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1. INTRODUCTION

Adequate boiler draught plant protection is essential to safeguard the plant and prevent major damage and shall always be available on demand. However, the benefits of such protection must be balanced against the inevitable reduction in reliability associated with the protection equipment and systems. This Standard strives to achieve such a balance, and to ensure the documentation and control of the protection requirements and settings at each relevant Eskom fossil fired Power Station (PS).

The document content has been compiled jointly by a working group of boiler draught plant and C&I engineers from Group Technology and representative PS's, incorporating input from the 1991 Plant Reliability Study and the consideration of protection philosophies and systems already existing on respective fossil fired boilers.

2. SUPPORTING CLAUSES

2.1 SCOPE

2.1.1 Purpose

The purpose of this document is to prevent loss of life or major plant damage by ensuring that fossil fuel fired boiler draught plant are not operated beyond safe limits. This is achieved by:

- Defining the minimum protection functions for all fossil fired boiler draught plant.
- Ensuring that each Power Station has a protection philosophy document detailing the specific plant protection functions, setting values and testing requirements.

The protection functions as defined in this document should be supplemented by appropriate control setpoints, process limiters, alarms, sequential tripping, automatic load reduction and/or manual operator interventions.

2.1.2 Applicability

This standard shall apply to all Eskom fossil fired boilers.

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] OPG 0145: Eskom Power Station Plant Protection Philosophy.

[2] GGR 0568: Pulverised Fuel Firing Regulations.

[3] GGD 1447: Plant Asset Management Directive.

[4] 36 – 976: Fossil and Peaking Generation Modification Impact Team, Terms of Reference and Process.

[5] GGP 0464: Administration of Operations related ESKOM Regulations.

[6] 36-486: Standard for Fossil Fired Boiler Protection Functions: Requirements and Control Measures

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2.2.2 Informative

1VGB-R 117 C: Guideline for Power Plant Equipment Protection

2.3 DEFINITIONS

2.3.1 Protection functions:

All those functions that will trip the boiler draught plant, or initiate actions to prevent major plant damage, in the event of a predetermined process level being exceeded in terms of the plants defined operating envelope.

2.3.2 Boiler Master Trip:

Boiler master trip means a device which will, either automatically or by means of a manual push button, stop all fuel input into a boiler furnace.

2.3.3 Waiver:

A waiver means permission of a permanent nature to be excused from a provision of this standard.

2.3.4 Exemption:

Exemption means permission of a temporary nature to be excused from a provision of this standard.

Note: Where applicable definitions were taken from PFFR (GGR 0568).

2.4 ABBREVATIONS

Abbreviation	Description
ARP	Alarm Response Procedure
BPS	Boiler Protection System
C&I	Control and Instrumentation
FD fan	Forced draft (secondary air) fan
FFP	Fabric Filter Plant
GT SM (Fleet)	Group Technology Senior Manager (Fleet)
ID fan	Induced draft fan
OEM	Original Equipment Manufacturer
PA fan	Primary air fan
PS	Power Station
PSM	Power Station Manager
RT&D	Research Test and Development
SM	Senior Manager

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2.5 ROLES AND RESPONSIBILITIES

Each PS is responsible to develop and implement the requirements described in this Standard to ensure that the boiler draught plant protection systems installed are managed such that the integrity of the equipment is ensured, and that it is available on demand to prevent major plant damage and loss of human life.

2.6 PROCESS FOR MONITORING

Compliance monitoring to this Standard will be via peer reviews and audits.

2.7 RECORDS

The following documentation shall be produced as a result of this Standard;

- The relevant PS shall compile a boiler draught plant protection philosophy document as required.
- The relevant PS shall maintain records that certify that proof tests and inspections were completed as required.

