GENERAL SPECIFICATION

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CO BOILER PACKAGE

ENGINEERING TECHNICAL STANDARDS & PROCEDURES

PT KILANG PERTAMINA INTERNASIONAL

DIREKTORAT PROYEK INFRASTRUKTUR

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1. INTRODUCTION

1.1 This general specification establishes the minimum requirements for design, fabrication, assembly, supply, inspection, testing, delivery, installation, commissioning and documentation of CO Boiler Package.

1.2 This general specification along with other referenced documents, drawings includes minimum design requirements for the package. The package shall be operationally complete, including all ancillary equipment required to meet the design and environmental conditions as stated in.

1.3 This boiler specification and the related design work are based on a boiler design consisting of a refractory lined combustion chamber followed by a convection section for steam generation. The convection section design may be natural or forced water circulation.

2. SCOPE

2.1 This specification covers the general requirements for a CO Boiler package and accessories required for operation of RFCC/RCC unit. The document shall be the design, materials, fabrication, transportation, erection, commissioning, inspection and testing of CO Boiler. Unless otherwise specified in this specification, CO Boiler shall be designed, fabricated, erected, inspected and tested in accordance with ASME.

2.2 All equipment and materials supplied by the Manufacturer must have been demonstrated to be proven for at identification and shall be furnished with the boiler:

1. PENGANTAR

1.1 Spesifikasi umum ini mencakup persyaratan minimal untuk desain, fabrikasi, *assembly, supply*, inspeksi, pengujian, pengantaran, pemasangan, *commissioning*, dan dokumentasi CO *Boiler Package.*

1.2 Spesifikasi umum ini bersama dengan seluruh dokumen referensi, gambar termasuk persyaratan minimal yang dibutuhkan dalam *package*. *Package* harus lengkap dari sisi operasional, termasuk seluruh perlengkapan tambahan yang dibutuhkan untuk mencapai desain dan kondisi lingkungan yang telah disebutkan.

1.3 Spesifikasi beserta desain kerja *boiler* didasarkan pada desain *boiler* yang terdiri dari ruang bakar dengan *refractory* diikuti dengan sisi konveksi untuk *steam generation*. Desain bagian konveksi dapat berupa sirkulasi air secara natural atau paksa (*forced*).

2. LINGKUP

2.1 Spesifikasi ini mencakup persyaratan umum untuk CO *Boiler Package* dan kelengkapan yang dibutuhkan untuk operasional dari unit RFCC/RCC. Dokumen berisi desain, material, fabrikasi, transportasi, pemasangan, *commissioning*, dan pengujian CO *Boiler*. Kecuali disebutkan dalam spesifikasi ini, CO *Boiler* harus dirancang, difabrikasi, dipasang, diinspeksi, dan diuji sesuai dengan standar ASME

2.2 Seluruh peralatan dan bahan yang disediakan oleh *Manufacturer* harus dibuktikan dengan identifikasi dan lengkap bersama dengan *boiler*;

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a. Firing zone (furnace)
b. Steam generation surface (screen tubes and steam generation tubes)
c. Steam Drum with level instruments
d. Headers, downcomers and other interconnecting piping
e. Refractory and Insulation
f. Structural steel
g. Superheater
h. Desuperheater
i. Economizer complete with isolation block valves, bypass valve and thermal relief valve
j. Steam Drum Water Circulating pumps and drivers
k. Pressure Casing
l. CO (Regenerator Flue Gas) Ducts at the boiler (between a single CO gas connection and the CO ports entering the boiler)
m. Retractable sootblowers, control system, and related piping
n. Supplementary Fuel Burners
o. Air Ducts and Air Measuring Elements
p. Ductwork between boiler and economizer
q. Forced Draft Fans and Drivers
r. Dampers: fan inlet, fan discharge, combustion air to supplementary fuel burners, and combustion air to secondary air ports.
s. Valves, fittings and connections as described
t. Platforms and Ladders as required

a. Area pengapian (*furnace*)
b. *Steam generation surface* (*screen tube* dan *steam generation tube*)
c. *Steam drum* dengan *level instrument*
d. *Header, downcomer,* dan pipa lain yang saling terhubung
e. *Refractory* dan insulasi
f. Struktur baja
g. *Superheater*
h. *Desuperheater*
i. *Economizer* lengkap dengan isolasi *block valve*, *bypass valve* dan *thermal relief valve*
j. Pompa sirkulasi air pada *steam drum* dan penggeraknya
k. *Pressure casing*
l. Saluran CO (*Regenerator Flue Gas*) pada *boiler* (antara koneksi gas CO tunggal dengan lubang masukan CO ke *boiler*)
m. *Retractable sootblower,* sistem kontrol, dan pipa yang berhubungan
n. *Burner* bahan bakar tambahan
o. Saluran udara dan elemen pengukur aliran udara
p. Saluran antara *boiler* dan *economizer*
q. *Forced draft fan* beserta penggeraknya
r. *Damper: inlet fan, discharge fan,* udara pembakaran menuju bahan bakar tambahan, dan udara pebakaran menuju sambungan udara sekunder
s. *Valve*, *fitting*, dan sambungan sebagaimana telah dijelaskan
t. *Platform* dan *ladder* sebagaimana disyaratkan

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u. View ports

v. Inspection and Access Doors

w. Special tools necessary for maintenance

u. *View port*

v. Pintu inspeksi dan akses

w. Peralatan khusus untuk perawatan

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.

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. ABBREVIATIONS

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

ANSI	American National Standards Institute
API	American Petroleum Institute
ASME	American Society of Mechanical Engineers
AWG	Average Wall Thickness
dBA	Weighted Decibels
FRP	Fiberglass Reinforced Plastic
GA	General Arrangement
HBW	Hot Boiler Water
HHV	Higher Heating Value
HLCO	High Water Level Cutout
HP	High Pressure Steam
ISBL	Inside Battery Limits

4. SINGKATAN

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

ANSI	*American National Standards Institute*
API	*American Petroleum Institute*
ASME	*American Society of Mechanical Engineers*
AWG	*Average Wall Thickness*
dBA	*Weighted Decibels*
FRP	*Fiberglass Reinforced Plastic*
GA	*General Arrangement*
HBW	*Hot Boiler Water*
HHV	*Higher Heating Value*
HLCO	*High Water Level Cutout*
HP	*High Pressure Steam*
ISBL	*Inside Battery Limits*

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JIS	Japanese Industrial Standards	JIS	*Japanese Industrial Standards*
LHV	Lower Heating Value	LHV	*Lower Heating Value*
LWL	Low Water Level	LWL	*Low Water Level*
LLCO	low water level cut out	LLCO	*low water level cut out*
LS	Low Pressure Steam	LS	*Low Pressure Steam*
MCC	Maximum Continuous Capacity	MCC	*Maximum Continuous Capacity*
MCR	Maximum Continuous Rating	MCR	*Maximum Continuous Rating*
MIGAS	Indonesian Government Regulation for Oil & Gas	MIGAS	*Indonesian Government Regulation for Oil & Gas*
NEMA	National Electrical Manufacturers Association	NEMA	*National Electrical Manufacturers Association*
NPS	Nominal Pipe Size	NPS	*Nominal Pipe Size*
NWL	Normal Water Level	NWL	*Normal Water Level*
OSBL	Outside Battery Limits	OSBL	*Outside Battery Limits*
OSHA	Occupational Safety & Health Act	OSHA	*Occupational Safety & Health Act*
PMI	Positive Material Identification	PMI	*Positive Material Identification*
PO	Purchase Order	PO	*Purchase Order*
PTC	Performance Test Code	PTC	*Performance Test Code*
PWHT	Post Weld Heat Treatment	PWHT	*Post Weld Heat Treatment*
RFO	Refinery Fuel Oil	RFO	*Refinery Fuel Oil*
SI	International system unit	SI	*International system unit*
SNI	Standard Nasional Indonesia	SNI	*Standard Nasional Indonesia*
TEFC	Totally Enclosed Fan Cooler	TEFC	*Totally Enclosed Fan Cooler*
TENV	Totally Enclosed Not Ventilated	TENV	*Totally Enclosed Not Ventilated*
TST	Total Steam Temperature	TST	*Total Steam Temperature*
UTL	Utilities	UTL	*Utilities*

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

5. DEFINISI

5.1 Kata-kata berikut akan memiliki makna khusus jika digunakan pada dokumen ini:

PEMILIK	Pemilik Kilang didefinisikan sebagai

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	Pertamina Internasional.		PT Kilang Pertamina Internasional.
CONTRACTOR	Defined as The Organization to which PT Kilang Pertamina Internasional assign the work.	KONTRAKTOR	Didefinisikan sebagai Organisasi yang ditunjuk oleh di PT Kilang Pertamina Internasional untuk melakukan suatu pekerjaan.
shall	Indicates that the statement is mandatory.	*shall*	Menunjukkan bahwa pernyataan itu wajib.
should	Indicates a recommendation.	*should*	Menunjukkan rekomendasi.

6. REFERENCES

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.

6.1 Code and Standards

American National Standard Institute (ANSI)

ANSI A14.3	Fixed Ladders

American Society of Mechanical Engineers (ASME)

ASME Section I	Rules for Construction of Power Boiler
ASME Section II	Material Specification
ASME Section V	Non Destructive Examination

6. REFERENSI

Code, standar, dan spesifikasi berikut berlaku untuk spesifikasi ini. Ketika edisi tanggal atau pembaruan dari *code* atau standar tidak disebutkan di dalam dokumen spesifikasi ini, maka harus edisi yang terbaru atau edisi yang berlaku pada saat pembelian yang akan digunakan. Material & peralatan harus sesuai spesifikasi atau setara dengan yang disetujui oleh PEMILIK.

6.1 *Code* dan Standar

***American National Standard Institute* (ANSI)**

ANSI A14.3	*Fixed Ladders*

***American Society of Mechanical Engineers* (ASME)**

ASME Section I	*Rules for Construction of Power Boiler*
ASME Section II	*Material Specification*
ASME Section V	*Non Destructive Examination*

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ASME Section VIII Div. I	Rules for Construction of Pressure Vessels
ASME Section IX	Welding, Brazing, and Fusing Qualifications
ASME B31.1	Power Piping
ASME B16.5	Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/ Inch Standard
ASME B16.47	Large Diameter Steel Flanges: NPS 26 Through NPS 60 Metric/ Inch Standard
ASME B16.11	Forged Fittings, Socket Welding and Threaded
ASME B16.20	Metallic Gaskets for Pipe Flanges: Ring-Joint Spiral Wound and Jacketed
ASME B16.21	Nonmetallic Flat Gaskets for Pipe Flanges
ASME B1.20.1	Pipe Threads, General purpose, inch
ASME B18.2.1	Square Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series)
ASME PTC 4	Performance Test Code Fired Steam Generator
ASME STS-1	Steel Stacks
American Society of Civil Engineer (ASCE)	
ASCE/SEI 7	Minimum Design Loads for Building and other Structure
American Society for Testing and Materials (ASTM)	

ASME Section VIII Div. I	*Rules for Construction of Pressure Vessels*
ASME Section IX	*Welding, Brazing, and Fusing Qualifications*
ASME B31.1	*Power Piping*
ASME B16.5	*Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/ Inch Standard*
ASME B16.47	*Large Diameter Steel Flanges: NPS 26 Through NPS 60 Metric/ Inch Standard*
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ASME B1.20.1	*Pipe Threads, General purpose, inch*
ASME B18.2.1	*Square Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series)*
ASME PTC 4	*Performance Test Code Fired Steam Generator*
ASME STS-1	*Steel Stacks*
***American Society of Civil Engineer* (ASCE)**	
ASCE/SEI 7	*Minimum Design Loads for Building and other Structure*
American Society for Testing and Materials **(ASTM)**	

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ASTM C401	Standard Classification of Alumina and Alumina-Silicate Castable Refractories
ASTM D1066	Standard Practice for Sampling Steam
ASTM D3370	Standard Practices for Sampling Water from Closed Conduits

National Fire Code (NFC) – NFPA 85 for safety of fuel system

International Civil Aviation Organization (ICAO)

International Building Code (IBC) Edition 2006

National Electrical Manufacturers Association (NEMA)

Indonesian Regulation Peraturan Uap (StoomVerordening) 1930

Indonesian Regulation PERMEN LH No. 13 tahun 2009

American Boiler Manufacturers Association (ABMA)

Occupational Safety & Health Act (OSHA)

Standard Nasional Indonesia (SNI)

7. EQUIPMENT QUALIFICATION

7.1 Manufacturer shall have experienced in design and manufacture CO Boiler Package and auxiliaries.

7.2 Manufacturer shall have ISO 9001 Quality Management certification within scope design and manufacture CO Boiler Package equipment which still valid during the project.

ASTM C401	*Standard Classification of Alumina and Alumina-Silicate Castable Refractories*
ASTM D1066	*Standard Practice for Sampling Steam*
ASTM D3370	*Standard Practices for Sampling Water from Closed Conduits*

National Fire Code* (NFC) – NFPA *85 for safety of fuel system

***International Civil Aviation Organization* (ICAO)**

International Building Code (IBC) Edition 2006

***National Electrical Manufacturers Association* (NEMA)**

Peraturan Pemerintah Indonesia Peraturan Uap (*StoomVerordening*) 1930

Peraturan Pemerintah Indonesia PERMEN LH No. 13 tahun 2009

***American Boiler Manufacturers Association* (ABMA)**

***Occupational Safety & Health Act* (OSHA)**

Standard Nasional Indonesia (SNI)

7. KUALIFIKASI PERALATAN

7.1 *Manufacturer* harus memiliki pengalaman dalam merancang dan membuat *CO Boiler* dan kelengkapannya.

7.2 *Manufacturer* harus memiliki sertifikat ISO *9001: Quality Management* dengan lingkup desain dan pembuatan paket peralatan CO *Boiler* yang masih berlaku selama proyek berlangsung.

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7.3 Manufacturer shall comply with applicable standard within this code as listed in item 6.	7.3 *Manufacturer* harus mematuhi standar yang berlaku sebagaimana tercantum pada *item* 6.
7.4 Manufacturer shall give a predictive performance result similar CO Boiler Package which OWNER planned to buy.	7.4 *Manufacturer* harus memberikan gambaran performa/ hasil kinerja prediksi dari *CO Boiler Package* yang sejenis dengan rencana pembelian oleh PEMILIK.
7.5 Manufacturer shall have an ASME U stamp for pressure vessel manufacturer such as Drum.	7.5 *Manufacturer* harus memiliki sertifikat ASME U-*Stamp* untuk *pressure vessel manufacturer* semisal *drum.*
7.6 Manufacturer shall have an ASME S stamp for manufacturing and the assembly of power boilers.	7.6 *Manufacturer* harus memiliki sertifikat ASME S-*Stamp* untuk memproduksi dan merakit *power boiler*.
7.7 Manufacturer shall have an ASME PP stamp for manufacturing power piping	*7.7 Manufacturer* harus memiliki stempel ASME PP untuk memproduksi *power piping.*
7.8 Manufacturer shall provide references of CO Boiler installations similar to the recommended design proposed, for CO Boilers installed in Indonesia, South East Asia and the rest of the world.	7.8 *Manufacturer* harus memberikan referensi pemasangan CO *Boiler* serupa dengan desain yang diajukan, untuk CO *Boiler* yang dipasang di Indonesia, Asia Tenggara, dan belahan bumi lainnya.
7.9 Manufacturer shall provide sufficient evidence with their bids to demonstrate that the equipment meets these criteria, and highlight any aspect of the design that has not been previously implemented with a successful operating record. Any deviations shall require written approval from OWNER.	7.9 *Manufacturer* harus memberikan bukti yang cukup kuat bahwa peralatan yang diajukan memenuhi kriteria, dan menonjolkan aspek desain yang beleum pernah diterapkan sebelumnya dengan catatan pengoperasian yang sukses. Segala macam perubahan membutuhkan persetujuan tertulis dari PEMILIK.
7.10 Manufacturer shall supply equipment design shall be reliable, in regular and current production. Equipment shall have a minimum of 2 years proven continuous operational service in a similar environment and operating conditions. Equipment and/ or any sub-components of the equipment which are prototype shall not be accepted or deployed on the project. Prototype equipment shall not be proposed.	7.10 *Manufacturer* harus menyediakan desain peralatan yang andal, dalam kondisi produksi normal dan saat ini. Peralatan memiliki setidaknya 2 tahun pemakaian operasional secara berkelanjutan dengan kondisi lingkungan dan operasi yang sejenis. Peralatan dan/ atau komponen peralatan yang masih berupa *prototype* tidak diterima atau digunakan dalam proyek. Peralatan dalam bentuk *prototype* tidak boleh diajukan.

