

BOILER DATA SHEET

1	Project	Nong Saeng Power Plant Project	Doc. No.	DS - BLR - 100
2	Client	Gulf JP NS Company Limited (GNS) / Kingdom of Thailand	Date	2012. 4. 2.
3	Contractor	Mitsubishi Heavy Industries, Ltd. (MHI)	Revision	0
4	Code	ASME Sec. I ASME Stamp No	Sheet No.	1 of 4
5	Service of Unit	Auxiliary Boiler	Item No.	Later
6	Type	Fire & Smoke Tube		
7	No. of Uints, Operating	1	Stand-by	0
			Total	1

PROCESS DATA of ONE UNIT

Kind of Steam	Superheated	Saturated	Fuels fired	Fuel 1	Fuel 2	Fuel 3
Capacity, MCR *1) kg/h	6,000	0	Kind of Fuel	Liquid Fuel	- N/A -	- N/A -
Steam Press. *1) kg/cm2.g	7	***	Fuel Name	No. 2 Oil		
Steam Temp. *1) °C	260	***	Fuel LHV kcal/kg	10,306		
Turn-down Ratio	20	% of MCR	Fuel HHV kcal/kg	10,756		
Condensate / Make-up Water	Condensate	Make-up Water	Unit of LHV / HHV	***		
Temperature °C	- N/A -	32.2	Boiler Efficiency %	90.6		
Pressure kg/cm2.g	- N/A -	2.5	* at 100%, base on LHV			
Dearator Press. kg/cm2.g	0.43		Fuel Consumption kg/h	438		
Dearator Temp. °C	110.0		Unit of Fuel Consumption	***		

CONFIGURATION

Type	Natural Circulation	Superheater	Installed	Bare Tube Type
	Single Shell	De-superheater	Installed	Spray Type
	Front Firing	Economizer	Installed	Bare Tube Type
	Forced Draft	Air Preheater	- N/A -	
Construction	Shop Assembled	Steam Air Heater	- N/A -	
	Bottom Supported	Deaerator	Spray & Tray Type	
Location	Out-door	Chemical Dosing Unit	Supplied	
	Non-hazardous			

PERFORMANCE of ONE UNIT

Load ID	MCR	NOR	HALF	MIN	Remark
	100 %	80 %	60 %	20 %	
Steam Flowrate kg/h	6,000	4,800	3,600	1,200	*1)
Steam Press. kg/cm2.g	7	7	7	7	*1)
Steam Temp. °C	260	260	260	192	*1)
Make-up Water Temp. °C	32.2	32.2	32.2	32.2	
Make-up Water Press. kg/cm2.g	2.5	2.5	2.5	2.5	
Boiler Oper. Pressure kg/cm2.g	9	9	9	9	
Boiler Oper. Temperature °C	179.2	179.2	179.2	179.2	
Flue Gas Temperature °C	185	165	147	123	* at Stack Inlet
Boiler Efficiency %	90.6	91.3	91.6	87.6	* based on LHV
Fuel Consumption kg/h	438	348	260	86	* No. 2 Oil

OPERATION & CONTROL

Feed Water Control	Three Element	Overload	0 %	for 0 hours
Draft Control	Inlet Vane	Load Change Rate	Nor. 7	Max. 10 %MCR/min.
Steam Temp. Control	Spray Type Final Stage	Allowance at Battery Limit		
Control Range	60 ~ 100 % MCR	Pressure	- 1 ~ + 1	kg/cm2
Blowdown		Temperature	- 10 ~ + 10	°C
Continuous	Manual	Start-up Time		
Bottom	Manual	Cold Start	80	min.
		Warm Strat	30	min.
		Hot Start	10	min.