3. REQUIREMENTS

3.1 BOILER DRAUGHT PLANT PROTECTION PHILOSOPHY DOCUMENT

Each relevant PS shall compile and maintain a boiler draught plant protection philosophy document with the following content;

3.1.1 Front Cover

The cover shall include;

- The name of the PS.
- The relevant units at the PS. Where boiler draught plant on the same PS incorporate different protection philosophies, a separate document shall be compiled and authorised for each group of boiler draught plant. Where boiler draught plant use different trip limit values for the same protection function, both shall be specified and highlighted in the document.
- Acceptance, approval and authorisation signatures.
- Revision status of the document.

3.1.2 Protection Functions Implemented at the Subject PS

This section shall include all installed protection functions, which include the following information per protection function;

- Protection function description.
- Alarm and trip limit values, including any time delays applied.
- Testing requirements and frequency, both on- and off-load where applicable.
- Brief summary of the protection logic formation, actions initiated and degree of redundancy used to implement the protection function.
- Test reporting/ recording requirements.

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The section may be in the format of tables, functional logic diagrams, descriptive text or any other suitable means to adequately display the necessary information.

3.1.3 Plant information

Supporting information, for example OEM descriptions, drawings and other information may at the discretion of the PS Management be attached to the document as an Appendix.

3.2 BOILER DRAUGHT PLANT PROTECTION PHILOSOPHY DOCUMENT CONTROL

- The boiler draught plant protection philosophy document shall be compiled by the relevant PS Engineering department, approved by the PS Manager and authorised by the Group Technology SM (Fleet).
- Modifications to the PS boiler draught plant protection philosophy or trip limit value changes contained in the document shall be controlled as for Level 1 classified components.
- Modifications to alarm limit values of the respective protection functions may be revised through the relevant PS modification process; however these changes shall be recorded by amending the boiler draught plant protection philosophy document.
- Temporary changes to trip limit values shall be approved by the relevant PS Manager, but authorised by the Group Technology SM (Fleet) in terms of its Level 1 classification status. Implementation is controlled via the relevant PS temporary modification and out of normal processes.
- Temporary changes to alarm limit values shall be approved by the PS Engineering department with concurrence from the GTSM (Fleet) and controlled by the relevant PS out of normal process.
- The alarm and trip limit values, protection function mechanisms and levels of redundancy initially entered in the document shall be those existing on the plant at the time of compiling the boiler draught plant protection philosophy document. Any modification to this shall be processed only after authorisation of the initial document, through the above defined process.
- There may be individual isolated cases where existing plant does not require the stipulated protection function due to specific design characteristics. In this case the relevant PS Manager shall provide written motivation for non-compliance to the Group Technology SM (Fleet). This will then be reviewed and authorised by the Group Technology SM (Fleet) by means of a waiver.
- Where modification to existing equipment is required to meet the requirements of this Standard, a programme to implement will be agreed between the Group Technology SM(Fleet) and the relevant PS Manager. The Group Technology SM (Fleet) will issue an exemption for compliance as per the agreed programme.

3.3 GENERAL MANAGEMENT PRINCIPLES

Each protection function listed in this Standard shall incorporate predetermined values for alarm and boiler draught plant trip value limits. The alarm limit values should be set such that the warning functions shall direct the operator's attention towards the plant condition requiring timely assessment and response.

The following alarm management principles should be followed;

- Each alarm shall alert, inform and guide the operator.
- Every alarm shall have a defined response (alarm response procedure).
- Every alarm presented to the operator shall be useful and relevant to the operator.
- Adequate time shall be available for the operator to carry out the defined alarm response.

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All protection functions shall have documented procedures for testing. These procedures shall be used as a framework within which each PS shall establish test instructions, which must take local conditions and equipment technologies into account.

The boiler draught plant protection system is integrated with the unit control and automation system. The protection system shall accept plant protection input signals in a 2oo3, 2oo2, 1oo2 or 1oo1 selection configuration, depending on the measurement loop installation constraints and criticality requirements. It is important to note that the boiler draught plant is integrated with the boiler master trip. This philosophy will ensure that the fuel supply to the boiler has been effectively isolated and prevents the possibility of disastrous furnace conditions.

