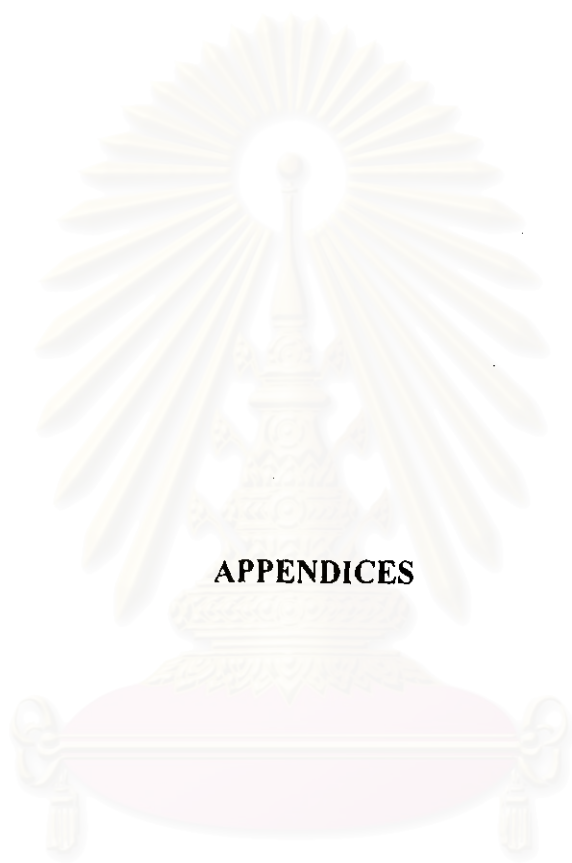


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APPENDICES

สถาบันวิทยบริการ
จุฬาลงกรณ์มหาวิทยาลัย

APPENDIX A : Customer Requirement Questionnaire of TMC Project

F - PE - 002 - TMC - 0

CUSTOMER REQUIREMENT QUESTIONNAIRE

1. GENERAL

1. Customer Name **TMC Co.,Ltd.**
 2. Address
 3. Contact Person
 4. Phone
 5. Facsimile

2. CUSTOMER SUPPLIED INFORMATION AND SERVICE

2.1 Water to be treated

- 2.1.1 Source of Water **Surface Water** (Deep Well, River, Municipal, etc.)
 2.1.2 Volume available for treatment (m³/hr) **30**
 2.1.3 General Appearance (Color, Clarity) **None**
 2.1.4 Line Pressure Min. **n.a.** Psig, Max. **n.a.** Psig, Avg. **n.a.** Psig

2.2 Water Analysis

pH	6.5 - 7.8				
P Alkalinity	N.D.	ppm as CaCO ₃	Silica	N.D.	ppm as CaCO ₃
M Alkalinity	300	ppm as CaCO ₃	Conductivity	1240	Micro S/cm
Total Alkalinity	300	ppm as CaCO ₃	Turbidity	5	NTU
Total Iron	0.5	ppm as Fe	Residual Chlorine	N.D.	ppm
Manganese	N.D.	ppm as Mn	Total Solids	500	ppm
Chloride	250	ppm as Cl			
Sulfate	200	ppm as SO ₄			
Total Hardness	392.5	ppm as CaCO ₃			
Ca Hardness	187.5	ppm as CaCO ₃			
Mg Hardness	205	ppm as CaCO ₃			
Sodium	N.D.	ppm as Na			

2.3 Available Equipment

- Do you have Clarifier Sand Filter Carbon Filter
 Deiron Softener DI system
 Others Reverse Osmosis system

Available Product Storage **Underground Water Storage Tank 400 M³**Space Available **35** (m) Length, **5.5** (m) Width, _____ (m) HeightEquipment Location _____ Indoor Outdoor

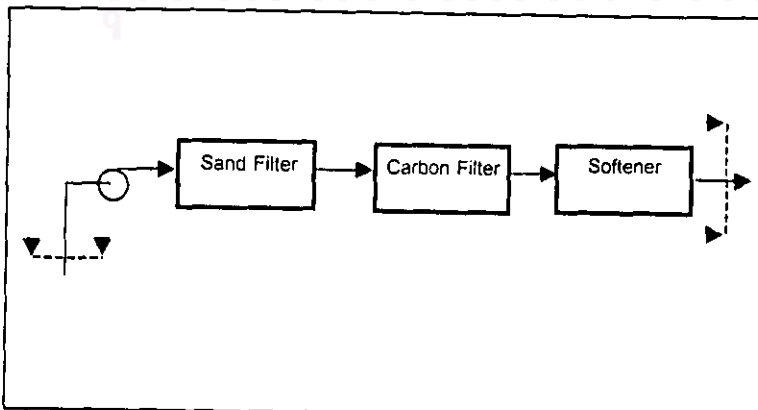
APPENDIX A : Customer Requirement Questionnaire of TMC Project (Continued)

F - PE - 002 - TMC - 0

CUSTOMER REQUIREMENT QUESTIONNAIRE

3. CUSTOMER REQUIREMENTS					PROPOSED	
					Yes	No
1. System capacity requirement	<u>25</u>	m ³ /hr	working hours	<u>12</u>	Hrs/day	1
2. Quality requirement						
2.1	<u>Turbidity < 1 NTU</u>					2.1
2.2	<u>Total hardness < ppm as CaCO₃</u>					2.2
2.3	<u>pH 6.5 - 7.5</u>					2.3
2.4						2.4
2.5						2.5
2.6						2.6
2.7						2.7
2.8						2.8
2.9						2.9
2.10						2.10
3. Operation requirement						3
					Automatic	<input checked="" type="checkbox"/>
					Manual	<input type="checkbox"/>
4. Additional special requirements						4
5. Equipment requirements						
5.1	<u>Water Pump</u>					5.1
5.2	<u>Sand Filter</u>					5.2
5.3	<u>Activated Carbon Filter</u>					5.3
5.4	<u>Water Softener</u>					5.4
5.5						5.5
5.6						5.6
5.7						5.7
5.8						5.8
5.9						5.9
5.10						5.10
5.11						5.11
5.12						5.12
5.13						5.13

6. Schematic



Checked By
Name
Signature
Checked Date
.....

