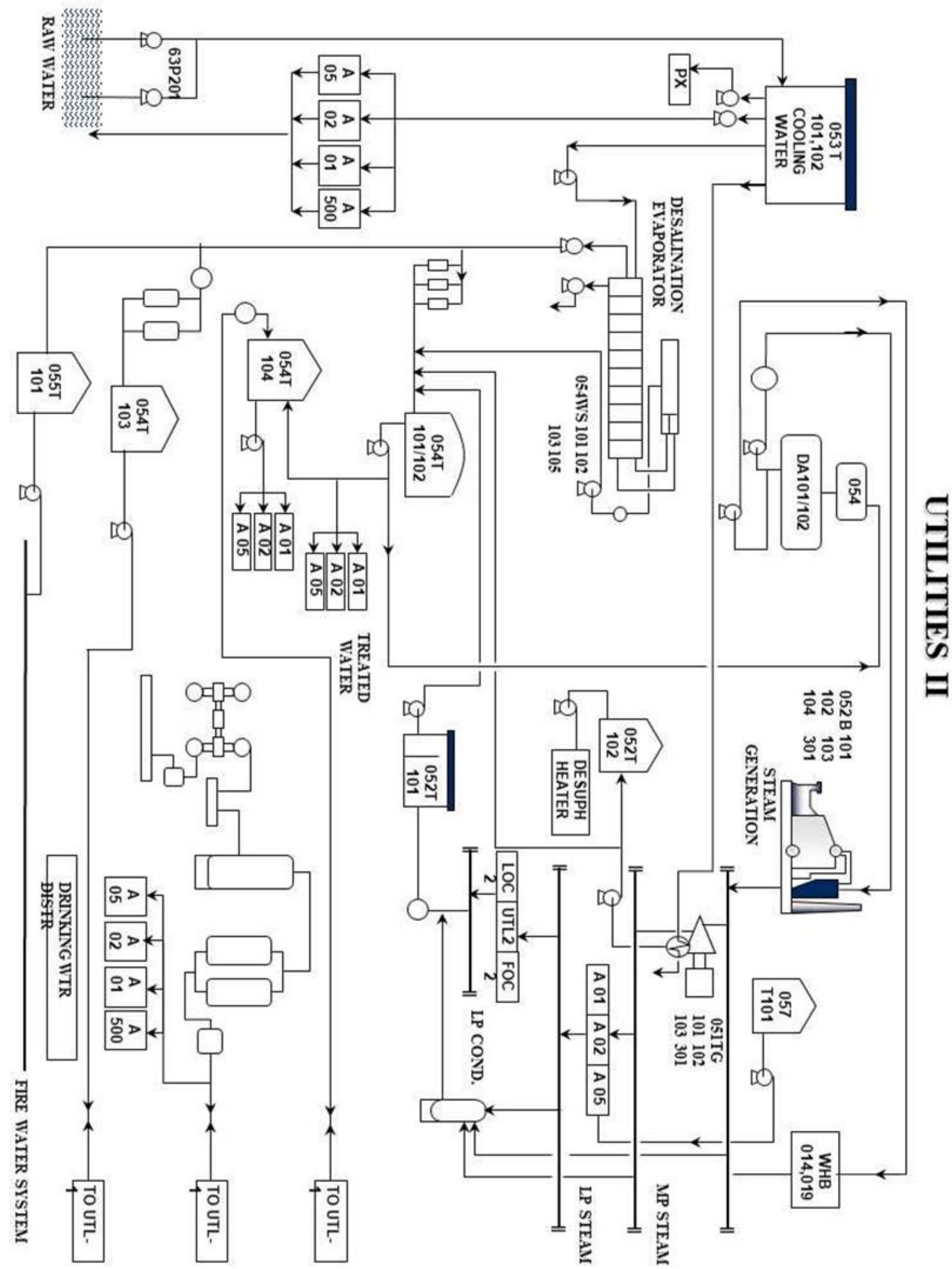