Each source of operation of the boiler draught plant trip shall actuate a “cause of trip” indication that informs the operator of the initiating cause of the tripping impulse.

3.4 PROTECTION FUNCTIONS

The following represents the minimum protection functions for fossil fired boiler draught plant. It further provides supportive information by capturing the intent and requirement of the respective protection functions;

3.4.1 Boiler protection function impacting on draught plant:

Furnace pressure protection

Both ID fans off

Both FD fans off

Both air heaters off

All mills tripped – then the PA fans shall trip

Air heater fire protection

3.4.2 ID Fans

3.4.2.1 Fan Lubricating oil pressure < minimum;

Intent: To protect the fan bearings against loss of lubrication.

Requirement: Initiate ID fan trip, which in turn shall initiate a draught group trip.

3.4.2.2 Fan bearing temperature > maximum (Fan and fan motor);

Intent: To protect the fan bearings and fan shaft journals against damage.

Requirement: Initiate ID fan trip, which in turn shall initiate a draught group trip

3.4.2.3 No flue gas flow path protection;

Intent: To protect the furnace and fan ducting from pressure disturbances due to a total loss of flue gas extraction.

Requirement: Initiate ID fan trip, which in turn shall initiate a draught group trip.

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3.4.2.4 FD Fan off;

Intent: To protect the furnace and fan ducting from under pressurisation due to a total loss of flue gas extraction. Further to protect the air heater against overheating.

Requirement: Initiate ID fan trip, which in turn shall initiate a draught group trip.

3.4.2.5 ID Fan bearing vibration protection;

Intent: To protect the IF fan rotating components against damage.

Requirement: Initiate ID fan trip, which in turn shall initiate a draught group trip.

3.4.2.6 ID Fan stall protection (Axial flow fans only)

Intent: To prevent structural damage of ID fans due to high frequency blade vibrations (stall). This requirement should also incorporate surge protection with fabric filter plant.

Requirement: Initiate ID fan trip, which in turn shall initiate a draught group trip

3.4.3 FD Fans

3.4.3.1 Fan Lubricating oil pressure < minimum;

Intent: To protect the fan bearings against loss of lubrication.

Requirement: Initiate fan trip, which in turn shall initiate a draught group trip.

3.4.3.2 Fan bearing temperature > maximum (Fan and fan motor);

Intent: To protect the fan bearings and fan shaft journals against damage.

Requirement: Initiate FD fan trip, which in turn shall initiate a draught group trip

3.4.3.3 No secondary air flow path protection;

Intent: To protect the furnace and fan ducting from pressure disturbances due to a total loss of secondary air supply.

Requirement: Initiate FD fan trip, which in turn shall initiate a draught group trip.

3.4.3.4 ID Fan off;

Intent: To protect the furnace and fan ducting from under pressurisation due to a total loss of flue gas extraction. Further to protect the air heater against overheating.

Requirement: Initiate FD fan trip, which in turn shall initiate a draught group trip.

3.4.3.5 Fan bearing vibration protection;

Intent: To protect the fan rotating components against damage.

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Requirement: Initiate FD fan trip.

3.4.3.6 Fan stall protection (Axial flow fans only)

Intent: To prevent structural damage of FD fans due to high frequency blade vibrations (stall). This function should be integrated with suction surge, where control dampers and steam pre-heaters are installed on the fan suction.

Requirement: Initiate fan trip, which in turn shall initiate a draught group trip.

3.4.4 PA Fans (PA fan per draught group)

3.4.4.1 All mill motors off;

Intent: To prevent structural damage of primary air ducting.

Requirement: If all mills are off, the PA fans are tripped.

3.4.4.2 Fan Lubricating oil pressure < minimum;

Intent: To protect the fan bearings against loss of lubrication.

Requirement: Initiate PA fan trip, which in turn shall initiate a PA fan trip.