APPENDIX B : Process Design Worksheet

DESIGN BASIS WORKSHEET					
F-PE-004-TMC-0					
Quotation & Rev. No	QP 038/6/99 SCwr	Worksheet Ref. No.			
Costing Rev. No	0	Worksheet Rev. No.			
Project No.	TMC-0		Name	Signature	Date
Customer	TMC	Applic Eng. (Done By)	TWC		10-Jun-99
Enduser	TMC	Applic Eng. (Checked By)			
Plant Location	CCS Province	Sales Eng. (Approved By)			
System Type	Water Supply	Project Eng. (Checked By)			
System Capacity	25				
PROCESS DESIGN SUMMARY					
Lab Analysis Ref.					
PFD / PID Ref.					
Design Assumptions or Customer Input					
Pretreatment Plant					
<p>MMF : Multimedia Filter</p> <p>ACF : Activated Carbon Filter</p> <p>WST : Water Softener Filter</p> <p> : Pump</p> <p> : PVC class 13.5 pipe</p>					
Recommensation Specification For Equipment					

APPENDIX C : Engineering Design Details

F-PE-005-TMC-0

DESIGN BASIS WORKSHEET

Quotation & Rev. No	QP 038/6/99 SCwr	Worksheet Ref. No.			
Costing Rev. No	0	Worksheet Rev. No.			
Project No.	TMC-0		Name	Signature	Date
Customer	TMC	Applic Eng. (Done By)	TWC		10-Jun-99
Enduser	TMC	Applic Eng. (Checked By)			
Plant Location	CCS Province	Sales Eng. (Approved By)			
System Type	Water Supply	Project Eng. (Checked By)			
System Capacity					

ENGINEERING DESIGN DETAILS

Equipment Type	
Tag Number	
Design Assumptions or Customer Input	

Details of sesing steps :

1. Chlorine Dosing Systm

Water Flow rate : 30 m³/hr (132 gpm)

Dosage : 5 ppm

Solution : 10 %

Metering pump = $(30) \times (5) / (10) \times (10)$

= 1.5 lph

= 3.0 lph (Recommendation)

Pump model "Pulsa Feeder" Series C (model LC04)

Recommensation Specification For Equipment

APPENDIX C : Engineering Design Details (Continued)

DESIGN BASIS WORKSHEET

F-PE-006-TMC-0

ENGINEERING DESIGN DETAILS (Continue)

Details of sesing steps :

2. Pipe velocity calculation

From Harvel manual (page 29)

$$v = 0.3208 G/A$$

v : velocity, in ft/sec

g : gpm

A : Inside cross sectional area, in in²

Recommended velocity for Water Supply 5 - 8 ft/sc (Selected 6 ft/sec)

$$12 \text{ ft/sec} = 0.3208 (132 \text{ gpm}) / A$$

$$A : 7.0576 \text{ in}^2$$

$$d^2 : 4(7.0576) / \pi$$

$$d^2 = 8.986$$

$$d = 2.997$$

From the table : d 2.997 (inside diameter) is 3" diameter of Standard pipe

สถาบันวิทยบริการ
จุฬาลงกรณ์มหาวิทยาลัย

Recommendation Specification For Equipment

APPENDIX D : Datasheet of Multimedia Filter for TMC Project

MULTIMEDIA FILTER DATA SHEET				
Client	TMC			
Project Name	TMC-0			Spec
Project No.				Checked
Location	CCS Province			Approved
Equipment Name	Multimedia Filter			TWC
Inquiry No.				10-Jnue-99
Tag No.	MMF			Rev
P & ID no.				By
Quantity Total	1	Working Stand by	1	Date
			0	
SYSTEM DATA		OPERATING CONDITION		
Type	Vertical	Flow capacity		
Operating System	Manual	- Normal, m ³ /hr		30
		- Allowed Max. , m ³ /hr		40
ANTHRACITE		Linear Velocity		
Type		- Normal, m/hr		12.18
Model		- Allowed Max. , m/hr		15
Manufacturer		Anthracite volume (per column), litres		1250
		- Bed depth, mm		1500
		Sand Volume (per column), litres		1000
		- Bed depth, mm		400
VESSEL DATA		Gravel Volume (per column), litres		800
Dimensions		- Bed depth, mm		300
- Diameter (mm)	1800	Pressure drop		
- Overall Height (mm)	1515	- Normal, psig		5
Internal Pressure		- Allowed Max. , psig		12
- Design (Barg)	5	Backwash cycle		
- Test (Barg)	9	- Flow rate, m ³ /hr		60
Thickness		- Time, minutes		20
- Sheel (mm)		- Cycle of backwash, per day		1
- Top Head (mm)		Inlet Water Pressure : Min./ Max, Psig		2.0/3.0
- Bottom Head (mm)		Face Piping		
Internal Liner		- Material		PVC
- Material	See Specification	- Pipe size, inches		3
- Total Thickness (mm)	See Specification	- Water velocity in pipe, m/hr		1.87
- Microns (dry)	See Specification	Control valve		
INTERNALS DATA (TYPE AND MATERIALS)		- Type		Butterfly
Inlet Distributor	Top Stack Diffuser	- Size		3
Intermediate Collector	no	- Material		SUS
Underdrain Collector	Fish Bone Type			
WATER DATA				
Inlet water type	Surface water			
Inlet water pH				
REMARKS				
Tank Area = 2.545 m ² Inside pipe area = 46 x 10 ⁻⁴				

APPENDIX E : Datasheet of Activated Carbon Filter for TMC Project

ACTIVATED CARBON FILTER DATA SHEET				
Client	TMC			
Project Name	TMC-0			Spec
Project No.	WT [DI2/99/SM]			Checked
Location	CCS Province			Approved
Equipment Name	Activated Carbon Filter			TWC
Inquiry No.				10-Junue-99
Tag No.	ACF			Rev
P & ID no.				By
Quantity Total	1	Working	1	Date
		Stand by	0	
SYSTEM DATA			OPERATING CONDITION	
Type	Vertical		Flow capacity	
Operating System	Manual		- Normal, m ³ /hr	25
			- Allowed Max. , m ³ /hr	31
ACTIVATED CARBON			Linear Velocity	
Type	Granular		- Normal, m/hr	13.3
Model	PK 1 -3		- Allowed Max. , m/hr	15
Manufacturer	Norit		Activated Carbon filter volume (per column) , litres	2000
Iodine Adsorption, mg/g	800		Bed depth	
			- Bed depth, mm	1025
			- Bed expansion, Min. %	50
VESSEL DATA			Supporting Media	
Dimensions			- Sand volume, liter	no
- Diameter (mm)	1575		- Sand bed depth	
- Overall Height (mm)	1800		- Gravel volume, liter	no
Internal Pressure			- Gravel bed depth	
- Design (Barg)	5		Pressure drop	
- Test (Barg)	9		- Normal, psig	5
Thickness			- Allowed Max. , psig	15
- Sheel (mm)			Backwash cycle	
- Top Head (mm)			- Flow rate, m ³ /hr	25
- Bottom Head (mm)			- Time, minutes	15
Internal Liner			- Cycle of backwash, per day	1
- Material	See Specification		Inlet Water Pressure : Min./ Max., Psig	2.0/3.0
- Total Thickness (mm)	See Specification		Face Piping	
- Microns (dry)	See Specification		- Material	PVC
			- Pipe size, inches	3
			- Water velocity in pipe, m/hr	1.87
INTERNAL'S DATA (TYPE AND MATERIALS)			Control valve	
Inlet Distributor	Top distributor		- Type	Butterfly
Backwash Distribution	Plate with Strainer		- Size	3
Underdrain Collector	Plate with Strainer		- Material	SUS
Number of Strainer	97			
WATER DATA				
Inlet water type	Surface Water			
Inlet water pH				
REMARKS				
Tank Area = 1.95 m ²				