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8. INDONESIAN GOVERNMENT AGENCY REQUIREMENTS

8.1 The Indonesian Government require all equipment to be certified prior to installation on any Indonesian location. Those items which are field fabricated in situ have a similar process for site certification process.

8.2 DEPNAKER, is an Indonesian Government agency under the Directorate of Man Power. As required by the regulation of Indonesian Government, equipment for Steam Generation shall be certified by DEPNAKER.

8. PERSYARATAN BADAN PEMERINTAH

8.1 Pemerintah Indonesia mensyaratkan agar seluruh peralatan telah tersertifikasi sebelum terpasang di wilayah Indonesia. Peralatan yang difabrikasi di lapangan memiliki proses sertifikasi yang sama dengan lainnya.

8.2 DEPNAKER, merupakan Badan Pemerintah dibawah Kementerian Ketenagakerjaan. Sesuai dengan persyaratan Peraturan Pemerintah Indonesia, peralatan yang berupa *Steam Generation*/ Pembangkit Uap harus tersertifikasi oleh DEPNAKER.

9. BASIC DESIGN/ TECHNICAL REQUIREMENTS

9.1 **General**

9.1.1. Unit SI system shall be applied for the unit system, otherwise specified for all aspects of documents, drawings, nameplates, instrumentation, etc.

9.1.2. CO boiler shall consist of bare tube convection surface for the generation and superheating of steam and the heating of boiler feedwater.

9.1.3. The CO Boiler shall reduce CO in the CO Boiler stack gas to 500 volume ppm max (dry basis).

9.1.4. Tubes shall be inline (square pitch) rather than staggered.

9.1.5. Tubes shall be a minimum of 50 mm (2") OD. Minimum wall thickness shall be 5 mm (.2") for 50 mm (2") OD tubes. Corrosion allowance

9. DESAIN DASAR/ PERSYARATAN TEKNIS

9.1 **Umum**

9.1.1. Sistem satuan yang harus digunakan adalah satuan SI, kecuali terdapat aspek tertentu dari dokumen, gambar, *nameplate*, instrumentasi, dll.

9.1.2. CO *boiler* harus terdiri dari *bare tube* untuk permukaan area konveksi untuk pembuatan dan *superheating* uap serta pemanasan *boiler feedwater*.

9.1.3. CO *Boiler* harus dapat menurunkan kadar CO pada *stack* menjadi maksimal 500 ppm volume (udara kering).

9.1.4. *Tube* harus disusun dalam posisi sejajar (*inline – square pitch*) dari pada *staggered*.

9.1.5. *Tube* harus memiliki minimum diameter luar sebesar 50 mm (2"). Ketebalan minimal sebesar 5 mm (0.2") untuk *tube* berdiameter luar

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shall be 3 mm (1/8") on all tubes. All tubes shall be seamless type.

50 mm (2"). Korosi yang diijinkan sebesar 3 mm (1/8") untuk semua *tube*. Semua *tube* yang digunakan berjenis *seamless*.

9.1.6. Steam generating tubes shall be designed for a water to steam ratio of at least 15:1.

9.1.6. *Tube* untuk pembangkitan uap harus dirancang dengan rasio air/uap setidaknya sebesar 15:1.

9.1.7. The boiler shall be designed and manufactured considering to the project requirements, so that the design life of each project will be different.

9.1.7. *Boiler* dirancang dan dibuat dengan mempertimbangkan kebutuhan proyek sehingga *design life* setiap proyek akan berbeda.

9.1.8. The boiler and all auxiliary equipment included in this specification shall be suitable for an outdoor location.

9.1.8. *Boiler* beserta semua peralatan pendukung yang termasuk ke dalam spesifikasi ini harus dapat beroperasi di luar ruangan.

9.1.9. The boiler firing front shall be protected by an open-sided, roofed shelter.

9.1.9. Bagian depan pengapian *boiler* harus dilindungi oleh sisi terbuka, pelindung beratap.

9.1.10. To minimize spare parts inventory and costs, equipment and component parts of standard manufacture shall be used and provided to the maximum practical extent.

9.1.10. Untuk meminimalkan persediaan dan biaya suku cadang, peralatan dan komponen bagian dari standar manufacture harus digunakan dan disediakan (didesain) sesuai ketentuan praktis.

9.1.11. The Boiler and auxiliaries shall be capable of sustained operation in the automatic control mode between 20 % MCR (Maximum Continuous Rating) and 110% MCR for minimum period of the year between turnaround, unless otherwise specified by OWNER.

9.1.11. *Boiler* dan kelengkapannya harus dapat beroperasi secara berkelanjutan dalam mode kontrol otomatis antara 20 - 110 % MCR minimum dalam satu tahun antar periode *turnaround*, kecuali ditentukan lain oleh PEMILIK.

9.1.12. The Boiler and auxiliaries shall be capable of accommodating a rate of change of 20% MCR per minute over the control range of the boiler, for both increasing and decreasing steam demand, without causing a level shutdown or water carry over during the transient condition.

9.1.12. *Boiler* dan kelengkapannya harus dapat mengakomodir perubahan sebesar 20% dari MCR per menit dalam jangkauan kendali, baik untuk peningkatan dan penurunan permintaan uap, tanpa menyebabkan *shutdown* atau kelebihan air pada kondisi transien.

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9.1.13. The boiler and auxiliaries shall be capable of operating at 110 percent MCR for a one hour period once every 24 hours.

9.1.14. The superheater shall deliver steam downstream of the non-return valve at the specified temperature and pressure from 50% MCR to 100 % MCR, unless otherwise specified by OWNER.

9.1.15. The design of drums and boiler pressure containing parts, excluding tubes, shall provide a minimum 3 mm corrosion allowance.

9.1.16. Regardless of the climate conditions, all external surfaces shall be self-draining and protected against corrosion. An adequate open cover (roof and sides only) shall be provided over the firing aisle to protect personnel form inclement weather.

9.1.17. The boiler shall be designed to operate continuously over the control range within the emission standards enforced by the local authorities.

9.1.18. Space and access shall be provided for the inspection, cleaning, removal, and maintenance of all parts of the boiler such as tube bundles, headers, retractable burner parts, valves, pumps, fans, turbines, and motor drivers.

9.1.19. Facilities shall be provided for the complete draining of all the water from the fireside of the boiler unit after washing or for emergency use. The drain opening shall have a

9.1.13. *Boiler* dan kelengkapannya harus dapat beroperasi pada beban 110% MCR selama satu jam, sekali dalam 24 jam.

9.1.14. *Superheater* harus mengalirkan menghasilkan *steam downstream* ke *non-return valve* pada temperatur dan tekanan yang ditentukan dari 50 % - 100 % MCR, kecuali ditentukan lain oleh PEMILIK.

9.1.15. Desain *drum* dan komponen tekan dari *boiler* kecuali *tube*, memiliki toleransi korosi minimal 3 mm.

9.1.16. Dalam kondisi iklim apapun, seluruh bagian eksternal harus *self-draining* dan dilindungi dari terjadinya korosi. Untuk melindungi personil dan peralatan, diperlukan *open cover* yang memadai.

9.1.17. *Boiler* dirancang untuk dapat beroperasi terus-menerus melalui kendali jarak jauh dengan emisi sesuai dengan kebijakan local.

9.1.18. *Space* dan akses harus disediakan untuk keperluan inspeksi, pembersihan, penghilangaan dan perawatan seluruh komponen boiler seperti *tube bundle, header, burner*, *valve*, pompa, *fan*, turbin, dan motor penggerak.

9.1.19. Fasilitas harus disediakan untuk *complete draining* seluruh air dari *fireside* unit boiler setelah pembersihan atau untuk kondisi darurat. Lubang drainase harus

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minimum 80 mm (3 in.) diameter and shall be effectively sealed against overheating and the escape of flue gas. The location and size of openings and water washing procedures shall be submitted in the proposal.

memiliki diameter minimal sebesar 80 mm (3 inchi) dan harus dilakukan *seal* secara efektif terhadap *overheat* dan keluarnya *flue gas*. Lokasi dan ukuran bukaan serta prosedur *water washing* harus diajukan dalam proposal.

9.1.20. The flue gas content to stack must meet following requirements:

9.1.20. Kandungan *flue gas* pada *stack* harus memenuhi kriteria berikut:

a	Particulates, mg/Nm3	Max. 150	U.S EPA Method 5b
b	SO2, mg/Nm3	Max. 1200	US. EPA Method 6
c	NO2, mg/Nm3	Max. 160	US. EPA Method 7

9.2 **Combustion side**

9.2.1. Regenerator flue gas, combustion air, and supplementary fuel will be reacted in the combustion zone. The combined gases will then flow across screen tubes, superheater, steam generation tubes, economizer tubes, and out to a stack integral to the CO Boiler.

9.2.2. The boiler shall be suitable for operation with regenerator flue gas at flow rates between 60% and 115% of the process design rates unless otherwise specified. For these cases, the regenerator flue gas composition and temperature can be assumed identical to that of the process design case. Rated steam is not required for turndown cases, but the normal superheated steam temperature shall be maintained.

9.2.3. The boiler shall be capable of startup and sustained operation on supplementary fuel without regenerator flue gas. The boiler shall produce up to 60 % of rated

9.2 ***Combustion side***

9.2.1. *Regenerator flue gas*, udara pembakaran, dan bahan bakar tambahan bereaksi di dalam ruang bakar. Campuran gas mengalir melalui *screen tube, superheater, steam generation tube, economizer*, dan keluar melewati *stack* yang terintegrasi dengan CO *Boiler*.

9.2.2. *Boiler* harus dapat beroperasi dengan *regenerator flue gas* dengan laju aliran antara 60% hingga 115% dari desain proses, jika tidak ditentukan lain. Dalam kasus ini, komposisi dan temperatur *flue gas* pada regenerator dapat diasumsikan identik dengan desain proses. *Rated steam* tidak dibutuhkan saat *turndown* namun demikian, pada kondisi normal, temperatur uap jenuh harus dijaga.

9.2.3. *Boiler* harus dapat dijalankan dan beroperasi dengan bahan bakar tambahan tanpa gas buang *regenerator*. *Boiler* harus menghasilkan hingga 60% dari total

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steam flow on supplementary fuel only.

9.3 **Drums**

9.3.1. Drum connections as required shall be provided for steam outlet, safety valves, continuous blowdown, chemical feed, level controls, low level shutdown, feedwater inlet, pressure gage, vent and bottom blowdown. Separate connections shall be provided for pressure, level controls (2 connections for a pipe column for two level indicators – one level transmitter or control and a second level transmitter to span the entire level range of the drum), low level shutdown (3 sets of nozzles required for low level trips), and for each gauge glass. Drain connections shall be provided on all headers. Two 24 inch Welding Neck RF flanged manways shall be provided for access to the steam drum and any other drums and headers requiring access.

9.3.2. Adequate steam separation devices shall be provided to achieve steam leaving the steam drum in compliance with Table 1 of the ASME Consensus on Operating Practices for the Control of Feedwater and Boiler water Chemistry in Modern Industrial Boilers.

9.3.3. Steam drum shall be liberally sized to insure good liberation of steam during normal operation as well as under all local fluctuations.

9.3.4. Steam drum size should take in account also suitable spacing for maintenance and repair.

aliran uap hanya dengan bahan bakar tambahan.

9.3 ***Drums***

9.3.1. Sambungan drum harus disediakan untuk *steam outlet, safety valve, continous blowdown, chemical feed, level control, low level shutdown, inlet feedwater, pressure gage*, ventilasi, dan bottom blowdown. Koneksi terpisah harus disediakan untuk tekanan, kontrol tekanan dan level (2 koneksi untuk pipa kolom pada 2 level indikator – satu level *transmitter* atau kontrol dan *transmiter level* kedua untuk seluruh jangkauan level dari drum), *low level shutdown* (3 set level *nozzle* untuk *trip* rendah), dan untuk tiap gelas ukur. Koneksi drain harus disediakan untuk seluruh *header*. Dua buah *manway* 24 inci tipe flange *Welding Neck RF* harus disediakan untuk mengakses *steam drum* dan area lain yang memerlukan akses masuk.

9.3.2. Perangkat pemisahan uap yang memadai harus disediakan untuk mendapatkan uap yang keluar dari *steam drum* sesuai dengan Tabel 1 ASME *Consensus on Operating Practices* dalam mengendalikan *Feedwater* dan *Boiler Water Chemistry* pada *Boiler* Industri Modern.

9.3.3. *Steam drum* harus memiliki ukuran yang sesuai untuk memastikan penguapan pada kondisi normal sebagaimana pada kondisi fluktuasi

9.3.4. *Steam drum* memiliki ukuran yang memungkinkan untuk dapat dilakukan *maintenance* dan perbaikan.

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9.3.5. Drum shall be fusion welded, stress relieved and x-rayed, and shall have a manhole at each end. The interior of all drums shall be shop shot-blasted for smooth clean surface. Manhole cover at each end of the drum shall be attached to the inside of the drum by hinges.	9.3.5. *Drum* harus dilas, *stress relieve*, *x-ray*, dan harus dilengkapi dengan *manhole* pada kedua ujungnya. Bagian dalam harus memiliki permukaan yang halus dan bersih. *Manhole* pada kedua ujung dipasang pada bagian dalam menggunakan penggantung.
9.3.6. To improve connection hinges and davit from tube to drum, drum area shall be groove prior to connection. Those connection shall be pneumatic/ hydraulic expand and recorded.	9.3.6. Untuk meningkatkan koneksi engsel dan tiang penggantung dari *tube* ke *drum*, area *drum* harus dibuat *groove* sebelum disambungkan. Sambungan berupa pneumatik/ hidrolik dan masuk dalam catatan.
9.3.7. When multiple lower drums are furnished, they shall have hand hole access sufficient in size and number to permit inspection and plugging of tubes and to permit cleaning and rolling tubes into the drums with commercially available equipment.	9.3.7. Ketika beberapa *lower drum* dilengkapi, *lower drum* harus memiliki akses *hand hole* yang cukup dalam ukuran dan jumlah yang memungkinkan untuk melakukan inspeksi dan *plugging tube* serta memungkinkan pembersihan dan *rolling tube* ke dalam *drum* dengan peralatan yang tersedia secara komersial.
9.3.8. The steam drum shall have steam separators, baffles and distribution pipes for feed water, chemical and blow down collection. Drum internals shall be removable without damage to drum.	9.3.8. *Steam drum* harus memiliki separator, *baffle* dan pipa distribusi air, bahan kimia dan tampungan *blow down*. Bagian dalam drum harus dapat dilepas tanpa merusak *drum*.
9.3.9. With the dissolved solids concentration in water as stipulated by ABMA, the solids content of steam shall not exceed 1000 (a thousand) ppm in the range from 50 to 100 percent of MCC.	9.3.9. Dengan adanya konsentrasi larutan sesuai ABMA, kandungan *solid* tidak boleh lebih dari 1000 ppm pada rentang 50 – 100 MCC.
9.3.10. No part of a boiler drum shall be directly exposed to furnace radiation unless it is adequately protected by insulating refractory	9.3.10. Tidak ada komponen *drum* yang terpapar radiasi *furnace* secara langsung kecuali terlindung dengan baik oleh insulasi *refractory.*

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9.3.11. Water surge volume within the steam drum shall be adequate to accommodate the resulting swell from a 20 percent increase in load per minute, without boiler water carryover. Also, drum water volume below the normal level shall accommodate the water shrinkage resulting from a 20 percent decrease in load per minute without actuating the low water level cut-off.