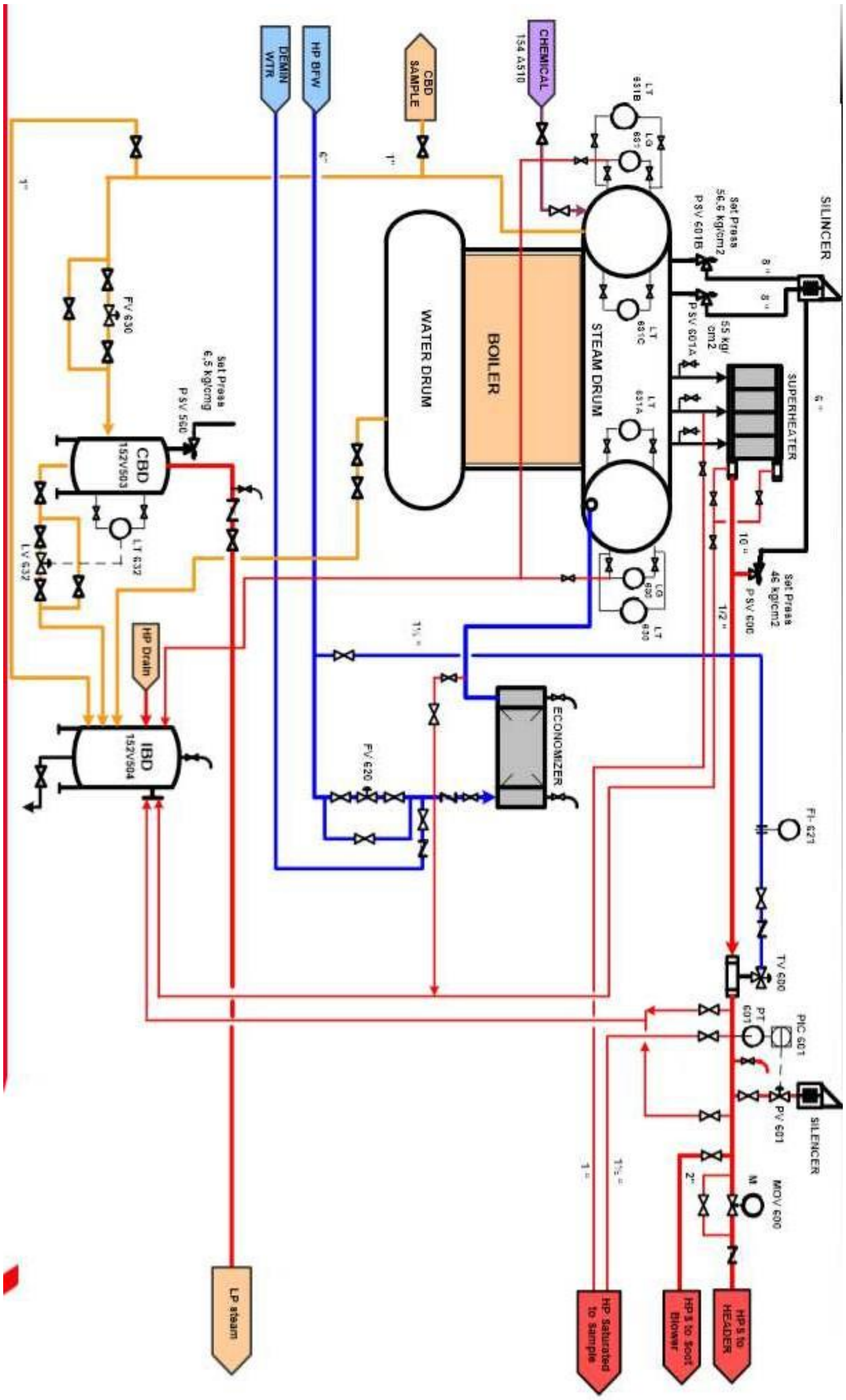
LAMPIRAN

