



SUBHOLDING
REFINING & PETROCHEMICAL

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DESIGN CRITERIA

BOILER PACKAGE

ENGINEERING TECHNICAL STANDARDS & PROCEDURES PT KILANG PERTAMINA INTERNASIONAL DIREKTORAT PROYEK INFRASTRUKTUR

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1. INTRODUCTION

1.1 This Design Criteria establishes the minimum requirements for safe and reliable Design Criteria for Boiler Package that meets the needs of Projects.

2. SCOPE

2.1 This Process design criteria document covers the minimum mandatory requirements of design criteria for the Boiler Package required for operation of 20 years lifetime.

2.2 This document covers the general design criteria requirement of the new Boiler Package.

3. CONFLICTS AND DEVIATIONS

3.1 Any conflicts between this standard and other applicable Engineering Technical Standards & Procedures (ETSP), or OWNER standard, codes, and forms shall be resolved in writing by OWNER.

3.2 All direct requests to deviate from this standard (ETSP) in writing to OWNER, who shall follow internal OWNER procedure and forward such requests to OWNER for approval.

4. ABBREVIATIONS

4.1 Abbreviations used for this specification shall have the following definitions:

ABMA American Boiler Manufacturers Association

ANSI American National Standard Institute

1. PENGANTAR

1.1 Design Kriteria ini menetapkan persyaratan minimum yang aman dan memiliki nilai kehandalan untuk Design Kriteria terkait *Boiler Package* yang memenuhi kebutuhan Proyek.

2. LINGKUP

2.1 Dokumen kriteria desain Proses ini mencakup persyaratan wajib minimum kriteria desain untuk *Boiler Package* yang diperlukan untuk pengoperasian selama 20 tahun masa pakai.

2.2 Dokumen ini mencakup persyaratan kriteria desain umum *Boiler Package* baru.

3. KONFLIK DAN DEVIASI

3.1 Apabila terdapat konflik antara standar ini dengan *Engineering Technical Standards & Procedures* (ETSP) yang berlaku lainnya, atau standar PEMILIK, *codes* dan formulir, maka harus diselesaikan secara tertulis oleh PEMILIK.

3.2 Semua permintaan penggunaan standar yang berbeda dari standar ini (ETSP), harus diajukan kepada PEMILIK secara tertulis dengan mengikuti prosedur internal PEMILIK untuk mendapatkan persetujuan.

4. SINGKATAN

4.1 Singkatan yang digunakan pada spesifikasi ini harus memiliki definisi sebagai berikut:

ABMA *American Boiler Manufacturers Association*

ANSI *American National Standard Institute*

API	American Petroleum Institute	API	<i>American Petroleum Institute</i>
ASME	American Society of Mechanical Engineers	ASME	<i>American Society of Mechanical Engineers</i>
ASTM	American Society for Testing and Materials	ASTM	<i>American Society for Testing and Materials</i>
BEDD	Basic Engineering Design Data	BEDD	<i>Basic Engineering Design Data</i>
BSI	British Standards Institution	BSI	<i>British Standards Institution</i>
BSP	Burner Start-up Panel	BSP	<i>Burner Start-up Panel</i>
CBD	Continuous Blowdown	CBD	<i>Continuous Blowdown</i>
CCR	Central Control Room	CCR	<i>Central Control Room</i>
DCS	Distributed Control System	DCS	<i>Distributed Control System</i>
DN	Diameter Nominal, in (mm)	DN	<i>Diameter Nominal, in (mm)</i>
ETSP	Engineering Technical Standards & Procedures	ETSP	<i>Engineering Technical Standards & Procedures</i>
FDF	Forced Draft Fan	FDF	<i>Forced Draft Fan</i>
HPP	High Point of Paving	HPP	<i>High Point of Paving</i>
ID	Internal Diameter	ID	<i>Internal Diameter</i>
LHV	Low Heating Value	LHV	<i>Low Heating Value</i>
LLL	Low Liquid Level	LLL	<i>Low Liquid Level</i>
LLLL	Low Low Liquid Level	LLLL	<i>Low Low Liquid Level</i>
MBTU	Metric British Thermal Unit	MBTU	<i>Metric British Thermal Unit</i>
MCR	Maximum Continuous Rating	MCR	<i>Maximum Continuous Rating</i>
MFT	Master Fuel Trip	MFT	<i>Master Fuel Trip</i>
NAFM	National Association of Fan Manufacturers	NAFM	<i>National Association of Fan Manufacturers</i>
NPS	Nominal Pipe Size, in (inch)	NPS	<i>Nominal Pipe Size, in (inch)</i>
ppm	parts per million	ppm	<i>parts per million</i>
PTC	Performance Test Code	PTC	<i>Performance Test Code</i>
RDMP	Refinery Development Master Plan	RDMP	<i>Refinery Development Master Plan</i>
TDS	Total Dissolved Solids	TDS	<i>Total Dissolved Solids</i>
vol%	Volume Percent	vol%	<i>Volume Percent</i>

5. DEFINITIONS

5.1 The following words shall have these special meanings when used herein:

OWNER Owner of the Plant is defined as PT Kilang Pertamina Internasional.

CONTRACTOR/CONSULTANT Defined as The Organization to which PT Kilang Pertamina Internasional assign the work.

shall Indicates that the statement is mandatory.

should Indicates a recommendation.

Air Heater or Air Preheater An air heater or air preheater is a heat transfer Apparatus through which combustion air is passed and heated by a medium of higher temperature, such as the products of combustion, steam or other fluid.

Atomizer An atomizer is a device used to reduce a fluid to a fine spray, Atomization means are normally either steam, air or mechanical.

Blowdown The drain connection including the pipe and the valve at the lowest practical part of a boiler, or at the normal water

5. DEFINISI

5.1 Penggunaan kata-kata berikut harus memiliki arti khusus sebagai berikut:

PEMILIK Pemilik Kilang didefinisikan sebagai PT Kilang Pertamina Internasional.

KONTRAKTOR/KONSULTAN Didefinisikan sebagai Organisasi yang ditunjuk oleh di PT Kilang Pertamina Internasional untuk melakukan suatu pekerjaan.

shall Menunjukkan bahwa pernyataan itu wajib.

should Menunjukkan rekomendasi.

Air Heater atau Air Preheater *Air heater* atau *air preheater* adalah alat perpindahan panas melalui udara pembakaran yang dilewatkan dan dipanaskan oleh media dengan suhu yang lebih tinggi, seperti produk pembakaran, *steam* atau cairan lainnya.

Atomizer *Atomizer* adalah alat yang digunakan untuk mereduksi cairan menjadi *fine spray* sarana *Atomization* biasanya berupa *steam*, udara atau mekanis.

Blowdown Sambungan saluran pembuangan termasuk pipa dan *valve* pada *lowest practical part* dari *boiler*, atau pada

level in the case of a surface blowdown. The amount of water that is blown down.

Burner

A burner is a device for the introduction of fuel and air into a boiler at the desired velocities, turbulence and concentration to establish and maintain proper ignition and combustion. Burners are classified by the types of fuel fired, such as: oil, gas or a combination of gas and oil. A secondary consideration in classifying burners how combustion air is mixed with the fuel.

Burner

ketinggian air normal dalam kasus *surface blowdown*. Jumlah air yang di *blown down*.

Burner adalah alat untuk memasukkan bahan bakar dan udara ke dalam *boiler* pada kecepatan, *turbulensi*, dan konsentrasi yang diinginkan untuk menetapkan dan mempertahankan *ignition* dan pembakaran yang tepat. *Burner* diklasifikasikan berdasarkan jenis bahan bakar yang dibakar, seperti: minyak, gas atau kombinasi gas dan minyak. Pertimbangan sekunder dalam mengklasifikasikan burner adalah cara bagaimana udara pembakaran dicampur dengan bahan bakar.

Burner
Management
System

The portion of a boiler control system associated with the supply of fuel to the burners. This includes the complete fuel train, safety shut-off valves, fuel pressure and temperature limits, burner starting and sequencing logic and annunciation of trouble signals.

*Burner
Management
System*

Bagian dari *boiler control system* yang terkait dengan *supply* bahan bakar ke *burner*. Ini termasuk rangkaian bahan *fuel train*, *safety shut-off valves*, *fuel pressure* dan batas suhu, *burner starting* dan *sequencing logic*, serta *annunciation of trouble signals*.

Carryover

The moisture and entrained solids forming the film of steam

Carryover

Moisture dan *entrained solids* membentuk lapisan gelembung

	bubbles, a result of foaming in a boiler. Carryover is caused by a faulty boiler water condition.		<i>steam</i> , akibat <i>foaming</i> dalam <i>boiler</i> . <i>Carryover</i> disebabkan oleh kondisi air boiler yang rusak.
Combustion Control System	The portion of a boiler control system associated with the control and maintenance of air/fuel mixtures throughout the operating range of the burner and during changes in firing rate.	<i>Combustion Control System</i>	Bagian dari <i>boiler control system</i> yang terkait dengan kontrol dan pemeliharaan campuran udara/bahan bakar di seluruh rentang operasi <i>burner</i> dan selama perubahan laju pembakaran.
Damper	A damper is a device for introducing a variable resistance for regulating the volumetric flow of gas or air.	<i>Damper</i>	Damper adalah perangkat untuk memperkenalkan resistensi variabel untuk mengatur aliran volumetrik gas atau udara.
Downcomer	A tube or pipe in a boiler or water wall circulating system through which fluid flows downward between headers.	<i>Downcomer</i>	<i>Tube</i> atau <i>pipe</i> dalam boiler atau <i>water wall circulating system</i> di mana fluida mengalir ke bawah di antara header.
Draft	Draft is the negative pressure (vacuum) of the flue gas measured at any point in the boiler, expressed in millimeters of water column (kilopascals).	<i>Draft</i>	Draft tekanan negatif (vakum) dari <i>flue gas</i> yang diukur pada setiap titik di <i>boiler</i> , dinyatakan dalam milimeter kolom air (<i>kilopascal</i>).
Economizer	A series of tubes located in the path of the flue gases. Feed water is pumped through these tubes on its way to the boiler in order to absorb waste heat from the flue gas.	<i>Economizer</i>	Serangkaian <i>tube</i> yang terletak di <i>flue gas path</i> . <i>Feed water</i> dipompa melalui <i>tube</i> ini dalam perjalanan ke <i>boiler</i> untuk menyerap panas buangan dari gas buang.

Efficiency, Fuel	Efficiency, fuel refers to the heat absorbed divided by the net heat of combustion of the fuel as heat input, expressed as a percentage.	<i>Efficiency, Fuel</i>	<i>Efficiency, fuel</i> mengacu pada panas yang diserap dibagi dengan <i>net heat of combustion of the fuel</i> sebagai <i>heat input</i> , dinyatakan sebagai persentase.
Efficiency, Thermal	Efficiency, thermal refers to the total heat absorbed divided by total heat input, expressed as a percentage.	<i>Efficiency, Thermal</i>	<i>Efficiency, thermal</i> mengacu pada total panas yang diserap dibagi dengan total <i>heat input</i> , dinyatakan sebagai persentase.
Excess Air	Excess air is the amount of air above the stoichiometric requirement for complete combustion expressed as percentage.	<i>Excess Air</i>	<i>Excess air</i> adalah jumlah udara di atas kebutuhan stoikiometrik untuk pembakaran sempurna yang dinyatakan dalam persentase.
Ignitor	A term used in industry to denote the device that provides the proven ignition energy required immediately to light on the pilot flame.	<i>Ignitor</i>	Sebuah istilah yang digunakan dalam industri untuk menunjukkan perangkat yang menyediakan <i>proven ignition energy</i> diperlukan segera untuk menyalakan <i>pilot flame</i> .
Low Heating Value (LHV)	The high heating value minus the latent heat of vaporization of the water formed by burning the hydrogen in the fuel.	<i>Low Heating Value (LHV)</i>	<i>High heating value</i> dikurangi <i>latent heat</i> dari <i>vaporization</i> dari air hasil pembakaran hidrogen dalam bahan bakar.
Mud or Lower Drum	A drum or header-tube pressure chamber located at the lower extremity of a water tube boiler convection bank which is normally provided with a blow off valve for periodically	<i>Mud atau Lower Drum</i>	Sebuah drum atau <i>header-tube pressure chamber</i> yang terletak di ujung bawah <i>water tube boiler convection bank</i> yang biasanya dilengkapi dengan <i>blow off valve</i> untuk secara

blowing off sediment collecting in the bottom of the drum.

berkala *blowing off* pengumpulan sedimen di bagian bawah *drum*.

Pressure Part A component that contains pressurized water or steam or a mixture of the two.

Pressure Part Komponen yang mengandung air bertekanan atau *steam* atau campuran keduanya.

Shop-Assembled Boilers Water tube boilers, wholly or partially assembled in the manufacturer's workshop, requiring no further fabrication work on the pressure parts and shipped as one unit. It should be noted that such boilers are sometimes referred to as Packaged Boilers by suppliers.

Shop-Assembled Boilers *Water tube boilers*, seluruhnya atau sebagian dirakit di *manufacturer's workshop*, tidak memerlukan pekerjaan fabrikasi lebih lanjut pada bagian bertekanan dan dikirim sebagai satu unit. Perlu dicatat bahwa *boiler* semacam itu kadang-kadang disebut sebagai *Packaged Boilers by suppliers*.

Vendor Boiler manufacturer

Vendor Produsen *Boiler*

6. CODES AND STANDARDS

The following Codes, Standard and Specifications apply to this specification. When an edition date is not indicated for a code or standard or any update in codes and standards in this specification document, the latest edition and addendum in force at the time of purchase shall apply. Material & equipment shall be as a specification or an equal approved by OWNER.

ASME (American Heat Loss Abbreviated Society of Method Mechanical Engineers) PTC-4.1

6. KODE DAN STANDAR

Kode, standar, dan spesifikasi berikut berlaku untuk spesifikasi ini. Kode dan standar harus menggunakan edisi yang terbaru atau edisi yang berlaku pada saat pembelian. *Material* & peralatan harus sesuai spesifikasi atau setara dengan yang disetujui oleh PEMILIK.

ASME (American Heat Loss Abbreviated Society of Method Mechanical Engineers) PTC-4.1

ASME	Boiler and Pressure Vessel Code, Section I	ASME	Boiler and Pressure Vessel Code, Section I
ASTM (American Society for Testing and Materials)	Special Technical Publication No. 148	ASTM (American Society for Testing and Materials)	Special Technical Publication No. 148
ASTM D-1066	Standard Practice for Sampling Steam	ASTM D-1066	Standard Practice for Sampling Steam
ASTM D-1125-50T	Standard Test Method for Electrical Conductivity and Resistivity of Water	ASTM D-1125-50T	Standard Test Method for Electrical Conductivity and Resistivity of Water
NAFM (National Association of Fan Manufacturers)	Standard Test Code	NAFM (National Association of Fan Manufacturers)	Standard Test Code

7. BOILER CLASSIFICATION AND PARTS

7.1 General

The choice of boiler and distributor design is crucial to give the best performance of boiler. Good performance of a boiler is influenced by the maximum the heat absorbed and minimum heat loss. The design of boiler may be influenced by factors, including process requirements, economics and safety.

A boiler is any closed vessel in which for any purpose, steam is generated under pressure that is greater than atmospheric pressure. It includes any economizer used to heat to the water fed to the boiler, any superheater used for heating steam, and any pipes and fitting connected to the equipment.