9.3.12. Tube holes and any other nozzles shall not be placed on a weld line, as much as possible.

9.3.13. The steam drum shall be of sufficient size to hold a 5 minute inventory of boiler feedwater between the low liquid level alarm and the minimum safe operating level. An additional 5 minutes of reserve water volume shall be provided below the minimum safe operating level to protect the tubes during shutdown.

9.3.14. The LLCO shall be located not less than 50 mm (2 in.) above the top of the highest downcomer.

9.3.15. The rise in water level (swell) above the normal water level (NWL) resulting from the requirements shall not cause a carryover or actuation of the high water level cut-out (HLCO).

9.3.16. The fall in water level (shrinkage) below the NWL resulting from the requirements shall not cause the actuation of the LLCO.

9.3.17. The level and pressure indicator and transmitter of the steam drum shall be certified and calibrated both at shop and at site.

9.3.11. *Water surge volume* di dalam *steam drum* harus cukup untuk menampung semburan yang dihasilkan dari kenaikan beban sebesar 20% per menit, tanpa *boiler water carryover*. *Drum water volume* dibawah level normal harus menampung *water shrinkage* yang dihasilkan dari penurunan beban sebesar 20% per menit tanpa *low water level cut-off*.

9.3.12. Lubang *tube* dan nozzle sebisa mungkin tidak ditempatkan pada garis las.

9.3.13. *Steam drum* harus memiliki ukuran yang mencukupi untuk menampung cadangan *boiler feedwater* selama 5 menit antara *low liquid level alarm* dan *minimum safe operating level*. Cadangan volume air harus dapat bertahan setidaknya selama 5 menit untuk melindungi *tube* selama *shutdown*.

9.3.14. LLCO harus ditempatkan setidaknya 50 mm di atas *downcomer* tertinggi.

9.3.15. Kenaikan level air di atas NWL yang diperoleh dari persyaratan, tidak boleh menyebabkan *carryover* atau *actuation* HLCO.

9.3.16. Penurunan level air di bawah NWL yang diperoleh dari persyaratan, tidak menyebabkan *actuation* pada LLCO.

9.3.17. Indikator level dan tekanan serta *transmitter steam drum* harus disertifikasi dan dikalibrasi baik di lokasi pembuatan dan di lapangan

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(lokasi pemasangan).

9.3.18. The level transmitter shall be calibrated in accordance with the level gauge installed at the drums.

9.3.18. *Level transmitter* harus terkalibrasi sesuai dengan *level gauge* yang terpasang pada drum.

9.3.19. Relief valves of the steam drum shall be provided complete with selection calculation and engineering protection philosophy.

9.3.19. *Relief valve* pada *steam drum* harus disediakan serta dilengkapi dengan perhitungan untuk pemilihan (tipe) dan perancangan sesuai filosofi proteksi (yang berlaku).

9.3.20. Relief valves shall be certified at and calibrated both at shop and at site.

9.3.20. *Relief valve* harus tersertifikasi dan terkalibrasi baik di lokasi pembuatan maupun di lapangan (lokasi pemasangan).

9.4 **Burners**

9.4 ***Burner***

9.4.1. Supplementary fuel burners shall be gas burners only. Burners shall be staged fuel low NOx type. Startup secondary fuel oil shall be fired in standard oil guns.

9.4.1. Bahan bakar tambahan harus diperuntukanuntuk gas *burner* saja. *Burner* harus menggunakan tipe *staged fuel low NOx*. Bahan bakar lain berupa *fuel oil* untuk penyalaan awal harus menggunakan standar *oil gun*.

9.4.2. Fuel gas shall be used for pilots. Vaporized LPG or secondary fuel oil (diesel oil or light cycle oil) shall be used for main burners during startup.

9.4.2. Vaporized LPG dan bahan bakar sekunder (*fuel oil* seperti minyak solar atau *light cycle oil*) harus digunakan untuk *main burner* saat *start up.*

9.4.3. Each supplementary fuel burner shall have a non-modulating (either open or closed) pneumatically operated automated air register. The register will close upon burner shutdown.

9.4.3. Setiap *burner* tambahan harus memiliki register udara otomatis yang dioperasikan menggunakan sistem pneumatik (terbuka atau tertutup). Register akan tertutup saat *burner* mati.

9.4.4. Each supplementary fuel burner shall be equipped with a gas pilot, ignition transformer and spark ignitor and shall be designed for the installation of two dual ultraviolet and infrared (self checking) flame sensors. The sensors on each burner are to be positioned or

9.4.4. Tiap *burner* tambahan harus dilengkapi dengan *gas pilot, ignition transformer,* dan *spark ignitor* serta harus dirancang untuk dapat dipasangi dua sensor api *ultraviolet* dan *infrared (self checking)*. Sensor pada tiap *burner* diposisikan sedemikian rupa sehingga satu

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shielded so that one sensor will sense only that burner's main flame and the other sensor will sense only that burner's pilot flame. The flame sensors shall be pointed downward – preferably at 45 degrees. The flame sensor ports shall be instrument air purged.

9.4.5. Manual indicating valves (firing cocks) shall be provided on the gas lines at each burner.

9.4.6. Dry air purged sight ports shall be provided for sighting individual pilots and burners.

9.4.7. Burners-General

a. The burners shall permit complete fuel combustion in the furnace envelope without causing flame impingement on furnace tubes and/ or secondary fuel combustion in the super heater or boiler flue gas passages.

b. The individual burner turndown ratio shall be 10:1 for fuel Gas, and 4:1 for Fuel Oil, unless otherwise specified.

c. Burner capacity shall be sufficient to maintain MCC at the specified steam conditions while firing any one of the specified fuels or combination of fuels shown on the data sheets.

d. Arrangement of the burners shall be such as to provide uniform heat distribution throughout the furnace without flame impingement on the heating surfaces while firing at loads up to 110 percent of MCC.

sensor hanya dapat mendeteksi api utama sementara sensor lain hanya mendeteksi api pada *pilot*. Sensor api harus diposisikan menghadap ke bawah – lebih dianjurkan 45 derajat. *Port* sensor api harus dibersihkan menggunakan udara (terhubung dengan *purging instrument air*).

9.4.5. *Valve* indikator manual harus disediakan untuk tiap saluran gas pada tiap *burner*.

9.4.6. Lubang penglihatan untuk masing-masing *pilot* dan *burner* harus terhubung dengan *dry air purged*.

9.4.7. *Burner* – Umum

a. *Burner* harus dapat melakukan pembakaran sempurna dalam *furnace* tanpa menyebabkan kontak api langsung pada *tube* dan/ atau pembakaran sekunder pada *superheater* atau *flue gass passage.*

b. Rasio *turndown* tiap burner sebesar 10:1 untuk gas dan 4:1 untuk minyak, kecuali jika ditentukan lain.

c. Kapasitas *burner* harus dapat menjaga MCC pada kondisi uap tertentu selama pengapian dari bahan bakar atau kombinasinya sesuai dengan *data sheet.*

d. *Burner* diletakkan pada posisi yang dapat menghasilkan distribusi pengapian yang merata tanpa terjadi kontak api langsung dengan permukaan pemanas selama pengapian hingga 110 % MCC.

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e. Burner heat release curves shall be marked to show minimum stable operating conditions and maximum and minimum fuel pressures for each of the specified fuels.

9.4.8. Gas Burners

a. Gas burners shall be capable of burning the specified fuels to complete combustion with no more than 10 percent excess air. The burners shall operate throughout the full firing range without instability, pulsation, blowtorch effect or poor combustion.

b. Burners shall be of the multiport type.

c. Burners shall be designed to resist exposure to furnace heat by shielding all parts of the register from the furnace radiation and conducted heat.

9.4.9. Oil Burners

a. Oil burners shall be of the steam atomizing type, with air registers, diffusers and variable capacity atomizers, providing uniform atomization throughout the entire range of the burner and to efficiently burn the specified fuels.

b. The burner design shall permit ready removal and interchangeability of atomizer tips.

c. Unless therwise specified, the steam atomizer shall operate at pressures not to exceed 17.6 kg/cm2.g (250 psig). The burner

e. Kurva pelepasan panas harus menunjukkan kondisi operasi stabil dan tekanan bahan bakar maximum/ minimum untuk tiap bahan bakar yang ditentukan.

9.4.8. *Gas Burner*

a. *Gas burner* harus dapat membakar bahan bakar dengan kelebihan udara tidak lebih dari 10%. *Burner* dioperasikan dengan jangkauan penuh tanpa terjadi instabilitas, pulsasi, efek semburan atau pembakaran lemah.

b. *Burner* harus menggunakan tipe *multiport*.

c. *Burner* dirancang untuk tahan terhadap paparan panas dengan melindungi seluruh komponen register udara dari radiasi dan konduksi.

9.4.9. *Oil Burner*

a. *Oil burner* berjenis *steam atomizing*, dengan *air register*, *diffuser*, dan *variable capacity atomizer,* untuk menghasilkan atomisasi yang seragam pada seluruh lokasi burner dan mengefisiensikan pembakaran untuk bahan bakar tertentu.

b. Desain *burner* memungkinkan untuk dilakukan pelepasan dan pergantian ujung *atomizer*.

c. Jika tidak disebutkan lain, *steam atomizer* harus beroperasi pada tekanan tidak lebih dari 17.6 kg/cm2.g (250 psig). Kebutuhan

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shall require not more than 11 kg/cm2.g (156 psig) oil at the burner and shall require not more than 1 percent of the steam generated at full load for proper atomization.

tekanan minyak pada *burner* tidak lebih dari 11 kg/cm2.g (156 psig) dan tidak lebih dari 1 persen dari uap bangkitan pada atomisasi dengan beban penuh.

d. Burner guns shall be of the quick-release, removable type and shall be provided with compressed air actuated aspirator seals, and interlocks to prevent withdrawal before aspiration.

d. *Burner gun* harus dapat dilepas dengan mudah, dan dilengkapi dengan *aspirator seal* dengan penggerak udara bertekanan, serta *interlock* untuk menghindari kegagalan sebelum terjadi aspirasi.

e. The oil burner on boilers equipped with only one burner shall be equipped with at least 2 (two) separately installed and operating fuel oil guns, each suitable for 100 percent firing.

e. *Oil burner* pada *boiler* dengan satu *burner* harus dilengkapi setidaknya dengan 2 *oil gun* yang dipasang terpisah, dimana masing-masing memiliki kemampuan 100% pengapian.

f. Burner assembly shall be arranged so that it will be possible to remove any oil gun for cleaning, renewal and adjustments without affecting operation of the boiler.

f. Perakitan *burner* harus memungkinkan untuk memisahkan *oil gun* untuk pembersihan, pembaruan, dan pengaturan tanpa mempengaruhi operasi *boiler*.

9.4.10. Combination Gas and Oil Burners

9.4.10. Kombinasi *Gas* dan *Oil Burners*

a. Combination burners shall conform to all burner requirements listed above.

a. Kombinasi *burner* harus sesuai dengan persyaratan *burner* di atas.

b. Air registers shall be provided with adjustable control mechanisms to provide maximum flame control for the best possible mixing of fuel and combustion air while burning each fuel at maximum efficiency.

b. *Air register* harus dilengkapi mekanisme kontrol yang dapat diubah untuk mendapatkan api yang maksimum dengan campuran udara dan bahan bakar yang paling efisien.

c. Provisions shall be made to protect unused burners from overheating when other fuel is being fired.

c. *Burner* yang tidak digunakan harus dilindungi dari adanya *overheat*.

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9.4.11. Pilot Igniters

a. An air gas automatic electric pilot igniter shall be provided for each burner, of a type using boiler fan air for combustion, so that shutting off air to the main burner also will shut off air to the pilot igniter.

b. Pilot igniters shall be designed so that overheating or other igniter damage would not occur even if fired continuously.

c. Pilot igniters shall be equipped with flame detectors. These shall be purged with instrument air. Pilot igniters shall be “blowout proof”, capable of maintaining ignition while maximum combustion air is flowing through the main burners with main fuel shutoff.

d. Booster fans for eddy plate igniters shall be furnished.

e. A shop assembled electrical igniting control cabinet with necessary electrical accessories, flex pipes and connecting lines shall be furnished.

f. Pilot igniters shall be controlled automatically by Burner Management System but on certain condition manual is allowed.

9.4.12. Burner Piping

Burner piping and valves shall be provided as specified on the data

9.4.11. *Pilot Igniter*

a. Tiap *burner* harus dilengkapi dengan pemantik (*air gas automatic electric pilot igniter),* yang menggunakan *boiler fan* untuk pembakaran. Pemantik harus terhubung dengan *fan* udara pembakaran sehingga bila suplai udara pada *main burner* dihentikan, suplai udara pada *pilot igniter* juga berhenti.

b. *Pilot igniter* harus dirancang agar tidak terjadi kerusakan dan *overheat* sekalipun pengapian tetap dilakukan.

c. *Pilot igniter* harus dilengkapi dengan detektor api. *Pilot igniter* harus dibersihkan (dan terkoneksi) dengan *instrument air*. *Pilot igniter* harus “*blowout proof*”, mampu menjaga pengapian saat udara pembakaran dialirkan secara maksimum melalui main *burner* dengan bahan bakar *shutoff*.

d. *Booster fan* untuk *eddy plate igniter* harus di lengkapi.

e. Kaninet kontrol untuk pengapian elektrik lengkap (*shop assembled)* dengan kelengkapannya, pipa fleksibel, dan konektor harus di lengkapi.

f. *Pilot igniter* harus dapat dikontrol secara otomatis melalui *Burner Management System* dan dapat diatur manual pada kondisi tertentu.

9.4.12. Pipa *Burner*

Pipa dan *valve burner* harus sesuai dengan spesifikasi pada data

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sheets. Materials shall be in accordance with OWNER Specification.

9.4.13. Burner Wind Box

Each boiler shall be provided with a burner wind box (Carbon Steel) completely shop fabricated with cut out and drillings for field installation of burners. Each wind box shall be constructed of not less than 6 mm (1/4 inch) steel plate and shall be provided with all necessary supports, stiffeners and access doors. Observation ports shall not protrude through wind box.

The wind box shall contain the necessary dampers, guide vanes, and rounded inside corners to assure equal distribution of combustion air to the air registers for each burner and to avoid flow-induce disturbances that could affect flame stability and combustion efficiency.

Where a wind box supplies combustion air to more than two burners, a dynamic flow model shall be provided (following the contract award) to demonstrate the effectiveness of the proposed wind box air distribution system. Full test details of the proposed model shall be submitted in the proposal.

9.4.14. Burner Management System.

a. Burner Management System shall be provided to control Fuel Gas, Fuel Oil, Combination gas and oil burners, Force Draft Fan, Air register, and other process parameter which affected package boiler efficiency.

sheet. *Material* yang digunakan harus mendapat persetujuan dari Spesifikasi PEMILIK.

