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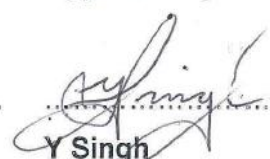
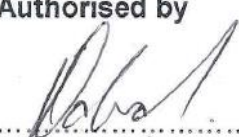
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## 1. INTRODUCTION

This document regulates the safe operations of Fossil Fuel Fired **Boiler Plant**.

## 2. SUPPORTING CLAUSES

### 2.1 SCOPE

The Regulations in this document are applicable to all Eskom Holdings SOC (Ltd) Fossil Fuel Firing Power Stations (**Boiler Plant**).

#### 2.1.1 Purpose

The purpose of these Regulations is to prevent explosions<sup>[\*]</sup> on **Boiler Plant** and **Auxiliary Boilers** through safe and sound operating, maintenance and engineering methods.

These Regulations also contain the minimum requirements necessary for the effective prevention of uncontrolled fires, implosions and extensive furnace damage to the **Boiler Plant** and **Auxiliary Boilers**.

#### 2.1.2 Applicability

This Regulations **Shall** apply to all involved in the management, operation, maintenance and engineering of **Boiler Plant** on all Fossil Fuel Fired **Boiler Plant** in ESKOM.

### 2.2 NORMATIVE/INFORMATIVE REFERENCES

Parties using this document **Shall** apply the most recent edition of the documents listed in the following paragraphs.

#### 2.2.1 Normative

- |     |              |  |
|-----|--------------|--|
| [1] | ISO 9001     | Quality Management Systems.  |
| [2] | NFPA 85      | Boiler and Combustion Systems Hazards Code.  |
| [3] | NFPA 54      | National Fuel Gas Code.  |
| [4] | 240-46979537 | Training evaluation and authorisation of personnel operating under Statutory and ESKOM health and safety requirements. |
| [5] | 36-232       | Administration of operations - related ESKOM regulations.  |
| [6] | 240-56241288 | Fossil Fired Boiler Protection Functions Standards   |

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<sup>1</sup> [\*] refers to an explanatory note with similar number in the Appendix A

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- [7] IEEE 61511 Functional safety – safety instrumented systems for the process industry sector (Parts 1, 2 and 3).
- [8] 240- 72273656 Power Generation Asset Criticality classification standards.
- [9] 240-53114002 Engineering Change Management procedure
- [10] 32-391 Integrated Risk Management Standard
- [11] 32-520 Occupational Health and Safety Risk Assessment procedure
- [12] BS EN 12952 Watertube boilers and auxiliary installations – Part 9: Requirements for firing systems for pulverised solid fuels for the boiler
- [13] 240-105249370 Operating and Maintenance Requirements for Coal Fired Boilers Flame Failure Protection Devices Standard.

### 2.2.2 Informative

- [14] 240-83797789 Specification for Fuel Oils for Coal Fired Boilers Standard
- [15] 240-76440331 Pulverised Fuel Sample Collection and Size Grading Standard
- [16] SANS 329:2013 Industrial Thermo-processing equipment – Safety requirements for combustion and fuel handling systems
- [17] BS EN 13611:2015 Safety and Control Devices for Burners and Appliances burning gaseous and/or liquid fuels – General requirements
- [18] 240-105249370 Operating and Maintenance Requirements for Coal Fired Boiler Flame Failure Protection Devices Standard
- [19] GGPP1538 Safe operation and maintenance of submerged scraper conveyors
- [20] 36-1307 Standards for safe clinker or loose ash removal from boilers.

### 2.3 DEFINITIONS

	Definition	Description
2.3.1	<b>Amendment / Amend / Amended</b>	means a permanent change to the Regulations, which will be implemented by issuing a revised page or pages to replace existing pages in the Regulations
2.3.2	<b>Authorise / Authority / Authorisation /</b>	means permission in writing to perform specific duties in terms of these Regulations

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	Definition	Description
	<b>Authorised</b>	
2.3.3	<b>Authorised Boiler Operator</b>	means a <b>Competent Operator</b> who has been <b>Authorised</b> in terms of these Regulations to operate and control boiler firing plant
2.3.4	<b>Auxiliary Boilers</b>	means a boiler supplying process steam to a power station for commissioning purposes
2.3.5	<b>Blanketing Air</b>	means air supplied through the top burner row(s) for the purpose of reducing furnace exit gas temperature during start-up of the boiler. This air <b>Shall</b> not form part of the <b>Total Combustion Air</b> as calculated for the respective <b>Burners</b> in service nor form part of the combustion process. A local procedure <b>Shall</b> be developed for using <b>Blanketing Air</b>
2.3.6	<b>Boiler Maximum Continuous Rating (BMCR)</b>	means the maximum continuous rating of the boiler as defined by the Original Equipment Manufacturer (OEM) for a certain fuel quality and is defined as a steam flow at a certain steam pressure and temperature
2.3.7	<b>Boiler Master Fuel Trip</b>	means a device, which will, either automatically or by means of a manual push button, stop all fuel input into the furnace immediately
2.3.8	<b>Boiler Plant</b>	means the air and fuel supply systems to the furnace, furnace, flue gas extraction system and the bottom ash removal system. This includes <b>Auxiliary Boilers</b>
2.3.9	<b>Boiler Start-up</b>	means the operational activities carried out to achieve stable combustion in a boiler from an offload and unpurged condition
2.3.10	<b>Boxed-up</b>	means isolated from all sources of fuel, air and flue gas
2.3.11	<b>Burner Cooling Air</b>	means air supplied for cooling purposes through out of service burners during normal boiler operation
2.3.12	<b>C&amp;I Failures</b>	<b>Common Cause Failure</b> – means failure which is the result of one or more events, causing failures of two or more separate

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	Definition	Description
		<p>channels in a multiple channel system, leading to a system failure.</p> <p><b>Common Mode Failure</b> – means failure of two or more channels in the same way, causing the same erroneous result.</p> <p><b>Dependant Failure</b> – means failure whose probability cannot be expressed as the simple product of the unconditional probabilities of the individual events that caused it.</p>
2.3.13	<b>Co-firing</b>	means the simultaneous firing of other fuels with the existing <b>Primary Fuel</b> firing system
2.3.14	<b>Combustion Air Flow / Steam Flow Curve</b>	means a curve or graph relating boiler steam flow to <b>Total Combustion Air</b> flow with the resultant Oxygen measurement at the economiser outlets based on the original design and design <b>fuel</b> quality
2.3.15	<b>Competent Operator</b>	means a person who has been sufficiently trained and assessed in writing and has sufficient knowledge to be aware of the dangers in terms of the Fossil Fuel Firing Regulations to carry out his/her duties to ensure safe operation of the <b>Boiler Plant</b>
2.3.16	<b>Competent Person</b>	means a person other than an operator who has been trained and assessed in writing that he/she has sufficient knowledge in terms of the Fossil Fuel Firing Regulations to carry out specific maintenance and/or engineering duties to ensure safety on the <b>Boiler Plant</b>
2.3.17	<b>Core Air</b>	means the air supplied to the <b>Oil Burner</b> for the combustion of the fuel oil. The <b>Core Air</b> may be supplied either from dedicated <b>Core Air</b> fans or taken from the <b>Secondary Air</b> system
2.3.18	<b>Dangerous Conditions and Incidents</b>	Any abnormal condition that may put the <b>Boiler Plant</b> at risk in terms of these Regulations
2.3.19	<b>Employee</b>	means any person employed or contracted by ESKOM
2.3.20	<b>Employer</b>	means a person appointed in writing by ESKOM as the delegated

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	Definition	Description
		<b>Employer</b> in terms of the provisions of the Act.
2.3.21	<b>Examining Committee</b>	means a committee appointed for the purpose of examining persons to determine whether their knowledge is adequate to justify <b>Authorisation</b> in terms of these Regulations
2.3.22	<b>Excess Air</b>	means air supplied to the furnace in excess of the theoretical <b>Stoichiometric Air</b> requirements
2.3.23	<b>Exemption</b>	means permission of a temporary nature to be excused from a specific provision of these Regulations.
2.3.24	<b>Flame</b>	means visible evidence of a chemical combustion process that emits radiant and thermal energy
2.3.25	<b>Flame Monitor</b>	means a device installed to detect/monitor of a <b>Flame</b> in the furnace
2.3.26	<b>Flame Scanners</b>	Means a device installed to detect/monitor the condition of the <b>Flame</b> on an individual burner basis and includes <b>Fuel</b> oil and Pulverised <b>Fuel Burner</b> scanners
2.3.27	<b>Flash-back<sup>[*]</sup></b>	means the burning back of a <b>Flame</b> from the furnace into the <b>Fuel Burner</b> and pipework
2.3.28	<b>Fossil Fuel Firing Regulation Site Compliance Committee</b>	means a site specific committee appointed by the <b>Power Station Manager</b> to manage, monitor, advise and ensure compliance to the <b>Fossil Fuel Firing Regulation</b> at the respective site
2.3.29	<b>Fuel</b>	means hydrocarbons such as coal, gas, bio-fuels and oil that contain energy which can be extracted by combustion through chemical reactions
2.3.30	<b>Fuel Burner</b>	means a device or a group of devices for the introduction of <b>Fuel</b> and air into a furnace at the velocity, turbulence and concentration required to maintain stable ignition and combustion of the <b>Fuel</b>
2.3.31	<b>Functional Manager</b>	means the manager appointed by the Group Executive - Generation as custodian of the Regulations to compile, <b>Amend</b> ,

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	Definition	Description
		and clarify the Regulations and to grant <b>Exemptions</b> and <b>Waivers</b>
2.3.32	<b>Furnace Flame Failure Protection System</b>	a system consisting of a series of <b>Flame Monitors</b> to detect a <b>Stable Flame</b> and protect the furnace in the event that the <b>Flame</b> becomes unstable or on a loss of ignition. The <b>Flame Monitors</b> information may also be used to determine the stability of the combustion. <b>Flame Scanners</b> may additionally be used as furnace protection <b>Flame Failure</b> devices
2.3.33	<b>Igniter</b>	means a gas torch or spark <b>Igniter</b> , which provides ignition energy for an <b>Oil Burner</b>
2.3.34	<b>Mill Group</b>	means the mill with its associated feeder(s), air supply system, pulverised <b>Fuel</b> classification system (s), pulverised <b>Fuel</b> distribution system, pulverised <b>Fuel</b> pipework, seal air system(s), reject system, <b>Fuel Burners</b> , lubrication oil systems, dampers/registers and actuators and any associated electrical motors and auxiliaries
2.3.35	<b>Oil Burner</b>	means a device which provides ignition energy for a main <b>Fuel Burner</b>
2.3.36	<b>Oil Burner Classification</b>	<p>An <b>Oil Burner</b> with a classification of Class 1 provides greater than 10% of the associated main <b>Fuel Burner(s)</b> thermal heat input at design <b>Boiler Maximum Continuous Rating</b>.</p> <p>An <b>Oil burner</b> with a classification of Class 2 provides between 4% and 10% of the associated main <b>Fuel Burner(s)</b> thermal heat input at design <b>Boiler Maximum Continuous Rating</b>.</p> <p>A Class 1 <b>Oil Burner</b> with variable heat input can become a Class 2 <b>Oil Burner</b> or lower as the heat input is reduced</p>
2.3.37	<b>Operating Technical Specification</b>	<b>The Operational Technical Specification (OTS)</b> for an asset contains a set of operational envelopes on unit, system and component level which includes the range of normal operation, the operational limits and the analysed functional design limits as

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	Definition	Description
		provided for in the engineering calculations provided in the Design Base. It further provides for the management of the operational margins and out of normal asset operating conditions.
2.3.38	<b>Overfire Air</b>	means that part of the <b>Total Combustion Air</b> admitted at a point above the top burners through dedicated nozzles
2.3.39	<b>Person in Charge of the Plant</b>	means the person on duty that has been sufficiently trained and assessed in writing and has sufficient knowledge to be aware of the dangers in terms of the <b>Fossil Fuel Firing Regulation</b> to carry out his/her duties to ensure safe operation of the <b>Boiler Plant</b> and be duly <b>Authorised</b> in writing as the <b>Person in Charge of the Plant</b> .
2.3.40	<b>Power Station Manager</b>	means the person appointed as <b>Power Station Manager</b> or <b>General Manager</b> for the Power Station(s) and <b>Shall</b> also mean any person to whom the <b>Power Station Manager</b> has delegated, in writing, specific duties in terms of these Regulations, on the understanding that such delegation never absolves the <b>Power Station Manager</b> from his/her ultimate accountabilities in terms of these Regulations or other laws, Regulations, codes and standards
2.3.41	<b>Primary Air</b>	Means the air required to dry and transport the <b>Fuel</b> from the milling system to the furnace through the <b>burners</b> . The <b>Primary Air</b> for tube mills is made up of <b>Primary Air</b> and bypass air.
2.3.42	<b>Primary Fuel</b>	means the main <b>Fuel</b> type that the <b>Boiler Plant</b> is designed to produce the rated thermal output
2.3.43	<b>Secondary Air</b>	means that part of <b>Total Combustion Air</b> supplied to the burners in addition to the <b>Primary Air</b> to ensure complete combustion
2.3.44	<b>Shall</b>	Indicates a mandatory requirement
2.3.45	<b>Should</b>	Indicates a recommendation or advice that is not mandatory
2.3.46	<b>Side Wall Air</b>	means that part of the <b>Total Combustion Air</b> supplied to the furnace through dedicated side wall nozzles to form an oxidising

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	Definition	Description
		atmosphere to inhibit fireside corrosion
2.3.47	<b>Stable Flame / Flame Stability</b>	means a <b>Flame</b> which provides sufficient energy to maintain its own ignition
2.3.48	<b>Stoichiometric Air</b>	means the correct quantity of air required to theoretically achieve complete combustion of a specific <b>Fuel</b> . For any variation in the quality of a specific <b>Fuel</b> , the quantity of air required will vary accordingly
2.3.49	<b>Supervise / Supervision</b>	Means to oversee the actions of a person(s) to such an extent as to prevent any dangerous act, as far as reasonably practical. Such a <b>Supervisor</b> must be trained in risk assessment and able to understand the dangers/hazards associated with the task and who has the authority to ensure that precautionary measures taken are implemented
2.3.50	<b>Sweeping Air</b>	means air that is admitted through the top idle <b>Burners</b> to increase the flue gas velocity under low load conditions. This air <b>Shall</b> not form part of the <b>Total Combustion Air</b> as calculated for the respective burners in service nor form part of the combustion process. A local procedure <b>Shall</b> be developed for using <b>Sweeping Air</b>
2.3.51	<b>Tertiary Air</b>	means that part of the <b>Total Combustion Air</b> supplied to the furnace through tertiary ports in the <b>burner</b> systems
2.3.52	<b>Total Combustion Air</b>	means the <b>Stoichiometric Air</b> and <b>Excess Air</b> required to achieve complete combustion and supplied through the burners including the <b>Overfire Air</b> and/or <b>Side Wall Air</b> , but excluding <b>Tramp Air</b> .  For calculation purposes, <b>Core / Burner Cooling Air</b> and a certain quantity of <b>Tramp Air</b> must be considered based on the boiler manufacture's experience or as proven by tests.
2.3.53	<b>Tramp Air</b>	means unmeasured air entering the furnace from sources other than the <b>Burners</b> , <b>Overfire Air</b> nozzles and <b>Side Wall Air</b>

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	Definition	Description
		nozzles
2.3.54	<b>Waiver</b>	means permission of a permanent nature to be excused from a provision of the Regulations. The issuance of such a <b>Waiver</b> may be subject to the adherence to specific requirements depending on plant design and these requirements become an extension of these Regulations

## 2.4 DISCLOSURE CLASSIFICATION

Controlled disclosure: **controlled disclosure to external parties (either enforced by law, or discretionary).**

## 2.5 ABBREVIATIONS

N/A

## 2.6 ROLES AND RESPONSIBILITIES

### 2.6.1 Group Executive – Generation

The Group Executive - Generation ensures compliance to the Fossil Fuel Firing Regulation and grants **Exemptions/Waivers** from any of these Regulations on the recommendation from the **Fossil Fuel Firing Regulation Management Committee**.

