ภาคผนวก จ

สำเนาเอกสารเกี่ยวกับการจัดการคุณภาพน้ำ

ภาคผนวก จ-1

แผนผังระบบรวบรวมน้ำภายในโครงการ

BLCP Drawing No. : M0-MN-GC-PP-00018

SUPPLIER DRAWING NO./ MITSUBISHI DRAWING NO. / SUPPLIER NAME 97000-2121

PLAN RECORD

REVISIONS	
Rev. No.	**Description (Date)**
14	Revised according to Plant Modification No. 1179 (the detail please see amendment) (Refer Change request # BLCP-DCC-CN-0309)
15	In addition, a new NaOCl skid unit includes a metering diaphragm pump, a digital flow measurement, material UPVC, inline static mixer UPVC, a control panel, and the electrical work (power cable and control) in P&ID for Potable Water. (BLCP-DCC-CN-0437)
16	Plant Modification No. 1438 and 1528: Project replace some portion of Raw water pipe header unit 1 and unit 2 from carbon steel pipeline to Syler pipeline. The purpose of this modification is to reduce posibility of pipe leakage from internal corrosion which affect to plant efficiency in case of could not stop leakage. This case is relate to PI-1217 which make leak and performamce of BATC belt cleaning system drop.BLCP-DCC-CN-0440

[redacted]

AS BUILT

A4 x
A3 x
Total SHEETS WITH COVER

TITLE

RAW WATER & DEMINERALIZED WATER SYSTEM FLOW DIAGRAM

BLCP DRAWING NO. **M0-MN-GC-PP-00018**

REV. NO. **16**

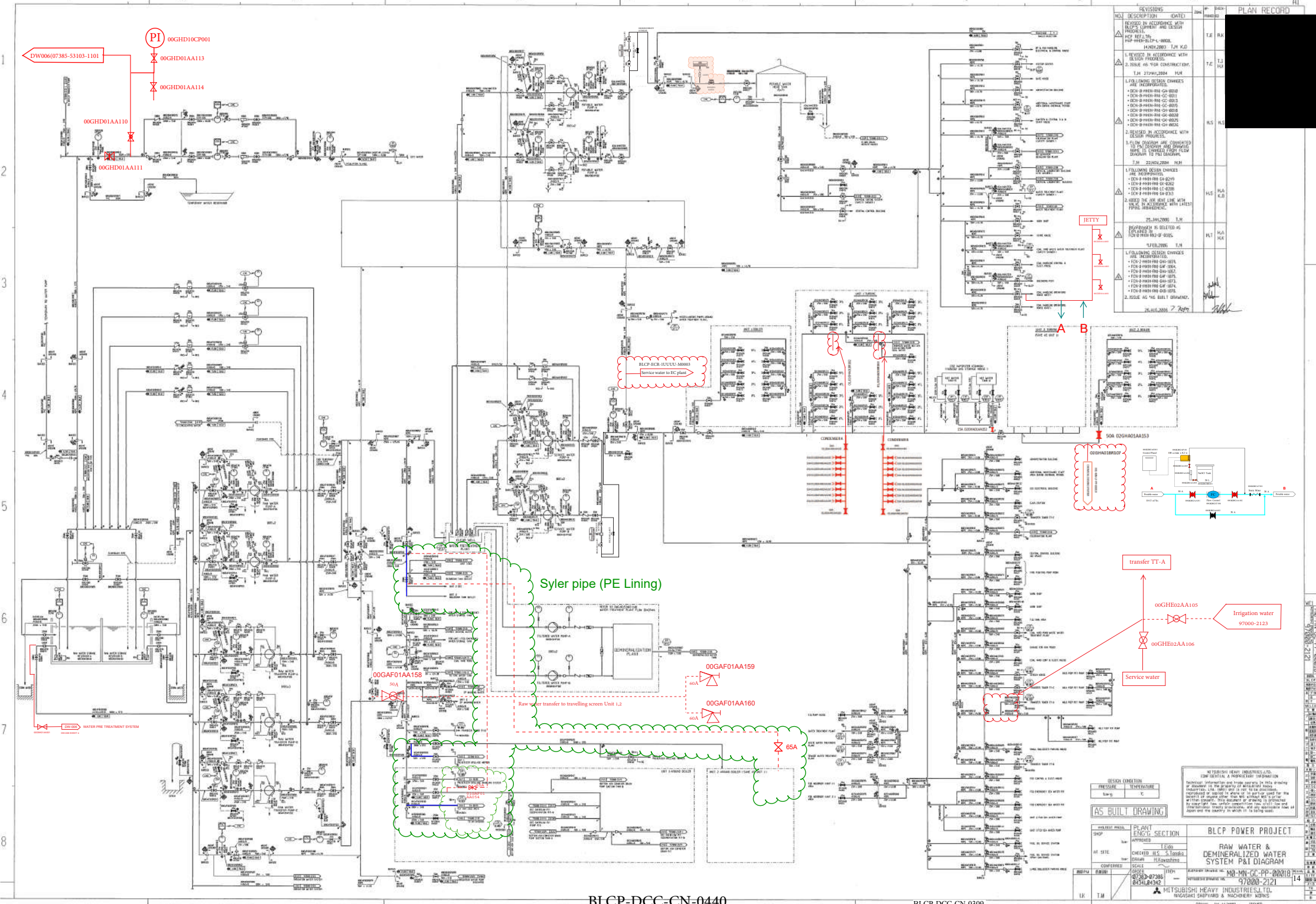
SUPPLIER NAME/SUPPLIER DRAWING NO./ MITSUBISHI DRAWING NO. **97000-2121**

BLCP POWER

BLCP POWER PROJECT

AMENDMENT RECORD

REVISED	DESCRIPTION	AMENDMENT	REMARK
14	**Revised according to Plant Modification #** PI# 1179. The Treated waste water Zero dischrage project. To install new raw water supply from raw water metering station to Clarifier (BLCP-DCC-CN-0309)	**13-Jun-16**	
15	Plant Modification No. 1627 Addition a new NaOCl Injection Skid for control Free residual Chlorine in Potable water for supply to Jetty Area to improvement FRC content in Potable water at Jetty around 0.2 – 0.5 ppm. (BLCP-DCC-CN-0437)	**4-Oct-22**	
16	Plant Modification No. 1438 and 1528: Project replace some portion of Raw water pipe header unit 1 and unit 2 from carbon steel pipeline to Syler pipeline. The purpose of this modification is to reduce posibility of pipe leakage from internal corrosion which affect to plant efficiency in case of could not stop leakage. This case is relate to PI-1217 which make leak and performamce of BATC belt cleaning system drop. BLCP-DCC-CN-0440	5-Oct-22	


PI
00GHD10CP001
DW006(07385-53103-1101)
00GHD01AA113
00GHD01AA114
00GHD01AA110
00GHD01AA111
JETTY
A
B
BLCP-ECR-1UUUU-M0003
Service water to EC plant
50A 02GHA01AA153
02GHA01BR102
Syler pipe (PE Lining)
transfer TT-A
00GHE02AA105
00GHE02AA106
Irrigation water
97000-2123
Service water
00GAF01AA158
50A
00GAF01AA159
60A
00GAF01AA160
60A
65A
Raw water transfer to travelling screen Unit 1,2
WATER PRE TREATMENT SYSTEM
REVISIONS
PLAN RECORD
AS BUILT DRAWING
DESIGN CONDITION
PRESSURE
TEMPERATURE
MITSUBISHI HEAVY INDUSTRIES,LTD.
CONFIDENTIAL & PROPRIETARY INFORMATION
PLANT ENGR. SECTION
BLCP POWER PROJECT
RAW WATER & DEMINERALIZED WATER SYSTEM P&I DIAGRAM
M0-MN-GC-PP-00018
97000-2121
14
MITSUBISHI HEAVY INDUSTRIES,LTD.
NAGASAKI SHIPYARD & MACHINERY WORKS

ภาคผนวก จ-2

แผนผังระบบบำบัดน้ำเสียภายในโครงการ

BLCP Drawing No. : M0-MN-GN-PP-01510

SUPPLIER NAME / DRAWING NO. : 53106-1601

PLAN RECORD

REVISIONS		CHECKED	APPROVED
Rev. No.	Description (Date)		
4	Revised according to Plant Modification No. 437 (Addition of Sludge level transmitter) (Refer Change Request # PGS-DCC-CN-0062)		
5	Revised according to PI No. 661 (Addition new manual valve at dehydrator sludge inlet pipe. (Refer Change Request # BLCP-DCC-CN-0116)		
6	Revised according to Plant Modification No. 832 and wo#3713552. Modification addition new pressure control valve and maunal isolate valve for pressure control valve . (Refer Change request # BLCP-DCC-CN-0204)		
7	Revised according to Plant Modification No. .976,977,978,979. Install permanence level indicator for calculate. (Refer Change request # BLCP-DCC-CN-0260) Revised according to Plant Modification No. 769 and wo#3871927. Addition new line and isolation valve to transfer waste water between regular and irregular basin. (Refer Change request # BLCP-DCC-CN-0261)		
8	Addition of pipeline tie line between the common discharge of Agitation Blower for the Waste Water Treatment Plant in page no. 7 of P&ID. BLCP-DCC-CN-0446		

AS BUILT

A4 x
A3 x
Total 10

SHEETS WITH COVER

TITLE

WASTE TREATMENT PLANT FLOW DIAGRAM

BLCP DRAWING NO.	REV. NO.
M0-MN-GN-PP-01510	8
SUPPLIER DRAWING NO.	
53106-1601	

BLCP POWER

BLCP POWER PROJECT

REVISIONS	
Rev. No.	DESCRIPTION (DATE)
1	1. Added the trough and drain pipe at the bottom of cake hopper based on BLCP' comment.
	2. Added the following items as per design progress.
	1) Piping Size and Material.
	2) Legend table of piping material
	3) Flexible Joint and Silencer in discharge line of agitation blower [DWW-001, Sheet2]
	4) Air Chamber in discharge line of diaphragm type pump [DWW-002, Sheet3]
	5) Pressure Relief Valve in discharge line of diaphragm type pump [DWW-002, Sheet1]
	6) Pressure Indicator in suction line of magnetic drive pump [DWW-002, Sheet3]
	7) Detail of wastewater [DWW-001, Sheet1, 2]
	8) Detail of oil separator unit [DWW-001, Sheet1]
	9) Sampling points
	10) Caustic soda injection line to irregular waste water storage basin [DWW-001, Sheet2]
	11) Agitator in pH adjustment tank [DWW-002, Sheet1]
	12) Service water line to clarifier unit and sludge thickener unit for maintenance [DWW-002, Sheet1, 2]
	13) Reducing valve and pressure indicator in service water line [DWW-002, Sheet1]
	14) Instrument air line [DWW-002, Sheet2]
	3. Revised the following items as per design progress.
	1) Symbol of pump and blower
	2) Capacity of sulfuric acid dosing pump for waste water treatment plant [DWW-002, Sheet3]
	1.2m³/Hr → 2.5m³/Hr
	3) Capacity of caustic soda dosing pump for waste water treatment plant [DWW-002, Sheet3]
	1.2m³/Hr → 2.5m³/Hr
	4) Capacity of PAC dosing pump for pH adjustment tank [DWW-002, Sheet3]
	20L/Hr → 0.03m³/Hr
	5) Capacity of polymer dosing pump for flocculation tank [DWW-002, Sheet3]
	350L/Hr → 0.36m³/Hr
	6) Inlet/Outlet valve type of sulfuric acid dosing pump for waste water treatment plant [DWW-002, Sheet3]
	(Aug. 19, 2004)
2	1. Added the following items.
	1) Service water line for priming of self-priming pumps [DWW-001 Sheet2 / DWW-002 Sheet1]
	2) Isolation valve in turbidity and pH instrument of treated water line [DWW-002, Sheet1]
	3) Flexible joint in inlet of dehydrator [DWW-002, Sheet2]
	4) Service water line for maintenance of pH instrument in pH adjustment tank [DWW-002 Sheet1]
	2. Modified the capacity and head of polymer dosing pump for dehydrator
	3m³/Hr x 20m → 1~3m³/Hr x 35m [DWW-002 Sheet 3]
	3. Modified the type of flow instrument on dehydrator inlet
	FIC → FI [DWW-002 Sheet 2]
	4. Revised the cloud marked points as per design progress.
	(Jan. 7, 2005)
3	1. Following design change is corporated.
	FCN-0-MHIN-RB4-GNA-1026
	2. Added MNS No.
	3. Changed the material of instrument air piping. (Carbon Steel + Galv. → SUS304)
	4. Issued as AS BUILT DRAWING.
	(Aug. 30, 2006)

AMENDMENT RECORD

REVISED	DESCRIPTION	AMENDMENT ISSUE DATE	REMARK
4	**Revised according to Plant Modification #** No.437 (Addition of Sludge level transmitter) **Revised sheets No.:** 1. Revised sheet No.4 (DWW-004)	- 3 APR 2009	
5	Revised according to Plant Modification No. 661 (Addition new manual valve at dehydrator sludge inlet pipe.) (Refer Change request # BLCP-DCC-CN-0116) Revised sheet No. 1. Sheet No. DWW-004	3 Feb. 2010	
6	Revised according to Plant Modification No. 832 and wo#3713552. Modification addition new pressure control valve and maunal isolate valve for pressure control valve . (Refer Change request # BLCP-DCC-CN-0204) Revised sheet No. 1. Sheet No. DWW-004	8 Feb. 2012	
7	Revised according to Plant Modification No. 387 and WO# 3871927. Additional new line and isolation valve to transfer waste water between regular and irregular basin. (Refer Change request # BLCP-DCC-CN-0261) Revised sheet No. 1. Sheet No. DWW-004 (sheet No. 2)	11 Apr. 2013	
8	Plant Modification No. 1694 Addition of a new isolating valve 3" and pipe tie line between the common discharge of the Aeration Blower for the Sewage Treatment Plant and Agitation Blower for the Waste Water Treatment Plant. Purpose of Modification; 1. The Sewage Treatment Plant is improving (DO) dissolved oxygen by 2-4 ppm from 5-7 ppm during regular operation due to the existing dissolved oxygen control relatively high dissolved oxygen more than the control criteria. 2. Energy saving due to Agitation Blowers for Waste Water Treatment Plant compressed air through the Sewage Treatment Plant instead of the Aeration Blowers. (BLCP-DCC-CN-0446)	18-APR-23	Sompong Thumthan Assistant Operations Manager Phakorn Suwansing Mechanical Engineer

CONTENTS

NO.	SUBCONTRACTOR DRAWING NO.	REV.	DESCRIPTION	PAGE
1	DWW-000 [Sheet No.1]	4	WASTE WATER TREATMENT PLANT SYMBOL & ABBREVIATION	1
2	DWW-004 [Sheet No.1]	7	WASTE WATER TREATMENT PLANT P & I DIAGRAM	2
3	DWW-004 [Sheet No.2]	9	WASTE WATER TREATMENT PLANT P & I DIAGRAM	3
4	DWW-004 [Sheet No.3]	8	WASTE WATER TREATMENT PLANT P & I DIAGRAM	4
5	DWW-004 [Sheet No.4]	12	WASTE WATER TREATMENT PLANT P & I DIAGRAM	5
6	DWW-004 [Sheet No.5]	6	WASTE WATER TREATMENT PLANT P & I DIAGRAM	6

PIPING SYMBOLS

- UNDICIDED (TYPE) VALVE
- GATE VALVE
- GLOBE VALVE
- CHECK VALVE
- NEEDLE VALVE
- BALL VALVE
- 3 WAY BALL VALVE
- BALL VALVE WITH JACKET
- Y-GLOBE VALVE
- BUTTERFLY VALVE
- REDUCING VALVE
- DIAPHRAGM VALVE
- SAFETY VALVE
- SLIDE VALVE
- AIR FLOW CONTROL VALVE
- PNEUMATIC OPERATED CONTROL VALVE
- SELF ACTUATED CONTROL VALVE
- MOTOR OPERATED VALVE
- SOLENOID OPERATED VALVE
- PNEUMATIC OPERATED ON-OFF VALVE

WITH SUBSCRIPT

FF : FAIL FIX

FC : FAIL CLOSE

- FOOT VALVE
- PRESSURE RELIEF VALVE BACK PRESSURE VALVE
- EV EXHAUST VALVE

- PROCESS LINE
- BLOWER LINE
- BLIND FLANGE
- FLANGE
- UNION
- SPADE BLIND
- SPECTACLE BLIND
- RO RESTRICTION ORIFICE
- CAP (BUTT WELD TYPE)
- CAP (SOCKET WELD OR SCREWED TYPE)
- HOSE CONNECTION
- Y TYPE STRAINER
- T TYPE STRAINER
- BUCKET TYPE STRAINER
- STEAM TRAP
- SIGHT GLASS
- EXPANSION JOINT
- FLEXBLE JOINT
- OPEN FUNNEL
- PIT
- EJECTOR
- FA FA FLAME ARRESTER
- VENDOR SCOPE
- (S) SAMPLING POINT
- AIR CHAMBER

INSTRUMENT SYMBOLS & IDENTIFICATION LETTERS

- LOCALLY MOUNTED INSTRUMENT
- DCS INSTRUMENT
- CONTROL PANEL
- LOCALLY MOUNTED TRANSMITTER
- ORIFICE
- VENTURI TUBE
- POSITIVE DISPLACEMENT FLOW METER
- PADDLE WHEEL FLOW METER
- MAGNETIC FLOW METER
- VORTEX METER
- AREA METER
- PITOT TUBE
- MASS FLOW METER
- FLAPPER SIGHT GLASS
- AIR REGULATOR-1 (AR-1)
- AIR REGULATOR-2 (AR-2)
- DRIP FUNNEL-1 (DF-1)
- PI PRESSURE GAUGE WITH DIAPHRAGM SEAL
- AIR FILTER REGULATOR

EXAMPLE OF LETTERING

(FC 123)

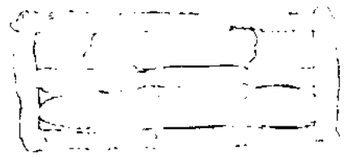
- F : FIRST LETTER
- C : SUCCEEDING LETTERS
- 123 : LOOP NUMBER

EXAMPLE OF LETTERING

- A ANALYZER (WITH CORRESPONDING UNIT AS A SUBSCRIPT e.g. (A)$_{pH}$, (A)$_{EC}$)
- C CONDUCTIVITY
- D DENSITY OR SPECIFIC GRAVITY
- E VOLTAGE
- F FLOW RATE
- H HAND
- L LEVEL
- M MOISTURE OR HUMIDITY
- P PRESSURE
- R REMOTE (VALVE)
- S SPEED OR FREQUENCY
- T TEMPERATURE
- TQ TORQUE
- U MULTIVARIABLE
- V VISCOSITY
- W WEIGHT OR FORCE
- X ANOTHER

MEANINGS OF SUCCEEDING LETTERS

- A ALARM
- C CONTROL
- E ELEMEMT
- G GAUGE
- I INDICATION
- K COMPUTER CONTROL
- L LOGGING
- Q QUANTITY
- R RECORDING
- S SWITCH
- T TRANSMITTION OR CONVERSION
- U MULTIFUNCTION
- V VALVE
- W WELL
- X ANOTHER
- Y CALCULATION
- Z EMERGENCY OR SAFETY



NOTE

A0 : CARBON STEEL
A1 : CARBON STEEL/HOT DIPT GALV
A2 : CARBON STEEL/INNER HRL
A3 : SUS-304
A4 : SUS-316L
A5 : PVC ASTM D1785
A6 : FRP DIN 1695 PN10
A7 : HDPE PN6
A8 : CARBON STEEL/INNER TEFLON LINING

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Rev.	Description	Date	Draw	Checked	Approved
4	As built drawing	20-07-06	-	[illegible]	[illegible]

KURITA WATER INDUSTRIES LTD.

Rev.	Description	Date	Draw	Checked	Approved
4	As built drawing	20-07-06	[illegible]		
3	Rev. as mark	30-06-04	PSR	KT	KM
2	Rev. as marks	17-05-04	CHA	KM	KM
1	Rev. as marks	11-12-03	CHA	KM	HS
0	First issued	01/12/03	CHA.	KM	HS

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70 Moo 5 Kingkaew rd., Bangphli Samutprakarn 10540 THAILAND
Tel. (662) 312-4159, 312-4165-7, 312-4171-5
Fax (662) 312-4162

Project Name :

BLCP POWER PROJECT

Messrs :

MITSUBISHI HEAVY INDUSTRIES LTD.

Title :

WASTEWATER TREATMENT PLANT
SYMBOL & ABBREVIATION

JOB NO.	PJ-0311002			Drawing No.	Rev.
Sheet :	1	Scale :	NONE	DWW-000	4
Sheet No :	1	Format :	A3		

07385 - 53106 - 1101

FILE NAME

NOTE
A0 : CARBON STEEL
A1 : CARBON STEEL/HOT DIPT GALV
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A3 : SUS-304
A4 : SUS-316L
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A6 : FRP DIN 1695 PN10
A7 : HDPE PN6
A8 : CARBON STEEL/INNER TEFLON LINING

ITP-WWT-15
(100A, RF)
OIL WASTE FROM TRANS YARD
UNIT 1/2 AREA
TRANSFORMER OIL PIT AREA

OIL SEPARATOR FOR TRANS YARD
00 GNA05BB201

00 GNA01 BR157 100A-A6

LS 00 GNA05CL101

HOLDING TANK FOR TRANS YARD
00 GNA05BB301

AA004 40A, AA005 40A, AA006 40A, AA007 25A

00 GNA01 BR149 50A-A6

OIL COLLECTING PIT FOR TRANS YARD
00 GNA05BB101

00 GNA01 BR101, BR102, BR103

AA101 65A, AA102 65A, 65A-A6

OIL SEPARATED WATER PUMP FOR TRANS YARD-A
00 GNA05AP101
10 m³/Hr x 30 mH

OIL SEPARATED WATER PUMP FOR TRANS YARD-B
00 GNA05AP102
10 m³/Hr x 30 mH

00 GNA01 BR104, BR105, BR106 50A-A6

AA103 50A, AA104 50A, 15A-A3, AA801 15A, AA601 15A, AA802 15A, AA602 15A

PI 00 GNA05CP501, PI 00 GNA05CP502, PI 00 GNA05CP505, PI 00 GNA05CP506, AA832 15A, AA833 15A

ITP-WWT-01
(50A, FF)
DWW-004 Sheet2
TO REGULAR WASTE WATER STORAGE TANK

ITP-WWT-02
(80A, FF)
DWW-004 Sheet2
TO REGULAR WASTE WATER STORAGE TANK

00 GNA01 BR112 80A-A6

00 GNA01 BR110, BR111 65A-A6

AA109 65A, AA110 65A, AA111 65A, AA112 65A, 15A-A3, AA803 15A, AA804 15A

PI 00 GNA05CP503, PI 00 GNA05CP504, PI 00 GNA05CP507, PI 00 GNA05CP508, AA834 15A, AA835 15A

00 GNA01 BR107, BR108, BR109

AA107, 100A, AA108, 100A, 100A-A6

OIL SEPARATED WATER PUMP FOR FUEL OIL TANK YARD-A
00 GNA05AP103
25 m³/Hr x 20 mH

OIL SEPARATED WATER PUMP FOR FUEL OIL TANK YARD-B
00 GNA05AP104
25 m³/Hr x 20 mH

ITP-WWT-16
(150A, RF)
OIL WASTE FROM FUEL OIL TANK YARD

1	RAIN WATER FROM FUEL OIL TANK YARD SUMP
2	BUNKER CONVEYOR AUX. TRANSFORMER OIL PIT
3	BOILER HOUSE OILY SUMP
4	TURBINE HOUSE SUMP
5	SMALL BULLDOZER PACKING HOUSE SUMP
6	COAL YARD AUX. TRANSFORMER OIL PIT

OIL SEPARATOR FOR FUEL OIL TANK YARD
00 GNA05BB202

00 GNA01 BR158 150A-A6

LS 00 GNA05CL102

HOLDING TANK FOR FUEL OIL TANK YARD
00 GNA05BB302

AA008 40A, AA009 40A, AA010 40A, AA011 25A

00 GNA01 BR150 50A-A6

OIL COLLECTING PIT FOR FUEL OIL TANK YARD
00 GNA05BB102

Rev.	Description	Date	Draw	Checked	Approved
7	As built drawing	16-07-06	—	[illegible]	[illegible]

KURITA WATER INDUSTRIES LTD.

Rev.	Description	Date	Draw	Checked	Approved
7	As built drawing	20-07-06			
6	Rev. as marks	12-11-04	PSR	KT	RS
5	Rev. as marks	01-11-04	PSR	SN	KM
4	Rev. as marks	10-09-04	PSR	SN	KM
3	Rev. as marks	30-06-04	PSR	KT	KM
2	Rev. as marks	17-05-04	TP	KM	KM
1	Rev. as marks, pipe size&mat.	26-03-04	TP	KM	HS
0	First Issued	11-12-03	TP	KM	HS

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Project Name :
BLCP POWER PROJECT

Messrs :
MITSUBISHI HEAVY INDUSTRIES LTD.

Title :
WASTE WATER TREATMENT PLANT
P & I DIAGRAM

JOB NO.PJ-0311002		Drawing No.	Rev.
Sheet :	.	Scale : NONE	DWW-004	7
Sheet No :	1	Format : A3	

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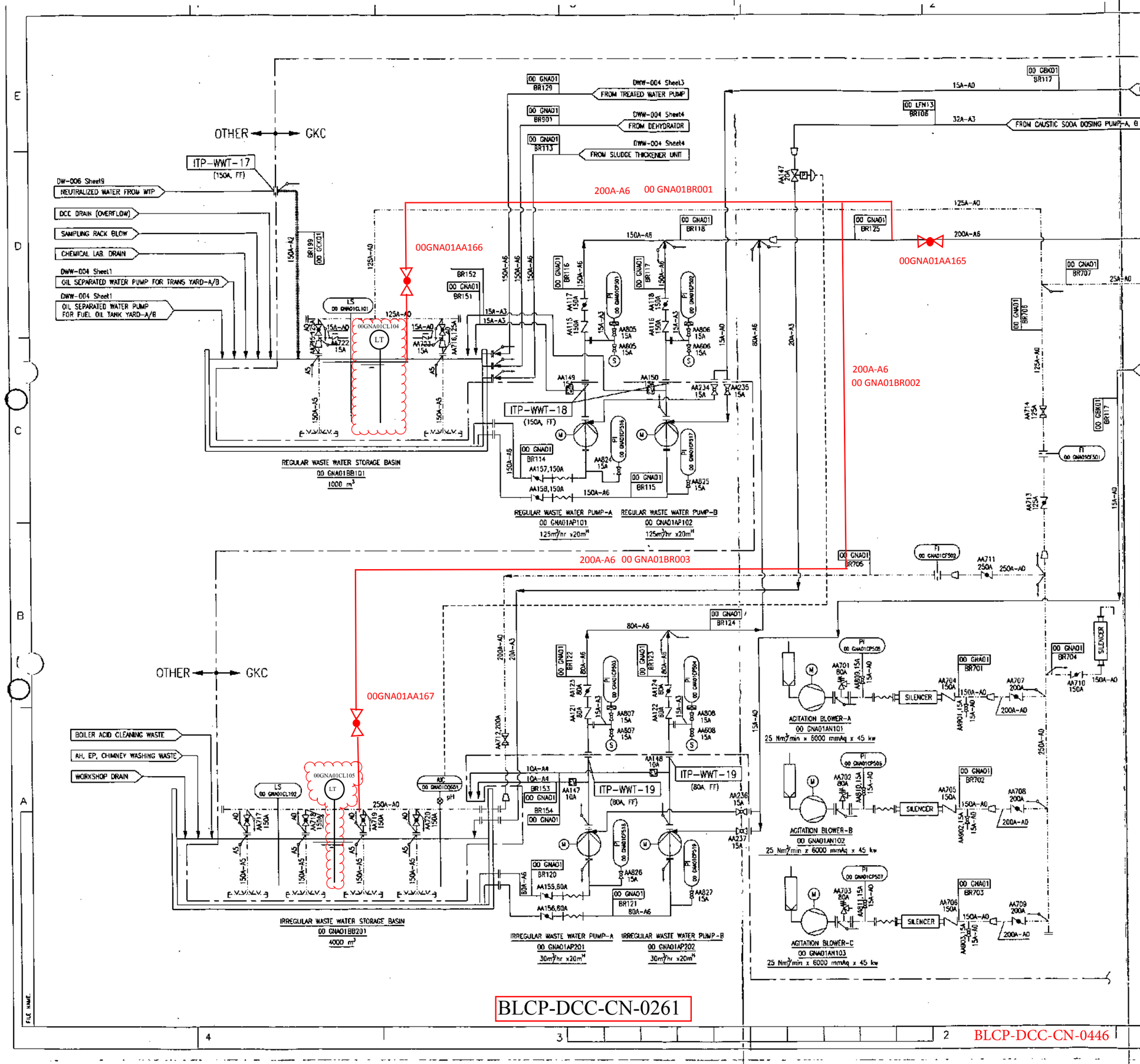
FILE NAME:



NOTE
A0 : CARBON STEEL
A1 : CARBON STEEL/HOT DIPT GALV
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A3 : SUS-304
A4 : SUS-316L
A5 : PVC ASTM D1785
A6 : FRP DIN 1695 PN10
A7 : HDPE PN6
A8 : CARBON STEEL/INNER TEFLON LINING

Rev.	Description	Date	Draw	Checked	Approved
8	As built drawing	26-07-06	—	JFT	725

KURITA WATER INDUSTRIES LTD.

Rev.	Description	Date	Draw	Checked	Approved
8	As built drawing	20-07-06	[redacted]		
7	Rev. as marks	29-11-04	PSR	KM	KM
6	Rev. as marks	12-11-04	PSR	KT	RS
5	Rev. as marks	01-11-04	PSR	KT	KM
4	Rev. as marks	10-09-04	PSR	SN	KM
3	Rev. as marks	30-06-04	PSR	KT	KM
2	Rev. as marks	17-05-04	TP	KM	KM
1	Rev. as marks, pipe size&mat.	20-01-04	TP	KM	HS
0	First Issued	11-12-03	TP	KM	HS

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Project Name :
BLCP POWER PROJECT

Messrs :
MITSUBISHI HEAVY INDUSTRIES LTD.