Lampiran 1. Process Engineering Flow Diagram



Lampiran 2. Process Engineering Flow Diagram Boiler



Lampiran 3. Gambar boiler 052 B101

Lampiran 4. Data Analisa komposisi fuel oil dari 057T 101

Tanki	Uraian	Satuan	Aug-23		Sep-23		Oct-23	
			01 s/d 14	5 s/d Akh	01 s/d 14	5 s/d Akh	01 s/d 14	5 s/d Akhi
057T 101	Sg		0.9270	0.9205	0.9248	0.9335	0.9125	0.9392
HFO	Caloric Value Gro	Btu/lb	18,962	19,049	18,928	18,929	19,072	18,893
	Pour Point Actual	oC	36	33	33	36	36	42
FOC 2	Ash Content	% wt	0.01	0.02	0.02	0.02	0.02	0.02
LOC 2	Water Content	% vol	0.10	0.10	0.15	0.10	0.16	0.10
UTL 2	Sulphur Content	% wt	0.58	0.31	0.83	0.51	0.53	0.50
	Nitrogent Content	ppm	-	-	2,296	-	2,119	-
	TSRF		0.9699	0.9700	0.9699	0.9646	0.9699	0.9629
	LHV Calc.	Btu/lb	17,943	17,945	17,943	17,845	17,943	17,814
	LHV Calc.	Kcal/kg	9,968	9,969	9,968	9,914	9,968	9,897
	Visco Kin. At 210 °	cSt	10.730	11.88	9.603	15.62	9.884	15.61
	Metal Content :	ppm						
	Cr	ppm		0		0		0
	Cu	ppm		0		0		0
	Fe	ppm		71		57		63
	Na	ppm		1		12		16
	Ni	ppm		11		5		7
	Al	ppm		32		29		12
	Si	ppm		12		14		24
	V	ppm		8		26		13

Lampiran 5. Ultimate analysis fuel oil

FO Composition	**Value**
API of Fuel Oil	22,1374
C/H Ratio	7,206
Weight % C	87,323
Weight % H	12,117
Weight % S	0,310
Weight % N	0
Weight % Ash	0,020
Moisture %	0,100
Total	**100**

Keterangan Perhitungan:

- API of fuel Oil (Deg API Gravity)

  Deg API Gravity $= \frac{141,5}{Specific\ gravity\ at \frac{60}{60F}} - 131,5$

  Deg API Gravity $= \frac{141,5}{0,921} - 131,5$

  $= 22,1374\ \%$

- % Weight N = Nitrogen Content (ppm) / 10000

  = 0 ppm/10000

  = 0 %

- C/H Ratio = 8,528 x e^{-1} x (ln Deg API Gravity – 1,288)^2/19,440

  (Sumber: PT KPI RU IV Cilacap)

  C/H Ratio = 8,528 x e^{-1} x (ln 22,1374 – 1,288)^2/19,440

  = 7,2064 %

- % Weight C = (100-(Wt%S+Wt%N+Wt%Ash+Wt%Moisture)) x C/H Ratio/(1+C/H Ratio)

  (Sumber: PT KPI RU IV Cilacap)

Keterangan:

Wt%S = Sulfur Content

= 0,310%

Wt%N = Weight % Nitrogen

= 0 %

Wt%Ash = Weight % Ash / Ash content

= 0,020 %

Wt%Moisture= Weight % Moisture / water content

= 0,100 %

% Weight C = (100-(Wt%S+Wt%N+Wt%Ash+Wt%Moisture)) x C/H Ratio/(1+C/H Ratio)

% Weight C = (100-(0,310%+0,130%+0,020%+0,100%)) x 7,201%/(1+7,201%)

% Weight C = 87,3230

- % Weight H = (100-(Wt%S+Wt%N+Wt%Ash+Wt%Moisture)) /(1+C/H Ratio)

(Sumber: PT KPI RU IV Cilacap)

% Weight H = (100-(0,310%+0%+0,020%+0,100%)) /(1+7,2064%)

%Weight H = 12,1174 %

Lampiran 6. ASME PTC 4.1 Test Form

ASME PTC*4.1-B 64 ■ 0759670 0084471 4 ■

PTC 4.1-b (1964)

