of RPN value before and after implementation of quality assurance is shown on **table 6.4** as below.

From the table, the design control document was used to improve the design processes of substation project as specified in column RPN2 (after implementation) comparing with the column RPN1 (before implementation). The difference of RPN1 and RPN2 is compared in percentage of change ranging form 36% to 93%. The occurrence (the probability that potential caused of the failures will occur) was reduced because of the use of review check-lists. The review checklists could remind the design staff to do the necessary and important tasks in the project. In addition, the control documents have also increased the ability of the proposed system to detect potential causes of failures or detect the subsequent failure modes as the reduction of the detection (D) value.

| Item | Process | Potential Failure Mode | RPN 1 | RPN 2 | % Change |
|------|--|---|----------|----------|-------------|
| 1 | Internal KOM | Deviation between the invitation to Bid and the contract is not discussed | 480 | 72 | 85 |
| 2 | Internal KOM | Verbal commitments are not fully discussed | 420 | 84 | 80 |
| 3 | Internal KOM | Failure to check the customer data/document | 480 | 72 | 85 |
| 4 | Find out the scope of delivery | Failure to understand some items in the scope of delivery | 400 | 96 | 76 |
| 5 | Arrange filing system | Difficult to find out document | 300 | 30 | 90 |
| 6 | Arrange filing system | Loss of some document used in project | 480 | 48 | 90 |
| 7 | List of Doc./Dwg. for submission | List of doc./dwg. is not covered all customer required. | 240 | 32 | 87 |
| 8 | List of Doc./Dwg. for submission | Design schedule is not related to project schedule. | 140 | 28 | 80 |
| 9 | Prepare Design Quality Plan | Quality plan does not apply to the actual project. | 300 | 45 | 85 |
| 10 | Design Input | Insufficient design information | 480 | 36 | 93 |
| 11 | Perform the functions according to the customer's requirement. | Poor design | 200 | 50 | 75 |
| 12 | Perform the functions according to the customer's requirement. | Not fulfil the customer's requirement | 210 | 63 | 70 |
| 13 | Perform the functions according to the customer's requirement. | Design work is based on wrong standard | 150 | 96 | 36 |
| 14 | Perform the functions according to the customer's requirement. | Design work is delay to submit | 168 | 28 | 83 |
| 15 | Design review and verification | Failure to check the design output meet the Design input | 336 | 28 | 92 |
| 16 | Design Change | Design change from customer | 512 | 96 | 81 |
| 17 | Approval | Failure to check the revised Doc./Dwg. | 150 | 24 | 84 |
| 18 | Distribution for end users | Incorrect to stamp the purpose of Doc./Dwg. | 120 | 30 | 75 |
| 19 | As built Doc./Dwg. preparation | Failure to revise as the red/green marks | 288 | 72 | 75 |
| 20 | Feedback Design Result | Cannot keep this information to use in the future project. | 200 | 16 | 92 |

Table 6.4 Comparison of the RPN before and after implement the quality assurance system

6.3 Improvements after implement quality assurance

1) Understand the procedure of design work clearly

The proposed quality assurance system can help the design engineer to know well the procedure of design work in step by step with the related document control and working manual through the design stage (see flowchart in appendix II). This method can help not only junior design engineer but also the senior design engineer to handling the design work easily and prevent the problems of misunderstanding procedure during design stage.

2) Understand the scope of design work clearly at the beginning stage with document control

The proposed quality assurance system can help the design engineer to clearly understand the scope of design work for substation project execution. The internal kick off meeting check list (D1) can help the design engineer to check and clarify item by item during the project transfer stage with Project Manager such as all the scope of work, deviations or discrepancies between the XYZ proposal and customer requirements, project schedule, interfacing party and etc.

3) Design planning with document control and status

With the proposed quality assurance system, the design team can easier plan and control the design schedule. The design planning check list (D2) was used to show the basic information and document which should be prepared before start the design work. The design engineer can design faster and comfortable with complete necessary information, settled scope of work and document. Furthermore, the design schedule (D3) and document status (D4) which contain the design activities against their period of time and all design document with issued date is very helpful for design engineer to follow and complete their work on the target.

5) Easy to handle the design work with the same standard with the Design Working Manuals

The proposed design working manual which contain the instruction and standard as the same criteria within the company. In the past, many design engineers had their own standard of work, document and method to design. Some document issued from XYZ company were different both format of document and also the method of design (referred to different standard) owing to different design engineer. After the design working manual was established and implemented, the standard of design work will be the same although their was prepared by different design engineer. This included to help the young design engineer to learn the method of design by using these working manual.

6) Design in process check list

With the design in process check list, the design engineer can ensure that the design output will be done with enough information (design input) and contain with the complete content

before submitted to the customer for approval. This check list was created by covering all of the crucial design output and often use in the design substation project.

7) Design Review and Verification with the document control

The proposed quality assurance system can help the design team to easily review and verify the design work in term of design schedule and design performance. The design review and verify check list (D7) is used for check items by items during design stage. For example, the design review for design planning, input, output design stage. This design review will be recorded in form of design review report (D8).

8) Improvement the process of design change

The proposed quality assurance system can help the design manager and project manager to control and manage when the design change occurred during handling the project in term of document and procedure control. This quality assurance system introduced the design document comprised of Design Modification Proposal (D12), Summary of Additional Hours and Costs (D13) and Design Modification Request (D14).

When the design change occurred in the project due to customer requests or other reasons, the source of modification must be identified including the description of such modification. The affected document from proposed modification will be listed in this form. After that the summary of modification impact will be listed, and also the result of decision which is rejected or accepted.

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