

CHAPTER 5

ESTABLISHMENT OF THE DESIGN STANDARD PROCEDURE

Refer to the discussion of the problem in previous chapter, we found that the cause of poor design work is the lack of good procedure and guideline to help design engineer as a tool to follow. Such problem can be reduced by applying quality assurance system as a tool through the design stage. The following items are establish followed the ISO 9001 requirement to keep the design work with the same standard.

5.1 Improvement in Design Procedure

1.) Project Transfer

1.1) Internal Kick off meeting check list (D1)

This document is intended to be as a guideline for design staff to check and clarify during the Project Transfer stage (Internal KOM) in order to be completely transferred the general of project, contract information, scope of work, addendum, deviation of order project. This includes the scope of work which may interface to other departments or subcontractors.

The major topic in the D1 are as below:

- Organization Chart
- Document Review
- Master Project Schedule
- Project Meeting
- ISO / Quality Plan
- Safety and Security
- Civil and Other Information

2.) Design Planning

In this procedure, the document control for planning design work are as below;

2.1) Design Planning Check list (D2)

This document is intended to be as a guideline for design staff to check before start the design work. This check list will show which document should be prepared and also which basic information should be used for prepared such document.

The major topic in the D2 are as below:

- Design Schedule
- Basic Data
- Drawing and Document List
- Supplier Selection, Drawing/Documents
- General Requirement
- Quality Plan (Design)
- Standard

2.2) Design Schedule (D3)

For “**Design Schedule**”, all design activities according to design staff’s responsibility will be shown against the period of time and also match the main project schedule that made by Project Manager.

2.3) Document Status (D4)

“**List of Design Drawing and Document**” will be done in “Documents Status ” form. All issued documents, as Design Output, will be listed with planned issuing date.

Design Department Manager has to review these documents and signs for approval, they will be kept in “ Design Files ” and a copy will be sent to Project Manager for information.

Issuing of each document, the status of document will be recorded in a “Document Status” form. This form will also be updated every time that document’s status changes.

2.4) Design Quality Plan form (D5)

The design quality plan is to ensure and demonstrate that the project is done in compliance with the quality assurance guidelines of the ISO9001 with regard to design of substation project.

The quality plan is prepared for a particular project in the condition of agreement with the customer.

The quality plan breakdown is based on ISO9001 which refers to the chapter of the design control and design document control as detail below;

- Review and Preparation
- Planning
- Design in Process
- Review, Verification and Modification

2.5) Design Filing System (WM01)

This working manual is intended to guideline the design staff to prepare the filing system to keep the document related to project in systematic. Every document will be gathered before keep them into the file. Such system will help the administrative project work during handling the project. The detail of this working manual will be described in session 5.3.1

2.6) Identification Drawing and Document Number (WM02)

This working manual is intended to guideline the design staff to identify the document and drawing which issued from the design department. The design document and drawing is very important to has their own identical number in order to make a difference. Because each document and drawing in the design substation work will be referred to each other to complete the function, understanding meaning and etc. The detail of this working manual will be described in session 5.3.2

2.7) Lists of Technical Document (WM03)

This working manual is intended to guideline the design staff to prepare a list of document and drawing which must be submitted to customer for approval or to the end users. The reason is that there are many type of substation for example the drawing will represent the indoor and outdoor type of substation is different type and amount of drawing. These include the type of control system, protection system and type of equipment used in substation are also make a different type of document or drawing to represent them. The detail of this working manual will be described in session 5.3.3

3.) Design Input

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.

Department Manager will review this information and transfer to the responsible Engineer for starting design works.

During period of design, if Engineer require more information from any party, the request from Engineer will be done to relevant party directly.

3.1) Design in Process Check lists (D6)

This document is intended to be as a guideline to help the design staff to check which input data should be used for making a design document and drawing by identifying the input information of each type of document and drawing.