Title :
WASTE WATER TREATMENT PLANT
P & I DIAGRAM

JOB NO.PJ-0311002				Drawing No.	Rev.
Sheet :		Scale :	NONE	DWW-004	9
Sheet No :	2	Format :	A3		

07385 - 53106 - 1101

BLCP-DCC-CN-0261

BLCP-DCC-CN-0446

NOTE
A0 : CARBON STEEL
A1 : CARBON STEEL/HOT DIPT CALV
A2 : CARBON STEEL/INNER HRL
A3 : SUS-304
A4 : SUS-316L
A5 : PVC ASTM D1785
A6 : FRP DIN 1695 PN10
A7 : HDPE PN6
A8 : CARBON STEEL/INNER TEFLON LINING

GKC ◄► OTHER

ITP-WWT-13 (20A, SW) — DWW-004 Sheet5 — FROM SULFURIC ACID DOSING PUMP-A, B FOR WASTEWATER TREATMENT PLANT
ITP-WWT-12 (40A, SW) — DWW-004 Sheet5 — FROM CAUSTIC SODA DOSING PUMP-A, B FOR WASTEWATER TREATMENT PLANT
ITP-WWT-11 (15A, SOCKET) — DWW-004 Sheet5 — FROM PAC DOSING PUMP-A, B FOR pH ADJUSTMENT TANK
DWW-004 Sheet2 — FROM REGULAR WASTE WATER PUMP-A, B / FROM IRREGULAR WASTE WATER PUMP-A, B
DWW-004 Sheet2 — FROM AGITATION BLOWER-A, B, C
DWW-004 Sheet2 — TO IRREGULAR WASTE WATER STORAGE BASIN
DSW-003 Sheet1 — FROM SEWAGE TREATMENT PLANT
ITP-WWT-10 (40A, SOCKET) — DWW-004 Sheet5 — FROM POLYMER DOSING PUMP-A, B FOR FLOCCULATION TANK
ITP-WWT-07 (40A, SW) — FROM SERVICE WATER

AGITATOR FOR pH ADJUSTMENT TANK 00 GNA01AM801
pH ADJUSTMENT TANK 00 GNA01BB301 27 m³
AGITATOR FOR FLOCCULATION TANK 00 GNA01AM401
FLOCCULATION TANK 00 GNA01BB401 60 m³
CLARIFIER UNIT 00 GNA01BB501 ø13000x4000H
AGITATOR FOR CLARIFIER UNIT 00 GNA01AM701
AGITATOR FOR FINAL pH ADJUSTMENT TANK 00 GNA01AM601
FINAL pH ADJUSTMENT TANK 00 GNA01BB503 27 m³
TREATED WATER BASIN 00 GNA01BB701 200 m³
TREATED WATER PUMP A 00 GNA01AP701 135 m³/Hr x 30 mH
TREATED WATER PUMP B 00 GNA01AP702 135 m³/Hr x 30 mH
CLARIFIER SLUDGE PUMP-A 00 GNA01AP501 30 m³/Hr x 20 mH
CLARIFIER SLUDGE PUMP-B 00 GNA01AP502 30 m³/Hr x 20 mH

ITP-WWT-20 (200A, FF) — TO REGULAR WASTE WATER STORAGE BASIN
ITP-WWT-20 (200A, FF) — DWW-004 Sheet3 — FROM SERVICE WATER, ITP-WWT-07
ITP-WWT-06 (150A, FF) — TO DISCHARGE

DWW-004 Sheet3 — TO TREATED WATER PUMP-A,B
DWW-004 Sheet4 — TO DEHYDRATOR / TO SLUDGE THICKENER UNIT
DWW-004 Sheet2 — TO REGULAR WASTE WATER PUMP-A,B
DWW-004 Sheet2 — TO IRREGULAR WASTE WATER PUMP-A,B
DWW-004 Sheet4 — TO SLUDGE THICKENER UNIT

Rev.	Description	Date	Draw	Checked	Approved
8	As built drawing	26.07.06	–	224	224

KURITA WATER INDUSTRIES LTD.

Rev.	Description	Date	Draw	Checked	Approved
8	As built drawing	20-07-06			
7	Rev. as marks	29-11-04			
6	Rev. as marks	12-11-04	PSR	KT	RS
5	Rev. as marks	01-11-04	PSR	KT	KM
4	Rev. as marks	10-09-04	PSR	SN	KM
3	Rev. as marks	30-06-04	PSR	KT	KM
2	Rev. as marks	17-05-04	TP	KM	KM
1	Rev. as marks, pipe size&mat.	26-03-04	TP	KM	HS
0	First Issued	11-12-03	TP	KM	HS

GOSHU KOHSAN CO., LTD.
70 Moo 5 Kingkaew rd., Bangphli Samutprakarn 10540 THAILAND
Tel. (662) 312-4159, 312-4165-7, 312-4171-5
Fax (662) 312-4162

Project Name : BLCP POWER PROJECT

Messrs : MITSUBISHI HEAVY INDUSTRIES LTD.

Title : WASTE WATER TREATMENT PLANT P & I DIAGRAM

JOB NO.PJ-0311002				Drawing No.	Rev.
Sheet :		Scale :	NONE	DWW-004	8
Sheet No :	3	Format :	A3		

07385 - 53106 - 11010

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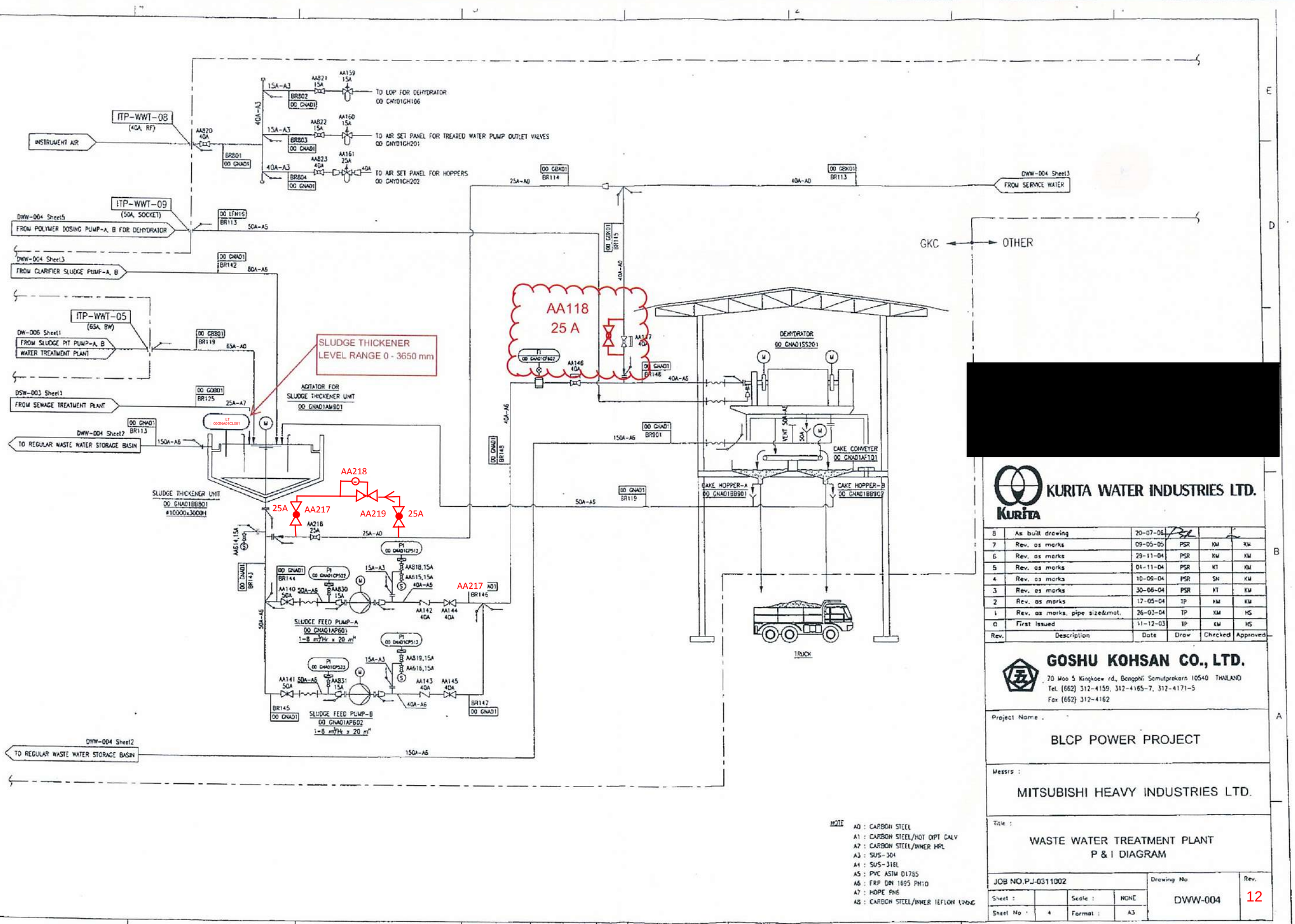

KURITA WATER INDUSTRIES LTD.

Rev.	Description	Date	Draw	Checked	Approved
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7	Rev. as marks	09-05-05	PSR	KM	KM
6	Rev. as marks	29-11-04	PSR	KM	KM
5	Rev. as marks	04-11-04	PSR	KT	KM
4	Rev. as marks	10-09-04	PSR	SN	KM
3	Rev. as marks	30-06-04	PSR	KT	KM
2	Rev. as marks	17-05-04	TP	KM	KM
1	Rev. as marks, pipe size&mat.	26-03-04	TP	KM	HS
0	First Issued	11-12-03	TP	KM	HS

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Project Name :
BLCP POWER PROJECT

Messrs :
MITSUBISHI HEAVY INDUSTRIES LTD.

Title :
WASTE WATER TREATMENT PLANT
P & I DIAGRAM

JOB NO.PJ-0311002				Drawing No	Rev.
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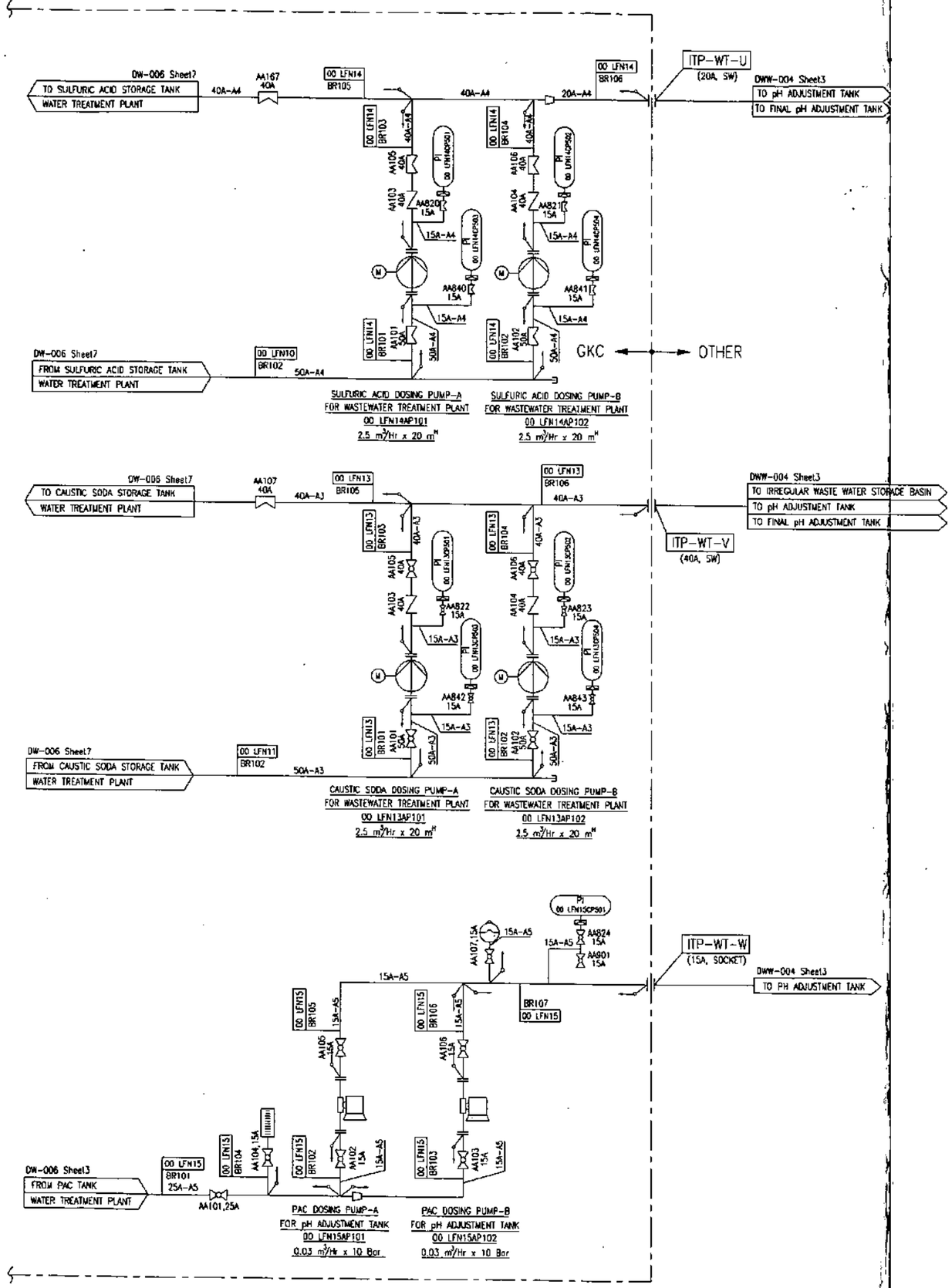
Sheet No :	4	Format :	A3		

53106-1101

BLCP-DCC-CN-0204

(M0-MN-GN-PP-01510 (53106-1101)



NOTE
A0 : CARBON STEEL
A1 : CARBON STEEL/HOT DIPT GALV
A2 : CARBON STEEL/INNER HRL
A3 : SUS-304
A4 : SUS-316L
A5 : PVC ASTM D1785
A6 : FRP DIN 1695 PN10
A7 : HDPE PN6
A8 : CARBON STEEL/INNER TEFLON LINING

Rev.	Description	Date	Draw	Checked	Approved
6	As built drawing	26/7/06	–	???	???

KURITA WATER INDUSTRIES LTD.

Rev.	Description	Date	Draw	Checked	Approved
6	As built drawing	20-07-06			
5	Rev. as marks	01-11-04			
4	Rev. as marks	10-09-04	PSR	SN	KM
3	Rev. as marks	30-06-04	PSR	KT	KM
2	Rev. as marks	17-05-04	TP	KM	KM
1	Rev. as marks, pipe size&mat.	26-03-04	TP	KM	HS
0	First Issued	11-12-03	TP	KM	HS

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MITSUBISHI HEAVY INDUSTRIES LTD.

Title :
WASTE WATER TREATMENT PLANT
P & I DIAGRAM

JOB NO.PJ-0311002				Drawing No.	Rev.
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Sheet No :	5	Format :	A3		

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ภาคผนวก จ-3

แผนผังตำแหน่งติดตั้งบ่อรวบรวมน้ำที่ผ่านการบำบัด จากระบบบำบัดน้ำเสียของโครงการ

BLCP Drawing No. : M0-MN-GHE-PP-00409	SUPPLIER DRAWING NO./ MITSUBISHI DRAWING NO. / SUPPLIER NAME 97000-2123	PLAN RECORD	REVISIONS		CHECKED	APPROVED
			Rev. No.	Description (Date)		
			9	Revised according to Plant Modification No. 734 and 1183 (the detail please see amendment) (Refer Change request # BLCP-DCC-CN-0310)		
			9	Revised according to Plant Modification No. 1181 (the detail please see amendment) (Refer Change request # BLCP-DCC-CN-0317)		

AS BUILT

A4 x
A3 x
Total SHEETS WITH COVER

TITLE

IRRIGATION WATER SYSTEM P&I DIAGRAM

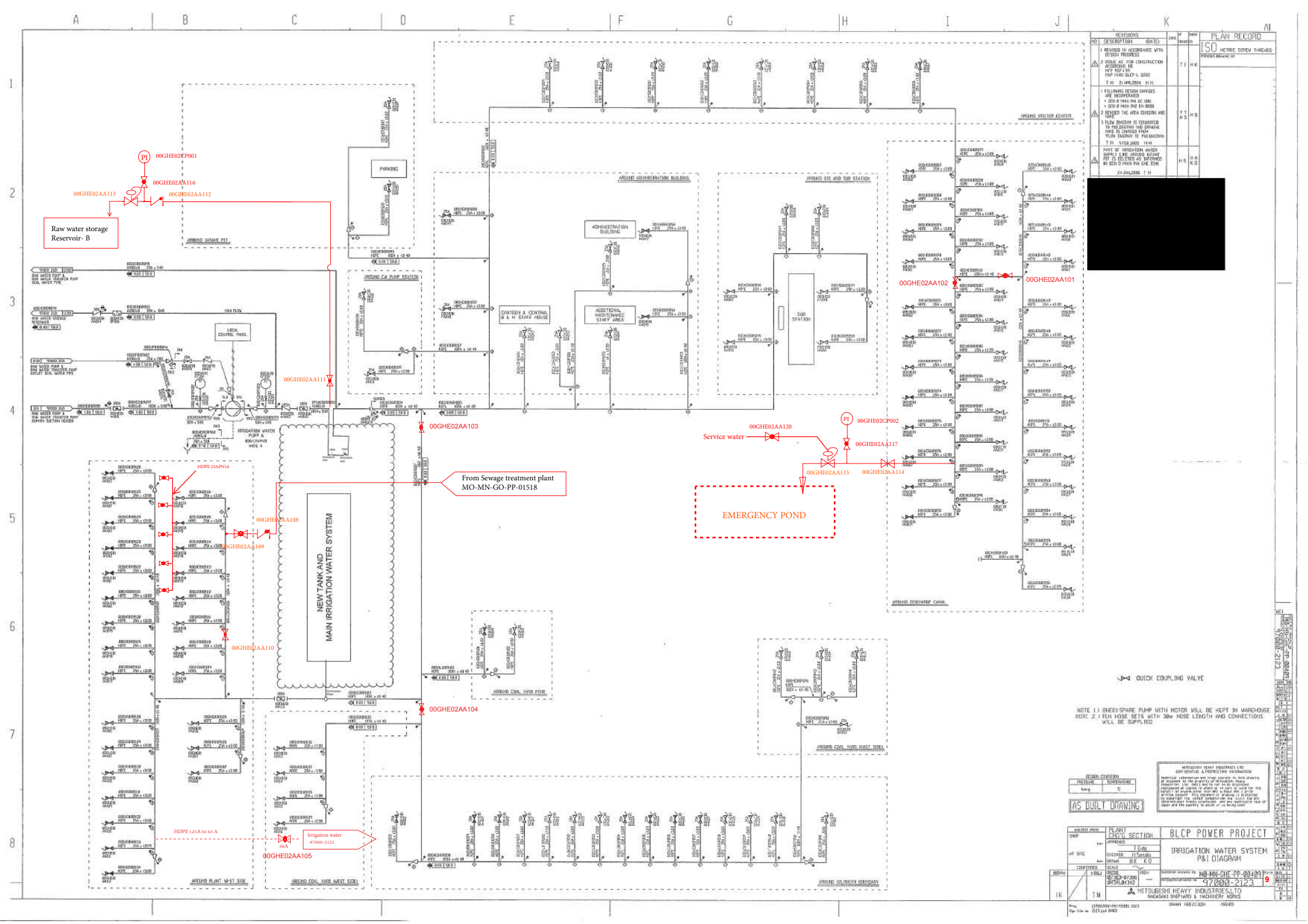
BLCP DRAWING NO.	REV. NO.
M0-MN-GHE-PP-00409	9
SUPPLIER NAME/SUPPLIER DRAWING NO./ MITSUBISHI DRAWING NO. 97000-2123	

BLCP POWER

BLCP POWER PROJECT

AMENDMENT RECORD

REVISED	DESCRIPTION	AMENDMENT	REMARK
8	**Revised according to Plant Modification #** PI# 734. The Treated waste water Zero dischrage project. To install irrigation water supply instead of wservice water for cleaning the jetty floor and install new potable water supply 3 point at jetty PI# 1183. Modify Irrigation water pipe and valve to FGD emergency basin. (BLCP-DCC-CN-0310)	**13-Jun-16**	
9	**Revised according to Plant Modification #** PI# 1181. Modify pipe line for Irrigation water discharge return back to Raw water basin B (BLCP-DCC-CN-0317)	**Oct. 25, 2016**	


00GHE02CP001
00GHE02AA116
00GHE02AA113
00GHE02AA112
Raw water storage Reservoir- B
00GHE02AA111
00GHE02AA103
From Sewage treatment plant MO-MN-GO-PP-01518
00GHE02AA120
Service water
00GHE02CP002
00GHE02AA117
00GHE02AA115
00GHE02AA114
EMERGENCY POND
00GHE02AA102
00GHE02AA101
HDPE 25APN16
00GHE02AA108
00GHE02AA109
NEW TANK AND MAIN IRRIGATION WATER SYSTEM
00GHE02AA110
00GHE02AA104
HDPE 125A to 63 A
50A
Irrigation water 97000-2121
00GHE02AA105
QUICK COUPLING VALVE
NOTE 1) ONE(1) SPARE PUMP WITH MOTOR WILL BE KEPT IN WAREHOUSE
NOTE 2) TEN HOSE SETS WITH 30m HOSE LENGTH AND CONNECTIONS WILL BE SUPPLIED
AS BUILT DRAWING
PLANT C&G'S SECTION
BLCP POWER PROJECT
IRRIGATION WATER SYSTEM P&I DIAGRAM
MO-MN-GHE-PP-00400
97000-2123
MITSUBISHI HEAVY INDUSTRIES,LTD
NAGASAKI SHIPYARD & ENGINEERING WORKS

ภาคผนวก จ-4

รายละเอียดการออกแบบระบบบำบัดน้ำเสียของโครงการ

PLAN RECORD	REVISIONS		AP-PROVED	CHECK-ED
ISOMETRIC SCREW	NO.	DESCRIPTION(DATE)		

CUSTOMER DRAWING NO. M0-MN-GN-PP-00090

MITSUBISHI DRAWING NO. 97000-2262-26

Sec. Code RN1

出図先		部数
BLCP		3
三菱		1
プ技一		1
浅田PD		C
富原PM		C
プ	計機	A+2
ラ	配	C+1
ン	設	C
プ	装	C
ラ	海洋	C+1
計	計二	C+1
電	電	C
火制技		C
陸	計画	C
上	新技	
水	保技	
	設	C
エ	環シ	
ネ	燃シ	C
環	機	C
	計	C
陸	技	
ク	本	
	方	
風力		
船タ		
原設(冷)		C
火計(冷)		C
火計(輸)		C
計電工		C
建設		C+1
土建		C+1
生管		C
品保		C
機品一		
機品二		
配船生管		
素材Gr.		
装置Gr.		
機器Gr.		
神船		1
広島		1
原船二		C
座		
計		14

FOR REVIEW

A4×21 SHEET(S) WITH COVER

[redacted]

BLCP POWER PROJECT

WASTE WATER TREATMENT PLANT DESIGN MANUAL

CUSTOMER DRAWING NO. M0-MN-GN-PP-00090

MITSUBISHI DRAWING NO. 97000-2262-26

REV NO 0

[redacted]

MITSUBISHI HEAVY INDUSTRIES,LTD.
NAGASAKI SHIPYARD & MACHINERY WORKS

DRAWN 2003/12/25 ISSUED

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Revision Control			
Page Number	Description of Amendment	Amendment Revision	Date Amended Pages Inserted

Part I. Waste Water Treatment Plant

1. Function

The contaminated drains of various qualities from different areas of the plant are collected by the drainage system and sent to the Waste Water Treatment Plant (WWTP) for treatment to meet the effluent quality, as mentioned hereinafter, before discharging to the sea. The plant is a common facility for the two units.

The contaminated run-off water from coal yard and rain water from boiler & EP areas will be sent to the Coal Yard Waste Water Treatment Plant (CWWTP), which is described in the Part II of this document.

2. System Description

The Waste Water Treatment Plant includes the following major equipment and facilities:-

- One (1) 1,000 m^3 Regular Waste Water Storage Basin
- One (1) 4,000 m^3 Irregular Waste Water Storage Basin
- One (1) 10 m^3/h Oil Separator for Trans Yard
- One (1) 25 m^3/h Oil Separator for Fuel Oil Tank Yard
- One (1) pH Adjustment Tank
- One (1) Flocculation Tank
- One (1) Clarifier Unit
- One (1) Final pH Adjustment Tank
- One (1) Treated Water Basin
- One (1) Sludge Thickener Unit
- One (1) Dehydrator

- Two (2) Cake Hoppers
- Two (2) Regular Waste Water Pumps
- Two (2) Irregular Waste Water Pumps
- Two (2) Clarifier Sludge Pumps
- Two (2) Sludge Feed Pumps
- Two (2) Treated Water Pumps
- Two (2) Oil Separated Water Pump for Trans Yard
- Two (2) Oil Separated Water Pump for Fuel Oil Tank Yard
- Three (3) Agitation Blowers
- H_2SO_4 dosing system
- NaOH dosing system
- Polymer dosing system
- PAC dosing system
- Interconnecting piping, valves, instrumentation and controls

Various contaminated drains are classified as follows:

Oily drain

For design of the Waste Water Treatment Plant, the following oily drains are considered as the intermittent drain:

- Rainwater from the fuel oil storage area, the transformer yard and the turbine oil tank area
- Boiler house, IDF area, and Turbine Generator bldg. equipment floor drain
- Fuel Oil Service Station drain

- Bulldozer Parking drain

Contaminated but oil-free drain

For design of the Waste Water Treatment Plant, the following contaminated drain is considered as the continuous drain:

- DCC overflow

Chemical drain

For design of the Waste Water Treatment Plant, the following chemical drains are considered as the continuous drain:

- Chemical Laboratory drain
- Sampling rack blow
- Chemical Injection Pump/Tank Area drain
- Demineralizing System Regeneration Waste

And the following chemical drains are considered as the intermittent drain:

- Washing waste of Regenerative Air Heater and Chimney
- Drain of Chemical Cleaning of Boiler
- Boiler Hydrostatic Test drain

As the Boiler Blowdown during normal operation is expected to be within the Water Quality Standard, it will be directly directed to the sea. Hence the Boiler Blowdown is not considered as the continuous drain in the WWTP capacity. In the case the Boiler Blowdown quality does not meet the Water Quality Standard during a short period, it can be directed to the Regular or Irregular Waste Water Storage Basin via the Boiler House Chemical Sump and can be treated by the WWTP as the irregular /intermittent drain. A sampling point is provided in the Boiler Blowdown Tank drain pipe.

Oily drain is collected separately in oily waste water sumps and passed through the oil separators before further treatment in the waste water treatment plant. Two numbers of CPI type oil separators are provided.

The separated oil collects into an oil collection pit for periodic disposal and the water is pumped into the regular waste water storage basin of the Waste Water Treatment Plant.

There will be two waste water storage basins in the treatment plant. The regular waste water storage basin is fed with regular drains like the DCC overflow, sampling rack & chemical laboratory drains, boiler & turbine area equipment floor drains, and rainwater in transformer areas. The irregular waste water storage basin is used for irregular drains generated during air heater washing, etc. as mentioned above. A set of agitation blowers will supply air to these basins for aeration and mixing.

Water from either of the basins will be fed by separate sets of waste water pumps to a pH adjustment tank, where pH will be controlled by dosing acid (H_2SO_4) and alkali (NaOH) as required. PAC will also be added to the tank as required to coagulate suspended solids in the waste water. The water in the tank will be agitated by the same set of agitation blowers provided for the waste water basins. The overflow from this tank will be fed to the flocculation tank, where flocculation will take place with the addition of polymer. Then the waste water will be fed to the clarifier unit. The sludge from the clarifier will be pumped to a sludge thickener while the clear water will go into a tank for final adjustment of pH by dosing acid/alkali as needed. The treated water from sewage treatment plant will also be fed to this tank. The water will finally collect in the treated water basin from where it will be discharged by a set of treated water pumps.

Apart from the waste water sludge mentioned above, the sludge thickener will also accept the sludge from the sewage treatment plant and the pretreatment plant. The separated water from the thickener will overflow to the regular waste water storage basin by gravity. The sludge will be fed to the dehydrator by a set of sludge feed pumps. Polymer will be dosed into the sludge to help the dehydration. The dehydrated sludge will be carried by a cake conveyor to the cake hopper for final disposal by trucks. The separated water from dehydrator will be transferred to the regular waste water storage basin by gravity.

3. Design Criteria

The system will be designed as per the industry practice and to comply with the requirements of the applicable standard.

The waste water balance for two units for design of the Waste Water Treatment Plant will be as mentioned in Attachment-1.

The treated water quality after WWTP will be as mentioned in Table-1.

3.1 Operating Conditions

The waste water flow rate to the pH adjustment tank is 100 m^3/hr.

Oily water flow rates to the Oil Separators for Trans Yard and for Fuel Oil Tank Yard are 10 m^3/hr and 25 m^3/hr respectively.

A portion of the various drains coming to WWTP is rainwater. In estimating the rainwater quantity, the design rainfall of 135.4 mm/day has been considered.

The WWTP capacity of 100 m^3/hour will be adequate to handle the regular drain & a part of the irregular drain. The irregular waste water storage basin capacity will be sufficient to store the largest of all incoming intermittent drains. The regular waste water storage basin will be capable of storing design inflow of about 12 hours.

Two cake hoppers of 21m^3 capacity, which correspond to total two days capacity per two hoppers, are provided for storage and discharge of sludge to trucks.

3.2 Functional Constraints

The separation of oil or sludge will be by gravity. Hence all the basins, tanks and clarifiers will be designed to provide sufficient retention time for gravity separation. The flow velocity will be sufficiently low as required for the separation process.

Effluent of the WWTP will be monitored by in-line pH & SS analyzers and a laboratory type oil-in-water analyzer is provided to monitor the oil content in the effluent.

3.3 Physical Constraints

The installation levels of pH adjustment tank, flocculation tank, clarifier, sludge thickener etc. in WWTP will be decided so that gravity flow at desired rate is possible in such equipment.

The plant layout will ensure easy access to monitor instruments and maintenance items and will avoid dead pockets as far as possible.

The material for aboveground waste water piping will be FRP. Buried pipes will be HDPE or 304 stainless steel. The pipes for acid/alkali/hypochlorite dosing will be carbon steel/stainless steel/PVC as applicable.

4. Process Control

pH measuring and controlling instruments on the first and the final pH adjustment tanks will regulate the control valves in the respective acid and alkali dosing lines to these tanks. The signal from the same instrument in the final pH adjustment tank will be used to regulate two automatic on-off valves in the effluent line after the tank – one for collection in the treated water basin if the pH is within acceptable limits and the other for re-circulating back to regular waste water storage basin if pH is unacceptable after treatment.

A magnetic type flow indicator is installed in the inlet of the pH adjustment tank to monitor the flow.

pH monitoring instruments will be provided in the final discharge line after treated water basin, and SS monitoring instruments will be provided in the treated water basin.

Oil-in-water analyzer (non-continuous automatic type as mentioned Vol.III 6.1.23) is provided for manual analyzing for residual oil.

5. System Operation

The plant will be operated continuously depending on the drain collection in the regular waste water storage basin. The sequential operation of the equipment in the plant will be built in the control logic.

The WWTP will be provided with PLC based automatic controls. The PLC is interfacing with DCS by communication network.

Normally, operator can monitor main status of equipment in Wastewater treatment system and monitor main alarms. Furthermore, operator initiate group sequence command to the Wastewater treatment system from OPS at CCR.