### 2.6.2 Group Executive - Technology

The Group Executive – Technology is responsible for the technical content of this document and ensures revisions are made to the **Fossil Fuel Firing Regulation** accordingly.

### 2.6.3 Functional Manager

The **Functional Manager** is appointed by the Group Executive - Generation as custodian of the Regulations to ensure compliance to the Regulations, clarify the Regulations and to grant **Exemptions/Waivers** based on feedback from the **Fossil Fuel Firing Regulation Management Committee**.

#### 2.6.3.1 Fossil Fuel Firing Regulation Management Committee

The **Fossil Fuel Firing Regulation Management Committee** Shall:

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- Compile and ensure that the Regulation is current and reflects industry best practices.
- Review and manage **Waivers** and **Exemptions** as requested by power stations and give recommendations to the **Functional Manager**.
- Provide advice to the power stations when requested
- Notify the station of any risks that may come to the attention of the committee
- Assist with compliance reviews when required.

#### 2.6.4 Fossil Fuel Firing Regulation Site Compliance Committee

The responsibility of the **Fossil Fuel Firing Regulation Site Compliance Committee** is to:

- Manage, monitor, advise and ensure compliance to the **Fossil Fuel Firing Regulation** at the respective site.
- Ensure that incidents are reported to the **Fossil Fuel Firing Regulation Management Committee**.
- Regular meetings are conducted to discuss and analyse any relevant occurrences, ensure systems are in place to prevent reoccurrences and to manage the site **Fossil Fuel Firing Regulation** implementation and control.

#### 2.6.5 Power Station Manager

The **Power Station Manager Shall** be responsible and accountable for the execution of and control over all actions taken in order to comply with these Regulations and the local adaptations made in terms of these Regulations.

#### 2.6.6 Examining Committee

The purpose of the **Examining Committee** is to evaluate and recommend persons for **Authorisation** according to these Regulations. Each representative **Shall** be appointed in writing by the **Employer**

The **Examining Committee Shall** consist of at least two appointed senior representatives from the operating function, and one appointed engineering function representative, at every meeting.

The members of the **Examining Committee** must have sufficient knowledge of these Regulations and of the plant and control system to be able to evaluate personnel.

## **2.7 PROCESS FOR MONITORING**

The **Fossil Fuel Firing Regulation Site Compliance Committee Shall** be responsible for monitoring, compliance and incident reporting of non-compliance or violation to the **Fossil Fuel Firing Regulation Management Committee**.

## **2.8 RELATED/SUPPORTING DOCUMENTS**

36-680 rev 1	Fossil Fuel Firing Regulations
GGR 0568 rev 2	Pulverised Fuel Firing Regulations
GGR 0568 rev 1	Pulverised Fuel Firing Regulations
OPR 1857 rev 2	Code of Practice for Pulverised Fuel Fired Boiler Plants.

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### 3. REQUIREMENTS

#### 3.1 GENERAL REQUIREMENTS

- [1] These Regulations or any local instructions produced there-from **Shall** not be seen as restrictive. The content can be broadened to cover all aspects of good management in the safe operation, maintenance and engineering of Fossil **Fuel Fired Boiler Plants**.
- [2] These Regulations may not be applied in such a manner as to contravene the requirements of the Occupational Health and Safety Act (Act 85 of 1993), hereafter referred to as the Act, or the Regulations framed there-under as **Amended**.
- [3] An individual Regulation within these Regulations **Shall** be read and interpreted in context of the entire **Fossil Fuel Firing Regulation**.
- [4] Ignorance of these Regulations, or of statutory requirements, will not be accepted as a justifiable reason for neglect of duty for all involved in the operation, maintenance and design of **Boiler Plant**.
- [5] Any contravention of these Regulations may be the subject of an inquiry by staff appointed for this purpose by the Group Executive - Generation or his or her delegate.
- [6] A copy of these Regulations must be issued to all **Authorised Boiler Operators** and to other persons as decided by the **Power Station Manager**. Each of these persons must sign a receipt for the copy received. Complete records must be kept of all issues and **Amendments** to these Regulations.
- [7] Any **Amendments** to these Regulations must be approved by the Group Executive - Generation. Upon receipt of **Amendments** which have been approved by the Group Executive - Generation, the person in possession of a copy of these Regulations must update the Regulations accordingly.
- [8] The Group Executive - Generation grants **Waivers** and **Exemptions** from any of these Regulations on the recommendation from the **Fossil Fuel Firing Regulation Management Committee**. Similarly the **Functional Manager Shall** have the right to grant **Waivers** and **Exemptions** from these Regulations.
- [9] The Group Executive - Generation will appoint a **Fossil Fuel Firing Regulations Management Committee** to review these Regulations when required, to recommend and to ensure continuity and uniformity of **Amendments, Waivers** and **Exemptions** in accordance with 36-232.
- [10] Subject to review, **Waivers** and **Exemptions** may be revoked with the issue of every new revision of the Regulation within a time period as defined by the **Functional Manager**.

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- [11] All test methods and results related to **Waivers** and **Exemptions** need to be approved by the **Fossil Fuel Firing Regulations Management Committee** appointed (refer to Regulation 2.6.3.1)
- [12] The master of these Regulations is prepared in English. However, the Regulations can be translated into any other language as needed. In the event of a dispute over the meaning of any part, the English master will be interpreted and this interpretation will apply to all translations.
- [13] These Regulations remain the property of ESKOM Holdings SOC Ltd Reg No 2002/015527/30 (hereafter ESKOM).
- [14] These revised Regulations take effect six months from date of Steering Committee of Technology approval.

### 3.1.1 Dangerous Conditions and Incidents

- 3.1.1.1 All **Dangerous Conditions and Incidents Shall** be reported as soon as possible to the **Power Station Manager**.
- 3.1.1.2 The established channels and methods must be utilised to report and resolve such **Dangerous Conditions**.
- 3.1.1.3 **Dangerous Conditions and Incidents Shall** be reported to the **Fossil Fuel Firing Regulation Management Committee** immediately. Near misses must be presented and discussed at the **Fossil Fuel Firing Regulation Management Committee** meetings.

### 3.1.2 Authorisation of Personnel <sup>[\*]</sup>

- 3.1.2.1 Only persons who have satisfied the **Examining Committee** that their technical knowledge is adequate to perform the duties on the plant, and that their knowledge of these Regulations is sufficient to justify such an appointment, may be **Authorised**.
- 3.1.2.2 Re-assessment and re-**Authorisation** of personnel **Shall** be done at intervals not exceeding two years. On re-issuing of a revised **Fossil Fuel Firing Regulation**, all **Authorised** personnel **Shall** be re-**Authorised** within six months.

### 3.1.3 Authorisation certificates

The certificate of **Authorisation** for all relevant **Authorised** personnel **Shall**:

- have a unique reference number;
- state the **Authorisation** and expiry date;
- state the person's full name, designation and ESKOM unique number and/or ID number;

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- specify the plant and function to which it applies;
- bear the signature of the **Employer** (in terms of the Act).

The **Authorisation** certificate **Shall** not be transferable between sites.

### 3.1.4 Station Local Instructions

**3.1.4.1** These Regulations **Shall** be used as a framework within which each station **Shall** establish its own written procedures or instructions, which must take local conditions into account. Such procedures or instructions **Shall** not contradict or result in lower safety standards than these Regulations.

**3.1.4.2** Each station **Shall** have a station specific procedure written in parallel to the **Fossil Fuel Firing Regulations** indicating compliance and application of the Regulation. Any additional condition stipulated in an approved **Waiver**, **Shall** be included in the power station specific procedure.

**3.1.4.3** The Station Local Instructions **Shall** also refer to any additional condition stipulated in an approved **Exemption** and **Shall** be captured as a list in the Station Local Instruction.

**3.1.4.4** The Station Local Instruction **Shall** be revised after any changes to **Exemptions** or **Waivers**.

### 3.1.5 Compliance with any Other Law beside the Fossil Fuel Firing Regulation

Notwithstanding any provisions contained in these Regulations it **Shall** remain the responsibility of the **Power Station Manager** to ensure that these Regulations and any other laws which relate to the safety of plant and personnel are adhered to.

### 3.1.6 Short Term Adaptation

The **Power Station Manager** may, within the limits of responsibility delegated to him/her, adapt the provisions of these Regulations when a short duration deviation becomes necessary. The duration of such adaption **Shall** be valid for a period not exceeding 24 hours. All such adaptations **Shall** be communicated and controlled through the Risk process. This adaption may be extended for further 24 hour periods subject to the risk being re-evaluated and re-issued for each extension.

This accountability in terms of the Short Term Adaptation cannot be delegated.

### 3.1.7 Changing of Settings and Manual Adjustments to Control and Protection Systems

**3.1.7.1** Only **Competent Persons** may change settings to control and protection systems via the Simulation or Engineering Change Management procedure. The **Power Station Manager**

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**Shall** ensure that all changes to control and protection system settings are formally controlled, communicated and available in the control room.

**3.1.7.2** Only **Competent Operators** may carry out manual adjustments or operate any plant on the boiler(s) for which they are responsible on instruction of the **Authorised Boiler Operator**.

### **3.1.8 Engineering Change Management**

**3.1.8.1** All modifications which have the potential to impact the safe operation of the **Boiler Plant** in terms of these regulations, **Shall** be considered as Level 1 Modifications, as defined in 240-72273656 and **Shall** be formally declared to the **Power Station Manager, Person in Charge of the Plant, Authorised Boiler Operator, Fossil Fuel Firing Regulations Management Committee** and the site Training Department.

**3.1.8.2** An Engineer that has been appointed as a **Competent Person Shall** be a member of the local Site Change Control Committee that approves **Fossil Fuel Firing Regulation** related changes. Such an Engineer **Shall** have been declared a **Competent Person** by the **Examining Committee**.

### **3.1.9 Overriding or Biasing of Controls**

Any necessity to override automatic controls by manual operation or biasing **Shall** be logged, indicating the magnitude and reason for such action.

### **3.1.10 Defects on Automatic Controls and Protection Functions**

Defects on the automatic control and protection systems **Shall** be reported and actioned for repair immediately by the **Authorised Boiler Operator**. In the event of a defect to the automatic controls or a failed protection function, the **Authorised Boiler Operator Shall** take appropriate action to ensure safe operation of the plant.

### **3.1.11 Post Maintenance Inspections and Commissioning<sup>[1]</sup>**

When plant is handed back from any maintenance activity, such plant **Shall** be inspected, formally re-commissioned, test run and declared serviceable and operable within design limits before returning it to service or leaving the plant on standby.

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### 3.1.12 Essential Instrumentation Requirements

The design of the operator interface **Shall** be such that the likelihood of **Common Cause, Common Mode and Dependant Failures Shall** prevent the loss of the display of essential instrumentation to the **Authorised Boiler Operator**. To achieve this requirement a sound design philosophy **Shall** be followed using the concepts of independency, diversity, and physical separation.

As a minimum, but not limited to, the power station **Shall** have the following instrumentation installed as a physically separate means of indications **Should** the computer based Human Machine Interface (HMI) fail:

- Electrical generated load;
- Boiler outlet steam flow;
- Boiler outlet steam pressures and temperatures;
- Feed water or economiser flow;
- Drum level (where applicable);
- Attemporator 1.1 temperature or Evaporator outlet temperatures (where applicable);
- **Total Combustion Air** flow;
- Furnace **Flame** failure monitors;
- Furnace pressure;
- Total **Fuel** flow (where **Co-Firing** exists, all **Fuels Shall** be indicated separately);
- Oxygen (O<sub>2</sub>) measurement at the economiser outlet.
- Control air supply pressure at the unit.

### 3.1.13 Availability of Oxygen Measurement

Boiler Oxygen measurement **Shall** be reliable and accurate. Boilers with split flue gas outlets **Shall** have at least two Oxygen analysers per flue gas pass before the air heaters. Boilers with a single flue gas pass outlet **Shall** have at least three Oxygen analysers on the flue gas duct before the air heaters. The position of the Oxygen analysers **Shall** be such that they provide a representative indication of the Oxygen concentration of the weighted average of the total volume flow in the duct.

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### 3.1.14 Availability of Carbon Monoxide Measurement<sup>[1]</sup>

Carbon Monoxide measurement **Shall** be reliable and accurate. Boilers with split flue gas outlets **Shall** have at least one Carbon Monoxide analyser per flue gas pass at the economiser outlet. Boilers with a single flue gas pass **Shall** have at least two Carbon Monoxide analysers at the economiser outlet. Carbon Monoxide analysers installed in single stacks is also deemed to meet this requirement.

### 3.1.15 Placing Plant into Service

Before **Boiler Plant** is placed in service, it **Shall** be confirmed locally on the plant that it is safe to do so to ensure safety of personnel and plant.

### 3.1.16 Tapping Points and Impulse Lines

The power station **Shall** prepare and implement a maintenance plan to ensure the integrity/correct functioning of tapping points and impulse lines.

### 3.1.17 Damper Operation

All isolating and control dampers must be verified to ensure proper functioning and operation according to the particular dampers operation philosophy.

### 3.1.18 Total Combustion Air Flow Metering Device<sup>[1]</sup>

**3.1.18.1** The **Total Combustion Air** required by the boiler **Shall** be measured after the air heaters. This **Shall** include mill tempering air but exclude mill seal air.

**3.1.18.2** Proper calibration of the **Total Combustion Air** flow metering devices in kg/s (not percentages) **Shall** be performed with an approved independent mass flow measuring device every 72 months.

**3.1.18.3** Verification of the Distributed Control System /Historian readings of **Total Combustion Air** flow metering devices in kg/s (not percentages) **Shall** be performed with an approved independent mass flow measuring device every 24 months.

**3.1.18.4** Each site **Shall** prepare a procedure to maintain the **Total Combustion Air** flow measurement calibration to an accuracy of three (3) percent at boiler MCR. The three (3) percent **Shall** be referenced to the 'as calibrated' parameters obtained from the calibration done with the approved independent mass flow measurement device.

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### 3.1.19 Logging and Reporting

The **Authorised Boiler Operator** **Shall** write a detailed log of all operating activities on the **Boiler Plant** and **Shall** have access, at all times, to a complete record of all current defects on the plant under the **Authorised Boiler Operator's** control.

For reporting of **Near Misses, Dangerous Conditions** or **Incidents**, refer to Regulation 3.1.1.

### 3.1.20 Communication at Change-Over of Shifts

On changing over shifts, all operating staff taking over **Shall** ensure that they are fully aware of all conditions which could affect the safe and efficient operation of the plant. All outgoing staff **Shall** ensure that the incoming staff is fully informed regarding all existing or impending conditions of which they are aware that could affect the safe and efficient operation of the plant. A shift hand-over document **Shall** be completed by both the incoming and outgoing shift during shift change-over.