Notes

- *1) at Battery Limit
- *2)
- *3)
- *4)
- *5)

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5	Service	Auxiliary Boiler				Item No.	Later					
6	Type	Fire & Smoke Tube										
7	No. of Uints, Operating	1	Stand-by	0	Total	1						
8	SITE CONDITION											
9	Ambient Air					Wind Design Code	ASCE					
10	Pressure	1.013	bar.a		Basic Wind Speed	120	km/h	33.3	m/sec			
11	Temperature	Max.	41.4	°C	Seismic Design Code	IBC 97	Zone	1				
12		Min.	9.8	°C								
13		Design	32.2	°C								
14	Relative Humidity	Max.	88	%	Noise Limit	85	dB(A)	at	1 m distance			
15		Design	75	%								
16	UTILITY CONDITION											
17	Electricity					<u>Pressure</u>	<u>Temperature</u>					
18	MV Motor	AC	6,600	V	50	Hz	3	Ph	bar.g	°C		
19	LV Motor	AC	380	V	50	Hz	3	Ph	Service Water	Nor 4 Nor 40		
20	Control	AC	230	V	50	Hz	1	Ph	Cooling Water	Nor 4 Nor 38		
21		DC	220	125	V				Instrument Air	Nor 7 Max 52		
22									Service Air	Nor 7 Max 52		
23	* MV Motor	:	201	kw	and above							
24	FUEL SPECIFICATION											
25	Kind of Fuel	Liquid Fuel										
26	Fuel Name	No. 2 Oil										
27	Composition :	<u>Component</u>	<u>weight%</u>									
28		Carbon	85									
29		Hydrogen	14.1									
30		Oxygen	0.5									
31		Nitrogen	0.4									
32		Sulfur	0.005									
33												
34												
35												
36												
37												
38												
39												
40												
41												
42	WATER & STEAM QUALITY											
43	Boiler Feedwater				Boiler Water				Steam			
44	pH	8.3	~	10.5	TDS	max.	5,000	ppm	TDS	max.	3	ppm
45	Dissolved Oxygen	max.	0.007	ppm	Total Alkalinity, CaCO ₃	max.	1200	ppm	Quality, Dryness	99	%	
46	Total Iron	max.	0.1	ppm	Suspended Solids	max.	100	ppm	Silica	max.	0.1	ppm
47	Total Copper	max.	0.05	ppm	Silica as SiO ₂	max.	150	ppm				
48	Total Hardness	max.	1	ppm	Total Iron	max.	10	ppm				
49	Nonvolatile TOC	max.	10	ppm								
50	Oily Matter	max.	1	ppm								
51												
52	Notes											
53	*1) WATER & STEAM QUALITY : According to ABMA, ASME and JBMA											
54	*2) Max. Allowable TDS in Feedwater, Fmax											
55	Fmax = (B x Rd + S x 100) / (Rd + 100) = 149 ppm -> Divided by 0.7 = 212 μS/cm											
56	Where, TDS Boiler Water B 5,000 ppm Steam S 3.0 ppm											
57	Design Blowdown Rate Rd 3 %											
58	*3)											
59	*4)											
60	*5)											

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4	Code/Standard	ASME	Sec. I	ASME Stamp	No	Sheet No.	3 of 4
5	Service	Auxiliary Boiler			Item No.	Later	
6	Type	Fire & Smoke Tube					
7	No. of Uints, Operating	1	Stand-by	0	Total	1	

MECHANICAL DESIGN

Pressure & Temperature Setting				Materials and Size			
		Pressure	Temperature	Designation	OD	Thk	* Avg.
		kg/cm ² .g	°C	Fire Tube	A 516-60	1230	15 mm
11	Design	Boiler	11	250.0	Smoke Tube, 2nd Pass	A 210-A1	63.5 3.2 mm
12	Test	Boiler	16.5		Smoke Tube, 3rd Pass	A 210-A1	*** *** mm
13	Design	Superheater	11	450	Superheater		
14					Superheater	A 213-T22	38.1 3.5 mm
15	Design	Economizer	15	250	Economizer	A 210-A1	31.8 2.9
16		Boiler PSV1	11	187.2	Air Preheater	***	*** ***
17	Setting	Boiler PSV2	11.33	188.4			Tube C.A. > 0
18		S/H PSV	11	450			ID
19					Boiler Shell	A 516-60	2,250 18 mm
20					Tubeplate	A 516-60	22 mm
Dimensions							
21		Width	2,486	mm			
22	Boiler Proper	Height	2,736	mm	Superheater	Inlet	Outlet NPS
23		Length	5,044	mm	Superheater	A 335-P22	A 335-P22 6"
24							
25							
26	Furnace	ID	1,200	0	Economizer	A 106-B	A 106-B 5"
27							
28							
Furnace Parameters at MCR				Heating Surface Area			
29					Fire Tube	15.2	m2 * Projected
30	Furnace Volume	4.13	m3		Smoke Tube, 2nd Pass	45.8	m2
31	Heat Input	4,515,567	kcal/h		Smoke Tube, 3rd Pass	0.0	m2
32	Furnace Heat Release Rate	1,093,873	kca/h.m3		Superheater		
33	EPRS Heat Release Rate	297,488	kcal/h.m2		Superheater	78.1	m2
34					Economizer	47.5	m2
35					Air Preheater	***	m2
36					Steam Air Heater	***	m2
Level Setting in Boiler				Loading Data			
37	Shell Top		Vol.	Retention Time			
38		HHWL	400	m3			
39			50	0.38			
40		HWL	75	0.60			
41	NWL		75	0.63	5.4		
42		LWL	50	0.43	3.7	9.1	
43		LLWL					
44	Shell Center						
45							
46							
47							
48							
49							
50							
51							
52							
53							
54							
55	Notes						
56	*1)						
57	*2)						
58	*3)						
59	*4)						
60	*5)						