In remote mode, group sequence command is initiated manually by push button at OPS. In local mode, Individual operation(waste water pumps, treated water pumps, clarifier sludge pumps, sludge feed pumps and various dosing pumps) and monitoring will be carried out from local control panel in local control room of water treatment plant house.

The PLC is common to the Sewage Treatment Plant. For detail of system operation of the Sewage Treatment Plant, refer to the Sewage Treatment Plant Design Manual.

Interlocks

Suitable interlocks for safe operation of the pumps depending on the levels of the corresponding tanks on the suction side will be provided.

Alarms

Alarms required for monitoring of WWTP are provided in the local control room. Main alarm will be sent to DCS, and they are monitored at OPS in CCR.

6. References

1. Waste Water Treatment Plant Flow Diagram (Dwg. Nos. 53106-1101, Rev. 0)
2. Sewage Treatment Plant Design Manual (Dwg. No. 97000-2262-29, Rev. 0)
3. Contract Specification Vol. II, Sec. 1.7.2.2 Water Quality Standards
4. Contract Specification Vol. III, Sec. 2.1.1 Meteorological Data

Part II. Coal Yard Waste Water Treatment Plant

1. Function

An additional Coal Yard Waste Water Treatment Plant (CWWTP) is provided to receive the rainwater run-off water in the Coal yard with HDPE sheet, Pier and Boiler & EP area drain. The drains will be treated to keep the limit of Thai Water Quality Standard (refer to Table-1) before discharging to the sea. The plant is a common facility for the two units.

2. System Description

The Coal Yard Waste Water Treatment Plant includes the following major equipment and facilities:-

- Outward wall with inscribed open ditch surrounding the entire coal yard
- One (1) Motorized gate installed at connecting channel between Coal Yard and Coal Yard Pond
- One (1) 8,000 m^3 Coal Yard Pond to serve as a buffer storage pond for accumulation of rainwater and sedimentation of coarse particles
- Two (2) Coal Yard Pond Transfer Pump to transfer waste water to pH Control Tank
- One (1) pH Control Tank for chemical dosing to limit the pH of rain water runoff within acceptable limit for preparation of flocculation to assist in sedimentation in the subsequent stages
- NaOH dosing system
- H_2SO_4 dosing system
- One (1) Flocculation Tank for chemical dosing to assist in sedimentation and thus reduction of suspended solids from rainwater runoff

- Two (2) Coagulating Chemical (PAC and Polymer) dosing system
- One (1) Agitation Blower for better mixing of chemicals in pH Control Tank and Flocculation Tank
- One (1) Sedimentation Tank with flow straightener for sedimentation of suspended solids from the waste water
- One (1) Treated Water Tank for storage of clean water
- Two (2) Treated Water Transfer Pumps for discharging treated water to the Outfall
- One (1) Safety Shower with Eye Washer
- Interconnecting piping, valves, instrumentation and controls

In addition, as a part of the Yard Spray system, two (2) Water Pumps for coal yard spray are installed at the Treated Water Tank, and a raw water make-up system to Treated Water Tank is provided.

For storage of rainwater run-off in the coal yard, two storage area is designated - one is the coal yard and the other is in Coal Yard Pond. The entire coal storage stock pile is surrounded with open ditch having an outward wall of adequate height. Instead of directing the Boiler, EP Drain accumulation to this skirt walled coal yard area, a separate 8,000 m^3 Coal Yard Pond is provided to gather all the rainwater. Rainwater runoff from the coal yard will also be directed to this pond. The coal yard open ditch is connected with the Coal Yard Pond through an open channel and a motorized gate. Two 50% Coal Yard Pond Transfer Pumps are installed at the Coal Yard Pond with floating flexible suction piping for transferring the surface water of the waste water from the Coal Yard Pond to pH Control Tank.

Besides the above, one pH Control Tank and one Flocculation Tank are provided for the purpose of waste water pH recovery and to assist in chemical mixing for sedimentation. Flow from pH Control Tank to Treated Water Tank, through Flocculation Tank and Sedimentation Tank, is effected through spillover flow mechanism.

Sedimentation Tank is equipped with a flow straightener near the entry of the tank. This flow straightener assists in reducing the flow turbulence in the subsequent part of Sedimentation Tank and thus assist in sedimentation through reduction of agitation.

After sedimentation, the clear water will spillover to Treated Water Tank for final discharge to the Outfall or for spray for coal yard. Water reserve in this tank will always be maintained to a normal level for spray water use purpose either through supply of treated waste water or supply of raw water through a different pipe route.

Two Water Pumps are provided as a part of the Yard Spray System for supplying spray water from the Treated Water Tank for coal dust suppression in the coal handling facility. The Water Pumps are installed in the Treated Water Tank instead of any other reservoir, to avoid possibility of getting the spray nozzle clogged by suspended coal dust particles.

Also other Two Treated Water Transfer Pumps are installed in Treated Water Tank for discharging any excess waste water to the Outfall. The capacity of each of the transfer pumps in the Coal Yard Pond and Treated Water Tank are rated at 300 m^3/h.

3. Design Criteria

The system will be designed as per the industry practice and to comply with the requirements of the applicable standard.

The treated water quality after CWWTP will be as mentioned in Table-1. For monitoring of the treated water quality during normal operation, pH & SS monitoring instruments will be provided in the final discharge line after treated water tank.

3.1 Operating Conditions

The capacity of CWWTP is 600 m^3/h. A substantial portion of this drain is rainwater. In estimating the rainwater quantity, the maximum rainfall of "209 mm in three days(*1)" and the maximum rainfall intensity of "70 mm/h" has been considered instead of the design rainfall of 135.4 mm/day.

(*1) Recorded maximum rainfall data in both 3 & 5 continuous days in the past decade around Map Ta Phut area

According to the study of the maximum storage volume shown in Figure 2, the total waste water storage capacity of the coal yard and Coal Yard Pond are designed to hold the maximum rainwater run-off storage of 29,150 m^3.

3.2 Functional Constraints

The separation of particles will be by gravity. Hence the coal yard pond and the sedimentation tank will be designed to provide sufficient retention time for gravity separation. The flow velocity will be sufficiently low as required for the separation process.

As the CWWTP is occasionally utilized only during the rainy season, the standby facilities are basically not provided.

3.3 Physical Constraints

pH control tank, flocculation tank, sedimentation tank and treated water tank are located outdoor and the installation levels of these tanks will be decided so that gravity flow at desired rate is possible in such equipment.

The plant layout will ensure easy access to monitor instruments and maintenance items and will avoid dead pockets as far as possible.

The material for aboveground Coal Yard Spray System water piping will be carbon steel. Buried pipes will be HDPE. The pipes for acid/alkali dosing will be PVC.

4. Process Control

4.1 pH control at pH control tank

pH will be adjusted by injection of H_2SO_4 and NaOH.

4.2 Level control for treated water tank

Level of treated water tank is regulated to XXX (m) by the CWWTP treated water tank control valve.

4.3 Analyzer

pH & SS monitoring instruments will be provided in treated water tank.

5. System Operation

The operation of the plant is dependent on water collection in the pond, which, in turn, is dependent on rainfall.

The rainwater runoff is stored in the Coal Yard, Open Ditch and Coal Yard Pond. The stored water in the Coal Yard Pond is eventually transferred to the Treated Water Tank through pH Control Tank, Flocculation Tank and Sedimentation Tank for pH adjustment and suspended solid removal before the final discharge to the Outfall. Attempt should always be made to keep the coal yard pond buffer capacity of 8,000 m^3 empty as a preparatory caution for accommodating the heavy rain.

In the flow path, the pumped waste water from the Coal Yard Pond is directed to the pH Control Tank to adjust the pH level within the Thai Water Quality Standard (5.5 - 9.0). The treated water in pH Control Tank then spills over to Flocculation Tank for coagulant chemical injection and mixing for removal of the suspended solids in the subsequent Sedimentation Tank, and finally the clear water spills over to Treated Water Tank for temporary storage.

From the Treated Water Tank, this clear water is used for coal yard water spray for dust suppression when the water in treated water tank is at normal level. If the level of Treated Water Tank increases beyond the normal level required for storing the spray water to the coal handling facilities, the clear water is discharged to the Outfall by the Treated Water Transfer Pumps.

The operating philosophy of Coal Yard Waste Water Treatment Plant has three distinctive features depending on the intensity of rain as experienced at Map Ta Phut area in the past. From the meteorological record provided by the Contract Specification, it is noted that site weather condition can be divided in three different phases based on rainfall precipitation, viz. Normal Rain, Heavy Rain and Dry condition.

Normal Rain Condition

In case of Normal rain condition, the flow path of waste water starting from gravity flow from Coal Yard to Coal Yard pond through the open channel, Coal Yard Pond to Outfall through the CWWTP can be continuously maintained. Since the Treated Water Tank reserves water storage for supply of spray water for coal dust suppression in the Coal Handling facility, water transfer from Treated Water Tank to Outfall will be made if the level increases beyond normal storage level. In this case one transfer pump operation in automatic made in both the Coal Yard Pond and Treated Water Tank might be adequate to cater for waste water handling.

Heavy Rain Condition

In case of Heavy rain, the accumulation rate in the combined area of coal yard and Coal Yard Pond will be too high and accordingly controlled from

flow coal yard to Coal Yard Pond is required. The Motorized gate in the open channel between coal yard and Coal Yard Pond will operate in on-off mode to maintain the level of the Coal Yard Pond below the maximum storage level. Depending on the pond level, one or two transfer pump(s) will operate to transfer the waste water to pH Control Tank which will be subsequently directed to Treated Water Tank through the CWWTP. As shown in Figure 2, this will be repeat of batch treatments.

Dry Condition

In dry condition, no rain is expected and hence that can be considered as appropriate timing for cleaning of all the pond and tanks. For removal of coal sludge from the Sedimentation Tank, one normally closed valve will be opened to direct the stored water above coal sludge from Sedimentation Tank to Coal Yard Pond. Afterwards, once the Sedimentation Tank gets dried-up, the coal sludge may be removed with the help of bulldozer. Coal sludge from Coal Yard Pond can also be removed utilizing bulldozers during the dry season. Also for inspection and maintenance of Motorized Gate and Transfer Pumps, dry season would be the best timing.

Based on the above operating philosophy, operation of each of the equipment is individually summarized below:

Motorized Gate

The Motorized gate has OPEN/CLOSE operation based on the signal received from the Coal Yard Pond level transmitter. Normally the gate is kept open as long as the water level of the Coal Yard Pond is low. When the water level goes high, the gate will be closed.

Coal Yard Pond Transfer Pumps

The pump operation (either single or double) will be in automatic mode based on the signal received from the Coal Yard Pond level transmitter.

Treated Water Transfer Pumps

The pump operation (either single or double) will be in automatic mode based on the signal received from the Treated Water Tank level transmitter. The level setting for pump start shall be made above the normal water reserve requirement for spray water use.

NaOH dosing system

NaOH dosing system covers NaOH Tank, NaOH Transfer Pump, NaOH Dilution Tank, NaOH Dilution Tank Agitator and NaOH Pump. NaOH Pump is controlled according to the measured pH value from pH transmitter in the pH Control Tank following a feedback control mechanism. NaOH solution preparation in the NaOH Dilution Tank shall be carried out through manual operation of NaOH Transfer Pump and Agitator.

H_2SO_4 dosing system

H_2SO_4 dosing system covers H_2SO_4 Tank, H_2SO_4 Transfer Pump, H_2SO_4 Dilution Tank, H_2SO_4 Dilution Tank Agitator and H_2SO_4 Pump. H_2SO_4 Pump is controlled according to the measured pH value from pH transmitter in the pH Control Tank following a feedback control mechanism. H_2SO_4 solution preparation in the H_2SO_4 Dilution Tank shall be carried out through manual operation of H_2SO_4 Transfer Pump and Agitator.

PAC dosing system

PAC dosing system covers PAC Tank and PAC Pump. PAC Pump operation is automatic operation and is interlocked with Coal Yard Pond Transfer Pump(s) operation. If any of the two Coal Yard Pond Transfer Pumps operates - the PAC Pump will start operation. For this chemical injection - the solution with a fixed concentration will be kept ready for use and the PAC Pump will vary the injection rate based on number of Coal Yard Transfer Pump operation.

Polymer dosing system

Polymer dosing system covers Polymer Tank, Sub Tank, Polymer Tank Agitator and Polymer Pump. Polymer Pump operation is automatic operation and is interlocked with Coal Yard Pond Transfer Pump(s) operation. If any of the two Coal Yard Pond Transfer Pumps operates - the Polymer Pump will start operation. For this chemical injection - the solution with a fixed concentration will be kept ready for use and the Polymer Pump will vary the injection rate based on number of Coal Yard Transfer Pump operation.

Agitation Blower

The Agitation Blower operation is automatic operation and is interlocked with Coal Yard Pond Transfer Pump operation. If any of the two Coal

Yard Pond Transfer Pumps operates - the Agitation Blower will start operation.

Interlocks

Suitable interlocks for safe operation of the pumps depending on the levels of the corresponding tanks on the suction side will be provided.

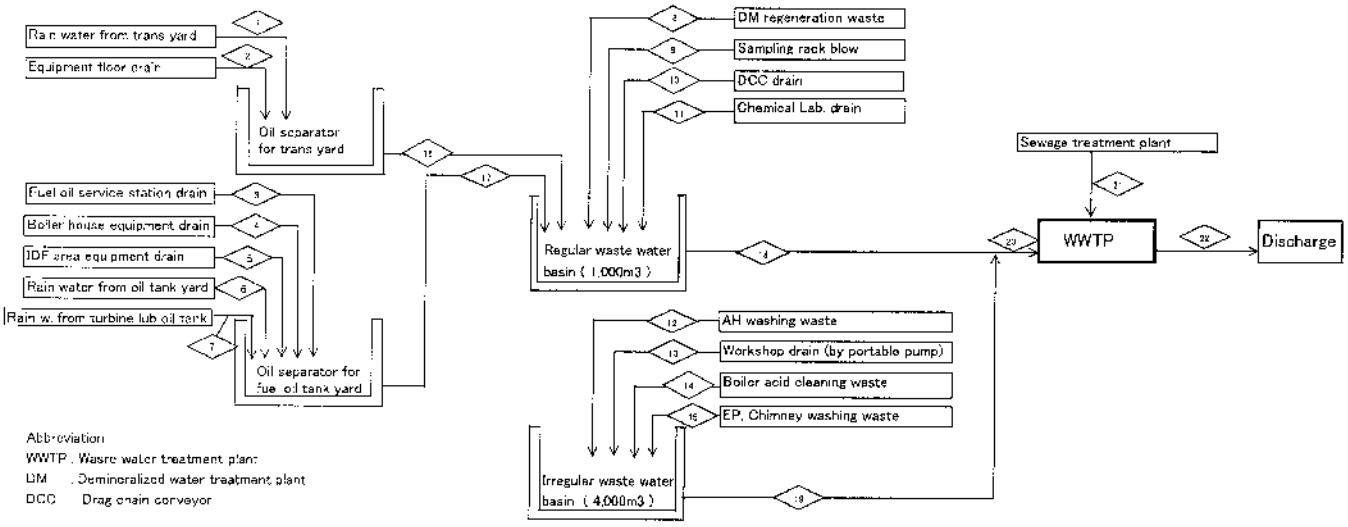
Alarms

Alarms required for monitoring of CWWTP are provided on the local panel in the Control Room in the Water Treatment Plant House. A common alarm is transmitted to DCS and indicated in the CCR.

6. References

1. Coal Yard Waste Water Treatment Plant Flow Diagram (Dwg. No. Later)
2. Contract Specification Vol. II, Sec. 1.7.2.2 Water Quality Standards
3. Contract Specification Vol. II, Appendix A Meteorological Data
3. Contract Specification Vol. III, Sec. 2.1.1 Meteorological Data

Figure 1. **Waste Water Balance for Two units**



Note: As No. 12, 14 and 15 are not processed simultaneously, No. 12 is used for design.

No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Design flow (m^3/d) (Case-1)	0	0	0	0	0	0	0	180	40	576	10	3540m^3/one operation	1	2000m^3/one operation	200m^3/one operation	0	0	806	600	1406	105	1511
Design flow (m^3/d) (Case-2)	151	0	37	50	49	322	11	180	40	1152	10	0	1	0	0	151	469	2002	0	2002	105	2107
Design flow (m^3/d) (Case-3)	151	0	37	50	49	322	11	180	40	576	10	3540m^3/one operation	1	2000m^3/one operation	200m^3/one operation	151	469	1426	600	2026	105	2131

Case-1 : Steady water +Air heater washing waste treatment Case-2 : Steady water +Rainy water treatment Case-3 : Steady water +Air heater washing waste +Rainy water treatment

Figure 2. Estimated Rain Water Flow and Volume of the Rain Water

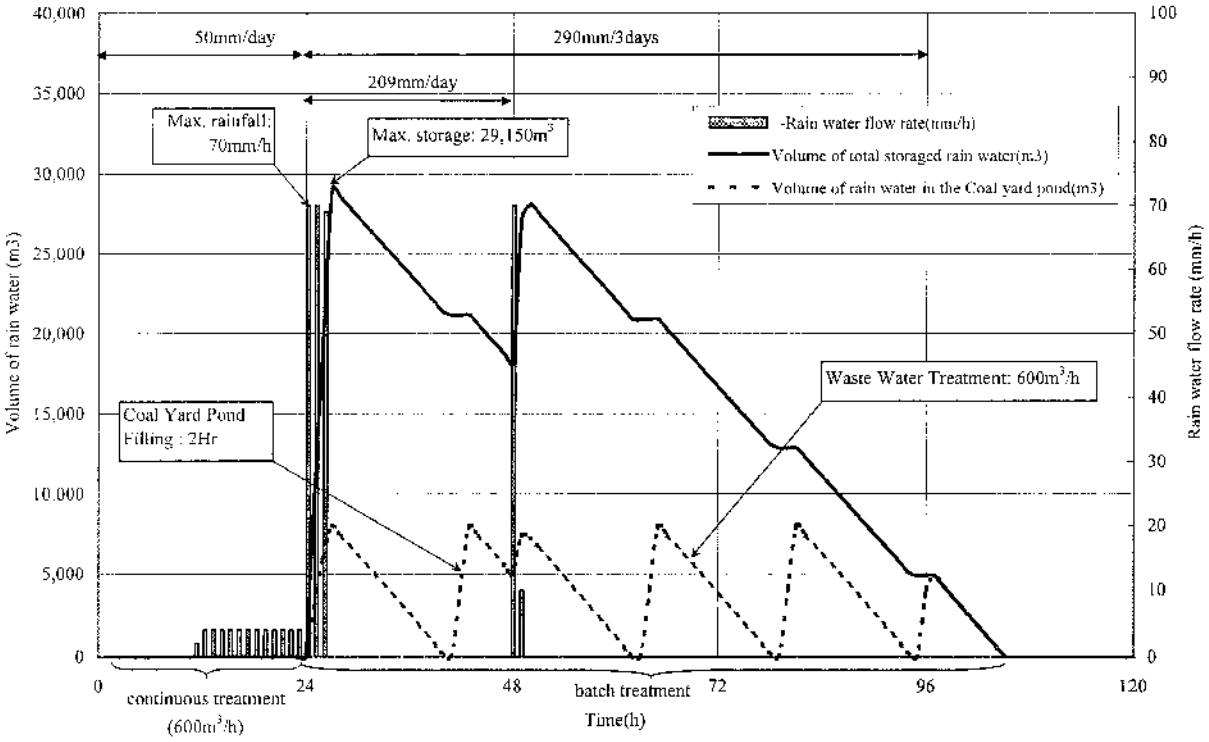


Table-1. Thai Water Quality Standard
(per Contract Specification Vol. II, Sec. 1.7.2.2)

Item	Unit	Standard Values
1. pH		5.5 – 9.0
2.Total Dissolved Solids (TDS)	mg/l	-not more than 3000 mg/l depending on receiving water or type of industry under consideration of PCC but not exceed 5000 mg/l -not more than 5000 mg/l exceed TDS of receiving water having salinity of more than 2000 mg/l or TDS of sea if discharge to sea
3.Suspended Solids (SS)	mg/l	-not more than 50 mg/l depending on receiving water or type of industry or type of wastewater treatment system under consideration of PCC but not exceed 150 mg/l
4.Temperature	°C	not more than 40
5. Colour and Odor		not objectionable
6. Sulfide (as H_2S)	mg/l	not more than 1.0
7. Cyanide (as HCN)	mg/l	not more than 0.2
8. Heavy Metals -Zinc -Chromium(Hexavalent) -Chromium(Trivalent) -Arsenic -Copper -Mercury -Cadmium -Barium -Selenium -Lead -Nickel -Manganese	mg/l	not more than:- 5.0 0.25 0.75 0.25 2.0 0.005 0.03 1.0 0.02 0.2 1.0 5.0
9. Fat, Oil & Grease (FOG)	mg/l	-not more than 5 mg/l depending on receiving water or type of industry under consideration of PCC but not exceed 15 mg/l
10. Formaldehyde	mg/l	not more than 1.0
11. Phenol	mg/l	not more than 1.0
12. Free Chlorine	mg/l	not more than 1.0
13. Pesticides	mg/l	not detectable
14. Biochemical Oxygen Demand (BOD)	mg/l	not more than 20 mg/l depending on receiving water or type of industry under consideration of PCC but not exceed 60 mg/l
15.Total Kjeldahl Nitrogen (TKN)	mg/l	not more than 100 mg/l depending on receiving water or type of industry under consideration of PCC but not exceed 200 mg/l
16. Chemical Oxygen Demand (COD)	mg/l	not more than 120mg/l depending on receiving water or type of industry under consideration of PCC but not exceed 400 mg/l

ภาคผนวก จ-5

ความสามารถในการรองรับน้ำเสียของ Coal Yard Pond

BLCP Drawing No. : M0-MN-GN-PP-01528

SUPPLIER DRAWING NO./ MITSUBISHI DRAWING NO. / SUPPLIER NAME 53117-1101

PLAN RECORD

REVISIONS		CHECKED	APPROVED
Rev. No.	Description (Date)		
5	Accroding to revised as PI# 692 Install additional emergency alarm system to the six existing shower eye wash stations (Refer to BLCP-DCC-CN-0153)		
6	Revised according to Plant Modification No. .976,977,978,979. Install permanence level indicator for calculate. (Refer Change request # BLCP-DCC- CN-0260)		
7	Revised according to Plant Modification No. 853 Install flow transmitter at raw water supply coal yard treatment. (Refer Change request # BLCP-DCC- CN-0272)		
8	Plant Modification No. 1577 Addition submersible pumps and control system for storm drainage system at Zone-D nearby the outfall of Canal discharge to Coal Yard gutter. BLCP-DCC-CN-0429		

AS BUILT

A4 x
A3 x
Total

SHEETS WITH COVER

TITLE

COAL YARD WASTE WATER TREATMENT PLANT FLOW DIAGRAM

BLCP DRAWING NO.	REV. NO.
M0-MN-GN-PP-01528	8
SUPPLIER NAME/SUPPLIER DRAWING NO./ MITSUBISHI DRAWING NO.	53117-1101

BLCP POWER

BLCP POWER PROJECT

AMENDMENT RECORD			
REVISED	**DESCRIPTION**	**AMENDMENT**	**REMARK**
5	Accroding to revised as PI# 692 Install additional emergency alarm system to the six existing shower eye wash stations (Refer to BLCP-DCC-CN-0153) Revised : 1. Drawing No. : DCY-003 sheet No.1	**16 June 2010**	
6	Revised according to Plant Modification No. .976,977,978,979. Install permanence level indicator for calculate. (Refer Change request # BLCP-DCC- CN-0260) Revised : 1. Drawing No. : DCY-003 sheet No. 1	**11 April 2013**	
7	Revised according to Plant Modification No. .845,851,853,854.. PI-845 Install flow transmitter at flow outlet discharge sewage waste water. PI-851 Install flow transmitter at portable water pump discharge header PI-853 Install flow transmitter at raw water supply coal yard treatment PI-854 Install flow transmitter at service water pump discharge header. (Refer Change request # BLCP-DCC- CN-0272) Revised : 1. Drawing No. : DCY-003 sheet No. 1	**01 August 2013**	
8	Plant Modification No. 1577 Addition submersible pumps and control system for storm drainage system at Zone-D nearby the outfall of Canal discharge to Coal Yard gutter. : Addition submersible pumps, check valves, valves and control system in P&ID for Coal Yard Waste Water Treatment Plant as below. BLCP-DCC-CN-0429		

REVISIONS	
Rev. No.	DESCRIPTION (DATE)
1	1. Added the following items. 1) Service water line for priming of self-priming pumps 2) Air break valve in air line 2. Modified motor rated power of the following items 1) Agitator for H_2SO_4 dilution tank : 0.37kw → 0.4kw 2) Agitator for polymer tank : 0.37kw → 0.4kw 3) Agitator for NaOH dilution tank : 1.1kw → 1.5kw 3. Modified the type of level instrument into treated water tank : LS → LIT 4. Revised the cloud marked points as per design progress. (Feb. 1, 2005)
2	Added MNS No. (Equipment, Piping, Instrument and Valve number). (Jun. 20, 2005)
3	Issued as AS BUILT DRAWING. (Jun. 14, 2006)
4	1. Following design change is corporated. FCN-0-MHIN-RB4-GNA-0310 DCN-0-MHIN-RB4-GN-0391 DCN-0-MHIN-RB1-GN-0474 2. Issued as AS BUILT DRAWING. (Aug. 30, 2006)

PIPING SYMBOLS

- UNDICIDED (TYPE) VALVE
- GATE VALVE
- GLOBE VALVE
- CHECK VALVE
- NEEDLE VALVE
- BALL VALVE
- 3 WAY BALL VALVE
- BALL VALVE WITH JACKET
- Y-GLOBE VALVE
- BUTTERFLY VALVE
- REDUCING VALVE
- DIAPHRAGM VALVE
- SAFETY VALVE
- SLIDE VALVE
- AIR FLOW CONTROL VALVE
- PNEUMATIC OPERATED CONTROL VALVE
- SELF ACTUATED CONTROL VALVE
- MOTOR OPERATED VALVE
- SOLENOID OPERATED VALVE
- PNEUMATIC OPERATED ON-OFF VALVE

WITH SUBSCRIPT

FF : FAIL FIX

FC : FAIL CLOSE

- FOOT VALVE
- PRESSURE RELIEF VALVE BACK PRESSURE VALVE
- EV EXHAUST VALVE

- PROCESS LINE
- BLOWER LINE
- BLIND FLANGE
- FLANGE
- UNION
- SPADE BLIND
- SPECTACLE BLIND
- RESTRICTION ORIFICE (RO)
- CAP (BUTT WELD TYPE)
- CAP (SOCKET WELD OR SCREWED TYPE)
- HOSE CONNECTION
- Y TYPE STRAINER
- T TYPE STRAINER
- BUCKET TYPE STRAINER
- STEAM TRAP
- SIGHT GLASS
- EXPANSION JOINT
- FLEXBLE JOINT
- OPEN FUNNEL
- PIT
- EJECTOR
- FA FA FLAME ARRESTER
- VENDOR SCOPE
- (S) SAMPLING POINT
- AIR CHAMBER

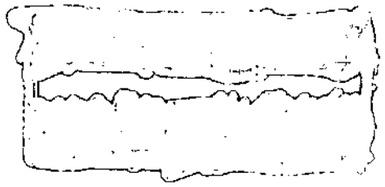
INSTRUMENT SYMBOLS & IDENTIFICATION LETTERS

- LOCALLY MOUNTED INSTRUMENT
- DCS INSTRUMENT
- CONTROL PANEL
- LOCALLY MOUNTED TRANSMITTER
- ORIFICE
- VENTURI TUBE
- POSITIVE DISPLACEMENT FLOW METER
- PADDLE WHEEL FLOW METER
- MAGNETIC FLOW METER
- VORTEX METER
- AREA METER
- PITOT TUBE
- MASS FLOW METER
- FLAPPER SIGHT GLASS
- AIR REGULATOR-1 (AR-1)
- AIR REGULATOR-2 (AR-2)
- DRIP FUNNEL-1 (DF-1)
- (PI) PRESSURE GAUGE WITH DIAPHRAGM SEAL
- AIR FILTER REGULATOR

EXAMPLE OF LETTERING

(FC 123)

- F : FIRST LETTER
- C : SUCCEEDING LETTERS
- 123 : LOOP NUMBER



EXAMPLE OF LETTERING

A	ANALYZER (WITH CORRESPONDING UNIT AS A SUBSCRIPT e.g. $(A)_{pH}$, $(A)_{EC}$)
C	CONDUCTIVITY
D	DENSITY OR SPECIFIC GRAVITY
E	VOLTAGE
F	FLOW RATE
H	HAND
L	LEVEL
M	MOISTURE OR HUMIDITY
P	PRESSURE
R	REMOTE (VALVE)
S	SPEED OR FREQUENCY
T	TEMPERATURE
TQ	TORQUE
U	MULTIVARIABLE
V	VISCOSITY
W	WEIGHT OR FORCE
X	ANOTHER

MEANINGS OF SUCCEEDING LETTERS

A	ALARM
C	CONTROL
E	ELEMEMT
G	GAUGE
I	INDICATION
K	COMPUTER CONTROL
L	LOGGING
Q	QUANTITY
R	RECORDING
S	SWITCH
T	TRANSMITTION OR CONVERSION
U	MULTIFUNCTION
V	VALVE
W	WELL
X	ANOTHER
Y	CALCULATION
Z	EMERGENCY OR SAFETY

NOTE

A0 : CARBON STEEL
A1 : CARBON STEEL/HOT DIPT GALV
A2 : CARBON STEEL/INNER HRL
A3 : SUS-304
A4 : SUS-316L
A5 : PVC ASTM D1785
A6 : FRP DIN 1695 PN10
A7 : HDPE PN6
A8 : CARBON STEEL/INNER TEFLON LINING
(A9 : CPVC)

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Rev.	Description	Date	Draw	Checked	Approved
2	Rev. as mark	15-07-09	—	[illegible]	[illegible]

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4-7, Nishi-Shinjuku 3-Chome, Shinjuku-Ku, Tokyo
160-8383 Japan
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Rev.	Description	Date	Draw	Checked	Approved
2	Rev. as mark	09-07-04	[illegible]	[illegible]	[illegible]
1	Rev. as marks	17-05-04	TP	KM	KM
0	First issued	02-04-04	CH	KM	KM

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Tel. (662) 312-4159, 312-4165-7, 312-4171-5, Fax : 312-4162
Fax (662) 312-4162

Project Name :

BLCP POWER PROJECT

Messrs :

MITSUBISHI HEAVY INDUSTRIES LTD.