The boiler system comprises of a feed water system, steam system and fuel system. The feed water system provides

7. KLASIFIKASI DAN BAGIAN BOILER

7.1 Umum

Pemilihan desain *boiler* dan distributor sangat penting untuk memberikan kinerja *boiler* yang terbaik. Kinerja boiler yang baik dipengaruhi oleh panas maksimum yang diserap dan *heat loss* yang minimum. Desain *boiler* dapat dipengaruhi oleh faktor-faktor, termasuk persyaratan proses, ekonomi dan keamanan.

Boiler adalah setiap *closed vessel* untuk tujuan apa pun, *steam* dihasilkan di bawah tekanan yang lebih besar dari tekanan atmosfer. Ini mencakup setiap *economizer* yang digunakan untuk memanaskan *feed water* ke *boiler*, setiap *superheater* yang digunakan untuk memanaskan *steam*, dan setiap pipa dan sambungan yang terhubung ke peralatan.

Sistem *boiler* terdiri dari *feed water system*, *steam system* dan *fuel system*. *Feed water system* menyediakan air ke *boiler* dan

water to the boiler and regulates it automatically to meet the steam demand. The steam system collects and controls the steam produced in the boiler.

Steam is directed through a piping system to the point of use. Steam pressure is regulated using valves and checked with steam pressure gauges. The fuel system includes all equipment used to provide fuel to generate the necessary heat.

There are several different chemical approaches used to treat boilers and their Selection and performance depend upon many factors. Some of these include:

- a) Feed water characteristics.
- b) The type and reliability of external treatment.
- c) Boiler type.
- d) Boiler pressure and heat flux.
- e) Steam load and variations in load.
- f) Waterside condition of the boiler and current and long-term goals of the program such as cleaning up scale or maintaining present conditions.
- g) Steam purity requirements.
- h) Regulatory restrictions such as Government of Republic of Indonesia requirements, other health and safety concerns, or process restrictions.
- i) Feed, testing, and control needs or restrictions.
- j) Economic considerations.
- k) Boiler room layout and number of boilers.

mengaturinya secara otomatis untuk memenuhi kebutuhan *steam*. *Steam system* mengumpulkan dan mengontrol *steam* yang dihasilkan dalam *boiler*.

Steam dialirkan melalui sistem perpipaan ke titik penggunaan. *Stea pressure* diatur menggunakan *valve* dan diperiksa dengan *steam pressure gauges*. *Fuel system* mencakup semua peralatan yang digunakan untuk menyediakan bahan bakar untuk menghasilkan panas yang diperlukan.

Ada beberapa pendekatan kimia berbeda yang digunakan untuk *treat boiler* dan Pemilihan serta kinerjanya bergantung pada banyak faktor. Beberapa di antaranya adalah:

- a) *Feed water characteristics*.
- b) Tipe dan *reliability* dari *external treatment*.
- c) Tipe *Boiler*.
- d) Tekanan *Boiler* dan *heat flux*.
- e) *Steam load* dan variasi *load*.
- f) Kondisi *Waterside* boiler dan tujuan program saat ini dan jangka panjang seperti membersihkan *scale* atau mempertahankan kondisi saat ini.
- g) *Steam purity requirements*.
- h) Pembatasan peraturan seperti persyaratan Pemerintah Republik Indonesia, masalah kesehatan dan keselamatan lainnya, atau pembatasan proses.
- i) *Feed, testing, dan control* kebutuhan atau *restrictions*.
- j) Pertimbangan Ekonomi
- k) *Boiler room layout* dan jumlah *boilers*.

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7.2 Boiler Classification

On industrial practices, Boiler could be classification based on several criteria.

7.2.1 Boiler Based on Utilization

A boiler is utilized to produce steam for electrical power generation. Normally have large capacity, high steam parameters, and high boiler efficiency. There are two type of boilers: industrial boiler and marine boilers.

- a) Industrial Boiler is utilized to produce steam for electrical power generation. Normally, it has a large capacity, high steam parameters, and high boiler efficiency.
- b) Marine Boiler is utilized as a source of motive power for ships. Normally, it has compact general shape, lighter general weight, and mostly fuel oil fired.

7.2.2 Boiler Based on Steam or Water Circulation

- a) Natural Circulation Boiler is the circulation of the working fluid in the evaporating tube is produced by the difference in density between the steam / water mixture in the risers and water in the downcomers.
- b) Forced Multiple Circulation Boilers is the circulation of the working fluid in the evaporating tube is forced using a circulating pump included in the circulation circuit.
- c) Once Through Boiler means no drum, the working fluid passes

7.2 Boiler Classification

Pada praktik industri, *Boiler* dapat diklasifikasi berdasarkan beberapa kriteria.

7.2.1 *Boiler* Berdasarkan Utilisasi

Boiler digunakan untuk menghasilkan *steam* untuk pembangkit tenaga listrik. Biasanya memiliki kapasitas besar, parameter steam tinggi, dan efisiensi *boiler* tinggi. Ada dua jenis *boiler*: *Industrial Boiler* dan *Marine Boiler*.

- a) Industrial Boiler digunakan untuk menghasilkan *steam* untuk pembangkit tenaga listrik. Biasanya, ia memiliki kapasitas besar, parameter uap tinggi, dan efisiensi boiler tinggi.
- b) Marine Boiler dimanfaatkan sebagai sumber tenaga penggerak kapal. Biasanya, ia memiliki bentuk umum yang kompak, berat umum yang lebih ringan, dan sebagian besar berbahan bakar minyak.

7.2.2 *Boiler* Berdasarkan *Steam* atau *Water Circulation*

- a) *Natural Circulation Boiler* adalah sirkulasi *working fluid* di dalam tabung evaporasi yang dihasilkan oleh perbedaan densitas antara campuran steam/air di *riser* dan air di *downcomer*.
- b) *Forced Multiple Circulation Boilers* adalah sirkulasi *working fluid* dalam tabung evaporasi yang dipaksakan menggunakan *circulating pump* yang termasuk dalam sirkuit sirkulasi.
- c) *Once Through Boiler* berarti tidak ada drum, *working fluid* melewati

through the evaporating tubes only under the action of the feed water pump.

- d) Combined Circulation Boiler is the system that includes a pump, back pressure valve, and a mixer in the circuit. At starting the back-pressure valve is opened and the boiler operates as a forced multiple circulation boiler.

7.2.3 Boiler Based on Operating Pressure

- a) Low to medium pressure (< 10 Bar) is used as industrial boilers, normally has a natural circulation.
- b) High pressure (10 – 14 Bar) is used as utility boilers, normally has natural circulation.
- c) Super high pressure boilers (> 17 Bar) : used as utility, can be natural or forced circulation. The prevention of film-boiling and high-temperature corrosion should be considered.
- d) Supercritical pressure boilers (> 22.1 Bar) – used as utility boiler with large capacity once through or combined circulation. The prevention of film-boiling and high-temperature corrosion should be considered.

7.2.4 Boiler Based on Heat Source

- a) Solid Fuel Fired Boiler is typically low cost. The components of fuel and the characteristics of the ash are an important factor for boiler design.

tabung evaporasi hanya di bawah aksi *feed water pump*.

- d) *Combined Circulation Boiler* adalah sistem yang mencakup *pump, back pressure valve*, dan *mixer* di dalam sirkuit. Saat memulai, *back-pressure valve* dibuka dan *boiler* beroperasi sebagai *forced multiple circulation boiler*.

7.2.3 Boiler Berdasarkan *ion Operating Pressure*

- a) Tekanan rendah hingga sedang (< 10 Bar) digunakan sebagai *industrial boiler*, biasanya memiliki sirkulasi alami.
- b) Tekanan tinggi (10 – 14 Bar) digunakan sebagai *utility boiler*, biasanya memiliki sirkulasi alami.
- c) *Super high pressure boilers* (> 17 Bar) : digunakan sebagai utilitas, dapat berupa sirkulasi alami atau *forced*. Pencegahan korosi *film-boiling* dan suhu tinggi harus dipertimbangkan.
- d) *Supercritical pressure boilers* (> 22.1 Bar) – digunakan sebagai *utility boiler* dengan kapasitas *once through* besar atau sirkulasi gabungan. Pencegahan korosi *film-boiling* dan suhu tinggi harus dipertimbangkan.

7.2.4 Boiler Berdasarkan *Heat Source*

- a) *Solid Fuel Fired Boiler* biasanya berbiaya rendah. Komponen bahan bakar dan karakteristik abu merupakan faktor penting untuk desain *boiler*.

- b) Fuel Oil Fired Boiler has higher flue gas velocity and smaller furnace volume.
- c) Gas Fired Boiler is used to utilize Natural Gas with higher flue gas velocities and smaller furnace volumes.
- d) Waste Heat Boiler is a piece of equipment to utilize waste heat from any industrial process as the heating source.

7.2.5 Boiler Based on Combustion System

a) Fired Tube Boiler

The flue of hot gas is flowing inside the tubes. Water is contained inside the shell. Normally for small capacity boilers.

Fired tube boilers consist of a series of straight tubes that are housed inside a water-filled outer shell. The tubes are arranged so that hot combustion gases flow through the tubes. As the hot gases flow through the tubes, they heat the water surrounding the tubes.

The water is confined by the outer shell of the boiler. To avoid the need for a thick outer shell fired tube boilers are used for lower pressure applications. Generally, the heat input capacities for fired tube boilers are limited to 50 Mbtu per hour or less, but in recent years the size of fired tube boilers has increased.

- b) *Fuel Oil Fired Boiler* memiliki kecepatan *flue gas* yang lebih tinggi dan volume furnace yang lebih kecil.
- c) *Gas Fired Boiler* digunakan untuk memanfaatkan *natural gas* dengan kecepatan *flue gas* yang lebih tinggi dan volume *furnace* yang lebih kecil.
- d) Waste Heat Boiler adalah peralatan untuk memanfaatkan *waste heat* dari proses industri sebagai *heat source*.

7.2.5 Boiler Berdasarkan Sistem Pembakaran.

a) *Fired Tube Boiler*

Flue dari *hot gas* mengalir di dalam tubes. Air terkandung di dalam *shell*. Biasanya untuk *boiler* berkapasitas kecil.

Fired tube boilers terdiri dari serangkaian *straight tubes* yang ditempatkan di *water-filled outer shell*. *Tubes* diatur sedemikian rupa sehingga *hot combustion gases* mengalir melalui *tubes*. Saat *hot gas* mengalir melalui *Tube*, mereka memanaskan air di sekitar *Tube*.

Air dibatasi oleh outside shell boiler. Untuk menghindari kebutuhan thick outer shell, shell fired tube boilers digunakan untuk aplikasi tekanan rendah. Secara umum, kapasitas heat input untuk fired tube boilers dibatasi hingga 50 Mbtu per jam atau kurang, tetapi dalam beberapa tahun terakhir ukuran fired tube boilers telah

Fired tube boilers typically have a lower initial cost, are more fuel efficient and are easier to operate, but they are limited generally to capacities of 25,000 kg/h and pressures of 17.5 kg/cm².

b) Water Tube Boiler

Water is flowing inside the tubes. Flue or hot gas is flowing inside the furnace or shell. Normally this is for large capacity boilers. Water tube boilers are designed to circulate hot combustion gases around the outside of a large number of a water filled tubes. The tubes extend between an upper header, called a steam drum, and one or lower headers or drums. Because the pressure is confined inside the tubes, water tube boilers can be fabricated in larger sizes and used for higher-pressure applications.

Typically, the tubes should be greater than 5 mm in diameter and should be spaced so as to allow plenty of room for a flame path between them. Increasing the number of tubes may not increase the boiler's ability to generate steam. The inner surface of the outer casing is insulated with a ceramic sheet.

Most modern water boiler tube designs are within the capacity range of 4,500 – 120,000 kg/h of

meningkat.

Fired tube boilers biasanya memiliki biaya awal yang lebih rendah, lebih hemat bahan bakar dan lebih mudah dioperasikan, tetapi umumnya terbatas pada kapasitas 25.000 kg/jam dan tekanan 17,5 kg/cm²

b) *Water Tube Boiler*

Air mengalir di dalam *tube*. *Flue gas* atau *hot gas* mengalir di dalam *furnace* atau *shell*. Biasanya ini untuk *boiler* berkapasitas besar. *Water tube boiler* didesain untuk mensirkulasikan gas pembakaran panas di sekitar bagian luar sejumlah besar *tube* berisi air. *Tube* memanjang antara *upper header*, yang disebut *steam drum*, dan satu atau *lower headers* atau *drums*. Karena tekanan dibatasi di dalam *tube*, *Water tube boiler* dapat dibuat dalam ukuran yang lebih besar dan digunakan untuk aplikasi tekanan tinggi.

Biasanya, *tube* harus berdiameter lebih dari 5 mm dan harus diberi jarak untuk memungkinkan banyak ruang untuk *flame path* di antara mereka. Meningkatkan jumlah tabung mungkin tidak meningkatkan kemampuan *boiler* untuk menghasilkan *steam*. Permukaan bagian dalam dari *outer casing* diisolasi dengan *ceramic sheet*.

Kebanyakan desain modern water boiler tube berada dalam kisaran kapasitas 4.500 –

steam at very high pressures. Many water tube boilers are of “packaged” construction if oil and /or gas are to be used as fuel. Solid fuel fired water tube designs are available but packaged designs are less common. The features of water tube boilers are:

- Forced, induced and balanced draft provisions help to improve combustion efficiency.
- Less tolerance for water quality calls for water treatment plant.
- Higher thermal efficiency levels are possible.

120.000 kg/jam steam pada tekanan sangat tinggi. Banyak water tube boilers memiliki konstruksi “packaged” jika minyak dan/atau gas akan digunakan sebagai bahan bakar. Desain Solid fuel fired water tube tersedia tetapi packaged designs kurang umum. Fitur modern water boiler adalah:

- *Forced, induced dan balanced draft* membantu meningkatkan efisiensi pembakaran.
- Kurangnya toleransi terhadap kualitas air memerlukan instalasi pengolahan air.
- Tingkat efisiensi termal yang lebih tinggi dimungkinkan.

Table 1 Comparison of Fired Tube and Water Tube Boiler

No	Parameter	Fired Tube	Water Tube
1	Rate of Steam Generation	Less rapid	More rapid
2	Pressure	< 25 kg/cm ²	.> 125 kg/cm ²
3	Risk of Operation	Less	More
4	Floor Space	More	Less
5	Cost	Higher	Less
6	Operating Skill	Less	Higher
7	Water Treatment	Low	Higher

7.2.6 Boiler Based on Tube Layout

There are three basic designs: A, D and O type. The names are derived from the general shapes of the tube and drum arrangements. All have steam drums for the separation of the steam from the water, and one or more mud drums for the removal of sludge.

7.2.6 Boiler Berdasarkan *Tube Layout*

Ada tiga desain dasar: tipe A, D dan O. Nama-nama tersebut berasal dari bentuk umum susunan *tubes* dan drum. Semua memiliki *steam drum* untuk memisahkan *steam* dari air, dan satu atau lebih *mud drum* untuk menghilangkan *sludge*.

