

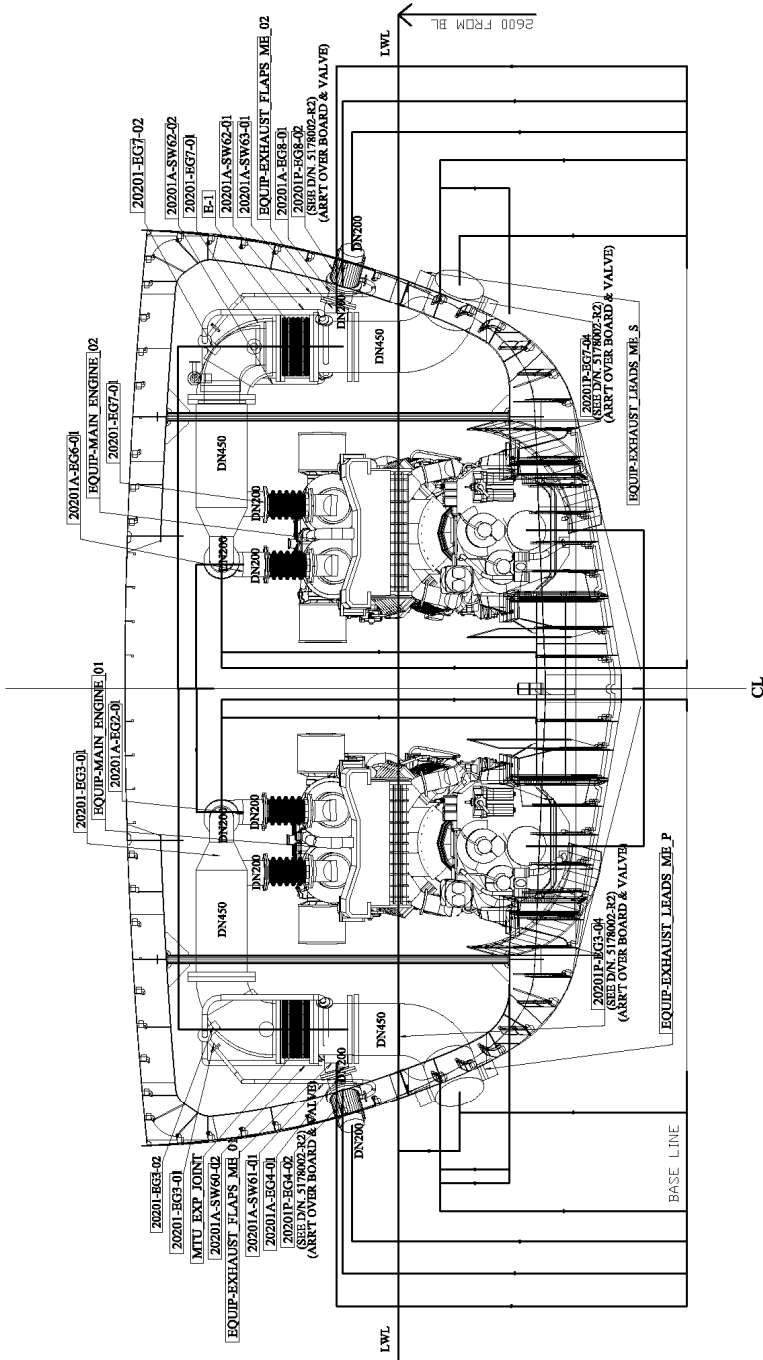


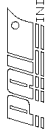
# Lampiran 2

## EXHAUGAST IN ENGINE ROOM

LOOKING FORWARD

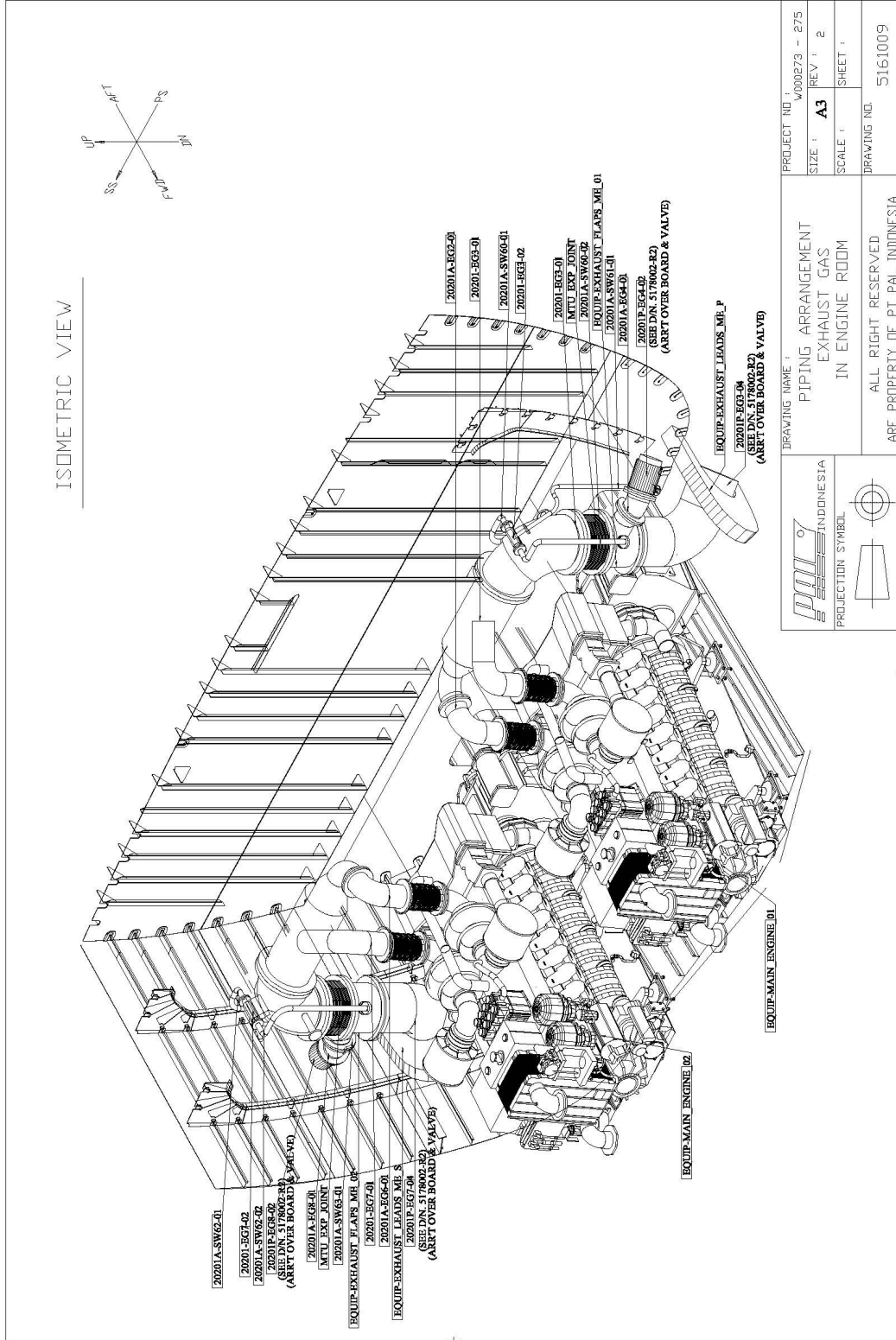
FR.16



 PT. PAL INDONESIA	DRAWING NAME :	PROJECT NO. :
	PIPING ARRANGEMENT EXHAUST GAS IN ENGINE ROOM	W000273 - 275
	PROJECTION SYMBOL 	SIZE : A3
	SCALE :	SHEET :
		DRAWING NO. : 5161009
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# Lampiran 3

## EXHAUGGAST IN ENGINE ROOM



# Lampiran 4

## TABEL ELBOW

BENDING OF STEEL PIPES

Dimension in mm.