### 3.1.21 Operation and Supervision on Boiler Plant

No person **Shall** be permitted to operate **Boiler Plant** or **Supervise** the operation of **Boiler Plant** unless that person has been trained, assessed and **Authorised** in boiler operation to the satisfaction of the **Power Station Manager**, and has demonstrated a thorough knowledge and understanding of the contents of these Regulations and local instructions compiled in compliance with these Regulations.

### 3.1.22 Maintenance and Engineering on Boiler Plant

No person **Shall** be permitted to carry out maintenance and/or engineering activities on the **Boiler Plant** or **Supervise** maintenance and/or engineering activities on the **Boiler Plant** unless that person has been trained and assessed and that he/she has sufficient knowledge of these Regulations and local instructions compiled in compliance with these Regulations.

### 3.1.23 Safety as a Paramount Requirement

Load requirements are secondary to the safe operation of the plant. Never "push" or try to "save" load in a manner that could jeopardise the safety of personnel and safe operation of the **Boiler Plant**. Rather save the plant so that it may be safely reloaded within a reasonable time. Combustion controls **Shall** not be altered to cater for deficiencies on other **Boiler Plant**.

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### 3.1.24 Housekeeping

Good housekeeping is essential on **Boiler Plants** in order to ensure safe operation and prevent fires or explosions. Provision **Shall** be made for the periodic cleaning of pipework, ledges, surfaces of buildings and equipment and other affected areas to prevent the accumulation of appreciable **Fuel** dust and oil deposits.

Special attention **Shall** be paid to prevent an accumulation of **Fuel** that might ignite on any surfaces in the **Boiler Plant** (refer to Regulation 4.5.7)

### 3.1.25 Boiler Master Fuel Trip

Provision **Shall** be made for both automatic and manual tripping functionality as defined below:

- a) Automatic tripping by means of a **Boiler Master Fuel Trip** generated by a Safety Instrumented System (SIS).
- b) Manual tripping by means of a **Boiler Master Fuel Trip** generated from a hard wired push button independently of the Safety Instrumented System (SIS) logic solver and the plant control system, operating directly the final trip actuation elements.
- c) The activation of the **Boiler Master Fuel Trip Shall** be executed without any time delay after initiation.
- d) The conditions described in Regulation 3.5.1.1 **Shall** initiate a **Boiler Master Fuel Trip**. Any condition initiating a **Boiler Master Fuel Trip Shall** stop and inhibit all **Fuel** supply to the boiler without any time delay.

### 3.1.26 Furnace Flame Failure Protection

**Furnace Flame Failure Protection** devices **Shall** be positioned at strategic points around the boiler furnace and designed to detect when ignition has been lost or is in danger of being lost. The **Furnace Flame Failure Protection** philosophy is:

- a) The **Furnace Flame Failure Protection** device **Shall** be armed at 900°C during a light- up.
- b) With a decreasing temperature an alarm may be given at 800°C.
- c) The tripping of the mill(s) in service **Shall** be activated according to the protection philosophy at a temperature no less than 600°C. Any mill may continue to operate provided all associated Fuel Oil Burners are in operation at a Class 1 rating as per interlocking philosophy.

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- d) A maximum time delay of 3 seconds is permitted between the initiating event and the final tripping of the mill(s) in service.

The fitting of this protection is mandatory on all Eskom **Boiler Plant**. Any changes to these devices and technologies or its positioning on the **Boiler Plant** **Shall** be approved via the Engineering Change Management process and **Shall** be classified as Level 1 plant.

### 3.1.27 Pulverised Fuel Burner Flame Protection

Where pulverised **Fuel Burner Flame Scanners** are installed and proven to be reliable in discriminating between different **Fuel Flames**, it **Shall** be used to trip the mill associated to the burners indicating a **Flame** failure according to Original Equipment Manufacturer specifications and proven through testing.

### 3.1.28 Coal Quality Monitoring

Each power station **Shall** appoint a person(s) who **Shall** analyse and monitor the proximate analysis results of the coal on a daily basis and any risks due to deviations in coal qualities **Shall** be highlighted to the **Power Station Manager** and Primary Energy Division for further action.

### 3.1.29 Observance of and Adherence to Limits

The Power Station **Shall** ensure that the approved **Operating Technical Specification** contains the approved operating limits for all **Boiler Plant**. All limits detailed in the approved **Operating Technical Specification** **Shall** be strictly adhered to at all times.

### 3.1.30 Golden Rule

The most important rule for boiler operation **Shall** remain:

**"WHEN IN DOUBT - SWITCH OUT"**

## 3.2 BOILER OPERATION

### 3.2.1 Start-up

#### 3.2.1.1 Notification to Staff

All staff concerned with the start-up **Shall** be notified by the **Person in Charge of the Plant** as to the requirements of the start-up and any special instructions and other relevant information prior to starting of the draught groups for the purpose of lighting up. Any special instructions and/or information **Shall** be issued by the **Person in Charge of the Plant** responsible for such duties to all staff concerned in writing, prior to the start-up.

#### 3.2.1.2 Start-up Procedure

The power station **Shall** prepare and implement a start-up procedure for cold, warm and hot starts, covering, but not restricted to the requirements of the check list as per Regulation 3.2.1.3.

#### 3.2.1.3 Check List

Each power station **Shall** prepare and implement a pre-start check list to ensure the correct preparation of the plant. The pre-start checks **Shall** be completed and the **Person in Charge of the Plant** **Shall** be satisfied that the plant may be safely started. The **Authorised Boiler Operator** **Shall** verify and record that at least the following requirements have been met before a start-up commences:

##### 3.2.1.3.1 Doors and openings

All boiler access and inspection doors have been properly closed, including those on the ash hoppers, grit bins, dust extraction plant and the Flue Gas Desulphurisation plant.

##### 3.2.1.3.2 All sources of Fuel isolated

All **Fuel** supplies to the furnace are isolated. For isolation of **Oil Burner** equipment, refer to Regulation 3.2.6.1.

##### 3.2.1.3.3 Availability of water, Fuel, air and auxiliary steam

A sufficient supply of water, **Fuel**, air and auxiliary steam are available. This includes, but not limited to cooling water; boiler feed water, **Igniter** gas, **Fuel** oil, **Fuel**, control air and service air supplies.

##### 3.2.1.3.4 Electrical, hydraulic and pneumatic supplies

Electrical, hydraulic and pneumatic supply is available to all controls, instruments, interlocks, hydraulic and pneumatic actuators for dampers and valves including hydraulic or pneumatic/gas loading systems on milling plant.

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**3.2.1.3.5**      Outstanding permits

Plant on which permits are still in force are correctly isolated. Plants which are available may be started safely.

**3.2.1.3.6**      Spades and blank flanges

All spades and blank flanges which can impede the correct functioning of equipment have been removed.

**3.2.1.3.7**      Boiler ash hoppers, flue gas cleaning plant ash hoppers, continuous ashing systems and grit bins

All ash hoppers and grit bins are clear of dust, grit, ash or foreign matter and that water filled ash hoppers/continuous ashing systems are correctly filled. Hopper sprays must be operating satisfactorily.

Continuous ashing systems **Shall** be fully commissioned and operable.

**3.2.1.3.8**      Water expansion seals

All water expansion seals are clean and correctly filled to the required water level and all automatic filling devices are available.

**3.2.1.3.9**      Interlock, sequential and safety trip testing

Testing of interlock and sequential tripping of the boiler auxiliaries **Shall** be done in accordance with an approved commissioning plan, in order to prove all such interlocks and tripping philosophies or any further safety tests as required by the **Power Station Manager**.

The following conditions **Shall** require that such testing **Shall** be conducted:

- a) after an outage such as a general overhaul, interim repair or general inspection;
- b) or any maintenance activity on the boiler protection or related systems, the appropriate trip tests **Shall** be performed.

**3.2.1.3.10**      Simulation management

All control or protection simulations applied for maintenance or testing purposes have been removed and signed off by maintenance and verified by the **Person in Charge of the Plant**.

**3.2.1.3.11**      Damper and actuator positions

All critical and safety dampers and actuators which are operable from the boiler control interface are operated in turn from fully closed to fully open, and that the position indication on the boiler control panel is verified to be correct. Always ensure that the sections under test are properly isolated where any

danger might exist that the operation of the damper or actuator could endanger the safety of personnel or plant.

All dampers and actuators are set in the correct position for the start-up, and that the dampers and/or fan speed controls are set so as to prevent any fans from being started under load conditions.

#### **3.2.1.3.12**     Air register and damper settings

All manual or automated air registers and/or dampers on combustion related plant **Shall** be proven to operate correctly where after it **Shall** be correctly set in preparation for a furnace purge.

#### **3.2.1.3.13**     Essential instrumentation

Verify that all essential instrumentation is available. Known defects **Shall** be repaired before start-up commences.

#### **3.2.1.3.14**     Non-essential instrumentation

All non-essential instrumentation which is known or suspected to be defective is clearly marked to be defective, and formally reported.

#### **3.2.1.3.15**     Notification

Any abnormalities or deficiencies have been brought to the notice of the **Person in Charge of Plant**. Notifications must be raised for all defective plants.

#### **3.2.1.3.16**     Water level and circulation

A drum level above the minimum trip level is established and maintained in drum-type boilers. A circulating flow is established in forced circulation boilers and minimum economiser flow and circulation is established and maintained in the once-through type boilers.

#### **3.2.1.3.17**     Oxygen and Carbon Monoxide analysers

Confirm that the Oxygen and Carbon Monoxide analysers installed at the economiser outlets are operational and indicating an Oxygen concentration of 20.9% and a Carbon Monoxide concentration of less than 20 ppm before admission of **Fuel** to the boiler.

#### **3.2.1.3.18**     Topping-up of hydraulic couplings

Hydraulic couplings on all fans so equipped **Shall** be checked for correct oil level at no load once for each cold Boiler Start-Up in accordance with the prescribed method.

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### 3.2.2 Start-up Authority

Authority for a light-up to commence **Shall** be given in writing by the **Person in Charge of the Plant** after operating, maintenance, engineering and outage/production signatures have been obtained declaring that the plant is available to be returned to service.

### 3.2.3 Start-up of Draught Groups

The draught group(s) **Shall** be started in the correct sequence. Fans **Shall** be started against closed dampers and/or at minimum speed/flow setting.

### 3.2.4 Furnace Purge

A furnace purge with atmospheric air **Shall** be carried out before any other operations are performed on the flue gas side of a boiler. The starting of all firing equipment **Shall** be inhibited until the furnace purge has been completed.

### 3.2.5 Furnace Purge Requirements

#### 3.2.5.1 Fuel sources

All sources of **Fuel** are isolated

#### 3.2.5.2 Flame Monitors

All **Flame Monitors** and scanners **Shall** register no **Flame** before purge is initiated and during the purging process.

#### 3.2.5.3 Air flow limits<sup>[\*]</sup>

A furnace purge **Shall** be carried out at a **Total Combustion Air** flow rate of between 25% and 40% of **Boiler Maximum Continuous Rating** mass **Total Combustion Air** flow, or as specified by the boiler manufacturer in the Operating Instructions.

#### 3.2.5.4 Register, damper position

During the furnace purge period the air registers or regulating dampers on all **Fuel Burners** **Shall** be set so as to provide adequate air sweeping of the furnace. Fully open registers are strongly recommended or as specified by the boiler manufacturer in the Operating Instructions. All air heater recirculating dampers **Shall** be closed for the duration of the purge.

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### 3.2.5.5 Duration of the purge

The duration of the purge **Shall** ensure that at least five exchanges of volume of the combustion chamber and flue gas passes needs to be achieved. The minimum purge duration **Shall** not be less than five minutes.

### 3.2.5.6 Confirmation of a successful purge

An Oxygen concentration at economiser gas outlet must be observed to be greater than 20% and the Carbon Monoxide concentration **Shall** be lower than 20ppm after the purge cycle. If the Oxygen and Carbon Monoxide concentration limits have not been reached, the boiler **Shall** be re-purged.

### 3.2.5.7 Electrostatic precipitators

The precipitators **Shall** be de-energised to avoid the danger of **Fuel** ignition in the precipitators.

### 3.2.5.8 Sulphur Trioxide (SO<sub>3</sub>) injection

Injection of Sulphur Trioxide **Shall** be inhibited.

## 3.2.6 Oil Burner Firing Requirements

### 3.2.6.1 Isolation of Oil Burner, Fuel oil and gas supply

The isolation of the **Oil Burner Fuel** oil and gas supply refers to methods used to ensure that no **Fuel** oil or gas is inadvertently or unintentionally admitted to the furnace. The following methods are deemed to be acceptable to ensure that the **Fuel** oil is adequately isolated.

**3.2.6.1.1** All **Boiler Plant** **Shall** be equipped with unitised **Fuel** oil trip valves. The **Fuel** oil trip valves **Shall** be equipped with a means of proof of closure signal to verify that these valves are in the shut position.

Each **Fuel Oil Burner** **Shall** be equipped with shut-off valves<sup>[1]</sup> as close as practically possible to the **Fuel Oil Burner**. These **Fuel Oil Burner** shut-off valves **Shall** be equipped with a means of proof of closure signal to verify that these valves are in the shut position. On recirculating type **Oil Burners**, **Fuel Oil Burner** shut-off valves **Shall** be provided on the supply and return lines.

Further verification methods may additionally include visual confirmation that the valves have shut or monitoring of flows and pressures to ensure that the valves are not passing.

**3.2.6.1.2** On **Boiler Plant** where the **Fuel** oil is supplied by dedicated **Fuel** oil pumps without interconnection to other supplies of **Fuel** oil, shutting down of the **Fuel** oil pumps is deemed

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to satisfy this requirement, provided that the individual **Fuel Oil Burner** shut-off valves are also confirmed to be in the shut position by means of a proof of closure signal.

- 3.2.6.1.3** Uncoupling and withdrawal of the lances is deemed to satisfy this requirement, provided that:
- a) This method is used in conjunction with one of the previous two methods of isolation.
  - b) There is a proof of closure signal available for each individual **Oil Burner** isolation valve.
  - c) The proof of closure signal is monitored to ensure that the valves have shut.
  - d) The uncoupling and withdrawal of lances occurs without delay **Should** the **Boiler Master Fuel Trip** initiate or the boiler firing release is not present.
- 3.2.6.1.4** Where gas is used for the **Igniter**, the isolation of the **Igniter** gas supply **Shall** be by means of a double isolation (quick acting and automatic) with a vent located between the two valves on the common supply to the boiler. The vent may be omitted provided there is a proof of closure signal from the valves. A further proviso is that the valves must be proven to isolate the gas supply on an interval not exceeding 18 months.
- 3.2.6.1.5** Where electrically generated spark **Igniters** are used, the point of electrical supply **Shall** be inhibited

### **3.2.6.2 Oil Burner Flame Protection**

An **Oil Burner Flame** **Shall** be declared healthy by means of a dedicated **Flame Scanner** and integrated burner management system. The **Flame Scanner** **Shall** have sufficient discriminating ability to ensure that the oil **Flame** protection integrity is not compromised.

If an attempt is made to ignite the oil and the **Oil Burner** does not receive a “**Flame-On**” feedback within five (5) seconds after the **Fuel** oil valve was opened, the associated **Fuel** oil shut-off valve **Shall** close.

