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This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

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Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/ Figure/Table/Note	Type of comment	Comment (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	



5/278/CD

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SECRETARIAT: China	SECRETARY: Mr Chang Fu
OF INTEREST TO THE FOLLOWING COMMITTEES:	HORIZONTAL FUNCTION(S):
ASPECTS CONCERNED: Energy Efficiency	

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TITLE:

Rules for steam turbine thermal acceptance tests - Part 1: High accuracy for large condensing steam turbines

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Resource materials

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- OSD NC roles overview: [here](#)
- How to add and submit comments to the IEC: [here](#)

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CONTENTS

FOREWORD	8
INTRODUCTION	10
1 Scope	11
1.1 General	11
1.2 Object	11
1.3 Matters to be considered in the contract	11
2 Normative references	12
3 Units, symbols, terms and definition	12
3.1 General	12
3.2 Symbols, units	12
3.3 Subscripts, superscripts and definitions	12
3.4 Guarantee parameters	12
3.4.1 Guidance on guarantee parameters	12
3.4.2 Thermal efficiency	12
3.4.3 Heat rate	12
3.4.4 Thermodynamic efficiency	12
3.4.5 Steam rate	12
3.4.6 Main steam flow capacity	12
3.4.7 Power output	12
3.4.8 Guarantee values for extraction and mixed-pressure turbines	12
3.4.9 Thermal Load Capacity (for Nuclear applications)	12
4 Guiding principles	13
4.1 Advance planning for test	13
4.2 Preparatory agreements and arrangements for tests	13
4.3 Planning of the test	14
4.3.1 Time for acceptance tests	14
4.3.2 Direction of acceptance tests	14
4.4 Preparation of the tests	14
4.4.1 Condition of the plant	14
4.4.2 Condition of the steam turbine	14
4.4.3 Condition of the condenser	14
4.4.4 Isolation of the cycle	14
4.4.5 Checks for leakage of condenser and feed water heaters	17
4.4.6 Cleanliness of the steam strainers	17
4.4.7 Checking of the test measuring equipment	17
4.5 Comparison measurements	17
4.5.1 General	17
4.5.2 Reduced uncertainty for comparison measurements	17
4.6 Settings for test	17
4.6.1 Load settings	17
4.6.2 Special settings	17
4.7 Preliminary tests	17
4.8 Acceptance tests	17
4.8.1 Constancy of test conditions	17

4.8.2	Maximum deviation and fluctuation in test conditions	18
4.8.3	Duration of test runs and frequency of readings	19
4.8.4	Reading of integrating measuring instruments	19
4.8.5	Alternative methods	19
4.8.6	Recording of tests	19
4.8.7	Additional measurement	19
4.8.8	Preliminary calculations	19
4.8.9	Consistency and number of tests	19
4.9	Repetition of acceptance tests	20
5	Measuring techniques and measuring instruments	20
5.1	Overview	20
5.1.1	Instrument accuracy requirements	20
5.1.2	Measuring instruments	21
5.1.3	Measuring uncertainty	21
5.1.4	Calibration of instruments	21
5.1.5	Alternative instrumentation	22
5.2	Measurement of power	22
5.2.1	Determination of mechanical turbine output	22
5.2.2	Measurement of boiler feed pump power	22
5.2.3	Determination of electrical power of a turbine generator	22
5.2.4	Measurement of electrical power	22
5.2.5	Electrical instrument connections	22
5.2.6	Electrical instruments	22
5.2.7	Instrument transformers	23
5.2.8	recalibration of instruments and transformers	23
5.3	Flow measurement	23
5.3.1	Determination of flows to be measured	23
5.3.2	Measurement of primary flow	23
5.3.3	Installation and location of flow measuring devices	25
5.3.4	Calibration of primary flow devices for water flow	25
5.3.5	Inspection of flow measuring devices	26
5.3.6	Differential pressure measurements	27
5.3.7	Water flow fluctuation	27
5.3.8	Secondary flow measurements	27
5.3.9	Occasional secondary flows	27
5.3.10	Density of water and steam	28
5.3.11	Determination of cooling water flow of condenser	28
5.4	Pressure measurement (excluding condensing turbine exhaust pressure)	28
5.4.1	Pressures to be measured	28
5.4.2	Instruments	28
5.4.3	Main pressure measurements	28
5.4.4	Pressure tapping holes and connecting lines	28
5.4.5	Shut-off valves	28
5.4.6	Calibration of pressure measuring devices	29
5.4.7	Atmospheric pressure	29
5.4.8	Correction of readings	29
5.5	Condensing turbine exhaust pressure measurement	29
5.5.1	General	29