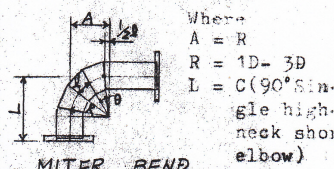
3/19

Cold bending

High-frequency bending

Nominal dia.	Out dia.	Bending radius	Required grip length												Downward length		
			Std		Standard						Bend after fix. flange (Std)			Bend after (Substd)			
			St.	Substd	St.	Int.	End	St.	Int.	End	St.	Int.	End	MAX			
15 <sup>A</sup>	21.7	80°	60°	MIN 110	MIN 110	MIN 200	MIN 130	MIN 110	MIN 200	MIN 50	MIN 110	MIN 200	MAX 950				
20	27.2	80	60	"	"	"	"	"	"	"	"	"	"				
25	34.0	100	85	"	"	"	"	"	"	"	"	"	"				
32	42.7	150	100	"	"	"	"	"	"	"	"	"	"				
40	48.6	150	100	"	"	"	"	"	"	"	"	"	"				
50	60.5	150	130	"	150	"	150	250	100	150	250	"	"				
65	76.3	200	150	200	200	350	250	200	350	200	200	350	"				
80	89.1	250	200	"	"	"	"	"	"	210	"	"	"				
90	101.6	300	250	"	480	270	"	480	250	"	480	850	"				
100	114.3	350	300	"	220 (Substd)	200 (Substd)	"	270	250	"	"	"	"				
125	139.8	420	400	250	500	350	250	500	300	250	500	"	"				
150	165.2	500	"	"	"	"	"	"	"	"	"	"	"				
150	165.2	500	"	400	400	"	"	"	"	"	"	1400	"				
175	190.7	580	"	"	"	"	"	"	"	"	"	"	"				
200	216.3	650	"	"	"	"	"	"	"	"	"	"	"				

Min R	Downward length	Req. grip length	Req. push length	Nominal dia.
550	1300			250 <sup>A</sup>
750		450		300
850		450		350
900		450		400
1350		650		450
1500		650		500
1600		650		550
1800	1300	650	1800	600



Style	Div. H	Ang.	Remarks
A	4~5	18°-22.5°	For complicated corner
B	3~4	"	For simply & shorter corner

c. 数字は標準半径R使用の中間寸法

Where  $l = (R \times \sin \frac{\theta}{2}) \times 2$

SEVERAL DATA FOR STEEL PIPES AND STEEL ELBOWS

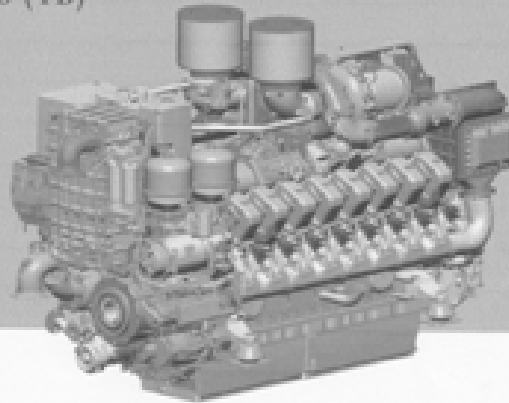
Dimension in mm. & Kg.