9.4.13. *Burner Wind Box*

Tiap *boiler* dilengkapi dengan *wind box* (material baja karbon) yang difabrikasi dengan pemotongan dan pengeboran untuk keperluan instalasi *burner*. Tiap wind box dibangun dengan tebal pelat baja tidak kurang dari 6 mm (1/4 inch) lengkap dengan *support*, *stiffener*, dan pintu akses. Lubang obervasi tidak menonjol dari *wind box.*

Wind box harus dilengkapi dengan *damper, guide vanes*, dan tepi melengkung untuk memastikan udara pembakaran terdistribusi merata di *air register* pada masing-masing *burner* dan untuk menghindari terjadinya gangguan yang menggangu stabilitas api dan efisiensi kebakaran.

Apabila *wind box* menyupali udara pembakaran ke lebih dari dua *burner*, diperlukan model aliran dinamis untuk menunjukkan efektivitas *wind box* yang diajukan. Detail dari *wind box* dan model aliran dimasukkan ke dalam proposal.

9.4.14. *Burner Management System*

a. *Burner Management System* diperlukan untuk mengatur *fuel gas, fuel oil*, kombinasi gas dan minyak pada *burner, force draft fan, air register*, dan parameter proses lain yang mempengaruhi efisiensi *boiler*.

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b. Burner Management system shall also control sequence of firing.

9.5 **Superheater**

9.5.1. The superheater shall be bare-tube type.

9.5.2. The superheater steam flow shall be co-current with the flue gas flow.

9.5.3. The maximum allowable pressure drop for the superheater shall be 2.5 kg/cm2.

9.5.4. The superheater shall be drainable.

9.5.5. The superheater outlet temperature shall be controlled by a desuperheater utilizing boiler feedwater. The boiler manufacturer shall provide the desuperheating water control valve assembly (including isolation and bypass provisions) for incorporation in the steam temperature control system (specified elsewhere). The control valve assembly shall follow the same general specifications and shall be of the same manufacturer as the equipment in the boiler combustion control and feedwater control systems. The control valve action will be to fail locked, i.e. the valve position shall not change upon loss of actuation signal.

9.5.6. Thermocouples shall be furnished and located on superheater tubes in the highest steam temperature section. The thermocouples are to provide an indication of element temperatures during start-ups and temperature distribution during operation. The vendor shall determine the exact number and location of thermocouples.

b. *Burner management system* harus dapat mengatur urutan pengapian.

9.5 ***Superheater***

9.5.1. *Superheater* harus berupa *bare-tube.*

9.5.2. Aliran uap *superheater* harus sejalan dengan aliran *flue gas.*

9.5.3. Penurunan tekanan pada *superheater* maksimum sebesar 2.5 kg/cm2.

9.5.4. *Superheater* harus dapat dikuras.

9.5.5. Temperatur pada *outlet superheater* dapat diatur dengan desuperheater memanfaatkan *feedwater*. *Boiler manufacturer* harus menyediakan rangkaian *valve* pengontrol *desuperheater* (termasuk isolasi dan *bypass*) yang tergabung ke dalam sistem kontrol temperatur uap. *Control valve* pengatur harus mengikuti spesifikasi umum dan dibuat oleh *manufacturer* yang sama dengan sistem kontrol pembakaran dan *feedwater*. Aksi *control valve* berupa *fail-locked* dimana posisi *valve* tidak berubah saat kehilangan sinyal aktuasi.

9.5.6. Termokopel harus dipasang dan pada bagian *tube superheater* dengan temperatur tertinggi. Termokopel digunakan untuk mengetahui komposisi temperatur selama *start-up* dan distribusi temperatur saat operasional. *Vendor* harus memastikan jumlah dan lokasi pemasangan termokopel. *Wiring* termokopel

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Thermocouple wiring shall terminate in a junction box located near the superheater outlet header.

terkumpul pada kotak sambungan yang berada di dekat *header outlet superheater*.

9.5.7. A steam sampling nozzle of the design recommended by the ASME Performance Test Code 19.11 shall be provided between the steam drum and the superheater. Piping between the steam drum and the superheater shall be provided by the vendor.

9.5.7. *Nozzle* sampel uap dirancang mengacu pada ASME *Performance Test Code* 19.11 berada di antara *steam drum* dan *superheater*. Pipa antara *steam drum* dan *superheater* disediakan oleh *Vendor*.

9.5.8. Unless otherwise specified, acceptable superheater tube materials are 2 ¼ Cr, 5 Cr or 9 Cr. Tube design temperature shall be at least 55ºC above max calculated tube wall temperature (TWT). Corrosion allowance for superheater tubes shall be at least 3 mm. In no case shall superheater tube thickness be less than Sch 80 AW.

9.5.8. Jika tidak disebutkan lain, material *tube superheater* yang diterima adalah 2.25% Cr, 5% Cr atau 9% Cr. Temperatur desain *tube* setidaknya sebesar 55^0C di atas maksimum *tube wall temperatur* (TWT). Batas korosi yang diizinkan minimal sebesar 3 mm. Tebal *tube superheater* tidak kurang dari Sch 80 AW.

9.5.9. The super heater shall be designed with enough pressure drop to prevent element burnout over full load range. Tubes welded to the headers shall be outside the gas passes. Locate and support the super heater elements and header to operate without vibration, sagging or misalignment. The super heater and headers shall be supported on pressure parts.

9.5.9. *Superheater* dirancang dengan *pressure drop* tertentu untuk menghindari *burnout* akibat beban penuh. Pengelasan *tube* harus dilakukan pada sisi luar laluan gas. Pemasangan dilakukan dengan sedemikian rupa untuk menghindari terjadi vibrasi, goncangan, dan *misaligniment*. *Superheater* dan *header* harus ditumpu pada bagian bertekanan.

9.5.10. Super heater shall be designed so that the soot blowers can effectively remove accumulated soot from the outside surface of the tubes. Super heater tube shall be spaced to minimize the possibility of soot "bridging" and/or "plugging" of super heater tube lances.

9.5.10. *Superheater* dirancang agar *sootblower* dapat menghilangkan *soot* dari permukaan secara efektif. Penempatan *tube* pada *superheater* dilakukan dengan meminimalkan kemungkinan terjadinya *bridging* dan/ atau *plugging*.

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9.6 **Steam Generating Coils**

9.6.1. Screen tubes and steam generation tubes shall be designed for a water to steam ratio of at least 15:1.

9.6.2. Tubes shall be seamless killed carbon steel (SA-192); 50 mm OD minimum, 5 mm thickness minimum. Corrosion allowance shall be at least 3 mm.

9.6.3. All tubes (water wall tubes, dividing wall tubes, screen tubes, generating tube banks, superheater and economizer) and their headers shall be designed to permit chemical cleaning and complete draining.

9.6.4. All tubes in furnaces shall be fusion welded to the headers.

9.6.5. Vertical tubes shall be properly supported or guided, or both, to prevent sagging and vibration and to permit expansion.

9.6.6. The boiler shall be designed to permit tube replacement in the boiler, furnace or super heater with a minimum of difficulty and downtime. Tube arrangement shall permit tube replacement without unreasonable removal of other tubes or steel casing.

9.6.7. All tubes shall be fabricated from maximum lengths to produce a continuous tube section with a minimum number of circumferential tube joints. Tube bends shall meet the ABMA standard out of roundness tube bend tolerances.

9.6.8. The boiler tube ends shall be lightly ground before installation to provide

9.6 ***Steam Generating Coils***

9.6.1. *Screen tube* dan *tube* pembangkit uap dirancang untuk perbandingan air dan uap setidaknya sebesar 15:1.

9.6.2. *Tube* berupa *seamless killed carbon steel* (SA-192): diameter luar minimal 50 mm, ketebalan minimal 5 mm. Korosi yang diperbolehkan minimal 3 mm.

9.6.3. Seluruh *tube* (*water wall, dividing wall, screen, generating*, *superheater*, dan *economizer*) serta *header* dirancang untuk dapat dibersihkan dan dikuras total.

9.6.4. Seluruh *tube* pada *furnace* dilas menyatu dengan *header*.

9.6.5. *Tube* pada posisi vertikal harus disangga atau diberikan *guide* untuk menghindari *sagging* dan vibrasi serta memberikan ruang ekspansi.

9.6.6. *Boiler* dirancang untuk dapat dilakukan pergantian *tube*, dengan tingkat kesulitan dan waktu *downtime* seminimal mungkin. Susunan *tube* harus memungkinkan penggantian *tube* tanpa pelepasan yang tidak wajar baik dari tabung atau *steel casing*.

9.6.7. Seluruh *tube* dibuat dengan panjang maksimum untuk menghasilkan bagian *tube* yang kontinyu dengan jumlah sambungan seminimal mungkin di area melingkar. Tekukan *tube* harus sesuai dengan standar ABMA untuk toleransi *out of roundness*.

9.6.8. Ujung *tube* harus di beri alas sebelum pemasangan untuk

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clean metal surfaces.

menghasilkan permukaan logam yang bersih.

9.7 **Economizer**

9.7.1. The economizer shall be a bare-tube type.

9.7.2. The economizer water flow shall be counter-current with the flue gas flow.

9.7.3. The maximum allowable pressure drop for the economizer shall be 1.1 kg/cm^2.

9.7.4. The economizer tubes and headers shall be completely drainable.

9.7.5. Piping between economizer and steam drum shall be furnished by the manufacturer.

9.7.6. A 1-1/2 inch ID ANSI RF flanged nozzle shall be provided on the feedwater line between the economizer and the steam drum for the installation of a thermowell.

9.7.7. The economizer shall be designed to avoid steaming during all operating cases and particularly as a result of short term feedwater rate fluctuations. As a minimum precaution, the economizer shall be designed for an outlet temperature that is at least 28°C below the boiling point at the economizer outlet pressure.

9.7.8. Tubes shall be seamless killed carbon steel (SA-192); 2” (50 mm) OD minimum, 0.2” (5 mm) thickness minimum. Corrosion allowance shall be at least 1/8” (3 mm).

9.7.9. Vendor shall provide isolation block valves, bypass valve and thermal relief valve for the economizer coil.

9.7 ***Economizer***

9.7.1. *Economizer* harus berupa tipe *bare-tube*.

9.7.2. Aliran air pada *economizer* berlawanan dengan aliran *flue gas.*

9.7.3. *Pressure drop* pada *economizer* tidak lebih dari 1.1 kg/cm^2.

9.7.4. *Tube* dan *header economizer* harus dapat dikuras hingga bersih.

9.7.5. Pipa antara *economizer* dan *steam drum* disiapkan oleh *manufacturer*.

9.7.6. *Flanged nozzle* dengan ID 1.5 inchi ANSI RF diperlukan untuk pemasangan *thermowell* di jalr *feedwater* antara *economizer* dan *steam drum.*

9.7.7. *Economizer* harus dirancang agar tidak terjadi penguapan selama operasi akibat adanya fluktuasi *feedwater*. Temperatur *outlet* pada *economizer* setidaknya sebesar 28^{0}C pada tekanan keluaran *economizer*.

9.7.8. *Tube* berupa pipa *seamless* yang terbuat dari baja karbon (SA-192); diameter luar minimal 2” (50 mm), ketebalan minimum 0.2” (5mm). Batas korosi yang diizinkan minimal 1/8”(3 mm).

9.7.9. *Vendor* harus menyediakan *block valve* isolasi, *bypass valve* dan *thermal relief valve* untuk *coil*

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	economizer.
9.7.10. The economizer shall be steel-encased, arranged for counter flow of water and gas, and minimum draft loss. The economizer shall be designed to avoid steaming.	9.7.10. *Economizer* harus tertutup oleh penutup baja, diatur untuk *counter flow* antar air dan gas, dan *draft loss* seminimal mungkin. *Economizer* dirancang untuk menghindari penguapan.
9.7.11. Casing for economizer shall be suitable reinforced and stiffened. Where size and shipping facilities permit, the economizer shall pre-fabricated to allow for field installation with minimum assembly and welding.	9.7.11. *Casing economizer* harus diperkuat dan diperkaku. Apabila secara ukuran dan fasilitas pengiriman memadai, economizer harus dilakukan pre-fabrikasi untuk meminimalkan perakitan dan pengelasan di lapangan.
9.8 **Boiler Feedwater Preheating**	9.8 ***Boiler Feedwater Preheating***
9.8.1. Make up Boiler Feed Water shall be preheated before entering the Economizer coil by mixing with a pumped stream of water from the Steam Drum. Water from the Steam Drum is added in sufficient quantity to raise the mixture temperature as defined before entering the Economizer coil to stay above the dewpoint of the flue gas to avoid condensing acid corrosion.	9.8.1. *Make up Boiler Feed Water* harus dipanaskan terlebih dahulu sebelum memasuki *Economizer* dengan cara mencampurkan air dari steam *drum*. Air dari *steam drum* ditambahkan dalam jumlah tertentu untuk mendapatkan temperatur campuran sebelum memasuki *Economizer* untuk menjaga gas buang di atas titik pengembunan yang dapat menyebabkan kondensasi dan berujung pada korosi asam.
9.8.2. Manufacturer shall supply water circulating pumps and drivers to send water from the Steam Drum to mix with the incoming Boiler Feedwater. Pumps shall be API 610 Process pumps.	9.8.2. *Manufacturer* menyediakan pompa dan penggeraknya untuk menyalurkan air dari *steam drum* ke campuran dengan air masukan *boiler*. Pompa mengacu pada standar API 610 *Process pump*.
9.9 **Sootblower**	9.9 ***Sootblower***
9.9.1. A fully automatic sootblowing system shall be provided to keep the superheater, boiler, and economizer surfaces free of soot and catalyst dust.	9.9.1. Sistem *sootblowing* otomatis harus disediakan untuk menjaga permukaan *superheater*, *boiler*, dan *economizer* terbebas dari jelaga dan debu katalis.
9.9.2. The maximum radial coverage for	9.9.2. Jangkauan perlindungan maksimal

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sootblowers shall be 1200 mm. Maximum number of rows between soot blowers shall be 12. End rows shall be 8.	dari *sootblower* sebesar 1200 mm. Jumlah baris maksimum antar *sootblower* adalah 12 dan 8 pada bagian ujung.
9.9.3. All sootblowers shall have electric motor driven retractable elements. Individual soot blowers shall be equipped with an isolation valve. Air purges from the valve to the boiler and from the packing gland to the valve shall be provided.	9.9.3. Seluruh *sootblower* harus memiliki penggerak berupa motor listrik. Tiap *soot blower* dilengkapi dengan *valve* isolasi. Semprotan angin dari *valve* menuju boiler dan dari *packing gland* menuju *valve* harus disediakan.
9.9.4. The soot blower system shall be complete including wall boxes, heads, elements, operators, steam valves, isolation valves and purge connections and steam piping.	9.9.4. Sistem *soot blower* harus dilengkapi dengan *wall boxes, head, element*, operator, *valve* uap, isolation *valve* dan *purge connection* serta pipa uap.
9.9.5. The system shall have automatic sequential control which will allow the remote manual operation of any element.	9.9.5. Sistem harus dilengkapi dengan kontrol otomatis sekuensial yang memungkinkan untuk dilakukan pengoperasian manual
9.9.6. Lanes at soot blowers shall be 24” (610 mm) to facilitate access for inspection and maintenance.	9.9.6. Laluan/ *Lanes* pada *soot bower* setidaknya sebesar 24 inchi (610 mm) sebagai akses inspeksi dan pemeliharaan.
9.9.7. A heat up system shall be included to warm the sootblower piping prior to initiating the sootblowing cycle that prevents introduction of condensate into the flue gas stream.	9.9.7. Sistem pemanas dapat digunakan untuk memanaskan pipa *sootblower* guna memulai siklus *sootblowing* yang mencegah kondensasi akibat aliran *flue gas*.
9.9.8. Sootblower control panel shall be located at near the Boiler local operating control panel either the middle platform to easier operator operating sootblower. Operator shall have clear visibility of sootblower while operating at sootblower control panel.	9.9.8. Panel kontrol *soootblower* berada di dekat panel operasi *boiler* sehingga memudahkan operator. Operator harus memiliki visibilitas yang baik terhadap *sootblower* selama mengoperasikan dari panel kontrol *sootblower.*
9.9.9. Each soot blower shall be complete with wall box suitable for pressurized firing, clamps, hangers and supports, and all	9.9.9. Tiap *soot blower* harus dilengkapi dengan *wall box* yang cocok untuk *pressurized firing, clamp, hanger,* dan *support* serta semua

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appurtenances required for a complete unit. Soot blowers shall be connected by tubing to the forced draft fan in a manner to provide sufficient air for continuous scavenging of the soot blowers while the boiler is firing and the soot blowers are not in operation.