### **3.2.6.3 Oil Burner Classification<sup>[1]</sup>**

- 3.2.6.3.1** Each station **Shall** determine where the transition from a Class 1 to a Class 2 **Oil Burner** firing occurs or vice versa and **Shall** make it available to the **Authorised Boiler Operator** through a local procedure.
- 3.2.6.3.2** **Oil Burner Classification** **Shall** remain at its Class or higher during operation of the **Oil Burner**.
- 3.2.6.3.3** Each station must determine what conditions might change the classification of the burner.

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**3.2.6.3.4** Where a variable energy output **Oil Burner** is used, the range where the **Oil Burner** is classed as a Class 1 or 2 **Oil Burner** must be determined and made available to the **Authorised Boiler Operator**. This range may be expressed as a **Fuel** oil flow rate or **Fuel** oil supply pressure.

**3.2.6.3.5** The **Boiler Plant** control system **Shall** provide the **Authorised Boiler Operator** with sufficient information to determine the **Oil Burner Classification**.

**3.2.6.4** Opening of main **Fuel Oil** supply to the **Oil Burner** and detection of leaking **Oil Burner(s)**<sup>[\*]</sup>

**3.2.6.4.1** Opening of the main **Fuel** oil trip valves, or starting of dedicated **Fuel** oil pumps, or re-inserting and coupling of **Fuel** oil lances **Shall** only be permitted on verifying that the individual **Oil Burner** isolating valves are shut.

**3.2.6.4.2** After the **Fuel** oil supply to all **Oil Burners** has been opened, each **Oil Burner** **Shall** be checked for external leakage, and also for **Fuel** leakage into the furnace, by whatever means is reasonably practical. Defective **Oil Burner(s)** **Shall** be isolated, retracted and clearly marked.

**3.2.6.4.3** During operation, inspections **Shall** be carried out to ensure that no unburnt **Fuel** oil is entering the furnace from any of the **Oil Burners**. Any **Oil Burner** showing these symptoms **Shall** be isolated, withdrawn, replaced and reported immediately.

**3.2.6.4.4** Each station must develop a local procedure on the method for determining whether **Oil Burners** are leaking.

### **3.2.6.5 Oil Burner Functional Requirements**

No **Oil Burner** **Shall** be started or be allowed to continue operating if the following conditions are not within specifications as per the boiler manufacturer or as stipulated in the **Operating Technical Specifications**:

- a) **Fuel** oil temperature
- b) **Fuel** oil pressure
- c) **Core Air** supply
- d) Control air pressure
- e) Atomising steam pressure, where applicable
- f) Atomising steam temperature, where applicable

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### 3.2.6.6 Confirmation of the Oil Burner Combustion

- 3.2.6.6.1 The **Authorised Boiler Operator Shall** be in control of all **Oil Burner** operations at all times.
- 3.2.6.6.2 The **Person in Charge of the Plant Shall** perform a visual inspection of the **Oil Burner Flames** to ensure proper combustion after ignition of each **Burner** row has been established.
- 3.2.6.6.3 The **Person in Charge of the Plant Shall** sign off the start-up document to confirm stable **Fuel** oil combustion.

### 3.2.6.7 Repeated Firing of Oil Burner(s)<sup>[1]</sup>

- 3.2.6.7.1 Repeated firing of an **Oil Burner** locally or remotely within one minute is prohibited.
- 3.2.6.7.2 If the **Flame** of an **Oil Burner** is not established after three attempts, the cause of the failure must be investigated and rectified before any further attempt is made to start the **Oil Burner** for continuous use.

### 3.2.6.8 Air Registers during Oil Burner Operation

During any period when only **Oil Burner(s)** are in use, air registers or dampers on appropriate **Fuel Burners Shall** be set in accordance with the requirements of the start-up procedure.

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### 3.2.7 Start-up Operation

#### 3.2.7.1 Minimum Air Flow Limitation<sup>[\*]</sup>

Once a furnace purge has been completed and up to when the first oil fires is established, the **Total Combustion Air** flow **Shall** not be reduced to less than 25% of the **Boiler Maximum Continuous Rating** combustion air mass flow under any circumstances.

If the air flow drops below 25% during the purge period, the boiler furnace **Shall** be re-purged.

#### 3.2.7.2 Checking the Response of the Air Flow Indication

Before either the boiler master pressure controller, **Fuel** input controller, or total air flow controller is selected to automatic control, the air flow indication **Shall** be established as working. If the response time and/or magnitude of change appear defective in any way, the defects **Shall** be rectified before the boiler master pressure or **Fuel** controller is placed on automatic control.

#### 3.2.7.3 Electrostatic Precipitators Start-up

The precipitator **Shall** only be put in operation after the boiler has been purged and there is at least one mill in service or as per local instruction.

#### 3.2.7.4 Primary Air Fan Start

The first **Primary Air** fan **Shall** not be started until the **Person in Charge of the Plant** has confirmed and signed off that stable **Oil Burner** ignition is present as required for starting of mills in Regulation 4.1

#### 3.2.7.5 Adjusting the Combustion Air Flow

The **Combustion Air Flow** **Shall** be adjusted at all times in order to maintain the correct air/**Fuel** ratio.

**Combustion Air Flow** **Shall** be measured by accurate air flow measurement devices and not be estimated from windbox pressures.

The **Fuel** input **Shall** be established from the **Fuel** flow calculation or estimated from the load on the mill(s) and **Oil Burners**, but not from boiler pressure or steam flow.

#### 3.2.7.6 Use of Blanketing Air

When **Blanketing Air** is admitted to the furnace through idle burner air registers, as a means of controlling steam temperature during start-up. Care **Shall** be taken against the risk of over-cooling the combustion zone. Such air **Shall** not form part of the **Combustion Air** calculations and as such the use of Oxygen trimming **Shall** not be active during this period.

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### 3.2.7.7 Precautions during Pressure Raising and at Low Load

During pressure raising and early load periods, and until the **Furnace Flame Failure Protection** is armed, there **Shall** be an interlock between the **Fuel** firing and associated **Oil Burners**. **Oil Burner** support must be adequate for a permissive mill start [Regulation 4.1.3]. If **Oil Burner** support subsequently becomes inadequate, the associated mill tripping sequence **Shall** be initiated.

### 3.2.7.8 Placing Combustion Controls on Automatic Control

All combustion controls **Shall** be put on automatic control as soon as it is possible and safe to do so.

### 3.2.7.9 Shutting Down of Oil Burner Support

**Oil Burners** may only be removed from service once all of the following criteria have been met:

- a) Boiler steam flow is at least 38% **Boiler Maximum Continuous Rating**
- b) Stable ignition of the **Fuel Burners** is established
- c) **Furnace Flame Failure Protection** is armed
- d) Carbon Monoxide concentration at economiser gas outlet or in the stack is below alarm value.

### 3.2.7.10 Overfire Air<sup>[1]</sup>

**Overfire Air Shall** be introduced as per boiler manufacturer instruction and **Shall** not cause any combustion instability.

### 3.3 NORMAL OPERATION

Normal operation commences when firing **Primary Fuel** and/or **Co-Firing** with stable combustion. The boiler steam flow **Should** normally be above 38% **Boiler Maximum Continuous Rating**.

#### 3.3.1 Maintaining Flame Stability

The prime precaution against furnace explosions lies in the maintenance of **Flame Stability** at all times and the tripping of the boiler immediately if the ignition is lost or in danger of being lost. This precaution **Shall** always take precedence over loading requirements.

**Should** the conditions be such that the **Flame Stability** could be compromised through any event, **Oil Burner** support may be used to ensure **Flame Stability** provided the **Flame** temperature as indicated by the **Furnace Flame Failure Protection** monitors recovers to a temperature above 900°C.

**Should** the conditions with **Oil Burner** support be such that the **Flame** temperature remain below 800°C as indicated by the **Furnace Flame Failure Protection** and reach 700°C, the boiler **Shall** be tripped manually. A local procedure **Shall** be developed to guide the **Authorised Boiler Operator** on site specific requirements.

#### 3.3.2 Interdependency of Air Flow, Flue Gas Flow and Fuel Flow

The Forced Draught fan vane control and/or **Secondary Air** flow control **Shall** never be put on manual control while the boiler master pressure controller or **Fuel** input controller is on automatic control.

The Forced Draught fan controls **Shall** never be on automatic if the Induced Draught fan controls are on manual.

When necessary to operate with one of the Induced Draught fans on manual, both Induced Draught fans **Shall** be put on manual unless the reason for putting one Induced Draught fan on manual is with the intent to shut down that draught group.

When either one or both the Forced Draught fans is put on manual control, the integrated **Primary Air** fan (taking suction after Forced Draught fan) and the **Fuel** input controller **Shall** be put on manual unless the intent is to shutdown the Draught Group.

#### 3.3.3 Regulation of Total Combustion Air Flow

**Total Combustion Air Flow Shall** be determined and regulated according to the **Fuel** flow. Provision **Shall** be made for cross limiting<sup>[7]</sup> between the **Total Combustion Air Flow** and the **Fuel** flow controls such that the furnace exit air/**Fuel** ratio cannot be operated:

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- a) with a Lambda below 1.10 for tangential boilers
- b) with a Lambda below 1.13 for wall fired boilers

This event **Shall** be alarmed.

**Total Combustion Air Flow Shall** not be adjusted in order to maintain a particular windbox pressure.

It is recommended that **Total Combustion Air Flow** and Oxygen concentration at the economiser outlet is indicated according to steam flow on a curve, provided by Engineering and made available to the **Authorised Boiler Operator** for referencing and guidance on the health of the combustion process.

### 3.3.4 Oxygen Concentration in Flue Gases<sup>[\*]</sup>

For loads above 38% BMCR the Oxygen concentration (on a wet volume basis) of the flue gases as measured at the economiser outlet **Shall**:

- a) not be higher than 9% nor lower than 2% for tangential fired boilers
- b) not be higher than 9% nor lower than 2.5% for wall fired boilers

The Oxygen concentration of the flue gasses as measured by any individual instrument after the economiser **Shall** be controlled as per the boiler manufacturer specification or as indicated in the **Operating Technical Specification**.

The Oxygen concentration as measured after the economiser **Shall** be representative of the Oxygen concentration at furnace exit as given in the **Operating Technical Specifications** of each station.

Notwithstanding the Oxygen concentration, it **Shall** be ensured that the Carbon Monoxide concentration is not higher than 200 ppm (referenced to 3,0% Oxygen) at the economiser outlet and/or 100 ppm (referenced to 6,0% Oxygen) in the smoke stack under stable operational conditions.

### 3.3.5 Ingress of Unmeasured Air<sup>[\*]</sup>

The introduction of air other than that intended for combustion such as **Tramp Air Shall** be avoided as far as possible (such as from open inspection doors, leaking expansion joints, holes in ducting's, damaged dipper plates and inadequate water seal level).

Furnace tightness **Shall** be determined to identify areas of unmeasured air ingress before long term planned outages commences to enable effective repairs during the outage.

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### 3.3.6 Setting of Air Registers or Dampers

Air registers, dampers or other devices provided to regulate the **Combustion Air Flow** to the burners **Shall** be checked and adjusted as necessary after every significant change in the firing rate, **Combustion Air Flow** change, or when mills are changed over unless such regulating dampers are automated.

### 3.3.7 Maintaining Plant Controllability

**Fuel**, air and flue gas flow **Shall** be maintained within a controllable range between the maximum and minimum limits at all times while on automatic control.

Continuous operation with the final control elements in a state of saturation is prohibited.

### 3.3.8 Maintaining a Mutually Supporting Burner Pattern

The most stable and mutually supporting pattern of **Fuel Burners** **Shall** be maintained whenever possible, while the boiler is steaming.

Local instructions **Shall** be issued to give guidance to the **Authorised Boiler Operator** as to the limits and precautions to be observed when **Mill Groups** are out of commission, taking possible changes in coal qualities into account.

### 3.3.9 Re-ignition by Enriching the Mixture

The **Secondary Air** flow **Shall** never be reduced in order to re-establish ignition or rectify unstable ignition.

### 3.3.10 Alarms to be regarded as Correct

All alarms and indications **Shall** be regarded as correct and acted upon immediately. Alarms or indications that have been proven to be defective **Shall** be reported.

### 3.3.11 Conflicting Alarms

In the event of conflicting alarms or indications, none of which are known to be defective, action **Shall** be taken in response to the most pessimistic alarm or indication, until the conflict is resolved.

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### 3.3.12 Essential Instrumentation

All Essential Instrumentation and indications **Shall** be available and in good working order at all times (Regulation 3.1.12 and 3.2.1.3.13). Authority to continue operating with any Essential Instrumentation out of commission or part thereof **Shall** be given in writing by the **Power Station Manager** and recorded in the operator's log. Any defects on these instruments or unavailability of these instruments for maintenance work **Shall** be logged at the start and end of each shift.

### 3.3.13 Instruments are Correct until Proven Otherwise

Instruments **Shall** be deemed to be correct until proven otherwise. Incorrect instrumentation **Shall** be reported and rectified as soon as possible.

### 3.3.14 Interference with Combustion Safety Devices<sup>[1]</sup>

It is prohibited to interfere with any combustion safety devices.

Essential maintenance on combustion safety devices **Shall** only be carried out after permission has been given in writing by the **Power Station Manager** and **Authorised** by the **Person in Charge of the Plant**. The **Person in Charge of the Plant** **Shall** ensure that all personnel concerned have been fully informed regarding the extent and duration of the non-availability of the combustion safety devices.

### 3.3.15 Mechanical Limits and Limit Switches

No one may interfere with, and no **Unauthorised** adjustments may be made to mechanical limits or electrical limit switches.

### 3.3.16 Interlocks and Simulations

The **Boiler Plant** **Shall** not be operated with interlocks that are inoperative, defective, out of commission, simulated or bypassed, without the written approval of the **Power Station Manager**.

### 3.3.17 Malfunction of Automatic Controls

Any part of a boiler of which the automatic control is on manual, or which is defective and may need manual adjustment, **Shall** be under the continuous **Supervision** of an **Authorised Boiler Operator**.

Manual adjustments of components on the plant that may affect the operation of the boiler process **Shall** only be carried out by a **Competent Operator** under the instruction of the **Authorised Boiler Operator**.

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### 3.3.18 Sootblowing of the Boiler and Air Heater

- 3.3.18.1** Boiler and furnace cleaning by sootblowers or water cannons **Shall** only be done when combustion is stable. If cleaning of the boiler is likely to induce instability, appropriate **Oil Burner** support **Shall** be provided.
- 3.3.18.2** Air heaters<sup>[1]</sup> may be sootblown at any time provided the steam condition for sootblowing is correct.

### 3.3.19 Ashing of Furnace Ash Hoppers with the Boiler on Load

Ashing of furnace ash hoppers **Shall** only be done when combustion is stable. If ashing is likely to induce instability, appropriate **Oil Burner** support **Shall** be provided.

Ashing **Shall** only be carried out from each ash door in turn. Ash doors not in use **Shall** be kept properly closed.

No hot unquenched bottom ash **Shall** be allowed to protrude or accumulate above the ash hopper water level or the Submersible Scraper Conveyor water level on a boiler.

In any event, the **Authorised Boiler Operator Shall** always be notified in advance of activities which may affect the boiler flue gas side.