The major items in the D6 are as below:

- Single Line Diagram, Relay and Metering Diagram Input Check
- General Arrangement plan, Layout plan of Substation Input Check
- Concept Design Input Check
- Detail Design Input Check
- Calculation Input Check
- Bill of Material, List of apparatus Input Check
- Review, coordinate with Civil and Material Drawing Input Check

-Review, Drafting of Drawing Input Check

4.) Design Process

This 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 design output which may be drawing, calculation and etc. must be submitted for customer approval. If applicable, the design output will be done according to working manual **WM01-WM20** and customer's requirement.

For organization and technical interfaces, the assigned engineer will be a part of project team that done by Project Manager. Design engineer will have technical interfaces with customers, sales staff, project staff, etc according to the relation of work. Design engineer will ensure that the necessary data or information is complete by these interface functions.

4.1) Design in Process Check lists (D6)

The major items in the D6 are as below:

- Single Line Diagram, Relay and Metering Diagram Output Check
- General Arrangement plan, Layout plan of Substation Output Check
- Concept Design Output Check
- Detail Design Output Check
- Calculation Output Check
- Bill of Material, List of apparatus Output Check
- Review, coordinate with Civil and Material Drawing Output Check
- Review, Drafting of Drawing Output Check

4.2) Design Working Manual (WM01-WM20)

These working manual are intended to guideline design engineer during design stage. After designing, design output will be made according to working manual and according to customer's requirement. Normally, there is no official instruction or standard to help during designing stage. Many engineers have their own design method and form. As a result the design output is different although issued from the same company.

5.) Design Review and Verification

I. Design Review

The design review process is established to review at appropriate stages of design, the design manager together with design engineer will hold a meeting to review such as the design input, design output, design plan, design changes and etc. at a suitable time, at least once a month. The design review must be kept as a record in the design working file. A copy of the design review will be sent to Project Manager. Man-hours charge as well as drawing status will also be reviewed.

II. Design Verification

The design verification process is established to ensure that before the design output is released for use, it is reviewed as set out in the plans for the design work. Design verification which has been carried out must be documented.

After finishing of each design document, Engineer has to give that document to design manager for review and verification.

The scope of verification depends on the degree of complexity and the potential risk. The questions subject to verification include whether the design satisfies the provisions of the input requirement specification and the requirements of the actual customer of order, including any specific regulatory requirements, and whether the design is appropriate with regard to the production resources available, availability of subcontractors and inspection facilities.

The design manager will select a method of verification which takes place in different ways, including;

- Comparing with the old project that has same aspect.
- Through design reviews.
- Through calculations.
- Through the review of drawings and other design output.
- Through tests.
- Referring to the International standard (IEC, IEEE, DIN and etc.)

After verification, correction of document by design manager may be done if necessary. Design manager will sign on the documents that already verified and corrected. Design engineer will keep a copy of document in design files or in a suitable place.

5.1) Design Review and Verification Check list (D7)

The design review and verification method by using design check list is more practical and reduce an error by checking item by item stated in design output.

5.2) Design Review report (D8)

This report is used to verify that design activity output conforms to specified requirements. Normally, this form was prepared in the same form as "Minutes of Meeting" form.

6.) Design Change

The design change can be arise from changing in customer requirement or the result of customer comments, up-date information from external sources such as suppliers, new legislation, environmental matters and etc. This includes internally from other departments within company .

The revision in design document due to this change is to be made in respect of what has been changed compared to the previous contents and, where applicable, together with the reasons for change. The change is preferably to be shown in the document together with a revision index and date . Changed document will be verified and distributed according to Design Document Control in the next subject.

The design change process is established to ensure that the changes are documented , They must be reviewed and formally approved before the documents are released for use in the same systematic manner as the original documents. This depends on the scope of the changes and their effect in various contexts, either the whole, or parts of the procedure for verification as per the above carried through. The design manager is responsible for ensuring that the procedures are carried out in an appropriate manner. However, the acceptance is always obtained from those functions which are affected by the changes and the consequence of change such as additional cost, extent time schedule and etc.