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a) Type A

It has two mud drums symmetrically below the steam drum. Drums are each smaller than the single mud drums of the type D or O. Bottom blows should not be undertaken at more than 80% of the rated steam load in these boilers. Bottom blow refers to the required regular blow down from the boiler mud drums to remove sludge and suspended solids.

b) Type D

It is the most flexible design. It has a single steam drum and a single mud drum, vertically aligned. The boiler tubes extend to one side of each drum. Generally, have more tube surface exposed to the radiant heat than other designs.

c) Type O

It has a single steam drum and a single mud drum. The drums are directly aligned vertically with each other and have a roughly symmetrical arrangement of riser tubes. Circulation is more easily controlled, and the larger mud drum design renders the boilers less prone to starvation due to flow blockage, although burner alignment and other factors can impact circulation.

7.2.7 Package Boiler

It comes as a complete package. Once delivered to the site, it

a) Tipe A

Tipe A memiliki dua *mud drum* simetris di bawah *steam drum*. *Drum* masing-masing lebih kecil dari *single mud drum* tipe D atau O. *Bottom blows* tidak boleh dilakukan lebih dari 80% dari *rated steam loads* di boiler ini. *Bottom blows* mengacu pada *regular blow down* yang diperlukan dari *boiler mud drum* untuk menghilangkan *sludge* dan padatan tersuspensi.

b) Tipe D

Ini adalah desain yang paling fleksibel. Ini memiliki *single steam drum* dan *single mud drum*, sejajar secara vertikal. *Boiler tubes* memanjang ke satu sisi setiap *drum*. Umumnya, permukaan tabung lebih banyak terkena panas radiasi daripada desain lainnya.

c) Tipe O

Tipe O memiliki *single steam drum* dan *single mud drum*. *Drum* secara langsung disejajarkan secara vertikal satu sama lain dan memiliki susunan *riser tube* yang kira-kira simetris. Sirkulasi lebih mudah dikontrol, dan desain *mud drum* yang lebih besar membuat *boiler* kurang rentan terhadap *starvation* karena penyumbatan aliran, meskipun *burner alignment* dan faktor lain dapat memengaruhi sirkulasi.

7.2.7 Package Boiler

Package boiler datang sebagai paket lengkap. Setelah dikirim ke

requires only the steam, water pipe work, fuel supply and electrical connections to be made for it to become operational. Packaged boilers are generally shell type with fire tube design to achieve high heat transfer rates by both radiation and convection.

The features of packaged boilers are:

- a) Small combustion space & high heat release rate resulting in faster evaporation.
- b) A large number of small diameter tubes leading to good convective heat transfer.
- c) Forced or induced draft systems resulting in good combustion efficiency.
- d) Number of passes resulting in better overall heat transfer.
- e) Higher thermal efficiency levels compared with other boilers.

7.2.8 Parts of Boilers

Boilers equipment consists of drums, shell, headers, tubes, baffles & economizer.

- a) Drums, shell and headers

Boiler drums, shells or header are used to collect steam or hot water generated in the boiler and distributes it as necessary within the boiler tubes. These components must be strong enough to contain the generated

lokasi, hanya membutuhkan *steam*, *water pipe work*, pasokan bahan bakar dan sambungan listrik yang akan dibuat agar dapat beroperasi. *Packaged boiler* umumnya bertipe *shell* dengan desain *fire tube* sehingga dapat mencapai laju perpindahan panas yang tinggi baik secara radiasi maupun konveksi.

Fitur packaged boilers adalah:

- a) Small combustion space & high heat release rate menghasilkan penguapan lebih cepat.
- b) Sejumlah besar tube berdiameter kecil menghasilkan perpindahan panas konveksi yang baik.
- c) Forced atau induced draft systems menghasilkan efisiensi pembakaran yang baik.
- d) Jumlah passes yang menghasilkan perpindahan panas keseluruhan yang lebih baik.
- e) Tingkat efisiensi termal yang lebih tinggi dibandingkan dengan *boiler* lainnya.

7.2.8 Bagian Boiler

Peralatan *boiler* terdiri dari *drum*, *shell*, *header*, *tube*, *baffle* & *economizer*.

- a) *Drums*, *shell* dan *headers*

Drum boiler, *shell* atau *header* digunakan untuk mengumpulkan *steam* atau air panas yang dihasilkan dalam *boiler* dan mendistribusikannya seperlunya di dalam *boiler tubes*. Komponen-komponen ini harus

steam and to mechanically hold the boiler tubes as they expand and contract with temperature changes. The shells of fire tubes boilers may be reinforced by the use of stays to hold the boiler heads in place. These components are generally fabricated with welded seams and connections.

b) Boiler Tubes

Boiler tubes carry water, steam, or flue gases through the boiler. Boiler tubes are installed by expanding or welding them into seats in the drums or headers. The expander is slipped into the end of the tube; it consists of a tapered pin which fits into a cage containing small rollers. The pin is turned with a wrench or motor, forcing the rollers out against the tube and simultaneously moving into the tube.

c) Baffles

Baffles are thin walls or partitions installed in water tube boilers to direct the flow of gases over the heating surface in the desired manner. The number and position of baffles effect the boiler efficiency. A leaking baffle permits gases to short circuit through the boiler. Heat which should have been absorbed by the water is then dissipated and lost furthermore tube may be damaged. Baffles may be made of iron castings, a sheet metal

cukup kuat untuk menampung steam yang dihasilkan dan untuk menahan *boiler tubes* secara mekanis saat *expand* dan *contract* dengan perubahan suhu. *Shells* dari *fire tubes boilers* dapat diperkuat dengan penggunaan penahan untuk menahan *boiler heads* pada tempatnya. Komponen-komponen ini umumnya dibuat dengan sambungan dan sambungan yang dilas.

b) *Boiler Tubes*

Boiler tubes membawa air, *steam*, atau *flue gas* melalui *boiler*. *Boiler tubes* dipasang dengan *expanding* atau mengelasnya ke *setas* di *drum* atau *header*. *Ekspander* diselipkan ke ujung *tube*; itu terdiri *tapered pin* yang cocok ke dalam *cage* berisi *roller* kecil. *Pin* diputar dengan *wrench* atau *motor*, memaksa *roller* keluar melawan *tube* dan secara bersamaan menggerakkan *tube*.

c) *Baffles*

Baffles dinding tipis atau partisi yang dipasang di *water tube boilers* untuk mengarahkan aliran gas di atas *heating surface* dengan cara yang diinginkan. Jumlah dan posisi *baffle* berpengaruh pada efisiensi *boiler*. Sebuah *leaking baffle* memungkinkan gas untuk *short circuit* melalui *boiler*. Panas yang seharusnya diserap oleh air kemudian didisipasi dan hilang lebih banyak dan *tube* bisa rusak. *Baffle* dapat dibuat dari

strips, brick, tile, or plastic refractory. Provision must be made to permit movement between the baffle and setting walls while still maintaining a gas tight seal.

d) Gage glass, Gage cocks.

Each boiler must have at least one water gage glass. If the operating pressure is 400 psig or greater, two gage glasses are required on the same horizontal line. Each gage glass must have a valved drain, and the gage glass and pipe connections must not be less than ½ inch pipe size. The lowest visible part of the gage glass must be at least 2 inches above the lowest permissible water level, which is defined as the lowest level at which there is no danger of overheating any part of the boiler during operation. For horizontal fire tube boilers, the gage glass is set to allow at least 3 inches of water over the highest point of the tubes, flues, or crown sheet at its lowest reading. A valve drains to some safe discharge point.

Each boiler must have three or more gage or try cocks located within the visible length of the gage glass. Gage cocks are used to check the accuracy of the boiler water level as indicated by the gage glass. They are opened by hand wheel,

iron castings, sheet metal strips, brick, tile, atau plastic refractory. Ketentuan harus dibuat untuk memungkinkan pergerakan antara *baffle* dan *setting wall* sambil tetap mempertahankan *gas tight seal*.

d) *Gage glass, Gage cocks.*

Setiap *boiler* harus memiliki setidaknya satu *water gage glass*. Jika tekanan operasi 400 psig atau lebih besar, dua *gage glass* diperlukan pada garis horizontal yang sama. Setiap *gage glass* harus memiliki valved drain, dan *gage glass* dan sambungan pipa tidak boleh kurang dari inci ukuran pipa. Bagian terendah yang terlihat dari *gage glass* harus setidaknya 2 inci di atas level air terendah yang diizinkan, yang didefinisikan sebagai level terendah di mana tidak ada bahaya *over heating* pada bagian mana pun dari *boiler* selama operasi. Untuk *horizontal fire tube boilers*, *gage glass* diatur untuk memungkinkan setidaknya 3 inci air di atas titik tertinggi *tubes, flues*, atau *crown sheet* pada pembacaan terendah. Sebuah valved drain ke beberapa titik pelepasan yang aman.

Setiap *boiler* harus memiliki tiga atau lebih *gage* atau *try cocks* yang terletak di dalam panjang yang terlihat dari *gage glass*. *Gage cocks* digunakan untuk memeriksa keakuratan level air *boiler* seperti yang ditunjukkan oleh *gage glass*. Mereka dibuka

chain wheel, or lever, and are closed by hand, a weight, or a spring. The middle cock is usually at the normal water level of the boiler, and the other two are spaced equally above and below it. Spacing depends on the size of the boiler.

e) Soot blowers

A soot blower is a device that is designed to blast soot and ash away from the walls of a furnace or similar piece of equipment. Soot blowers operate at set intervals, with a cleaning cycle that can vary in length, depending on the device and the size of the equipment which needs to be cleaned.

Soot blower's function is to keep combustion particles from sticking to boiler tube banks within the boiler tower.

The basic principle of the soot blower is the cleaning of heating surfaces by multiple impacts of high pressure air, steam or water from opposing nozzle orifices at the end of a translating-rotating tube. A traveling lance with nozzle jets penetrates the narrow openings in the boiler tube banks to blast the tubes clean. The tubes must be kept clean to allow optimum boiler output and efficiency. A common application at oil, coal or multi fuel source power plants is retractable or rotary soot blowers. The primary elements

dengan *hand wheel*, *chain wheel*, atau *lever* dan ditutup dengan *hand*, *weight*, atau *spring*. *Middle cock* biasanya berada pada ketinggian air normal *boiler*, dan dua lainnya diberi jarak yang sama di atas dan di bawahnya. Jarak tergantung pada ukuran *boiler*.

e) Soot blowers

Soot blower adalah perangkat yang didesain untuk *blast soot* dan *ash away* dari dinding *furnace* atau peralatan serupa. *Soot blower* beroperasi pada interval yang ditentukan, dengan siklus pembersihan yang dapat bervariasi panjangnya, tergantung pada perangkat dan ukuran peralatan.

Soot blower fadalah untuk menjaga agar partikel pembakaran tidak menempel pada *boiler tube banks* di dalam *boiler tower*.

Prinsip dasar dari *Soot blower* adalah pembersihan permukaan pemanas dengan berbagai dampak udara bertekanan tinggi, *steam* atau air dari *opposing nozzle orifices* di ujung *translating-rotating tube*. *Traveling lance dengan nozzle jets* menembus bukaan sempit di *boiler tube banks* untuk membersihkan *tube*. *Tube* harus dijaga kebersihannya untuk memungkinkan keluaran dan efisiensi *boiler* yang optimal. Aplikasi umum di pembangkit listrik sumber minyak, batu bara atau multi bahan bakar adalah

of the typical soot blower should be: (1) A nozzle-specially selected for each application. (2) A means to convey the nozzle-conveying mechanism includes the lance tube, carriage and drive motor. (3) A means to supply blowing medium into the nozzle-poppet valve, feed tube, packing gland and lance tube. (4) A means to support and contain the lower component -- a canopy type beam with a two-point suspension. (5) Controls-integral components protected by special device^[RD1] to control the blowing cycle and supply power to the drive motor.

f) Economizer

Economizers are used to recover heat from the boiler flue gases and thereby increase boiler efficiency. The heat absorbed by the economizer is transferred to the boiler feed water flowing through the inside of the economizer tubes. Continuous tube construction is common. Bare tubes are used for coal fired boilers and fin tubes or extended surface for gas and oil-fired units. The extended surface on a natural gas fired boiler may use up to 9 fins/in and for heavy oil fired 2 fins/in.

Economizers are usually arranged with the gas flow down

retractable atau *rotary soot blowers*. Elemen utama dari *soot blowers* tipikal adalah: (1) Nosel—khusus dipilih untuk setiap aplikasi. (2) Sarana untuk menyampaikan nozzle-conveying mechanism meliputi *lance tube, carriage dan drive motor*. (3) Sarana untuk memasok *blowing medium* ke *nozzle-poppet valve, feed tube, packing gland* dan *lance tube*. (4) Sarana untuk *support* dan memuat komponen bawah -- *canopy type beam* dengan suspensi dua titik. (5) Kontrol-komponen integral yang dilindungi oleh perangkat khusus untuk mengontrol *blowing cycle* dan memasok daya ke motor penggerak.

f) *Economizer*

Economizers digunakan untuk *recover* panas dari *flue gas* boiler dan dengan demikian meningkatkan efisiensi *boiler*. Panas yang diserap oleh *economizer* dipindahkan ke *boiler feed water* yang mengalir melalui bagian dalam the *economizer tubes*. Konstruksi *tube* terus menerus adalah umum. *Bare tubes* digunakan untuk *boiler* berbahan bakar batubara dan *fin tubes* atau permukaan yang diperluas untuk *oil-fired units*. Permukaan diperpanjang *pada natural gas fired boiler* dapat menggunakan hingga 9 fin/in dan untuk *heavy oil fired* 2 fin/in.

Economizers biasanya diatur dengan aliran gas ke bawah dan

and water flow up which helps to avoid water hammer. Economizers should be equipped with a three valve bypass on the waterside to allow bypassing water at low boiler loads and minimize economizers corrosion.

Stacks or chimneys are necessary to discharge the products of combustion at a sufficiently high elevation to prevent nuisance due to low-flying smoke, soot, and ash. A certain amount of draft is also required to conduct the flue gases through the furnace, boiler, tubes, economizers, air heaters, and dust collectors, and the stack can help to produce part of this draft. The height of the stack necessary to:

- Stack Construction

Stacks are built of steel plate, masonry, and reinforced concrete. Caged ladders should be installed. All stack guys should be kept clear of walkways and roads and, where subject to hazardous contact, should be properly guarded. Stacks are provided with means of cleaning ash, soot, or water from their base, the means depending mainly of the size of the stack.

- Flues and ducts

Flues are used to interconnect boiler outlets, economizers, air heaters &

aliran air ke atas yang membantu menghindari *water hammer*. *Economizer* harus dilengkapi dengan *three valve bypass* di waterside untuk memungkinkan air melewati pada *low boiler loads* dan meminimalkan korosi *economizers*.

Stacks atau *chimneys* diperlukan untuk membuang hasil pembakaran pada elevasi yang cukup tinggi untuk mencegah gangguan akibat asap, *soot*, dan *ash* yang beterbangan rendah. Sejumlah *draft* juga diperlukan untuk mengalirkan *flue gas* melalui *furnace, boiler, tubes, economizers, air heaters, dan dust collectors*, dan *stack* dapat membantu menghasilkan sebagian dari *draft* ini. Ketinggian *stack* diperlukan untuk:

- Konstruksi *Stack*

Stacks dibangun *steel plate, masonry, dan reinforced concrete*. *Caged ladders* harus dipasang. Semua *stack guys* harus dijauhkan dari *walkways* dan jalan dan, jika terkena kontak berbahaya, harus dijaga dengan baik. *Stack* dilengkapi dengan sarana untuk membersihkan abu, *soot*, atau air dari *base*, sarana tersebut terutama tergantung pada ukuran *stack*.