9.9.10. All necessary pipe, valves and fittings required to connect the soot blowers to the superheated steam supply shall be provided by Manufacturer. Valves shall include automatic steam supply and temperature controlled vent and drain valves interlocked with the soot blower controls, and manual emergency steam shutoff valves. Piping shall be designed and adequately sized to permit simultaneous operation of any three blowers. All valves shall be flange stack.

9.9.11. Each control panel shall provide for individual selective operation of any soot blower or automatic sequential operation of any group of soot blowers. Provision shall be made to allow changing the blowing sequence of each individual blower or allow several blowers to operate at least twice in a given sequence by means of patch cords and jack board. Blower select switches shall be provided so that individual blowers may be included or deleted from the sequence. Interlocks and alarms shall be provided as follows:

perlengkapan yang diperlukan untuk unit yang lengkap. *Soot blower* harus dihubungkan dengan *tube* ke *draft fan* dengan cara menyediakan udara yang cukup untuk membersihkan jelaga secara terus menerus saat *boiler* menyala dan *soot blower* tidak beroperasi.

9.9.10. Semua *pipe*, *valve* dan alat kelengkapan yang diperlukan untuk menghubungkan *soot blower* ke pasokan *superheated steam* harus disediakan oleh *Manufacturer*. *Valve* harus sudah mencakup suplai uap otomatis dan ventilasi yang dikontrol temperatur dan *valve* pembuangan yang saling terkait dengan kendali *soot blower*, dan *valve* penutup uap darurat manual. Perpipaan harus dirancang dan memliki ukuran yang cukup untuk memungkinkan operasi simultan dari tiga *blower*. Semua *valve* harus berupa *flange stack.*

9.9.11. Setiap panel kendali harus menyediakan operasi selektif untuk setiap *soot blower* atau operasi berurutan otomatis dari setiap kelompok *soot blower*. Ketentuan harus dibuat untuk memungkinkan perubahan urutan tiupan dari masing-masing *blower* atau memungkinkan beberapa *blower* untuk beroperasi setidaknya dua kali dalam urutan tertentu dengan menggunakan kabel *patch* dan papan *jack*. Sakelar untuk memilih blower yang beroperasi harus disediakan sehingga masing-masing *blower* dapat disertakan atau dihapus dari urutannya. *Interlock* dan alarm harus

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a. Loss of blowing medium
b. Low header pressure
c. Excessive elapsed time
d. Control voltage loss
e. Magnetic overload interlock for traversing motor
f. Rotary motion interlock

Boiler diagrams shall be provided complete with operation indicating lights for each blower. Lights are to be energized directly from the park limit switch on each blower. The panel shall have provision to prove the lamp integrity for all lamps while the soot blower system is in or out of service.

9.9.12. Each soot blower shall have a shop-wired local NEMA 4 pushbutton actuator. The local control stations shall be subject to the same interlock devices and safeguards present in the primary soot blower control system.

9.9.13. The control panel shall be completely wired and tested before shipment from the factory. Shop test shall demonstrate satisfactory performance of all control routines and protective interlocks.

9.10 **Enclosure**

9.10.1. The walls, floor and roof of the firing zone and steam generating sections (including the economizer) shall be of a construction that provides a completely pressure-tight enclosure which will be maintained at a temperature above the dew

disediakan sebagai berikut:

a. *Loss of blowing medium*
b. *Low header pressure*
c. *Excessive elapsed time*
d. *Control voltage loss*
e. *Magnetic overload interlock for traversing motor*
f. *Rotary motion interlock*

Diagram *boiler* harus disediakan lengkap dengan lampu indikator operasional pada tiap *blower*. Lampu ditenagai langsung dari *limit switch* pada tiap *blower*. Panel diharuskan tidak mengalami masalah saat *soot blower* dalam kondisi mati atau menyala.

9.9.12. Tiap *soot blower* memiliki 4 tombol aktuator NEMA. Stasiun kontrol lokal memiliki *interlock device* dan pengamanan yang sama dengan sistem kontrol *soot blower*.

9.9.13. Panel kontrol harus terhubung dan teruji sebelum dikirimkan dari pabrik. Pengujian di pabrik harus menunjukkan hasil yang memuaskan terhadap semua sistem kontrol dan *interlock* prtotektif.

9.10 ***Enclosure***

9.10.1. Dinding, lantai dan atap dari zona pembakaran dan bagian *steam generating* (termasuk *economizer)* harus dari konstruksi yang menyediakan *casing* yang sepenuhnya kedap tekanan yang akan dipertahankan pada temperatur di atas titik embun gas

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point of the furnace gases.

9.10.2. Gas-tight, bolted access doors shall be provided to allow entrance to all parts of the equipment for the purposes of inspection, cleaning, repair and replacement. Access doors shall be a minimum of 610 mm x 610 mm inside of refractory.

9.10.3. Air-cooled, air-purged, gas-tight view ports shall be provided to allow visual inspection of burner and flame pattern during operation.

9.10.4. The insulation and refractories thickness shall be designed such that the temperature of any exterior surface shall not exceed 65^{o}C at maximum ambient temperature 35^{o}C and an air velocity of 0 km/h.

9.10.5. Enclosure leakage must be reduced to a realistic minimum value. The entire casing shall be airtight and able to withstand a maximum internal pressure of not less than 1-1/2 times predicted maximum operating pressure. If design includes a damper between boiler and stack, enclosure must withstand maximum forced draft fan discharge pressure.

9.10.6. The welded tube wall construction of the furnace will comprise part of the inner casing and shall be welded and sealed pressure tight.

9.10.7. Seals shall be provided to prevent gas leakage around drums, headers, tube passing through the

tungku.

9.10.2. Pintu akses yang kedap gas dan dibaut harus disediakan untuk memungkinkan masuk ke semua bagian peralatan untuk keperluan inspeksi, pembersihan, perbaikan dan penggantian. Pintu akses harus memiliki dimensi minimal 610 mm x 610 mm di dalam *refractory*.

9.10.3. Lubang pengelihatan harus disediakan untuk keperluan inspeksi selama pengoperasian. Lubang pengelihatan didinginkan dan dibersihkan dengan udara bertekanan serta tidak dapat dilalui oleh gas pembakaran.

9.10.4. Ketebalan insulasi dan *refractory* dirancang agar temperatur luar tidak lebih dari 65^{0}C dengan temperatur lingkungan sebsar 35^{0}C dan kecepatan angin 0 km/jam.

9.10.5. Kebocoran pada penutup harus diminimalisir hingga nilai minimum yang realistis. Seluruh *casing* harus kedap udara dan mampu menahan hingga 1.5 kali tekanan internal maksimum operasional. Apabila damper antara *boiler* dan *stack* masuk dalam desain, *enclosure* harus dapat menahan tekanan *discharge* maksimum dari *forced draft fan*.

9.10.6. Dinding *tube* pada bagian dalam *furnace* merupakan bagian dari penutup bagian dalam dan harus dilas serta tertutup rapat.

9.10.7. *Seal* digunakan untuk mengantisipasi kebocoran pada *drum, header,* dan laluan *tube*

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setting walls and baffles.

9.10.8. Openings or flanged pipe casing drains shall be provided in low points of furnace and boiler passes to permit rapid and complete drainage when water washing outside tube surface.

9.11 **Structural Steel, Ladders and Platforms**

9.11.1. All necessary structural steel shall be furnished to properly support the equipment. Necessary platforms, stairways and access ladders for convenient operation and maintenance of the equipment shall be provided.

9.11.2. Platform which provide a 1.0 m (3 feet – 3 inch) minimum clear width shall be provided for access to all boiler and superheater valves and trim, manhole, and manhole covers, access and observation doors, sootblower, damper support, and all instruments and controls including stack flue gas sampling connection. Access to these platforms shall be by ladders. Where practical, platform adjacent to casing shall be supported from boiler steel. Miscellaneous blow down, vent, or drain valves shall be accessible from platforms, stairways, and accessible locations.

9.11.3. 1 m (3 feet – 3 inch) minimum clear width continuous firing aisle platform at burner levels shall be provided. These platforms hall have stairways to grade on both sides. Platforms at burner shall be designed to allow access around

antara *setting wall* dan *baffle*.

9.10.8. Pada bagian bawah furnace dan laluan harus disediakan bukaan atau pipa drainase agar pengosongan pada kondisi tertentu dapat dilakukan dengan segera.

9.11 ***Structural Steel, Ladders* dan *Platforms***

9.11.1. Seluruh struktur harus dapat menyangga peralatan dengan baik. *Ladder* dan kelengkapan akses lain harus disediakan untuk tujuan inspeksi, operasi, dan pemeliharaan.

9.11.2. *Platform* yang menyediakan lebar minimal 1,0 m (3 kaki – 3 inci) harus disediakan untuk akses ke semua *valve boiler* dan *valve superheater* dan *trim*, *manhole*, dan *manhole cover*, akses dan pintu observasi, *sootblower*, *damper support*, dan semua instrumen dan kendali termasuk koneksi pengambilan sampel gas buang di *stack*. Akses ke *platform* ini harus melalui *ladder*. Untuk keperluan praktis, *platform* yang berdekatan dengan *casing* harus ditopang dari *boiler* yang terbuat baja. *Valve blowdown*, ventilasi, atau pembuangan lain-lain harus dapat diakses dari *platform*, *stairway*, dan lokasi yang dapat diakses.

9.11.3. Lorong *platform* pengapian kontinu dengan lebar bersih 1 m terus menerus pada tingkat *burner* harus disediakan. Aula *platform* ini memiliki *stairway* untuk diratakan di kedua sisinya. *Platform* di *burner* harus dirancang untuk

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burner fuel guns in their retracted position.

9.11.4. Platforms for servicing retractable soot-blowers shall provide 1 meter (3 feet – 3 inch) clear access around the soot – blower when in retracted position.

9.11.5. Manufacturer is responsible for providing the minimum clear walking space of 1 m wide by 2,2 m high (3 feet – 3 inch by 7 feet – 3 inch) on all platforms, ladders, and stair areas when portions of the boiler interfere.

9.11.6. Stairways shall be a minimum of 1 m (3 feet – 3 inch) wide and equipped with safety rails and toe guards.

9.11.7. All platform, stair treads, railing, and fasteners shall be galvanized.

9.12 **Stack, Ductwork, Dampers, and Air Measuring Elements**

9.12.1. All stacks shall be full penetration butt welded construction and self supporting. Guy wires are not permitted. Field splices shall be welded joints with bolting for positioning only. Longitudinal seams shall be staggered and preferably clear all stack openings and reinforcements. Girth seams shall not be covered by any other parts welded to the stack.

9.12.2. Minimum stack plate thickness shall be 9,5 mm (3/8 inch) (including corrosion allowance).

memungkinkan akses di sekitar *burner* dalam posisi *burner* ditarik.

9.11.4. *Platform* untuk pemeliharaan *soot blower* yang dapat ditarik (*retractable*) harus memiliki akses sebesar 1 meter (3 kaki – 3 inci) di sekitar *soot blower* saat dalam posisi ditarik.

9.11.5. *Manufacturer* bertanggung jawab untuk menyediakan ruang untuk berjalan dengan dimensi minimal lebar 1 m dan tinggi 2,2 m (3 kaki – 3 inci dan 7 kaki – 3 inci) di semua area *platform*, *ladder*, dan *stair* ketika ada bagian dari *boiler* yang menghalangi.

9.11.6. *Stairway* harus memiliki lebar minimal sebsear 1 meter (3 kaki – 3 inch) dan dilengkapi dengan rel pengaman serta pelindung jari kaki.

9.11.7. Seluruh *platform*, *stair tread*, *railing*, dan *fastener* harus diberi lapisan galvanis.

9.12 ***Stack*, *Ductwork*, *Damper*, dan *Air Measuring Elements***

9.12.1. Seluruh *stack* harus dilas dengan penetrasi penuh tanpa bantuan penyangga. *Guy wire* tidak diizinkan. Sambungan bidang harus dilas sambungan baut yang hanya digunakan untuk pengaturan posisi. *Longitudinal seam* harus dipasang berselang dan bebas dari semua *stack opening* dan *reinforcement*. *Girth seam* tidak boleh ditutupi oleh bagian lain yang dilas ke *stack*.

9.12.2. Ketebalan minimal pelat *stack* sebesar 9.5 mm (3/8 inchi) (termasuk batas toleransi korosi).

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Minimum corrosion allowance shall be 1.6 mm (1/16 inch). Minimum duct thickness shall be 6,4 mm (1/4 inch).

9.12.3. Unless otherwise specified, stack and gas duct shall be lined with a castable refractory lining of 38 mm (1 1/2 inch) minimum thickness.

9.12.4. Unless otherwise specified, stack shall be designed to resist wind loads specified in project basic engineering design data. Deflection at top of stack shall not exceed 1 mm per meter of height above the base (25 mm max.)

9.12.5. Minimum stack height shall be 70 m above grade.

9.12.6. Stack shall be equipped with aircraft warning light.

9.12.7. Minimum stack exit velocity shall be 7.6 m/s (25 fps) at MCC.

9.12.8. The stack design shall be such that its critical wind velocity with basic wind speed 125 Km/hr.

9.12.9. Approved Vortex disrupters or damping may be provided as follows:

a. Properly designed spoilers to prevent formation of Von Karman vortices. The licensed NPL (National Physical Laboratory, London - England) spiral type spoilers, with 3 start strakes, are the preferred type. Licensing arrangements shall be made by the Manufacturer.

Batas toleransi korosi sebesar 1.6 mm (1/16 inchi). Ketebalan minimum saluran sebesar 6.4 mm (1/4 inch).

9.12.3. Kecuali ditentukan lain, *stack* dan *gas duct* harus dilapisi dengan lapisan tahan api yang dapat dicor dengan ketebalan 38 mm (1,5 inchi).

9.12.4. Kecuali ditentukan lain, *stack* harus dapat menahan beban angin yang terdapat pada data desain teknik. Defleksi pada puncak *stack* tidak lebih dari 1 mm tiap meter ketinggian dari dasar. (maksimum 25 mm).

9.12.5. Ketinggian *stack* minimal sebesar 70 mm dari permukaan tanah.

9.12.6. *Stack* harus dilengkapi dengan lampu peringatan pesawat terbang.

9.12.7. Kecepatan keluar *stack* minimal sebesar 7.6 m/s (25 fps) pada MCC.

9.12.8. Desain *stack* memiliki kecepatan angin kritis sebesar 125 km/jam.

9.12.9. *Vortex disrupter* atau *damping* yang disetujui dapat diberikan dengan ketentuan sebagai berikut:

a. *Spoiler* yang didesain dengan benar untuk mencegah pembentukan *Von Karman vortices*. Disarankan untuk menggunakan jenis *spoiler* spiral yang terlisensi olehi NPL (*National Physial Laboratory, London – England*). Lisensi merupakan tanggung jawab *Manufacturer*.