Nominal dia.	Out dia.	Steel pipes								Steel butt-welding elbow										
		1/2 out dia.		Thickness		Weight		Long E.		Short E.		60° Single high-neck	90° Single high-neck	FLG. length	FLG. length	FLG. length	FLG. length	Nominal dia.		
		sch. 40	sch. 80	sch. 40	sch. 80	sch. 40	sch. 80	90°	45°	90°	45°								A	B
15 <sup>A</sup>	21.7	11	2.8	2.8	3.7	1.21	1.31	1.64	38.1	15.8										15 <sup>A</sup>
20	27.2	14	2.8	2.9	3.9	1.68	1.94	2.24	38.1	15.8										20
25	34.0	17	3.2	3.4	4.5	2.43	2.57	2.71	38.1	15.8	25.4									25
32	42.7	22	3.5	3.6	4.9	3.28	3.47	4.67	47.6	19.7	31.8	13.2	6							32
40	48.6	25	3.5	3.7	5.1	3.29	4.10	5.47	57.2	23.7	38.1	15.8	6	A	B	C				40
50	60.5	31	3.8	3.9	5.5	5.21	5.44	7.04	76.2	31.6	50.8	21.0	6							50
65	76.3	39	4.2	5.2	7.0	7.97	9.12	12.00	95.3	39.5	63.5	26.3	9	100	63.5	135		7	6	65
80	89.1	48	4.2	5.5	7.4	8.44	11.30	15.20	114.3	47.3	76.3	31.6	9	110	76.2	150		"	"	80
90	101.6	57	4.3	5.7	8.1	10.21	13.55	18.70	133.4	55.3	88.9	36.8	10	125	88.9	170		"	"	90
100	114.3	58	4.5	6.0	8.6	12.24	16.00	22.40	152.4	63.1	101.6	42.1	10	140	101.6	185	7	"	"	100
125	139.8	70	4.5	6.6	9.5	15.00	21.70	30.20	190.5	78.9	127.0	52.6	11	165	127.0	230	8	"	7	125
150	165.2	83	5.0	7.1	11.0	19.20	27.10	41.80	228.6	94.7	152.4	63.1	12	195	142.4	255	"	"	"	150
175	190.7	96	5.3	"	"	24.20	"	"	266.7	110.5	177.8	73.6	13	220	177.8	290	8	"	"	175
200	216.3	107	5.8	8.2	12.7	30.40	42.10	57.80	304.8	126.5	203.2	84.2	14	255	203.2	325	9	9	8	200
250	267.4	134	6.6	9.3	15.1	42.40	57.20	79.30	381.0	157.8	254.0	105.3	16	310	264.0	375	10	10	"	250
300	318.5	160	6.9	10.3	17.4	53.70	70.20	97.50	467.2	189.4	304.8	126.2	17	370	304.8	445	"	"	"	300
350	355.6	178	7.9	11.1	19.0	67.70	84.20	112.00	533.4	220.9	355.6	147.3	18	420	355.6	495	12	12	9	350
400	406.9	204	7.9	12.7	21.9	77.50	123.00	203.00	609.6	257.2	406.9	168.2	21	475	406.9	550	"	"	"	400
450	457.2	229	7.9	14.3	23.8	87.50	156.00	265.00	685.8	284.1	447.2	189.4	22	565	457.2	610	"	14	"	450
500	508.0	254	7.9	15.1	26.2	97.50	184.00	311.00	762.0	315.1	507.9	210.2	22	610	508.0	660	"	"	"	500
550	558.0	280	7.9	15.9	28.6	107.00	213.00	374.00	838.2	347.2	558.0	231.5	22	665	558.0	720	"	15	10	550
600	609.6	305	7.9	17.3	31.0	117.00	255.00	442.00	914.4	378.7	609.6	252.5	22	715	609.6	770	"	16	10	600

# Lampiran 5

## DATA MAIN ENGINE

### 16V 4000 M73/M73L Diesel Engines for fast vessels with high Load Factors (1B)



Typical examples:  
Ferries (e.g. single-hull vessels,  
hydrofoils, catamarans,  
hovercraft) and yachts

Engine type		16V 4000 M73	16V 4000 M73L
Rated power (CP) <sup>a</sup>	kW (hp)	2560 (3480)	2880 (3960)
Speed	rpm	975	1050
Number of cylinders		16	16
Bore/stroke	mm (in)	178/190 (7.0/7.5)	170/190 (6.7/7.5)
Overall displacement	l (cu in)	49.0 (4210)	49.8 (4210)
Cylinder housing		SAE 90	SAE 90
Gearbox type <sup>b</sup>		ZF 7850	ZF 9050
Optimization of exhaust emissions <sup>c</sup>		IMO / EPA 2	IMO / EPA 2
<b>Fuel consumption<sup>a</sup></b>			
at rated power	g/kWh	213	214
	l/h (gal/h)	457.8 (123.6)	742.6 (194.2)

<sup>a</sup> Tolerance +1% as per ISO 3046, diesel fuel as per DIN EN 590 with a lower heating value of 42800kJ/kg (10200 BTU/lb)

<sup>b</sup> IMO - International Maritime Organization

EPA - US marine directive 40 CFR 14, with NTE

<sup>c</sup> gearbox variants "Down Angle (A)" and "V-Drive" available on request