- *Flues* dan *ducts*

Flues digunakan untuk menghubungkan *outlet boiler, economizers, air heaters &*

stack. Ducts are used to interconnect forced-draft fans, air heaters, and wind boxes or combustion air plenums. Flues and ducts are usually made of steel. Expansion joints are provided to allow for expansion and contraction. All flues or ducts carrying heated air or gases should be insulated to minimize radiation losses. Outside insulation is preferred for its maintainability. Flues and ducts are designed to be as short as possible, free from sharp bends or abrupt changes in cross-sectional area and of adequate cross-sectional area to minimize draft loss at the design flow rates.

A boiler must meet operational safety; generation of clean steam or hot at the desired rate, pressure, and temperature; economy of operation and maintenance; & conformance to applicable codes.

To meet these requirements, a boiler must have the following characteristic:

- Adequate water or steam capacity
- Properly sized steam / water separators for steam boilers
- Rapid, positive, and

stack. Ducts digunakan untuk menghubungkan *interconnect forced-draft fans, air heaters, dan wind boxes* atau *combustion air plenums*. *Flue dan ducts* biasanya terbuat dari baja. Sambungan ekspansi disediakan untuk memungkinkan ekspansi dan kontraksi. Semua flue atau ducts yang membawa udara atau gas panas harus *insulated* untuk meminimalkan kehilangan radiasi. *Outside insulation* lebih disukai karena perawatannya. Flue dan ducts didesain sependek mungkin, bebas dari *sharp bend* atau perubahan mendadak pada area penampang dan area penampang yang memadai untuk meminimalkan *draft loss* pada laju aliran desain.

Sebuah *boiler* harus memenuhi keselamatan operasional; pembangkitan *clean steam* atau panas pada laju, tekanan, dan suhu yang diinginkan; ekonomi operasi dan pemeliharaan; & kesesuaian dengan kode yang berlaku.

Untuk memenuhi persyaratan ini, *boiler* harus memiliki karakteristik sebagai berikut:

- Air yang cukup atau *steam capacity*
- *Steam/ water separators* untuk *steam boilers* dengan ukuran tepat
- Sirkulasi air *Rapid,*

- | | |
|--|---|
| regular water circulation
- Heating surfaces which are easy to clean on both water and gas sides
- Parts which are accessible for inspection and repair
- Correct amount and proper arrangement of heating surface
- A furnace of proper size and shape for efficient combustion and for directing the gases flow for efficient heat transfer. | <i>positive, dan regular</i>
- <i>Heating surfaces</i> yang mudah dibersihkan di kedua sisi air dan gas
- Bagian yang dapat diakses untuk inspeksi dan perbaikan
- Jumlah <i>land proper arrangement</i> yang benar dari <i>heating surface</i>
- <i>Furnace</i> dengan ukuran dan bentuk yang tepat untuk pembakaran yang efisien dan untuk mengarahkan aliran gas untuk perpindahan panas yang efisien. |
|--|---|

7.3 General Rules for Boilers

- a) 5% reduction in excess air increases boiler efficiency by 1% (or 1% reduction of residual oxygen in stack gas increases boiler efficiency by 1%).
- b) 22°C reduction in flue gas temperature increases the boiler efficiency by 1%.
- c) 6 °C rise in feed water temperature brought about by economizer or condensate recovery corresponds to a 1% savings in boiler fuel consumption.
- d) 20 °C increase in combustion air temperature, pre-heated by waste heat recovery, results in a 1% fuel saving.
- e) A 3 mm diameter hole in a pipe carrying 7 kg/ cm² steam would waste 32,650 liters of fuel oil per year.

7.3 Aturan Umum untuk *Boilers*

- a) 5% pengurangan udara berlebih meningkatkan efisiensi *boiler* sebesar 1% (atau 1% pengurangan residu oksigen dalam *stack gas* meningkatkan efisiensi *boiler* sebesar 1%).
- b) Penurunan suhu *flue gas* sebesar 22°C meningkatkan efisiensi *boiler* sebesar 1%.
- c) Kenaikan suhu *feed water* sebesar 6 °C yang disebabkan oleh *economizer* atau *condensate recovery* sesuai dengan penghematan 1% dalam konsumsi bahan bakar *boiler*.
- d) Peningkatan suhu udara pembakaran sebesar 20 °C, *pre-heated* dengan *waste heat recovery*, menghasilkan penghematan bahan bakar sebesar 1%.
- e) Lubang berdiameter 3 mm dalam pipa yang membawa uap 7 kg/ cm² akan menghabiskan 32.650 liter bahan bakar minyak per tahun.

- | | |
|---|---|
| <p>f) 100 m of bare steam pipe with a diameter of 150 mm carrying saturated steam at 8 kg/ cm² would waste 25 000 litres furnace oil in a year.</p> <p>g) 70% of heat losses can be reduced by floating a layer of 45 mm diameter polypropylene (plastic) balls on the surface of a 90 °C hot liquid/condensate.</p> <p>h) A 0.25 mm thick air film offers the same resistance to heat transfer as a 330 mm thick copper wall.</p> <p>i) A 3 mm thick soot deposit on a heat transfer surface can cause a 2.5% increase in fuel consumption.</p> <p>j) A 1 mm thick scale deposit on the waterside could increase fuel consumption by 5 to 8%.</p> | <p>f) 100 m <i>bare steam pipe</i> diameter 150 mm membawa steam jenuh pada 8 kg/cm² akan membuang 25.000 liter minyak <i>tfurnace</i> dalam setahun.</p> <p>g) 70% <i>heat loss</i> dapat dikurangi dengan mengapungkan lapisan bola polypropylene (plastik) berdiameter 45 mm pada permukaan cairan/kondensat dengan panas 90 °C.</p> <p>h) <i>Thick air film</i> 0,25 mm menawarkan <i>resistance</i> yang sama terhadap perpindahan panas seperti <i>copper wall</i> setebal 330 mm.</p> <p>i) 3 mm <i>thick soot deposit</i> pada permukaan perpindahan panas dapat menyebabkan peningkatan konsumsi bahan bakar sebesar 2,5%.</p> <p>j) 1 mm <i>thick scale deposit</i> pada <i>waterside</i> meningkatkan konsumsi bahan bakar sebesar 5 hingga 8%.</p> |
|---|---|

Note: General rules for boiler (see website: www.energyefficiencyasia.org)

Catatan: Aturan umum untuk boiler (lihat situs web: www.energyefficiencyasia.org)

7.4 Boiler Instrumentation and Safety Devices

7.4 Instrumentasi dan *Safety Devices Boiler*

Boilers are equipped with safety devices to minimize the risk of low water and explosion related damage. A typical oil or gas fired boiler instrumentation and safety control system includes the following components:

Boiler dilengkapi dengan perangkat keselamatan untuk meminimalkan risiko air rendah dan kerusakan terkait ledakan. Sistem instrumentasi *gas fired boiler* atau gas dan *safety control system* mencakup komponen-komponen berikut:

- | | |
|---|--|
| <p>a) Low water fuel cutoff switch</p> <p>b) High steam pressure or high-water temperature switch</p> <p>c) Flame scanner</p> <p>d) Gas supply high pressure switch</p> <p>e) Gas supply low pressure switch</p> <p>f) Combustion air flow switch</p> <p>g) Purge air flow switches</p> <p>h) Fuel safety shutoff valves with closed-</p> | <p>a) <i>Low water fuel cutoff switch</i></p> <p>b) <i>High steam pressure</i> atau <i>high-water temperature switch</i></p> <p>c) <i>Flame scanner</i></p> <p>d) <i>Gas supply high pressure switch</i></p> <p>e) <i>Gas supply low pressure switch</i></p> <p>f) <i>Combustion air flow switch</i></p> <p>g) <i>Purge air flow switches</i></p> <p>h) <i>Fuel safety shutoff valves</i> dengan</p> |
|---|--|

position switches

- i) Fuel control valves with low-fire position switch
- j) Manual valves, cocks, strainers, and traps
- k) Atomizing steam or air switch(es)
- l) Atomizing steam or air shutoff and control valves
- m) Low oil pressure switch
- n) High furnace pressure switch (for boiler with induced draft fans)
- o) Fan motor switch(es)
- p) Control logic
- q) Automatic combustion control
- r) De-super heater control
- s) Feed water control
- t) Soot blower control
- u) Air flow measurement
- v) Continuous emission monitoring device
- w) De NOx system-Low NOx burners
- x) Draft control damper device
- y) Steam temperature control

closed-position switches

- i) *Fuel control valves dengan low-fire position switch*
- j) *Manual valves, cocks, strainers, dan traps*
- k) *Atomizing steam atau air switch(es)*
- l) *Atomizing steam atau air shutoff and control valves*
- m) *Low oil pressure switch*
- n) *High furnace pressure switch (untuk boiler dengan induced draft fans)*
- o) *Fan motor switch(es)*
- p) *Control logic*
- q) *Automatic combustion control*
- r) *De-super heater control*
- s) *Feed water control*
- t) *Soot blower control*
- u) *Air flow measurement*
- v) *Continuous emission monitoring device*
- w) *De NOx system-Low NOx burners*
- x) *Draft control damper device*
- y) *Steam temperature control*

8. DESIGN CRITERIA

8.1 General Design Criteria

8.1.1. The vendor's guarantee of boiler performance shall be based on specified ambient conditions at plant site.

The design shall be proven in practice, rugged and reliable, tenderer shall provide a list of similar installations which have already been built and which are in operation.

8. KRITERIA DESAIN

8.1 Desain Kriteria Umum

8.1.1. Jaminan kinerja boiler dari vendor harus didasarkan pada kondisi ambien yang ditentukan di lokasi kilang.

Desain harus terbukti dalam praktek, *rugged* dan reliable, tender harus memberikan daftar instalasi serupa yang telah dibangun dan yang sedang beroperasi.

Ease of operation, safety, inspection, maintenance, repair and cleaning shall be of major concern in the design and arrangement of boilers.

The boilers and auxiliary equipment shall be designed and erected in accordance with the latest edition of section I of the ASME boiler and pressure vessel code, including all published addenda and interpretations thereto. The boiler and all auxiliary equipment listed as being supplied by Vendor shall be suitable for outdoor installation.

- a) Boiler and ancillaries shall be capable of continuous 24 hours a day operation between a 48-months statutory shut down period.
- b) The boiler supplier shall inform Contractor/ Company about the feed water pressure required at the inlet to that section of the feed pipework in his supply. He shall provide Contractor/ Company with the breakdown of the total pressure requirement, indicating maximum operating pressure of the boiler and the various pressure losses in the feed system, including static head to be overcome.
- c) Boiler shall be designed for the following operating conditions:
 - Guaranteed MCR, normal and minimum steam capacity, for each boiler at superheater outlet excluding all blowdown, heat losses

Kemudahan pengoperasian, keamanan, inspeksi, pemeliharaan, perbaikan dan pembersihan harus menjadi perhatian utama dalam desain dan pengaturan boiler.

Boilers dan peralatan bantu harus dirancang dan dipasang sesuai dengan edisi terbaru bagian I ASME *boiler and pressure vessel code*, termasuk semua tambahan yang dipublikasikan dan interpretasinya. *Boiler* dan semua peralatan bantu yang terdaftar *disupply* oleh Vendor harus sesuai untuk pemasangan di luar ruangan.

- a) *Boiler* dan perlengkapan tambahannya harus mampu beroperasi 24 jam sehari terus menerus antara periode penghentian resmi selama 48 bulan.
- b) *Supplier boiler* harus menginformasikan Kontraktor/ Perusahaan tentang tekanan *feed water* yang diperlukan pada *inlet* ke bagian *feed pipework* dalam pasokannya. Dia harus memberikan kepada Kontraktor/ Perusahaan rincian kebutuhan tekanan total, yang menunjukkan tekanan operasi maksimum *boiler* dan berbagai kehilangan tekanan dalam *feed system*, termasuk kepala statis yang harus diatasi.
- c) *Boiler* harus dirancang untuk kondisi operasi berikut:
 - *Guaranteed MCR*, kapasitas steam normal dan minimum, untuk setiap *boiler* di outlet superheater tidak termasuk semua *blowdown*, *heat loss*

and all steam used for boiler auxiliaries such as fans, soot blowers, burners, etc. ,as specified on data sheet.

- Over design capacity for 4 (four) hours continuous operation with an interval of not less than 20 hours between periods, Vendor to specify (minimum - acceptable 15%). The vendor shall also specify the time required for increasing the load of the boiler from $\frac{1}{4}$ MCR to full load of MCR.
- Guaranteed turn down ratio, Vendor to specify.
- Minimum thermal efficiency (minimum 92% and LHV), as specified in the project specification, on fuel gas firing based on LHV at MCR (please refer to ASME PTC-4.1).

The above-mentioned boiler efficiency shall be guaranteed under the following conditions:

- Final super heater/ desuperheater pressure (MCR, normal, minimum)
- Final super heater/ desuperheater temperature
- Feed water temperature at economizer inlet
- Feed water pressure at economizer inlet

dan semua steam yang digunakan untuk alat bantu boiler seperti *fans, soot blowers, burners, dll.*, seperti yang ditentukan pada *data sheet*,

- *Over design capacity* selama 4 (empat) jam operasi terus menerus dengan selang waktu tidak kurang dari 20 jam antar periode, ditentukan oleh Vendor (minimal - dapat diterima 15%). Vendor juga harus menentukan waktu yang diperlukan untuk meningkatkan *load* boiler dari MCR ke *full load* MCR.
- *Guaranteed turn down ratio*, ditetapkan *Vendor*.
- Efisiensi termal minimum (minimum 92% dan LHV), sebagaimana ditentukan dalam spesifikasi proyek, pada *fuel gas firing* berdasarkan LHV di MCR (lihat ASME PTC-4.1).