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3	Contractor	Mitsubishi Heavy Industries, Ltd. (MHI)	Revision	0
4	Code/Standard	ASME Sec. I	ASME Stamp	No
5	Service	Auxiliary Boiler	Sheet No.	4 of 4
6	Type	Fire & Smoke Tube	Item No.	Later
7	No. of Uints, Operating	1	Stand-by	0
			Total	1

AUXILIARY EQUIPMENT SPECIFICATION

9	Burner	Low Nox	Oil Burner	Draft Fan	Forced Draft
10	Quantity	1	set(s) / boiler	Quantity	100 % x 1 set(s) /boiler
11	Gas Burner	- N/A -		Type	Centrifugal driven by Motor
12	Capacity, max.		kg/h / burner	Capacity	120 Nm3/min
13	Turn-down ratio	- N/A -	: 1	Discharge Pressure	440 mmH2O
14	Oil Burner	Rotary		Total Head	450 mmH2O
15	Capacity, max.		kg/h / burner	Noise Limit	85 dB(A) at 1 m distance
16	Turn-down ratio	5	: 1		
17					
18	Sootblower	- N/A -		Aux. Boiler Feed Pump	Supplied
19	Blowing Medium	- N/A -	Type	Quantity	2 set(s) / boiler
20	Quantity	Furnace	*** set(s) /boiler - N/A -	Type	Centrifugal driven by Motor
21		Tube Bank	*** set(s) /boiler - N/A -	Capacity	9.3 m3/h
22		Superheater	*** set(s) /boiler - N/A -	Suction P. / Disch. P.	0.43 15 kg/cm2.g
23		Economizer	*** set(s) /boiler - N/A -	Differential P.	14.57 kg/cm2
24		Gas Air Heater	*** set(s) /boiler - N/A -	Total Head	153 mH2O
25					
26	Economizer	Installed		Deaerator	Spray & Tray Type
27	Quantity	1	set(s) / boiler	Quantity	1 set(s) , Total
28	Type	Bare Tube Type		Storage Capa.	1.5 m3
29	Tube	Material	A 210-A1	Material	A 516-70
30		Size	OD 31.8 2.9 t mm	Size Deaerator	ID 1,600 x TL-TL 2,500 mm
31				Storage Tank	ID *** x TL-TL *** mm
32					
33	Air Preheater	- N/A -		Fuel Oil Tank	Supplied
34	Quantity	***	set(s) / boiler	Quantity	1 set(s) /boiler
35	Type	***		Material	A 516-70
36	Tube	Material	***	Size	ID 2,400 x TL-TL 3,500 mm
37		Size	OD *** *** t mm	Capacity	15.4 m3
38				Blow Down Tank	Supplied
39	Steam Air Heater	- N/A -		Quantity	1 set(s) /boiler
40	Quantity	***	set(s) / boiler	Material	A 516-70
41	Type	***		Size	ID 650 x TL-TL 900 mm
42	Tube	Material	***	Volume	0.37 m3
43		Size	OD *** *** t mm	Blowdown Transfer Pump	Supplied
44				Quantity	2 set(s) / boiler
45				Type	Centrifugal driven by Motor
46	Stack	- N/A -		Capacity	1.5 m3/h
47	Quantity	***	set(s) /boiler	Suction P. / Disch. P.	0 5 kg/cm2.g
48	Material	***		Differential P.	5 kg/cm2
49	Size	ID ***	x H *** m	Total Head	50 mH2O
50					
51				Chemical Dosing Unit	Supplied
52				Chemical	Phosphate *** ***
53				Tank Q'ty /boiler	1 *** ***
54				Pump Q'ty /boiler	2 *** ***