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b. Alternatively, if the manufacturer can document long term successful experience with straight vertical fin type spoilers, these may be proposed together with the supporting documentation. Straight spoilers will typically consist of four sets of fins spaced at 90° around the stack with each of the four sets made up of six or more bars offset one below the other and spread over the top 25 percent of the stack and with a projection of 0.08D.

b. Sebagai alternatif, apabila *manufacturer* dapat mendokumentasikan catatan kesuksesan jangka panjang dengan *spoiler* tipe *straight vertical fin*, ini dapat diusulkan bersama dengan dokumen pendukung. *Spoiler* lurus biasanya terdiri dari 4 set sirip yang berjarak 90^0 disekitar stack dengan masing-masing dari 4 set yang terdiri dari 6 batang atau lebih yang diimbangi satu di bawah yang lain dan tersebar diatas 25% dari *stack* dan dengan proyeksi 0,08D.

c. Properly designed, energy absorbing, Haydite-Lumnite refractory lining for the bottom 25 percent of the stack. The refractory shall have a density of 1600 kg/m^3 (100 lb/ft^3) or more; it shall be provided with sufficient anchorage and reinforcement so that it will act integrally with the stack shell and it shall be solidly compacted down to solid bearing contact with the concrete foundation supporting the stack. Refractory linings for energy absorption are only acceptable for stack sitting directly on concrete foundations and then only when the design properly evaluates the damping effect of such linings.

c. Lapisan *Haydite-Lumnite refractory* yang dirancang dengan benar, menyerap energi untuk 25% sisi bagian bawah *stack*. *Refractory* harus memiliki densitas sebesar 1600 kg/m^3 (100 lb/ft^3) atau lebih dan haris dilengkapi dengan anchor dan penguat yang cukup sehingga akan bekerja secara integral dengan menyatu dengan *stack shell* dan harus dipadatkan dengan kuat hingga *solid bearing contact* dengan fondasi beton yang menopang *stack*. *Lining refractory* untuk penyerapan energi hanya dapat diterima untuk *stack* yang diletakkan langsung dengan fondasi beton dan hanya apabila desain mengevaluasi dengan benar efek *damping* dari pelapis tersebut.

9.12.10. The entire vibrating structure including the stack, its lining, its supports and foundation must

9.12.10. Seluruh komponen struktur yang mengalami vibrasi, termasuk *stack*, *lining, support* dan

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have sufficient damping capability to absorb the cycling energy input at the critical wind velocity within an amplitude which results in acceptable stresses. This requirement is waived where the critical wind velocity exceeds 97 km/hr (60 mph) due to the non-uniform nature of such winds. The Manufacturer is cautioned, however that disregard of support flexibility will not be permitted and incorporation, into the calculations, of such flexibility may lower the critical wind velocity by an appreciable amount and possibly into the unacceptable range of 48 - 97 km/hr (30 - 60 mph). The critical wind velocity must be calculated for all different axes, for both the corroded and un corroded conditions and must properly allow for support flexibility.

fondasinya harus memiliki kemampuan *damping* yang cukup untuk menyerap masukan siklus energi pada kecepatan angin kritis dalam suatu amplitudo dengan menghasilkan tegangan yang dapat diterima. Persyaratan ini diabaikan apabila kecepatan angin kritis melebihi 97 km/jam (60 mph) dikarenakan sifat angin yang tidak seragam. *Manufacturer* diperingatkan, namun mengabaikan fleksibilitas tersebut dapat menurunkan kecepatan angina kritis dengan jumlah yang cukup besar dan mungkin ke kisaran yang tidak dapat diterima antara 48 - 97 km/jam (30 – 60 mph). Kecepatan angin kritis harus dihitung untuk semua sumbu yang berbeda, baik untuk kondisi terkorosi dan tidak terkorosi serta harus benar-benar memungkinkan untuk mendukung fleksibilitas.

9.12.11. Reinforcement with plate and/or angles shall be provided should the strength of the stack be reduced at the breeching and access openings. The check for reinforcement shall be calculated on both the replacement of area and moment of inertia basis. Internals welded directly to the shell shall be designed to provide adequate flexibility for expansion effect and when used in lined stack, shall be properly insulated to prevent recessive localized shell temperature.

9.12.11. Penguatan dengan pelat dan/ atau besi siku harus disediakan jika kekuatan *stack* berkurang pada area *breeching* dan akses bukaan. Kalkulasi dilakukan untuk mengecek perkuatan pada *replacement* area dan momen berbasis inersia. Pengelasan pada area internal harus mengakomodir fleksibilitas untuk pemuaian. Apabila digunakan pada *stack* yang telah diberi lining pengelasan harus diinsulasi untuk menghindari adanya konsentrasi panas/ temperatur.

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9.12.12. The stack shall be equipped with a painter's trolley, trolley ring and trolley rigging including 5 mm (3/16 inch) stainless steel cable.

9.12.13. A suitable breeching shall be provided between stack and combustion chamber. Minimum breeching plate thickness shall be 6,4 mm (1/4 inch). A gas tight expansion joint, having bolted flanged joint at both breeching and stack, made of materials capable of withstanding the flue gas temperature shall be included.

9.12.14. A 610 mm (24 inch) diameter or 610 mm by 762 mm (24 inch by 30 inch) rectangular access door shall be provided in either the breeching or base of stack.

9.12.15. On stacks located at grade or stacks with bottom plates, provide:

a. A 6 mm (1/4 inch) carbon steel bottom plate 1 m (3 feet) from the bottom of the lowest flue gas duct opening protected with 35 mm (1-1/2 inch) of insulating refractory.

b. A 3 inch drain connection in the base.

c. A 50 mm by 76 mm x 13 mm (2 inch by 3 inch by 1/2 inch) plate welded to stack 305 mm (12 inches) above base for a ground connection.

9.12.16. Manufacturer shall furnish a complete system of ductwork, including supports, expansion

9.12.12. *Stack* harus dilengkapi dengan *trolley*, *ridging*, dan kabel *stainless steel* berdiameter 5 mm (3/16 inch).

9.12.13. Di antara *stack* dan ruang bakar harus diberikan suatu *breeching*. Ketebalan minimum plat *breeching* sebesar 6.4 mm (1/4 inchi). *Expansion joint* yang kedap gas dengan koneksi *bolted flange* baik pada sisi *breeching* dan *stack* harus disediakan, yang terbuat dari material yang tahan terhadap temperatur *flue gas*.

9.12.14. Pada bagian *breeching* atau bawah *stack* harus disediakan pintu akses dengan diameter sebesar 610 mm (24 inchi) atau persgi panjang dengan ukuran 610 x 762 mm (24 x 30 inchi).

9.12.15. Pada *stack* yang terletak di atas atau *stack* dengan pelat bawah, harus dilengkapi dengan:

a. Pelat baja karbon dengan tebal 6 mm (1/4 inch) sejauh 1 m (3 feet) dari bagian bawah bukaan saluran *flue gas* terendah yang terlindungi dengan lapisan *refractory* setebal 35 mm (1.5 inch).

b. Koneksi *drain* sebesar 3 inchi pada bagian *base.*

c. Pelat dengan ukuran 50 mm 76 mm x 12 mm (2x 3 inchi x ½ inchi) yang dilas pada posisi 305 mm (12 inchi) di atas sambugan dasar.

9.12.16. *Manufacturer* harus melengkapi sistem saluran kerja lengkap termasuk koneksi untuk *support*,

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joints, hangers, access doors, gas, air temperature and pressure connections. The responsibility for thermal expansion joint design shall be by the Manufacturer.

9.12.17. Purge steam connections shall be provided in the air ducts downstream of the dampers closest to the boiler.

9.12.18. Air ducts between the forced draft fan and burner wind box shall be constructed of not less than number 10 gauge steel plate. Gas ducts between the boiler and stack shall be constructed of not less than 6,4 mm (1/4 inch) steel plate. All ducts shall be properly stiffened and reinforced to prevent warping and buckling. Each duct shall be provided with insulated bolted plate type access doors as required, flanged bolted duct section compete with expansion joints with internal sleeves, supports and hangers, bolts and nuts.

9.12.19. Duct connections may be bolted or welded. Bolted connections shall be seal welded in the field.

9.12.20. Ductwork shall be completely shop fabricated for field assembly including installation of all metal supports. Where external thermal insulation is required, the final covering shall be removable 1.02 mm (0.040 inch) minimum thick embossed aluminum sheet metal lagging supplied by the Manufacturer.

9.12.21. A flanged spool section shall be provided in air ducts to accommodate a future steam coil.

expansion joint, hanger, akses bukaan, gas, tekanan udara dan temperatur. Desain *thermal expansion joint* merupakan tanggung jawab *Manufacturer*.

9.12.17. Pada saluran udara *downstream damper* terdekat dengan *boiler* harus disediakan saluran uap pembersih.

9.12.18. Saluran udara antara *draft fan* dengan *burner wind box* harus terdiri dari plat baja dengan ketebalan tidak lebih dari 10 *gauge*. Saluran antara *boiler* dan *stack* terbuat dari pelat baja dengan ketebalan tidak kurang dari 6.4 mm (1/4 inch). Seluruh bagian saluran harus diperkuat dan diperkaku untuk menghindari terjadinya lengkungan dan *buckling*. Tiap saluran memiliki pintu akses dengan *flange* dan sambungan baut lengkap dengan *expansion joint*, selubung dalam, *support* dan *hanger*, baut dan mur.

9.12.19. Sambungan baut hasrus dilakukan *seal welded* di lapangan.

9.12.20. Fabrikasi *ductwork* diatur agar dapat dilakukan perakitan di lapangan untuk seluruh tumpuan metal. Apabila dibutuhkan insulasi eksternal, tutup akhir disarankan menggunakan lembaran aluminium dengan ketebalan minimal 1.02 mm (0.040 inchi) dan disediakan oleh *Manufacturer*.

9.12.21. Saluran udara harus dillengkapi dengan *spool* untuk koneksi spool dengan flange untuk

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	mengakomodir tambahan *steam coil* di masa mendatang.
9.12.22. An air measuring element and a pneumatically operated damper (for control purposes) shall be provided in the duct supplying air to the supplementary fuel burners, and in the duct supplying secondary air. Dampers shall be designed to open on minimum pneumatic signal, and shall be equipped with a handwheel and an adjustable limit stop.	9.12.22. Saluran suplai udara menuju *burner* tambahan dan suplai udara sekunder harus dilengkapi dengan instrumen pengukuran udara dan *damper* yang dikendalikan secara pneumatik. *Damper* harus dapat dikendalikan dengan sinyal pneumatik yang sangat minim dan dilengkapi dengan roda kendali serta limiter yang dapat diatur.
9.12.23. Pneumatically operated double isolating dampers shall be provided in the discharge of each fan. Space between dampers shall be air purged to ensure against leakage. These dampers will be used for shutoff of the air duct in case of fan shutdown. These dampers shall be designed to close on minimum pneumatic signal.	9.12.23. Pada tiap *discharge fan* harus disediakan *damper* ganda yang dioperasikan melalui pneumatik. Jarak antar *damper* harus dapat dibersihkan menggunakan semprotan udara untuk menjamin bebas dari kebocoran. *Damper* digunakan untuk menutup saluran udara bilamana *fan* mati. *Damper* tersebut didesain untuk dapat ditutup dengan sinyal pneumatik yang sangat lemah.
9.12.24. Air measuring elements shall be venturi type.	9.12.24. Alat ukur udara berupa *venturi.*
9.12.25. Flue gas dampers and shafts shall be constructed of type 321 Stainless Steel. Dampers for duct/ stacks under 1.22 m (4 feet) outside diameter shall be of the single butterfly type. Larger dampers shall be built of two to three elements. Dampers shall be designed for either manual or pneumatic operation, at grade, as specified on the datasheets. Dampers shall be provided complete with a large, easily visible external position indicator which shall be locked in position	9.12.25. *Damper* untuk *flue gas* dan poros harus dibuat dari *Stainless Steel* tipe 321. *Damper* dibuat dari saluran/ *stack* dibawah diameter luar 1.22 m (4 feet) harus berupa jenis *single butterfly*. *Damper* yang lebih besar harus dibuat dari 2 sampai 3 elemen. *Damper* harus dirancang untuk pengoperasian secara manual atau pneumatic, pada kemiringan, sesuai dengan *datasheet*. *Damper* harus dilengkapi dengan indikator posisi ekternal yang besar dan

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on the clamper shaft such that indicator arrow is parallel to damper. Manually operated dampers shall be equipped with cable and winch or lever operators and locks accessible from grade. Pneumatically operated dampers shall have both control and mechanism at grade. The damper shaft shall be supported by self aligning pillow block bearings. Dual damper cables shall be provided and shall be 304 stainless steel, 5 mm (3/16 inch) minimum diameter, with pulleys used at changes in cable direction. Dampers shall have fail safe mechanism where in case of failure, damper will assume full open position.

9.12.26. A grade level indicator of damper position shall be provided.

9.13 **Forced Draft Fan and Drivers**

9.13.1. Two 100% forced draft fans shall be provided, one operating and one full spare. One fan is turbine and the other is motor driven. Turbine will use MP steam at the inlet and exhaust to LP steam header. Auto start of spare fan is not recommended due to concerns of the presence of combustibles.

mudah terlihat yang harus dikunci posisinya pada *clamper shaft* sedemikian rupa sehingga panah indikator sejajar dengan *damper*. *Damper* yang dioperasikan secara manual harus dilengkapi dengan kabel dan *winch* atau tuas yang dioperasikan serta kunci yang dapat diakses dari *grade*. *Damper* yang dioperasikan secara pneumatik harus memiliki kontrol dan mekanisme pada *grade.* Poros *damper* harus ditumpu oleh *self aligning pillow block bearing*. *Dual damper cable* harus disediakan dan harus terbuat dari stainless steel 304, berdiameter minimal 5 mm (3/16 inchi), dilengkapi dengan *pulley* yang digunakan pada perubahan arah kabel. *Damper* harus memiliki mekanisme *fail safe* apabila terjadi kegagalan, *damper* akan terletak pada posisi terbuka penuh.

9.12.26. Indikator level posisi damper harus disediakan.

9.13 ***Forced Draft Fan* dan Penggerak**

9.13.1. *Manufacturer* harus menyediakan 2 *draft fan* dimana tiap *fan* memiliki kemampuan 100% beban operasi dan *fan* lain sebagai cadangan. Turbin memanfaatkan uap bertekanan sedang dan keluaran menuju *header* uap bertekanan rendah. *Auto start* tidak dapat digunakan untuk menyalakan *fan* tidak direkomendasikan untuk menghindari adanya material yang mudah terbakar.

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9.13.2. Each fan shall be sized to supply:

a) A minimum of 50 % more air (at a corresponding higher head) than required for any of the specified cases. This percentage should be applied after making allowance for design excess air (i.e., 2 volume % oxygen in the stack gas on a dry basis).

b) 100% of the air requirement for the Supplementary Fuel Firing case.

9.13.3. Each fan shall be provided with a manually operated inlet vane damper, suction weather hood, bug screen, and inlet silencer.

9.13.4. Fans shall be designed and constructed in accordance with API RP 673. Forced draft fans shall have oil mist lubrication on bearings.

9.13.5. Exposed shaft surfaces and couplings shall be covered by guard cage.

9.13.6. The fan shall be rated with sufficient air flow and static load, at boiler MCR or at boiler peak (if required) with a sufficient air excess ratio for complete and stable combustion.

9.13.7. Fan and driver shall be so designed that there is no shortage of shaft power in the coldest winter or no shortage of volumetric capacity in the hottest summer.

9.13.2. *Tiap* fan harus memenuhi ketentuan berikut:

a) Dapat menghasilkan kebutuhan sebesar 50% di atas kebutuhan. Presentase berlaku setelah penambahan *allowance* untuk design *excess air* (missal 2% volume oksigen pada kondisi udara kering).

b) 100% kebutuhan udara untuk pembakaran bahan bakar tambahan.