Efisiensi boiler yang disebutkan di atas harus dijamin dalam kondisi berikut:

- *Final super heater/ desuperheater pressure (MCR, normal, minimum)*
- *Final super heater/ desuperheater temperature*
- Suhu *Feed water* pada *economizer inlet*
- Tekanan *Feed water* pada *economizer inlet*

- | | |
|---|--|
| <ul style="list-style-type: none"> - Ambient air temperature at FDF inlet - Ambient air relative humidity - Barometric pressure - Flue gas temperature - Based on ASME PTC 4.1 heat loss abbreviated method - Continuous blowdown rate - Gaseous emission shall be based on government regulation. <ul style="list-style-type: none"> • Superheater (in case desuperheater is not considered) outlet temperature shall be uncontrolled, and Vendor shall guarantee the maximum variation in superheater steam outlet temperature throughout the operating range from 40% to full load. • Guaranteed operation superheater/ desuperheater outlet pressure specified on the data sheet (typical boiler data sheet is shown in Appendix A). • Feed water inlet temperature specified on the data sheet. • Purity of produced steam as specified in the project specification in ppm mass (mg/kg) with consideration of ppm mass (mg/kg) of total solids in the boiler water. The boiler manufacturer shall state the maximum TDS in the boiler water at which the | <ul style="list-style-type: none"> - <i>Ambient air temperature pada FDF inlet</i> - <i>Ambient air relative humidity</i> - <i>Barometric pressure</i> - <i>Flue gas temperature</i> - Berdasarkan ASME PTC 4.1 <i>heat loss abbreviated method</i> - <i>Continuous blowdown rate</i> - Emisi gas didasarkan pada peraturan pemerintah. <ul style="list-style-type: none"> • <i>Superheater (jika desuperheater tidak dipertimbangkan) suhu outlet harus tidak terkontrol, dan Vendor harus menjamin variasi maksimum suhu superheater steam outlet di seluruh rentang operasi dari 40% full load.</i> • <i>Tekanan outlet superheater/ desuperheater operasi terjamin yang ditetapkan pada data sheet (boiler data sheet tipikal ditunjukkan pada Lampiran A).</i> • <i>Suhu Feed water ditetapkan pada data sheet.</i> • <i>Kemurnian steam yang dihasilkan sebagaimana ditetapkan dalam spesifikasi proyek dalam massa ppm (mg/kg) dengan pertimbangan massa ppm (mg/kg) dari total padatan dalam air boiler. Produsen boiler harus menyatakan TDS</i> |
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required steam purity can be obtained.

- The steam as measured at drum outlet shall have an impurity not greater than 0.02 mg/kg (ppm mass) silica. The wetness of the steam leaving the drum shall not exceed 0.02%.
- Heat release (maximum and average) per cubic meters of furnace volume (volume enclosed by the effective heating surface) when firing specified fuels, Vendor to specify subject to Owner's approval.

Maximum intensity of heat flow rate in kW/m² released in a furnace based on the effective heating surface (as defined below), the Vendor to specify subject to Owner's approval.

The effective heating surface is defined as the flat projected area of tubes and extended surface integral with tubes exposed to direct radiation (only the first row of tubes in flue gas passes exposed to direct radiation should be counted for calculation of flat projected surface and the refractory covered surface shall not be counted).

maksimum dalam *boiler water* di mana kemurnian *steam* yang dibutuhkan dapat diperoleh.

- *Steam* yang diukur pada outlet drum harus memiliki *impurity* tidak lebih besar dari 0,02 mg/kg (massa ppm) silika. *Wetness* dari *steam* yang meninggalkan drum tidak boleh melebihi 0,02%.
- *Heat release* (maksimum dan rata-rata) per meter kubik volume *furnace* (volume yang tertutup oleh permukaan pemanas efektif) saat *firing* bahan bakar tertentu, ditentukan *Vendor* dengan persetujuan Pemilik.

Intensitas maksimum *heat flow rate* dalam kW/m² yang dilepaskan dalam *furnace* berdasarkan permukaan pemanas efektif (sebagaimana didefinisikan di bawah), ditentukan oleh *Vendor* dengan persetujuan Pemilik.

Heating Surface efektif didefinisikan sebagai area proyeksi datar tube dan permukaan yang diperluas yang integral dengan tube yang terpapar radiasi langsung (hanya baris pertama tube dalam *flue gas passes* yang terpapar radiasi langsung yang harus dihitung untuk perhitungan permukaan proyeksi datar dan permukaan refraktori tertutup tidak akan dihitung).

- | | |
|--|---|
| <ul style="list-style-type: none"> • Superheater, drums and boiler tube system maximum design pressure, Vendor to specify, but a minimum of 300 kPa (3 bar) above operating pressure is required. • Steam drum and boiler tube system maximum design temperature specified on the data sheet, super heater design temperature per code. • Total continuous and intermittent blowdowns shall not be more than the allowable figure specified in the boiler data sheet of steam generated. • Limit for CBD is up to 5%. • Vendor to specify capacity at 100% rating. • Steam for fan drivers specified on the data sheet. • Exhaust steam from fan drivers specified on the data sheet. • Stack temperature, Vendor to specify. • Boiler feed water and chemical injection specified on the data sheet. • Comply with Government Regulations on Effluents and Emission Limit and other Government guidelines (SO₂, CO, NO_x). | <ul style="list-style-type: none"> • <i>Superheater, drums dan boiler tube system maximum design pressure, ditentukan oleh Vendor, tetapi diperlukan minimum 300 kPa (3 bar) di atas tekanan operasi.</i> • <i>Steam drum dan boiler tube system maximum design temperature ditetapkan dalam data sheet, super heater design temperature per code.</i> • <i>Total blowdown kontinu dan intermiten tidak boleh lebih dari angka yang diizinkan yang ditentukan dalam data sheet boiler dari uap yang dihasilkan.</i> • Batas untuk CBD hingga 5%. • Vendor menentukan kapasitas pada <i>rating</i> 100%. • <i>Steam</i> untuk <i>fan drivers</i> ditetapkan pada <i>data sheet</i>. • <i>Exhaust steam</i> untuk <i>fan drivers</i> ditetapkan pada <i>data sheet</i>. • <i>Stack temperature, ditetapkan oleh Vendor.</i> • <i>Boiler feed water dan chemical injection</i> ditetapkan pada <i>data sheet</i>. • Memenuhi Peraturan Pemerintah tentang limit <i>effluent</i> dan Emisi dan pedoman Pemerintah lainnya (SO₂, CO, NO_x). |
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8.2 Special Design Criteria

8.2.1. Drums and Steam Generators

- a) Necessary drum connections shall be provided for chemical

8.2 Kriteria Desain Spesial

8.2.1. *Drums dan Steam Generators*

- a) Sambungan drum yang diperlukan harus disediakan

cleaning and nitrogen sealing of boilers in addition to connections as required, i.e., steam outlet, safety valves, continuous blowdown, chemical feed, water column level controls, level alarm, feed water, vent and bottom blowdown, etc. In case of necessity for winterization of the boiler, the vendor shall provide steam coils in each lower drum.

- b) Suitable internals shall be provided for the distribution of the incoming feed water to ensure a proper distribution of the incoming water along the length of the drum, suitably placed to feed the downcomer tubes but not to interfere with the correct function of the water level gages, and also for the chemical and for the collection of the continuous blowdown.
- c) Provision for acid cleaning of boilers and nitrogen blanketing of (idle) boilers shall be provided.
- d) Adequate provision should be considered for inspection and cleaning of water wall headers (minimum two, one at each end of header).
- e) Steam drums shall be equipped internally with steam separators and scrubbers to ensure that the carryover of TDS from the boiler water shall not exceed the following:
 - 1 ppm mass (mg/kg) up to 65 bar (ga);

untuk pembersihan kimia dan *nitrogen sealing* pada boiler selain sambungan yang diperlukan, yaitu, *steam outlet*, *safety valves*, *continuous blowdown*, *chemical feed*, *water column level controls*, *level alarm*, *feed water*, *vent* dan *bottom blowdown*, dll. Dalam hal kebutuhan untuk *winterization* boiler, vendor harus menyediakan *steam coik* di setiap *lower drum*.

- b) Bagian dalam yang sesuai harus disediakan untuk distribusi *incoming feed water* untuk memastikan distribusi air masuk yang tepat di sepanjang *drum*, ditempatkan dengan tepat untuk *feed downcomer tubes* tetapi tidak mengganggu fungsi *water level gages* yang benar, dan juga untuk bahan kimia dan untuk pengumpulan *blowdown* kontinu.
- c) Ketentuan untuk *acid cleaning boiler* dan *nitrogen blanketing* dari boiler (*idle*) harus disediakan.
- d) Perlengkapan yang memadai harus dipertimbangkan untuk inspeksi dan pembersihan *wall water header* (minimal dua, satu di setiap ujung *header*).
- e) *Steam drums* harus dilengkapi secara internal dengan *steam separator* dan *scrubber* untuk memastikan bahwa sisa TDS dari *boiler water* tidak boleh melebihi yang berikut:
 - 1 ppm mass (mg/kg) hingga 65 bar (ga);

- 0.5 ppm mass (mg/kg) from 65 bar (ga), to 135 bar (ga).
 - f) In order that drum stability may be evaluated, the boiler designer shall indicate the steam drum water content (effective) at normal, low-level and MCR loading.
 - g) The boiler designer shall state the minimum and maximum water levels between which the boiler should be allowed to continue operating.
 - h) Furnace wall, floor and roof tubes shall not incorporate bends or sets sufficiently small in radius to interfere significantly with water circulation. In particular, roof tubes exposed to radiant heat shall be free from bends and sets as far as possible, so as not to upset the division of flow between tubes or bring to a doubtful value the head available to promote circulation in any part of the circuits.
 - i) Downcomers supplying the furnace wall, etc. with feed water shall preferably be outside the flue gas path. If the downcomers are in contact with the flue gases, the heat transfer shall not significantly affect the circulation head.
 - j) Tube banks shall be arranged, as far as practicable, to permit access for tube renewal with minimum cutting out of serviceable tubes.
- 0.5 ppm mass (mg/kg) dari 65 bar (ga), hingga 135 bar (ga).
 - f) Agar stabilitas drum dapat dievaluasi, perancang *boiler* harus menunjukkan kandungan air *steam drum* (efektif) pada *Loading* normal, level rendah dan MCR.
 - g) *Designer boiler* harus menyatakan tingkat air minimum dan maksimum di mana *boiler* harus diizinkan untuk terus beroperasi.
 - h) *Furnace wall, floor* dan *roof tubes* tidak boleh menggabungkan *bend* atau set yang cukup kecil dalam radius untuk mengganggu sirkulasi air secara signifikan. Khususnya, *roof tubes* yang terkena panas radiasi harus bebas dari *bend* dan set sejauh mungkin, sehingga tidak mengganggu pembagian aliran antara *tubes* atau membawa ke nilai yang meragukan *head* yang tersedia untuk meningkatkan sirkulasi di setiap bagian sirkuit.
 - i) *Downcomers* yang mensupply *furnace wall*, dll. dengan *feed water* sebaiknya berada di luar *flue gas path*. Jika *downcomer* bersentuhan dengan *flue gas*, perpindahan panas tidak akan mempengaruhi *circulation head* secara signifikan.
 - j) *Tube banks* harus diatur, sedapat mungkin, untuk memungkinkan akses *tube renewal* dengan pemotongan minimum dari *tube* yang dapat diservis.

k) The boiler designer shall state the holding time provided by the reserve of water in the steam drum, between "low liquid level" (LLL) and "low-low liquid level" (LLLL), and the Company will approve this time against that required to introduce effectively the standby boiler feed pump. The size of the steam drum may have to be increased to provide a longer period in which to recover water level without incurring the automatic shutdown of the boiler.

- In case of boiler quantity of more than 1 (one) unit, boiler load sharing shall be provided.
- Drains for boiler should be adequately sized to drain boiler completely in 4 (four) hours after hydrotest and 2 (two) hours from normal water level.
- Boiler shall be capable of generating 100% MCR with 1 (one) burner in off condition.
- Burner and BMS design code shall follow NFPA latest edition.
- Noise level shall be maximum 85 dBA at 1 (one) meter from equipment in continuous operation.

8.2.2. Burners

a) Combination forced draft

k) *Designer boiler* harus menyatakan *holding time* yang disediakan oleh cadangan air di dalam *steam drum*, antara "*low liquid level*" (LLL) dan "*low-low liquid level*" (LLLL), dan Perusahaan akan menyetujui waktu ini terhadap yang disyaratkan untuk memperkenalkan secara efektif *standby boiler feed pump*. Ukuran *steam drum* mungkin harus ditingkatkan untuk menyediakan periode yang lebih lama untuk *recover* ketinggian air tanpa menimbulkan penghentian otomatis *boiler*.

- Dalam hal jumlah *boiler* lebih dari 1 (satu) unit, harus disediakan pembagian beban *boiler*.
- *Drain* untuk *boiler* harus berukuran cukup untuk mengeringkan *boiler* sepenuhnya dalam 4 (empat) jam setelah *hydrotest* dan 2 (dua) jam dari ketinggian air normal.
- *Boiler* harus mampu menghasilkan MCR 100% dengan 1 (satu) *burner* dalam kondisi mati.
- Kode desain *burner* dan BMS mengikuti NFPA edisi terbaru.
- Tingkat *noise* maksimum 85 dBA pada jarak 1 (satu) meter dari peralatan yang beroperasi terus menerus.

8.2.2. Burners

a) Kombinasi *forced draft burners*

burners for firing all specified gas, all gasoline, all gas oil, all oil or any combination thereof shall be provided.

Atomizing steam facilities for fuel and gas oil (if required) burners should be provided. The fuel on which boiler performance shall be guaranteed and specified.

Provision shall be made for changing fuel or any burner without affecting boiler operation in any way.

One liquid fuel burner gun and one gas fuel burner shall be provided per each burner, separate tips for oil fuel and gasoline fuel shall be provided. Vendor shall specify the possibility of using a single tip for both liquid fuels. The Provision shall be made for preventing flue gas leakage when the oil burner gun is removed for tip change or cleaning by use of air purge, etc.

- b) A fixed gas fired pilot burner, removable for maintenance while the boiler is in operation, shall be provided at each burner assembly. It must be suitable to ensure safe and efficient ignition of all fuels specified. Each pilot burner shall be permanently lit when its main burner is in use. The pilot flame shall be visible through the burner peep-hole, at least prior to the ignition of the

untuk *firing* semua gas yang ditetapkan, semua bensin, semua minyak gas, semua minyak atau kombinasinya harus disediakan.

Atomizing steam facilities untuk *fuel* dan minyak gas (jika diperlukan) harus disediakan. *Fuel* di mana kinerja boiler harus dijamin dan ditentukan.

Ketentuan harus dibuat untuk mengganti fuel atau salah satu *burner* tanpa mempengaruhi operasi *boiler* dengan cara apapun.

Satu liquid fuel burner gun dan satu gas fuel burner harus disediakan untuk setiap burner, tip terpisah untuk bahan bakar minyak dan bahan bakar bensin harus disediakan. Vendor harus menentapkan kemungkinan menggunakan single tip untuk kedua bahan bakar cair. Ketentuan harus dibuat untuk mencegah kebocoran gas buang ketika oil burner gun dilepas untuk penggantian tip atau pembersihan dengan menggunakan *air purge*, dll.

- b) *Fixed gas fired pilot burner*, yang dapat dilepas untuk pemeliharaan saat *boiler* sedang beroperasi, harus disediakan pada setiap *burner assembly*. *Fixed gas fired pilot burner* harus cocok untuk memastikan *ignition* yang aman dan efisien dari semua bahan bakar yang ditentukan. Setiap *pilot burner* harus menyala secara permanen saat *burner* utamanya sedang

main flame. The pilot burner shall be proven capable of igniting the main fuels efficiently and of remaining lit under all wind box and furnace conditions likely to be experienced.

- c) Each burner shall be sized for 110% of its design load or such that the boiler MCR can be maintained with one burner out of use, whichever is greater. Burner flames shall be horizontal and not parallel with the steam drum. The flame shall not impinge on wall or any metal parts.

Operational and control firing in the range of 30 – 110%.

Multi-fuel firing shall be considered for fuel gas and fuel oil with the turndown ratio (1:4 for fuel oil and 1:10 for fuel gas).