APPENDIX F : Datasheet of Water Softener for TMC Project

WATER SOFTENER DATA SHEET				
Client	TMC			
Project Name				Spec
Project No.				Checked
Location	CCS Province			Approved
Equipment Name	Water Softener			TWC
Inquiry No.				10-Jun-99
Tag No.	WST			Rev
P & ID no.				By
Quantity Total	1	Working Stand by	1	Date
			0	
SYSTEM DATA			OPERATING CONDITION	
Type :	Cation Exchange, Brine regeneration		Flow Capacity (per column)	
Operating System :	Manual		- Normal (m ³ /hr)	25
Regeneration System :	Co-Current		- Allowed max. (m ³ /hr)	40
			Service Flow Rate (BV)	14.49
VESSEL DATA			Linear Velocity	
Dimensions			- Normal (m ³ /hr)	14.14
- Diameter (mm)	1500		- Allowed max. (m ³ /hr)	22.6
- Overall Height (mm)	1800		Resin Volume (per column, litre)	1725
Internal Pressure			Bed Depth	
- Design (Barg)	5		- Depth (mm)	1195
- Test (Barg)	9		- Bed Expansion (%)	50
Thickness			Pressure Drop	
- Sheel (mm)			- Normal (kPa)	15.96
- Top Head (mm)			- Allowed max. (kg/m ²)	0.5
- Bottom Head (mm)			Exchange Capacity (equivalent)	
Internal Liner			(per column)	
- Material	See Specification		Max. Capacity per cycle (m ³)	
- Total Thickness (mm)	See Specification		(At specified exchanged hardness)	
- Microns (dry)	See Specification		Regenerate	
INTERNAL'S DATA (TYPE AND MATERIALS)			- Dosage (kgs-NaCl/m ³ of resin)	200
Inlet Distributor	Top Distributor		- Per Cycle (Kgs)	345
Regenerant Distribution			Hardness Leakage (ppm as CaCO ₃)	3.5
Underdrain Collector	Plate with nozzle		Regeneration Flow Rate	
			- Backwash (m ³ /hr)	
RESIN			- Regen (m ³ /hr)	
Type :	Strong Acid Cation Resin		- Fast Rinse	
Manufacturer	Lewatit		- Slow Rinse	
Exchange Capacity (eq/ l of resin)	≥ 1		Regeneration Time	
			- Backwash (min.)	
			- Regen (min)	
			- Fast Rinse (min.)	
			- Slow Rinse (min)	2.0/3.0
			Inlet Water Pressure : Min./Max (barg)	
WATER DATA				
Inlet water hardness (ppm as CaCO ₃)				
Outlet water hardness (ppm as CaCO ₃)				
GENERAL DATA				
Indoor or Outdoor Installation	Outdoor			
Electrical supply for control	24 VDC/AC			
REMARKS				
Tank Area = 1.767 m ²				

**POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(PROCESS FMEA)**

FMEA Doc Number FMEA-PE-001-0
 Page 1 of 10
 Prepared By Tawatchai
 FMEA Date (Orig.) 4-Jun-99
 FMEA Date (Rev.) 9-Dec-99

Item Water Treatment Project Process responsibility Water Treatment Project process
 Project Management Key Date
 Core Team 1.Pramuk 2.Sataporn 3.Tawatchai 4.Wittaya 5.Poowanai.

Process Function and Requirements	Potential Failure Mode	Potential Effect(s) of Failure	S e v	Potential cause(s) / Mechanism(s) of Failure	O c c u r	Current Process Controls	D e t e c t	R. P. N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results				
											Action Results Taken	S e v	O c c u r	D e t e c t	R. P. N.
Receive Project Requisition	1. Insufficient information used for design	1. Lead to easily design error and/or fail to meet the customer requirement	7	1. Customer informs data inadequate 2. No use inquiry form	8	Inquiry Form None	8	448	1. Control the use of Modified Customer Requirement Questionnaire	Tawatchai 21-Jun-99	Done	7	4	2	56
Study Information	1. Failure to understand customer requirement and condition of design	1. System can not work as requirement 2. More maintenance required 3. Customer dissatisfy	7	1. Incomplete of collected data 2. Failure to review critical information	3	None	5	105	1. Establish customer requirement information checklist	Tawatchai 22-Jun-99	Done	7	2	2	28
Concept Design	1. Designed concept failure 2. Design the wrong equipment installing in the plant	1. System cannot work 2. Produced water can not meet specification requirement 3. Reconcept design 4. Over budgetary 1. Equipement fail in operation	8	1. Misunderstand equipment specification 2. Misunderstand requirement 1. Misunderstand Equipment specification	2		3	48 64							

**POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(PROCESS FMEA)**

FMEA Doc Number FMEA-PE-001-0
 Page 2 of 10
 Prepared By Tawatchai
 FMEA Date (Orig.) 4-Jun-99
 FMEA Date (Rev.) 9-Dec-99

Item Water Treatment Project Process responsibility Water Treatment Project process
 Project Management Key Date
 Core Team 1.Pramuk 2.Sataporn 3.Tawatchai 4.Wittaya 5.Poowanai.

Process Function and Requirements	Potential Failure Mode	Potential Effect(s) of Failure	S e v	Potential cause(s) / Mechanism(s) of Failure	O c c u r	Current Process Controls	D e t e r	R. P. N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results				
											Action Results Taken	S e v	O c c	D e t	R. P. N.
Design basic specification	1. Incorrect equipment specification is designed	1. System is easily fail in operation	8	1. Design by using old catalog or misunderstand equipment application	2	None	8	128	1. Establish designed basic specification checklist	Tawatchai 25-Jun-99	Done	8	2	4	64
		2. Require new equipment or modifying the existing item													
	2. Specific equipment cannot work as requirement	1. Replaced by new item	8	1. Specification informed by vendor error	1	None	7	56							
		2. Project cost higher													
3. Designed specification has error in calculation	1. System fail in operation	1. System fail in operation	8	1. Human error	4		7	224	1. Establish equipment standard data sheet	Tawatchai 25-Jun-99	Done	8	2	4	64
		2. Redesign							2. Review design by equipment checklist						
4. Material used in system has a short life time	1. Customer claims the warrantee	1. Customer claims the warrantee	5	1. Inappropriate material to be selected because of insufficient information	2	None	5	50							
		2. Project cost is higher													

**POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(PROCESS FMEA)**

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Item Water Treatment Project Process responsibility Water Treatment Project process
 Project Management Key Date
 Core Team 1.Pramuk 2.Sataporn 3.Tawatjai 4.Wittaya 5.Poowanai

Process Function and Requirements	Potential Failure Mode	Potential Effect(s) of Failure	S e v	Potential cause(s) / Mechanism(s) of Failure	O c c u r	Current Process Controls	D e t e c	R. P. N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results			
											Action Results Taken	S e v	O c c	D e t
Prepare design document and drawing	1. Having some ambiguous data in proposal	1. Customer unclear specification	5	1. Misunderstand equipment function	6	None	2	60						
	2. Insufficient specified information	1. Difficult to be evaluated	4	1. Less data from vendor	6	None	2	48						
	3. Error in typing	1. Customer confuse in specification	2	1. Human error	5	None	3	30						
Release design document for cost estimation	1. Incomplete equipment specification release for cost estimation	1. Cost maybe higher or lower the exact	6	1. Human error 2. Estimation eng failure to understand application	2	None	4	48						
Assigns Project Engineer														

APPENDIX G : Process FMEA Table (Continued)

**POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(PROCESS FMEA)**

FMEA Doc Number FMEA-PE-001-0
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Prepared By Tawatchai
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Item Water Treatment Project Process responsibility Water Treatment Project process
Project Management Key Date
Core Team 1.Pramuk 2.Sataporn 3.Tawatchai 4.Wittaya 5.Poowana