6.1) Design Modification Proposals (D9)

This document is a typical of design modification proposals which shows the source of the required change and the description of the change (part 1).

At this stage, the decision to proceed or not proceed with the change is taken by the project manager (part 2)

If the decision is to proceed, then all involved project staff estimate the effect of the proposed change on their individual work (part 3)

6.2) The summary of additional hours and costs (D10)

The effect of the cost in time and resources will be documented and document control, the summary of additional hours and costs (D10) is a form which identifies such cost

When the impact of the change is calculated, then it is documented in part 4 of the design modification proposal (D9) which is then accepted or rejected by project manager (part 5)

6.3) Design Change Request Form (D11)

After the proposal receive approve by the project manager, then it will go forward to the customer for approval. A change in the contract will be required and it will be documented as a **design change request form (D11)**

7.) Approval

7.1) Letter of Transmittal form (D12)

For distributing, documents will be covered with **“Letter of Transmittal”** form. The person who received these documents has to sign as received in a copy of “Letter of Transmittal” and send back to the Engineer. Engineer will keep the copy of “Letter of Transmittal” as a record in design files.

All distributed documents will also be stamped, as below, at least in the first page, in “blue color” to identify the purpose of distribution.

“ For Approval “

Used for Documents that sent to the customer for approval.

“ For Re-approval “

Used for documents that sent to the customer for re-approval due to customer's changed and/or comment.

“ For Final “

Used for documents that sent to the customer as final documents.

“ For Construction “

Used for documents that sent to production, Site Management and / or Sub-contractor for construction work.

“ For Commissioning “

Used for documents that sent to commissioning staff for commissioning work.

“ As-built “

Used for documents that sent to the customer after reviewed and / or corrected according to actual installation.

7.2) Document and drawing for approval check list (D13)

This document contains the check list in order to ensure that the issued drawing and document is met to the customer requirement such as specification, deviation, technical requirement, drawing requirement, schedule and etc.

8.) Distribution for end users

8.1) Distribution Design document and drawing form (D14)

Distribution of documents to the end user have 2(two) alternative.

- Engineer => End user
- Engineer => Project Manager => End user

Selection of distribution route will be agreed between Engineer and Project Manager at the beginning state of the project by using the distribution Design document and drawing form.

9.) Project Execution

Out of scope to this study

10.) Design Validation

The design validation process is established to ensure that the product conforms to the customer's needs or requirements. The design validation is performed after successful design verification. The validation is normally performed on the final stage (complete substation), in most cases by testing or commissioning.

11.) As built drawing

11.1) As built drawing check list (D15)

This document is intended to help the design engineer to follow during as built drawing stage. Before the As-built drawing process begin, the review of general customer and technical requirement, marked up drawing for modification made during testing and commissioning, and etc. should be done. Then the process of correction of drawing and collection of final material detail will be done respectively.

12.) Feedback Design Result

12.1) Design feedback result form (D16)

Design feedback result will ensure that problems reported at all stages of a project from installation through commissioning receive attention in such a way as to avoid repetition of past problems and promote future improvements.

5.2 Design Document and Data Control

5.2.1 Identification and registration of documents

An important aspect of the documentation quality system is the correct use of title block on documents. The purpose of the title block is to :

- Identify the document and valid revision
- Identify the owner and the author, note date and responsible for the issue and revisions
- Shortly describe the contents and the document

I. Setting out drawing headers on documents

This instruction followed the Working Manual, WM04 " Drawing Dimensioning ". The purpose of Drawing Dimensioning is to specify sizes and layout of forms for technical drawings used in a project produced by CAD application. It will describe how the current drawing headers for XYZ should be set out. If it is necessary to deviate from this instruction for a special project, the decision must be made by the Project Manager, and all persons responsible for sections of the documentation must be informed of the deviation. Rules for approval and signing of drawings must in case be followed.