3.4.4.3 Fan bearing temperature > maximum (Fan and fan motor);

Intent: To protect the fan bearings and fan shaft journals against damage.

Requirement: Initiate PA fan trip

3.4.4.4 No primary air flow path protection;

Intent: To protect the PA fan and primary air circuit against extended operation with no flow.

Requirement: Initiate PA fan trip.

3.4.4.5 Fan bearing vibration protection;

Intent: To protect the fan rotating components against damage.

Requirement: Initiate PA fan trip.

3.4.5 PA Fans (Dedicated PA fans)

3.4.5.1 Associated mill motor off;

Intent: To prevent PF carry-over / isolate fuel flow structural damage in primary air ducting.

Requirement: Mill off, trip associated PA fan.

3.4.5.2 Fan Lubricating oil pressure < minimum;

Intent: To protect the fan bearings against loss of lubrication.

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Requirement: Initiate PA fan trip.

3.4.5.3 Fan bearing temperature > maximum (Fan and fan motor);

Intent: To protect the fan bearings and fan shaft journals against damage.

Requirement: Initiate PA fan trip, which in turn shall initiate a draught group trip

3.4.6 Air Heater

3.4.6.1 Loss of air heater bearing lubrication (Alarm only);

Intent: To protect the air heater bearings against loss of lubrication.

Requirement: Initiate an alarm in the unit control room.

Note: The alarm may be based on low lubrication pressure or –flow

3.4.6.2 Air heater bearing temperature > maximum (Alarm only);

Intent: To protect the air heater bearings and shaft journals against damage.

Requirement: Operator action.

3.4.6.3 Air heater no rotation protection;

Intent: To protect the air heater and flue gas path against overheating due to the total loss of flue gas or air flow.

Requirement: Initiate ID fan trip, which in turn shall initiate a draught group trip.

Note: The alarm can be achieved by a no rotation signal or gas outlet high temperature signal. A time delay of max.10 minutes before trip may be used

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3.4.6.4 ID fan inlet gas temperature > maximum;

Intent: To prevent damage to air heater, FFP's, ID fans and ducting due to over temperature conditions.

Requirement: Trip associated draught group, but not air heaters.

Note: In most cases the protection settings and philosophies will be those of the relevant OEM at the time of construction.

4. TESTING

4.1 PROOF TESTING AND INSPECTION

The relevant PS shall prepare and implement a plan for the routine testing of the boiler draught plant protection system and respective protection functions, such that it cover the following aspects;

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- **Validation of the alarm and trip devices and settings:** Alarm and trip value settings and device calibration shall be validated as part of the off load simulated functional tests.
- **Off load simulated functional testing:** A full off load simulated functional test shall be performed as part of the re-commissioning of the protection system after a major outage or modification or repair to all or part of the boiler draught plant protection system. The periodicity of such tests shall however not exceed six years.
- **Inspections:** The protection system and devices shall be periodically visually inspected to ensure the integrity of the system and that there are no simulations, unauthorised modifications and no observable deterioration (for example, missing bolts or instrument covers, rusted brackets, open wires, broken conduits and missing insulation).

4.2 DOCUMENTATION OF PROOF TESTS AND INSPECTIONS

The relevant PS shall maintain records that certify that proof tests and inspections were completed as required. These records shall include the following information as a minimum;

- Description of the test and inspection performed.
- Dates of the tests and inspections.
- Name of the person(s) who performed the test and inspections.
- The plant code of the loop or system tested.
- Results of the tests and inspections.

5. AUTHORISATION

This document has been seen and accepted by:

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6. REVISIONS

Date	Rev.	Remarks
September 2011	0	Defined the minimum boiler draught plant protection requirements for fossil fired boilers in Eskom
September 2011	0.1	Draft under development
September 2011	0.2	Draft under development
September 2011	1	Final Revision

7 DEVELOPMENT TEAM

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