Process Function and Requirements	Potential Failure Mode	Potential Effect(s) of Failure	S e v	Potential cause(s) / Mechanism(s) of Failure	O c c u r	Current Process Controls	D e t e c	R. P. N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results				
											Action Results Taken	S e v	O c c u r	D e t e c	R. P. N.
Review proposed system	1. Failure to detect the deviated customer requirement in contract	1. Designed system has failed to meet requirement	8	1. Review only equipment specification	4	None	4	128	1. Establish contract verification and review by checklist	Pramuk and Tawatchai 05-Jul-99	Done	8	3	3	72
	2. Project schedule and planning is poor monitored and controlled	1. Project completion delay 2. Customer dissatisfy 3. Project cost is over the budget	7	1. Less of project monitor and control document	3	None	5	105	1. Establish the document to monitor and control project execution	Tawatchai 10-Aug-99	Done	7	2	3	42
Design detailed specification	1. Equipment difficult to operate	1. Customer dissatisfy	5	1. No clarify with customer	2	None	4	40							
	2. Poor detailed design	1. Required rework or repair	4	1. Do not review procedure	6	None	6	144	1. Establish checklist to verify designed detail	Tawatchai and Sataporn 12-Jul-99	Done	4	2	2	16
Prepare P&I D															

APPENDIX G : Process FMEA Table (Continued)

**POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(PROCESS FMEA)**

FMEA Doc Number FMEA-PE-001-0
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Item Water Treatment Project Process responsibility Water Treatment Project process
 Project Management Key Date
 Core Team 1.Pramuk 2.Salaporn 3.Tawatchai 4.Wittaya 5.Poowanai

Process Function and Requirements	Potential Failure Mode	Potential Effect(s) of Failure	S e v	Potential cause(s) / Mechanism(s) of Failure	O c c u r	Current Process Controls	D e t e c t	R. P. N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results						
											Action Results Taken	S e v	O c c	D e t	R. P. N.		
Prepare Bill of Material	1. Lack of parts or component to be prepared	1. Waste time to waiting 2. Redesign if cannot wait	5	1. Lack of checkin procedure	3		6	90									
Prepare procurement document	1. Wrong product model is ordered	1. Waiting for the correc product model	7	1. Misunderstand the product application	2	None	5	70									
		2. System has to be redesigned 3. Project cost higher than budget		2. Lacking of update product information													
	2. Vendor has changed the product model	1. System must change design	3	1. Lack of update information	4		5	60									
Release request quotation	1. Wrong equipment model or specification is requested	1. Order the wrong equipment or parts	5	1. Human error	1		2	10									
Receive quotation	1. Wrong specification of equipment or parts is quoted	1. Risk to order the wrong equipment	8	1. Vendor misunderstand	1		4	32									

**POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(PROCESS FMEA)**

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Prepared By Tawatchai
FMEA Date (Orig.) 4-Jun-99
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Item Water Treatment Project Process responsibility Water Treatment Project process
Project Management Key Date
Core Team 1.Pramuk 2.Sataporn 3.Tawatchai 4.Wittaya 5.Poowanai.

Process Function and Requirements	Potential Failure Mode	Potential Effect(s) of Failure	S e v	Potential cause(s) / Mechanism(s) of Failure	O c c u r	Current Process Controls	D e t e c	R. P. N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results				
											Action Results Taken	S e v	O c c	D e t	R. P. N.
Select vendor and subcontractor	1. Select poor performance vendor	1. Ease to cancel the purchasing order	6	1. No procedure to assess vendor	3	None	6	108	1. Establish procedure to assess vendor	Tawatchai and Purchaser 23-Jul-99	Done	6	3	5	90
		2. The product quality is poor		2. No vendor performance's record											
	2. Select inappropriate subcontractor	1. Ease to delay and poor quality of work	6	1. Subcontractor is not evaluated	3	None	7	126	1. Establish procedure to assess subcontractor	Tawatchai and Purchaser 23-Jul-99	Done	6	3	5	90
				2. Less specific vendor											
Release Purchase order	1. Wrong model is ordered	1. Parts or component cannot be used	4	1. Human error	2		3	24							
		2. Waste time													
		3. Project cost is higher													

**POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(PROCESS FMEA)**

FMEA Doc Number FMEA-PE-001-0
 Page 7 of 10
 Prepared By Tawatchai
 FMEA Date (Orig.) 4-Jun-99
 FMEA Date (Rev.) 9-Dec-99

Item Water Treatment Project Process responsibility Water Treatment Project process
 Project Management Key Date
 Core Team 1.Pramuk 2.Sataporn 3.Tawatchai 4.Wittaya 5.Poowanaï.

Process Function and Requirements	Potential Failure Mode	Potential Effect(s) of Failure	S e v	Potential cause(s) / Mechanism(s) of Failure	O c c u r	Current Process Controls	D e t e c	R. P. N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results				
											Action Results Taken	S e v	O c c	D e t	R. P. N.
Receive product	1. Wrong model is delivered	1. Waiting for new item	5	1. Internal error	5		3	75							
		2. System has to be redesigned													
		3. The project comple delay													
	2. Poor guality of product to be received	1. Reque repairing work to improve quality	7	1. Vendor is poor qualify	3	None	5	105	1. Establish procedure to inspect items	Wittaya and Poowanaï 02-Sep-99	Done	7	2	2	28
Prepare final Layout drawing															

APPENDIX G : Process FMEA Table (Continued)

**POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(PROCESS FMEA)**

FMEA Doc Number
Page
Prepared By
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FMEA Date (Rev.)

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Tawatchai
4-Jun-99
9-Dec-99

Item Water Treatment Project Process responsibility Water Treatment Project process
Project Management Key Date
Core Team 1.Pramuk 2.Sataporn 3.Tawatchai 4.Wittaya 5.Poowanai

Process Function and Requirements	Potential Failure Mode	Potential Effect(s) of Failure	S e v	Potential cause(s) / Mechanism(s) of Failure	O c c u r	C u r r e n t Process Controls	D e t e c t	R. P. N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results				
											Action Results Taken	S e v	O c c	D e t	R. P. N.
Equipment Installation	1. Incorrect position of installed equipment	1. Re-installation	4	1. No drawing to show the point of installation	5		6	120	1. Provide installation drawing and establish inspection procedure	Wittaya 01-Nov-99	Done	4	3	2	24
		2. Produce scrap and/or waste													
	2. Lacking of parts during installation	1. Lead to rework	4	1. Lack of required equipment plan	8		5	160	1. Establish procedure to verify installation agreement and prepare material plan	Pramuk 21-Jul-99	Done	4	3	4	48
		2. Project completion is delay		2. Lack of installation plan											
3. Lacking of installation tools	1. Ease to make defect on the product	4	1. Inappropriate installation plan	6		5	120	1. Provide installation plan	Pramuk 06-Jul-99	Done	4	4	2	32	
4. Plan Lay out has been changed		1. More unplanned work	4	1. Customer change	2	None	4	32							
		2. Project time delay													
		3. More required parts													
		4. Some has to be redesigned													

**POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(PROCESS FMEA)**

FMEA Doc Number FMEA-PE-001-0
Page 9 of 10
Prepared By Tawatjai
FMEA Date (Orig.) 4-Jun-99
FMEA Date (Rev.) 9-Dec-99

Item Water Treatment Project Process responsibility Water Treatment Project process
Project Management Key Date
Core Team 1.Pramuk 2.Sataporn 3.Tawatjai 4.Wittaya 5.Poowanai

Process Function and Requirements	Potential Failure Mode	Potential Effect(s) of Failure	S e v	Potential cause(s) / Mechanism(s) of Failure	O c c u r	Current Process Controls	D e t e r m i n e	R P. N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results				
											Action Results Taken	S e v	O c c u r	D e t e r m i n e	R P. N.
Interconnection piping	1 Inappropriate route of pipe	1. Waste and scrap is produced	4	1. Lack of installation drawing	8		4	128	1 Prepare interconenction drawing and	Wittaya 10-Nov-99	Done	4	3	2	24
		2. Wrong parts is installed							2 Establish interconnecting pipe review checklist	Tawatjai 10-Nov-99	Done				
Install electrical control panel and wiring work	1 Incorrect control panel function	1. The system cannot operate following the design	8	1. Error in design and assemble electrical control panel	4	None	7	224	1. Establish checklist for reviewing control panel	Poowanai 09-Nov-99	Done	8	2	2	32
		2. Inappropriate instrument installed and calibration	8	1. Misunderstand calibration method	4	None	6	192	1. Establish calibration procedure and checklist	Sataporn 09-Nov-99	Done	8	2	2	32

**POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(PROCESS FMEA)**

FMEA Doc Number FMEA-PE-001-0
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 Prepared By Tawatchai
 FMEA Date (Orig.) 4-Jun-99
 FMEA Date (Rev.) 9-Dec-99

Item Water Treatment Project Process responsibility Water Treatment Project process
 Project Management Key Date
 Core Team 1.Pramuk 2.Sataporn 3.Tawatchai 4.Wittaya 5.Poowanai.

Process Function and Requirements	Potential Failure Mode	Potential Effect(s) of Failure	S e v	Potential cause(s) / Mechanism(s) of Failure	O c c u r	Current Process Controls	D e t e c t	R. P. N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results				
											Action Results Taken	S e v	O c c	D e t	R. P. N.
System test run	1. Failure of installed equipment	1. Requires repair and rework	8	1. Human error	5	None	7	280	1. Establish procedure to review final installation	Tawatchai 10-Nov-99	Done	8	3	3	72
		2. Produce scrap and waste		2. Defect of parts											
	2. Error of equipment function	1. Repair and rework is performed	8	1. Do not check function of equipment	3		2	40							
		2. Project schedule is delay													
		3. Make the customer dissatisfaction													
Commissioning															

**POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(DESIGN FMEA)**

FMEA Doc Number
Page
Prepared By
FMEA Date (Orig.)
FMEA Date (Rev.)

FMEA-PE-002
1 of 3
Tawatchai
5-Jun-99
9-Dec-99

Item Water Treatment Equipment Process responsibility _____
Equipment Multimedia Filter Key Date _____
Core Team 1.Pramuk 2.Sataporn 3.Tawatchai 4.Wittaya 5.Poowanai

Process Function and Requirements	Potential Failure Mode	Potential Effect(s) of Failure	S e v	Potential cause(s) / Mechanism(s) of Failure	O c c u r	Current Process Controls	D e t e r m i n e	R. P. N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results				
											Action Results Taken	S e v	O c c u r	D e t e r m i n e	R. P. N.
Multimedia filter	1. High differential pressure	1. More backwash cycle 2. Higher operating cost	5	1. High bed depth 2. High velocity 3. Inappropriate media layer	4	None	5	100	1. Control the use of standard criteria and review by checklist	Tawatchai 25-Jun-99	Done	5	2	2	20
	2. Poor quality of treated water	1. Redesign the system 2. Replace filter media 3. Add the media depth	6	1. Inappropriate design criteria 2. High flow rate 3. Insufficient media filter 4. Inappropriate media depth 5. Poor backwash operation	3	None	6	108	1. Control the use of standard criteria and review by checklist	Tawatchai 25-Jun-99	Done	6	2	3	36
	3. Media filter leakage	1. Loss of media 2. Reload filter media	6	1. Fail to design support material	3	None	5	90							

**POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(DESIGN FMEA)**

FMEA Doc Number FMEA-PE-002
 Page 2 of 3
 Prepared By Tawatchai
 FMEA Date (Orig.) 5-Jun-99
 FMEA Date (Rev.) 9-Dec-99

Item Water Treatment Equipme
 Equipment Activated Carbon Filter
 Core Team 1.Pramuk 2.Salaporn 3.Tawatchai 4.Wittaya 5.Poowanai
 Process responsibility _____
 Key Date _____

Process Function and Requirements	Potential Failure Mode	Potential Effect(s) of Failure	S e v	Potential cause(s) / Mechanism(s) of Failure	O c c u r	Current Process Controls	D e t e c	R. P. N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results				
											Action Results Taken	S e v	O c c	D e t	R. P. N.
Activated Carbon Filter	1. High differential pressure	1. More backwash cycle 2. Higher operating cost	7	1. Clogging	2	None	4	56							
	2. Poor quality of treated water	1. Other equipment will fail in operation	6	1. Media life cycle has ended 2. Carbon media is insufficient	5	None	4	120	1. Control the use of criteria standard and review by checklist	Tawatchai 25-Jun-99	Done	6	3	2	36
	3. Carbon Leakage	1. Clog in the piping line 2. Flow rate drop	6	1. Nozzle crack 2. Loosen of nozzle	2		5	60							

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**POTENTIAL
FAILURE MODE AND EFFECTS ANALYSIS
(DESIGN FMEA)**

FMEA Doc Number FMEA-PE-002
Page 3 of 3
Prepared By Tawatchai
FMEA Date (Orig.) 5-Jun-99
FMEA Date (Rev.) 9-Dec-99