Drawing header

A new layout for the drawing header has been developed for XYZ company. The layout is adapted from the existing one. Actually, the title head is equal for all types and sizes of drawings.

Selection and designation of sizes

Technical drawings should be made on the smallest standard sheet, permitting the necessary clarity and resolution. Preferred sized for forms are selected from the main ISO-A series as below:

Designation	Dimensions in mm
A0	841 x 1189
A1	594 x 841
A2	420 x 594
A3	297 x 420
A4	210 x 297

Forms

Form used for A4 or A3-size drawings as shown in appendix VI

Title Block

Certain data are necessary, if a drawing shall be possible to refer to, to use and handle. These data are in a title block. The title block is at the lower part of the drawing and always separated from the drawing space by a line.

Entry fields, description

Each field in title block shall be filled in when applicable. Description of each field is shown below.

1. Drawing number

Each technical drawing has to be supplied with a drawing number. This number identifies the drawing and makes an expedient handling possible

2. *Internal Order number*

Entry of internal reference number for the project.

3. *Type of Drawing*

The title gives a name to the contents of a drawing and facilitates the verbal understanding.

4. *Object*

Object gives a short description about scope (object) of the project, i.e. 115/22 kV GIS.

5. *Customer / Project name*

Entry of customer and/or project name.

6. *Drawn by*

Entry of preparation name. The name shall concern a person who draws up the drawing.

7. *Drawing checked by*

Entry of designer's name. The name shall concern a person who knows the content of the drawing in order to be of help at the searching for information.

8. *Design checked by*

Entry of approval name. This entry confirms that the drawings may be used for manufacture, production, purchase, etc. and furthermore can be issued to factories, suppliers, licensees and can be repeatedly used.

9. *Responsible department*

Entry of department designation. This entry documents which department that is responsible for the information in the drawing and its revision.

10. *Year Week*

Entry of year and week of drawing issued.

11. *Item designation*

Entry of Function and/or Local item designation of what is shown in the drawing.

12. *Description-1*

Entry of short description of what is shown in the drawing.

13. *Description-2*

Entry of more description of what is shown in the drawing.

14. *Sheet number*

Entry of sheet number. Sheet numbers are separating characters for single sheets in a multi-sheet drawing.

15. *Number of continuing sheet*

Entry of the sheet number of the continuing sheet.

16. *Current revision index*

The index documents the current revision stage of drawing. It need not be the same as the latest revision on the sheet.

17. *Customer drawing number*

Entry of customer reference in drawing number.

18. *Customer's revision index*

Entry of customer reference in revision index.

19. *Customer's sheet number*

Entry of customer reference in sheet number.

20. *Revision index*

The index documents the revision stage.

21. *Revision description*

Entry of short description of what is changed in the revision.

22. *Revision approved*

Entry of approval name as sub-item 8

23. *Year-Week of Revision*

Entry of year and week of drawing revised.

24. *Drawing file name*

Entry of electronic file name

25. *Scale*

Entry of scale used in the drawing.

26. *Language*

Entry of language code. TH = Thai, EN = English

II. Adapting drawings to the customer

In case of a customer's special label is required, this label is normally drawn on the right side, above the title block, on the first page. The label may contain the customer's drawing number, revision notes and logo, etc. This information is entered in accordance with the agreement made with the customer. See in appendix VI

5.2.2 Quality control of drawings

I. General

The main feature of the Document Control system in engineering department is that most documents are registered as "Drawings". This provides for a uniform handling of all kinds of documents, from their preparation, review, distribution, filing and revision up to their final filing or cancellation.

II. Document and data approval and issue

Each project has a list of drawings and documents presenting identification numbers and revision of the main plant documents. The list also includes information of which documents are to be sent to the Customer for INFORMATION or APPROVAL. The list is updated at least every month.