55	Notes			
56	*1)			
57	*2)			
58	*3)			
59	*4)			
60	*5)			

SUPERHEATER DATA SHEET

1	Project	Nong Saeng Power Plant Project	Doc. No.	DS - SH - 100
2	Client	Gulf JP NS Company Limited (GNS) / Kingdom of Thailand	Date	2012. 3. 10.
3	Contractor	Mitsubishi Heavy Industries, Ltd. (MHI)	Revision	0
4	Code/Standard	ASME Sec. I	ASME Stamp	No
5	Service of Unit	Superheater	Flow Pattern	Cross-Counter
6	Type	Bare	Tube Installation	Horizontal
7	Surface/Unit, Eff.	78 m ²	Shell Fluid Flow	Horizontal

PERFORMANCE of ONE UNIT

Fluid Allocation	Shell Side			Tube Side	
Fluid Name	Flue Gas			Steam	
	Inlet	Outlet		Inlet	Outlet
Fluid Quantity, Total	6,248	Nm3/h		6,231	kg/h
Vapor	6,248	6,248		6,231	6,231
Liquid	0	0		0	0
Condensate		0			
Temperature	580.0	300.5		179.2	370.0
Density	0.41	0.61		5.07	3.37
Viscosity	0.037	0.027		0.015	0.023
Molecular Weight	28.563			18.015	
Specific Heat	0.295	0.275		0.646	0.507
Thermal Conductivity	0.051	0.036		0.030	0.045
Latent Heat	***			481.7	
Inlet Pressure	79	mmH2O		9.0	kg/cm2.g
Velocity, i / m / o	14.08	11.77	9.47	18.74	23.47 28.20
Pressure Drop	50			0.92	
Fouling Resistance	0.0025			0.0002	
Heat Duty	634,266	kcal/h	MTD	161.65	°C H. T. Rate, Clean 60.38 kcal/m ² .h. °C
H. T. Rate, Cal'd	51.79	kcal/m ² .h. °C	H. T. Area, Req.	75.8	m ² Cleanliness Factor 85.8 %
H. T. Rate, Service	50.22	kcal/m ² .h. °C	H. T. Area, Act.	78	m ² H. T. Area Margin 3.1 %

DESIGN, MATERIALS and CONSTRUCTION of ONE UNIT

	Shell Side		Tube Side		SKETCH
Design Pres. mmH2O / kg/cm2.g	450		11		<div style="border: 1px solid black; padding: 10px; width: fit-content; margin: auto;"> Please refer to " Superheater GA " </div>
Test Press. mmH2O / kg/cm2.g	675		14.3		
Design Temp. °C	600		450		
No. of Passes	1		34		
Corrosion Allowance, mm	0		1.6 * Except Tube		
Nozzle	Inlet	Outlet	Inlet	Outlet	
Material	A 240 304	A 240 304	A 106-B	A 106-B	
Q'ty	1	1	1	1	
Size	800 x 1400	800 x 1400	6"	6"	
Rating	***	***	Sch.40	Sch.40	

	Type	Material	Q'ty	OD	Thick	Length
Tube	Bare	A 213-T22	816	38.1	Avg. 3.5	800 * Effective
Fin	- N/A -	***		***	***	Height *** FPI ***
Header	Pipe	A 335-P22	2	168	11	1,492 Sch. Sch.80
Tubesheet	- N/A -					
Tube Bundle	No. of Tubes / Row	24	No. of Rows	34	No. of Rows / Header	1
	Support Plate :	A 240 304	2		12	
	Pitch	In-line	Trans.	58	Long.	106.7
Shell		A 240 304			6	
Transition Duct		A 240 304			6	
Gasket	Shell Side	Non-asbestos	Tube Side	Non-asbestos		
Accessories	Safety Valve	Provided	Expansion Joint	Provided		
	Insulation	Provided	Ladder	Provided		
Weight	Empty	4,328	Oper.	4,330	Filled with Water	4,899 kg

