	Standard	Technology
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1. INTRODUCTION

In order to be certain that all governing and overspeed protection systems and valves are functioning properly and reliably, it is necessary to perform periodic tests to ensure that there is no malfunction, jamming or sticking on any part of the systems, mechanisms or valve spindles, and to confirm the protection devices' speed settings. This may involve quite different requirements for mechanical vs electronic systems, both of which are addressed in this document.

2. SUPPORTING CLAUSES

2.1 SCOPE

2.1.1 Purpose

This standard defines the frequency of routine overspeed and associated valve operability tests on operational steam turbine machines and the conditions under which those tests shall be carried out.

2.1.2 Applicability

The document is applicable to all main steam turbo-generators and boiler feed pump turbines, unless specifically noted in the text. This document shall apply throughout Eskom Holdings Limited Divisions.

2.2 NORMATIVE/INFORMATIVE REFERENCES

2.2.1 Normative

- [1] Occupational Health and Safety Act No 85 of 1993: General Machinery Regulations: Regulations 3(a) and (c)
- [2] 240-56176056 [Steam Turbine Care Standard](#)
- [3] 240-56063895 [Minimum Outage Inspection for Steam Turbines Standard](#)
- [4] 240-56030600 [Steam Turbine Unit Islanding, Load Rejection and Speed Control Verification Standard](#)
- [5] 240-56065041 Steam Turbine Life Assessment Guideline

2.2.2 Informative

None

2.3 DEFINITIONS

Definition	Description
Overspeed	A speed greater than the normal operating speed range of the turbine when offload under normal governor control.
Overspeed protection circuit	Includes all of the devices and systems, whether mechanical, hydraulic or electric, utilised in the isolation of the steam inlet valves from an overspeed trip.
Physical overspeed test	A test carried out to prove the operation and setting of the overspeed protection circuit, involving the actual increase of machine speed to the trip setting speed.
Routine test	A test conducted as part of the regularly scheduled program in accordance with this Standard. This excludes those tests conducted as a result of additional maintenance on the system according to 3.1.2 below.

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Definition	Description
Simulation test	A simulated overspeed trip device test conducted to verify the operation of the trip devices, typically by oil injection into mechanical trip device assembly or by frequency injection into electronic systems. This is normally an on-load test with tripping of the steam valves prevented.
Speed control equipment	All equipment and devices directly associated with the control of turbine speed.

2.3.1 Disclosure Classification

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

2.4 ABBREVIATIONS

Abbreviation	Description
BFPT	Boiler Feedpump Turbine
CoE	Centre of Excellence
GO	General Overhaul
OEM	Original Equipment Manufacturer
PEIC	Production Engineering Integration Coal
PSM	Power Station Manager
SIL 3	Safety Integrity Level 3
SM	Senior Manager

2.5 ROLES AND RESPONSIBILITIES

None

2.6 PROCESS FOR MONITORING

Monitoring and reporting form a part of the normal operational processes by evaluation of Ops log and incidents reports.

2.7 RELATED/SUPPORTING DOCUMENTS

None

3. STANDARD FOR ROUTINE OVERSPEED TESTING OF MAIN AND BOILER FEED PUMP STEAM TURBINES

3.1 REQUIREMENTS

3.1.1 BFPT Coupled Testing

The physical overspeed test may be carried out either coupled or uncoupled to the pumps. However, in the former case, such operation shall not give rise to unacceptable pressures in any pipework or equipment, and the pump OEM shall give his written approval of the procedure

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3.1.2 Frequency of Testing

Simulation (where applicable) and *physical overspeed tests* shall be conducted as stipulated below, **and after any significant adjustment or maintenance work on the overspeed protection circuit or speed control equipment, which has the potential to adversely affect the operation of these systems or equipment.** In the latter cases appropriate tests shall be carried out on the first return to service after the relevant work is completed. This testing shall be agreed by the relevant Power Station Engineering and Turbine Engineering Managers, and ensure that the correct and reliable operation of the equipment worked on is fully restored and proven.

All time intervals are calendar intervals.

Should an outage occur which prevents an overspeed test being conducted at the required time, it shall be carried out as soon as the machine is next returned to service **but within the specified test frequency below:**

3.1.2.1 Machines equipped with on-load test facilities

- a. Simulation tests shall be conducted at least monthly and routine physical overspeed tests conducted **annually** unless the requirements in 3.1.2.1 below are met.
- b. The period determined above for carrying out **routine** physical overspeed tests on a specific machine may be extended by the Power Station Manager (PSM) provided that:
 - the records indicate that for at least the last two tests on that machine, the obtained speed values have been consistent. Where no adjustment of the trip devices has occurred between tests, the difference between subsequent speed values should be less than 2% of rated speed and within the limits defined in 3.1.4 below.
 - approval is obtained from the PEIC Senior Manager (SM),

However, under no circumstances shall the amended period between tests exceed 2 years.