### 3.3.20 Manual Air Lancing

Manual air lancing of the furnace or flue gas passages on a steaming or hot boiler is prohibited, except where, in the opinion of the **Power Station Manager**, satisfactory steps have been taken to ensure the safety of plant and personnel. The operation **Shall** at all times be under the direct **Supervision** of a **Competent Person Authorised** by the **Power Station Manager**, for this particular duty. Manual air lancing **Shall** require a temporary procedure and **Shall** be executed under a permit to work.

If air lancing is likely to induce instability, appropriate **Oil Burner** support **Shall** be provided.

### 3.3.21 Manual Water Lancing

Manual water lancing of the furnace or flue gas passages on a steaming or hot boiler is prohibited, except where, in the opinion of the **Power Station Manager**, satisfactory steps have been taken to ensure the safety of plant and personnel. The operation **Shall** at all times be under the direct **Supervision** of a **Competent Person Authorised** by the **Power Station Manager**, for this particular duty. Manual water lancing **Shall** require a temporary procedure and **Shall** be executed under a permit to work.

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If water lancing is likely to induce instability, appropriate **Oil Burner** support **Shall** be provided

### 3.3.22 Water Seal Inspections

On all operating boilers, it **Shall** be ensured that an adequate water level is present and an effective seal has formed to prevent air ingress whenever combustion is established in the boiler furnace.

The water seal(s) **Shall** be inspected at least once per shift and specifically after conditions which could have caused an abnormal furnace pressure change.

### 3.3.23 Low Load Operation

The following precautions **Shall** be observed during low load operation:

If the boiler load is to be sustained at less than 38% of **Boiler Maximum Continuous Rating**, sufficient<sup>[\*]</sup> **Oil Burners Shall** be placed in service in order to maintain stable ignition on all the **Fuel Burners** in service.

### 3.3.24 Sweeping Air<sup>[\*]</sup>

**Secondary Air** may be used for ash sweeping at the boiler outlets or for ducting cleaning. Such air **Shall** be admitted through the top out of service idle burners to increase the flue gas velocity under low load conditions. This air **Shall** not form part of the required **Total Combustion Air** necessary to maintain the correct air/**Fuel** ratios on the burners still in service as per station local instructions.

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### 3.4 SHUT DOWN

#### 3.4.1 Controlled Boiler Shutdown

Sufficient Class 1 **Fuel Oil Burners Shall** be put in service on all operational mills at loads below 38% of **Boiler Maximum Continuous Rating** and **Shall** be kept in service until the last mill and Pulverised Fuel pipes are cleared of **Fuel**. On the last mill to be shutdown, all the **Fuel Oil Burners** associated with that particular **Mill Group Shall** be in service to Class 1 specification.

#### 3.4.2 Steaming on Oil Burners only after last Mill Shutdown

If it is required to keep the **Oil Burners** in service after the last mill and Pulverised **Fuel** pipes have been cleared of **Fuel** and shut down, this **Shall** be done taking the precautions in Regulations 3.2.6.8 into account. It is important to note that the mill(s) and Pulverised **Fuel** pipes **Shall** be cleared of **Fuel** first as stipulated in Regulation 3.5.3.

#### 3.4.3 Isolation of Fuel Supplies

The **Power Station Manager Shall** issue local operating instructions to ensure that no **Fuel**, including ignition gas where used, can enter the furnace after the boiler is shut-down. The relevant actions **Shall** be carried out before commencement of the purge.

#### 3.4.4 Electrostatic Precipitators De-energised

During the boiler shut-down, the electrostatic precipitator **Shall** be de-energised not later than after the last mill has been removed from service. If the precipitator is required to be used during forced cooling, the precipitator **Shall** only be energised after the boiler has been purged or as per a local instruction.

#### 3.4.5 Boiler Purge after Fires-Out

The boiler **Shall** be purged to remove all combustibles after fires have been taken out of service as described in Regulation 3.2.5. After the boiler purge is completed, the furnace **Shall** be inspected visually for any glowing clinkers or other abnormalities.

If a glowing clinker(s) is noted within the furnace, the glowing clinker will need to be removed before any attempt is made to re-start the boiler. Any abnormalities must be investigated and declared not relevant to further safe operation of the boiler before an attempt is made to re-start the boiler.

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### 3.5 TRIP

#### 3.5.1 Conditions Requiring Boiler Master Fuel Trip

##### 3.5.1.1 Mandatory Trip Conditions

The **Boiler Master Fuel Trip** Shall operate automatically under any of the following circumstances,:

- a) When both the Forced Draught fans on a boiler trip.
- b) When both the Induced Draught fans on a boiler trip.
- c) When the requisite number of thermopiles or **Flame** detectors dictated by the tripping logic, indicate loss of ignition.
- d) When **Flame** failure has occurred in one half of a twin or split furnace.
- e) When loss of ignition occurs on all the **Oil Burners** in service at any time, unless the **Furnace Flame Failure Protection** is in commission and armed.
- f) When a positive or negative furnace pressure condition occurs in excess of the limits as described in the boiler design specification.
- g) When the **Total Combustion Air Flow** decreases to 5% below the boiler designed minimum **Total Combustion Air Flow** limit. Under no circumstances **Shall** the **Total Combustion Air Flow** be lower than 20% of the **Boiler Maximum Continuous Rating** design mass air flow rate.
- h) When there is a loss of all **Fuel** inputs.
- i) When water circulation or feed flow to the boiler is lost as per the trip philosophy of the respective plant.

In the event of the failure of the Mandatory automatic **Boiler Master Fuel Trip** to operate, the **Authorised Boiler Operator** Shall trip the plant manually.

##### 3.5.1.2 Discretionary Trip Conditions

The **Boiler Master Fuel Trip** may be operated manually, at the discretion of the **Authorised Boiler Operator**, under the following conditions:

- a) When, on loss of control air, electrical, hydraulic, or pneumatic motive supply, the boiler control fails to keep conditions steady or normal.
- b) When there is loss of any essential instrumentation or indications (Regulation 3.1.12) and, in the opinion of the **Authorised Boiler Operator**, operation can no longer be continued with safety.

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- c) When, at any time, in the opinion of the **Authorised Boiler Operator**, the operation of the boiler can no longer be safely controlled on automatic or manual control.

### 3.5.2 Purge following a Trip<sup>[1]</sup>

In the event of a **Boiler Master Fuel Trip**, the **Secondary, Tertiary and Overfire Air** flow **Shall** be left at the air flow existing at the time of trip for at least five minutes as a precaution against possible re-ignition. Thereafter, the air flow can be gradually increased or decreased as required for purge purposes. Refer to Regulation 3.2.5 for purge requirements.

**Should** both draught groups trip with the **Boiler Master Fuel Trip**, the boiler **Shall** be placed on natural draught for fifteen minutes before the draught groups are restarted. The exception is where a common stack is shared with the tripped boiler, the tripped boiler's Induced Draught discharged dampers **Shall** be shut to isolate it from the other boilers for fifteen minutes before the fans may be re-started. This exception is only applicable where there is a positive pressure from the interconnected running unit. Thereafter a normal purge **Shall** follow. After the furnace purge, the furnace **Shall** be inspected visually for any glowing clinkers or other abnormalities.

After the purge and if the unit is to be returned to service, the boiler **Shall** be restarted in accordance with the requirements for a start-up.

During abnormal conditions such as Air heater fire, Windbox fires or Precipitator/Fabric Filter Plant fires, no purge **Shall** be conducted until instructed to do so by the **Person in Charge of the Plant**.

### 3.5.3 Clearing the Tripped Mill of Coal

After obtaining permission to re-start the boiler and on completion of a furnace purge, all mills which tripped as a result of the **Boiler Master Fuel Trip** **Shall** be restarted in turn. All **Oil Burners** associated with the mill to be started **Shall** be put in service to ensure stable ignition. These mills **Shall** be cleared of coal and shut down in the normal manner (Regulation 3.4.2 and 4.1.3).

If it is not possible to run the mills empty, the mills **Shall** be boxed up and the presence of coal in the mills logged.

Where steam inerting is used, removal of **Fuel** through the reject system will be allowed as per boiler manufacturer instruction.

### 3.5.4 Procedure if the Boiler is not to be Restarted

If the boiler is not to be returned to service after a trip, the mills that tripped full of **Fuel** and is not intended to be returned to service **Shall** be cleared of **Fuel** manually after being cooled and isolated as described in Regulation 4.4.5.

### 3.5.5 Boiler not to be Boxed-up if it has not been Purged

If a boiler cannot be purged after a trip, it **Shall** not be **Boxed up** until it has been adequately purged (Regulation 3.2.5).

### 3.5.6 Initial Furnace Purge to clear Mill of Fuel

An initial purge of the furnace in accordance with the requirements of Regulation 3.2.5 **Shall** be carried out if the **Boiler Master Fuel Trip** has operated. After the boiler has been restarted and the mill(s) have been cleared of **Fuel**, a post purge **Shall** be required.

### 3.5.7 Electrostatic Precipitators to be De-energised

When the **Boiler Master Fuel Trip** has operated, the electrostatic precipitators **Shall** be de-energised immediately.

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### 3.6 OUT-OF-NORMAL CONDITIONS NOT REQUIRING BOILER SHUT-DOWN

#### 3.6.1 Conditions which shall be reported

Any of the following conditions, which do not necessarily result in the loss of load, **Shall** be brought to the immediate attention of the **Power Station Manager** in writing. A local procedure **Shall** be developed to address all these conditions:

- a) The loss of control air, or low control air pressure.
- b) Any malfunction of the interlocks, essential instrumentation or combustion safety devices.
- c) Any malfunction of damper operation.
- d) Any necessity to run plant in an overload condition.
- e) Any gross abnormalities or loss of redundancy in the functions of the automatic control system or operator interface.
- f) Any out of normal condition.
- g) Permission **Shall** be obtained from the **Power Station Manager** for any operation that needs to be carried out contrary to operating instructions, procedures and the **Fossil Fuel Firing Regulations**.

#### 3.6.2 Capability Trip Sequence Failure

When any capability operates and the associated **Primary Air** fan(s) and/or mills fail to trip in sequence, the **Authorised Boiler Operator Shall** trip the required number of **Primary Air** fans and/or mills in order to bring the load within the capability of the remaining plant.

#### 3.6.3 External Boiler Fire

In the case of a fire external to the boiler, an immediate attempt **Shall** be made to isolate the source or potential source of **Fuel** and extinguish the fire safely, failing which the boiler **Shall** be shut down and all **Fuel** supplies **Shall** be isolated.

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## 4. MILL OPERATION

### 4.1 STARTING OF MILLS

When starting mills the following **Shall** apply:

#### 4.1.1 Preparation of Fuel Burners

The impellers on **Fuel Burners** so equipped **Shall** be inserted on the burners to be used.

#### 4.1.2 Quick Close Dampers<sup>[1]</sup>

Quick close dampers and any mill dampers which are similar with a quick closing protection function **Shall** be reliable and operate correctly at all times. Any defects on these dampers **Shall** be reported and attended to immediately. No mill **Shall** be allowed to be put in service with defective quick close protection function dampers.

#### 4.1.3 Oil Burners in service

On the first **Mill Group** to be commissioned, all the **Oil Burners** associated with that particular **Mill Group** **Shall** be in service to Class 1 specification.

On subsequent mills sufficient **Oil Burners** necessary as per interlocks and to ensure adequate ignition energy on the **Fuel Burners** now to be used **Shall** be in service (refer to Regulation 4.2.1.7). The ignition on all these **Oil Burners** **Shall** be stable before any **Fuel** is fed to the mill.

#### 4.1.4 Commencement of mill warming

The warming of the mill selected for first firing **Shall** commence only when stable **Oil Burner** ignition has been established.

Seal air **Shall** be opened to all seals and seal air injection points on pressurised feeders and mills while they are being warmed.

The starting of the first mill **Shall** only commence once the defined boiler process conditions have been met as per a local procedure.

#### 4.1.5 Mill outlet temperature

The mill **Shall** be warmed as per a local instruction and the feeder **Shall** only be started once the minimum safe mill outlet temperature of 70°C is reached. If for any reason the mill outlet temperatures decrease below the minimum safe mill outlet temperature, a sufficient number of Class 1 **Oil Burners** **Shall** remain in service.

#### 4.1.6 Primary Air flow through the mill

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**Primary Air** flow through the pulverised **Fuel** pipes equal to or more than the minimum flow required to prevent settling in the pulverised **Fuel** pipes **Shall** be established. This required **Primary Air** flow **Shall** be determined taking the **Primary Air** temperature and ambient pressure into account. This information **Shall** be made available to the **Authorised Boiler Operator** in the **Operating Technical Specifications**. An automatic trip protection **Shall** be installed to prevent mill operation below the allowable minimum **Primary Air** flow.

#### **4.1.7 Setting of mill and burner air flow control dampers**

The affected air registers or control air dampers **Shall** be set in the correct position or flow rate for **Fuel** firing.

#### **4.1.8 Opening of coal gates**

The coal gate(s) on mills to be put in service **Shall** only be opened once a positive seal between the feeder and bunker is established. A positive seal **Shall** mean at least 10% of the bunker maximum capacity.

#### **4.1.9 Mill main loading control**

Loading of the mill **Shall** be controlled by regulating the **Fuel** and/or **Primary Air** flow through the mill.

#### **4.1.10 Shutting down of supporting Oil Burners once the Primary Fuel firing has been established**

After the establishment of stable ignition of the **Primary Fuel** and when the feed has been put on automatic control, the associated **Oil Burners** in service may be shut down subject to the requirements of Regulations 3.2.7.9.

#### **4.1.11 Steady Fuel Firing once the Mill is On Load**

Once **Primary Fuel** firing has commenced, the **Primary Fuel** feed to the mill must be regulated to maintain a steady heat input into the boiler. Large and/or sudden changes in heat input must be avoided. Intermittent firing is a potentially dangerous and undesirable mode of operation.



## 4.2 NORMAL MILL OPERATION

### 4.2.1 Milling Plant Rated Output

#### 4.2.1.1 Mill capacity

The mill rated output and coal quality envelope **Shall** be defined in the station local instructions. The minimum and maximum continuous rating of the mills **Shall** be made available to the **Authorised Boiler Operator** at all times and it may be displayed in kilogram/second or tonnes per hour.

#### 4.2.1.2 Re-rating of mill capacity

**Should** the maximum continuous rated output of the mills be altered as a result of modifications to the **Boiler Plant** or due to changes in coal properties, the mills **Shall** be re-rated through tests to determine the new maximum continuous rated output. This **Shall** be done and approved through the Engineering Change Management process and the following **Shall** be taken into consideration:

- a) Calorific value of the coal;
- b) Total moisture content of the coal;
- c) Hardgrove Index of the coal;
- d) Raw coal size;
- e) Grinding element/media condition;
- f) Required Pulverised Fuel fineness;
- g) Normal operating mill outlet temperature as defined
- h) Impact on maintenance philosophy
- i) **Primary Air** fan capacity
- j) Mill motor and gearbox maximum rating
- k) Classifiers and mill throat (where applicable)
- l) PF piping
- m) Burner maximum rating and exit velocities
- n) Availability of mill **Primary Air** inlet temperature and pressure
- o) **Secondary Air** mass flow and control

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#### 4.2.1.3 Loading of the Mills

A sufficient number of mills **Shall** always be kept in service and maintained within a loading range of between 60% and 90% of the maximum continuous rated output of the mills.