#### 2. GENERAL CONDITIONS (for maximum power)

1	Intake air depression (new filter)	A	mbar	15				
2	Intake air depression, max.	L	mbar	50				
3	Exhaust back pressure	A	mbar	30				
4	Exhaust back pressure, max.	L	mbar	85				
5	Fuel temperature at fuel feed connection	R	°C	25				
10	Fuel temperature at fuel feed connection, max.	L	°C	55				
18	Fuel temperature at fuel feed connection, min.	L	°C	-				
<b>3. CONSUMPTION</b>								
17	Specific fuel consumption (be) - 100 % CP (+ 5 %; EN 590; 42.8 MJ/kg)	G	g/kWh	205				
18	Specific fuel consumption (be) - 75 % CP (+ 5 %; EN 590; 42.8 MJ/kg)	R	g/kWh	214				

Explanation:

CP = Ref. value: Continuous power

FDP = Ref. value: Fuel stop power

A = Design value

G = Guaranteed value

R = Guideline value

L = Limit value, up to which the engine can be operated, without change (e.g. of power setting)

N = Not yet defined value

• = Not applicable

X = Applicable

Z = See notes provided after "ENGINE DATA"

## Lampiran 6

**FOTO EXHAUST GAS SEBELAH KIRI**

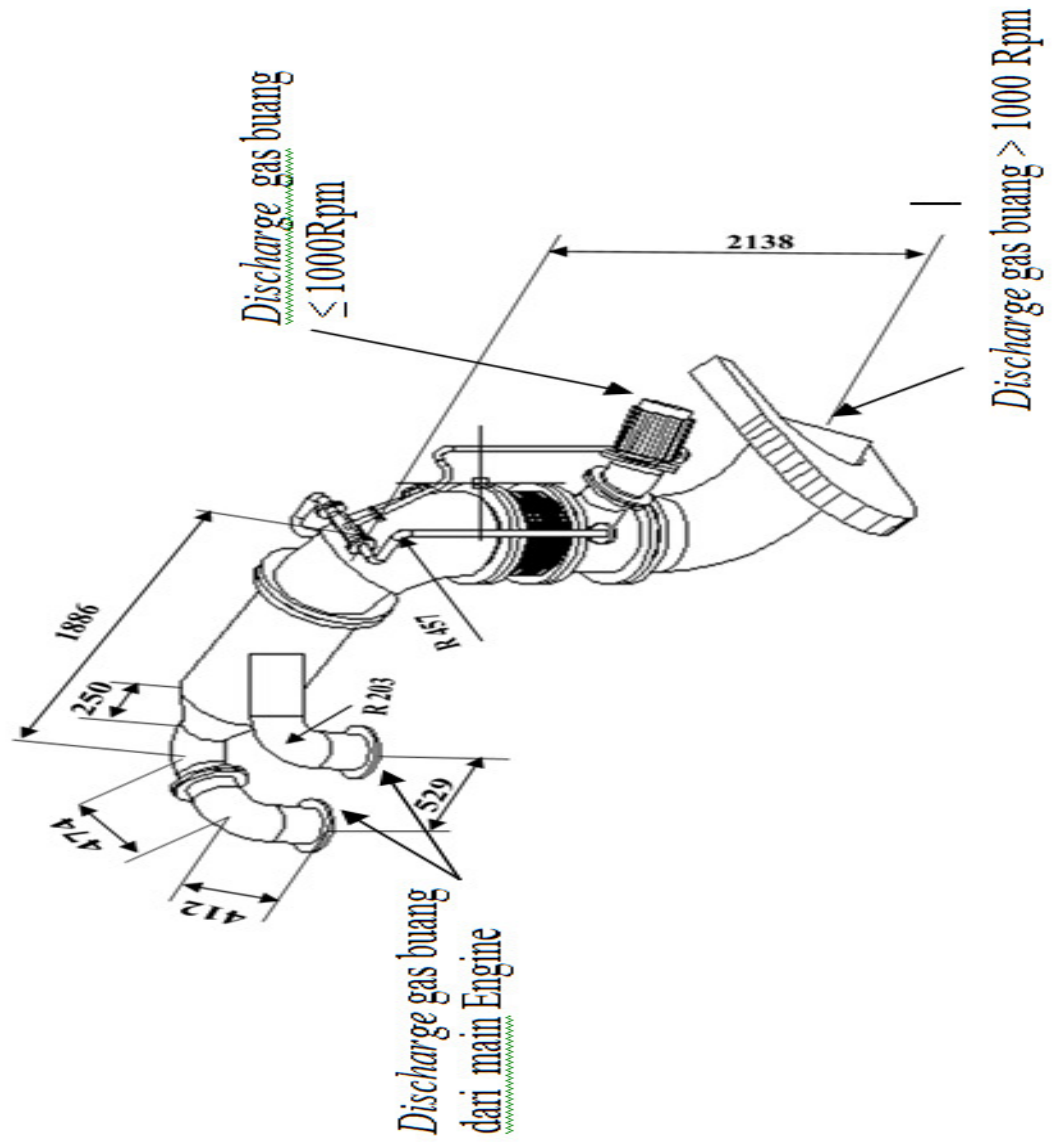