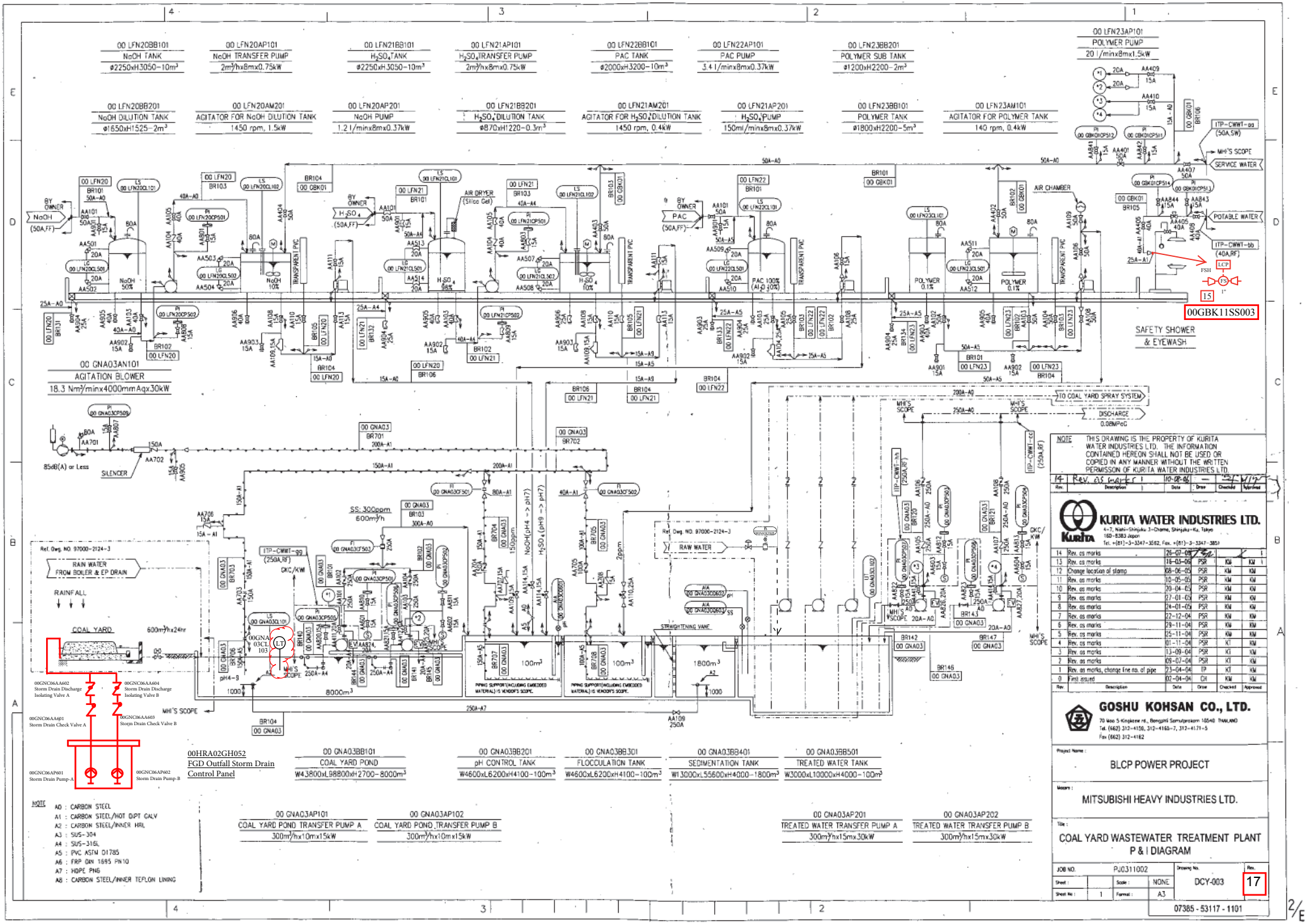
Title :

COAL YARD WASTEWATER TREATMENT PLANT
SYMBOL & ABBREVIATION

JOB NO.	PJ0311002			Drawing No.	Rev.
Sheet :	1	Scale :	NONE	DCY-000	2
Sheet No :	1	Format :	A3		

FILE NAME

07385-53117-1101



BLCP-DCC-CN-0429

BLCP-DCC-CN-0272

REVISIONS	
Rev. No.	DESCRIPTION (DATE)
1	1. Added the following items. 1) Service water line for priming of self-priming pumps 2) Air break valve in air line 2. Modified motor rated power of the following items 1) Agitator for H_2SO_4 dilution tank : 0.37kw → 0.4kw 2) Agitator for polymer tank : 0.37kw → 0.4kw 3) Agitator for NaOH dilution tank : 1.1kw → 1.5kw 3. Modified the type of level instrument into treated water tank : LS → LIT 4. Revised the cloud marked points as per design progress. (Feb. 1, 2005)
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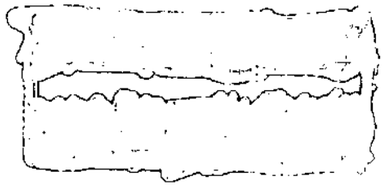

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SYMBOL & ABBREVIATION

JOB NO.	PJ0311002			Drawing No.	Rev.
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Sheet No :	1	Format :	A3		

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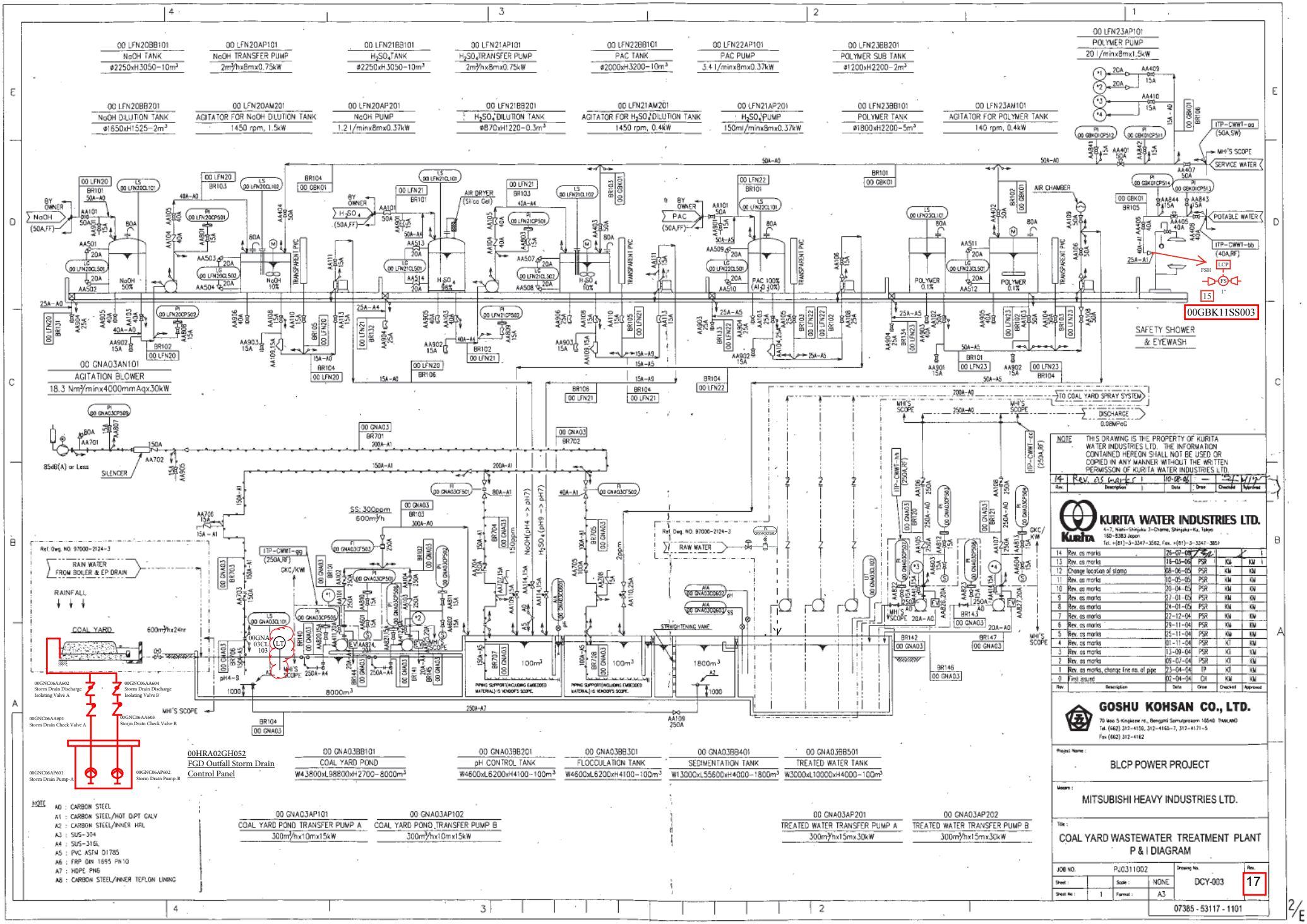

BLCP-DCC-CN-0429

BLCP-DCC-CN-0272

ภาคผนวก จ-6

การติดตั้งระบบเติมอากาศบริเวณ FGD Chamber

BLCP Drawing No. : M1-MF-HR-PP-00082

SUPPLIER DRAWING NO./ MITSUBISHI DRAWING NO. / SUPPLIER NAME: 97000-2262-18

PLAN RECORD	REVISIONS		CHECKED	APPROVED
	Rev. No.	Description (Date)	[redacted]	
	2	Revised according to Plant Modification No. 828 & 576. Installation FGD lower distributor inlet strainer system. (Refer Change request # BLCP-DCC-CN-0245)		

AS BUILT DRAWING

A4 x
A3 x
Total 9 SHEETS WITH COVER

TITLE

FLUE GAS DESULPHURIZATION (FGD) SYSTEM DESIGN MANUAL

BLCP DRAWING NO.	REV. NO.
M1-MF-HR-PP-00082	2
SUPPLIER NAME/SUPPLIER DRAWING NO./ MITSUBISHI DRAWING NO.: 97000-2262-18	

BLCP POWER

BLCP POWER PROJECT

AMENDMENT RECORD

REVISED	DESCRIPTION	AMENDMENT ISSUE DATE	REMARK
2	Revised according to PI#828 & 576. No. 828 & 576. Installation FGD lower distributor inlet strainer system. (Refer Change request # BLCP-DCC-CN-0245) Revised sheet : 1. 1. Dwg. No. D-1-005-01-B-F Attachment 4 sheet 2/4	10-Aug.-12	

BLCP Power Limited BLCP Power Plant Project	COMMENT RESOLUTION SHEET	BLCP Letter Ref No. TH041624MM182306IRN Date: 28 July 2004
BLCP Dwg No : M1-MF-HR-PP-00082 Rev No. 0 MCP Dwg. No. : 97000-2262-18	MCP Dwg. Title : Flue Gas Desulfurization System Design Manual MCP Transmittal No. : MAP-MHIN-BLCP-T-00749 Issue Date: : 25 June 2004	Sheet No (1/9)

NO.	BLCP COMMENT	MCP RESPONSE
1.	Does the system are designed for operational within Boiler load range 25% to 105% BMCR at worst coal 0.95% Sulphur content, please confirm.	The original MCP proposal, stated an overall design margin for the entire FGD package as 25% to 105% BMCR at worst coal 0.95% sulfur content, based on the Alstom design. However, with progress in detail design, the design margin in the FGD package is more accurately expressed in terms of actual margins on operating parameters applied to the individual major equipment within the FGD package. Thus, MCP clarifies that while stating that "the FGD system is rated for operation between the range TMCR 25% ~ BMCR 100% while firing the worst coal with 0.95%S", the actual design margins are explained below. While establishing the rated parameters for each major equipment, the MCP design incorporates margins on the individual operating parameters, as each equipment has its own criterion that imposes the most severe duty for that equipment within the FGD package. As explained in the FGD Boost Up Fan (BUF) Equipment Design Basis (Doc No. M1-MN-HR-ME-20026) this fan derives its design margins while operating at a maximum possible flue gas flow rate, similar to the Induced Draft Fans. The FGD Seawater Pump is designed similar to the Circulating Water Pumps. i.e , rated to operate at the lowest tide level, which represents its worst case. Design margins are applied to the frictional losses that decide the required differential head. This ensures that the pumped flow rate always exceeds the design requirement at all higher tidal levels, the flow rate being more with the actual differential head across the pump being lower than that rated for the pump. Similarly, the Aeration Blowers are rated to supply the air required for treatment of seawater while firing 0.95% sulfur coal. Accordingly, four aeration blowers (three working & one standby) are installed. During normal operation with performance coal,

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NO.	BLCP COMMENT	MCP RESPONSE
		only one aeration blower can meet the service requirement. Thus, irrespective of the sulfur content of the coal, at least one blower always stays on standby, clarifying the ample design margin provided here. Similarly, the absorber blowers are also sized to ensure one standby blower; while other two blowers are in operation. In conclusion, MCP clarifies that individual equipment are sized with design margins applied on their individual, most severe, operating case. Thus, if one has to assess the total design margin for the FGD package for a particular case like firing with 0.95% sulfur coal, the design adopted by MCP ensures that individual equipment will have adequate margin under any such service condition. Please note that MCP has established the operating parameters for individual equipment based on extensive laboratory tests and design verification, as clarified in the No 6 design review meeting.
2.	***Equipment Specification, page 50*** - Please provide the summary table of estimated power consumption for FGD system. The data shall identify: Rated power consumption. Estimated power consumption for "Blair Athol", "Valeria", Worst Case Coal at 0.95% Sulphur content and Performance Coal.	At this time, MCP, in conjunction with its equipment suppliers is estimating the power consumptions of each major equipment within the FGD package for various operating scenarios MCP will therefore issue the estimated power consumption later, after it concludes this evaluation. MCP will provide power consumption information at the following conditions: 1) Rated power consumption 2) Coal C with 0.95 wt % sulfur @ BMCR (Design condition) 3) Blair Athol and Valeria @ BMCR 4) Performance coal @ TMCR (Guaranteed condition of power plant power consumption)

NO.	BLCP COMMENT	MCP RESPONSE
3	***Equipment Specification, page 51*** The proposed material for Seawater pump casing is FCHD/JIS SCS14/JIS SUS316L under this design manual while the Ni resist Iron type D2 is utilized which identified in letter no MAP-MHIN- BLCP-L-0093 Dated 19 December 2003, please clarify the different In additional, due to the FGD Emergency Seawater Transfer Pump and Storage Pit Sump Pump will be drawn rich ash/trace element and low pH mixed seawater/raw water, please clarify the pump itself including piping material is carefully consider for this severe condition	The letter MAP-MHIN- BLCP-L-0093 dated 19 December 2003 indicated the proposed material to be used by a prospective pump supplier. However, the material of construction for the Sea Water Pump has been finalized to be FCHD/SCS14, as indicated in the system design manual. This material selection is based on the manufacturer's extensive experience in numerous successful installations for this pump type in similar service. This is based on the information provided by the pump manufacturer, and has been incorporated in the pump manufacturer's data. The FGD Emergency Sea Water Transfer Pump & associated piping will be placed in service only after an emergency like a plant blackout. The possibility of such an emergency mode of operation is extremely remote. In addition, the duration of operation of this pump and piping during such an emergency is not very long. The pump data sheet issued to the pump manufacturer did specify the presence of ash in the pumped fluid. But, the pump material of construction has been specified to withstand the low pH conditions. And also the piping material, FRP and HDPE, withstand the low pH. The abrasion resistance of these materials is however moderate, considering the very limited hours of operation of this pump during the entire plant service life. With design progress, the bottom level of emergency seawater storage pit has been elevated higher than that of the outfall. Therefore, the storm water of emergency seawater storage pit can be drained out by gravity and the emergency storage pit sump pump is deleted.

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NO.	BLCP COMMENT	MCP RESPONSE
4.	***P&ID Absorber area, page 41*** – When in emergency situation e.g, plant blackout, when the water is released from emergency water tank, How the system will perfectly protect the rich ash/trace element seawater escape through the Relay Pit discharge line to Mixing Pit without any isolation device, please clarify.	In emergency condition. e.g., black out, all BUFs and SWPs will trip. Relay pit has 736m^3 capacity. This is equivalent to 2.1 minutes retention time assuming a maximum possible effluent flow with rich particulates at the normal operation rate of 20609m^3/h from the absorber. In reality. the effluent flow rate will be lower than that of normal operation. as the water flows under gravity from the emergency water storage tank. The relay pit incorporates a weir, and there is no possibility that this effluent with rich particulates will overflow into the mixing pit. The effluent with rich particulates, stored in the emergency seawater storage pit, will be pumped out by the emergency sea water transfer pump
5	***Lining Scope Drawing, page 54*** – We understand that the lining material at p ping downstream of butterfly values of Seawater discharge pipe :o the length o' 2.5D is rubber – lined which should identify in number of '3 instead of 14. please consider As well as why does the rubber – lined is selected 'or this location and at 2.5 D, please clarify.	The fluid flow pattern downstream of a partially opened butterfly valve is characterized by a vortex formation. The turbulence in this vortex flow pattern can erode the tar epoxy lining on the pipe internal surface over prolonged periods of operation. Therefore, MCP has rubber-lined the pipe internal surface for a length of 2.5 D downstream of the butterfly valve. Experience suggests that the effects of this vortex are more pronounced up to a distance of 1.5 D downstream of the butterfly valve. Accordingly, MHI standards recommend internal rubber-lining for at least 1.5D length of pipe downstream of the valve. This effectively protects the pipe from flow assisted erosion. However, on the BLCP Power Project. the rubber lining is longer - 2.5D based on the agreement reached in #3 design review meeting. The lining identification number shown on the lining scope drawing will be corrected in the next revision.
6.	Corrosion protection. please provide the technical specification of Lining/Coating material for our information. E.g. Hastelloy, Flake, Rubber, Tar Epoxy, PE and FRP.	Please refer to the drawing No. M1-MN-HR-ZZ- 01033 (FGD SYSTEM LINING MATERIAL SPECIFICATION).

NO.	BLCP COMMENT	MCP RESPONSE
7.	For the all carbon steel buried pipe of FGD system, what is your design for corrosion protection of the outside of the pipe? Refer to drawing no. M1-MN-PU-PP-00083 Rev.0 (Cathodic Protection System Design Manual). page 24 and this FGD System Design Manual, page41. We understand that SW suction line will wrapping + Sacrificial Anode while the SW outlet line from relay pit to outfall don't have any protection, please clarify for this inconsistency	Similar to the corrosion protection on the outer surface of the buried absorber inlet seawater pipe, the outer surface of the buried seawater effluent pipe from the relay pit is effectively protected from external corrosion by the use of lapping tape and sacrificial anode. The acidic nature of the seawater effluent from the relay pit requires lining the pipe with a Flake lining. A pipe internally coated with flake lining does not require any cathodic protection for protection against corrosion due to exposure by the fluid handled, as described in the drawing M1-MN-PU-PP-00083 rev.1 (Cathodic Protection System Design Manual) P8.
8.	How could you protect the fouling along the seawater supply line and the equipment e.g. Air Cooler, please clarify.	Bar screens installed upstream of the SWP and strainers installed upstream of the air cooler seawater line protect the heat transfer surfaces from fouling. In addition, please note that the circulating water used in the FGD system has been already treated by chlorination and filtration in the intake area. These factors greatly limit fouling of equipment handling this seawater
9	What is the maximum permissible operating temperature for Glass Flake Lining which lined in the Absorber. Are there potential the high temperature flue gas damage the lining and what is your protection?	Design temperature for glass flake lining of the absorber is 150°C and maximum operating temperature of the flue gas is 140°C (Carrington Coal @ BMCR). Therefore, there is 10°C margin between design and maximum operating temperature. Moreover, the high absorber inlet temperature alarm is set at 150°C, considering this design condition.
10.	Please verify the design criteria and calculation of the Emergency water storage tank capacity of 60m^3 will release the raw water within 10 minutes.	Required emergency water splay flow to maintain the mist eliminator inlet temperature lower than the design condition, in the absence of sorbent seawater supply, is 6m^3/min. Based on this requirement, the emergency water storage tank capacity is designed for 10 min. The gravity drain line is sized to ensure that this tank will be effectively drained in 10 minutes.

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NO	BLCP COMMENT	MCP RESPONSE
11.	The Performance Test Procedure of the FGD is not appearing in "Drawing Submittal List" and "Method Statement and Procedure List". We understand that such kind of performance testing procedure complying with the Appendix 4 of Item 6.1.30 of EPC Contract Vol. IV will be submitted to us for review.	Performance test procedure will be issued later.
12.	*Flue Gas Composition, page 48* – What is the different between two groups of data of flue gas composition, please clarify.	One is expressed in dry %, and the other set of data are expressed in wet %.
13.	At the aeration pit area, how could we monitor the diffuser performance / condition to ensure that the diffuser will not be clog from the accumulation of fouling at diffuser nozzle, please advice. We consider a variation of pressure indication may not enough to confirm the diffuser working conditions. In additional, please provide the General arrangement of the Diffuser for our information.	Prevention of clogging at the diffusers has several aspects, which will be emphasized in the operation manual. **Functional aspects:** Aeration Air Filtration: The aeration system is designed to prevent fouling of the diffusers. A set of duplex fine air filters ensures supply of dust free aeration air to the diffusers and the diffusers should not clog by this prevention of dust entering into the aeration system. Circulating Water Treatment: Effective and appropriate circulating water treatment can prevent external bio fouling of the diffusers. **Operational aspects:** Cycling of diffuser headers: The number of operating aeration blowers depends on the sulfur content of the coal fired in the boiler. With the design margin and wide operating range of the seawater treatment plant, a more likely scenario will involve operation of only one (1) aeration blower with its group of five (5) aeration headers in service. This will require isolation of the remaining aeration headers. Isolation of any given set of diffusers for extended periods can contribute to external fouling. Therefore, proper operation of the seawater treatment plant involves periodic cycling of the system of aeration headers in operation. This exercises the diffusers. Experience suggests that this method is very effective in preventing external fouling & ensuring the durability of the diffusers. Typically, a set of diffusers should be cycled every two to three months – the actual period will be finalized based on actual experience at site

NO	BLCP COMMENT	MCP RESPONSE
		Monitoring Aeration Pressure: The aeration pressure can be effectively monitored at the blower discharge and at the inlet of individual aeration headers. The aeration pressure has two components: a non-varying component that depends on the frictional loss in the downstream aeration pipes, and a varying component that depends on the seawater level in the treatment plant & the condition of the diffuser itself. In the as-new condition, the aeration pressure should be monitored at all the measurement points (blower discharge & aeration header inlets) for its variation with the seawater level in the outfall, which varies with the tides. This forms the benchmark for further monitoring and trending. Monitoring the aeration pressure, based on this benchmark can provide a reliable indication of the condition and performance of the diffusers installed in the various headers. Monitoring the treated seawater pH: For a given sulfur content in the coal fired in the boiler, monitoring the variation in the seawater pH over a period, at the outlet of the seawater treatment plant is also an indicator of the degree of aeration, and thus the condition of the diffusers. The general arrangement of the diffuser will be issued later.
14.	*Empty the Discharge Cannel, page 14 & 24* – "A portable outfall dewatering sump pump" is being supply to empty the outfall cannel. Please verify that is it the same pump to empty the CW intake? And also please verify the dewatering process as well as required time at 24 hrs dewatering with appropriate calculation.	FGD system outfall dewatering pump will be supplied separate from CW intake sump pump. Considering the dewatering efficiency, stop log is inserted when the sea level is lower than that of outfall dam. Therefore, dewatering capacity is considered as the capacity required to empty the seawater below the outfall dam and approx. 8150m^3 for 1 unit. A dewatering time of 24 hours yields the pump capacity as follows: Calculated pump capacity = 8150m^3 ÷ 24hrs = 340m^3/h → rounded off to 350 m^3/h Accordingly, a pump with 350 m^3/h capacity is selected.

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NO.	BLCP COMMENT	MCP RESPONSE
15.	***P&ID, page 43*** We understand that the monitoring instrument for pH, Temperature and residual Chloride will be installed at outfall outlet location individually for Unit 1 and 2 due to the completely separated of the CW system, please confirm. Due to the width of outfall is 10m.(each side) approximately, we consider the installation of one analytical instrument AT may not enough to cover the entire amount of discharge seawater conditions, please verify. As you are aware this seawater monitoring data s sensitive environmenta issue and must be continuous and reliable data, we consider redundancy instrument might essential, please consider.	Monitoring instrument for pH, temperature and residual chloride will be installed individually for unit 1 and unit 2. Seawater condition will be uniform by the homogenous mixing in the mixing pit and by downstream aeration. Therefore, one measurement point will be adequate for sensing the discharge seawater condition for one unit total two. Consistent with the philosophy adopted for all instruments installed for monitoring environmentally sensitive parameters, only one (1) instrument is supplied for one unit total two.

NO	BLCP COMMENT	MCP RESPONSE
16.	Under the Contract Document item 6.1.30-15 of Vol, IV, MCP shall provide the additiona: data as following 1. FGD guarantee compliance to be determined by correction curves; SO_2 emission at stack Total FGD power consumption pH at SWTP discharge Temperature increase between absorber inlet and SWTP outlet 2 Correction Curve of; Flue gas flow (Nm^3/h) at ID Fan outlet as function of relevant fuel and boiler parameters SO_2 concentration (vppm, dry 6% O_2) at ID fan outlet as function of relevant fuel and boiler parameters Flue gas temperature (Deg. C) at ID fan outlet as function of relevant fuel and boiler parameters SO_2 emission (vppm, dry 6% O_2) through stack as function of flue gas flow (Nm^3/h) and SO_2 concentration (vppm, dry 6% O_2) at ID fan outlet Total FGD power consumption (kW) as function flue gas flow (Nm^3/h) at ID fan outlet pH at SWTP discharge as function flue gas flow(Nm^3/h), SO_2 concentration(vppm, dry 6% O_2) at ID fan outlet and salinity of CW Temperature increase (Deg. C) between absorber inlet and SWTP outlet as function flue gas flow (Nm^3/h) and temperature(Deg.C) at ID fan outlet and CW total flow (m^3/h) and temperature(Deg.C)	Total FGD power consumption and temperature increase between absorber inlet and SWTS outlet is not guarantee item to BLCP. MCP will submit the correction curve and kind of correction curve later.

BLCP Power Limited BLCP Power Plant Project	COMMENT RESOLUTION SHEET			BLCP Letter Ref No. TH04184MM182306IRN Date: 4 August, 2004
BLCP Dwg. : M1-MF-HR-PP-00082 No Rev No 0 MCP Dwg. No. 9700C-2262-18	MCP Dwg. Title	:	Flue Gas Desulfurization System Design Manual	Sheet No. (1/2)
	MCP Transmittal No	:	MAP-MHIN-BLCP-T-00749	
	Issue Date.	:	25 June, 2004	

NO.	BLCP COMMENT	MCP RESPONSE
1.	Refer to Company's specification item 7.3 – FGD Plant Operation Requirements, page 89, when the flue gas by-passes the FGD plant, or individual flows are taken out of service, for routine or breakdown maintenance, with the unit on load, does the FGD plant as a whole the inoperative streams shall be capable of be ng safely isolated and does the sufficient mechanical and electrical isolation are provided to accommodate this, please verify.	The FGD plant is provided with single isolation dampers in each of the two inlet flue gas ducts leading to the two boost up fans and in the absorber outlet duct leading to the stack. These dampers are required for isolation and bypass of the FGD unit under the following conditions: (i) While firing fuel oil (as done during Unit startup / shutdown) the flue gas bypasses the FGD to avoid excessive cooling. The SOx emissions while firing only fuel oil meet the environmental limit. The FGD is bypassed to prevent the formation of any visible plume at the stack outlet; and (ii) An ESP trip releases dust-laden gas into the downstream ducts, and the FGD is immediately bypassed. Such gas cannot be led to the FGD absorber in order to protect the absorber trays from fouling, and to prevent release of particulates in effluent seawater. These operating scenarios do not require double isolation dampers, and the single isolation dampers meet the service requirement. In addition, please note that any major maintenance on the FGD plant requires bypassing all the flue gas from the unit directly to the stack, without any treatment for SOx removal. Such operation will grossly exceed the environmental emission limit of 280 ppmv of SOx, and therefore cannot be tolerated. Accordingly, isolation of the FGD for maintenance entails shutting down the Unit itself. Therefore, on-load maintenance is not considered for the FGD plant, although the dampers do allow bypassing the FGD unit under special operating scenarios explained above Major FGD maintenance should therefore be carried out after the Unit is shutdown. Please note that MCP has supplied single isolation dampers for

		the FGDs on similar plants in Japan (e.g., 1000 MW Misumi Power Plant, 600 MW Hirono Power Plant), and based on this experience, assures BLCP that this design does not affect the maintainability of the FGD plant.
2	Are there potential to get foaming at the outfall affected from the absorber and SWTP, what the facilities and equipment to counteract the foaming are provided	Foaming is a possibility downstream of seawater treatment plants involving aeration diffusers; although the extent of foaming is unpredictable. Moreover, the degree of foaming cannot be effectively determined and remains open to judgment. However, foaming has only a visual impact. Accordingly, this need not be objectionable, and usually local environmental regulators hold the discretion to accept this or not. The outfall ends in a box culvert. The design of the culvert has features that enable the collection of foam formed on the surface of the seawater (See Dwg. No. M0-MN-XXX-CV-15991 C/W Discharge Outfall Outline & Section). Thus, foam if formed will mostly collect within the plant boundary, and will not be treated. If any foam should escape below the culvert into the open seas, and if the local environmental authority considers it objectionable, a seawater spray shower can be installed downstream of the seawater treatment plant in an effort to mitigate such foam formation.
3.	*4.2 FGD Bypass Damper Control, page 24* – "A differential pressure transmitter measures . . . . . will be function of MW demand" please give more explanation for this clause.	As shown in the control diagram attachment - 10 - (6/6), [FGD bypass damper opening demand] = [demand based on MW demand] — [bias based on differential pressure across the FGD bypass damper] When the differential pressure across the FGD bypass damper is positive, FGD bypass damper opening demand is equal to the demand based on MW demand. However, only when the differential pressure turns negative pressure, secondary PI controller generates the bias which is subtracted from the demand based on MW demand so that differential pressure across the FGD bypass damper is positive.