The top document in the plant documentation is the "scope of supply" giving references to important plant documents. For each item of equipment reference is given to the corresponding equipment manual.

III. Document and data changes

Changes to documents require the same process for review and approval as the originally issued documents, and the revisions are indicated by a note on the document and in the master-list of drawings and documents.

5.3 Establish Design Working Manual

The design working manual is intended to be as a guideline to follow up during design stage. These working manual were established to cover the primary circuit design , the secondary circuit design and also the document control which is intended to help the design engineer to do the design work in the same way and the same standard . These working manual comprise of twenty working manual (WM01-WM20). However, the way to establish all working manual was done by small group activity among design staffs by using their own experience, international standard (IEC, IEEE, DIN and etc.), Utilities specification and our company standard.

In this section, WM01-03 will be described through the detail but for WM05-20 will be described only main content in appendix V.

5.3.1 Design Filing System (WM01)

Design files shall be divided, logically, into 4 parts. Each part will divide into sections as shown below. All documents related to the project, except documents' size not suitable for keeping in file, have to be filed in design files according to appropriate section.

Part 1 : Project Execution

1. Schedule
 - Project time schedule
 - Design time schedule
2. Drawing Information
 - List of Drawings
 - Drawings status
3. Minute of Meeting - External
4. Minute of Meeting - Internal
5. Correspondence - External
6. Correspondence - Internal

Part 2 : Design Information

1. Customer information
 - Technical specification
 - Drawings
2. Tender information
 - Technical specification
 - Drawings
3. Equipment drawings
4. Commented drawings - External
5. Commented drawings - Internal

Part 3(A) : Documents - Switchyard

1. Single line diagram / Switchyard data
2. General layout
3. Bus structure layout
4. Bus section layout
5. Grounding plan
6. Indoor layout
7. Steel structure plan
8. Cable trench & conduit plan
9. ID plate installation

Part 3(B) : Documents - Electrical

- Block diagram
- Control / relay panel
- Function diagram

AC & DC distribution
Circuit diagram
Wiring diagram

Part 3(C) : Documents - Communication

Part 3(D) : Documents - Calculation

- 1.Short circuit force
- 2.Insulation co-ordination
- 3.Grounding calculation
- 4.Relay setting & co-ordination
- 5.Short circuit current
- 6.Battery & Battery charger sizing
- 7.Conductor & cable sizing
- 8.CT & PT verification

Part 4 : Order handling

1. Pre / Post calculation cost
- 2.BOM
- 3.Purchasing
 - Material ordering record
 - Purchase requisition
 - Purchase order
 - Order acknowledgement
- 4.Supplier
 - Quotation
 - Correspondence
- 5.Equipment drawings approved

Design files

Each design file will have it own cover sheet as attached.

5.3.2 Identification Drawing Number (WM02)

The purpose of this instruction is made for determining a format of identity number for drawings and calculation sheets used in a tender and project.

General

All drawings produced within design/engineering department must have an unique drawing number. No drawing are allowed to leave the department without a drawing number according to this instruction.

Format – Industrial Projects

The drawing numbers, for industrial projects, will be built up according to following format:

1 H Z T 2 8 0 0 1 - A E A (A)
1 2 3 4 5 6 7 8 9 10 11 12 13 14

Pos.	Description
1 – 2	Fixed. Standard world wide for Business Area (Substation business)
3	Fixed. Identification for Asia
4	Fixed. Identification for Thailand
5	1 = Tender, 2 = Project
6	Year of execution. 9 for 1999, 0 for 2000, 1 for 2001 and so on
7 – 9	Running number as recorded in "Project / Quotation register"
10	Fixed.
11	A = station 1, B = station 2 and so on within the same project
12 – 13	Identify number according to a Type of Drawings, See "List of Technical Documents"
14	Running alphabet for sub-drawings (Optional)

The first 10 positions must be the same on all drawings in a tender/project.