9.13.3. Tiap *fan* harus dilengkapi dengan *inlet vane damper, suction water hood*, saringan serangga dan peredam yang dapat dioperasikan manual.

9.13.4. *Fan* dirancang dan dibangun sesuai dengan API RP 673. *Forced draft fan* harus memiliki lubang pelumasan pada *bearing*.

9.13.5. Permukaan *shaft* dan kopling yang terbuka harus dilindungi dengan sangkar pelindung.

9.13.6. *Fan* harus dapat menahan beban udara dan beban statis pada kondisi MCR maupun puncak dengan rasio udara berlebih untuk pembakaran yang sempurna dan stabil.

9.13.7. *Fan* dan penggerak harus dirancang sedemikian rupa sehingga tidak ada pengurangan daya poros pada musim terdingin atau pengurangan kapasitas volumetrik pada musim terpanas.

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9.14 **Valves, Fittings, and Accessories**

9.14.1. Valves and fittings to be furnished with the boiler shall include but not necessarily be limited to the following:

a) Feedwater stop and check valves.

b) Non-return valve on the superheater outlet.

c) Safety valves on the boiler and superheater outlet. Economizer isolation block valves, bypass valve and thermal relief valve.

d) Illuminated gauge glasses complete with shutoff valves and blowdown valves.

e) Stop valves on the connections for continuous blowdown, chemical feed, pressure gauge, steam sample, and all vents and drains.

f) Tandem blowdown valves on the lower drum/ header.

g) Two 2” CL 300 ANSI RF flanged openings with stainless steel extensions through the boiler wall for installation of thermowells (by vendor). These should be located in an active, high velocity area in the transition zone between the combustion section and the heat recovery section. They will be utilized to monitor and adjust the furnace conditions to assure proper CO incineration.

h) 2” Class 300 ANSI RF flanged nozzles for the installation of thermowells (by vendor) at the following locations: Contractor to determine number of

9.14 ***Valve*, *Fitting*, dan Kelengkapan lain**

9.14.1. *Valve* dan *fitting* yang dilengkapi dengan *boiler* harus termasuk namun tidak terbatas pada hal-hal sebagai berikut:

a) *Feedwater stop* dan *check valve.*

b) *Non-return valve* pada *outlet superheater.*

c) *Safety valve* pada *boiler* dan *outlet superheater*. *Economizer isolation block valve*, *bypass* dan *thermal relief valve*.

d) *Gauge* kaca terang dilengkapi dengan *shutoff* dan *blowdown valve.*

e) *Stop valve* pada sambungan *continuous blowdown, chemical feed, pressure gauge*, sampel uap, dan seluruh ventilasi dan drainase.

f) *Tandem blowdown valve* pada *lower drum/ header.*

g) Dua buah nozzle 2 inci CL 300 ANSI RF *flanged opening* dengan ekstensi *stainless steel* sepanjang dinding *boiler* untuk pemasangan *thermowell*. *Thermowell* ditempatkan pada lokasi dengan kecepatan tinggi antara area pembakaran dan *recovery*. Peralatan digunakan untuk memonitor kondisi *furnace* untuk memastikan pembakaran CO.

h) *Flanged nozzle class* 300 ANSi RF dengan ukuran 2” sebagai tempat pemasangan *thermowell* yang ditempatkan di lokasi berikut: Kontraktor

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connections at each location.

(1) Between the screen tubes and the superheater

(2) Between the superheater and the steam generator

(3) Economizer inlet (gas side)

(4) Economizer outlet (gas side)

i) Local panel mounted draft gauges to monitor the following locations:

(1) Individual fan discharges and main air duct downstream of fans

(2) Air supply to supplementary fuel burners

(3) Air supply to secondary air ports

(4) Furnace

(5) Between the screen tubes and the superheater

(6) Between superheater and steam generation coils

(7) Economizer inlet

(8) Economizer outlet

j) A 1-1/2” ID ANSI RF flanged nozzle shall be provided on the feedwater line between the economizer and the steam drum for the installation of a thermowell (specified elsewhere).

k) Two 1” flanged connections in the economizer outlet duct for flue gas sampling.

l) Positive pressure view port on superheater coil section shall be

menentukan jumlah sambungan pada tiap lokasi.

(1) Antara *screen tube* dan *superheater*

(2) Antara *super heater* dan *steam generator*

(3) *Inlet economizer* (sisi gas)

(4) *Outlet economizer* (sisi gas)

i) *Draft gauge panel local* untuk memantau beberapa lokasi berikut:

(1) *Fan discharge* dan saluran udara utama *downstream*

(2) Suplai udara untuk *burner* tambahan

(3) Suplai udara skunder

(4) *Furnace*

(5) Antara *screen tube* dan *superheater*

(6) Antara *superheater* dan *steam generation coil*

(7) *Inlet economizer*

(8) *Outlet economizer*

j) *Flanged nozzle* 1.5 inchi ID ANSI diantara *economizer* dan *steam drum* untuk tempat pemasangan *thermowell.*

k) Dua *flanged connection* berukuran 1 inchi pada *outlet* saluran *economizer* sebagai *gas sampling.*

l) Lubang penglihatan tekanan positif pada *superheater* harus

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provided with an instrument air purge for cooling and removal of catalyst dust.

9.14.2. The superheater outlet relief valve number, size and set pressure shall be selected to assure that the boiler cannot cause the steam header to exceed the maximum allowable accumulated pressure under ASME Section VIII. This paragraph supplements but does not supersede the requirements of ASME Section I.

9.14.3. A superheater outlet vent shall be provided, equipped with a silencer, block valve and throttling valve, sized to vent the design steam rate. The maximum silenced sound pressure level shall be 80 dBA at 6 meters in all directions below the horizontal plane containing the silencer or vent pipe outlet. These noise level criteria should be considered the minimum requirement in the absence of other standards.

9.15 **Insulation and Refractory**

9.15.1. Headers, drums, furnaces, economizers, wind boxes, super heater headers, exposed tubes, hot gas ducts, steam turbines and any other exposed surfaces requiring insulation, shall be insulated in accordance with Manufacturer's standards.

9.15.2. Pipe coverings shall be molded type calcium silicate or diatomaceous silica materials. Asbestos containing materials shall not be used.

9.15.3. The furnace side of lower & upper drums shall be protected with

dilengkapi dengan semprotan udara untuk pendinginan dan menghilangkan debu katalis.

9.14.2. Jumlah, ukuran dan tekanan *outlet relief valve* pada *superheater* dipilih untuk menghindari kelebihan akumulasi tekanan mengacu pada ASME Section VII. Paragraf ini bersifat tambahan dan tidak terlepas dari ASME Section I.

9.14.3. *Outlet superheater* harus dilengkapi dengan ventilasi dengan tambahan peredam, *block valve* dan *valve* bukaan sesuai dengan laju uap desain. Tingkat kebisingan teredam maksimum sebesar 80 dBA diukur dari jarak 6 m dari segala arah pada bidang datar. Tingkat kebisingan merupakan syarat minmum yang harus dipenuhi bila mana tidak diatur dalam standar.

9.15 **Insulasi dan *Refractory***

9.15.1. *Header, drum, furnaces, economizer, wind box, superheater header, exposed tube, hot gas duct, steam turbine,* dan komponen lain yang membutuhkan insulasi harus sesuai dengan standar *Manufacturer*.

9.15.2. Pelindung pipa berupa kalsium silikat atau material silika diatomik. Tidak diperkenankan menggunakan material asbestos.

9.15.3. *Furnace* pada sisi atas dan bawah drum harus dilindungi dengan

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castable refractory where before refractory application, anchor application and anchor material shall be installed first refer to Pertamina's Standard.

castable refractory dimana *anchor* yang digunakan harus sesuai dengan standard Pertamina.

9.15.4. Furnace doors and access openings shall be insulated with firebrick. Steel rings shall be provided around manholes to protect insulation from damage.

9.15.4. Pintu dan akses *furnace* harus dilapisi dengan *firebrick*. Pada *manhole* diberi lingkaran baja untuk melindungi insulasi dari kerusakan.

9.15.5. All refractory and insulation shall be designed to allow for proper expansion of all parts under design operating conditions. Expansion joints in insulation and refractory shall be staggered to assure tightness.

9.15.5. Seluruh *refractory* dan insulasi harus dirancang untuk mengalami ekspansi semua komponen selama operasi. *Expansion joint* pada insulasi disusun berselang untuk mengakomodasi ekspansi.

9.15.6. Burner openings shall be lined with 1650^{o}C (3000^{o}F) minimum rated plastic or castable refractory.

9.15.6. Bukaan *burner* harus diberi lapisan dengan ketahanan terhadap *castable refractory* temperatur sebesar 1650^{0}C (3000^{0}F)

9.15.7. The Manufacturer shall supply all necessary structural steel to properly support the entire weight of all parts of the boiler and its appurtenances upon foundations supplied by EPC Contractor.

9.15.7. *Manufacturer* harus menyediakan struktur baja yang dibutuhkan untuk menampung seluruh beban dari komponen *boiler* beserta kelengkapannya pada pondasi yang telah disediakan oleh Kontraktor EPC.

9.15.8. Structural design shall comply to:

a. IBC 2018 Edition for wind pressure.

b. SNI 1726-2012 for earthquake data.

9.15.8. Desain struktur harus memenuhi persyaratan berikut:

a. IBC Edisi 2018 untuk tekanan angin.

b. SNI 1726-2019 untuk gempa bumi.

9.16 **Name Plate**

9.16 ***Name Plate***

9.16.1. Nameplates shall be provided for each of the supplied equipment items and be positioned on the equipment item in clear sight of the

9.16.1. *Nameplate* harus disediakan untuk setiap item perlengkapan yang disediakan dan ditempatkan pada item perlengkapan tersebut di jarak yang dapat dijangkau oleh

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operator.

9.16.2. Equipment shall be identified by an accurate and legible 316 stainless steel permanent label affixed to the equipment with 316 stainless steel pins, designed for outdoor installation, with minimum letter height of 5 mm.

9.16.3. The information on the nameplate shall be aligned to the requirements of the International Standard associated with the equipment and shall include:

- Manufacturers Name
- Manufacturers Serial Number
- Purchase Order Number
- Hydrostatic Test Pressure
- Year of Manufacture

9.16.4. The data provided on the nameplate shall be aligned to the units in the BEDD.

9.17 **Welding**

9.17.1. All welding procedures, welder qualifications, and electrodes shall conform to AWS D1.1 "Structural Welding Code-Steel" and ASME Section IX. All coated electrodes must be received by the end-user in unbroken containers. Electrodes after being received and removed from the shipping container must be placed in an approved dryer and always kept dry. At the jobsite and during transport to the jobsite, low hydrogen electrodes are to be kept in portable ovens. The storage temperature will be in accordance

mata *operator*.

9.16.2. Peralatan harus diidentifikasi dengan label permanen yang akurat dan reliable serta terbuat dari *stainless steel* 316 dan dapat dibaca ketika ditempelkan pada peralatan yang memiliki bahan 316 *stainless steel*, dirancang untuk pemasangan di luar ruangan, dengan tinggi huruf minimal 5 mm.

9.16.3. Informasi pada name plate harus disesuaikan dengan persyaratan Standar Internasional yang terkait dengan peralatan dan harus mencakup:

- Nama *Manufacturer*
- Nomor Seri *Manufacturer*
- Nomor *Purchase Order*
- Tekanan Pengujian Hidrostatis
- Tahun Produksi

9.16.4. Data yang diberikan pada *nameplate* harus disesuaikan dengan unit di BEDD.

9.17 **Pengelasan**

9.17.1. Semua prosedur pengelasan, kualifikasi tukang las, dan elektroda harus sesuai dengan AWS D1.1 "*Structural Welding Code-Steel*" dan ASME Bagian IX. Semua elektroda berlapis harus diterima oleh pengguna akhir dalam wadah yang tidak rusak. Elektroda setelah diterima dan dikeluarkan dari kontainer pengiriman harus ditempatkan di pengering yang disetujui dan selalu dijaga tetap kering. Di lokasi kerja dan selama pengangkutan ke lokasi kerja, elektroda hidrogen

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with the manufacturer's instructions.

harus disimpan dalam *portable ovens*. Temperatur penyimpanan akan disesuaikan dengan petunjuk *manufacturer*.

9.17.2. Before all welding process, manufacturers shall be submitted ITP, Welding Map, WPS and WPQ to OWNER for approval of all procedure.

9.17.2. Sebelum semua proses pengelasan dimulai, *manufacturer* harus menyerahkan ITP, Welding Map, WPS dan WPQ kepada PEMILIK untuk mendapatkan persetujuan tentang semua prosedur pengelasan.

9.17.3. Any welding of pressure holding parts shall be done by a qualified welder. A qualified welder, WPS and WPQ shall comply with the applicable code and local regulation.

9.17.3. Setiap pengelasan bagian penahan tekanan harus dilakukan oleh tukang las yang berkualifikasi. Seorang tukang las yang berkualifikasi, WPS dan WPQ harus mematuhi *code* dan peraturan setempat yang berlaku.

9.18 **Heat Treatment**

9.18 **Perlakuan Panas**

9.18.1. All heat treatment work shall be done in accordance with ASME Section I, ASME Section VIII and applicable code. All attachment places of pressure holding parts shall be welded before heat treatment. Records of all heat treatment shall be kept available.

9.18.1. Semua pekerjaan perlakuan panas harus dilakukan sesuai dengan standar ASME Bagian I, ASME Bagian VIII dan *code* yang berlaku. Semua tempat pemasangan bagian penahan tekanan harus dilas sebelum perlakuan panas. Catatan semua perlakuan panas harus tersedia.

9.18.2. All weld repairs, thermal gouging repairs and welded repairs of material defects shall be completed before the final post-weld heat treat. No welding on the pressure part of vessels and on the material, which exposed to solutions of ammonia or alkalis, is permitted after the post-weld heat treat. Flange facings must be protected against oxidation during heat treatment.

9.18.2. Semua perbaikan las, perbaikan *thermal gouging* dan perbaikan cacat *material* yang dilas harus diselesaikan sebelum perlakuan panas paska pengelasan. Tidak ada bagian pengelasan pada *pressure vessels* dan pada *material*, yang boleh terkena larutan amonia atau alkali, setelah perlakuan panas pasca-pengelasan. *Flange facings* harus dilindungi dari oksidasi selama perlakuan panas.

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9.18.3. When post-weld heat treatment is required, the entire vessel shall be given the final post-weld treatment in an enclosed furnace.

9.18.3. Ketika perlakuan panas setelah pengelasan, seluruh *vessel* harus diberikan perlakuan panas final setelah pengelasan di dalam *furnace* yang tertutup.

9.18.4. When the entire vessel cannot be post-weld heat treated in furnace because; its size, or because it is finally fabricated in the field, the final post weld heat treatment may be performed locally at outside of furnace. The section locally post-weld heat-treated shall be post-weld heat treated in an enclosed furnace. The manufacturer shall establish the procedure for post-weld heat treatment and submit it to the purchaser for approval.

9.18.4. Ketika seluruh *vessel* tidak dapat dilas pasca perlakuan panas di dalam *furnace* karena; ukurannya, atau karena akhirnya dibuat di lapangan, pengelasan setelah perlakuan panas dapat dilakukan secara lokal di luar *furnace.* Bagian lokal yang dilas paska perlakuan panas dilakukan di dalam *furnace* tertutup. *Manufacturer* harus menetapkan prosedur untuk melakukan pengelasan paska perlakuan panas dan mengirimkannya ke pembeli untuk disetujui.

9.18.5. The manufacturers shall establish a procedure for post-weld heat treatment and submit it to a purchaser for approval. The procedure shall specify holding temperature, holding time, heating and cooling rates, the number, and locations of thermocouples to be attached, and any other precautions to perform proper post-weld heat treatment. The manufacturers shall check that the post weld heat treatment has been correctly performed and that the temperature readings conform to the requirement of this specification.