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BLCP Power Limited **BLCP Power Plant Project**		**COMMENT RESOLUTION SHEET**		BLCP Letter Ref No. TH042133MM182306IRN Date: 30 November 2004
BLCP Dwg. No. : M1-MF-HR-PP-00082	Rev. No. 0	MCP Dwg. Title :	Flue Gas Desulfurization System Design Manual	Sheet No. (1/1)
		MCP Transmittal No. :	MAP-MHIN-BLCP-T-00749	
MCP Dwg. No. : 97000-2262-18		Issue Date: :	25 June, 2004	

NO.	BLCP COMMENT	MCP RESPONSE
1.	Regarding to our comment on letter no. TH041824MM182306IRN dated 28 July 2004 and TH041841MM182306IRN dated 4 August 2004 concerning to the FGD design, up to now we don't have any reply from your side. We are still waiting for such reply, please consider.	Please refer to MCP letter No. MAP-MHIN-BLCP-L-0543 and No. MAP-MHIN-BLCP-L-0546 respectively.
2.	According to truck loading connection at FGD Emergency Seawater Storage Pit, we learnt that the discharge line of uncontaminated seawater from FGD Emergency Seawater Storage Pit to outfall will be pumped by Emergency Seawater Pit Sump Pump as original design. Currently, the discharged seawater will be drained by gravity to outfall by manual operated value. It is therefore please consider utilizing this pump for pumping the water to the truck connection.	As the result of study of the level difference between FGD emergency seawater storage pit and outfall, the level of emergency seawater storage pit is decided to GL-300 and storm water in FGD emergency seawater storage pit can be drained out by gravity. Therefore, FGD emergency seawater storage pit sump pump is canceled before purchasing and the valve is supplied between FGD emergency seawater storage pit and outfall. This valve is normally closed to prevent the effluent from going to outfall without any check. Pumping the effluent from FGD emergency seawater storage has been planned by the pump of truck supplied by BLCP. Therefore, please provide the truck with pump.
3.	Page 21 - *"as long as the sample tests verify that the quality of the effluent meets the applicable environmental regulations."* Please confirm MCP shall provide the sampling port of the FGD Emergency Seawater Storage Pit drain line at ground level to serve the requirement mentioned above.	Emergency seawater storage pit drain will be sampled through piping for the truck unloading which is located at GL+500. In case that it is sure that the drain is residual storm water or non-reacted seawater in FGD emergency seawater storage pit, such drain can be drained out by opening FGD emergency seawater storage pit drain valve without sample test. However, in case that it is not sure that the drain in FGD emergency seawater storage pit meet the applicable environmental regulations, the drain should be sampled and tested from the above sampling point and it is decided whether the drain can be drained out to outfall or not.

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BLCP Power Project Flue Gas Desulfurization System Rev.01

Revision Control

Page Number	Description of Amendment	Amendment Revision	Date Amended Pages Inserted
Various	Correcting terminology and description as per latest P&ID	1	2006/10/24
Various	Incorporated available set point values	1	2006/10/24
23 -	Updated the Process Control as per design progress	1	2006/10/24
Attach-ment-3, 4, 8, 9 & 10	Attached latest Material & Heat Balance, FGD System P&I Diagram, Lining Scope, Single Line Diagram and DCS drawings	1	2006/10/24
Attach-ment-11	Attached estimated power consumption of the FGD system attached	1	2006/10/24
Attach-ment-12	Attached submitted comment resolution sheets	1	2006/10/24
Various	Changed parts are marked with vertical bar ("|") at right margin	1	2006/10/24

1. Function

The function of the Flue Gas Desulfurization (FGD) System is to remove the sulfur dioxide from the flue gas produced by the power plant, and to do so to the degree required to meet the emission levels guaranteed in Appendix 10 to the EPC contract.

The FGD system described here is for Unit 1; that for Unit 2 being identical.

2. System Description

Refer to the General Flow Diagram, the General Arrangement, the Material & Heat Balance and the P&I Diagram provided as Attachment – 1, 2, 3 and 4.

The FGD system is based on once-through, wet, seawater scrubbing process specified in the contract documents.

The FGD system consists of the following equipment specifications of which are summarized in Attachment - 7:

- One 100 percent absorber
- Two 50 percent boost up fans (BUFs)
- Three 50 percent absorber blowers
- Three 50 percent seawater pumps
- Four 33 percent aeration blowers
- One 100 percent aeration air cooler
- Two 100 percent aeration air filters
- Three seawater pump pits with bar screen for seawater pumps' suction
- One stop log for seawater pumps' suction (common for Units 1 & 2)
- One Relay pit
- One 100 percent emergency seawater transfer pump
- Emergency seawater storage pit with one 100 percent sump pump (common for Units 1 & 2)

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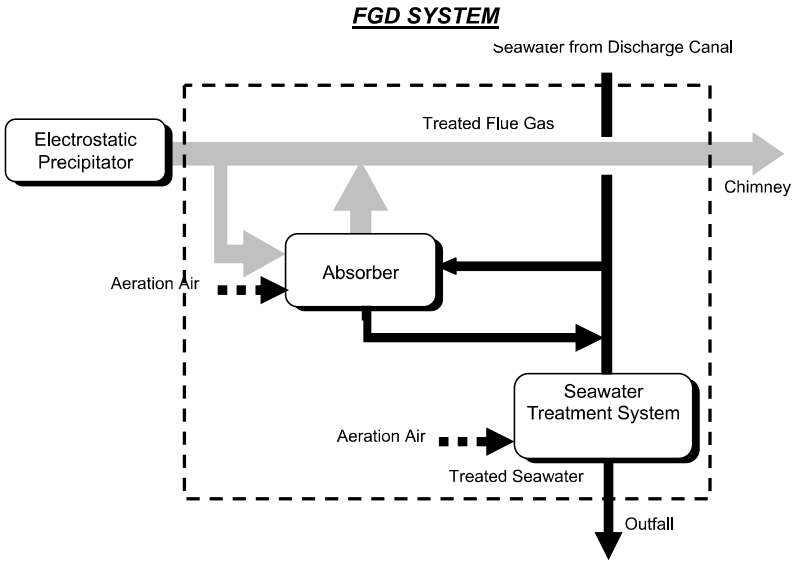
- One seawater treatment system
- One 100 percent portable outfall dewatering pump (common for Units 1 & 2)
- One Stop log for insertion at the discharge canal inlet (common for Units 1 & 2)
- One Stop log for insertion at the discharge canal outlet (common for Units 1 & 2)
- Interconnecting ducts and dampers

Refer to the Key Single Line Diagram provided as attachment – 9. The FGD electrical system consists of the following main components:

- 11 kV Switchgear
- 11 kV / 400 V Auxiliary transformer
- 400 V MCC
- 400 V Emergency MCC
- 380 / 220 V Control Distribution Panel (common for Units 1 & 2)
- 380 / 220 V Lighting Distribution Panel (common for Units 1 & 2)
- 110 V DC Distribution Board

The following subsections describe the operating principle, and the project specific system description.

2.1. Operating Principle



The selected FGD process is a once-through, wet, seawater scrubbing process. Flue gas to be treated passes through an absorber. The process utilizes a portion of the circulating seawater downstream of the condenser as the sorbent to absorb the SO_2 in the flue gas. The availability of seawater in large quantities within the power plant allows its effective use in the process. Seawater is alkaline in nature, and has a large neutralizing capacity with respect to SO_2. This natural alkalinity of seawater neutralizes the SO_2 in the flue gas.

The absorption of SO_2 takes place in the absorber where seawater and flue gas are brought in close contact in a countercurrent flow for effective scrubbing. Absorption of SO_2 in seawater creates bisulfite, and reduces its pH by the formation of hydrogen ions. Bisulfite can also be converted to sulfite. The following reaction statement explains the basic chemistry of SO_2 absorption in seawater:

$$SO_2 + H_2O \longrightarrow HSO_3^- + H^+$$

The sorbent collected in the absorber undergoes primary aeration within the vessel to oxidize some of the absorbed SO_2 (as bisulfite and sulfite) into sufate. Following this, the absorber effluent mixes with the condenser outlet circulating seawater in a dedicated mixing pit, and then flows to the seawater treatment system where it is air-sparged to complete the oxidation of absorbed SO_2 (as bisulfite and sulfite) into sulfate. The alkalinity in seawater, present as carbonates and bicarbonates, neutralizes the hydrogen ions to increase the seawater pH. The flowing reactions statements explain the basic chemistry representing the seawater treatment part of the process

$$HSO_3^- + {}^1/_2O_2 \xrightarrow{\text{Aeration}} SO_4^{2-} + H^+$$

$$CO_3^{2-} + 2H^+ \longrightarrow CO_2\uparrow + H_2O$$

$$HCO_3^- + H^+ \longrightarrow CO_2\uparrow + H_2O$$

The sulfate completely dissolves in seawater, so as a result there is no waste product to dispose of. Sulfate is a natural ingredient in seawater, and typically, there is only a slight increase of sulfate in the discharge. This increase is within variations naturally occurring in seawater.

Note: The FGD process differs slightly from that specified in the contract. The MCP design improves over the design specified in the contract. Of significance is MCP's provision of absorber blowers promoting primary aeration in the absorber itself and a dedicated mixing pit that increases the pH of the absorber effluent by mixing alone, before the effluent reaches the seawater treatment system. Provision of absorber blowers reduces the total air required for aeration to achieve the same degree of treatment. In addition, treatment of the effluent as diluted by circulating water in the mixing pit, reduces release of fugitive SO_2 emissions in the atmosphere over the seawater treatment system.

Experience in operation of seawater treatment systems on seawater FGDs has revealed nuisance of odor caused by fugitive SO_2 released during aeration. FKK's research confirms that this release of fugitive SO_2 depends on the pH of the seawater entering the aeration area. Maintaining a seawater pH above 6 at the inlet to the aeration area successfully abates any possibility of SO_2 release in the atmosphere around the seawater treatment system. Thus, the design with aeration within the absorber increases the pH of the diluted seawater, after mixing with circulating water, to a value greater than 6. Designs without aeration in the absorber cannot achieve a pH of 6 after mixing with circulating water, and subsequent aeration in these designs releases fugitive SO_2 with a foul odor in the environment around the seawater treatment system.

2.2. SO_2 Absorption system

Refer to Attachment – 4(2/4). The FGD system treats a relatively dust-free flue gas, discharged by the induced draft fans (IDFs), installed downstream of the electrostatic precipitators (EPs). Of the total flue gas released, approximately 70 percent flow passes through the FGD system, while the remaining flow bypasses to the chimney. The treated flue gas cools due to the treatment by seawater, and remixes with the bypassed hot flue gas. Treating only 70 percent of the flow is sufficient to meet the permissible SO_2 levels. In addition, the untreated bypassed flue gas flow has sufficient heat content that achieves a flue gas temperature exceeding the minimum temperature required to avoid a visible plume at the chimney outlet, after mixing with the cooler treated flue gas from the absorber. Pneumatically actuated isolation dampers located in the bypass duct and the FGD system inlet and outlet ducts enable bypassing 100 percent flue gas flow, as would be required when the FGD system is shutdown. The FGD system inlet and outlet dampers are shutoff dampers, while the bypass damper modulates to maintain the required pressure drop in the bypass duct, preventing any backflow of flue gas from the FGD system outlet and consequent unstable operation.

The two boost up fans, installed in FGD system inlet duct, increase the pressure of the flue gas for overcoming the pressure drops in the flue gas path of the FGD system. The boost up fans are single-stage axial fans, each driven by a single-speed motor. Variation in the pitch of the fan blades can vary the flow and the pressure ratio during operation. A hydraulic mechanism is used to adjust blade pitch. Pneumatically actuated inlet and discharge dampers provided on each boost up fan.

Refer to Attachment –5. Flue gas from the boost up fans enters the absorber. The absorber is a vertical cylindrical vessel designed to facilitate close contact between the sorbent (seawater) and the flue gas in the countercurrent direction. Seawater flows vertically downwards, while flue gas rises upwards through the absorbing section of the vessel. Along the height of the absorber, the vessel has subsections performing certain specific functions. The lowest section of the absorber collects the seawater rich in sulfates and sulfites formed during the absorption process. Preliminary treatment of this seawater by aeration using absorber blowers is possible in this section. The flue gas duct connects the absorber above the seawater collected in the absorber. The duct arrangement is inclined downwards as it enters the absorber, which reduces sorbent spray-back into the inlet duct. Here, seawater flowing down from the absorption section, and additionally sprayed over the entire vessel cross-section, quenches the hot flue gas in order to protect the absorber internals from exposure to high temperatures. The flue gas, thus cooled, enters the absorption section of the absorber.

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The absorption section of the absorber consists of three stages of perforated plates patented as MORETANA®. These sieve plates do not require any downcomers. This design offers good capacity, excellent efficiency, good turndown characteristics, and are ideally suited for fouling services. A central columnar pipe in the absorber leads seawater supplied by the seawater pumps to a system of headers and nozzles installed above the MORETANA ® plates. The fluid flow across the MORETANA® plates is countercurrent, and the bubbling upward flow of flue gas through the seawater leaking downwards provides sufficient interfacial area for enhanced mass transfer.

Treated flue gas leaves the absorber plates and enters the final section in the absorber comprising of a mist eliminator. This device traps any entrained seawater in the flue gas leaving the absorbing section. Flue gas thus treated leaves the absorber through the isolation damper in the FGD system discharge line.

An emergency water storage tank externally formed on the top of the absorber stores quenching water for emergency use, as would be required during a blackout, when the seawater supply to the absorber stops.

The effluent thus created during such an emergency is rich in particulates that pass through the non-energized electrostatic precipitator, and cannot be discharged to the outfall. Therefore, a horizontal centrifugal pump installed adjacent to the relay pit at the absorber outlet, pumps the effluent during a blackout from the absorber to a separate emergency seawater storage pit. This pit is common to both units, and has a storage capacity of 1500 m^3. The collected effluent is suitable for trucking for final disposal outside the power plant premises. A sump pump permanently installed in the emergency seawater storage pit can pump storm water or non-reacted seawater to the outfall, as long as the sample tests verify that the quality of the effluent meets the applicable environmental regulations.
The flue gas duct leading to the absorber and the bypass duct are insulated for personnel protection. Expansion joints provided at suitable locations accommodate thermal expansion.

2.3. Seawater supply system

Refer to Attachment – 4 (3/4). Circulating water pipes, leaving the condenser, release seawater into the discharge canal. A wall separates the discharge canals for the two Units. A portion of this seawater is diverted for use as sorbent in the flue gas desulfurization process. Three vertical centrifugal pumps (2 working + 1 standby) per Unit supply seawater from the discharge canal to the absorber for use as sorbent and as a quenching medium. Independent intake pits, arranged at an angle of 60 degrees to the normal direction of flow in the discharge canal, direct the seawater towards the individual pumps. The angular orientation of the intake pits with respect to the discharge canal, enables smooth flow of seawater with minimal pressure drop to the pump suction.

Each intake pit is a concrete structure equipped with a stop log guide frame and a bar screen. The bar screen protects the pump from any entering debris that could possibly fall in the open discharge canal. The stop log guide frame enables insertion of a stop log for maintenance isolation and cleaning of the intake pit.

The seawater pump motor is air-cooled. A motor operated discharge valve provided on the pump discharge line, enables individual pump isolation. Buried carbon steel piping, with tar epoxy coating, supplies the seawater from the seawater pumps to the absorber.

Refer to Attachment – 4 (2/4). A portion of the seawater, sprayed below the absorption section, quenches the incoming flue gas, while the rest enters the absorption section as the sorbent in the absorber. Manually adjustable and lockable butterfly valves ensure proper flow distribution of seawater between the quenching and absorbing sections. The valve opening will be locked based on the test results conducted while commissioning the system.

The arrangement and layout of spray nozzles in the quenching and absorption zones optimizes seawater consumption and ensures maximum coverage.

The aeration air cooler, installed at the seawater treatment system aeration blowers' discharge, sources its seawater-cooling medium from the seawater pumps' discharge header.

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2.4. Absorber aeration and seawater treatment system

See Attachment – 4 (2/4) and (4/4). After absorption of SO_2 in the flue gas, effective aeration treats the seawater, as described in item 2.1. Seawater treatment performed in three stages effectively treats the effluent seawater produced in the absorption process. An aeration section within the absorber is the first stage of seawater treatment. Mixing of the absorber effluent with the circulating water in the discharge canal is the second stage. Following this, the final stage of treatment takes place in the seawater treatment system.

Note: The contract does not describe the provision of aeration in the absorber. However, laboratory model tests conducted by MCP, with aeration under different conditions, confirmed its design philosophy that aeration under conditions of low pH (at acidic concentrations prevalent inside the absorber) was more effective than that done at increased pH (at conditions prevalent in the seawater treatment system, after dilution with circulating water flowing in the discharge canal). Thus, it was established that in order to achieve a given target increase in seawater pH, the design with aeration in the absorber, required significantly lower quantity of total aeration air, as compared to designs that aerated only in the discharge canal (as in the design specified in the contract).

The first stage of aeration takes place at low pH, immediately after absorption, and is more effective in oxidizing by aeration than the aeration performed only in the seawater discharge canal. The provision of this first stage of aeration contributes to a reduction in the total air quantity required for aeration as compared to a design based only on aeration performed in the seawater discharge canal. Thus, this first stage aeration contributes to a reduction in the specific power consumption of the FGD system. Absorber blowers aerate the seawater collected inside the absorber. These absorber blowers supply filtered atmospheric air into the absorber, and air diffusers installed near the bottom of the absorber distribute this air in the seawater collected in the absorber. The diffuser comprises of 2 mm diameter circular openings on a system of headers arranged near the absorber bottom. The blowers are root type positive displacement blowers. Silencers on the blower discharge attenuate noise. Pressure relief valves provided with the blowers prevent over pressurization. The air released in the absorber combines with the flue gas and passes through the absorption section before release in the chimney.

Seawater collected in the absorber continuously drains into a relay pit located adjacent to the absorber vessel. A weir in the relay pit prevents the absorber from completely draining out. The presence of minimum water level in the absorber is essential to maintain the water-seal. A concrete slab covers the relay pit, and adequately sized vent openings avoid any pressure fluctuations.

The absorber effluent seawater flows under gravity from the relay pit, through a carbon steel pipe with glass flake lining, to the discharge canal, at a point downstream of the seawater pump intake pits. Here, the effluent seawater enters the mixing pit through the effluent seawater distribution box, where it mixes with the seawater released by the condenser, and then flows to the downstream seawater treatment system in the same discharge canal. FRP lining protects the mixing pit from exposure to the low pH absorber effluent, until the seawater released by the condenser dilutes the effluent. This dilution increases the pH of the seawater above 6 before the seawater reaches the aeration section of the seawater treatment system. In addition, the provision of the mixing pit prior to aeration in the seawater treatment system eliminates any fugitive sulfur dioxide in the seawater, preventing any foul odor in the vicinity of the aeration pit, where such fugitive dissolved gases may be released.

Note: Experience in operation of seawater treatment systems on seawater FGDs has revealed nuisance of odor caused by fugitive SO_2 released during aeration. FKK's research confirms that this release of fugitive SO_2 depends on the pH of the seawater entering the aeration area. Maintaining a seawater pH above 6 at the inlet to the aeration area successfully abates any possibility of SO_2 release in the atmosphere around the seawater treatment system. Thus, the design with aeration within the absorber increases the pH of the diluted seawater, after mixing with circulating water, to a value greater than 6. Designs without aeration in the absorber cannot achieve a pH of 6 after mixing with circulating water, and subsequent aeration in these designs releases fugitive SO_2 with a foul odor in the environment around the seawater treatment system.

The seawater treatment system comprises of an aeration pit arranged along the length of the discharge canal. Fine bubble aeration in the discharged seawater transfers atmospheric oxygen to the effluent, reducing its chemical oxygen demand. The width of the discharge canal increases at the aeration pit, which reduces the seawater velocity for effective treatment. The seawater treatment system also utilizes a greater depth and a lower face velocity (flow rate of air released per unit area) as compared to the design specified in the contract. Utilizing a greater depth increases the contact time between the air and the seawater. Utilizing a lower face velocity produces finer air bubbles in the aeration system, which increases the contact surface area between the air and the seawater. These factors greatly influence the treatment efficiency, besides increasing the treatment time.

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Four aeration blowers (3 working + 1 standby) per Unit, aerate the seawater flowing in the aeration pit. 3 working aeration blowers are designed based on FGD performance while firing coal with 0.95% sulfur content. The actual maximum sulfur content in the coals proposed for use on the project is ≤ 0.7%; and this fact will directly contribute to a reduction in the number of working aeration blowers significantly during actual operation. The blowers are root type positive displacement blowers. Silencers on the blower discharge attenuate noise. Pressure relief valves provided with the blowers prevent over pressurization.

Heat of compression added in the blower increase the air temperature. A finned-tube air cooler, utilizing a portion of the seawater from the seawater pumps, cools the aeration air. A set of duplex fine air filters ensure supply of dust-free aeration air to the diffusers. Considering the frequency of cleaning the filter elements, the provision of the upstream air cooler is particularly beneficial in reducing the air temperature to 60 degree C maximum. This allows prompt and safe access to the filter elements of the air filter taken out of service. In addition, it obviates the need to clad the aeration air supply pipe, leading to the various diffusers, for personnel protection. The air cooler, itself, is a maintenance-free device. On rare occasions, when the air cooler is required to be maintained, it can be bypassed, with due precautions taken by maintenance personnel, in accordance to the maintenance instructions to be provided later on the project.

Note: Unlike the aeration air discharged by the aeration blower in the seawater treatment system, the aeration air at the absorber blower discharge does not require any filtration. The filtration of aeration air at the absorber blower suction filter is more than adequate, because this suction filter even eliminates fine dust particles that are significantly smaller than the absorber diffuser nozzle openings of 2 mm diameter. Further, in the absence of an air filter in the absorber blower discharge, there is no functional need to provide an air cooler.

A piping grid arranged at the bottom of the entire extents of the aeration pit distributes the cooled and filtered air to various diffuser units arranged in the aeration pit. The air from the aeration blowers enters the aeration air supply pipe running along the entire length of the aeration pit. Fifteen independent (15) headers branch off from the aeration air supply pipe, and supply air to the downstream diffusers. A manual valve on each header facilitates isolation of the entire array of downstream diffusers. Each header is sized such that a system of five (5) headers can handle the capacity of one aeration blower. Functionally, the operator designates a group of five (5) headers for operation with each aeration blower. Thus, variation in the number of operating aeration blowers requires isolation or opening of corresponding groups of aeration headers.

Each header supplies aeration air to about 930 diffuser units. Each diffuser unit is a fine pore, flexible membrane diffuser capable of providing a high level of oxygen transfer efficiency with maximum operating flexibility. The diffuser, manufactured in high-grade corrosion resistant plastic, utilizes an EPDM rubber membrane sleeve, specially perforated for high volumetric capacity. Air enters the diffuser pipe and disperses into the seawater through a perforated pattern in the membrane. This pattern comprises of very fine die cut apertures, which release the air into the seawater. Manually adjustable and lockable butterfly valves, installed at the inlet to each air distribution header, ensure proper flow distribution of air to all the diffusers. The valve opening will be locked according to the test results conducted while commissioning.

During a major overhaul of the seawater treatment system, it would be essential to empty the discharge canal for the Unit taken under shutdown. Accordingly, stop log guides provided on the either end of the discharge canal enable effective isolation of the discharge canal. A portable outfall dewatering sump pump then facilitates the emptying of the discharge canal.

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2.5. Electrical

Refer to Attachment – 9. The FGD electrical system supplies power to FGD loads such as motors, heaters, lighting, receptacles, space heaters etc. This dedicated electrical system also provides AC and DC control power to the FGD switchgear and control panels. The system configuration allows all FGD loads to receive power for normal operation, while enabling only the essential FGD loads to run on emergency power in the event of plant blackout. The utilization voltages are 11kV, 400V, and 220V AC, and 110V DC.

2.5.1. 11kV Switchgear

11kV switchgear supplies to the 11kV/400V FGD system dry type auxiliary transformers and to the FGD system motors, rated higher than 250kW. Two 11kV switchgears, one for each unit, are provided. Each 11kV FGD switchgear has two incomers – one normal and the other standby – for receiving power supplies from the respective unit's main 11kV unit switchgear.

2.5.2. 11kV/400V Auxiliary Transformer

11kV/400V dry type auxiliary transformers feed the 400V distribution panels of the FGD system. Two such transformers, one for each unit, are provided. Transformer primaries receive power supply from the 11kV FGD switchgear. The capacity of the transformer is so selected that one transformer can meet the full load requirement of the two unit FGD systems, in case the other transformer is unavailable.

2.5.3. 400V Motor Control Center

400V Normal MCC supplies power to low voltage FGD loads such as motors rated up to 75kW, motor operated valves, etc. Two such MCCs are provided – one for each unit FGD system. Each MCC receives incoming power supply from the respective unit's dry type auxiliary transformer. An interconnecting tie line feeder is additionally provided between the two MCCs. In case one dry type transformer is unavailable, the interconnecting tie feeder can be closed to allow feeding of the two MCC loads from the surviving auxiliary transformer. Apart from the normal MCC, each unit FGD system has a 400V emergency MCC that feeds power to the essential loads of the FGD system. The emergency MCC receives power supply form the respective unit's emergency MCC, to be fed by the emergency diesel generator during total power failure (blackout).

2.5.4. Distribution Panel

380/220V lighting distribution panel supplies lighting and space heating power of the FGD system. Unlike the individual, unitized 11kV and 400V FGD systems, the 380/220V system use a common distribution panel for the two FGD units. This distribution panel receives incoming power from the main lighting MCC.

A separate 220V control distribution panel is used to provide AC control power to the FGD system panels. The distribution panel is equipped with a 400/220V dry type transformer, which steps down the main supply voltage from 400V to 220V for feeding to loads. Two alternate incoming supply feeders are provided for the distribution panel: one each from the two 400 V FGD Normal MCCs. The incoming circuit breakers are so interlocked that one breaker can be closed at a time.

To meet the DC control power requirement of the FGD system, each unit FGD is provided with one 110V DC distribution board. The DC distribution board receives incoming power supply from the respective unit's main DC distribution panel and battery systems.

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3. Design Criteria

3.1. Operating Conditions

3.1.1. Refer to the Design Condition as attachment – 6. The FGD system is designed to ensure the following:

- Total SO_2 emission at chimney, corrected to 6% O_2 dry/dry at NTP conditions do not exceed 280 ppmv (800 mg/Nm³) under all operating conditions.
- Seawater temperature increase across the FGD package (including the seawater treatment system) does not exceed 1.0°C.
- The following limits apply to the seawater discharged from the seawater treatment system

  a) pH value greater than or equal to 7.0

  b) Increase in COD between absorber inlet and the seawater treatment system outlet does not exceed 2.5 mg/l.

  c) Minimum dissolved oxygen in discharge water from the seawater treatment system is 75% of saturation of discharged water.

- Noise levels measured not more than 1 m from the surface of any individual item of plant or equipment do not exceed 85 dB(A).

The FGD system is capable of achieving the emission requirement when the boiler is operating at BMCR load condition and firing coal with a mean sulfur level of 0.95 wt% (as received basis).

The FGD system bypass duct routes 100 percent flow of the flue gas when the FGD system is shutdown. During normal operation, the flue gas flow through the absorber is optimized to ensure a maximum SO_2 emission level of 280 ppmv dry 6% excess O_2 from the chimney based on burning 0.95% sulfur coal. The FGD system treats approximately 70 percent of the total flue gas, while the remaining flows through the bypass duct.

The emergency water storage tank storage capacity is equivalent to ten (10) minutes of water supply to the absorber.

Estimated power consumption of the FGD system is summarized in the Attachment-11.

3.1.2. Electrical component design

The basic design of FGD electrical system such as for 11kV switchgear, motor control center and distribution board accords the system design manual of electrical system for power station.

The FGD electrical system is designed to withstand short circuit currents and voltage drops determined through separate studies.

FGD electrical system is adequately protected by appropriate protective devices.

The following types of protective functions are generally considered:

- 11kV switchgear incomer: Instantaneous and time delayed overcurrent protection
- 11kV switchgear bus: Undervoltage protection (time delayed)
- 11kV motors: Thermal overload, short circuit, unbalanced current ground fault protection
- 400V MCC incomer: Instantaneous and time delayed overcurrent protection.
- 400V MCC bus: Undervoltage protection
- 400V motors: Thermal overload and ground fault protection
- Built-in short circuit and ground fault protection for incoming breaker feeders in 400V MCC
- Thermal magnetic release for circuit breakers in 220V AC and 110V DC distribution panels
- Temperature switch for dry transformer windings

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3.1.3. Materials of construction

Materials of construction are a significant design consideration for seawater FGD systems. Seawater released into the absorber quickly turns acidic, and becomes very corrosive in nature. In addition, flue gas at temperatures below the acid dew point is also very corrosive. Accordingly, the design incorporates the following corrosion prevention measures, which are also illustrated in Attachment – 8:

- Gas inlet duct: Carbon steel flue gas ducts leading to the absorber do not face any detrimental corrosive effects. However, the portion of the flue gas inlet duct connected to the absorber, with an increased cross-sectional area at the absorber inlet, requires protection from corrosion caused by exposure to seawater spray-back along with the dry hot flue gas. The corrosive condition at this location is therefore the most formidable with acidic environment at high temperature. Accordingly, this portion of the carbon steel duct is lined with Nickel-Alloy, which has very good resistance to pitting and crevice corrosion.

- Absorber vessel: The absorption process in the absorber exposes its internals to very severe conditions. The absorber inlet and quenching zones are subjected to a wide change in operating temperatures. The absorption process decreases the pH of the sorbent seawater. The seawater spray nozzles are located in the quenching zone and above the absorber plates. Spray impingement against the absorber shell does therefore occur, although the design positions the spray nozzles to minimize spray impingement force, without sacrificing spray coverage. High temperature and acid resistant glass-flake lining offers the best solution for withstanding the incoming hot flue gas, very acidic environment and spray impingement. Accordingly, the absorber vessel is manufactured in carbon steel, and the entire shell is internally lined using glass flake lining.

- Absorber bottom: In addition to the glass flake lining, the absorber bottom is also rubber lined. The 3 mm thick rubber lining protects the glass flake lining from mechanical damage caused by outage inspection and maintenance activities.

- Absorber outlet ducts: Corrosive attack by sulfurous acid caused by the presence of moisture and residual sulfur dioxide is the main problem. Here too, glass flake lining has demonstrated effective corrosion resistance ensuring prolonged service. Besides the absorber outlet duct, the bypass duct (downstream of the bypass damper), and the flue gas duct up to the chimney are also lined with glass flake lining for effective protection against sulfurous acid attack.

- Absorber mist eliminator: The mist eliminator is fabricated from polypropylene, which has effective acid resistance.

- Other absorber internals: Other absorber internals, such as the spray pipes, MORETANA ® plates, aeration pipes, supports, etc. are manufactured in duplex stainless steel (JIS SUS 329J4L). This stainless steel is an austenitic ferritic grade (25Cr-6.5Ni-3Mo-0.2N-Cu-W) alloy steel with superior corrosion resistance in an acidic environment.

- Seawater pump discharge pipes: The main seawater pump discharge piping is constructed in carbon steel lined with tar epoxy. The smaller size lines are also in carbon steel, but with PE lining. Similarly, the portion of raw water line (from the emergency water storage tank), which exposed to seawater downstream of the shutoff valve and up to the absorber is in carbon steel with PE lining. Piping downstream of butterfly valves is rubber-lined to a length of 2.5 pipe diameters.

- Seawater return pipe: The seawater return pipe is lined with acid resistant glass flake lining.

- Relay pit: The relay pit, being in concrete, is lined with 1.5 mm thick acid resistant FRP lining.

- Emergency seawater storage pit: The emergency sweater storage pit, also being in concrete, is lined with 1.5 mm thick acid resistant FRP lining.

- Discharge canal – Mixing Pit: The mixing pit, being in concrete, is lined with 0.6 mm thick acid resistant FRP lining; the thickness being thinner than that for the relay pit and emergency seawater storage pit, considering the exposure to diluted seawater with higher pH.