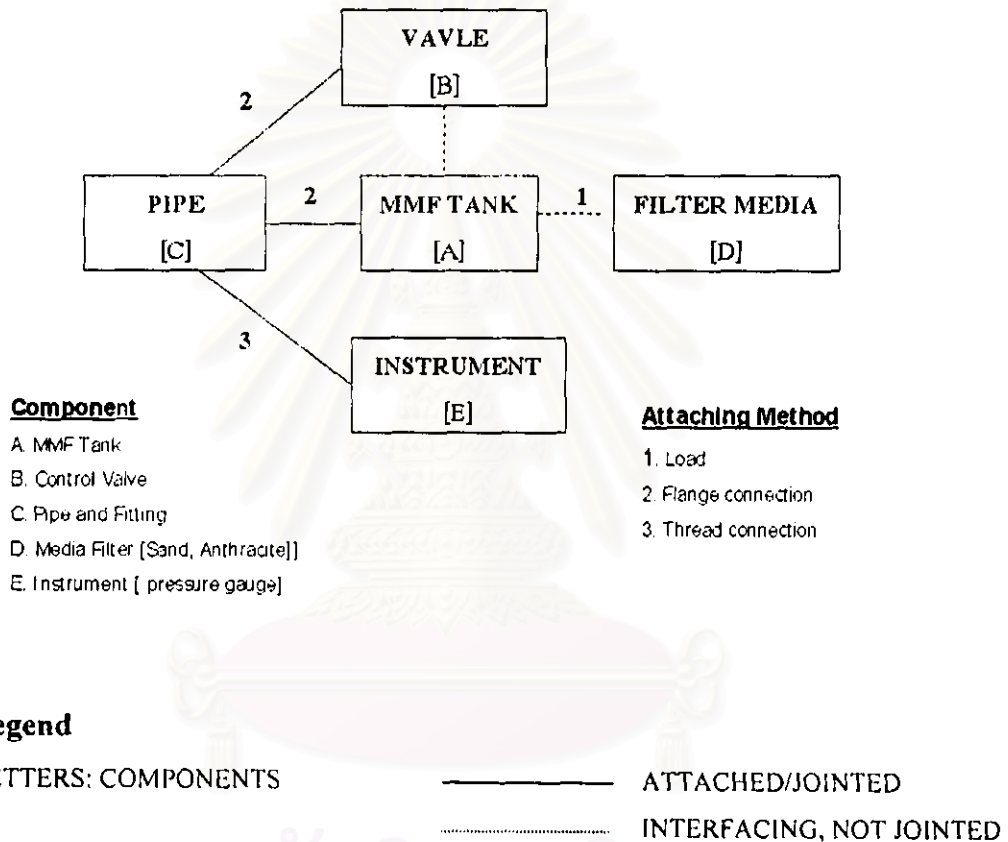
Item Water Treatment Equipment Process responsibility _____
Equipment Water Softener Key Date _____
Core Team 1.Pramuk 2.Sataporn 3.Tawatchai 4.Wittaya 5.Poowana

Process Function and Requirements	Potential Failure Mode	Potential Effect(s) of Failure	S e v	Potential cause(s) / Mechanism(s) of Failure	O c c u r	Current Process Controls	D e t e c	R. P. N.	Recommended Action(s)	Responsibility & Target Completion Date	Action Results				
											Action Results Taken	S e v	O c c u r	D e t e c	R. P. N.
Water Softener	1. Operating cycle is short	1. More regeneration 2. High operating cost	4	1. Insufficient resin 2. Less design safety factor	4	None	7	112	1. Control the use of criteria standard and review by checklist	Tawatchai 25-Jun-99	Done	4	3	3	36
	2. Treated water quality higher than specified	1. System shut down 2. More regeneration 3. High operating cost	5	1. Leakage 2. Improper system regeneration	2	None	8	80							
	3. Short life time of resin	1. Replaced by the new resin 2. High operating cost	4	1. Poor quality of water inlet	2		8	64							

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APPENDIX I : Design FMEA Block Diagram of Multimedia Filter

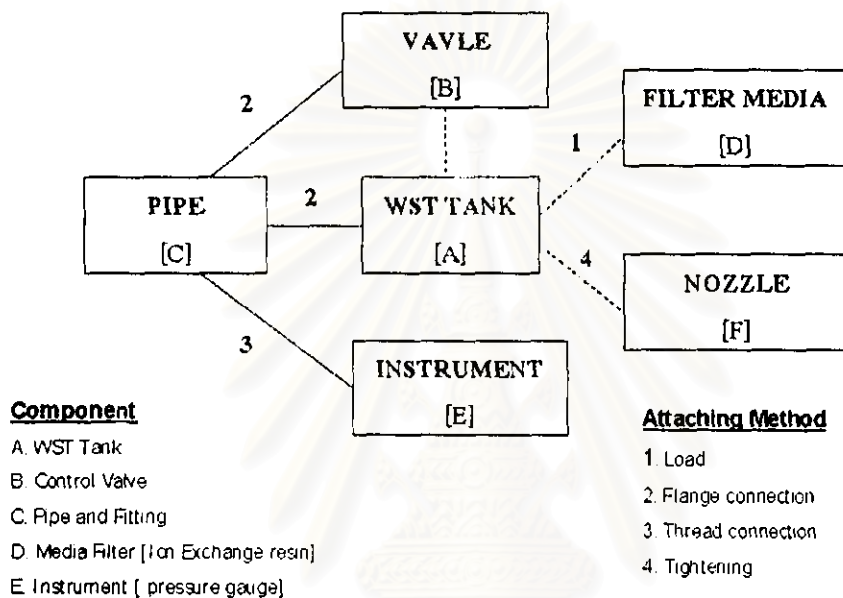
This is a relation block diagram of Multimedia filter that is used to clarify the FMEA.



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APPENDIX J : Design FMEA Block Diagram of Water Softener

This is a relation block diagram of Water Softener that is used to clarify the FMEA.



Legend

LETTERS: COMPONENTS

———— ATTACHED/JOINTED

..... INTERFACING, NOT JOINTED

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APPENDIX K : Internal Quality Audit Checklist

INTERNAL QUALITY AUDIT CHECKLIST			
ITEM	QUESTION	YES	NO
1	<p>Management Responsibility</p> <p>1.1 Quality Policy and Objectives</p> <p>1. Is the company's quality policy and objective made known and understood at all levels?</p> <p>2. Has company achieved the quality objective set?</p> <p>3. Are there records monitoring the quality objective set?</p> <p>4. Staff aware of their input to achieve objective and policy set?</p> <p>1.2 Organization Chart</p> <p>1. Are Organization Chart and reporting structure correct?</p> <p>1.3 Responsibility and Authority</p> <p>1. Responsibility and Authorities of all staff correct and understood by them?</p> <p>2. Changes to staff responsibility and Authorities arising from job function change, new responsibilities, changes in workscope etc. should be noted?</p> <p>1.4 Management representative</p> <p>1. Is a management representative appropriated for the system?</p> <p>2. Are responsibilities and authorities of Management Representative understood?</p> <p>1.5 Management Review</p> <p>1. Is the Records of Management Reviews maintained?</p> <p>2. Has a Management Review been conducted the previous year?</p> <p>3. Are approved Findings and Recommendation completed?</p> <p>1.6 Process Flowchart</p> <p>1. Are the Process flowchart and quality control plan implemented as documented?</p> <p>2. Do the Changes arising from process, inspection, sub-contracting, changes in manufacturing activities note?</p>		
Auditor 1..... 2.....		Date	

APPENDIX K : Internal Quality Audit Checklist (Continued)

INTERNAL QUALITY AUDIT CHECKLIST			
ITEM	QUESTION	YES	NO
2	Quality system 2.1 Quality Records 1. Are quality records kept per retention period indicated? 2. Are records systematically filed and readily accessible and available? 3. Are quality records legible and identifiable to the product involved?		
3	Contract Review 1. Are costing and Project Information updated on the costign record? 2. Is information on all records are completed and clear, including special requirement? 3. Correspondences and Quotation from clients are filed and available?		
4	Design Control 1. Does design output requirements meet design input requirements? 2. Is design changed and modified to requirement when needed? 3. Does the steps involved in change and modification of design follow procedure?		
5	Document and Data Control 1. Has the Quality Manual been controlled? 2. Are Forms, document changes updated in Quality Manual? 3. Are obsolete documents promptly removed from all points of issue and use? 4. Are Work Instruction updated, controlled and made available at location where operations essential to the effective functioning of the quality system?		
6	Purchasing 6.1 Assessment of vendors 1. Is Approved vendor List updated? 2. Are new vendors qualified according to procedures before listing? 3. Are vendor survey reports keep? 4. Are vendor's performance monitored?		