9.18.5. *Manufacturer* harus menetapkan prosedur untuk perlakuan panas setelah pengelasan dan mengirimkannya ke pembeli untuk disetujui. Di dalam prosedur ini telah ditentukan temperatur penahanan, waktu penahanan, tingkat pemanasan dan pendinginan, jumlah, dan lokasi sensor temperatur yang akan dilampirkan, dan tindakan pencegahan lainnya untuk melakukan perlakuan panas setelah pengelasan yang tepat. *Manufacturer* harus memeriksa bahwa perlakuan panas setelah pengelasan telah dilakukan dengan benar dan bahwa pembacaan temperatur sesuai dengan persyaratan spesifikasi ini.

9.18.6. Hardness test shall be conducted before heat treatment and post heat treatment, it shall be

9.18.6. Pengujian kekerasan harus dilakukan sebelum perlakuan panas dan pasca-perlakuan

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documented in the manufacturer data record.

panas, prosedur pengujian harus didokumentasikan di dalam catatan data *manufacturer*.

10. INSPECTION AND TEST

10.1 **General**

10.1.1. All materials and work of the manufacturer and his sub supplier shall be subject to inspection by Buyer's inspectors as well as by any other national, insurance, or OWNER inspectors. Any rejections made by an inspector will be final.

However, inspection and/or witnessing of tests in no way release the manufacturer from guarantees as to materials, apparatus, and workmanship. Waiver of any phase of inspection must be obtained in writing from OWNER.

10.1.2. The manufacturer shall notify OWNER least five days in advance of the date fabrication will begin and also five days in advance of when the CO Boiler Package and parts will be completed.

10.1.3. CO Boiler Package shall be certified by DEPNAKER RI. Fabrication inspection shall be performed by an inspector holding a commission issued by DEPNAKER RI.

10.2 **Test – Shop**

10.2.1. Boiler and accessories shall be shop tested in accordance with the requirements of Section I of the ASME Boiler and Pressure Vessel Code with minimum test as follows:

10. INSPEKSI DAN PENGUJIAN

10.1 **Umum**

10.1.1. Seluruh material dan pekerjaan *manufacturer* dan pemasoknya harus diperiksa oleh pengawas Pembeli sesuai kebutuhan peraturan nasional, asuransi, atau Pengawas dari PEMILIK. Seluruh penolakan dari pengawas bersifat final.

Hasil inspeksi, bagaimanapun hasilnya, tidak menghilangkan kewajiaban *manufacturer* atas garansi terhadap material, peralatan, dan tenaga kerja. Seluruh tahapan inspeksi harus menadapatkan persetujuan tertulis dari PEMILIK.

10.1.2. *Manufacturer* harus memberi tahu PEMILIK setidaknya lima hari sebelum dimulai fabrikasi dan lima hari sebelum pekerjaan *CO Boiler Package* dan komponennya diselesaikan.

10.1.3. *CO Boiler Package* harus tersertifikasi oleh DEPNAKER RI. Inspeksi dilakukan oleh inspektor yang diberi wewenang inspeksi oleh DEPNAKER RI

10.2 ***Test – Shop***

10.2.1. *Boiler* dan kelengkapannya harus dilakukan pengujian sesuai dengan persyaratan ASME Section I tentang *Boiler dan Pressure Vessel* dengan

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a. Visual inspection.
b. Dimensional check.
c. Hydrostatic test.
d. Radiographic examination.
e. Panel function test, sequence check.
f. Balance test of FDF.
g. Performace test of FDF.
h. Burner shop test
i. Refractory test

10.2.2. Manufacturer's Data Reports and Material Mill Test Reports shall be forwarded to OWNER for record, with minimal document as follows:

a. Material test report for all pressure parts materials, except for cast iron.
b. Result of welders performance qualification for boiler welding.
c. Records of dimensional inspection including:
   1. Length, internal diameter, actual plate thickness, actual tube thickness and other major dimension of the boiler and auxiliary equipment.
   2. Outline dimension and foundation bolt arrangement of forced fan and other auxiliaries.
d. Result of hydrostatic test.
e. Result of radiographic examination.
f. Time-temperature records of

pengujian berikut:

a. Inspeksi visual
b. Pemeriksaan dimensi
c. Pengujian Hidrostatis
d. Pemeriksaan radiografi
e. Pengujian fungsi panel dan *sequence check*
f. *Balance test* dari FDF
g. *Performace test* dari FDF
h. Pengujian *burner shop*
i. Pengujian *refractory*

10.2.2. *Manufacturer Data Report* dan Laporan Hasil Pengujian Material harus diteruskan kepada PEMILIK sebagai catatan, dengan ketentuan sebagai berikut:

a. Laporan hasil pengujian untuk seluruh material komponen tekan, kecuali besi tuang.
b. Hasil kualifikasi operator pengelasan untuk *boiler.*
c. Catatan inspeksi dimensional yang mencakup:
   1. Panjang, diameter dalam, ketebalan pelat aktual, ketebalan *tube* aktual, dan dimensi lain pada *boiler* dan kelengkapannya.
   2. Dimensi peletakan dan susunan baut pondasi *fan* dan kelengkapan lain.
d. Hasil pengujian hidrostatis
e. Hasil pengujian radiografi
f. Catatan waktu-temperatur

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Heat treatment.

10.2.3. Hydrostatic test shall met this criteria:

a. Following the application of test pressure, a visual inspection for leaks shall be performed at a pressure not less than the design pressure or two-thirds of the tests pressure whichever is greater. This pressure shall be at least held for one hour.

b. Pressure test shall be conformed with ASME I Part PG-99.

c. All hydrostatic tests shall be made in the presence of the OWNER's representative. No preliminary tests, regardless of pressure shall be made prior to any required PWHT.

d. Hydrostatic test water shall refer to project specification for Hydrotest Water Quality and Drying. All reinforcing pad welds for nozzles shall be checked for leaks with a minimum air pressure of 5 kgf/cm^{2}g, prior to the pressure test.

e. Gaskets used for the pressure test shall be same type as those specified for operation in the drawing. However, non asbestos gasket may be used in place of spiral wound or jacketed gasket for nozzle flanges those specified in ANSI or ASME standard.

proses perlakuan panas

10.2.3. Pengujian hidrostatis harus memenuhi kriteria berikut:

a. Mengacu pada penerapan pengujian tekanan, inspeksi visual untuk cacat harus dilakukan pada tekanan tidak kurang dari tekanan desain atau dua pertiga dari tekanan pengujian, dipilih yang terbesar. Pengujian tekanan dilakukan setidaknya selama satu jam.

b. Pengujian tekan harus sesuai dengan ASME I bagian PG-99.

c. Seluruh pengujian hidrostatis harus dihadiri oleh perwakilan PEMILIK. Tidak ada pengujian pendahuluan, berapapun tekanan yang dibutuhkan sebelum PWHT.

d. Air yang digunakan pada pengujian hidrostatis harus mengacu pada spesifikasi proyek untuk *Hydrotest Water Quality and Drying*. Seluruh bantalan las penguat untuk *nozzle* harus diperiksa dengan tekanan udara minimal sebesar 5 kgf/cm^{2}g, sebelum dilakukan pengujian tekanan.

e. *Gasket* yang digunakan pada pengujian tekanan harus memiliki jenis yang sama dengan kondisi operasional pada gambar. Penggunaan *gasket non-asbestos* pada *spiral wound* atau *gasket* berlapis untuk *flange nozzle* dapat dilakukan sebagaimana diatur pada standar ANSI atau

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f. There shall be no leakage of test water from nozzle blinds or seals during any leakage test.

10.3 **Test – Performance**

10.3.1. The Manufacturer will be give OWNER 10 days notice of the date on which tests are to be made.

10.3.2. All performance tests shall be conducted in accordance with the ASME Test Code PTC 4 Fired Steam Generator (latest edition). The results of these tests shall be the measure of conformance to guarantees. The performance characteristic shall include the following:

a. Efficiency
b. Output
c. Capacity
d. Steam temperature/ control range
e. Exit flue gas and air entering temperatures
f. Excess air
g. Water/ steam pressure drops
h. Air/ flue gas pressure drops
i. Air Infiltration

10.3.3. Performance calculations shall be made in accordance with the applicable short test from of the ASME Test Code PTC 4 Fired Steam Generator (latest edition).

10.3.4. Preparations, operators, testing personnel, and apparatus will be

ASME.

f. Tidak diperbolehkan ada kebocoran air dari *nozzle* atau *seal* selama pengujian kebocoran dilakukan.

10.3 ***Test – Performance***

10.3.1. *Manufacturer* harus memberikan pemberitahuan kepada PEMILIK 10 hari sebelum pelaksanaan pengujian.

10.3.2. Seluruh *performance test* harus dilakukan sesuai dengan ASME *Test Code* PTC 4 *Fired Steam Generator* (edisi terbaru). Hasil pengujian dijadikan sebagai tolak ukur kesesuaian dengan jaminan. Karaktersitik kinerja mencakup beberapa hal berikut:

a. Efisiensi
b. Hasil/ Produk
c. Kapasitas
d. Temperatur uap/ jangkauan
e. Temperatur gas buang dan udara masukan
f. Kelebihan udara
g. Penurunan tekanan air/ uap
h. Penurunan tekanan udara/ flue gas
i. Infiltrasi udara

10.3.3. Perhitungan kinerja dilakukan sesuai dengan tes singkat pada ASME *Test Code* PTC 4 *Fired Steam Generator* (edisi terbaru).

10.3.4. Persiapan, operator, personel pengujian, dan peralatan

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provided by EPC Contractor. Plant instruments with mutually acceptable calibrations shall be utilized. Test results will be binding.

10.4 **Non Destructive Examination**

10.4.1. General

a. General NDE document shall refer to project specification General Welding and NDE Requirements for Pressure Equipment

10.4.2. Radiography

a. All welded vessel, regardless of whether or not they are ASME Code stamped, shall be (as a minimum) spot examined by radiographic test per Paragraph UW-52 of the ASME Code. Sectioning is not permitted. Spot reexamination per Paragraph UW-52 of the ASME Code shall be made, when required.

b. Welded joints belonging to Categories A and B of Paragraph UW-3 of the ASME Code shall not be positioned to pass under 8 reinforcing pad where possible. If this is unavoidable, the joint under the pad shall be ground smooth and radiographed for its entire hidden length plus 25 mm (1 inch) on each side.

c. All vessels designed in accordance with ASME Code, Section VIII, Division 2 shall be radiographed in accordance with that Code whether or not they are ASME code stamped.

disediakan oleh kontraktor EPC. Instrumen yang digunakan harus terkalibrasi dan dapat diterima semua pihak. Hasil pengujian bersifat mengikat.

10.4 ***Non Destructive Examination***

10.4.1. Umum

a. Dokumen pengujian mengacu pada spesifikasi proyek *General Welding and* NDE *Requirements for Pressure Equipment.*

10.4.2. Radiografi

a. Seluruh *vessel* yang diproses las, baik menggunakan standar ASME atau tidak, harus dilakukan pengujian dengan *radiographic test* sesuai dengan Code ASME bagian UW-52. Tidak diperkenankan pengujian per bagian. Apabila diperlukan dapat dilakukan pengujian ulang ASME bagian UW-52

b. Sambungan las kategori A dan B menurut *Code* ASME UW-3 sedapat mungkin tidak berada di bawah 8 *pad* penguat. Apabila tidak terhindarkan, sambungan di bawah *pad* harus halus dan seluruh bagian tersebut beserta 25 mm (1 inch) kiri dan kanan harus dilakukan pengujian radiografi.

c. Seluruh *vessel* yang dirancang sesuai dengan *Code* ASME Bagian VIII, Divisi 2 harus dilakukan pengujian radiografi sesuai dengan *code* tersebut atau tidak diberikan cap ASME.

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d. Pipe with thickness >= 30mm shall be 100% Ultrasonic Test or Radiography Test shall be carried out per ASME Code Sect.V

10.4.3. Magnetic Particle and Liquid Penetrant Inspection

a. On low alloy vessels, when vessel drawing or supplementary specifications call for Magnetic particle or liquid penetrant inspection of welds, this procedure shall be applied to the back chipped surface of root pass welds before proceeding to weld on the opposite side.

b. When magnetic particle or liquid penetrant inspection is specified, machining or grinding of the welt surface will not be required either than to remove excessive irregularities which would interfere with proper interpretation of results.

c. For 5% or 9% nickel steels or for other non-magnetic materials, all MT shall be substituted by PT in accordance with specification.

10.4.4. Positive Material Identification (PMI)

a. Positive material identification (PMI) shall be refer to Project Specification.

d. Pipa dengan ketebalan >= 30 mm harus dilakukan pengujian dengan *Ultrasonic Test* atau *Radiographic Test* sesuai dengan *Code* ASME Bagian V

10.4.3. *Magnetic Particle* dan *Liquid Penetrant Inspection*

a. Untuk logam paduan, apabila terdapat keterangan untuk dilakukan pengujian *Magnetic particle* atau *liquid penetrant* pada pengelasan, pengujian juga berlaku pada bagian belakang jalur pengelasan sebelum melakukan pengelasan pada sisi yang berlawanan.

b. Apabila pada pengujian *magnetic particle* atau *liquid penetrant* telah ditentukan, *finishing* permukaan las tidak lagi diperlukan kecuali untuk menghilangkan kotoran dan ketidak normalan las yang dapat mempengaruhi hasil pengujian.

c. Untuk baja dengan kandungan Nikel 5-9 % atau material non-magnetik, seluruh pengujian MT harus diganti dengan PT yang disesuaikan dengan spesifikasi masing-masing.

10.4.4. *Positive Material Identification* (PMI)

a. *Positive Material Identification* (PMI) harus mengacu pada Spesifikasi Proyek.

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11. GUARANTEE

Manufacturer is requested to guarantee following items:

11.1 Maximum Continuous Steam Generation (MCR).

11.2 Boiler Efficiency and Fuel Consumption at MCR.

11.3 Steam Temperature and pressure at MCR.

11.4 Steam purity (SiO2 and conductivity at the upstream of the superheater at MCR.)

11.5 A Controlled flame profile at all loads within the boiler control range.

11.6 Minimum load operation with a stable flame when firing any of the fuels specified.

11.7 Flue gas emission level at all specified operating conditions.

11.8 Noise level at all specified operating conditions.

11.9 The condition for the performance guarantee (item are shown below) shall specified by Manufacturer:

a. Feed water temperature.

b. Excess air factor.

c. Blowdown rate.

d. Fuel (pressure, composition, consumption).

e. Measuring tolerance.

11. JAMINAN

Manufacturer diminta untuk menjamin item berikut:

11.1 *Maximum Continuous Steam Generation* (MCR)

11.2 Efisiensi *Boiler* dan Konsumsi Bahan Bakar di MCR.

11.3 Temperatur *steam* dan tekanan pada MCR.

11.4 Kemurnian steam (SiO2 dan konduktivitas di hulu *superheater* pada MCR).

11.5 Profil api yang terkontrol di semua rentang beban *boiler* yang terkendali.

11.6 Operasi beban minimum dengan nyala api yang stabil saat mengaktifkan salah satu bahan bakar yang ditentukan.

11.7 Tingkat emisi gas buang di semua kondisi operasi yang ditentukan.

11.8 Tingkat kebisingan di semua kondisi operasi yang ditentukan.

11.9 Kondisi untuk jaminan kinerja untuk item yang ditunjukkan di bawah) ditentukan oleh *Manufacturer*:

a. Temperatur *feed water.*

b. Faktor udara berlebih.

c. *Blowdown rate.*

d. Bahan bakar (tekanan, komposisi, konsumsi).

e. Toleransi dalam pengukuran.

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