Should an inconsistent result be obtained following this the periodicity shall revert to that in 3.1.2.1 above: i.e. annually.

3.1.2.2 Machines not equipped with on-load test facilities

Physical overspeed tests shall be conducted at least every 6 months.

3.1.2.3 Machines equipped with electronic overspeed trip systems with facility for electronic testing of speed trip settings

Simulation tests shall be conducted at least monthly.

Physical overspeed test shall by default be carried out as per 3.1.2.1 above. However, frequency may be greatly reduced **subject to prior review and approval of the system by the PEIC SM** or his appointed representative, to ensure adequate integrity and reliability of testing. **The attached Checksheet (Appendix A) shall be used for this review and incorporates the detailed requirements for compliance,** the summarised principal components of which are:

- a. The documented approval of the OEM is obtained
- b. Detailed procedures for testing of the complete circuit (i.e. electronic + hydraulic + mechanical etc), with periodic simulation testing

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- c. Minimal (preferably none) intervention in the system to perform the test, to eliminate the risk of failing to return the system or settings to the normal operating condition.
- d. A SIL 3 certified overspeed protection circuit is installed.

If the above approval is granted then the subsequent minimum frequency of carrying out physical overspeed tests **for every machine** shall be:

- e. Once during first commissioning after initial installation of the new electronic system
- f. At least at every GO, i.e. every 5-6 years, thereafter

Note, however, that these tests may be carried out at reduced speed subject to verification by the review in 3.1.2.3 above

3.1.3 Preconditions for physical overspeed tests

- a. All physical overspeed tests shall be immediately preceded by a simulation test (where the machine is so equipped) to prove the basic operation of the protection devices before stressing the component;
- b. The machine must be in a smooth operating condition with operating parameters within limits recommended by the OEM, hydrogen in the generator for hydrogen-cooled machines, and no known or suspected major defects in rotating components;
- c. If a fault exists (indicated by system diagnostics) in the speed measuring control and protection system, testing is not permitted and the fault shall be corrected;
- d. Speed measurement during a physical overspeed event shall be obtained from an independent, calibrated speed indicator, unless a recently calibrated digital speed indicator is fitted.

3.1.4 Results of tests

3.1.4.1 Main turbo-generators

- a. No machine may be allowed to exceed a speed of 115% of its rated speed at any time;
- b. Overspeed trip settings shall be as near as possible to 110%, and must be between 108% and 112% of rated speed.

3.1.5 BFPTs

- a. The settings and tolerances for overspeed protection, and the maximum speed allowable (should the protection not operate during a test) shall be as specified in writing by the OEM. However, the test tolerance on setting shall not exceed 2 % of the required value.

3.1.6 Unsuccessful Tests

- a. In the event that on-load test results fail to meet specifications, the Power Station Engineering Manager shall be informed as soon as possible and physical overspeed testing stopped until urgent remedial work can be carried out. Should this require any deviation from the requirements of this Standard, a Variation must be obtained (see 3.1.7 below). A failure of the simulation test on an overspeed trip device shall be considered a failure of the device for the purposes of this Standard.

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- b. Should any overspeed device fail to operate within the required limits, the Power Station Engineering Manager shall be informed as soon as possible.

If only one overspeed device is installed, the machine shall immediately be carefully taken out of service until the fault has been remedied.

If more than one device is installed and one fails, the machine may remain in service provided remedial work is carried out within four weeks and daily simulation tests are carried out to prove the effectiveness of the remaining device. Should both devices fail, the machine shall immediately be carefully taken out of service until the fault has been remedied.

If an electronic system with three channels is installed and one channel fails, the machine may remain in service provided remedial work is carried out within four weeks and daily simulation tests are carried out to prove the effectiveness of the remaining device. The system shall revert automatically to a '1-out-of-2' trip philosophy. If two or more channels fail, the machine shall immediately be carefully taken out of service until the fault has been remedied.

3.1.7 Waivers and Variations

- a. The PSM may postpone a **specific individual routine** physical test on a machine for a maximum period of 28 days for machines with on-load test facilities, provided that a machine outage has been planned to take place commencing within that time and that the test is carried out during the outage or during return to service after the outage.