- d) The boiler supplier shall state the heat input of the proposed pilot burners.
- e) Each furnace shall be supplied with burners with insula table forced draft registers with steam atomizing oil units, center fired-type gas units, flexible metallic oil and steam hoses, flexible stainless steel gas hose, oil and steam shut-off valves and oil burner fittings. The oil units shall

digunakan. *Pilot flame* harus terlihat melalui *burner peep-hole*, setidaknya sebelum penyalaan api utama. *Pilot burner* harus terbukti mampu menyalakan bahan bakar utama secara efisien dan tetap menyala di bawah semua kondisi *wind box* dan *furnace* yang mungkin dialami.

- c) Setiap *burner* harus berukuran 110% dari beban desainnya atau sedemikian rupa sehingga *MCR boiler* dapat dipertahankan dengan satu *burner* tidak digunakan, mana yang lebih besar. *Burner flame* harus horizontal dan tidak sejajar dengan *steam drum*. *Flame* tidak boleh mengenai dinding atau bagian logam apa pun.

Firing operasional dan kontrol dalam kisaran 30 – 110%.

Multi-fuel firing harus dipertimbangkan untuk bahan bakar gas dan bahan bakar minyak dengan rasio turndown (1:4 untuk bahan bakar minyak dan 1:10 untuk bahan bakar gas).

- d) *Supplier boiler* harus menyatakan *heat input* dari *pilot burner* yang diusulkan.
- e) Setiap furnace harus disuplai dengan *burner* dengan *insula table forced draft registers* dengan *steam atomizing oil units*, *center fired-type gas units*, *flexible metallic oil and steam hoses*, *flexible stainless steel gas hose*, *oil dan steam shut-off valves* dan *oil burner fittings*. *Oil*

be equipped with swing check valves and air seals for use in a pressurized type steam-generating Unit. The registers shall be equipped with necessary seals. Where gasoline fuel is specified, each burner shall be equipped with an interlocking device on the gasoline and atomizing steam supply complete with valves, interlock discs, piping and flexible joints on gasoline supply lines.

Each burner shall be provided with an electric gas ignitor with a complete flame protection system with flame scanners, flame protection relays, interlocks, purge cycle timer, operating switch indicating lights, transformer, safety shut off valves, stainless steel gas hose, air hose, stainless steel gas strainer and air seal.

One burner holder and wrench assembly shall be provided for each boiler. Steam atomizing oil units for gasoline and one spare gun complete with tip end assembly shall be provided for each boiler. Fuel oil return lines should be equipped with non-return valves. The liquid fuel oil lines should be large enough with a low friction factor.

- f) The boiler manufacturer shall furnish a burner wind box cut and drilled to accommodate the burners described herein. Wind box shall be complete with necessary supports, division

unit harus dilengkapi dengan *swing check valves* dan *air seals* untuk digunakan dalam Unit pressurized type steam-generating. Register harus dilengkapi dengan seal yang diperlukan. Jika bahan bakar bensin ditetaskan, setiap *burner* harus dilengkapi dengan interlocking device pada *gasoline* dan *atomizing steam supply* lengkap dengan *valves*, *interlock discs*, *piping* dan *flexible joints* pada *gasoline supply lines*.

Setiap *burner* harus dilengkapi dengan electric gas ignitor dengan sistem perlindungan api lengkap dengan *flame scanners*, *flame protection relays*, *interlocks*, *purge cycle timer*, *operating switch indicating lights*, *transformer*, *safety shut off valves*, *stainless steel gas hose*, *air hose*, *stainless steel gas strainer* dan *air seal*.

Satu *burner holder* dan *wrench assembly* harus disediakan untuk setiap *boiler*. *Steam atomizing oil units* untuk bensin dan satu *gun* cadangan lengkap dengan rakitan *tip end* harus disediakan untuk setiap *boiler*. *Fuel oil return lines* harus dilengkapi dengan *non-return valves*. *Liquid fuel oil lines* harus cukup besar dengan faktor gesekan rendah.

- f) Produsen *boiler* harus menyediakan *burner wind box cut* dan dibor untuk mengakomodasi *burner* yang dijelaskan di sini. *Wind box* harus dilengkapi dengan *support* yang

plates and access door if required.

- g) Specification of fuels to be burnt will be indicated for each installation.
- h) Number of burners and arrangement of burners shall be submitted to the Company for approval.
- i) A complete flame monitoring and safety control system to perform the functions shall be furnished by the Vendor. The system shall be clearly described in the proposal and shall be guaranteed for safe and efficient operation of the boiler. Logic circuitry being proposed shall be included in Vendor's proposal. Burner management systems shall be installed local to the burners, and the system shall jointly monitor the burner and boiler to ensure safe start-up and shut down of burners and boiler. Unless otherwise required by the Company, the system shall on the pressing of push buttons, arrange for the whole sequence of burner light-up or shut-down to be automatically carried out with a high degree of safety and reliability. It shall also automatically shut down the burners on identification of a fault condition serious enough to warrant such action or raise alarms to indicate faults of a less serious nature. Reset facilities shall be provided for both boiler and individual burner trips.

diperlukan, *division plates* dan pintu akses jika diperlukan.

- g) Spesifikasi bahan bakar yang akan dibakar akan ditunjukkan untuk setiap instalasi.
- h) Jumlah burner dan susunan burner harus diserahkan kepada Perusahaan untuk mendapatkan persetujuan.
- i) *Complete flame monitoring* dan *safety control system* untuk menjalankan fungsi harus disediakan oleh Vendor. Sistem harus dijelaskan dengan jelas dalam proposal dan harus dijamin untuk pengoperasian boiler yang aman dan efisien. *Logic circuitry* yang diusulkan harus dimasukkan dalam proposal Vendor. Sistem manajemen *burner* harus dipasang secara lokal ke burner, dan sistem harus bersama-sama memantau *burner* dan *boiler* untuk memastikan *start-up* dan *shutdown burner* dan *boiler* yang aman. Kecuali disyaratkan lain oleh Perusahaan, sistem harus menyala dengan menekan *push buttons*, mengatur agar seluruh urutan penyalaan atau pemadaman *burner* dilakukan secara otomatis dengan tingkat keamanan dan *reliability* yang tinggi. Itu juga harus secara otomatis mematikan *burner* pada identifikasi kondisi kesalahan yang cukup serius untuk menjamin tindakan tersebut atau *raise alarms* untuk menunjukkan kesalahan yang sifatnya kurang serius. Fasilitas reset harus disediakan untuk *boiler* dan

The system shall ensure that the agreed logic on which the sequence of operating functions is based shall not be capable of being interchanged or abridged. It shall be of proven reliability, operating on the stop-check principle where the system can only proceed if the preceding sequence has been completed. A failure to complete a sequence shall operate an alarm and a fault location system will identify the area of malfunction, and where practicable, the fault itself. Separate circuits shall be used so that only those required for actual operation are retained in service, the others maintaining a passive but energized role so that should component failure occurs, it can be identified and repaired with the burner in service.

Two main flame detectors shall be fitted to each burner, with any detector signal arranged to give an alarm and the two signals together to cause lockout of the fuels to the burner.

The system shall be complete, without any areas of split responsibility, especially regarding furnace purging and boiler safety.

- j) Separate buttons shall be provided to initiate purge and

individual burner trips.

Sistem harus memastikan bahwa logika yang disepakati yang menjadi dasar urutan fungsi operasi tidak dapat dipertukarkan atau diringkas. Sistem harus terbukti keandalannya, beroperasi pada prinsip *stop-check* di mana sistem hanya dapat melanjutkan jika urutan sebelumnya telah selesai. Kegagalan untuk menyelesaikan suatu urutan harus mengoperasikan alarm dan *fault location system* akan mengidentifikasi area malfungsi, dan jika memungkinkan, kesalahan itu sendiri. *Sirkuit* terpisah harus digunakan sehingga hanya yang diperlukan untuk operasi aktual yang dipertahankan dalam servis, yang lain mempertahankan peran pasif tetapi *energized role* sehingga jika terjadi kegagalan komponen, dapat diidentifikasi dan diperbaiki dengan *burner* dalam servis.

Dua detektor *flame* utama harus dipasang pada setiap *burner*, dengan salah satu sinyal detektor diatur untuk memberikan alarm dan kedua sinyal tersebut bersama-sama menyebabkan *lockout* bahan bakar ke *burner*.

Sistem harus lengkap, tanpa tanggung jawab terpisah, terutama mengenai *furnace purging* dan keselamatan *boiler*.

- j) Tombol terpisah harus disediakan untuk memulai *purge*

individual burner start-up, and also for individual burner and boiler shut down.

- k) Local and control room panels shall provide all the information necessary to enable the operators to ascertain the condition of each burner and all the associated functions of fans, purging, register positions, fuel valve position and safety interlocks.
- l) The boiler designer shall justify any atomizing steam consumption greater than 0.5% of boiler MCR.
- m) Burner minimum turndown ratio shall be 33% for liquid fuels and 10% for fuel gas, with the boiler supplier's guaranteed low O₂ in the flue gas maintained over the ranges mentioned below.
- n) Boilers having four or more burner assemblies for use with fuel gas or commercial grade liquid fuel shall operate satisfactorily with combustion conditions as near stoichiometric as practicable. The excess air shall not exceed 3% for liquid fuels and 5% for gaseous fuels. Over the full operating range of the boiler the following O₂ vol. percentage in flue gases should be achieved with liquid fuels:
- 0.5% O₂ between 70-100% MCR

dan individual burner start-up, dan juga untuk masing-masing burner dan shutdown boiler.

- k) *Local dan control room panels* harus menyediakan semua informasi yang diperlukan untuk memungkinkan operator memastikan kondisi setiap burner dan semua fungsi terkait *fans, purging, register positions, fuel valve position* dan *safety interlocks*.
- l) *Designer boiler* harus justifikasi konsumsi *atomizing steam* yang lebih besar dari 0,5% dari *MCR boiler*.
- m) Rasio *turndown minimum burner* harus 33% untuk bahan bakar cair dan 10% untuk bahan bakar gas, dengan jaminan O₂ rendah dari *supplier boiler* dalam *flue gas* yang dipertahankan pada rentang yang disebutkan di bawah.
- n) *Boiler* yang memiliki empat atau lebih rakitan burner untuk digunakan dengan bahan bakar gas atau bahan bakar cair kelas komersial harus beroperasi secara memuaskan dengan kondisi pembakaran sedekat mungkin dengan stoikiometrik. Udara berlebih tidak boleh melebihi 3% untuk bahan bakar cair dan 5% untuk bahan bakar gas. Selama rentang operasi penuh boiler, O₂ vol berikut persentase gas buang harus dicapai dengan bahan bakar cair:
- 0.5% O₂ antara 70-100% MCR

- | | |
|---|--|
| <ul style="list-style-type: none"> • 1.0% O₂ between 25-70% MCR • 5.0% O₂ between 0-25% MCR <p>o) Carbon monoxide in the flue gas shall not be greater than 0.01% by volume at specified O₂ content in flue gases.</p> <p>p) Duplex type filters, or two filters in parallel, of 125 micrometers (.005 in) mesh in monel, shall be provided in the gas supply for each convenient group of pilot burners. The pipework from the strainers to the pilot burners shall be in stainless steel.</p> <p>q) Horizontal distance between main burners and the vertical distance between rows of burners shall be such as to facilitate discrimination between individual flames by the proposed flame detectors.</p> <p>r) Burner viewing ports shall be fitted to each burner assembly front plate in such a position as to afford an adequate visual examination of the pilot burner and the root of the flame.</p> | <ul style="list-style-type: none"> • 1.0% O₂ antara 25-70% MCR • 5.0% O₂ antara 0-25% MCR <p>o) Karbon monoksida dalam <i>flue gas</i> tidak boleh lebih besar dari 0,01% volume pada kandungan O₂ yang ditentukan dalam <i>flue gas</i>.</p> <p>p) Filter tipe dupleks, atau dua filter secara paralel, dengan <i>mesh</i> 125 mikrometer (0,005 in) dalam monel, harus disediakan dalam <i>gas supply</i> untuk setiap kelompok <i>pilot burner</i> yang sesuai. <i>Pipework</i> dari <i>strainer</i> ke <i>pilot burner</i> harus terbuat dari in <i>stainless steel</i>.</p> <p>q) Jarak horizontal antara <i>burner</i> utama dan jarak vertikal antara deretan <i>burner</i> harus sedemikian rupa untuk memfasilitasi <i>discrimination</i> antara <i>flame</i> individu oleh <i>flame detectors</i> yang diusulkan.</p> <p>r) <i>Burner viewing ports</i> harus dipasang pada setiap <i>burner assembly front plate</i> dalam posisi sedemikian rupa sehingga memungkinkan pemeriksaan visual yang memadai dari <i>pilot burner</i> dan <i>roots</i> dari <i>Flame</i>.</p> |
|---|--|

8.2.3. Other Items & Control System

- a) Burner Management System
- b) De-super heater control
- c) Feed water control
- d) Soot blower control
- e) Continuous Emission Monitoring System Per Stack

8.2.3. Item & Sistem Kontrol Lainnya

- a) *Burner Management System*
- b) *De-super heater control*
- c) *Feed water control*
- d) *Soot blower control*
- e) *Continuous Emission Monitoring System Per Stack*

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- | | |
|---|---|
| f) Automatic Combustion Control | f) <i>Automatic Combustion Control</i> |
| g) Steam Temperature Control | g) <i>Steam Temperature Control</i> |
| h) Draft Control | h) <i>Draft Control</i> |
| i) Feed Water Control | i) <i>Feed Water Control</i> |
| j) Chemical Injection System shall be provided | j) <i>Chemical Injection System</i> harus disediakan |
| k) Boiler Load Sharing Facility (for above 2 units of Boilers). | k) <i>Boiler Load Sharing Facility</i> (untuk di atas 2 unit <i>Boiler</i>). |

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**APPENDIX A.
SAMPLE OF PROCESS DATA SHEET FOR BOILER PACKAGE**



ENGINEERING SERVICES				JOB NO. 26070-203	DOCUMENT NO. MXA-331-JA001	REV. 00E				
MEGA PROJECT REFINING & PETROCHEMICAL DIRECTORATE							SHEET 1 OF 6			
DATASHEET										
<p>PROCESS DATASHEET WATER TUBE BOILER PACKAGE</p> <p>REFINERY DEVELOPMENT MASTER PLAN (RDMP) PROJECT REFINERY UNIT-V BALIKPAPAN</p> <p>PT PERTAMINA (PERSERO) 2017, 2018</p>										
00E	25 APR 2018	6	RE-ISSUED FOR APPROVAL	AC	RK	PD	--	TM	SM	
00D	23 OCT 2017	6	RE-ISSUED FOR APPROVAL	SRA	EFN	EFN	DB	SM	SM	
00C	12 MAY 2017	6	RE-ISSUED FOR APPROVAL	DAM2	MH	EFN	SM	DC	JP	
00B	23 MAR 2017	6	RE-ISSUED FOR APPROVAL	DAM2	MH	EFN	SM	DC	JP	
00A	10 FEB 2017	6	RE-ISSUED FOR APPROVAL	DAM2	MH	EFN	SM	DC	JP	
REV.	DATE	PAGE	DESCRIPTION	PREP'D	CHK'D	REVW'D	CON CUR	APP'D	ENG MGT	CLIENT