- a) Power stations with mills with a rated capacity larger than 100 tons per hour may operate with a mill loading less than 60% provided that testing has been conducted to prove stable mill operation and stable combustion with a defined set of coal qualities. These tests results and related local procedure to be accepted by the Fossil **Fuel** Firing Regulation Committee.
- b) Given that there will always be coal quality and loading transient, the mill output **Shall**, on an hourly average, not be sustained above 90% and peaks never to exceed 100% of the mill maximum continuous rated output.
- c) **Should** the mill operate outside the maximum continuous rated output as set out above and be sustained at that output, the **Authorised Boiler Operator Shall** take appropriate action to adjust the mill output to within the defined limits.
- d) Notwithstanding the above, an automatic trip protection **Shall** be installed to prevent mills operating below the allowable minimum **Primary Air** flow.

#### 4.2.1.4 Calibration of Milling Plant

Mills **Shall** be kept in proper calibration at all times by a **Competent Person** in accordance with approved procedures and/or accepted standards.

The calibration **Shall** ensure that the following is known and within limits:

- a) Pulverised **Fuel** fineness;
- b) Pulverised **Fuel** and **Primary Air** flow distribution to **Fuel Burners**;
- c) Coal feed determination (tonnes per hour or kilogram per second);
- d) Coal bulk density,
- e) Pulverised Fuel pipe velocity<sup>[\*1]</sup>;
- f) Correlation of damper operation and air flows must be ensured through verification of actual damper positions, actuator position indication and actual flow in the control room.
- g) Flows, pressure and temperature measurements;
- h) Air/ **Fuel** ratios (load lines);
- i) Clean air curve (vertical spindle mills);

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- j) Mill coal level measurement calibration.
- k) Mill grinding element condition and running hours
- l) Mill grinding media charge seasoning and tonnage (tube mills),
- m) Grinding element loading system pressures.

#### 4.2.1.5 Use of Automatic Controls on Mills

The controls **Shall** be left on automatic control, unless there is an out of normal condition which requires manual intervention.

#### 4.2.1.6 Mill Outlet Temperatures

The mill outlet temperature **Shall** always be higher than the minimum safe temperature of 70°C without **Oil Burner** support during normal operation or the loading on the mill(s) can be reduced until such time the mill outlet temperature is restored (refer to Regulation 4.1.5)

At no time **Shall** continuous operation of the mill with an outlet temperature above 120°C be allowed. The mill **Shall** be tripped automatically if any mill outlet temperature reaches 150°C.

#### 4.2.1.7 Placing Fuel Burners or Mill Groups into or Out of Operation

**Fuel Burners Shall** not be placed into or taken out of operation without a sufficient number of **Fuel Oil Burners** to ignite the **Fuel** and maintain stable combustion at all times. The following exception applies.

On a corner fired boiler and with at least three mills in service already, the remaining **Fuel Burners** or a **Mill Group Shall** not be placed into or taken out of operation without sufficient support from either associated **Fuel Oil Burners** , or sufficient **Fuel Burners** in service directly below, to maintain stable combustion. These conditions **Shall** be covered by a local procedure.

#### 4.2.1.8 Precautions if all Pulverised Fuel Burners on a Mill are not in use on a Double Ended Tube Mill

In cases where fewer than the total number of burners associated with a mill are used for the purpose of single ended operation, the minimum **Primary Air** flow required to prevent settling in the Pulverised **Fuel** pipes and **Flash-Back Shall** be less than the primary flow required when all the burners are in use. A new value of airflow **Shall** be determined and **Shall** be made available to the **Authorised Boiler Operator** in the **Operating Technical Specifications**. The automatic **Primary Air** flow low trip **Shall** also be adjusted accordingly.

It must be ensured that a fire is not initiated due to an accumulation of Pulverised **Fuel** on the mill end not in service.

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### 4.3 SHUTTING DOWN OF MILLS

The following precautions **Shall** be observed:

#### 4.3.1 Reducing Primary Air flow

In running a mill empty the minimum Primary Air flow through the mill and/or bypass **Shall** never be reduced to below the minimum value required to prevent settling in the pulverised **Fuel** pipes or cause a **Flash-Back**.

Additionally, for any operating condition on tube mills, the airflow to the drum **Shall** never be reduced to the point where there is insufficient cooling of the grinding media and elements.

#### 4.3.2 Mill outlet temperature

When shutting down a mill, the mill outlet temperature **Shall** be lowered to the lowest practical value, but not to less than the minimum safe mill outlet temperature.

#### 4.3.3 Use of Fuel Oil Burners

All the **Fuel Oil Burners** of Class 1 classification as per the interlock requirements associated with a mill to be shut-down **Shall** be placed in service (refer to Regulation 4.2.1.7)

#### 4.3.4 Air-sweeping or purging of mills and Fuel pipes

The **Primary Air** flow through the mill and/or mill bypass systems **Shall** be maintained at or above the minimum **Primary Air** flow required to prevent settling of **Fuel** in the **Fuel** pipes. The purging period of the mill **Shall** be determined and proven by local tests to be adequate to clear the mills and **Fuel** pipes of combustibles. The duration of the purging process for the mills and the **Fuel** pipes **Shall** not be less than three minutes.

#### 4.3.5 Resetting of air registers, dampers or other devices

The air registers/dampers or other devices on the burners of a mill which was shut down **Shall** be closed as per the shut down or operated according to the design philosophy. The remaining air registers/dampers **Shall** be adjusted to give optimum combustion conditions.

#### 4.3.6 Mill damper operation

When taking a mill out of service, and after shutdown, mill **Primary Air** flows, pressures and temperatures **Shall** be observed to warn of any possible malfunction of dampers.

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#### 4.3.7 Emptying of bunkers<sup>[1]</sup>

**Should** the bunker be required to be emptied, a procedure must be made available to the **Authorised Boiler Operator** with precautions that needs to be taken to prevent or mitigate the formation of an explosive mixture within the bunker.

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#### 4.4 MILL TRIP

If a mill trips for any reason, the following precautions **Shall** be observed:

##### 4.4.1 Tripping of coal feed

The coal feeder(s) **Shall** be tripped if the coal feeder(s) has failed to trip in sequence.

##### 4.4.2 Mill damper operation

Following the mill trip, observe the correct operation of the affected mill quick close damper (refer to Regulation 4.1.2) and any other dampers and monitor that there is a decrease in the **Primary Air** flow, pressure and temperatures.

##### 4.4.3 Fuel Oil Burner operation

A sufficient number of **Fuel Oil Burners** may be put into service on the remaining operational mills to ensure continued **Flame Stability**.

##### 4.4.4 Regulation of boiler load

While the load on the boiler is being regulated in order to maintain the boiler steam pressure and/or temperature, prime consideration **Shall** always be to maintain furnace **Flame Stability**.

##### 4.4.5 Clearing Fuel from the tripped mill

The mill **Shall** be started in accordance with Regulation 4.1. **Should** it be decided not to return the mill to service, the tripped mill **Shall** be cleared of coal.

If it is not possible to run the mill empty, the mill **Shall** be cooled, isolated and the coal in the mill **Shall** be cleared manually.

Where steam inerting is used, removal of **Fuel** through the reject system will be allowed as per boiler manufacturer instruction.

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## 4.5 MILL OUT-OF-NORMAL CONDITIONS

### 4.5.1 Loss of Air Flow to the Mill

If the mill or feeder(s) fail to trip in the event of a loss of **Primary Air** flow to the mill, the mill and feeder(s) **Shall** be manually tripped immediately.

### 4.5.2 Coal Hang-Up or Coal Feeder Failure

In the event of a coal hang-up, or coal feeder failure, sufficient **Fuel Oil Burners Shall** be inserted immediately to ensure stable combustion. If efforts to clear the hang-up are not successful, the mill **Shall** be shut down as described in Regulation 4.3

Where mills are provided with two coal feeders the above would require the failure of, or a coal hang-up on both feeders.

At all times, stable combustion **Shall** be ensured.

### 4.5.3 Fuel Pipe Blockage<sup>[1]</sup>

In the event of a **Fuel** pipe blockage, a sufficient number of **Oil Burners Shall** be inserted in order to maintain stable ignition on all the **Fuel Burners** associated with the affected mill provided that ignition on these **Fuel Burners** is stable. The mill **Shall** then be shut down in the normal manner as described in Regulation 4.3. If a mill fire is evident and/or ignition becomes unstable the mill **Shall** be tripped.

A local procedure **Shall** be developed to clear blocked pipes after the mill has been shut down with the following as a guideline:

- a) Isolate unaffected **Fuel** pipes

As many unaffected **Fuel** pipes as possible **Shall** be isolated from the mill.

- b) Start **Fuel Oil Burners**

A sufficient number of **Fuel Oil Burners** to ensure stable combustion **Shall** be inserted. The **Oil Burner** associated with the blocked **Fuel** pipe **Shall** be in service.

- c) Circulate cold air

With the tempering air fully open, air **Shall** be forced through the circuit by gradually increasing the quantity until the maximum attainable air flow through the mill is reached. This maximum air flow **Shall** be maintained for at least five minutes.

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**d) System purge**

If the blockage clears, the system **Shall** be purged for a further five minutes at a flow rate above the minimum air velocity necessary to prevent settling in the **Fuel** pipes.

**e) Conditions for returning mill to service**

Only after the cause of the blockage has been established and corrected **Shall** the mill be returned to service.

**f) Procedure if blockage fails to clear**

If the blockage fails to clear after this attempt, the **Mill Group Shall** be shut down, isolated, cooled and not be returned to service until the blockage has been cleared manually.

**g) Tube mill single ended operation**

In the event that the mill is a double ended tube mill with the ability for single ended operation and the side affected by a blockage, can be removed from operation by selecting single ended operation.

#### **4.5.4 Blanking of Burners or Pulverised Fuel Pipes**

Under no circumstances **Shall** a mill be run when one or more burners or pulverised **Fuel** pipes are blanked or if any pulverised **Fuel** pipes are blocked.

In the case where double ended tube mills are used it is permitted to run the mill on single ended operation provided all pulverised **Fuel** pipes and burners associated with that end of the mill are in service and as allowed by the control interlocks. The affected pulverised **Fuel** pipe(s) **Shall** be isolated at the furnace and at the inlet of the affected pulverised **Fuel** pipe(s) immediately. The mill **Shall** not be returned to double ended operation until all the pipes are cleared and the reason for blockage determined, logged and corrective action implemented.

#### **4.5.5 Mill Fire<sup>[\*]</sup>**

**a) Symptoms of a mill fire**

Evidence of a mill fire may be a sharp uncontrollable rise in the mill outlet temperature, and higher than normal mill casing temperatures.

On a running mill there may be excessive variations of pressures (or differential pressures) and temperatures.

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**b) Method of dealing with a mill fire on load**

On identification of a mill fire, the mill **Shall** be tripped, boxed up and isolated from all possible air supply, including seal air.

**c) Use of inert gas or steam**

Inert gas or steam **Shall** be injected into the mill to prevent an explosion.

**d) Use of water**

The injection of water into the mill **Shall** not be permitted because of the possibility of agitating the Pulverised **Fuel** to form an explosive suspended cloud, danger of damaging the grinding elements and the rapid development of a large volume of steam.

The use of water on the casings of the mills and/or feeders for cooling purposes in the event of a fire is permitted but **Shall** be covered by a local procedure taking into account the specific condition and any risk to plant and personnel.

**e) Conditions for returning mill to service**

Only after the cause of the mill fire has been determined and rectified **Shall** the mill be returned to service.

**f) Opening of the mill, **Fuel** pipes and/or feeder in event of a mill fire**

Opening of the mill, **Fuel** pipes and/or feeder is prohibited unless it is cooled to ambient temperature and measures are taken to ensure that an explosive atmosphere does not exist.

**g) Vertical spindle mill reject boxes and plenum chambers**

Any accumulation of rejects within the **Primary Air** inlet ducts, plenum chamber and reject discharge chutes **Shall** not be permitted. It is prohibited to run a mill with a full reject box.

If this has occurred, the mill **Shall** be tripped and boxed. If a fire has occurred it **Shall** be dealt with as prescribed in Regulation 4.5.5.

Running a mill with **Primary Air** leaking from the reject box is a fire risk and **Shall** not be tolerated. Running a mill with the reject system inner doors and outer doors open simultaneously is not allowed.

Continuous mill operation with closed inner reject doors is not permitted except for the purposes of clearing the reject box.

**h) Risk of feeder fires due to air leaks**

Air leaks **Shall** not be tolerated on mill feeders that are not internally pressurised with seal air as it is a fire risk.

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#### 4.5.6 Running of Mills with no Air Flow

No mill **Shall** be run for any purpose without an adequate flow of **Primary Air** through it (i.e. boxed up) due to the risk of overheating and explosion.

If there is a need to run a mill for maintenance purposes without **Primary Air** flow, this process must be covered by a local procedure. This is applicable for barring of tube mills only.

In the case of vertical spindle mills where the rollers may be lifted to a level higher than the coal bed the rotation of the mill is allowed to clear the mill of coal provided the roller lifting mechanism is interlocked to prove sufficient roller lift has been achieved and that steam inerting is applied.

#### 4.5.7 Dealing with Pulverised Fuel Leaks

Pulverised **Fuel** leaks **Shall** be attended to immediately by either repairing the leaks on load or, if unsuccessful, the associated mill **Shall** be shut down immediately for off-load repairs.

In the event of a Pulverised **Fuel** leak occurring, the accumulation of leaked Pulverised **Fuel Shall** be cleared and remove from all areas affected. The potential for fire and/or secondary explosions **Shall** be avoided by the prevention of accumulation of combustible dust on any surface.

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## 5. TESTING

### 5.1.1 Testing of Furnace Flame Failure Protection Equipment

The power station **Shall** prepare and implement a plan for the routine testing of **Furnace Flame Failure Protection** equipment. This plan **Shall** cover the following aspects:

- a) On-load testing of the integrity of individual **Furnace Flame Failure Protection** equipment circuits **Shall** be conducted once every month.

The testing may be conducted by removing the **Flame Monitoring** device from the in service position to prove correct functioning of the alarms and indications.

These tests must be covered under a local procedure and recorded on a planned maintenance schedule.

- b) Full functional trip testing of all **Mill Groups** or the **Boiler Master Fuel Trip** from the **Furnace Flame Failure Protection** equipment. The periodicity of such tests **Shall** not exceed 48 months. This test can be simulated. These tests must be covered under a local procedure and recorded on a planned maintenance schedule.
- c) Additional tests as required by the **Power Station Manager**.
- d) Record the results of all tests and a record of the results to be kept and archived.
- e) Defective functioning of the **Furnace Flame Failure Protection** **Shall** be logged, defected and reported to the **Power Station Manager** (Regulation 3.1.1). Immediate action **Shall** be taken to restore the **Furnace Flame Failure Protection** equipment to its original condition.

### 5.1.2 Testing of the Boiler Master Fuel Trip and Interlock Functions

Off load functional testing and inspections, as defined in the Boiler Protection Functions Standard, **Shall** be performed. The periodicity of such tests **Shall** not exceed 72 months.

The signed-off results of the tests (together with corrective actions, where applicable) **Shall** be recorded and stored in the plant history.