**FOTO EXHAUST GAS SEBELAH KANAN**



# Lampiran 7

## GAMBAR EXHAUST GAS 3D

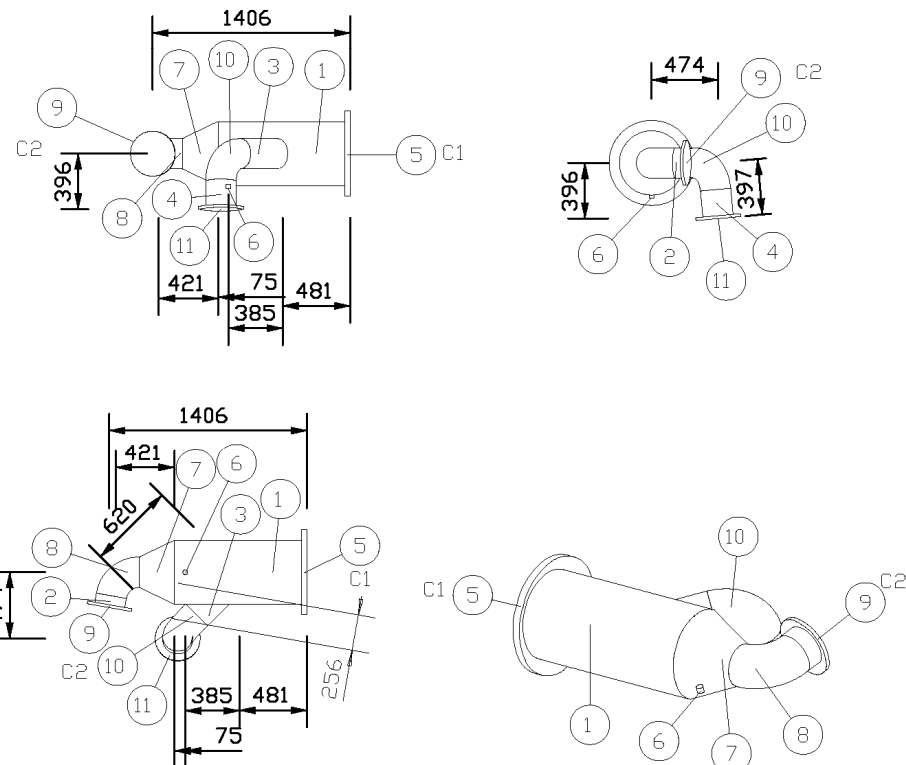


## Lampiran 8

### GAMBAR SKETCH EXHAUST GAS

MODS								
POS	QUANT	UNITS	DESCRIPTION			BUILD	MTRL NO.	AC
1	938	MM	St. Pipe 457.2X7.9	DN450 (SGP)		938	7101	LT
2	82	MM	St. Pipe 216.3X5.8	DN200 (SGP)		82	7101	LT
3	422	MM	St. Pipe 216.3X5.8	DN200 (SGP)		372	7101	LT
4	203	MM	St. Pipe 216.3X5.8	DN200 (SGP)		203	7101	LT
5	1		PCS Pipe Flange S/D St 5K-DN450	Flat Face		3	JIS B-2220	LT
6	1		PCS Screwed Seat R1/2(DN15)	Female Threading		30	XXXXX	0
7	1		PCS Pipe Reducer	DN450XDN200 SGP		250	reff	RR
8	1		PCS Pipe Elbow Short	SGP DN200		341	0-228-1077	L
CUT 80.0 DEGREES								
9	1		PCS Pipe Flange S/D St 5K-DN200	Flat Face		3	JIS B-2220	LT
10	1		PCS Pipe Elbow Short	SGP DN200		381	0-228-1077	L
CUT 86.3 DEGREES								
11	1		PCS Pipe Flange S/D St 5K-DN200	Flat Face		3	JIS B-2220	LT





  

3		45	0	E 8:	:SDL
5	0.0			E 8:	:
6		90	90	E 8:	:DRL
9	0.0			E 8:	:
11	44.9			E 10:	:

POS	ROT.	INCL	TURN	REMARKS	POS	X-COORD	Y-COORD	Z-COORD