CALCULATION SHEET

ASME TEST FORM
FOR ABBREVIATED EFFICIENCY TEST

Revised September, 1965

	OWNER OF PLANT	TEST NO.	BOILER NO.	DATE
30	HEAT OUTPUT IN BOILER BLOW-DOWN WATER = LB OF WATER BLOW-DOWN PER HR × $\left[\frac{\text{ITEM 15} - \text{ITEM 17}}{1000}\right]$ = ... kB/hr			
24	*If impractical to weigh refuse, this item can be estimated as follows* DRY REFUSE PER LB OF AS FIRED FUEL = $\frac{\text{\% ASH IN AS FIRED COAL}}{100 - \text{\% COMB. IN REFUSE SAMPLE}}$ CARBON BURNED PER LB AS FIRED FUEL = $\frac{\text{ITEM 43}}{100} - \left[\frac{\text{ITEM 22} \times \text{ITEM 23}}{14{,}500}\right]$ = ... NOTE: IF FLUE DUST & ASH PIT REFUSE DIFFER MATERIALLY IN COMBUSTIBLE CONTENT, THEY SHOULD BE ESTIMATED SEPARATELY. SEE SECTION 7, COMPUTATIONS.			
25	DRY GAS PER LB AS FIRED FUEL BURNED = $\frac{11CO_2 + 8O_2 + 7(N_2 + CO)}{3(CO_2 + CO)}$ × (LB CARBON BURNED PER LB AS FIRED FUEL + $\frac{3}{8}$ S) = $\frac{11 \times \text{ITEM 32} + 8 \times \text{ITEM 33} + 7(\text{ITEM 35} + \text{ITEM 34})}{3 \times (\text{ITEM 32} + \text{ITEM 34})} \times \left[\text{ITEM 24} + \frac{\text{ITEM 47}}{267}\right]$ = ...			
36	EXCESS AIR† = $100 \times \frac{O_2 - \frac{CO}{2}}{.2682N_2 - (O_2 - \frac{CO}{2})}$ = $100 \times \frac{\text{ITEM 33} - \frac{\text{ITEM 34}}{2}}{.2682(\text{ITEM 35}) - (\text{ITEM 33} - \frac{\text{ITEM 34}}{2})}$ = ...			

	HEAT LOSS EFFICIENCY	Btu/lb AS FIRED FUEL	LOSS/HHV × 100 =	LOSS %
65	HEAT LOSS DUE TO DRY GAS = LB DRY GAS PER LB AS FIRED FUEL × C_p × ($t_{lvg} - t_{air}$) = ITEM 25 × 0.24 (ITEM 13) − (ITEM 11) = ...	......	$\frac{65}{41}$ × 100 =	......
66	HEAT LOSS DUE TO MOISTURE IN FUEL = LB H_2O PER LB AS FIRED FUEL × [(ENTHALPY OF VAPOR AT 1 PSIA & T GAS LVG) − (ENTHALPY OF LIQUID AT T AIR)] = $\frac{\text{ITEM 37}}{100}$ × [(ENTHALPY OF VAPOR AT 1 PSIA & T ITEM 13) − (ENTHALPY OF LIQUID AT T ITEM 11)] = ...	......	$\frac{66}{41}$ × 100 =	......
67	HEAT LOSS DUE TO H_2O FROM COMB. OF H_2 = 9H_2 × [(ENTHALPY OF VAPOR AT 1 PSIA & T GAS LVG) − (ENTHALPY OF LIQUID AT T AIR)] = 9 × $\frac{\text{ITEM 44}}{100}$ × [(ENTHALPY OF VAPOR AT 1 PSIA & T ITEM 13) − (ENTHALPY OF LIQUID AT T ITEM 11)] = ...	......	$\frac{67}{41}$ × 100 =	......
68	HEAT LOSS DUE TO COMBUSTIBLE IN REFUSE = ITEM 22 × ITEM 23 = ...	......	$\frac{68}{41}$ × 100 =	......
69	HEAT LOSS DUE TO RADIATION* = $\frac{\text{TOTAL BTU RADIATION LOSS PER HR}}{\text{LB AS FIRED FUEL} - \text{ITEM 28}}$	......	$\frac{69}{41}$ × 100 =	......
70	UNMEASURED LOSSES **	......	$\frac{70}{41}$ × 100 =	......
71	TOTAL	......	......	......
72	EFFICIENCY = (100 − ITEM 71)	......	......	......

† For rigorous determination of excess air see Appendix 9.2 – PTC 4.1-1964
* If losses are not measured, use ABMA Standard Radiation Loss Chart, Fig. 8, PTC 4.1-1964
** Unmeasured losses listed in PTC 4.1 but not tabulated above may by provided for by assigning a mutually agreed upon value for Item 70.