Example

- 1HZT18002-AEA is a Block diagram for 1st station of 2nd tender in year 1998.
- 1HZT20015-CSEB is a 2nd sub-drawing of Grounding plan for 3rd station of 15th project in year 2000.
- 1HZT25999-EXD is a Short circuit calculation for 5th station of 999th project in year 2005.

Format – Utility Project

The drawing numbers, for Utility projects, will be built up according to following format:

X	Y	Z	/	S	M	P	-	E	2	-	0	1
1	2	3	4		5		6	7	8	9	10	11

Pos.	Description
1 – 3	Fixed. XYZ
4	Fixed.
5	Project or Substation abbreviation name
6	Fixed.
7 – 8	Drawing number according to a Type of Drawings, See "List of Technical Drawings"
9	Fixed. (Optional)
10 – 11	Running number for Sub-drawings (Optional)

The first 6 positions must be the same on all drawings in a tender/project.

Example

XYZ/SMP-S5-03 is a 3rd sub-drawing of Grounding plan for "SMP" Project/Substation.
 XYZ/BR-E3 is a Function Diagram for "BR" Project/Substation.

5.3.3 Lists of Technical document (WM03)

This instruction guides to some of Technical documents that should be produced, where appropriate, for a project. Other Documents not shown herein may also be made, depending on customer's requirement.

Lists shown below are documents with their identical number.

Identical number of industrial project's document normally will be 2 alphabet. However, if any document is divided into sub-documents, their identical number will be 3 alphabet instead.

For example, identical number for "Bus section layout" will be **SD** in general. In case of divide into 3 sub-documents, each identical number shall be **SDA**, **SDB** and **SDC** respectively.

Switchyard (Outdoor) :

Description	Number : Industrial Project	Number : Utility Project
Main concept		
- Switchyard data	SAA	-
- Single line diagram	SA(B)	S1
General layout	SB	S2
Bus structure layout	SC	S3
Bus section layout	SD	S4
Grounding plan	SE	S5
Indoor equipment layout	SF	S6
Steel structure plan	SG	S7
Cable trench and Conduit plan	SH	S8
ID plate installation	SI	S9
Typical installation	SJ	-

Switchyard (Indoor) :

Description	Number : Industrial Project	Number : Utility Project
Main concept		
- Switchyard data	SAA	-
- Single line diagram	SA(B)	S1
General layout	SB	S2
Grounding plan	SE	S5
Indoor equipment layout	SF	S6
ID plate installation	SI	S9
Typical installation	SJ	-

Electrical :

Description	Number : Industrial Project	Number : Utility Project
Block diagram	EA	E1
Panel layout		E2
- General panel layout	EBA	
- Assembly plan	EBB	
- Panel block-out	EBC	
- BOM / List of apparatus	ED	
- List of labels	ED	
- Used terminals	EE	
Function diagram	EF	E3
AC & DC distribution	EG	E4
Circuit diagram	EH	
(alternatively, AC schematic diagram		E5
DC schematic diagram		E6
Wiring diagram	-	E8
(alternatively, Cable table	EI	
Wiring table	EJ	

Communication :

Description	Number : Industrial Project	Number : Utility Project
Switchyard layout	KB	
Indoor layout	KF	
Paging / Telephone schematic diagram	KJ	
Installation for PLC system	KP	
Installation for Paging & Telephone	KT	

Calculation :

<i>Description</i>	<i>Number : Industrial Project</i>	<i>Number : Utility Project</i>
Short circuit force	XA	
Insulation co-ordination	XB	
Grounding calculation	XC	
Relay setting and co-ordination	XD	
Short circuit calculation	XE	
Battery & Charger sizing	XF	
Conductor & cable sizing	XG	
CT & PT verification	XH	

BOM :

<i>Description</i>	<i>Number : Industrial Project</i>	<i>Number : Utility Project</i>
BOM – Switchyard	BA	
BOM – Electrical	BB	
BOM – Communication	BC	

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