- Aeration Nozzles: The aeration nozzles are manufactured in ABS for corrosion resistance and strength, and the rubber membranes are manufactured in EPDM.

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3.2. Functional Constraints

The seawater process quenches the flue gas before treatment, and this flow distribution ensures minimum flue gas temperature required at the chimney outlet for plume prevention, while meeting the SO_2 limitation in the total flue gas released into the chimney.

An emergency water storage tank externally formed on the top of the absorber stores quenching water for emergency use, as would be required during mist eliminator temperature high high when the seawater supply to the absorber stops. During such an emergency, a pneumatically actuated on-off valve opens to release the stored raw water under gravity to the quenching zone of the absorber. Besides being controlled from the DCS, this valve opens on instrument air failure, ensuring operation of the system during a blackout. While quenching the flue gas led to the absorber vessel by the coasting boost up fans and induced draft fans & forced draft fans in the drafting system, this emergency supply of raw water scrubs entrained dust in the flue gas released by the now-de-energized upstream electrostatic precipitators. Unlike the effluent from the absorber during normal operation, the quench water released during a blackout is rich in ash and trace elements normally trapped in the electrostatic precipitators. Moreover, the temperature of this quench water could exceed the permissible limits. Therefore, a horizontal centrifugal pump installed adjacent to the relay pit at the absorber outlet, pumps the effluent during a blackout from the absorber to a separate emergency seawater storage pit. This pit is common to both units, and has a storage capacity of 1500 m^3. The collected effluent is suitable for trucking for final disposal outside the power plant premises. A sump pump permanently installed in the emergency seawater storage pit can pump any residual stormwater or non-reacted seawater to the outfall, as long as the sample tests verify that the quality of the effluent meets the applicable environment regulations.

Each seawater supply pump is equipped with an air release valve on the discharge elbow. This valve releases air in the pump column at startup.

The aeration process in the seawater treatment system increases the pressure drop in the seawater discharge canal. Accordingly, the circulating water system design ensures satisfactory operation of the circulating water pumps and seawater pumps with varying number of aeration nozzles placed in service. The design allows for stable operation despite any changes in the pressure drop across the aeration pit.

Proper selection of the capacity of the portable outfall dewatering sump pump ensures dewatering of the entire outfall for that unit in 24 hours.

As a safety feature, keys are provided for switchgear and motor control centers so that only authorized personnel can open and access the electrical panels.

3.3. Physical Constraints

Manholes provided in the seawater supply and effluent discharge pipes allow access for maintenance and inspection of the glass flake lining.

The absorber blowers' discharge piping leads to a ring header around the absorber vessel. This arrangement provides uniform distribution of air to the sparger pipes installed inside the absorber. Installing this ring header well above the maximum possible effluent level collected in the absorber vessel ensures that there is no effluent flow into the air supply pipes upon blower trip.

The emergency seawater transfer pump is an end-suction top discharge centrifugal pump with the centerline of the pump being below the effluent level in the relay pit. This eliminates the need to prime the pump.

The R-PIO cabinets of DCS are located in a dedicated building – the FGD electrical room – provided for the FGD units. This building is located near the FGD units. The majority of the electrical equipment belonging to the FGD system are also located in the FGD electrical room, although a few lighting distribution panels are to be installed outdoors.

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4. Process Control

Refer to the DCS drawing provided as Attachment - 10 (6/6). The DCS controls the FGD System automatically. The description of the major control loops follows:

4.1. FGD Boost up Fan Blade Control

The DCS controls the startup, shutdown and capacity control of the FGD Boost up Fan. The APS can automatically start / stop the FGD system, with these two (2) Boost up Fans A & B. The capacity of the individual fans can be effectively controlled using individual blade pitch control. The FGD boost up fans together can handle 70 percent of the flue gases generated at 100 percent MCR condition. The load (for circulation of this flue gases) can be distributed between the two Boost up Fans, by manipulating the control bias for individual Fan Blade Control Drive.

Two redundant flow transmitters are provided to measure the flue gas flow through each boost up fan (total 4 transmitters for 2 boost up fans), which enable the computation of the total flue gas flow as summation of these two flow signals.

The set point of the total flue gas flow through the Boost up Fans is determined by a function of the megawatt demand signal. The difference between the set point and the flue gas flow is controlled by the PI controller modulating the fan blade pitch adjustment.

An interlock inhibits above controller's service and drives the boost up fan blades closer, if the following condition occurs:

- Mist eliminator inlet temperature > 65 deg. C

4.2. FGD Bypass Damper Control

A MWD function, and a secondary PI controller based on the differential pressure across the FGD bypass damper control the FGD bypass damper opening.

A differential pressure transmitter measures the differential pressure across the FGD system Bypass damper. A secondary PI controller controls the differential pressure to be positive only when the differential pressure turns negative by modulating the FGD Bypass Damper drive. Thus, a portion of the flue gas mainstream will be diverted into the FGD system. The set point will be a function of MW demand.

An interlock fully opens the Bypass Damper, if any of the following conditions occurs:

- Both FGD Boost up Fans tripped or stopped

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5. System Operation

5.1. Normal Operation

5.1.1. DCS

In normal operation, the DCS controls the three seawater pumps (each 50 percent capacity) with two in duty, and another in standby mode, to supply the seawater into the Unit Absorber.

In normal operation, the DCS controls the three Absorber Blowers (each 50% capacity) with two in duty, and other in standby mode.

In normal operation, the DCS controls the four Aeration Blowers (each 33% capacity) with three in duty, and other in standby mode.

In normal operation, the DCS controls two Boost up Fans (each 50% capacity) in duty mode.

In normal operation, the DCS controls following electrical switchgear and MCC.

- 11 kV Switchgear
  Incoming circuit breaker
  Each feeder circuit breaker.

- 400 V MCC
  Incoming circuit breaker
  Tie line circuit breaker

5.1.2. Electrical system

The 11kV FGD Switchgear is energized from the upstream unit 11kV Switchgear A or B.

Each 400V MCC (Normal) is energized from its associated 11kV/400V dry type transformer. The interconnecting tie line circuit breaker at 400V Unit-1 FGD MCC is closed and the tie line circuit breaker at 400V Unit-2 FGD MCC is open.

Each 400V emergency MCC is energized from respective unit's main 400V emergency MCC.

The 380V/220V Lighting distribution panel energized from the upstream 380V/220V lighting MCC.

The 220V AC control distribution panel can be energized from 400V MCC (normal) by closing either of the incomer circuit breakers.

The 110V DC Distribution Board is energized from the upstream DC 110V unit Distribution board.

5.2. Power Supply Changeover

FGD 11kV switchgear, 400V normal MCC and 220V control distribution panel are provided with dual incoming sources. For normal operation, each panel receives power from one selected source designated as the normal supply source. In case the normal source is unavailable, power supply to the switchboard can be maintained from the alternate source.

5.2.1. 11kV Switchgear

If one of the incoming power supply is interrupted, 11kV bus voltage will drop to zero. Also, the 11 kV motors, such as BUF, SWP, absorber blower and aeration blower will be tripped by the under voltage relay, absorber bypass duct damper opens and absorber outlet duct damper, BUF inlet damper and BUF outlet damper closes and FGD system will be automatically bypassed.

In such an event, power supply to the 11kV panel can be restored manually by closing the other incoming power supply line. This changeover is to be done by the operator after ensuring that there are no other abnormalities in the electrical system.

After the bus voltage recovers to normal following this changeover, the 11kV motors, such as aeration blower, SWP, BUF and absorber blower can be restarted and the FGD system can be back in-service.

5.2.2. 400V MCC

If the incoming power supply is interrupted, power supply to the MCC is restored from the 100% back up source through automatic closing of the 400V interconnecting tie circuit breaker at Unit 2 FGD system MCC.

5.2.3. 220V Distribution Panel

If the distribution panel cannot receive incoming power supply form Unit 1, it can be supplied from Unit 2 as an alternative. Power supply to the distribution panel can be manually transferred from one feeding source to the other by switching the appropriate incoming circuit breaker.

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5.3. Startup / Shutdown

The Automatic Plant Startup/Shutdown Control (APS) System performs the various startup and shutdown functions associated with the FGD System automatically. Alternatively, the operator can initiate the startup / shutdown of these systems through any one – GROUP level, SUB GROUP level or DRIVE level.

The entire startup / shutdown operation can be monitored in the CRT OPS at the central control room.

The field and the central control room communicate the data for monitoring, data logging & operation of the FGD system through the remote I/O device (R-PIO), located in the FGD electrical room.
The DCS drawing provided as Attachment – 10 (2/6) ~ (5/6) schematically indicates the APS structure applicable to the FGD System.

5.3.1. Startup

The FGD System GROUP Level or SUB GROUP Level can start operation after the flowing condition is established:

- Emergency water storage tank level is normal

Refer to the DCS drawing provided as Attachment – 10 – (2/6) ~ (5/6). The GROUP Level FGD System receives FGD start command from APS to initiate the drive selection in Duty & Standby modes from the SUB GROUP Level: (1) Aeration Blower Selector – 3 running & 1 standby, (2) Absorber Blower Selector – 2 running & 1 standby, (3) Seawater pump group Selector – 2 running & 1 standby, (4) Boost up Fan Selectors for Seal Air Fan – 1 running & 1 standby and (5) Boost up Fan Selectors for Oil Pump – 1 running & 1 standby.

When above ‘Duty’ modes are selected, the following startup commands are issued:

- Step 1: Seawater Pump start command.

  The seawater Pumps will start when the following condition is established.

  - Absorber Level not high.

The Seawater Pump discharge isolating valve (motorized valves) will reach at full closed positions and then the corresponding Seawater pumps will start. To ensure a smooth startup of each pump, corresponding discharge isolating valve will gradually open over a time interval, before fully opening the valve.

The satisfactory operation of above Seawater Pumps will establish the normal seawater flow into the Absorber.

- Step 2: Boost up Fan-A group start command and Absorber Blower group start command.

  The Absorber Blowers will start, whereas the Boost up Fan-A group will initiate the following commands to its associated equipment:

  - Oil Pump – A1 or A2 start command
  - Seal Air Fan – A1 or A2 start command
  - Boost up Fan-A Blade zero percent (full close) command,
  - Inlet Damper open command,
  - Outlet Damper close command,

At the end state of above commands, the Boost up Fan-A will start. Outlet damper and Absorber outlet damper will open after the Boost up Fan-A starts.

- Step 3: The Boost up Fan-B start command

Both the Boost up Fans will run in automatic mode. The Boost up Fan Blade control loop and the Bypass Damper differential pressure control loop will operate in 'Automatic' mode. The details of control loops are described in item 4.0 for Process Control.

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5.3.2. Shutdown

The FGD System GROUP Level or SUB GROUP Level will shutdown if the following conditions are established:

- Unit Load drops below a preset value

  The GROUP FGD System will issue a shutdown command to the drives selected in Duty mode through the SUB GROUP Level. In response, the SUB GROUP Level issues the following shutdown commands:

- Step 1: Boost up Fan-B group stop command

  The Boost up Fan-B group stop end state is achieved.

- Step 2: Boost up Fan-A group stop command and Absorber Blower group stop command

  The Boost up Fan-A group stop end state is achieved. All Absorber Blowers are stopped.

- Step3: Absorber Outlet Damper close command

  The Absorber Outlet Damper is closed

- Step 4: The Aeration Blowers stop command

  The Aeration Blowers stop.

- Step 5: Seawater Pump stop command

  The Seawater Pump stop

The emergency seawater transfer pump will be operated by local control panel for removal of the effluent with rich particulates in the relay pit after FGD isolation.

5.4. Interlocks

The FGD system incorporates the following interlocks:

5.4.1. EP abnormal

When EPs are abnormal, FGD system will be isolated as follows to prevent the effluent with rich particulates that pass through the non-energized EP from being discharged to the outfall.

- Both Boost up Fans trip,
- Accordingly, Absorber Bypass Duct fully opens, Boost up Fan Inlet and outlet Dampers close,
- Absorber Outlet Duct Damper closes,
- All Absorber Blowers trip,
- All Seawater Pumps trip.

5.4.2. Absorber

The Mist Eliminator inlet temperature is measured at appropriate location in the Absorber. During normal operation, if this temperature becomes high (44 deg. C), an alarm is generated for operator's attention. If the temperature exceeds a preset high-high value (75 deg. C), emergency cooling water shutoff valve will open to spray the cooling water in the absorber and the Boost up Fan Blades will be tripped.

When the mist eliminator inlet temperature returns back to normal, the FGD system will be ready to resume its operation.

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5.4.3. Seawater Pump trip

Any of the following conditions will trip the working seawater pump:

- Seawater Pump Pit level is low-low (CD +3,140 mm)
- Discharge isolating valve remains closed for more than 15 seconds
- EP abnormal

5.4.4. Back up Seawater Pump Start

A trip of the operating seawater pump will automatically start the standby seawater pump.

5.4.5. Seawater Pump Discharge isolating valve

The seawater pump discharge isolating valve opens / closes when the associated seawater pump starts / stops.

5.4.6. Backup Aeration Blower start

A trip of the operating aeration blower will automatically start the standby aeration blower.

5.4.7. Backup Absorber Blower start

A trip of the operating absorber blower will automatically start the standby absorber blower.

5.4.8. Emergency Water Storage Tank Supply Shutoff Valve

The emergency water storage tank supply shutoff valve (in the raw water supply line) will open at low level (Top Plate of Tank -150 mm) of the Emergency Water Storage Tank. The valve will close at high level (Top Plate of Tank -30 mm) of the Emergency Water Storage Tank.

5.4.9. Emergency Cooling Water Shutoff Valve

The emergency cooling water shutoff valve will open above high high mist eliminator inlet temperature (75 deg. C) and close below a preset value of mist eliminator inlet temperature (40 deg. C).

5.4.10. FGD Boost up Fan trip

The following conditions will trip the working FGD boost up fan:

- All IDF trip,
- All Seawater Pump stop,
- Mist Eliminator inlet Temperature high-high (75 deg. C),
- Absorber Outlet Damper closed for some period (10 seconds),
- Boost up Fan Outlet Damper closed for some period (10 seconds),
- Boost up Fan control oil pressure low-low (30 bar),
- Boost up Fan lubricant oil pressure low-low (0.9 bar),
- All Boost up Fan control oil pumps stopped,
- All Boost up Fan seal air fans stopped,
- Boost up Fan bearing temperature high high (110 deg. C).

5.4.11. Absorber bypass duct damper full open interlock

- All Boost up Fans stop,

5.4.12. Backup Boost up Fan control oil pump start

Detection of low control oil pressure (50 bar), low lubricating oil pressure (1.2 bar) or a trip of the operating Boost up Fan control oil pump automatically starts the standby oil pump. Refer to the drawing “FGD Boost up Fan Piping and Instrument Diagram, M1-MN-HR-PP-20021”.

5.4.13. Backup FGD Boost up Fan seal air fan start

Detection of high bearing temperature (100 deg. C) or a trip of the operating Boost up Fan seal air fan automatically starts the standby seal air fan. Refer to the drawing “FGD Boost up Fan Piping and Instrument Diagram, M1-MN-HR-PP-20021”.

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5.4.14. Absorber outlet duct damper close interlock

Upon stopping of both BUFs, the absorber outlet duct damper is automatically closed.

5.4.15. Absorber Blower trip

- The absorber outlet duct damper is closed
- EP abnormal

5.4.16. Electrical safety interlocks

The two incoming circuit breakers of the 11 kV FGD Switchgear are electrically interlocked so that only one circuit breaker can be closed at a time.

The incoming and the interconnecting circuit breakers of the 400 V Motor control centers (Normal) are electrically interlocked so that a maximum of three breakers can be closed at a time; this prevents paralleling of the 11kV/400V dry type transformers.

The two incoming circuit breakers of the 220V control distribution panels are mechanically interlocked so that only one circuit breaker can be closed at a time.

5.5. Alarms

The FGD System annunciates the following alarm conditions:

- Boost up Fan tripped
- Boost up Fan bearing temperature High
- Boost up Fan bearing temperature High-High
- Boost up Fan Control Oil Pressure Low
- Boost up Fan Control Oil Pressure Low-Low
- Boost up Fan Lubricant Oil Pressure Low
- Boost up Fan Lubricant Oil Pressure Low-Low
- Boost up Fan Control Oil Pump tripped
- Boost up Fan Seal Air Fan tripped
- Seawater Pump Pit Level low
- Seawater Pump Pit Level low-low
- Seawater Pump tripped
- Seawater Flow low
- Absorber Blower tripped
- Aeration Blower tripped
- Mist Eliminator inlet Temperature High
- Mist Eliminator inlet Temperature High-High
- Mist Eliminator inlet Temperature High-High-High
- Absorber Level High
- Emergency water storage tank level low
- 11 kV Incoming switchgear failure
- 11 kV Incoming switchgear trip

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- 11 kV Bus tie switchgear failure
- 11 kV Bus tie switchgear trip
- 11 kV Switchgear power feeder failure
- 11 kV Switchgear power feeder trip
- 11 kV Switchgear motor feeder trip
- 11 kV Switchgear motor feeder failure
- 400 V MCC incomer trip
- 400 V MCC power feeder trip
- 400 V MCC feeder trip
- DC MC Motor feeder trip
- 11 kV / 400 V auxiliary transformer high temperature

6. References

6.1. Dwg. No. M1-MN-HR-PP-00105: FGD System Flow Diagram

6.2. Dwg. No. M1-MN-HR-EL-00290: FGD System Sequence Diagram

6.3. Dwg. No. M1-MN-HR-OM-00291: FGD System Operation & Maintenance Manual

6.4. Dwg. No. M1-MN-HR-PP-20021: FGD Boost up Fan Piping and Instrument Diagram

6.5. Dwg. No. MO-MN-HR-EL-06300: FGD System Key Single Line Diagram

6.6. Dwg. No. MO-MN-HR-EL-06301: Single Line Diagram for 11 kV Switchgear

6.7. Dwg. No. MO-MN-HR-EL-06302: Single Line Diagram for 400 V MCC (FGD)

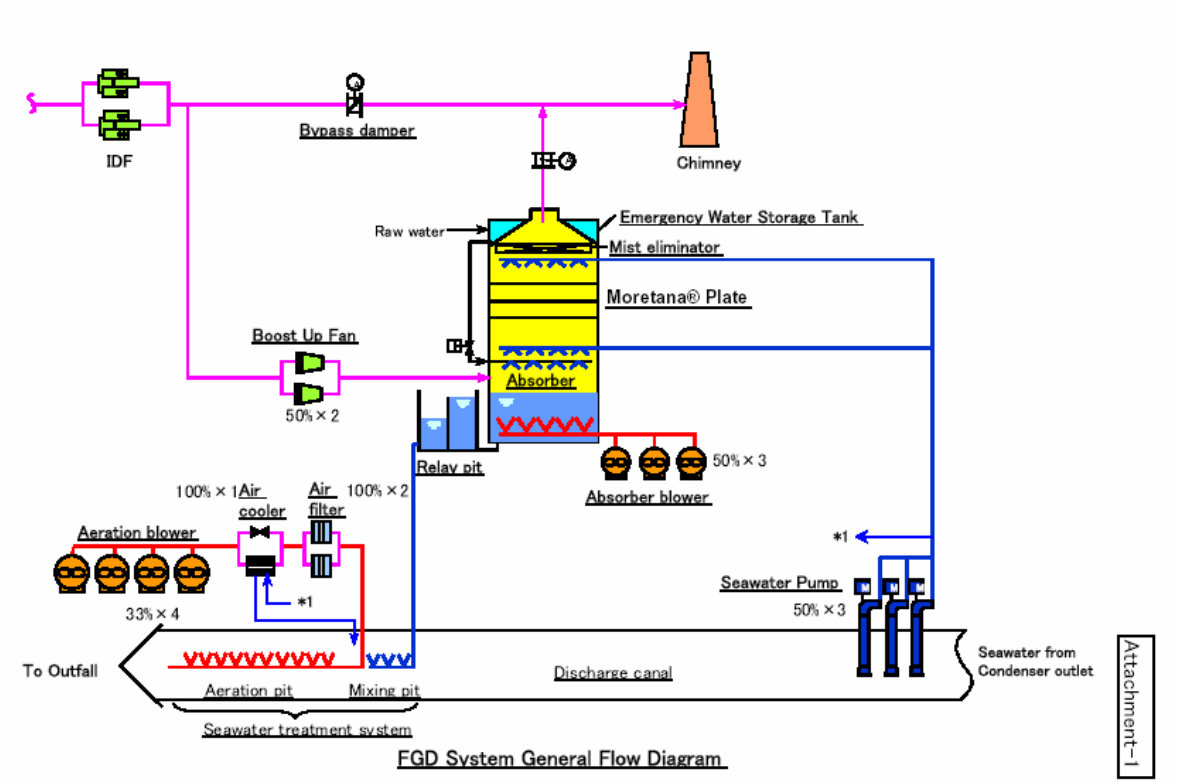
6.8. Dwg. No. MO-MN-HR-EL-06334: Single Line Diagram for 400 V Emergency MCC (FGD)

6.9. Dwg. No. MO-ME-AB-EL-70076: Electrical System Design Manual for Power Station

7. Related Systems

7.1. Circulating water System

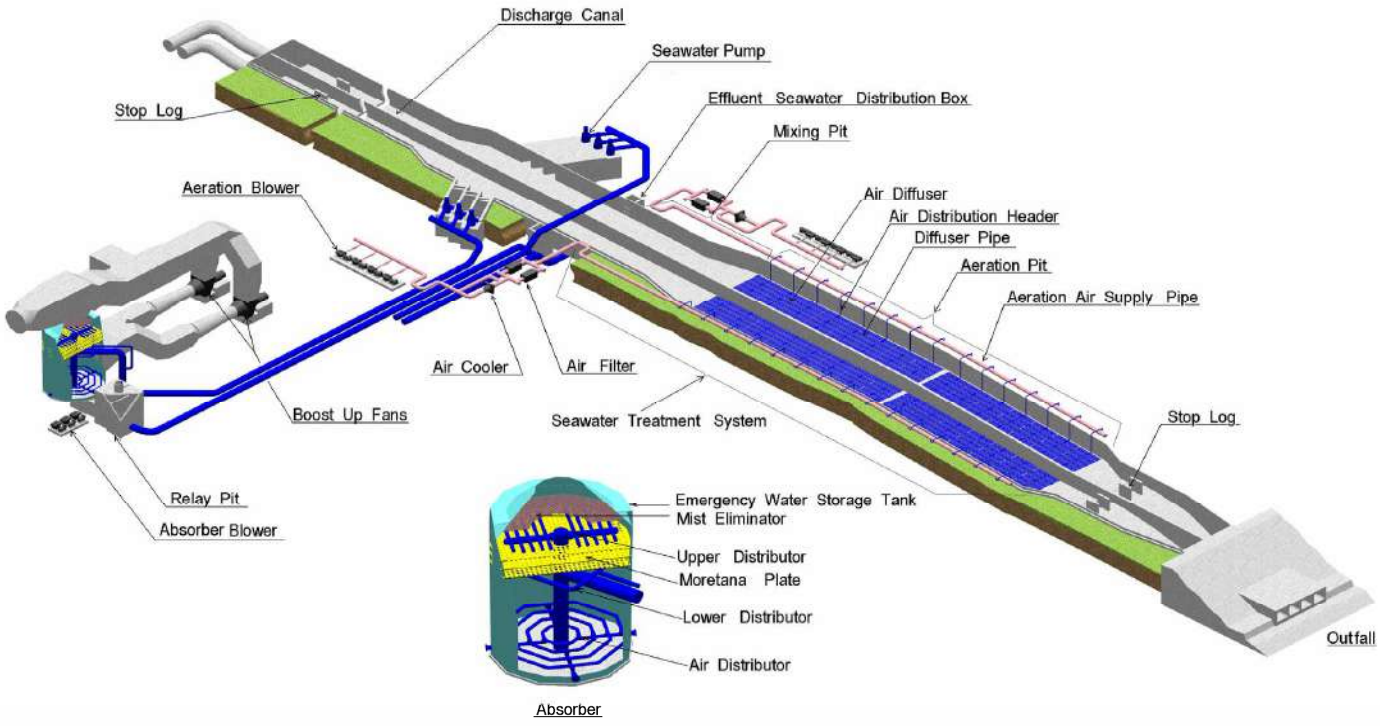
7.2. Air and Flue gas system



FGD System General Flow Diagram

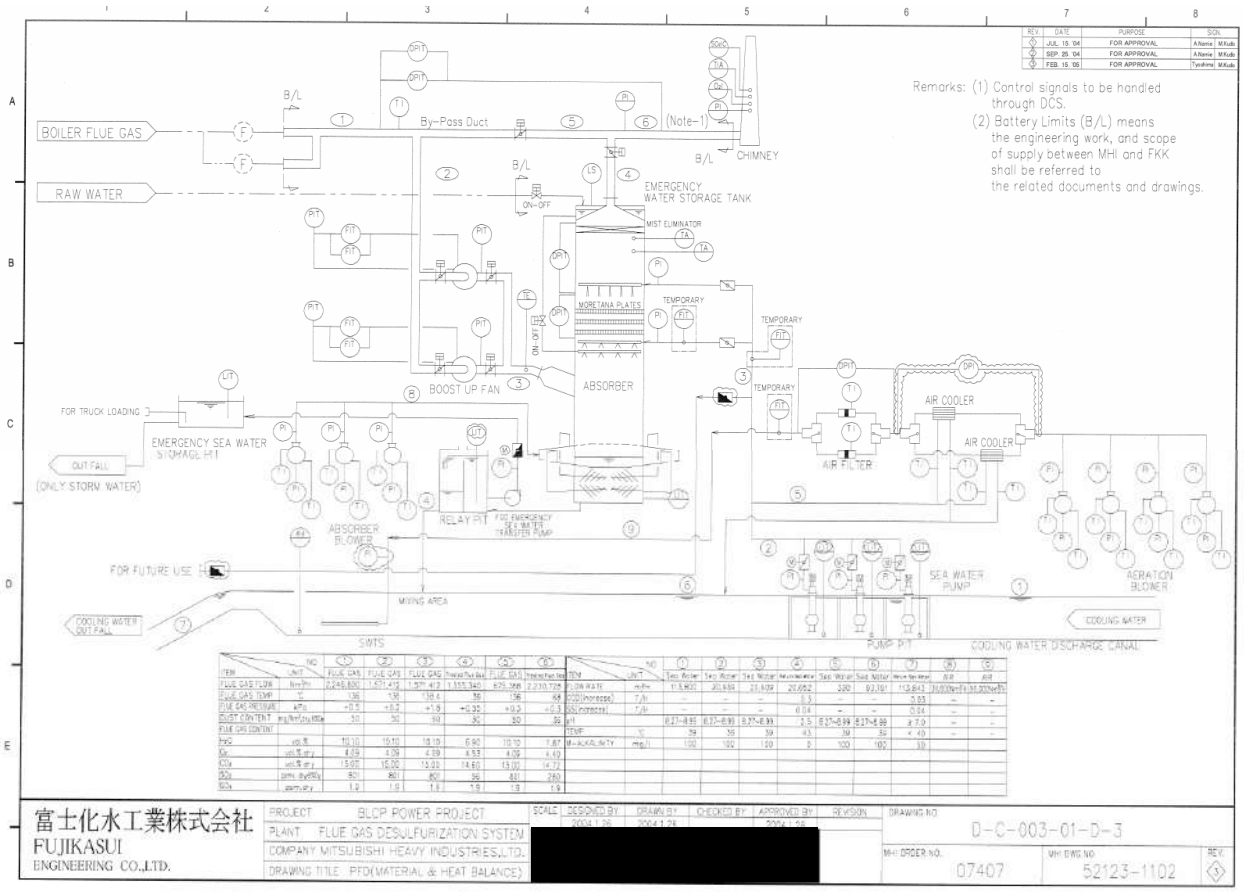
Attachment – 1 (Sheet 1 of 1)

Attachment – 2 (Sheet 1 of 1)



FGD SYSTEM GENERAL ARRANGEMENT

Attachment – 3 (Sheet 1 of 1)