Printed in U.S.A. (10/74)

This Test Form (C-37) may be obtained from ASME, 345 E. 47 St., New York, N.Y. 10017

Lampiran 7. Perhitungan Indirect Methode Agustus-Oktober

INDIRECT METHOD	Bulan	Agustus				
Calculation				**Value**		**Unit**
				FG	**FO**	
Theoretical air required (fuel gas)				9.572801416	10.67006	kg/kg fuel
O2 Level				3.509284		%
Excess Air				20.06369551		%
Actual mass of air supplied/kg of fuel (AAS)				11.49345914	12.81086	kg/kg fuel
Mass of dry fuel gas				12.36664555	13.88084	kg/kg fuel
% Heat loss in dry flue gas			L1	**3.845277693**		%
% Heat loss due to evaporation of water due to H2 in fuel			L2	6.24718536	3.082887	%
			total	**9.330072784**		
% Heat loss due to moisture in fuel			L3	**0.00282686**		%
% Heat loss due to moisture in air			L4	**0.07906544**		%
% Heat loss due to incomplete combustion			L5	**0.003398**		%
% Radiation and convection loss			L6	**2**		%
Efficiency					**84.7394**	**%**

INDIRECT METHOD	Bulan	September				
Calculation				**Value**		**Unit**
				FG	**FO**	
Theoretical air required (fuel gas)				9.572801416	10.6601	kg/kg fuel
O2 Level				3.609214		%
Excess Air				20.75359906		%
Actual mass of air supplied/kg of fuel (AAS)				11.55950224	12.87246	kg/kg fuel
Mass of dry fuel gas				12.44048264	13.95342	kg/kg fuel
% Heat loss in dry flue gas			L1	**3.878048571**		%
% Heat loss due to evaporation of water due to H2 in fuel			L2	6.265475597	3.035082	%
			total	**9.30055794**		
% Heat loss due to moisture in fuel			L3	**0.002835137**		%
% Heat loss due to moisture in air			L4	**0.079752576**		%
% Heat loss due to incomplete combustion			L5	**0.003398**		%
% Radiation and convection loss			L6	**2**		%
Efficiency					**84.7354**	**%**

INDIRECT METHOD	Bulan	September				
Calculation				**Value**		**Unit**
				FG	**FO**	
Theoretical air required (fuel gas)				9.572801416	10.6601	kg/kg fuel
O2 Level				3.609214		%
Excess Air				20.75359906		%
Actual mass of air supplied/kg of fuel (AAS)				11.55950224	12.87246	kg/kg fuel
Mass of dry fuel gas				12.44048264	13.95342	kg/kg fuel
% Heat loss in dry flue gas			L1	**3.878048571**		%
% Heat loss due to evaporation of water due to H2 in fuel			L2	6.265475597	3.035082	%
			total	**9.30055794**		
% Heat loss due to moisture in fuel			L3	**0.002835137**		%
% Heat loss due to moisture in air			L4	**0.079752576**		%
% Heat loss due to incomplete combustion			L5	**0.003398**		%
% Radiation and convection loss			L6	**2**		%
Efficiency					**84.7354**	**%**

Lampiran 8 . Data Ultimate Analysis Bulan Agustus-Oktober

ULTIMATE ANALYSIS FUEL OIL BULAN AGUSTUS

FO Composition	Value
API of Fuel Oil	22.1374
C/H Ratio	7.2064
Weight % C	87.3230
Weight % H	12.1174
Weight % S	0.31
Weight % N	0
Weight % Ash	0.02
Moisture %	0.10
Total	**100.0000**

ULTIMATE ANALYSIS FUEL OIL BULAN SEPTEMBER

FO Composition	Value
API of Fuel Oil	20.0801
C/H Ratio	7.3348
Weight % C	87.2457
Weight % H	11.8947
Weight % S	0.51
Weight % N	0
Weight % Ash	0.02
Moisture %	0.10
Total	**100.0000**

ULTIMATE ANALYSIS FUEL OIL BULAN OKTOBER

FO Composition	Value
API of Fuel Oil	19.1601
C/H Ratio	7.3948
Weight % C	87.3551
Weight % H	11.8130
Weight % S	0.50
Weight % N	0
Weight % Ash	0.02
Moisture %	0.10
Total	**100.0000**