ASSEMBLY INFORMATION					C1	15700.0	2551.7	4180.0
					C2	15952.1	1145.4	4180.0

	JOINT	HEAT	TESTP	FEED			ROT.	BEND
	1;2						BENDING DATA	
WELD	SURFT	EXT	INT	POS	POS	ANGLE	SERVICE	
8;15				AUTOMATIC WELD		5131030		

NOTES				SHDP	WD-NO.	DEST.
DATE	RAD	WEIGHT	BLOCK	PLAN UNIT	ARRGT. DRAWING NO.	
13-12-20		169	20201/ASB1	5P61008	5161008	
DESCRIPTION			QNT	PG	SHIP	SKETCH NAME
PRE-St. Pipe 457.2X7.9 DN450 (SGP)					W273-275	W273-20201-EG3-01
						REV:



## Lampiran 9

### GAMBAR SKETCH EXHAUST GAS

MODS							
POS	QUANT	UNITS	DESCRIPTION	BUILD	MTRL NO.	AC	
1	68		MM Plate Rool 457.2 x 4.5 SUS316L ERW DN 450	68	JIS G 3459	RR	
2	1		PCSPipe Flange S/D St 5K-DN450 Flat Face	3	JIS B-2220	LT	
3	1		PCSPipe Elbow Short SUS DN450	914	0-228-1077	L	
4	1		PCSPipe Flange S/D St 5K-DN450 Flat Face	3	JIS B-2220	LT	

C2

528

460

C1

528

C1

C2

460

C2

C1

C2

REVISI

2	0.0	E 3: 1
4	0.0	E 3: 1

POS	ROT.	INCL	TURN	REMARKS	POS	X-COORD	Y-COORD	Z-COORD
ASSEMBLY INFORMATION								
					C1	15700.0	3013.1	3652.0
					C2	15700.0	2552.7	4190.0