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Revision history

Amendment date	Revision number	Amender initials	Amendment
February 5 th , 2017	00A	DAM2	<ul style="list-style-type: none"> Update HHP Boilers completed with Flue Gas Treatment Revise capacity of normal operation HHP Boiler Revise pressure and temperature design of LP Blowdown Drum and Atmospheric Blowdown Drum
March 23 rd , 2017	00B	DAM2	<ul style="list-style-type: none"> Add Blowdown Cooler Delete Flue Gas Treatment of Boiler Main Fuel Gas and Start up use Natural Gas
May 9 th , 2017	00C	DAM2	Revise normal capacity of HHP Boiler
October 22 nd , 2017	00D	SRA	Revise Normal and Design Capacity of HHP Boiler
April 25 th , 2018	00E	AC	Revised as per updated Power block design data

SAMPLE



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1	CLIENT	: RU-V BALIKPAPAN																												
2	PROJECT	: RDMP BALIKPAPAN																												
3	LOCATION	: BALIKPAPAN, EAST KALIMANTAN, INDONESIA																												
4	ITEM NO	: A-331-01A/B/C/D/E																												
5	SERVICE	: HHP BOILERS																												
6	NO REQUIRED	: (RUNNING : 4 UNIT STAND BY : 1 UNIT TOTAL : 5 UNIT)																												
7	TYPE OF BOILER																													
8	<input checked="" type="checkbox"/> SHOP ASSEMBLED	<input checked="" type="checkbox"/> FIELD ASSEMBLING																												
9	<input checked="" type="checkbox"/> NATURAL CIRCULATION	<input type="checkbox"/> FORCED CIRCULATION																												
10	<input checked="" type="checkbox"/> FORCED DRAFT	<input type="checkbox"/> BALANCE DRAFT																												
11	<input checked="" type="checkbox"/> WATER TUBE WALL	<input type="checkbox"/> FIRE TUBE																												
12	<input checked="" type="checkbox"/> BI-DRUM	<input type="checkbox"/> MONO-DRUM <input type="checkbox"/> ONE THROUGH																												
13	<input checked="" type="checkbox"/> BOTTOM SUPPORTED	<input type="checkbox"/> TOP SUPPORTED																												
14	<input type="checkbox"/> GAS FIRED <input type="checkbox"/> OIL FIRED	<input checked="" type="checkbox"/> GAS & OIL FIRED <input type="checkbox"/>																												
15	<input checked="" type="checkbox"/> FRONT FIRING <input type="checkbox"/> SIDE FIRING	<input type="checkbox"/> OPPOSITE FIRING <input type="checkbox"/> CORNER FIRING																												
16	<input checked="" type="checkbox"/> SUPERHEATED STEAM	<input type="checkbox"/> SATURATED STEAM <input type="checkbox"/>																												
17	<input checked="" type="checkbox"/> OUTDOOR (<input checked="" type="checkbox"/> Non Hazardous <input type="checkbox"/> Hazardous)	<input type="checkbox"/> IN-DOOR <input type="checkbox"/>																												
18	FUEL																													
19	MAIN FUEL – A: DCO refer to Process Design Basis BFW, Steam, Condensate and Power Generation (26070-203-3BD-B04-J0002)																													
20	MAIN FUEL – B: NATURAL GAS refer to Natural Gas Composition Data (26070-203-3BD-G04-J0001)																													
21	MAIN FUEL – C: MIXED FUEL (DCO and Natural Gas with firing max. 73% of DCO and 27% of Natural Gas)																													
22	START-UP FUEL: NATURAL GAS refer to Natural Gas Composition Data (26070-203-3BD-G04-J0001)																													
23	IGNITION FUEL : NATURAL GAS refer to Natural Gas Composition Data (26070-203-3BD-G04-J0001)																													
24	PERFORMANCE OF BOILER																													
25	PROPERTIES	CONDITION MCR NORMAL MIN NOTE																												
26	EVAPORATION	Tons/hr 262 200 60 NOTE 6																												
27	LOAD RATIO OF MCR	(%)																												
28	STEAM PRESS.	(kg/cm ² G) Max. 61 59 57 NOTE 1																												
29	STEAM TEMP.	(°C) Max. 470 465 445 NOTE 1																												
30	FEED WATER PRESS.	(kg/cm ² G) 74 NOTE 2																												
31	FEED WATER TEMP.	(°C) 140 NOTE 2																												
32	FLUE GAS TEMP.	(°C) 165 NOTE 3																												
33	TOTAL DRAFT LOSS	(mmH ₂ O)																												
34	THERMAL EFFICIENCY	(%) 92.0 NOTE 4/5																												
35	FURNACE HEAT RELEASE	(kcal/m ³ .hr)																												
36	FURNACE HEAT RELEASE	(kcal/m ² .hr)																												
37	GASEOUS EMISSION refers to Item 13 "Environmental" in BEDD (26070-203-3BD-G04-J0001) at 100% Natural Gas and maximum DCO for Mixed Fuel firing. NOTE 5																													
38																														
39	NOTE 1 : <input type="checkbox"/> at BOILER OUTLET <input type="checkbox"/> at MAIN STOP VALVE <input checked="" type="checkbox"/> at MAIN HEADER INLET																													
40	NOTE 2 : <input type="checkbox"/> at FWCV INLET <input checked="" type="checkbox"/> at BATTERY LIMIT OF UTILITY AREA <input type="checkbox"/> at DRUM INLET <input type="checkbox"/>																													
41	NOTE 3 : <input checked="" type="checkbox"/> at STACK INLET <input type="checkbox"/>																													
42	NOTE 4 : <input type="checkbox"/> at BASED ONE <input checked="" type="checkbox"/> LHV <input type="checkbox"/> HHV																													
43	NOTE 5 : Thermal efficiency and Gaseous Emissions shall be fulfilled.																													
44	NOTE 6 : Design Case Operation Phase I: 229 tons/hr x 4 Units (1 Stand by); Phase II: 204 tons/hr x 4 Units (1 Stand by). Rating Case Operation Phase I: 270 tons/hr x 4 Units (1 Stand by); Phase II: 262 tons/hr x 4 Units (1 Stand by). Rating Case is referred to an upset scenario when RFCC CO Boiler and Expander is trip.																													
45																														
46	OPERATION																													
47	OPERATING CONDITION																													
48	OVERLOAD OPERATION :	<input type="checkbox"/> NON																												
49		<input checked="" type="checkbox"/> YES 110 % OF MCR 1 (ONE) HOURS																												
50	LOAD FLUCTUATION:	max. % OF MCR / Min.																												
51		max. % OF NOR / Min.																												
52	REMARKS:																													
	a) Boiler efficiency at MCR shall be guaranteed with Normal steam and water condition.																													
	b) Specification of Boiler Feed Water Quality as follows:																													
	<table border="1"> <thead> <tr> <th>No</th> <th>Analysis</th> <th>Unit</th> <th>Specification</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>pH</td> <td></td> <td>8.5-9.5</td> </tr> <tr> <td>2</td> <td>Conductivity</td> <td>micromhos</td> <td>Max 10</td> </tr> <tr> <td>3</td> <td>Oxygen</td> <td>ppb</td> <td>Max 7</td> </tr> <tr> <td>4</td> <td>Total Suspended Solid</td> <td>ppm</td> <td>0</td> </tr> <tr> <td>5</td> <td>Total Dissolved Solid</td> <td>ppm</td> <td>Max 5</td> </tr> <tr> <td>6</td> <td>Silica</td> <td>ppm</td> <td>Max 0.02</td> </tr> </tbody> </table>		No	Analysis	Unit	Specification	1	pH		8.5-9.5	2	Conductivity	micromhos	Max 10	3	Oxygen	ppb	Max 7	4	Total Suspended Solid	ppm	0	5	Total Dissolved Solid	ppm	Max 5	6	Silica	ppm	Max 0.02
No	Analysis	Unit	Specification																											
1	pH		8.5-9.5																											
2	Conductivity	micromhos	Max 10																											
3	Oxygen	ppb	Max 7																											
4	Total Suspended Solid	ppm	0																											
5	Total Dissolved Solid	ppm	Max 5																											
6	Silica	ppm	Max 0.02																											
	c) Steam HHP header mechanical design are 67 kg/cm ² g (design) & 493 °C (design)																													

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1	CLIENT	: RU-V BALIKPAPAN
2	PROJECT	: RDMP BALIKPAPAN
3	LOCATION	: BALIKPAPAN, EAST KALIMANTAN, INDONESIA
4	ITEM NO	: A-331-01A/B/C/D/E
5	SERVICE	: HHP BOILERS
6	NO REQUIRED	: (RUNNING : 4 UNIT STAND BY : 1 UNIT TOTAL : 5 UNIT)
7	CONTROL	
8	<input checked="" type="checkbox"/> AUTOMATIC COMBUSTION CONTROL	
9	FIRING MODE	CONTROL RANGE OF MCR
10	<input checked="" type="checkbox"/> 100% OF FUEL OIL FIRING	: FROM 30 TO 110 %
11	<input checked="" type="checkbox"/> 100% OF FUEL GAS FIRING	: FROM 30 TO 110 %
12	<input checked="" type="checkbox"/> MULTI FUEL FIRING	
13	CONTROL CONDITION & REQUIREMENT	:
14		
15		
16		
17	<input type="checkbox"/> % OF	FROM TO %
18	MASTER SIGNAL	<input checked="" type="checkbox"/> STEAM PRESS. <input type="checkbox"/> STEAM FLOW
19	CONTROLLED	<input checked="" type="checkbox"/> AIR <input checked="" type="checkbox"/> FUEL GAS <input checked="" type="checkbox"/> FUEL OIL <input type="checkbox"/>
20	<input checked="" type="checkbox"/> STEAM TEMP. CONTROL	
21	RANGE : 30 TO 110 % OF MCR	
22	TYPE:	<input type="checkbox"/> ONE ELEMENT <input type="checkbox"/> TWO ELEMENT <input type="checkbox"/> 1RY S/H STEAM TEMP.
23		<input type="checkbox"/> 2 RY S/H STEAM TEMP.
24		<input type="checkbox"/> COMBUSTION AIR FLOW
25	<input checked="" type="checkbox"/> BFW SPRAY <input type="checkbox"/> CONDENSATE WATER SUPPLY	<input type="checkbox"/>
26	<input type="checkbox"/> DRUM STEAM CONDENSATE SPRAY	<input type="checkbox"/>
27	<input type="checkbox"/> INTERMEDIATE SPRAY	<input checked="" type="checkbox"/> FINAL STAGE SPRAY
28	<input checked="" type="checkbox"/> DRAFT CONTROL TYPE	
29	<input checked="" type="checkbox"/> INLET VANE <input type="checkbox"/> OUTLET DAMPER <input type="checkbox"/> VARIABLE PITCH BLADE <input type="checkbox"/> FAN SPEED	
30	<input checked="" type="checkbox"/> FEED WATER CONTROL	
31	<input checked="" type="checkbox"/> THREE ELEMENT METERING TYPE	<input checked="" type="checkbox"/> TWO CONTROLLERS SYSTEM
32		<input type="checkbox"/> ONE FLOW CONTROLLER SYSTEM
33	<input type="checkbox"/> TWO ELEMENT POSITIONING TYPE	
34	<input checked="" type="checkbox"/> BURNER IGNITION	
35	<input type="checkbox"/> MANUAL AT LOCAL <input type="checkbox"/> INTERLOCKED <input checked="" type="checkbox"/> AUTOMATIC SEQUENTIAL	
36	DESIGN OF BOILER	
37	CODE & STANDARD	
38	<input type="checkbox"/> JIS <input type="checkbox"/> MITI <input checked="" type="checkbox"/> ASME <input type="checkbox"/>	
39	DESIGN PRESS.	kg/cm2G *MATERIAL (filled in by vendor)
40	S/V SET PRESS.	STEAM DRUM
41	DRUM-1	WATER DRUM
42	DRUM-2	FURNACE TUBE
43	S/H OUTLET	BANK TUBE
44	FURNACE VOLUME:	kg/cm2G 1RY-S/H /
45	HEATING SURFACE:	M3 1RY-S/H HEADER /
46	FURNACE	2RY-S/H /
47	BANK	M2 2RY-S/H HEADER /
48	1RY-S/H	M2 ECONOMIZER
49	2RY-S/H	M2 AIR HEATER
50	ECONOMIZER	M2
51	AIR HEATER	M2
52	DRUM UPPER DRUM (Remark a)	MM, ID, THICKNESS / MM, LENGTH MM
53	LOWER DRUM (Remark a)	MM, ID, THICKNESS / MM, LENGTH MM
54	MANHOLE UPPER DRUM	x MM DIA, <input type="checkbox"/> CIRCULAR <input type="checkbox"/> OVAL
55	LOWER DRUM	x MM DIA, <input type="checkbox"/> CIRCULAR <input type="checkbox"/> OVAL
56	SIZE & WEIGHT OF BOILER	
57	SIZE : WIDTH M	WEIGHT : EMPTY TONS
58	DEPTH M	OPERATING TONS
59	HEIGHT M	FULL WATER TONS
60	REMARKS: a) Steam Drum Volume shall have the hold-up time of 180 Sec. between normal water level and LL Level cut off.	