Note that this postponement is for **one specific routine test on one machine**, and does not require previous successful testing history. It is intended to provide some flexibility in outage date to perform the test. In contrast the postponement in par. 3.1.2.1 (b) is for all future routine tests on one machine, and is subject to previous and continuing successful test history. This is intended to reduce the demanding physical tests on machines with demonstrated successful test history.

- b. Any other waivers or variations to this Standard shall be motivated by the PSM and approved by the PEIC SM or his appointed representative.
- c. If a waiver is agreed, the new test date can form the basis for future test dates.

3.2 RECORDS

Detailed records of all overspeed test results, both simulated and physical, and of all waivers and variations, shall be kept at the power station for audit purposes.

4. AUTHORISATION

This document has been seen and accepted by:

Name & Surname	Designation
N.P. Lecordier	Senior Consultant (Steam Turbines)
K. Sukhnandan	Manager (Acting):Turbine Plant CoE
V. Pather	Senior Manager: Power Plant
J. Roy-Aikins	Chairman: Turbine Study Committee

5. REVISIONS

Date	Rev.	Compiler	Remarks
November 2012	0.1	N. Lecordier Senior Consultant (Steam Turbines)	Draft document for Review created from GST 36-739
February 2013	1	N. Lecordier Senior Consultant (Steam Turbines)	Final submitted for approval
June 2016	2	N. Lecordier Senior Consultant (Steam Turbines)	Final Rev 2 for Authorisation and Approval after Review Date Extension

6. DEVELOPMENT TEAM

- None


7. ACKNOWLEDGEMENTS

- None

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APPENDIX A: CHECK SHEET FOR THE EVALUATION OF ELECTRONIC TURBINE OVERSPEED SYSTEMS

	CHECK SHEET FOR THE EVALUATION OF ELECTRONIC TURBINE OVERSPEED SYSTEMS		
REFERENCE NONE	REV 0	DATE	CLASSIFICATION CONTROLLED DISCLOSURE
STATUS		DOCUMENT TYPE CHECK SHEET	DISCIPLINE TURBINE/ PROCESS CONTROL
DISTRIBUTION: Turbine Corporate Specialist (Acting) Process Control Corporate Consultant			COMPILED BY: Noel Lecordier Koos Veldman

PURPOSE

The purpose of the check sheet is to provide a structured approach for the evaluation of electronic overspeed protection systems in discrete construction technology. Full system compliance to the requirements contained in the check sheet is regarded as the basis on which approval is granted to relax physical overspeed testing.

APPLICABILITY

The check sheet applies to the turbine overspeed protection system, which represents only one of the three components making-up the turbine speed system, and testing requirements of the complete system. The structure of the turbine speed system is defined in the Table 1;

COMPONENTS	TASK
Speed Monitoring	Speed monitoring of the turbine during turning gear operation, start-up, synchronisation, operation and shut-down.
Speed Limiting	Speed controller (normally redundant) to record and eliminate any unfavourable operating states of the turbine plant without interrupting the turbine operation.
Speed Protection	Overspeed protection shall stop the turbine itself as soon as operating states occur which will endanger the turbine. The protection device against overspeed close all emergency safety valves quickly enough to ensure that the turbine speed does not exceed the maximum permissible speed of the turbo-set.

Table 1 : Turbine Speed System

REQUIREMENT

Electronic overspeed protection systems can be implemented in discrete construction. Eskom has adopted the characteristics and guidelines for operation of these systems as described in VGB Guideline R 103 M;

- Chapter 6.1.3.5 for systems with discrete components

Note that Eskom does not support electronic overspeed protection systems with programmable technology.

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In addition to the requirements defined in the VGB guideline, an internal decision was taken after the protections reviews by FM Global at the time that all future overspeed system shall be certified to an Safety Integrity Level 3 (SIL 3)

The Eskom overspeed system requirement is defined as;

The turbine overspeed protection is an independent SIL 3 certified system in accordance with IEC 61508 Standard, integrated in the turbine protection system. As a minimum four speed measurement probes and measuring wheel installed directly on the turbine shaft are provided, of which three of the speed probes are operational and one standby. The overspeed trip signal is based on three channels with a 2-o-o-3 voting trip block which trips the turbine directly. The system is designed such that no physical over speed testing is required as per the VGB R 103M Guideline.

Records

The following section must be completed by the reviewer of the system, and will serve as the record of compliance for the system under review.

Plant Data;

Power Station : -----

Unit Number/s : -----

Plant Area (Main Turb and/or BFPT) : -----

Date : -----

Review Team;

Station : _____

Turbine CoE : _____

Others : _____

Conclusion (Review Result):

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