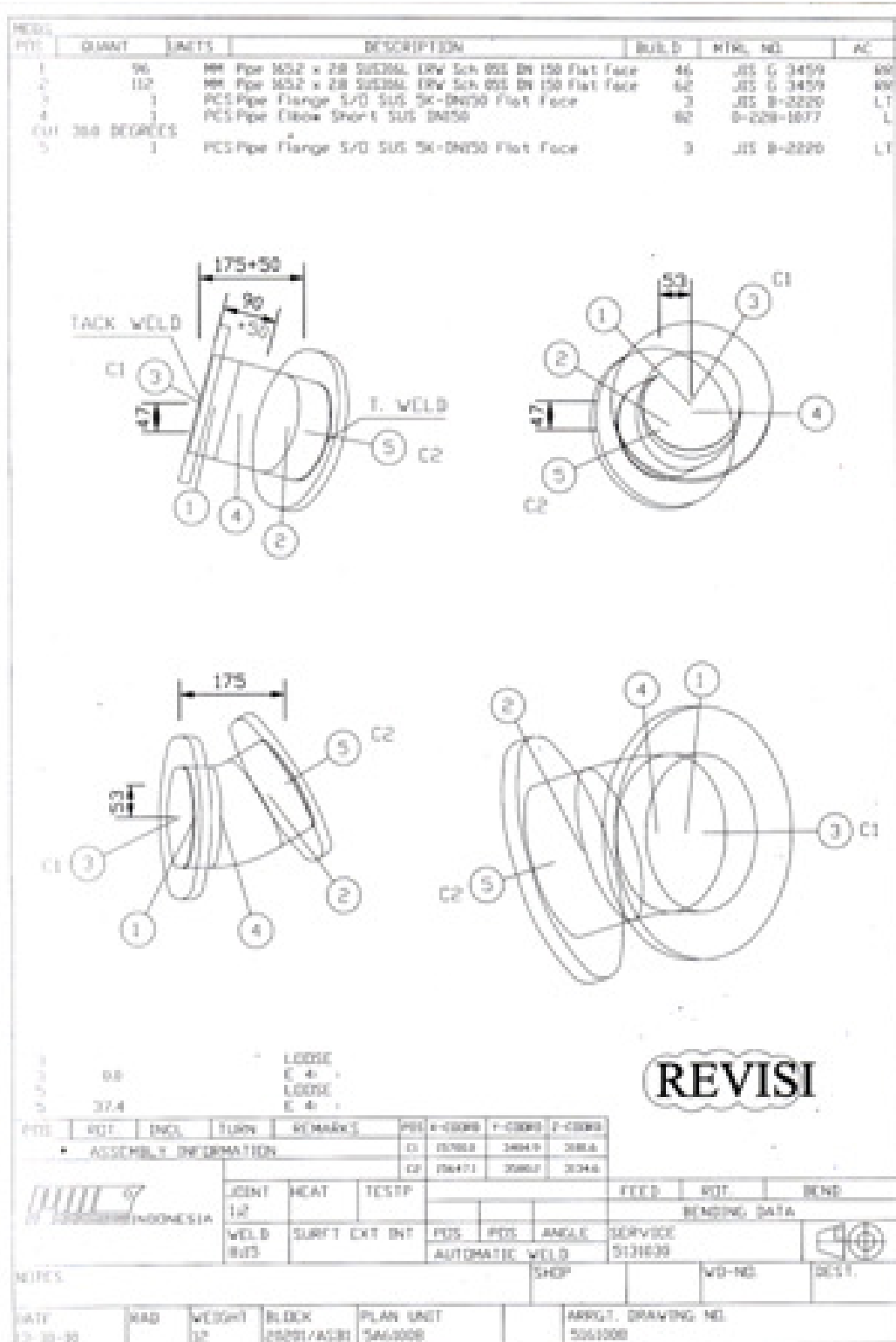
	JOINT	HEAT	TESTP	FEED	ROT.	BEND
	1/2			BENDING DATA		
WELD	SURFT	EXT	INT	POS	POS	ANGLE
8/15				AUTOMATIC WELD		
				SERVICE		
				3		

NOTES				SHDP	WO-NO.	DEST.
DATE	RAD	WEIGHT	BLOCK	PLAN UNIT	ARRGT. DRAWING NO.	
13-10-22		115	20201/ASB1	SP61008	5161008	
DESCRIPTION				QNT	PG	SHIP
PRE-Plate Rool 457.2 x 4.5 SUS316L ERW DN 450						W273
				SKETCH NAME		REV: 3
				W273-20201-EG3-02		

## Lampiran 10

### GAMBAR SKETCH EXHAUST GAS



**Lampiran 11**  
**ENDORSEMENT LETTER**



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**ENDORSEMENT LETTER**  
744/PB-UMS/EL/X/2015

This letter is to certify that the abstract of the thesis below

Title : Modeling Study of Under Water Exhaust Pipe Position on 60 M Patrol Vessel  
Student's name : Nanang Kurniawan  
Reg. Number : 20111334001  
Department : S1 Teknik Perkapalan

has been endorsed by Pusat Bahasa *UMSurabaya* for further approval by the examining committee of the faculty.

Surabaya, 02 October 2015



Sulton Dedi Wijaya, S.Pd