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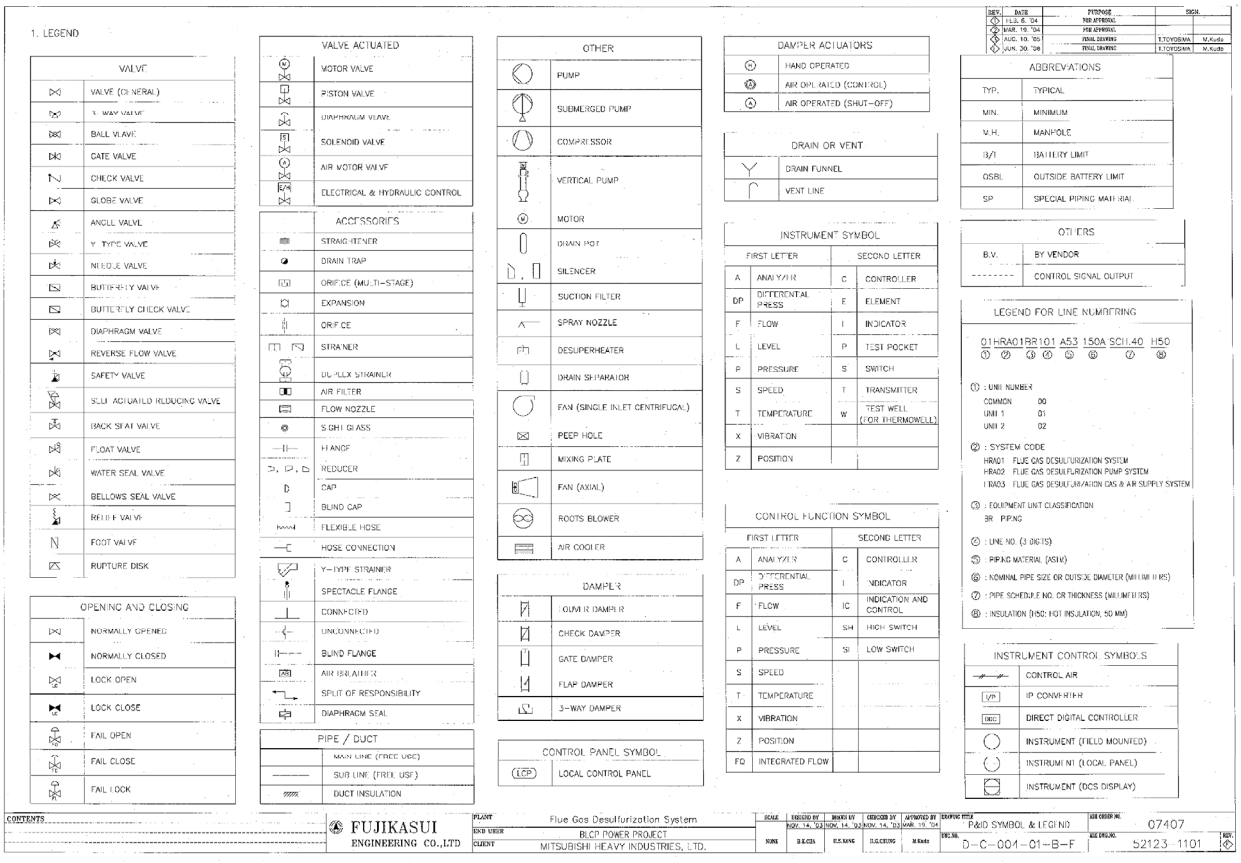
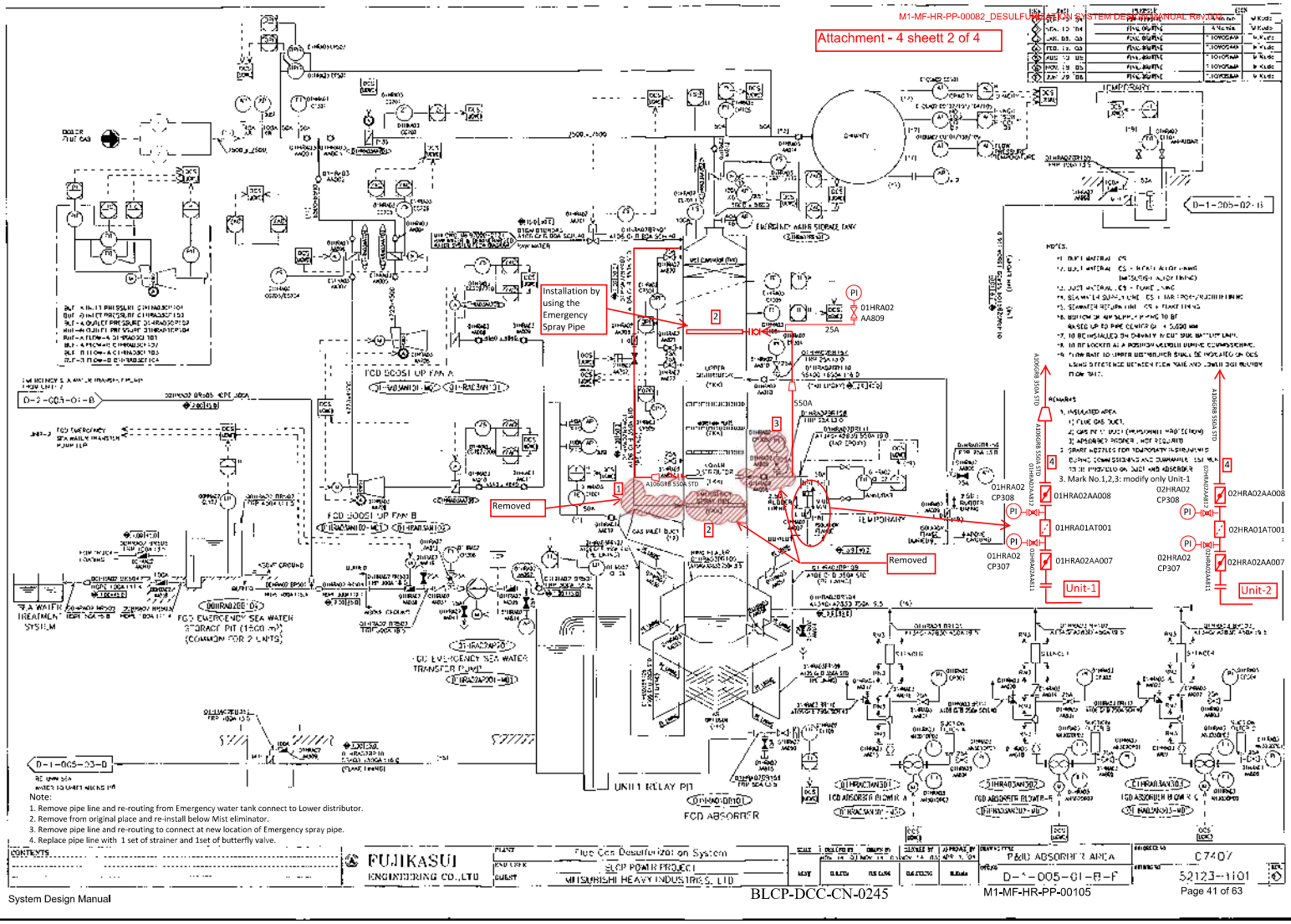
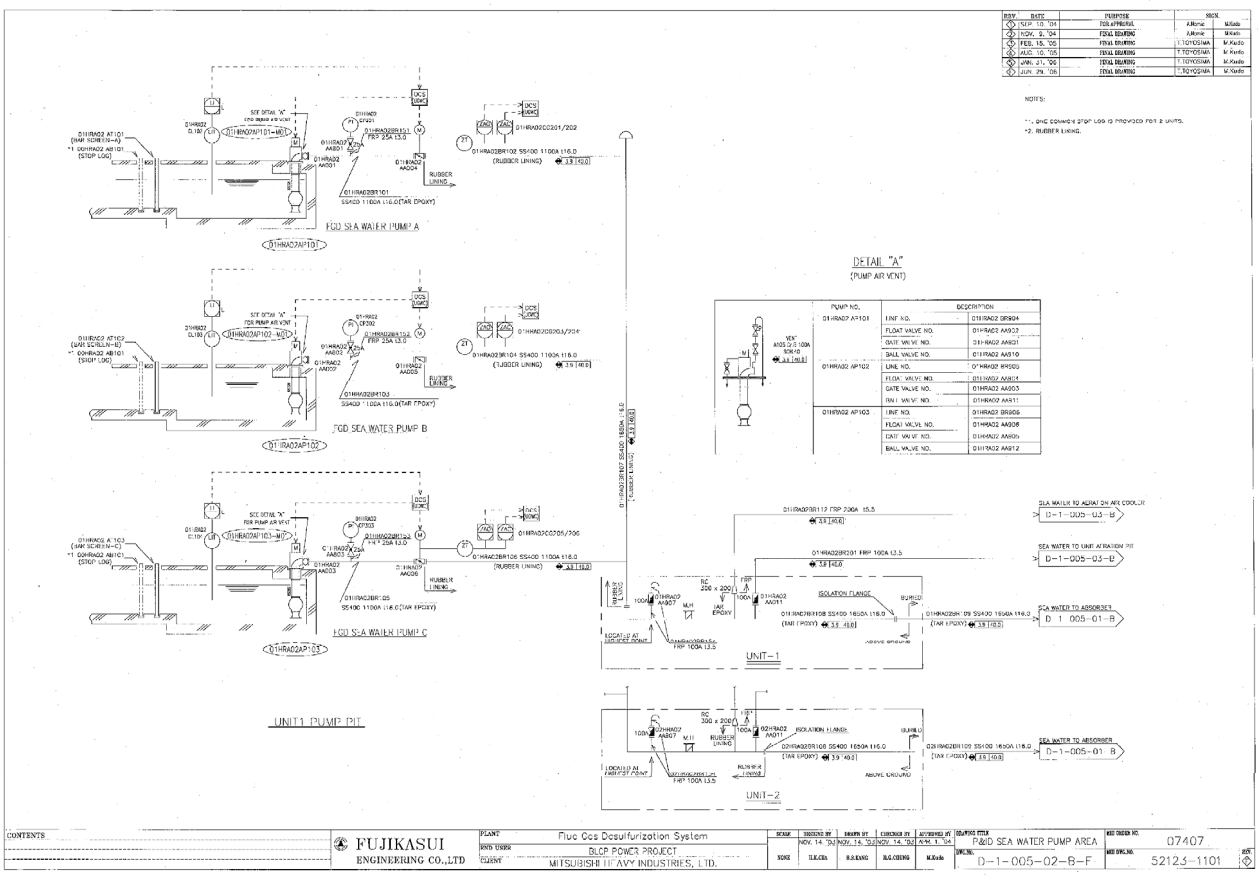


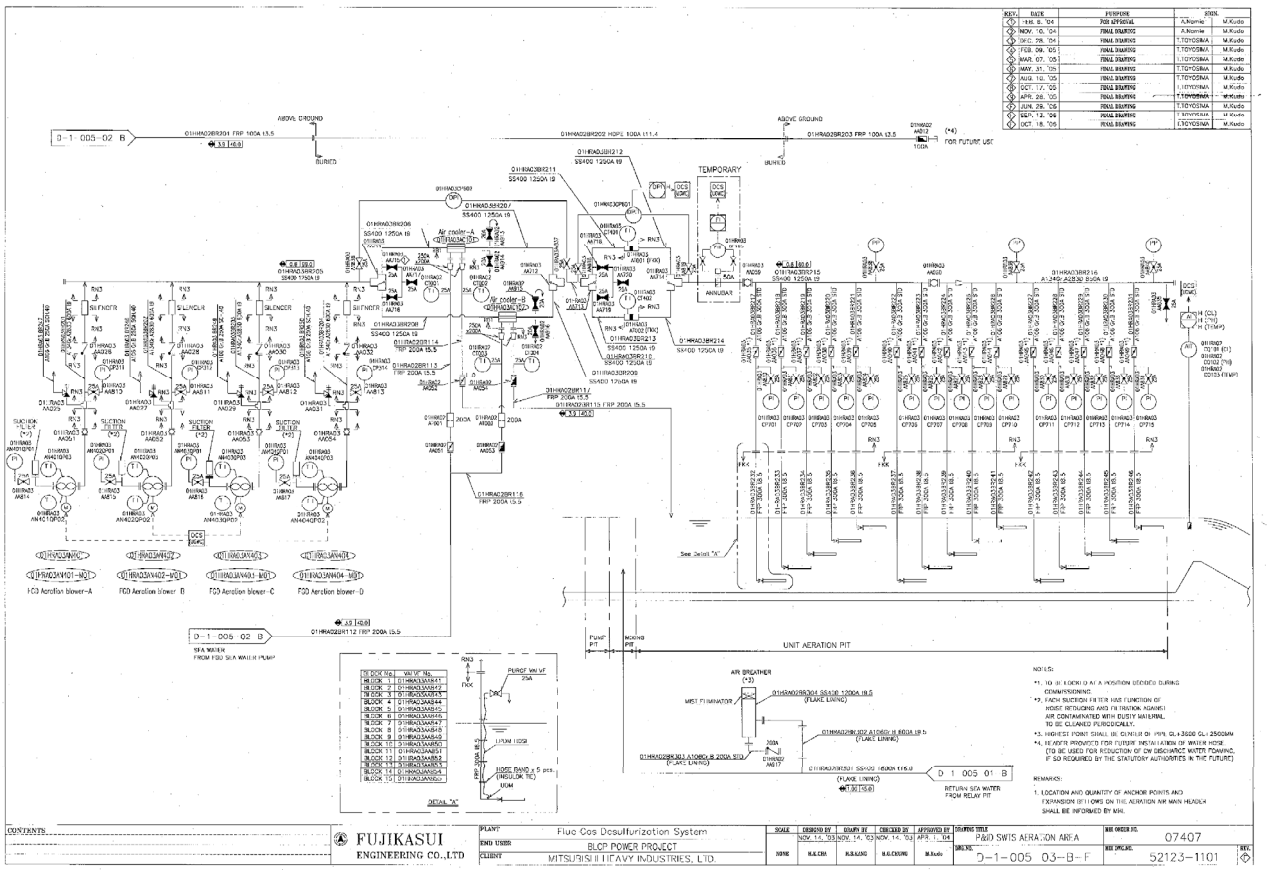
Attachment - 4 sheett 2 of 4



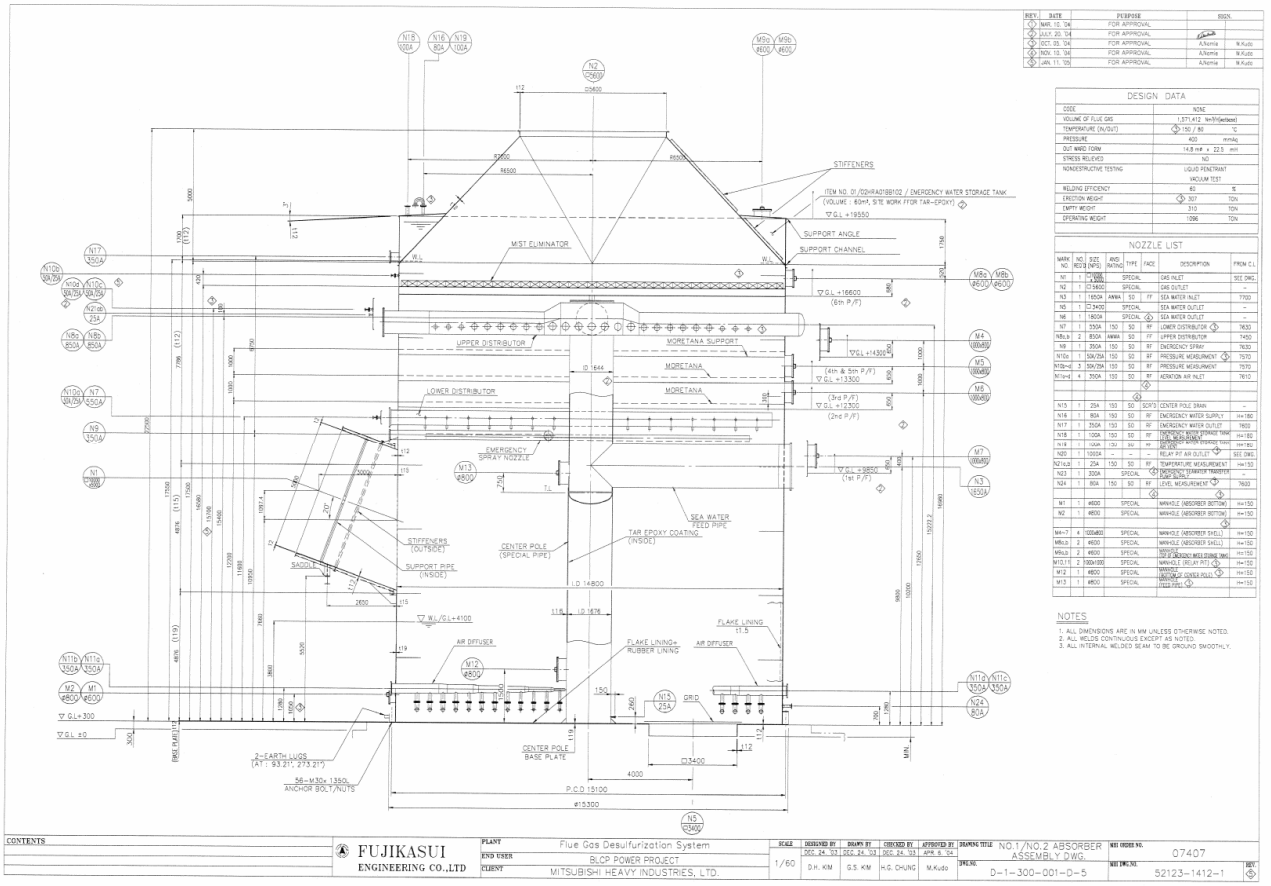
Attachment – 4 (Sheet 3 of 4)



Attachment – 4 (Sheet 4 of 4)



Attachment – 5 (Sheet 1 of 1)



Attachment – 6 (Sheet 1 of 2)

Design Condition

1. Inlet Condition

1) Boiler

Size of boiler	MW	717
No. of boiler		2
Design fuel		"Coal C" (SO_2 removal)
		"Blair Athol" (BUF Design)
Sulfur content in coal		
design	%	0.95
operation, max	%	0.7 "Valelia"

2) Flue gas

Flue gas flow, SO_2 removal	Nm^3/h	2,246,800 "Coal C"
Flue gas flow, BUF design	Nm^3/h	2,267,600 "Blair Athol"
Flue gas inlet temperature		
Design	°C	150
operation, max	°C	140
Flue gas composition		
CO_2	Vol%-wet	13.48
H_2O	Vol%-wet	10.10
N_2	Vol%-wet	72.71
O_2	Vol%-wet	3.67
SO_2	Vol%-wet	–
Total	Vol%-wet	100.00
CO_2	Vol%-dry	15.48
H_2O	Vol%-dry	0.00
N_2	Vol%-dry	80.87
O_2	Vol%-dry	4.09
SO_2	Vol%-dry	–
Total	Vol%-dry	100.00
SO_2	ppmv(actual)-dry	903
	ppmv(6%O_2)-dry	801
(Note) This SO_2 value is based on 0.95% sulfur content in coal		
SO_3	ppmv(actual)-dry	1.9
Particles	mg/Nm^3(6%O_2)-dry	50

Attachment – 6 (Sheet 2 of 2)

3) Seawater

Total water flow form condensers	m^3/h	113,800
Temperature condenser outlet, min-max	°C	29.8 – 39
pH		8.27 – 8.99
M-Alkalinity	mg/l	100

2. Outlet condition

1) Flue gas

SO_2	ppmv(6%O_2)-dry	280
	mg/Nm^3(6%O_2)-dry	800
Particles	mg/Nm^3(6% O_2)-dry	50
Temperature(See Note)	°C	65

2) Seawater

Flow rate	m^3/h	113,843
pH		≥ 7
Temperature, max (increase)	°C	1.0
DO, min at saturation of discharge seawater	%	75
COD, max (increase)	mg/l	2.5
SS, max (increase)	t/h	0.04

(Note) This temperature is based on the following conditions

- 100% BMCR unit gross output
- Maximum CW inlet temperature 32.2°C and CW outlet temperature 39.0°C
- Sulfur content 0.95%
- Boiler design ambient temperature 30°C

As clarified in the 7th design review meeting, 77°C can be achieved with SO_2 concentration at chimney inlet equal to or lower than 280 ppmv (6% O_2)-dry by increasing the gas bypass flow under the following conditions.

- 85% TMCR unit gross rate
- Minimum CW inlet temperature 23°C and CW outlet temperature 28.9°C
- Sulfur content of worst coal "Valeria" 0.7%
- Boiler design ambient temperature 30°C

Attachment – 7 (Sheet 1 of 4)

Equipment Specification

NO	Description	Q'ty (*1)	Specification and Component	Material	Remarks
1	Absorber	2 (2+0)	**Flue gas Inlet nozzle(10m^{W}×5m^{H}×3m^{L})**		
			Nozzle	ASTM A36	
			Internal support	Nickel Alloy Steel (Mitsubishi Alloy)	
			Lining Material	Nickel Alloy Steel (Mitsubishi Alloy)	
			Vessel(14.8mϕ×22.5m^{H})		
			Side wall , Bottom Plate	ASTM A36	
			MORETANA® Plate	Duplex Stainless Steel	
			Upper Distributor	Duplex Stainless Steel	
			Mist Eliminator®	Polypropylene	
			MORETANA® Plate support with setbolt	Duplex Stainless Steel	
			Lower Distributor and spray Nozzle	Duplex Stainless Steel	
			Emergency Distributor and spray Nozzle	Duplex Stainless Steel	
			Feed Pipe	ASTM A36	
			Aeration Piping (inside)	Duplex Stainless Steel	
			Air Diffuser Pipe	Duplex Stainless Steel	
			Safety Grid for Relay Pit	FRP	
			Lining , Coating	Side wall : Flake lining (*2)	
				Bottom plate : Flake lining + Rubber lining (*2)	
				Feed pipe inner : Tar epoxy coating	
				Feed pipe outer : Flake lining (*2)	
			Emergency water storage tank (Hold up capacity : 60m^{3})		
			Side wall , Roof plate	ASTM A36	
			Inner surface coating	Tar Epoxy coating	
2	Boost up fan	4 (4+0)	220Nm^{3}/s×1.853kPa(*3) Axial type	Casing : General carbon & welded Impeller : Cast steel Shaft : Forged steel	1220kW (*2)

Attachment – 7 (Sheet 2 of 4)

NO	Description	Q'ty (*1)	Specification and Component	Material	Remarks
3	Absorber blower	6 (4+2)	330Nm^{3}/min×5000 mmAq with accessory (Silencer, Safety valve, Expansion joint, Suction filter)	Casing : JIS FC250 Rotor : JIS FCD450 Shaft : JIS S48C·N	450kW (*2)
4	Seawater pump	6 (4+2)	10,750m^{3}/h×22m Vertical , Mix flow type	Casing : FCHD Impeller : JIS SCS14 Shaft : JIS SUS316L	850kW (*2)
5	Emergency Seawater pump	2 (0+2)	400m^{3}/h×15m Horizontal type	Casing : JIS SCS14 Impeller : JIS SCS14	55kw (*2)
6	Pump pit (approx 650m^{3})	2	Pit proper	RC	
7	Relay pit (approx 536m^{3})	2	Pit proper	RC	
			Lining	FRP lining 1.5t(*2)	
8	SWTS (Sea Water Treatment System) (approx 15200m^{3})	2	Aeration pit proper	RC	
			Air piping : Main header	Carbon steel	
			Sub header	FRP	
			Air diffuser connection header	C-PVC	
			Air diffuser	Membrane : EPDM Saddle : ABS Wedge : ABS	7000 duplex
9	Mixing pit (approx 1950m^{3})	2	Pit proper	RC	
			Lining	FRP lining 0.6t (50%Area) (*2)	
10	Aeration blower	8 (6+2)	500Nm^{3}/min×50kPa with accessory (Silencer, Safety valve, Expansion joint, Suction filter thermometer(Bearing & Unbearing Side))	Casing : JIS FC250 Rotor : JIS FCD450 Shaft : JIS S48C·N	700kw (*2)

Attachment – 7 (Sheet 3 of 4)

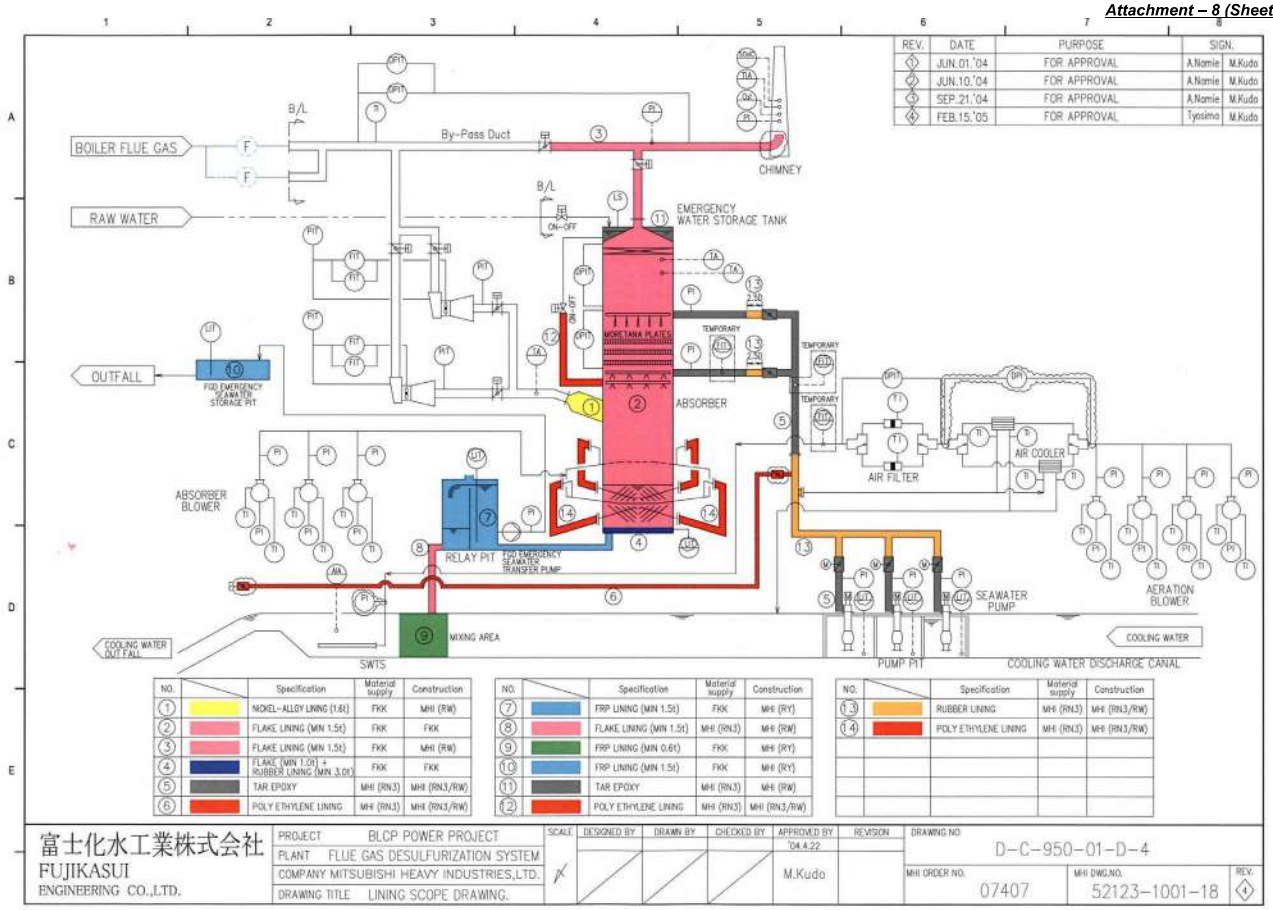
NO	Description	Q'ty (*1)	Specification and Component	Material	Remarks
11	Emergency Sea Water Pit Sump Pump	1 (1+0)	10 m3/hr×10 m	Casing : JIS SCS14 Impeller : JIS SCS14	0.75kw (*2)
12	Duct	1lot	**Main duct from tie-in point (7.5m×7.5m)**		
			Duct panel	ASTM A36	
			BUF inlet duct (6.55m×6.5m(Common)~4.72m×4.5m)		
			Duct panel	ASTM A36	
			BUF outlet duct (4.64m×4.64m~10.0m×5.0m(Common))		
			Duct panel	ASTM A36	
			Absorber outlet (5.6m×5.6m)		
			Duct panel	ASTM A36	
			Flake lining	Flake lining 1.5t(*2)	
			By-pass duct (7.5m×7.5m)		
			Duct panel	ASTM A36	
			Flake lining	Flake lining 1.5t (*2) (till by-pass damper)	
13	Duct damper (Boost up fan inlet)	4	Single louver type 4.72m×4.5m	JIS SS400	Air operation
14	Duct damper (Boost up fan outlet)	4	Single louver type 4.64m×4.64m	JIS SS400	Air operation
15	Duct damper (Absorber outlet)	2	Single louver type 5.6m×5.6m	JIS SUS316L	Air operation
16	Duct damper (By-pass)	2	Single louver type 7.5m×7.5m	JIS SUS316L	Air operation
17	Motor valve	6	1100 ϕ (OD)	ASTM A536+Tar epoxy coating	0.75kw (*2)
		2	300A	ASTM A536+Tar epoxy coating	0.75kw (*2)
18	FGD Emergency Seawater storage pit	1	**1500m^3 (Common for two units)**		
			Pit proper	RC	
			Lining	FRP lining 1.5t (*2)	

Attachment – 7 (Sheet 4 of 4)

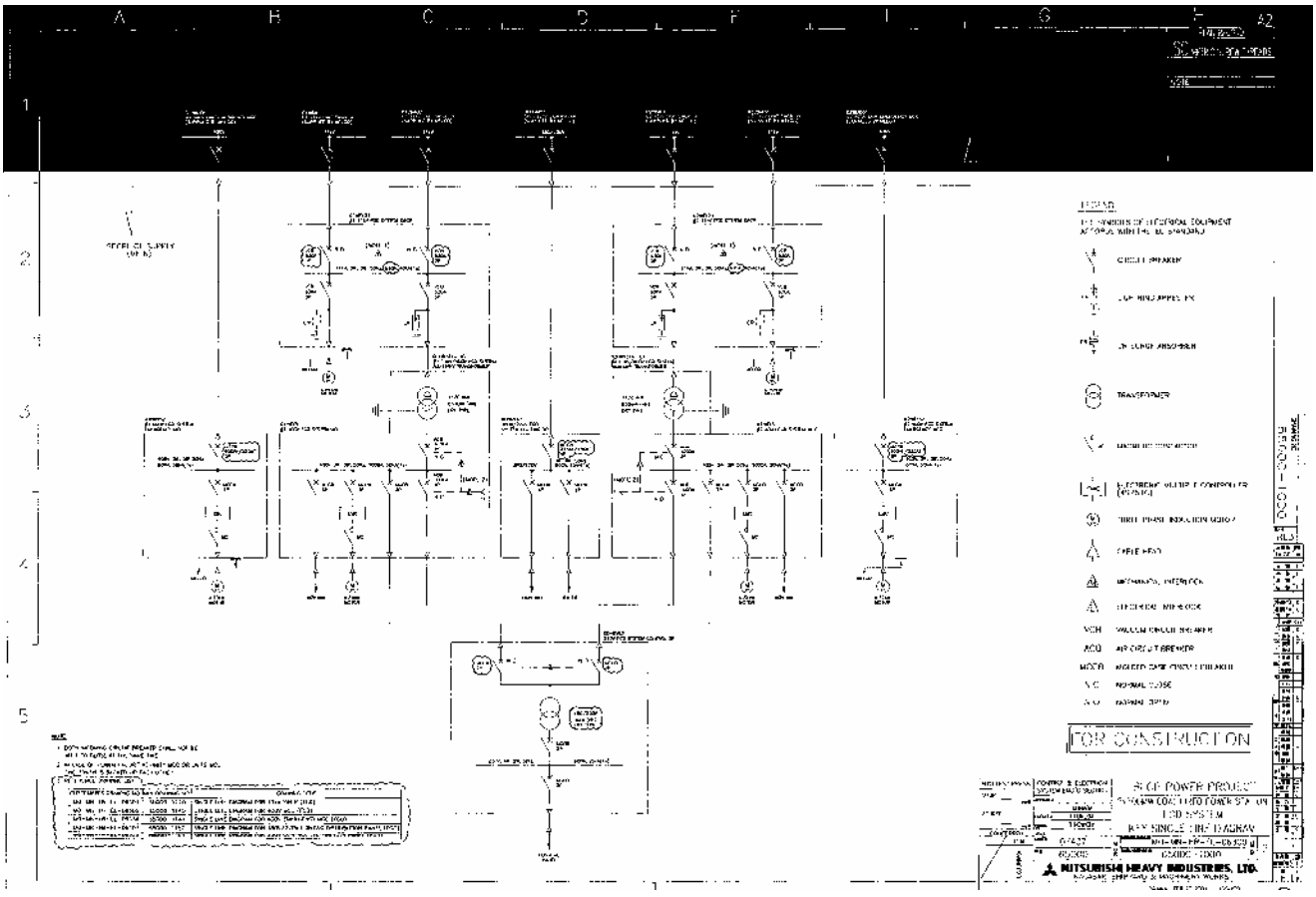
NO	Description	Q'ty (*1)	Specification and Component	Material	Remarks
19	Air filer	4 (2+2)	90,000Nm3/hr	Casing : JIS SS400 Prefilter : Glass fiber	
20	Inlet 3-way valve of air filter and air cooler for air diffusers	4	3-way valve	Casing : JIS SS400	
21	Outlet 3-way valve of air filer and air cooler for air diffusers	4	3-way valve	Casing : JIS SS400	
22	Air cooler	2 (2+0)	Tube type heat exchanger Heating surface : 1100m2	Casing : JIS SS400 Tube : Titanium	
23	Outfall dewatering Pump	1	350m3/hX6.5m Submerge	Casing : JIS FC250 + lining Impeller : JIS SCS14 Shaft : JIS SUS316L	
24	Stop log for insertion at the discharge canal inlet	1	Common for Un it-1&2	Stop log : Carbon Steel + epoxy	
25	Stop log for insertion at the discharge canal inlet	1	Common for Un it-1&2	Stop log : Carbon Steel + epoxy	
26	Stop log for seawater pump's suction	1	Common for Un it-1&2	Stop log : Carbon Steel + epoxy	