Auditor 1..... 2.....

Date

APPENDIX K : Internal Quality Audit Checklist (Continued)

INTERNAL QUALITY AUDIT CHECKLIST			
ITEM	QUESTION	YES	NO
6.2	<p>Purchasing data</p> <p>1. Do the Purchasing Requisition and Pruchasing Order contain data clearly describing the product orders?</p> <p>2. Are relevant and authorised signatures seen on purchasing documents?</p> <p>3. Are purchasing procedures implemented?</p>		
7	<p>Customer Supplied Product</p> <p>1. Is customer supplied product verified on suitability for use?</p>		
8	<p>Product Identification and Traceability</p> <p>1. Are Product Identification Label attached to boxes after production?</p> <p>2. Is pertinent inforamation indicated on labels</p> <p>3. Are labels used correctly?</p> <p>4. Is product identifiable and traceabke according to procedure?</p>		
9	<p>Process Control</p> <p>1. Are process carried out under controlled conditions such as documented procedure?</p> <p>2. Are personnel documented in appropriate form?</p> <p>3. Are criteira for workmanship provided for, such as written standards or representative samples?</p> <p>4. Are non-conforming materials clearly identified and segregated?</p> <p>5. Is the first insoection carried out before production run?</p> <p>6. Are in-process inspections performed according to Quality Control plan?</p>		
10	<p>Inspection and testing</p> <p>10.1 Inspection manual</p> <p>1. Does the Inspection manual covers the inspections required for incoming, inprocess and outgoing inspection?</p> <p>2. Is the Inspection manual generate according to the Quality Control Plan?</p>		

Auditor 1..... 2..... *Date*

APPENDIX K : Internal Quality Audit Checklist (Continued)

INTERNAL QUALITY AUDIT CHECKLIST			
ITEM	QUESTION	YES	NO
	<p>10.2 Incoming inspection</p> <p>1. Are incoming inspections performed for every incoming lot of raw materials sub-contracted part and customer supplied products?</p> <p>2. Is inspection of sub-contracted parts performed according to Inspection Manual</p> <p>3. Does inspection record contains all essential data?</p> <p>4. Are inspection status clearly indicated?</p> <p>5. Are non-conforming materials identified and segregated till disposition is made?</p> <p>6. Are written inspection instructions available to inspectors?</p>		
	<p>10.3 Outgoing Inspection products (By customer)</p> <p>1. Is inspection performed as per specified in Quality Control Procedure and Inspection Manual?</p> <p>2. Are inspections documented in appropriate form?</p> <p>3. Is inspection performed on finished products prior to delivery?</p> <p>4. Are non-conforming products clearly identified and segregated?</p>		
11	<p>Inspection, Measuring and Test Equipment</p> <p>11.1 Are equipment calibrated and properly maintained?</p> <p>11.2 Are individual calibration records maintained?</p> <p>11.3 Is status of calibration clearly indicated on each equipment? (Label)</p> <p>11.4 Is Masterlist of inspection, measuring and test equipment updated for all instruments indicating newly purchased equipments?</p>		
12	<p>Inspection and test status</p> <p>1. Do documented procedures identify how to mark the inspection and test status?</p> <p>2. Are non-conforming materials segregated by location or distinctive markings to avoid inadvertent use?</p> <p>3. Are inspection and test status records maintained as part of Quality Records?</p> <p>4. Are personnel trained to maintain inspection and test status?</p>		
<p>Auditor 1..... 2.....</p>		<p>Date</p>	

APPENDIX K : Internal Quality Audit Checklist (Continued)

INTERNAL QUALITY AUDIT CHECKLIST			
ITEM	QUESTION	YES	NO
13	Control of Non-Conformance 1. Are non-conforming products clearly identified? 2. Are there documentations for non-conforming products? 3. Are non-conforming products segregated? 4. Are disposition of non-conforming products clearly indicated and authorised?		
14	Corrective and Preventative action 1. Are the corrective actions implemented, verified and documented? 2. Is investigation carried out by affected personnel to determine cause of problem? 3. Are the preventative actions implemented, verified and documented?		
15	Handling, Storage, Packing, Preservation and Delivery 1. Are products properly stored? 2. Are product stored in appropriate location to prevent damage? 3. Are store records updated to reflect currentness? 4. Are products clearly identified? 5. Is store assessment conducted per documented procedure? 6. Proper handling of work-in-progress and finished goods practised? 7. Packing of parts accordind to incoming inspection procedure? 8. Are damaged carton boxes not used?		
16	Control of Quality records 1. Dose an established process for the control of Quality Records? 2. Are Quality Records referenced in documented procedures? 3. Are all Quality Records maintained within individual organizations of the company or centralized? 4. Is the retention period for Quality Records defined? 5. Are Quality Records maintianed in an environment consistent with the retention of the data?		


Auditor 1..... 2..... *Date*

APPENDIX K : Internal Quality Audit Checklist (Continued)

INTERNAL QUALITY AUDIT CHECKLIST			
ITEM	QUESTION	YES	NO
17	Internal Quality audits		
	1. Are internal quality audits conducted to determine the effectiveness of the quality system?		
	2. Are audits conducted by trained auditors independent of the function being audited?		
	3. Are the documented audit instructions?		
	4. Are areas re-audited to verify the effectiveness of the corrective action?		
	5. Are audit results maintained as part of Quality Records?		
	6. Are audit results reported to the Management Representative and submitted to executive management for review?		
18	Training		
	1. Is there a formal qualification of personnel who perform certain specialized operations process, tests, or inspections?		
	2. Does training establish an employee's competence to meet the requirements of the Quality System?		
	3. Do the training program provides executive management with an understanding of the Quality System?		
	4. Does every employee involved in the quality system have a training record?		
	5. Are employee training records maintained as a part of Quality Records?		
19	Servicing		
	1. Are servicing services provided to customer?		
	2. Does the company have established processes to provide customers with post-sales services?		
	3. Does the company define conditions for services provided by subcontractors, prior to use of services?		
	4. Does the company maintain records of services provided as part of Quality Records?		
	5. Does the company provide a customer service agreement?		
Auditor 1..... 2.....		Date	


APPENDIX K : Internal Quality Audit Checklist (Continued)

INTERNAL QUALITY AUDIT CHECKLIST			
ITEM	QUESTION	YES	NO
20	<p>Statistical Techniques</p> <ol style="list-style-type: none"> 1. Are check on correct use of sampling table, sampling techniques and data recording? 2. Are statistical techniques used for process and product improvements? 3. Does the company have established document procedures to measure, monitor, and improve products and processed by the use of statistical technique? 4. Is documentation of statistical techniques maintained as part of Quality Records? 5. Are employees trained in the proper use of statistical techniques? 		