### 5.1.3 Testing of Fuel Oil Burner Ignition and Protection System

Functional testing of all **Fuel Oil Burners** or group of **Fuel Oil Burners** **Shall** be conducted at a frequency not exceeding 14 days. **Should** the boiler have been on outage for a period of 14 days or longer, the functional testing **Shall** be conducted during the boilers return to service. **Should** any work have been carried out on a **Fuel Oil Burner**, that **Fuel Oil Burner** **Shall** be functionally tested.

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The functional testing **Shall** be carried out according to an approved procedure, which **Shall** require the **Fuel Oil Burner** to be started, stopped and tripped. As a minimum, such procedure **Shall** prove the following:

- a) The correct functioning of the **Fuel Oil Burner** management system.
- b) Correct functioning of the **Fuel Oil Burner Flame Scanner** in identifying its own **Flame** and good discrimination from other **Flames**
- c) Correct operation of valves during the sequence
- d) Correct operation of air supply dampers or fans
- e) Correct steam pressure and temperature, where applicable

All valves, valve sets or **Fuel** oil lances that are installed on the **Oil Burner** plant **Shall** have been maintained in accordance with an approved procedure prior to installation. Such procedure **Shall** ensure that the maintenance has been carried out in the correct manner and to the correct standards and tolerances. The procedure **Shall** also include testing of the valve, valve set or **Fuel** oil lance to ensure that the flows, pressures and atomisation, as applicable, are within the required tolerances for all modes of firing or recirculation.

#### 5.1.4 Accuracy Verification Testing of Oxygen Analysers<sup>[1]</sup>

Boiler Oxygen measuring devices **Shall** be verified with a certified portable Oxygen analysers at regular intervals. For analysers installed in tandem, the verification **Shall** be conducted at least 2 weekly and for single point analyser, the verification **Shall** be conducted at least weekly. During the verifications, the readings in Unit Control Room to be confirmed as correct. A maximum difference of 10 percent of the Oxygen reading is allowed.

A traverse **Shall** be conducted on a yearly basis to establish the weighted average Oxygen concentration to verify and to compare to the matrix or single point Oxygen concentration to ensure the representativeness of the matrix system or single point measurement.

The Oxygen concentration measurement at furnace exit **Shall** be conducted at least once every twelve months or when repairs are done to the furnace casings or when damage to compensators or duct casings is suspected. The results **Shall** be correlated with the installed Oxygen analysers at economiser outlet to ensure representativeness of the Oxygen concentration in the furnace.

Verification of the boiler Carbon Monoxide measuring devices with certified portable Carbon Monoxide analysers and the readings in Unit Control Room to be confirmed as correct at regular intervals (at least 2 weekly).

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### 5.1.5 Pulverised Fuel Burner Flame Scanners

In boilers that are equipped with individual Pulverised **Fuel Burner Flame Scanners** devices as part of the **Flame Failure Protection Equipment**, such devices **Shall** be treated in the same way as furnace failure monitoring devices (refer to Regulation 5.1.1)

## 6. RECORDS

For each site, in terms of these regulations, the following records **Shall** be maintained:

- Delegations of authority
- Training, testing and authorisation records
- Testing and plant specific procedures
- Approved **Waivers** and **Exemptions**, including all documentation and procedures relevant to each **Waiver** or **Exemption**
- Out-of-normal conditions, manual adjustments and changes to protection system settings
- Operating log
- Record of all incidences which were deemed reportable in terms of these regulations (Regulation 3.1.1)

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## 8. REVISIONS

Date	Rev.	Compiler	Remarks
June 2016	0.1	Christo Van Wyk	Updated Final Draft To comply with the 3 year review period and add on new learning since the last revision for comments Review Process
October 2016	0.2	Christo Van Wyk	Final Draft updated after the Comments Review Process
November 2016	1	Christo van Wyk	Final Document for Authorisation and Publication

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## 10. ACKNOWLEDGEMENTS

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## APPENDIX A: SUPPORTING INFORMATION

### A.2.1.1 THE PRIMARY CAUSES OF FURNACE EXPLOSIONS

#### [1] Requirements for an Explosion

A furnace explosion is caused by the uncontrolled rapid ignition of an explosive mixture in the boiler furnace or gas passes. A furnace explosion can occur after ignition is lost in the furnace or part of the furnace while a boiler is steaming, but most frequently occurs during the start up or shut down process, or after the boiler has been shut down. An explosion can occur only if the following basic requirements are met simultaneously:

- a) There must be an explosive mixture of gas, dispersed fuel dust or vapour with air in a confined space.
- b) There must be a source of heat at a sufficiently high temperature to increase the mixture temperature to the ignition point and to supply sufficient ignition energy.

#### [2] Dust Concentrations Required for Explosions

An explosive mixture is formed by as little as 45 grams of coal dust dispersed in a cubic metre of air. Explosions can still occur in concentrations as high as 10 000 grams of coal dust per cubic metre of air. Explosions may be followed by equally violent implosions, depending on the circumstances.

#### [3] Mixtures Required for Gas or Oil Explosions

The mixtures required by oil vapour, volatile vapours or gases will not be defined as the explosive concentration varies widely.

#### [4] Ignition Temperature and Energy for Dust Explosions

The temperature required igniting a mixture of coal dust and air is between 500°C and 600°C. A hot or glowing surface, an adjacent flame, a hot gas stream, or an attempt to re-light an oil or a coal burner can initiate a coal dust explosion.

#### [5] Ignition Requirements for Gas or Oil Explosions

A spark may be sufficient to ignite a gas or vapour mixture, as lower energies are generally sufficient to explode these mixtures. To initiate an explosion the concentration of the fuel mixture required will expand while the required ignition energy is lower as the temperature in the furnace increases. Thus a condition where unburnt fuel existing in a furnace may appear to be acceptable at the beginning of a light-up, the same amount of fuel may explode as the furnace temperature increases.

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[6] Oxygen Requirements for Explosions

For all dust or vapour mixtures, an Oxygen concentration of 14% or more in air is necessary to form an explosive mixture. Mixtures will not ignite and explode with lower Oxygen concentrations. A turbulent and dispersed mixture will increase the chances and violence of an explosion in all cases.

[7] Classification of Furnace Explosions

Furnace explosions are grouped in the following five classes or categories:

i. Class I

Coal dust explosions resulting from total or momentary ignition loss on a single coal burner and subsequent explosive re-ignition. This is commonly termed a "light puff" and is far more common than generally realised.

ii. Class II

Coal dust explosions resulting from total or momentary ignition loss on less than the total number of coal burners in service and subsequent explosive re-ignition of the explosive mixture so formed. This is commonly termed a "heavy puff".

iii. Class III

Coal dust explosions resulting from total ignition loss on all or the majority of the coal burners in service and subsequent explosive re-ignition of only a part of the explosive mixture so formed. This is commonly termed an "explosion".

iv. Class IV

Coal dust explosions resulting from total ignition loss on all or the majority of the coal burner in service and subsequent explosive re-ignition of the total explosive mixture so formed. This is commonly termed a "heavy explosion".

v. Class V

Gas or vapour explosions caused by fuel oil, volatiles or other gases. These explosions are invariably exceptionally violent.

#### **A.2.3.27 FLASH-BACK**

A flash-back can take place if the velocity of flame propagation in the pulverized fuel pipework is greater than the forward velocity of the fuel/air stream and where fuel/air mixture is in a combustible region.

**A.3.1.2 AUTHORISATION OF PERSONNEL**

All personnel who have a direct impact on Boiler Plant operation in terms of the Fossil Fuel Firing Regulations needs to be re-authorised or re-trained, including boiler Operators, System Engineers and Maintenance personnel, as well as contractors where applicable.

The Power Station Manager must ensure that the non-operating personnel involve in Boiler Plant related matters have sufficient knowledge of the Fossil Fuel Firing Regulation before any modifications and/or operation/maintenance decisions are made or approved.

**A.3.1.11 POST MAINTENANCE INSPECTIONS AND COMMISSIONING**

Where the maintenance activity only covered a minor portion of the plant and where the plant's overall performance is not affected, then the re-commissioning activity and test run may be adapted to suit the part of plant worked on.

**A.3.1.14 AVAILABILITY OF CARBON MONOXIDE MEASUREMENT**

The Carbon Monoxide concentration in the flue gas under normal operation shall not exceed 2000 ppm at furnace exit and 200 ppm (referenced to 3,0% Oxygen) at economiser outlet or 100 ppm (referenced to 6,0% Oxygen) in the stack. These figures are based on present test information and are therefore considered to be preliminary values. Each power station must do tests to determine normal operating and alarm values for the economiser outlet and/or in-stack measurements. The Fossil Fuel Firing Regulation Committee must be approached for approval of proposed alarm values and actions.

Note that there is a time lag in Carbon Monoxide measurement that needs to be taken into account when measuring Carbon Monoxide in the stack.

**A.3.1.18 TOTAL COMBUSTION AIR FLOW METERING DEVICE**

The combustion air required by the boiler must be measured after the air heaters to eliminate uncertainties and influences on the air flow admitted to the boiler. Such variations may exist due to duct leaks or air heater leakages.

Each power station must ensure that the total combustion air flow is accurately and reliably measured/calculated. This must be accomplished by compiling a comprehensive maintenance plan for the air flow metering devices (orifice plate, venturi meter, aerofoil, etc.). The maintenance plan must ensure that the inaccuracies due to distortion of ducting, wear of devices, leakage at the devices, impulse lines, transmitters and collection of contaminants are identified and eliminated. Any leakages of the total combustion air after the measuring devices must be eliminated through proper maintenance practices.

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Each power station must endeavour to establish the K-factor of each individual air flow device, preferably at commissioning. Should any maintenance activity impact on the integrity of the air flow device the K-factor shall be re-established through testing using an approved independent instrument and using an approved procedure for the test.

#### **A.3.2.5.3 AIR FLOW LIMITS**

Purging with too much air can be just as dangerous as purging with too little air. At one end of the scale excessive purge rates can disturb combustibles smouldering in hoppers, on ledges, and at other fall out areas. At the other end fuel can settle out in various places due to lack of supporting air flow.

#### **A.3.2.6.1.1 FUEL OIL BURNER SHUT-OFF VALVES ARRANGEMENT**

The objective of the shut-off valve arrangement is to ensure that the introduction of fuel oil to the boiler in the event of a Boiler Master Fuel Trip is not possible. The requirement is that there are at least two safety shut-off valves preventing this occurrence. There may be one common as well as individual safety shut-off valves or there may be two individual safety shut-off valves at the fuel oil burner. Should the fuel oil burner be of the recirculating type, provision must be made for safety shut-off devices being installed on the supply and return lines.

#### **A.3.2.6.3 OIL BURNER CLASSIFICATION**

Class 1 is equal or more than 10% of burner rating where the burner rating is calculated as the thermal input of the primary fuel through that burner at 100% Boiler Maximum Continuous Rating using the design fuel quality (gross Calorific Value on an as received basis). Class 2 is less than 10% of the burner rating and is similarly calculated.

$$\text{Oil burner capacity (\%)} = \frac{(M_{oil} \times CV_{oil}) \times 100}{M_{coal} \times CV_{coal}}$$

Where:

CV<sub>oil</sub> = Energy content of the fuel oil on a gross as received basis (MJ/kg)

CV<sub>coal</sub> = Designed energy content of the coal on a gross as received basis (MJ/kg)

M<sub>oil</sub> = Design mass flow of fuel oil through the fuel oil burner in kg/s

M<sub>coal</sub> = Design mass flow of the coal per pulverised fuel burner at 100% Boiler Maximum Continuous Rating in kg/s

There are several conditions that may inadvertently change the class of a fuel oil burner. These conditions need to be assessed and sufficient information made available to the Authorised Boiler Operator so that inadvertent operation with the incorrect Class oil burner is avoided.

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Typically, the following conditions may reduce the flow rate of the oil burner and therefore it's Class:

- a. Incorrectly dimensioned oil burner tip. This could occur as a result of wear or damage of the atomising nozzle, incorrect specification or blockage.
- b. A reduction in fuel oil supply pressure. Note that incorrectly operating fuel oil burner valves may cause a reduction of the fuel oil pressure as well.
- c. A change in viscosity may change the fuel oil flow rate.
- d. Any condition which may cause the reduction of the thermal input of the fuel oil burner must also be considered. Typically this is evidenced by fuel oil carry-over. Examples include incorrect air supply, poor atomisation and partial blockage of the lance or air swirler.

#### **A.3.2.6.4 LEAKING OIL BURNERS**

The detection of leaking oil burners may include a combination of the following methods:

- a. The use of supply and return flow meters to identify a loss of fuel oil at the boiler front when oil burners are not in use. Should a difference be noted, an assessment and inspection of the oil burners should be conducted to identify the leaking oil burners. Note that the difference between the supply and return flow rates may be very small when a leaking tip is present.
- b. Inspection of the oil burners to assess whether there is any evidence of leakages. For example, removal of oil lances to inspect the tip and the carrier tube. Should there be evidence of wet fuel oil on the tip or within the carrier tube; the oil burner lance can be deemed to be leaking. An excessive carbonised fuel oil deposit on the tip is also an indication of minor leakage of the lance.
- c. Provision of a pressure indication in a position which is after the burner supply isolating valve and before the return isolating valve. By closing the supply and return isolating valves temporarily, the pressure indication will not decrease if no leakage is present. This method is by far the most effective method of identifying leaking oil burner.

#### **A.3.2.6.7 REPEATED FIRING OF OIL BURNERS**

Repeated starting of oil burners increases the propensity of admitting unburned fuel oil to the furnace and flue gas passes. Fuel oil carry over must be eliminated to prevent possible air heater, electrostatic precipitators or fabric filter plant fire. The risk of air heater fire is increased when regenerative air heater packs have been replaced.

### A.3.2.7.1 MINIMUM AIR FLOW LIMITATION

A mandatory automatic Boiler Master Fuel Trip is required to trip the boiler at a total combustion air flow rate of 5% below the minimum total combustion air flow rate. For example if the minimum combustion air flow rate is 35% of the Boiler Maximum Continuous Rating total combustion mass air flow, the boiler will not be permitted to operate with a total combustion mass air flow rate below 30% of the Boiler Maximum Continuous Rating total combustion air flow mass flow.

#### A.3.2.7.10 OVERFIRE AIR SUPPLY

##### a. Low Nitrogen Oxide Information and Considerations

Nitrogen Oxides (mainly Nitrogen Oxide and/or Nitrogen dioxide) or Nitrogen Oxides (NO<sub>x</sub>) as it is referred to, is a generic term for a group of highly reactive gases which contain nitrogen and oxygen in various quantities and chemical configurations. Nitrogen Oxide is normally formed when **Fuels** are burned at high temperatures, such as in the combustion process of a boiler. There are primarily three sources responsible for Nitrogen Oxide production in the combustion process, namely:

[1] Prompt Nitrogen Oxide:

Prompt Nitrogen Oxide is formed during the early stage of combustion by the reaction of atmospheric nitrogen and radicals in the air. The quantity of prompt Nitrogen Oxide is generally negligibly small and not considered during the combustion process.

[2] Thermal Nitrogen Oxide:

Thermal Nitrogen Oxide is formed at very high temperatures, generally >1200°C. It is formed as a result of the oxidation of the diatomic nitrogen in combustion air and the residence time that the combustion air has at that high temperature.

[3] Fuel Nitrogen Oxide:

Fuel Nitrogen Oxide is formed when the nitrogen in the coal combines with the excess air in the combustion air and can make up as much as 80% of the total Nitrogen Oxide emissions.