Note (*1) Above quantities are shown 2(two) units.
The figure in ( ) shows the number of working and stand-by equipment.
(*2) Motor rated output

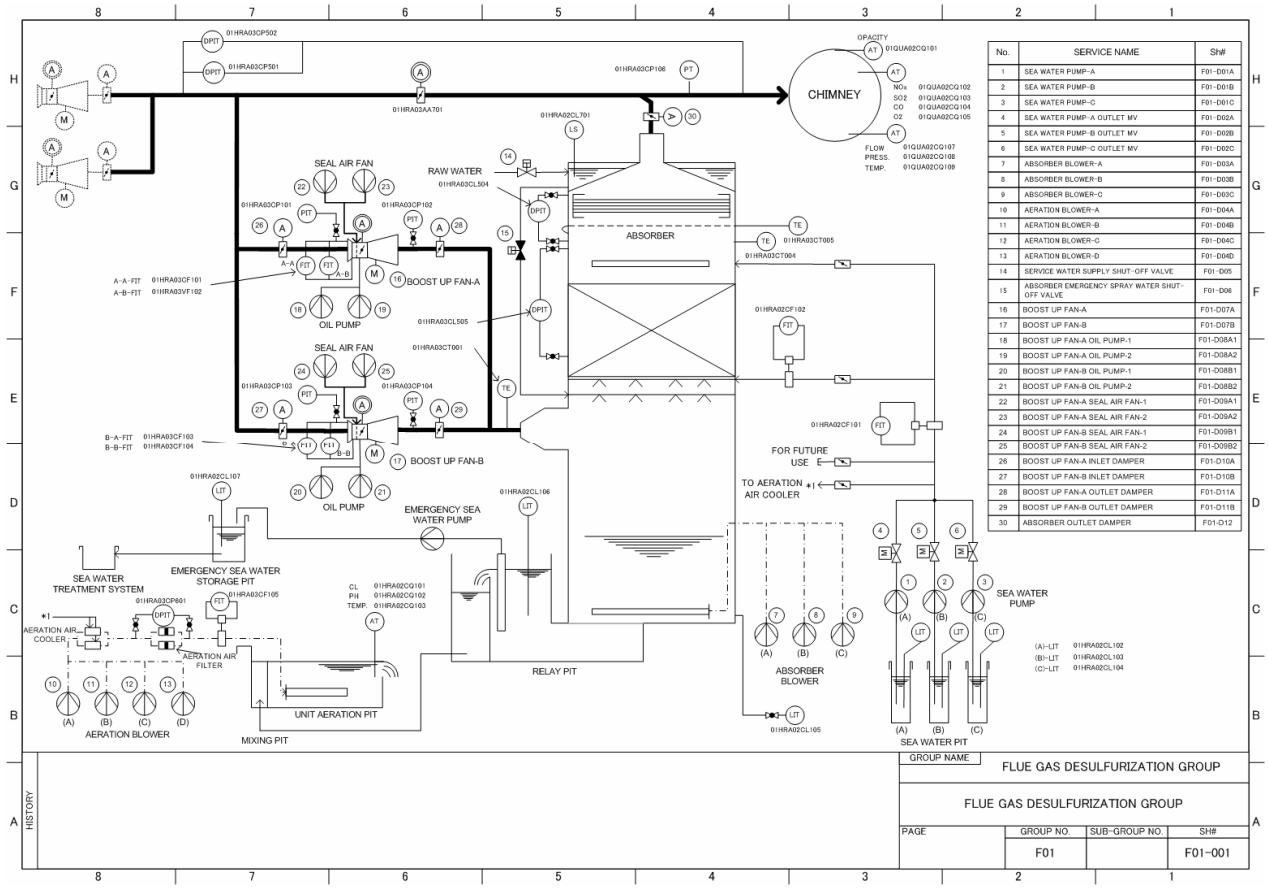
Attachment – 8 (Sheet 1 of 1)



Attachment – 9 (Sheet 1 of 1)

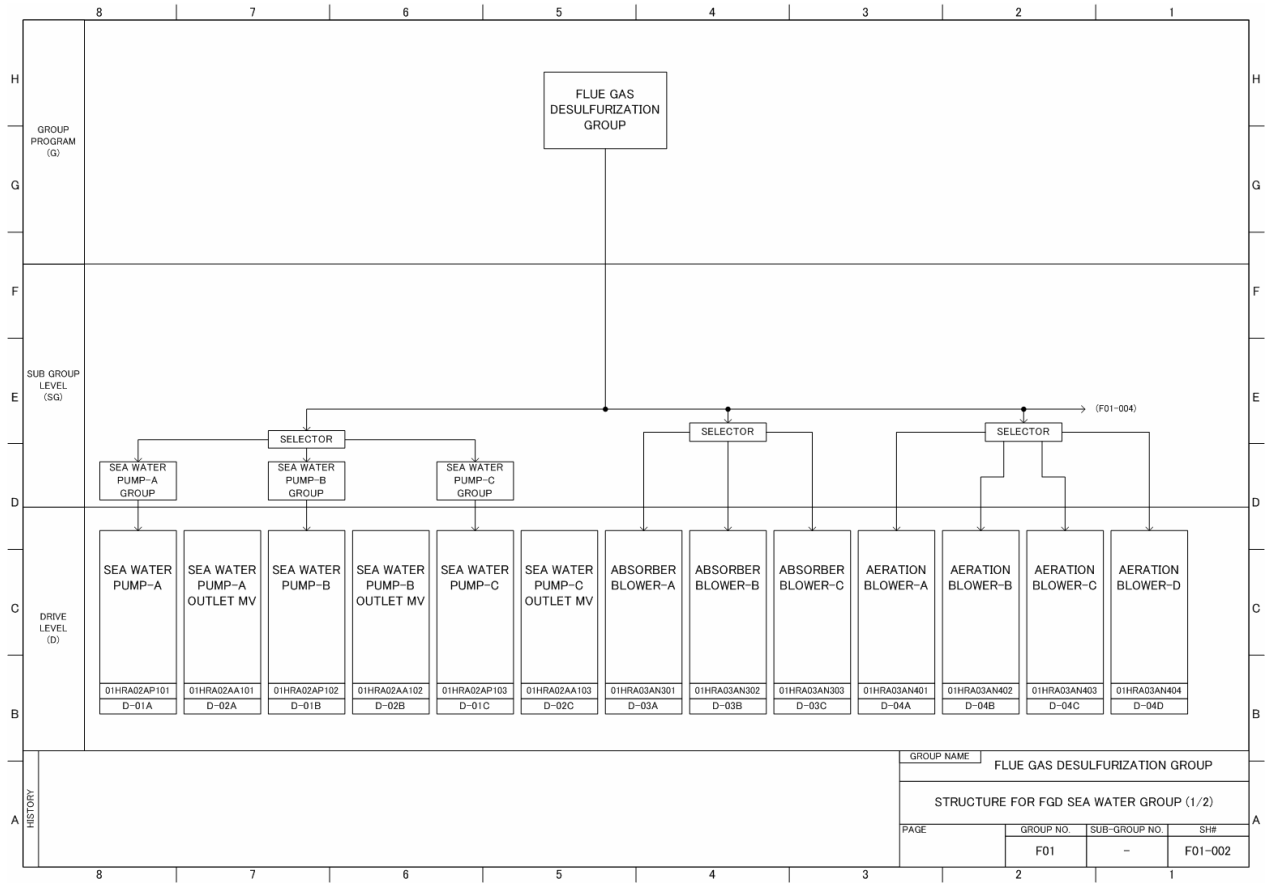


Attachment – 10 (Sheet 1 of 6)

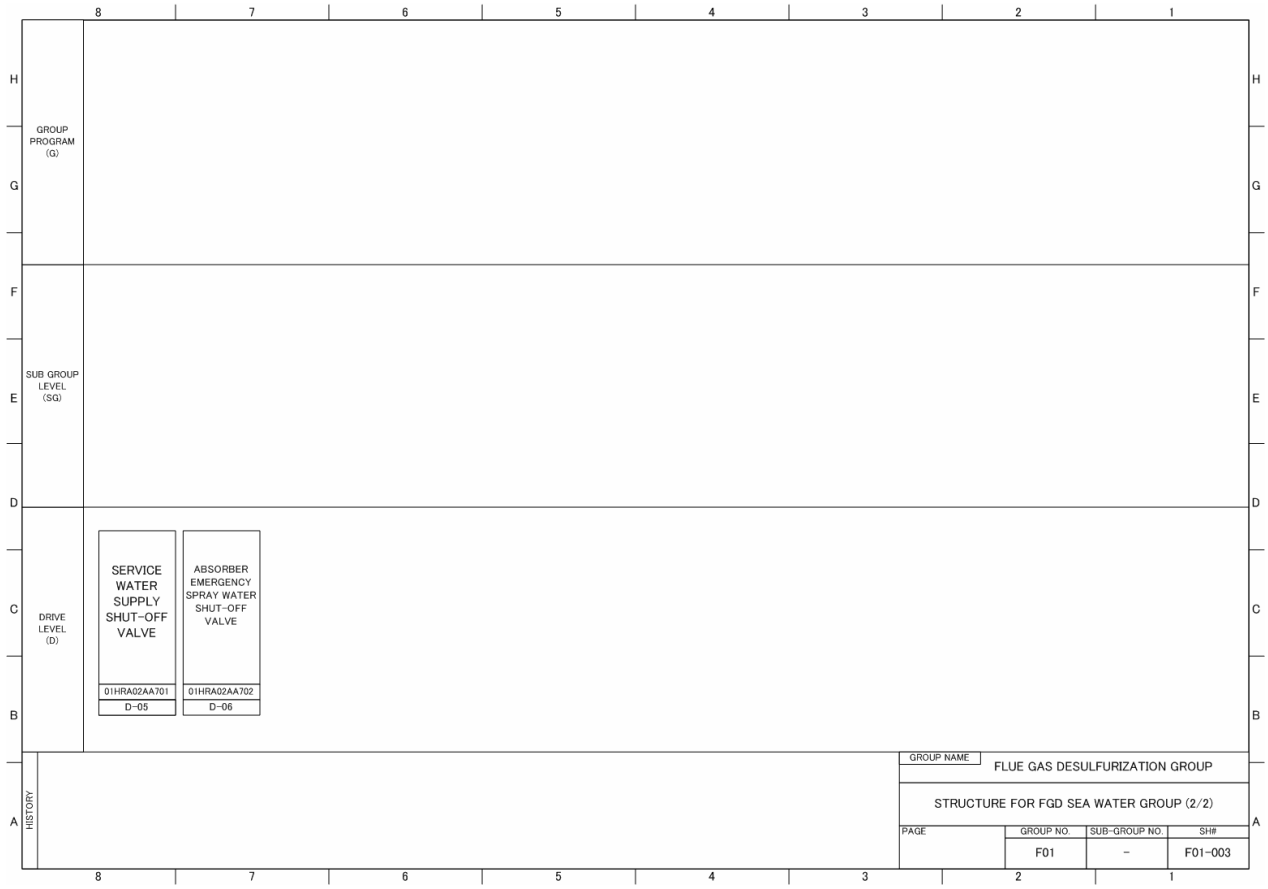


No.	SERVICE NAME	Sh#
1	SEA WATER PUMP-A	F01-D01A
2	SEA WATER PUMP-B	F01-D01B
3	SEA WATER PUMP-C	F01-D01C
4	SEA WATER PUMP-A OUTLET MV	F01-D02A
5	SEA WATER PUMP-B OUTLET MV	F01-D02B
6	SEA WATER PUMP-C OUTLET MV	F01-D02C
7	ABSORBER BLOWER-A	F01-D03A
8	ABSORBER BLOWER-B	F01-D03B
9	ABSORBER BLOWER-C	F01-D03C
10	AERATION BLOWER-A	F01-D04A
11	AERATION BLOWER-B	F01-D04B
12	AERATION BLOWER-C	F01-D04C
13	AERATION BLOWER-D	F01-D04D
14	SERVICE WATER SUPPLY SHUT-OFF VALVE	F01-D05
15	ABSORBER EMERGENCY SPRAY WATER SHUT-OFF VALVE	F01-D06
16	BOOST UP FAN-A	F01-D07A
17	BOOST UP FAN-B	F01-D07B
18	BOOST UP FAN-A OIL PUMP-1	F01-D08A1
19	BOOST UP FAN-A OIL PUMP-2	F01-D08A2
20	BOOST UP FAN-B OIL PUMP-1	F01-D08B1
21	BOOST UP FAN-B OIL PUMP-2	F01-D08B2
22	BOOST UP FAN-A SEAL AIR FAN-1	F01-D09A1
23	BOOST UP FAN-A SEAL AIR FAN-2	F01-D09A2
24	BOOST UP FAN-B SEAL AIR FAN-1	F01-D09B1
25	BOOST UP FAN-B SEAL AIR FAN-2	F01-D09B2
26	BOOST UP FAN-A INLET DAMPER	F01-D10A
27	BOOST UP FAN-B INLET DAMPER	F01-D10B
28	BOOST UP FAN-A OUTLET DAMPER	F01-D11A
29	BOOST UP FAN-B OUTLET DAMPER	F01-D11B
30	ABSORBER OUTLET DAMPER	F01-D12

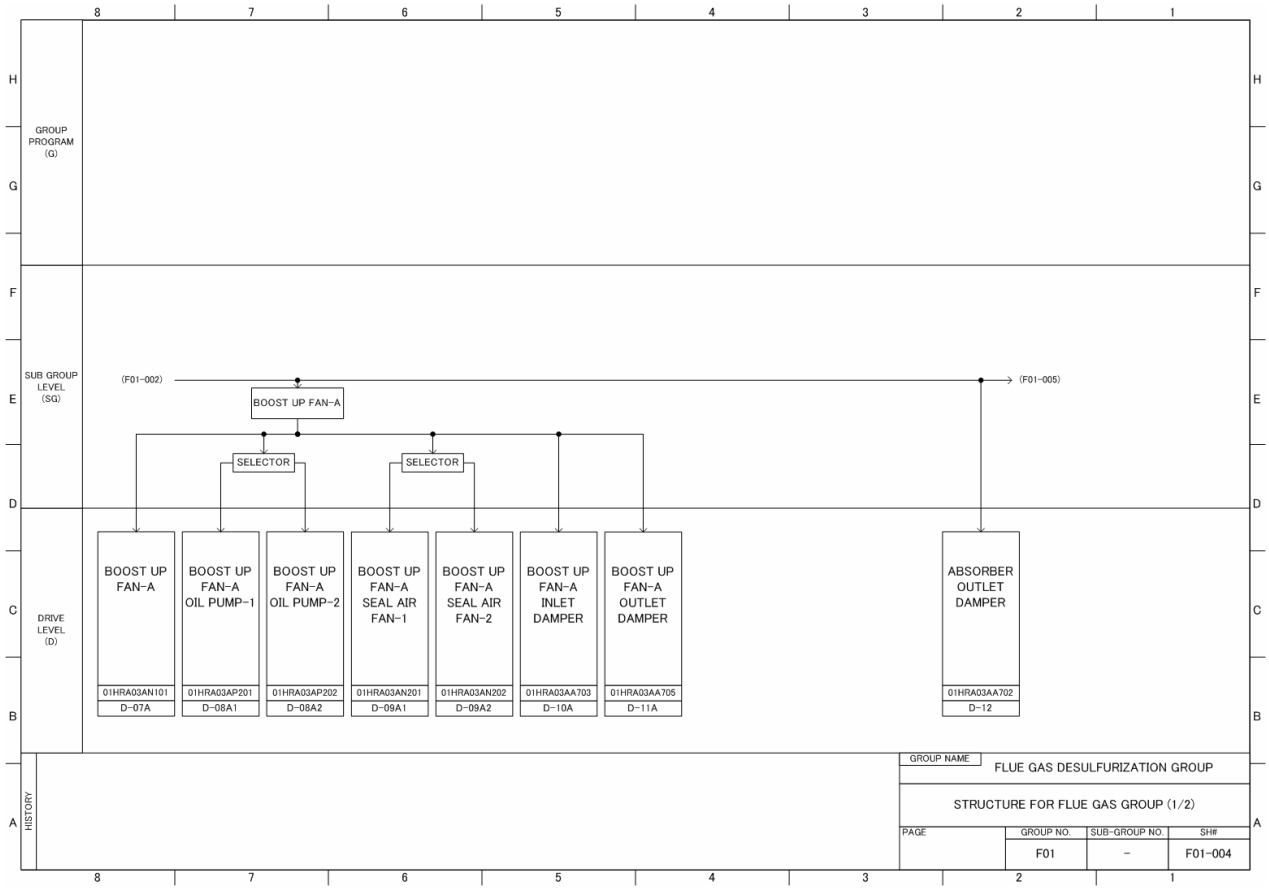
Attachment – 10 (Sheet 2 of 6)



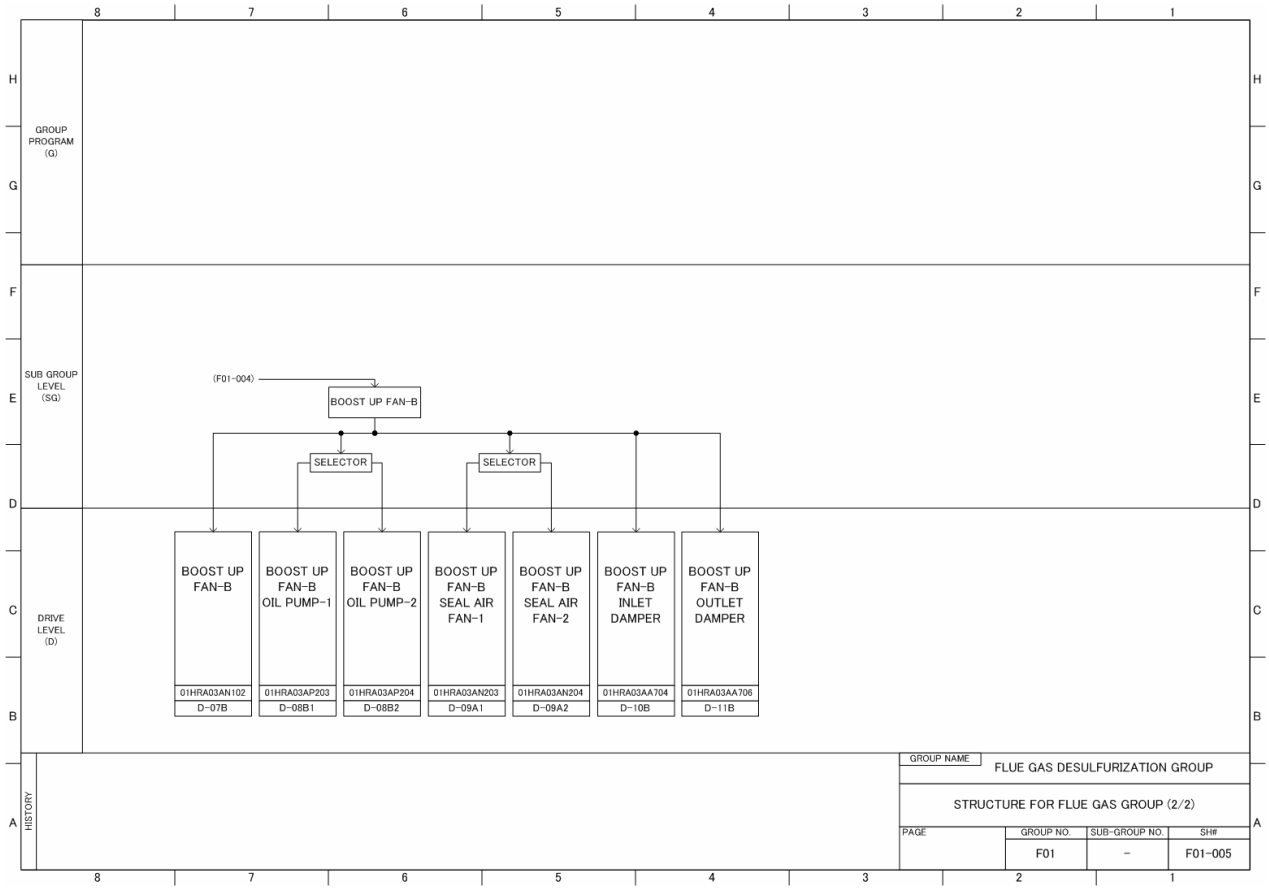
Attachment – 10 (Sheet 3 of 6)



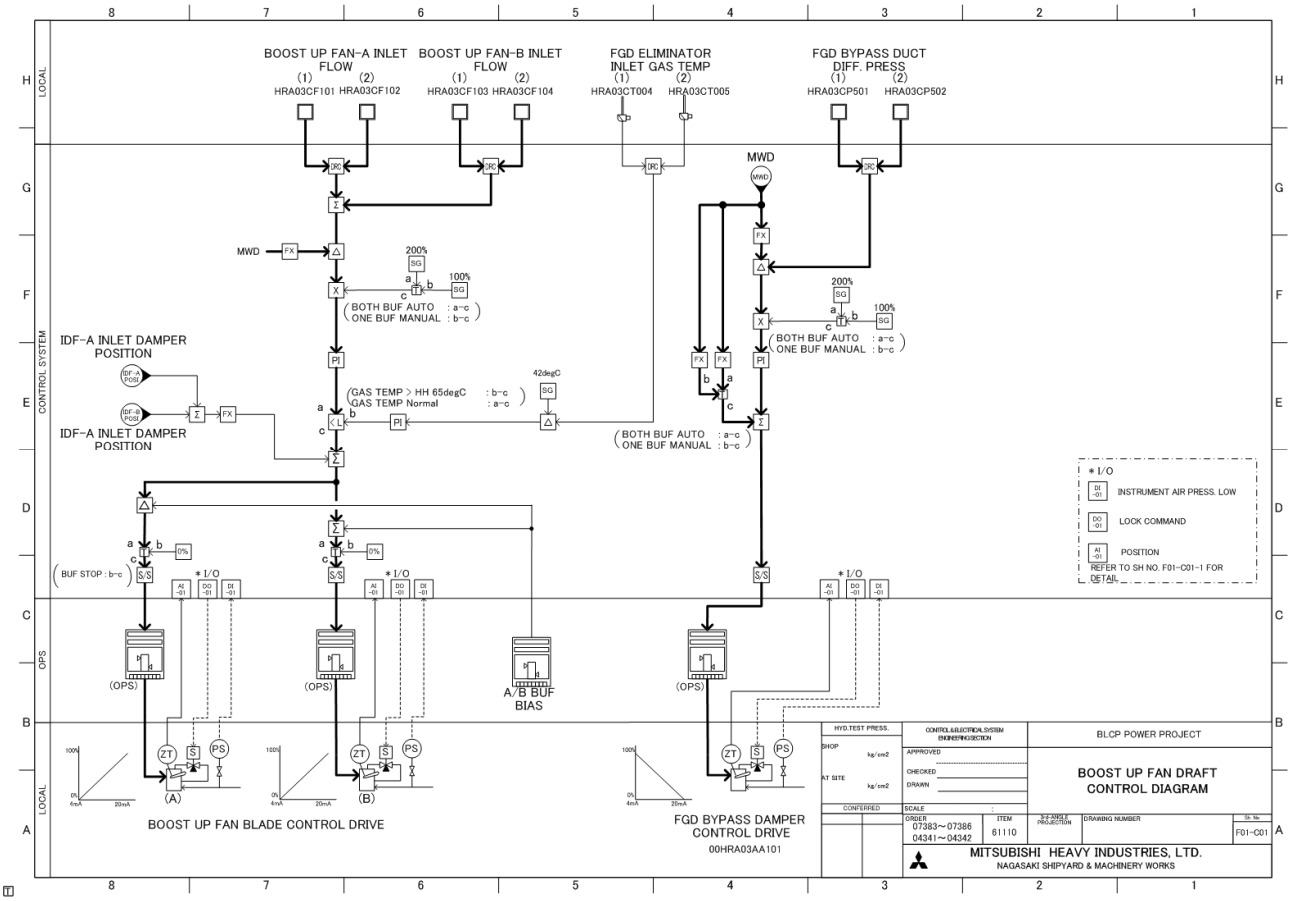
Attachment – 10 (Sheet 4 of 6)



Attachment – 10 (Sheet 5 of 6)



Attachment – 10 (Sheet 6 of 6)



Attachment – 11 (Sheet 1 of 1)

Estimated Power Consumption of FGD System

Coal		Rated Capacity	Coal C with 0.95 wt% sulfur	Blair Athol	Valeria	Performance Coal
Load			BMCR	BMCR	BMCR	TMCR
1. Boost Up Fan						
FGD inlet gas flow	Nm^3/h-wet	-	2,246,800	2,273,570	2,238,670	2,173,370
BUF inlet gas flow (30% bypass)	Nm^3/h-wet	-	1,572,760	1,591,499	1,567,069	1,521,359
FGD inlet gas temp.	deg. C	-	136	130	133	134
Power per 1 fan	kW	1,220	583	582	577	562
In Operation	set	2	2	2	2	2
Power for 1 Unit	kW	2,440	1,167	1,163	1,154	1,123
2. Seawater Pump						
Power per 1 fan	kW	850	850	850	850	850
In Operation	set	2	2	2	2	2
Power for 1 Unit	kW	1,700	1,700	1,700	1,700	1,700
3. Absorber Blower						
Power per 1 fan	kW	450	380	380	380	380
In Operation	set	2	2	2	2	2
Power for 1 Unit	kW	900	760	760	760	760
4. Aeration Blower						
Power per 1 fan	kW	700	600	-	-	-
In Operation	set	3	3	0	0	0
Power for 1 Unit	kW	2,100	1,800	0	0	0
TOTAL	**kW**	**7,140**	**5,427**	**3,623**	**3,614**	**3,583**

Attachment – 12 (Sheet 1 of 4)

Coversheet of Letters Submitting Comment Resolution Sheet

The Comment Resolution Sheets for this document were submitted the following letter:

MCP letter #MAP-MHIN-BLCP-L-0543 dated 2004/12/28
MCP letter #MAP-MHIN-BLCP-L-0546 dated 2004/12/28
MCP letter #MAP-MHIN-BLCP-L-0904 dated 2005/02/24

Attachment – 12 (Sheet 2 of 4)

[redacted]

Project: **BLCP POWER PROJECT**

Subject: Comment resolution sheet (Flue Gas Desulfurization System Design Manual)

References: 1. CLP Letter #TH04182MM182306IRN dated 2004/7/28

RECEIVED
29 DEC 2004
8:05 PM

Dear Sirs,

With reference to the avobe subject, MCP is pleased to furnish the attached sheet for BLCP review.

Best Regards,

Action Required: **NO**

Due Date: **N/A.**

Complete Response to: **CLP Letter #TH04182MM182306IRN**

Enclosures: **1. Comment Resolution Sheets (Flue Gas Desulfurization System Design Manual)**

(FOR INTERNAL USE) Originator: M. Michioka M. Michioka

CC: FTK 室（高原 PM）、プ…（計機）、プニ（装）、原輸二

File : A-1

Mitsubishi Corporation
Certified True Copy
From Original
BLCP Power Project

BLCP POWER PROJECT
Mitsubishi Corporation

	CC	O	Remarks FA	FI
SM				
DSM				
ADMIN		/		/
CIVIL				
MECH	/			/
EM				
MHI-N (Site)				
MHI-K (Site)				
MHI-H (Site)				
MELCO (Site)				
COMM				
DESIGN				
QA QC				
LOGISTICS				
MATECON				
SCH.CTRL				
SAFETY				
ENVIRON				
MC-TPO				
MHI-KK				
RECORDS				
	H	S	CODE	
FILE	/	/		

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FA: For Action
H: Hardcopy S: Softcopy

SCANNED

M1-MF-HR-PP-00082_DESULFURIZATION SYSTEM DESIGN MANUAL Rev.002

BLCP Power Project Flue Gas Desulfurization System Rev.01

Attachment – 12 (Sheet 3 of 4)

(1/2)

[redacted]

Project: **BLCP POWER PROJECT**

Subject: Comment resolution sheet (Flue Gas Desulfurization System Design Manual)

References: 1. CLP Letter #TH041841MM182306IRN dated 2004/8/4

RECEIVED
29 DEC 2004
8:05 PM

Dear Sirs,

With reference to the avobe subject, MCP is pleased to furnish the attached sheet for BLCP review.

Best Regards,

Action Required: **NO**

Due Date: **N/A**

Complete Response to: **CLP Letter #TH041841MM182306IRN**

Enclosures: **1. Comment Resolution Sheets (Flue Gas Desulfurization System Design Manual)**

(FOR INTERNAL USE) Originator: M. Michioka M. Michioka

CC: FTK 室（高原 PM）、プ…（計機）、プニ（装）、原輸二

File : A-1

Mitsubishi Corporation
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Mitsubishi Corporation

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MECH	/			/
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MHI-N (Site)				
MHI-K (Site)				
MHI-H (Site)				
MELCO (Site)				
COMM				
DESIGN				
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LOGISTICS				
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SCH.CTRL				
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Attachment – 12 (Sheet 4 of 4)

[redacted]

Project: **BLCP POWER PROJECT**

Subject: **Comment resolution sheet (Flue Gas Desulfurization System Design Manual)**

References: 1. CLP Letter #TH042133MM182306IRN dated 2004/11/30

RECEIVED
25 FEB 2005
8/15

Dear Sirs,

With reference to the above subject, MCP is pleased to furnish the attached sheet.

Best Regards,

BLCP POWER PROJECT
Mitsubishi Corporation

	CC	O	Remarks FA	Remarks FI
PM				
DEM				
ADMIN		✓		✓
CIVIL				
MECH	✓			✓
EXI				
MHI-Nagasaki				
MHI-K (Site)				
MHI-H (Site)				
MHI-CO (Site)				
COMM				
DESIGN				
QA QC				
FORESTICS				
MATRICON				
SCHECTRL				
SAFETY				
ENVIRON				
NO-TPO				
ENERGY				
STEERING				
	H	S	CODE	
FILE	✓	✓		

FI: For Information
FA: For Action
H: Handling, S: Sensitivity

Action Required: **NO**

Due Date: **N/A**

Complete Response to: **CLP Letter #TH042133MM182306IRN**

Enclosures: **1. Comment Resolution Sheets (Flue Gas Desulfurization System Design Manual)**

(FOR INTERNAL USE) Originator: M. Michioka

CC: FTK 室（高原 PM）、プー（計機）、プニ（装）、原輸二

File : A-1

Mitsubishi Corporation
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BLCP Power Project

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05.2.25