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1	CLIENT	: RU-V BALIKPAPAN	
2	PROJECT	: RDMP BALIKPAPAN	
3	LOCATION	: BALIKPAPAN, EAST KALIMANTAN, INDONESIA	
4	ITEM NO	: A-331-01A/B/C/D/E	
5	SERVICE	: HHP BOILERS	
6	NO REQUIRED	: (RUNNING: 4 UNIT STAND BY : 1 UNIT TOTAL : 5 UNIT)	
7	ACCESSORIES		
8	<input checked="" type="checkbox"/> BURNER	<input checked="" type="checkbox"/> FDF	
9	NO. OF ASSEMBLY min. 2 SET(S)/BOILER	NO. REQ'D 1 SET(S) / ONE BOILER	
10	(OIL BURNER GAS BURNER)	TYPE : <input checked="" type="checkbox"/> CENTRIFUGAL	
11	<input checked="" type="checkbox"/> OIL BURNER	CAPACITY (Remark a): Nm3/Hr	
12	<input type="checkbox"/> PRESS. ATOMIZING	PRESS. DIFF. (Remark a): mmH2O	
13	<input checked="" type="checkbox"/> STEAM ATOMIZING (Steam Press : 17.0 kg/cm2G)	MATERIAL (IMPELLER/CASING) /	
14	<input type="checkbox"/> AIR ATOMIZING	RPM	
15	<input type="checkbox"/> MAIN TIP	BHP kW	
16	<input type="checkbox"/> TIP FOR START-UP	DRIVER : <input type="checkbox"/> SINGLE <input checked="" type="checkbox"/> TANDEM	
17	<input type="checkbox"/> TIP FOR DRYING	<input checked="" type="checkbox"/> MOTOR <input checked="" type="checkbox"/> WITH CLUTH kW	
18	<input type="checkbox"/> TIP FOR LIGHT LOAD	<input checked="" type="checkbox"/> TURBINE <input checked="" type="checkbox"/> WITH CLUTH kW	
19	CAPACITY : DES. kg/Hr/ONE	NOISE 85 dBA apart from Fan and Drivers	
20	NOR. kg/Hr/ONE	<input type="checkbox"/> IDF	
21	OIL PRESS. at BURNER kg/cm2G	NO. REQ'D SET(S) / ONE BOILER	
22	OIL TEMP. at BURNER °C	TYPE : <input type="checkbox"/> CENTRIFUGAL	
23	<input checked="" type="checkbox"/> GAS BURNER	CAPACITY (Remark a): Nm3/Hr	
24	<input type="checkbox"/> GUN TYPE	PRESS. DIFF. (Remark a): mmH2O	
25	<input checked="" type="checkbox"/> MULTI SPUD TYPE	MATERIAL (IMPELLER/CASING) /	
26	CAPACITY : DES. kg/Hr/ONE	RPM	
27	NOR. kg/Hr/ONE	BHP kW	
28	GAS PRESS. at BURNER kg/cm2G	DRIVER : <input type="checkbox"/> SINGLE <input type="checkbox"/> TANDEM	
29	GAS TEMP. at BURNER °C	<input type="checkbox"/> MOTOR <input type="checkbox"/> WITH CLUTH kW	
30	<input type="checkbox"/> SPECIAL TYPE	<input type="checkbox"/> TURBINE <input type="checkbox"/> WITH CLUTH kW	
31		NOISE	
32	TURN-DOWN	<input type="checkbox"/> BOILER FEED WATER PUMP	
33	NOISE 85 dBA apart from Burner	NO. REQ'D	
34	<input checked="" type="checkbox"/> SOOT BLOWER LONG RETRACT. ROTARY	(MOTOR DRIVE TURBINE DRIVE)	
35	FURNACE NOS. kW <input type="checkbox"/> / <input type="checkbox"/>	CAPACITY : DES. m3/Hr	
36	BANK NOS. kW <input type="checkbox"/> / <input type="checkbox"/>	NOR. m3/Hr	
37	S/H-1 NOS. kW <input type="checkbox"/> / <input type="checkbox"/>	PRESS. : SUCTION kg/cm2G	
38	S/H-2 NOS. kW <input type="checkbox"/> / <input type="checkbox"/>	DISCHARGE kg/cm2G	
39	ECONOMIZER NOS. kW <input type="checkbox"/> / <input type="checkbox"/>	MATERIAL : INTERNAL	
40	GAS A/H NOS. kW <input type="checkbox"/> / <input type="checkbox"/>	CASE	
41	OPERATION : <input type="checkbox"/> HAND OPERATION	IMPELLER	
42	<input checked="" type="checkbox"/> FROM LOCAL PANEL	RPM	
43	<input type="checkbox"/> FROM CONTROL ROOM	BHP kW	
44	<input type="checkbox"/> GAS AIR HEATER	DRIVER RATED OUTPUT : kW	
45	NO.EQ'D SET(S)	DRIVER : <input type="checkbox"/> MOTOR <input type="checkbox"/> TURBINE	
46	TYPE : <input type="checkbox"/> TUBULAR	STEAM CONDITION FOR STEAM TURBINE	
47	<input type="checkbox"/> PLATE FINE	STEAM	INLET STEAM
48	<input type="checkbox"/> ROTATING <input type="checkbox"/> VERT. <input type="checkbox"/> HORI.	TURBINE	PRESS. TEMP. (Remark b) EX. STEAM
49	<input type="checkbox"/> LJUNG. <input type="checkbox"/> ROTH.	FOR FDF 32.0 400.0 10.0	kg/cm2G °C kg/cm2G
50	DRIVER (NOR.) <input type="checkbox"/> MOTOR	<input checked="" type="checkbox"/> FOR IDF	
51	(EMERGENCY) <input type="checkbox"/> AIR MOTOR	<input type="checkbox"/> FOR BFWP	
52	<input type="checkbox"/> E. MOTOR	<input type="checkbox"/> FOR	
53	AIR LEAK : <input type="checkbox"/> YES %	<input type="checkbox"/> FOR	
54	<input type="checkbox"/> NO	<input type="checkbox"/> FOR	
55	REMARKS : a) *10% margin of MCR Capacity and 10% margin of MCR Head shall be considered. b) Steam HP header Mechanical Design is : • Design Pressure : 40 kg/cm2G • Design Temperature : 448 °C		

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Engineering Technical
Standards & Procedures

**SUBHOLDING
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Doc. No. :
RP-ETS-PRO-DC-0023-00-2021

**DESIGN CRITERIA
BOILER PACKAGE**

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**PROCESS DATA SHEET
WATER TUBE BOILER**

Job Number	26070-203
Document Number	Rev
26070-203-MXA-331-JA001	00E
Client Document Number	
Sheet	6 of 6

1	CLIENT	: RU-V BALIKPAPAN
2	PROJECT	: RDMP BALIKPAPAN
3	LOCATION	: BALIKPAPAN, EAST KALIMANTAN, INDONESIA
4	ITEM NO	: A-331-01A/B/C/D/E
5	SERVICE	: HHP BOILERS
6	NO REQUIRED	: (RUNNING: 4 UNIT STAND BY : 1 UNIT TOTAL : 5 UNIT)
7	ACCESSORIES	
8	<input checked="" type="checkbox"/> STACK	<input checked="" type="checkbox"/> LP BLOWDOWN DRUM
9	NO. REQ'D	5 SET(S)
10	<input type="checkbox"/> COMMON <input checked="" type="checkbox"/> INDIVIDUAL	NO. REQ'D 5 SET(S)
11	MATERIAL	BLOW DOWN CAPACITY DESIGN (Remark b) kg/Hr
12	HEIGHT 70 M	PRESS.: DESIGN 16.0 kg/cm2G
13	LINING <input type="checkbox"/> YES <input type="checkbox"/> NO	OPERATING 10.0 kg/cm2G
14	<input type="checkbox"/> SHOP CONSTRUCTION	TEMP.: DESIGN (by vendor) °C
15	<input checked="" type="checkbox"/> PREFABRICATION	OPERATING (by vendor) °C
16	<input type="checkbox"/> SITE CONSTRUCTION	MATERIAL
17	SPECIAL REQUIREMENT: <input type="checkbox"/> YES <input type="checkbox"/> NO	SIZE
18	(refer to Process Design Basis for Oil / Gas Fired Boiler)	VOLUME (Remark b) M3
19		FLASH STEAM: <input checked="" type="checkbox"/> TO LOW PRESS. LINE
20	<input checked="" type="checkbox"/> GAS DUCT	<input type="checkbox"/> TO DEAERATOR
21	MATERIAL:	<input checked="" type="checkbox"/> ATMOSPHERIC BLOWDOWN DRUM
22	INSULATION:	NO. REQ'D 5 SET(S)
23	DAMPER:	BLOW DOWN WATER: <input type="checkbox"/> INTERMIT. BLOW DOWN
24	SPECIAL REQUIREMENT: <input type="checkbox"/> YES <input type="checkbox"/> NO	<input type="checkbox"/> BOILER DRAIN
25		CAPACITY DESIGN: (Remark b) kg/Hr
26		PRESS.: DESIGN atm (Remark b) kg/cm2G
27	<input checked="" type="checkbox"/> AIR DUCT	OPERATING atm (Remark b) kg/cm2G
28	MATERIAL: INSULATION	MATERIAL:
29	INSULATION:	SIZE:
30	DAMPER:	VOLUME: (Remark b) M3
31		VENT STEAM: <input checked="" type="checkbox"/> DISCHARGED
32	<input checked="" type="checkbox"/> PLATFORM <input type="checkbox"/> GRATING	<input checked="" type="checkbox"/> BLOW DOWN COOLER
33	<input type="checkbox"/> CHECKER PLATE	NO. REQ'D 5 SET(S)
34	FUEL SUPPLY EQUIPMENT	
35	NAME OF FUEL OIL:	DCO refer to Process Design Basis (26070-203-3BD-B04-J0002)
36		
37	NAME OF FUEL GAS:	Natural Gas refer to Fuel Gas Composition Data (26070-203-3BD-G04-J0001)
38		
39	<input type="checkbox"/> FUEL OIL BURNING PUMP	<input type="checkbox"/> FUEL OIL HEATER
40	NO. REQ'D SET(S)	NO. REQ'D (NOR. STANDBY)
41	(MOTOR DRIVE TURBINE DRIVE)	OIL TEMP.: INLET °C
42	TYPE: <input type="checkbox"/> GEAR <input checked="" type="checkbox"/> SCREW	OUTLET °C
43	<input type="checkbox"/> CENTRIFUGAL	OIL FLOW RATE:
44	CAPACITY: DES. m3/Hr	<input type="checkbox"/> STEAM HEATING TYPE
45	NOR. m3/Hr	TYPE: <input type="checkbox"/> SHELL & TUBE
46	DISCHARGE PRESS.:	
47	DRIVER RATED OUTPUT: kW	HEATING SURFACE: M2
48	<input type="checkbox"/> FUEL OIL TANK	HEATING STEAM PRESS.: kg/cm2G
49	NO. REQ'D SET(S)	CONSUMPTION: kg/Hr
50	TYPE:	<input type="checkbox"/> ELECTRIC HEATER
51	CAPACITY: m3	HEATING SURFACE: M2
52	SIZE:	POWER CONSUMPTION:
53	MATERIAL:	<input type="checkbox"/> ACCUMULATORS ON FUEL OIL LINE
54	<input type="checkbox"/> SUCTION HEATER	<input checked="" type="checkbox"/> DRAIN SEPARATOR ON FUEL GAS LINE
55	NO. REQ'D (NOR. STANDBY)	
56	<input type="checkbox"/> STEAM HEATER	
57	<input type="checkbox"/> ELECTRIC HEATER	
58	REMARKS:	
	a) Vendor to optimize the flash drum size. Size and furnish the relief valves for overpressure protection in accordance with ASME Code, Section VIII, Div. 1	
	b) Vendor to advise. Vendor to minimize the Continuous and Intermittent Blowdown and provide the information to the Owner.	
	c) Boiler shall be equipped with load sharing facility.	

Dokumen sesuai dengan aslinya, dicetak pada tanggal 11/06/2026 17:18:32 oleh



Engineering Technical
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**SUBHOLDING
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Doc. No. :
RP-ETS-PRO-DC-0023-00-2021

**DESIGN CRITERIA
BOILER PACKAGE**

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**PROCESS DATA SHEET
WATER TUBE BOILER**

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Document Number	Rev
26070-203-MXA-331-JA001	00E
Client Document Number	
Sheet	6 of 6

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5	SERVICE	: HHP BOILERS
6	NO REQUIRED	: (RUNNING: 4 UNIT STAND BY : 1 UNIT TOTAL : 5 UNIT)
7	ACCESSORIES	
8	<input checked="" type="checkbox"/> STACK	<input checked="" type="checkbox"/> LP BLOWDOWN DRUM
9	NO. REQ'D 5 SET(S)	NO. REQ'D 5 SET(S)
10	<input type="checkbox"/> COMMON <input checked="" type="checkbox"/> INDIVIDUAL	BLOW DOWN CAPACITY DESIGN (Remark b) kg/Hr
11	MATERIAL	PRESS.: DESIGN 16.0 kg/cm2G
12	HEIGHT 70 M	OPERATING 10.0 kg/cm2G
13	LINING <input type="checkbox"/> YES <input type="checkbox"/> NO	TEMP.: DESIGN (by vendor) °C
14	<input type="checkbox"/> SHOP CONSTRUCTION	OPERATING (by vendor) °C
15	<input checked="" type="checkbox"/> PREFABRICATION	MATERIAL
16	<input type="checkbox"/> SITE CONSTRUCTION	SIZE
17	SPECIAL REQUIREMENT: <input type="checkbox"/> YES <input type="checkbox"/> NO	VOLUME (Remark b) M3
18	(refer to Process Design Basis for Oil / Gas Fired Boiler)	FLASH STEAM: <input checked="" type="checkbox"/> TO LOW PRESS. LINE
19		<input type="checkbox"/> TO DEAERATOR
20	<input checked="" type="checkbox"/> GAS DUCT	<input checked="" type="checkbox"/> ATMOSPHERIC BLOWDOWN DRUM
21	MATERIAL:	NO. REQ'D 5 SET(S)
22	INSULATION:	BLOW DOWN WATER: <input type="checkbox"/> INTERMIT. BLOW DOWN
23	DAMPER:	<input type="checkbox"/> BOILER DRAIN
24	SPECIAL REQUIREMENT: <input type="checkbox"/> YES <input type="checkbox"/> NO	
25		CAPACITY DESIGN: (Remark b) kg/Hr
26		PRESS.: DESIGN atm (Remark b) kg/cm2G
27	<input checked="" type="checkbox"/> AIR DUCT	OPERATING atm (Remark b) kg/cm2G
28	MATERIAL: INSULATION	MATERIAL:
29	INSULATION:	SIZE:
30	DAMPER:	VOLUME: (Remark b) M3
31		VENT STEAM: <input checked="" type="checkbox"/> DISCHARGED
32	<input checked="" type="checkbox"/> PLATFORM <input type="checkbox"/> GRATING	<input checked="" type="checkbox"/> BLOW DOWN COOLER
33	<input type="checkbox"/> CHECKER PLATE	NO. REQ'D 5 SET(S)
34	FUEL SUPPLY EQUIPMENT	
35	NAME OF FUEL OIL:	DCO refer to Process Design Basis (26070-203-3BD-B04-J0002)
36		
37	NAME OF FUEL GAS:	Natural Gas refer to Fuel Gas Composition Data (26070-203-3BD-G04-J0001)
38		
39	<input type="checkbox"/> FUEL OIL BURNING PUMP	<input type="checkbox"/> FUEL OIL HEATER
40	NO. REQ'D SET(S)	NO. REQ'D (NOR. STANDBY)
41	(MOTOR DRIVE TURBINE DRIVE)	OIL TEMP.: INLET °C
42	TYPE: <input type="checkbox"/> GEAR <input checked="" type="checkbox"/> SCREW	OUTLET °C
43	<input type="checkbox"/> CENTRIFUGAL	OIL FLOW RATE:
44	CAPACITY: DES. m3/Hr	<input type="checkbox"/> STEAM HEATING TYPE
45	NOR. m3/Hr	TYPE: <input type="checkbox"/> SHELL & TUBE
46	DISCHARGE PRESS.:	
47	DRIVER RATED OUTPUT: kW	HEATING SURFACE: M2
48	<input type="checkbox"/> FUEL OIL TANK	HEATING STEAM PRESS.: kg/cm2G
49	NO. REQ'D SET(S)	CONSUMPTION: kg/Hr
50	TYPE:	<input type="checkbox"/> ELECTRIC HEATER
51	CAPACITY: m3	HEATING SURFACE: M2
52	SIZE:	POWER CONSUMPTION:
53	MATERIAL:	<input type="checkbox"/> ACCUMULATORS ON FUEL OIL LINE
54	<input type="checkbox"/> SUCTION HEATER	<input checked="" type="checkbox"/> DRAIN SEPARATOR ON FUEL GAS LINE
55	NO. REQ'D (NOR. STANDBY)	
56	<input type="checkbox"/> STEAM HEATER	
57	<input type="checkbox"/> ELECTRIC HEATER	
58	REMARKS:	
	a) Vendor to optimize the flash drum size. Size and furnish the relief valves for overpressure protection in accordance with ASME Code, Section VIII, Div. 1	
	b) Vendor to advise. Vendor to minimize the Continuous and Intermittent Blowdown and provide the information to the Owner.	
	c) Boiler shall be equipped with load sharing facility.	

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