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Auditor 1..... 2..... Date

APPENDIX L : The Procedure of Design control

 XYZ ENGINEERING CO.,LTD	PROCEDURE TITLE : DESIGN CONTROL FOR PRE-AWARDED PROJECT	Document No: P/PE\004-0 Page: 1 of 3 Version : 1 Issued Date: 12/12/1999
	Issued By <i>Mr. Tawatchai N.</i>	APPROVED BY <i>Dr. Sommai C. Engineering Manger</i>

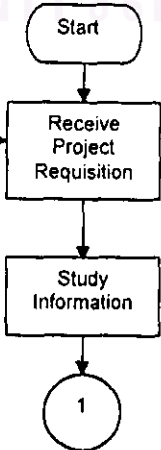
A. Objectives : To control the design execution for pre-awarded project in order to ensure that the design output (water treatment plant) can satisfy customer requirements.

B. Scope : This procedure includes activities from study customer requirements information up to the design system has been launched to submit the customer


C. Responsible Person:

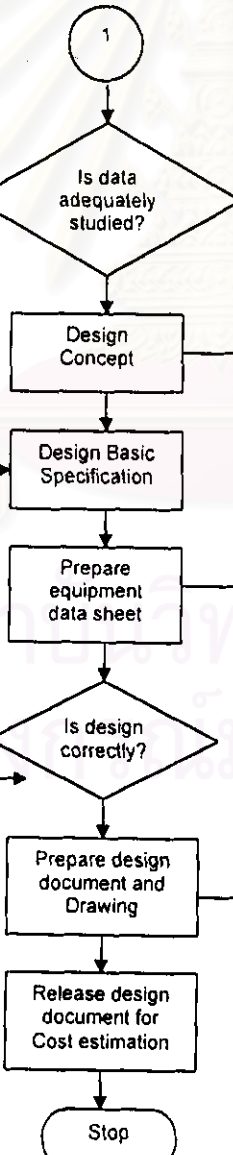
1. Design Engineer
2. Discipline Engineer

D. Activities : The activities of this procedure is explained in flow chart as following:


Step No.	Input Document	Activity	Output Document	Work Instruction	In Charge Person	
1	Service and Requisition Inquiry [F-PE-001-0] and Customer Requirement Questionnaire [F-PE-002-0]	 <pre> graph TD Start([Start]) --> RPR[Receive Project Requisition] RPR --> SI[Study Information] SI --> C1((1)) </pre>			Design Engineer	
1.1						Design Engineer
1.2					WI-PE-001-0	Design Engineer

APPENDIX L : The Procedure of Design control (Continued)

 XYZ ENGINEERING CO.,LTD	PROCEDURE TITLE : DESIGN CONTROL FOR PRE-AWARDED PROJECT	Document No: PIPE\004-0 Page: 2 of 3 Version : 1 Issued Date: 12/12/1999
	Issued By <i>Mr. Tawatchai N.</i>	APPROVED BY <i>Dr. Sommai C. Engineering Manger</i>

Step No.	Input Document	Activity	Output Document	Work Instruction	In Charge Person
1.3	Customer Requirement Information review Checklist [F-PE-019-0]		Revision Log Sheet [F-PE-003-0] And Designed Process work sheet [F-PE-004-0]	WI-PE-002-0	Design Engineer
1.4			Designed Engineering work sheet [F-PE-005-0] and Equipment Data sheet [F-PE-006-0]	WI-PE-003-0	Discipline Engineer
1.5	Designed basic specification review checklist [F-PE-020-0]		Proposal and Quotation	WI-PE-004-0	Design Engineer
1.6				WI-PE-005-0	Design Engineer

APPENDIX L : The Procedure of Design control (Continued)

 XYZ ENGINEERING CO.,LTD	PROCEDURE TITLE : DESIGN CONTROL FOR PRE-AWARDED PROJECT	Document No: P\PE\004-0 Page: 3 of 3 Version : 1 Issued Date: 12/12/1999
	Issued By <i>Mr. Tawatchai N.</i>	APPROVED BY <i>Dr. Sommai C. Engineering Manger</i>

F. References


Work Instruction

:	WI-PE-001-0	Study Information
:	WI-PE-002-0	Design Concept
:	WI-PE-003-0	Design Basic Specification
:	WI-PE-004-0	Prepare equipment data sheet
:	WI-PE-005-0	Prepare design document and Drawing

Form

:	F-PE-001-0	Service and Requisition Inquiry
:	F-PE-002-0	Customer Requirement Questionnaire
:	E-PE-003-0	Revision Log sheet
:	F-PE-004-0	Designed Process Work sheet
:	F-PE-005-0	Designed Engineering Work sheet
:	F-PE-006-0	Equipment Data sheet
:	F-PE-019-0	Customer Requirement Information review Checklist
:	F-PE-020-0	Designed Basic Specification review Checklist

APPENDIX M : Work Instruction 001

 XYZ ENGINEERING CO.,LTD	<p style="text-align: center;">WORK INSTRUCTION</p> <p style="text-align: center;">TITLE : STUDY INFORMATION AND VERIFICATION THE COLLECTED DATA</p>	<p>Document No: WI-PE-001-0</p> <p>Page: 1 of 2</p> <p>Version : 1</p> <p>Issued Date: 12/12/1999</p>
<p>Issued By</p> <p><i>Mr. Tawatchai N.</i></p>	<p>APPROVED BY</p> <p><i>Dr. Sommai C.</i> Engineering Manager</p>	


PURPOSE

The purpose of the study information collected from customer is to prevent failure from incorrect design basic and also ensure that design output meet the specified customer requirement. Any unclear information or ambiguous data is able to cause the water treatment system requires more maintenance or the short life cycle of equipment. Therefore, Design Engineer must understand the nature of water quality, the specified requirement, and customer supplied resources.

METHOD

1. After having been assigned to design and propose the water treatment plant for the customer, Design Engineer initiate review the documents that usually consists of Project Requisition Inquiry [F \ PE \ 001-0] and Customer Requirement Questionnaire [F \ PE \ 002-0].
2. Review item by item of collected data and remark on the item that did not be described or unclear the specified data.

APPENDIX M : Work Instruction 001 (Continued)

 XYZ ENGINEERING CO.,LTD	<p style="text-align: center;">WORK INSTRUCTION</p> <p style="text-align: center;">TITLE : STUDY INFORMATION AND VERIFICATION THE COLLECTED DATA</p>	<p>Document No: WI-PE-001-0</p> <p>Page: 2 of 2</p> <p>Version : 1</p> <p>Issued Date: 12/12/1999</p>
<p>Issued By</p> <p><i>Mr. Tawatchai N.</i></p>	<p>APPROVED BY</p> <p><i>Dr. Sommai C.</i> Engineering Manager</p>	

3. Discuss with Project Sale Engineer about that incomplete data. If Project Sale Engineer can not reply, Design Engineer must call back to contact person and ask about all unclear questions.
4. If there are any information that customer do not know exactly, Design Engineer can assume that data but it must base on the previous data and the customer must agree to use that data.

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VITA

Tawatchai Nawalamlert was born on October 12, 1968 in Bangkok Thailand. He graduated from Triam Udom Suksa School in high school level and obtained his Bachelor's degree in Engineering from King Monkut's Institute of Technology, Ladkrabang in 1992. After he graduated, he worked as Application Engineer in a local environment firm. Then, he has joined with a subsidiary company of Singapore enterprise as Project Engineer since 1995.



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