56	Notes
57	*1)
58	*2)
59	*3)
60	*4)

ECONOMIZER DATA SHEET

1	Project	Nong Saeng Power Plant Project	Doc. No.	DS - ECO - 100
2	Client	Gulf JP NS Company Limited (GNS) / Kingdom of Thailand	Date	2012. 3. 10.
3	Contractor	Mitsubishi Heavy Industries, Ltd. (MHI)	Revision	0
4	Code/Standard	ASME Sec. I	ASME Stamp	No
5	Service of Unit	Economizer	Flow Pattern	Cross-Counter
6	Type	Bare	Tube Installation	Horizontal
7	Surface/Unit, Eff.	47 m ²	Shell Fluid Flow	Horizontal
	Item No.	00QLA10AC002/B		
	No. of Units	1 set(s)		

PERFORMANCE of ONE UNIT

Fluid Allocation	Shell Side			Tube Side	
Fluid Name	Flue Gas			Boiler Feedwater	
	Inlet	Outlet		Inlet	Outlet
Fluid Quantity, Total	6,248	Nm3/h		6,411	kg/h
Vapor	6,248	6,248		0	0
Liquid	0	0		6,411	6,411
Temperature °C	300.5	185.0		110.0	148.3
Acid Dew / Water Dew / Sat. / Approach	98.2	53.4		183.3	35.1
Density kg/m ³	0.61	0.76		951.38	918.99
Viscosity Cp	0.027	0.023		0.255	0.185
Molecular Weight	28.563			18.015	
Specific Heat kcal/kg. °C	0.275	0.268		1.010	1.028
Thermal Conductivity kcal/m.h. °C	0.036	0.030		0.586	0.589
Latent Heat kcal/kg	***			478.2	
Inlet Pressure	29	mmH2O		10.0	kg/cm2.g
Velocity, i / m / o	8.33	7.49	6.65	0.13	0.13 0.14
Pressure Drop	mmH2O / kg/cm2			16 0.01	
Fouling Resistance	kcal/m ² .h. °C			0.0025 0.0002	
Heat Duty	249,510	kcal/h	MTD	109.10	°C H. T. Rate, Clean 60.55 kcal/m ² .h. °C
H. T. Rate, Cal'd	51.92	kcal/m ² .h. °C	H. T. Area, Req.	44.0	m2 Cleanliness Factor 85.7 %
H. T. Rate, Service	48.17	kcal/m.h. °C	H. T. Area, Act.	47	m2 H. T. Area Margin 7.8 %

DESIGN, MATERIALS and CONSTRUCTION of ONE UNIT

	Shell Side		Tube Side		SKETCH
Design Pres. mmH2O / kg/cm2.g	450		15.0		<div style="border: 1px solid black; padding: 10px; width: fit-content; margin: auto;"> Please refer to "Economizer GA" </div>
Test Press. mmH2O / kg/cm2.g	675		19.5		
Design Temp. °C	350		250		
No. of Passes	1		22		
Corrosion Allowance, mm	1.6		1.6	* Except Tube	
Nozzle	Inlet	Outlet	Inlet	Outlet	
Material	A 36	A 36	A 106-B	A 106-B	
Q'ty	1	1	1	1	
Size	800 x 1400	500 x 800	1 1/2"	1 1/2"	
Rating	***	***	Sch.40	Sch.40	

	Type	Material	Q'ty	OD	Thick	Length
Tube	Bare	A 210-A1	594	31.8	Avg. 2.9	800 * Effective
Fin	- N/A -	***		***	***	Height *** FPI ***
Header	Pipe	A 106-B	2	141	9.53	1,504 Sch. Sch.80
Tubesheet	- N/A -					
Tube Bundle	No. of Tubes / Row	27	No. of Rows	22	No. of Rows / Header	1
	Support Plate :	A 283-C	2	12		
	Pitch	In-line	Trans.	52	Long.	89
Shell		A 36			6	
Transition Duct		A 36			6	
Gasket	Shell Side	Non-asbestos	Tube Side	Non-asbestos		
Accessories	Safety Valve	N/A -	Expansion Joint	N/A -		
	Insulation	Provided	Ladder	Provided		
Weight	Empty	2,246	Oper.	2,527	Filled with Water	2,546 kg

56	Notes
57	*1)
58	*2)
59	*3)
60	*4)