##### a) Nitrogen Oxide reduction methods

Methods to reduce Nitrogen Oxide emissions could affect the stability of the flame due to controlled fuel/air mixing, distribution of heat over a larger area of the furnace producing lower flame temperatures as a result of longer, less turbulent flames. Thus it is important to ensure proper distribution of air flow to all burners (especially where multiple burners are fed from one windbox).

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As a result of the various methods used to reduce Nitrogen Oxide, there is a tendency to increase the unburned combustibles and the following risks should be kept in mind:

- Previous known margins to prevent the accumulation of unburnt carbon will now be marginal during transients or unstable combustion conditions;
- As a result of low excess air or even fuel rich conditions next to the furnace walls (burner belt area), the tubes could be subjected to corrosion (fire side corrosion);
- As a result of stoichiometric or sub-stoichiometric combustion bordering on an unstable operating regime in the burner belt area, the scanners might not scan the flame properly and might require repositioning or a change of scanner type.

**b) Low Nitrogen Oxide burner optimisation**

It is preferable to have a windbox-to-burner tertiary air side differential pressure or a windbox-to-furnace differential pressure indication to measure air side flow. These taps, where provided, should be installed per burner or per burner level respectively.

**c) Over-fire air supply**

Proper sizing of the over-fire air system is required to ensure that air flow is adequate under all operating conditions once placed in service. Special attention shall be given to control coordination between the over-fire air supply and furnace combustion air supply. When the over-fire air system is not in operation, enough cooling air shall be supplied to ensure the proper cooling of over-fire air ports during all operating conditions and purging of the boiler.

**A.3.3.3 CROSS LIMITING**

Cross limiting refers to the control systems ability to prevent the air flow decreasing below the required value as determined by the fuel flow in the event that the air flow supply becomes limited.

**A.3.3.4 OXYGEN CONCENTRATION IN FLUE GASES**

The purpose of this Regulation is to ensure that the boiler combustion is operated and adjusted using an Oxygen concentration which is representative of the combustion process, particularly at the furnace exit. To achieve this Oxygen measurement controls must consider the following:

- a)** The average on a duct may be used provided the deviation of the Oxygen concentration does not exceed 0,3% between the two or three analysers. Should the deviation exceed the 0,3%, the lowest value **Shall** be used for control purposes. This applies to single flue gas ducts as per design.

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- b) The average between the left and right sides may be used provided the deviation between the left and right hand side does not exceed 0,5%. Should the deviation exceed 0,5%, the lowest duct value shall be used for control purposes.

#### **A.3.3.5 INGRESS OF UNMEASURED AIR**

Possible points of air ingress such as boiler doors, inspection ports and seals must always be kept closed and properly maintained. This includes but is not limited to ducting and duct expansion joints, continuous ash system dipper plates, emergency ashing doors, hopper inspection ports and furnace inspection doors.

A local procedure must be in place to identify air ingress points. These procedures may include methods such as thermal scanning devices, smoke generators and/or pressurising of the furnace. Note that the boiler furnace maximum pressure protection values must not be exceeded.

#### **A.3.3.14 COMBUSTION SAFETY DEVICES**

The minimum (but not limited to) combustion related safety devices are:

- a) Boiler Protection System,
- b) Burner Management System,
- c) Flame Monitors and Flame Scanners,
- d) BMFT's,
  - i. Propane gas shut off valves,
  - ii. Fuel oil shut off valves,
  - iii. Quick close dampers/ Primary Air, isolating and control dampers
- e) Steam safety valves,
- f) Emergency drains

#### **A.3.3.18.2 SOOTBLOWING OF AIR HEATERS**

It is recommended to soot blow the air heater as soon as possible after boiler start-up. For stations equipped to carry out air heater sootblowing during the start-up, station practices must continue as per Original Equipment Manufacturer (OEM) instructions.

#### **A.3.3.23 SUFFICIENT OIL BURNERS**

Sufficient would mean no less than 65% of the installed oil burners on a burner row and no two oil burners adjacent to each other must be out of service simultaneously.

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**A.3.3.24 SWEEPING AIR**

It is allowed to admit air through the idle burners to increase the flue gas velocity at the boiler outlets to prevent accumulated ash from falling back into the furnace or over into the back pass. Once stable load is established after a boiler load transient, with the oxygen trimmer on manual the air flow must be increased gradually to increase the flue gas velocity as per the local instructions. However, the Oxygen level as measured prior to the air heaters must not increase above 9% as required in the regulation. On returning to normal operation, the air flow through the idle burners must be first gradually decreased before any boiler load transient is allowed.

Air used to sweep ash from ductings must only be done after the boiler load conditions have stabilised.

**A.3.5.2 PURGE FOLLOWING A TRIP**

On stations where the current control philosophy dictates that the secondary air dampers close after a boiler trip, the air flow must not be manually increased or decreased. This condition should be maintained for five minutes. Thereafter the Authorised Boiler Operator should gradually increase or decrease the air flow to purge requirements.

On all stations where this control philosophy is implemented, an Exemption shall be applied for.

**A.4.1.2 QUICK CLOSING DAMPERS**

The prime objection is to stop ignition in the furnace by using quick closing dampers to achieve that. The function of the quick close damper is to rapidly stop the primary air flow to or from the mill. The quick closing dampers may include:

- a) Primary air isolating dampers
- b) Mill outlet gates
- c) Quick close dampers
- d) Primary air control dampers

**A.4.2.1.5(e) PULVERISED FUEL PIPE VELOCITY**

A typically acceptable minimum velocity of the Pulverised Fuel /Air mixture to avoid Pulverised Fuel fall out is 20 metres/second.

Maintaining a minimum velocity of this order will also prevent a Flash-Back from the furnace.

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**A.4.3.7 EMPTYING OF BUNKERS**

Particular attention needs to be made to known or suspected existence of burning coal or any source of ignition within the feeder or bunker (burning coal) or the area above the bunker (welding) when compiling procedures to empty bunkers.

**A.4.5.3 FUEL PIPE BLOCKAGE**

On stations where there are known issues with fuel pipe blockages, inspections shall be conducted to identify any blocked fuel pipes. Methods used to identify blocked fuel pipes are:

- a) Thermal imaging
- b) Thermocouples
- c) Pressure drops or increase
- d) No flame at affected burner
- e) Infrared hand held pyrometer

**A.4.5.5 MILL FIRE**[1] Locations of Fires

Below are examples where fires have occurred on various areas of the milling plant.

- a) Holes in the raw coal chutes – coal and PF collecting in the lagging and cladding or disturb the classifying process.
- b) Hot box or Plenum chamber fires
- c) Screw conveyor failures
- d) Feeders
- e) Mixing boxes
- f) Accumulation of coal in raw coal chutes into the mill
- g) PF accumulation in the sound hood due to shell liners and bolts falling out.
- h) Blocked classifiers or accumulated coal in classifiers.
- i) Reject boxes
- j) Blocked or partial blocked PF pipes
- k) Coal leaking from labyrinth seal on vertical spindle mills
- l) In general, any place where coal or PF can accumulate between bunker and burners.

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[2] Recommended Mitigations (in order of priority)**a) Prevention by**

- i. Proper maintenance being done
- ii. Sound operational activities and principles
- iii. Engineering interventions

**b) Detection**

- i. Early detection of any mill fire is extremely important to reduce plant damage and additional risk to personnel. Methods and procedures must be developed to enable early detection, such as:
- ii. Thermocouples – installation of thermocouples in a manner that will detect if a fire exists in a certain position(s) or even if there is an accumulation of coal (permanent or portable).
- iii. Speed switch – installation of speed switches on the screw conveyor shafts to detect “no rotation”
- iv. Blocked raw coal chutes – installation of blocked chute detectors
- v. CO monitoring – installation of CO sniffers or CO analysers to detect CO generation when fires starts.
- vi. Alarms to the operator - reviewing of the process parameters, for example damper positions, feeder speed/amps, flows, mill temperature increase or any other process condition variable that can be used as an alarm during chute blockages and/or mill fires.
- vii. Continuous thermographic scans of the hot boxes in any other area prone to the occurrence of fires.

**c) Control (reaction)**

Once the fire is detected in any area of the mill, the mill shall be tripped immediately and boxed up (isolated). The mill shall remain off until the fire has been extinguished, the residue being cleared and the reason for the fire being investigated.

The industry norm for extinguishing mill fires is either by steam or gas inerting. The advantage of steam inerting is the relative low cost and the availability of large volumes of steam. Steam also has excellent cooling properties. Gas inerting will only be effective if the mill is sealed against air in-leakage and there is sufficient supply of gas available.

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It is also suggested that the use of atomized water is an option provided the mill fire have not progressed to high temperatures (i.e. if the actual temperature of the fire core is <300 degree Celsius). The use of water as a cooling medium on the casing to cool the region of an internal fire could be useful in limiting the damage.

**d) Warning**

The opening of access doors and/or any action which could create the suspension of pulverised fuel should be avoided while a fire is present internally to the mill in order to possible explosions.

**e) Steam Explosion**

A steam explosion is a violent boiling or flashing of water into steam, occurring when water is either superheated, rapidly heated by hot ash or clinkers. The water changes from a liquid to a gas with extreme speed, increasing dramatically in volume. A steam explosion sprays steam, boiling-hot water and hot ash in all directions (if not otherwise confined, e.g. by the combustion chamber or ash hopper enclosure), creating a danger of scalding and burning.

With boilers being off load, the surface of accumulated ash could appear cool, because of rapid heat loss due to radiation, but the bulk of the heap could still be hot due to self-insulation. A large heap of solids could after many hours still cause a steam explosion if it falls into the water of the ash hopper. Pressures of up to 3,0 kPa has been witness when a steam explosion occurred in an ash hopper 13 hours after the boiler had been off-load.

#### **A.5.1.4 ACCURACY VERIFICATION TESTING OF OXYGEN ANALYSERS**

Caution must be exercised to ensure that the basis on which the Oxygen content in the flue gas is measured, specified, calculated or quoted is clearly understood and indicated i.e. wet or dry basis. Similar consideration must be applied to any gas analysis.

While conducting the yearly traverse to determine the weighted average Oxygen content, it is expected that the profile of Oxygen content is comparable to previous testing. Should a difference occur, it could indicate that an abnormal condition exists, such as improper secondary air or coal flow distribution. With this in mind, it is imperative that a proper investigation is conducted to establish the reason for the difference. This also implies that when conducting the traverse, the condition of the plant must be assessed and verified to be within acceptable operating condition.

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## APPENDIX B: GAS CO-FIRING

### Gas Co-Firing (only as second fuel during Co-Firing conditions)

*Note: It is intended that the NFPA 54 and NFPA 85 codes shall be used when designing and operating gas **Co-Firing** systems.*

#### B.1 General Operating Requirements

##### B.1.1 Leak Test

A leak test of the piping systems **Shall** be done and proven successful before the main gas supply header is placed in service.

**B.1.2** Prior to starting the gas burners, three or more coal burner rows will be in service with a **Stable Flame** condition. All coal firing protection systems **Shall** be active.

**B.1.3 Fuel Oil Burners** associated with the gas burners to be placed in service, **Shall** be placed in service before the introduction and light-off of the gas.

**B.1.4** The gas pressure **Shall** be maintained above the minimum gas pressure at all times. **Should** the gas pressure reduce to below the minimum pressure, the associated gas burners must trip.

##### B.1.5 Total Heat Input

The total heat input of multiple **Fuels co-fired Shall** not exceed the maximum heat input for the burner(s) or furnace zone as specified by the Original Equipment Manufacturer.

##### B.1.6 Sequencing

Local procedures will be drawn up to allow gas to be admitted only when there is sufficient ignition energy and air flow to meet the minimum requirements for ignition and stable combustion of the gas as it enters the furnace.

##### B.1.7 Sootblowing

Sootblowing **Shall** only be allowed where the heat input into the furnace is high enough to prevent **Flame-out** during the sootblowing operation.

#### B.2 Starting of the Gas Burners as Second Fuel

- a) All gas isolating shut-off valves are closed.
- b) **Fuel** combustion is stable and **Fuel Oil Burner** are ready for use.

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- c) The venting valves are open and venting to the atmosphere. The supply lines are drained and cleared from any condensate.
- d) All controls and interlocks are in place and checked to be in working condition.
- e) The measurement of the gas pressure supplied to the boiler **Shall** always be available to the **Authorised Boiler Operator** locally on the plant and remotely at the point of plant operation.
- f) Start all **Fuel Oil Burners** to ensure coal firing is stable while lighting-off the gas.
- g) A leak test to be performed prior to admitting gas to the burners.
- h) Ensure the individual gas burner safety shut-off valves are closed and the individual vent valve is open.
- i) Close the main gas control valve, vent valve and open the main safety shut-off valve(s).
- j) Open the individual gas burner safety shut-off valves and close the individual vent valve and firing of the second **Fuel** may commence.
- k) Failure to ignite or loss of ignition for any reason on any burner **Shall** cause the gas flow to that burner(s) to be stopped immediately.

### B.3 Normal Operation

**B.3.1** The firing rate **Shall** be maintained by regulating the **Fuel** and air flow at predetermined air/**Fuel** ratios taking into account the lead or lag of the air flow.

**B.3.2** The **Fuel** flow rate **Shall** never be regulated by the individual burner safety shut-off valves. These valves **Shall** be fully open or fully close.

**B.3.3** The **Fuel** and air flow **Shall** be maintained within a range between the minimum and maximum limits as specified by the Original Equipment Manufacturer, or as determined by tests.

These tests **Shall** fulfill the different combinations of **Fuel** oil, gas and coal burners in service and combustion controls **Shall** remain on automatic control.

**B.3.4** The **Total Combustion Air Flow** rate of the boiler **Shall** not decrease below the minimum **Total Combustion Air Flow** rate at any time.

### B.4 Shutdown of Gas Burners as a Second Fuel

**B.4.1** With the **Fuel** oil and coal burners still in service, shut down the individual safety shut-off valves and open the associated vent valves in sequence as per the local instructions.

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**B.4.2** With the last burner safety shut-off valves being closed, the main gas isolating valve can be closed and all vent valves opened to prevent gas from leaking into the combustion chamber. For standby purposes, the main gas supply line to the burner safety shut-off valves may be left pressurised provided the boiler is on load.

## **B.5 Mandatory Trips**

**B.5.1** Where **Fuel** pressure at the burner is not measureable, a low **Fuel** gas pressure trip **Shall** be provided upstream of the control valve. If another **Fuel** is proven in service, this **Shall** cause a **Fuel** gas trip only and not a **Boiler Master Fuel Trip**.

**B.5.2** All other mandatory trips as required for coal combustion **Shall** apply.

**B.5.3** Loss of supply to boiler controls, burner management systems or interlock systems, the design philosophy **Shall** be fail safe by closing all safety shut-off valves and opening all the associated vent valves.

**B.5.4** With a **Boiler Master Fuel Trip**, the following **Shall** occur:

- a) All gas vent valves **Shall** be opened and the burner and main safety shut-off valves **Shall** trip close.
- b) Electrostatic precipitators **Shall** be de-energised immediately with the **Boiler Master Fuel Trip** initiation.
- c) Draught group **Shall** remain in service.
- d) The boiler **Shall** be purged before any further operation is allowed.

### **CONTROLLED DISCLOSURE**

When downloaded from the EDMS, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorised version on the system.