5.5.2	Plane of measurement	29
5.5.3	Pressure taps	29
5.5.4	Manifolds	30
5.5.5	Connecting lines	30
5.5.6	Instruments	31
5.5.7	Calibration.....	31
5.6	Temperature measurement.....	31
5.6.1	Points of temperature measurement.....	31
5.6.2	Instruments	31
5.6.3	Main temperature measurements	31
5.6.4	Feed train temperature measurements (including bled steam)	31
5.6.5	Condenser cooling water temperature measurement	31
5.6.6	Thermometer wells	31
5.6.7	Precautions to be observed in the measurement of temperature	31
5.7	Steam quality determination	31
5.7.1	General	31
5.7.2	Tracer technique	32
5.7.3	Condensing method	32
5.7.4	Constant rate injection method	32
5.7.5	Extraction enthalpy determined by constant rate injection method	32
5.7.6	Tracers and their use	32
5.8	Time measurement.....	32
5.9	Speed measurement.....	32
6	Evaluation of tests.....	32
6.1	Preparation of evaluation.....	32
6.2	Computation of results.....	33
6.2.1	Calculation of average values of instrument readings	33
6.2.2	Correction and conversion of averaged readings	33
6.2.3	Checking of measured data	33
6.2.4	Thermodynamic properties of steam and water	33
6.2.5	Calculation of test results	33
7	Correction of test results and comparison with guarantee	33
7.1	Guarantee values and guarantee conditions	33
7.2	Correction of initial steam flow capacity	33
7.3	Correction of output.....	34
7.3.1	Correction of maximum output.....	34
7.3.2	Correction of Output with specified initial steam flow	34
7.4	Correction of the thermal performance	34
7.5	Definition and application of correction values	34
7.6	Correction methods	34
7.6.1	General	34
7.6.2	Correction by heat balance calculation	34
7.6.3	Correction by use of correction curves prepared by the manufacturer.....	34
7.6.4	Tests to determine correction values	34
7.7	Variables to be considered in the correction of specific turbine cycles	34
7.7.1	Scope of corrections	34
7.7.2	Turbines with regenerative feed-water heating	34

7.7.3	Turbines which have no provision for the addition or extraction of steam after partial expansion	34
7.7.4	Turbines with steam extraction for purposes other than feed-water heating (extraction turbines)	34
7.7.5	Other types of turbine	34
7.8	Guarantee comparison	34
7.8.1	Tolerance and weighting	34
7.8.2	Guarantee comparison with locus curve	35
7.8.3	Guarantee comparison with guarantee point	35
7.8.4	Guarantee comparison for turbines with throttle governing	35
7.8.5	Guarantee comparison for extraction turbines	35
7.9	Deterioration of turbine performance (ageing)	35
7.9.1	Timing to minimise deterioration	35
7.9.2	Correction with comparison tests	35
7.9.3	Correction without comparison tests	35
8	Measuring uncertainty	35
8.1	General	35
8.2	Determination of measuring uncertainty of steam and water properties	35
8.2.1	Pressure	35
8.2.2	Temperature	36
8.2.3	Enthalpy and enthalpy difference	36
8.3	Calculation of measuring uncertainty of output	36
8.3.1	Electrical measurement	36
8.3.2	Mechanical measurement	36
8.3.3	Additional uncertainty allowance because of unsteady load conditions 36	
8.4	Determination of measuring uncertainty of mass flow	36
8.4.1	Measuring uncertainty of mass flow measurements	36
8.4.2	Measuring uncertainty of multiple measurements of primary flow	36
8.4.3	Uncertainty allowance for cycle imperfections	36
8.5	Calculation of measuring uncertainty of results	36
8.5.1	General	36
8.5.2	Measuring uncertainty of thermal efficiency	36
8.5.3	Measuring uncertainty of thermodynamic efficiency	36
8.5.4	Uncertainty of corrections	36
8.5.5	Guiding values for the measuring uncertainty of results	36
8.6	Example uncertainty calculation	37
Annex A (normative)	Feedwater heater leakage and condenser leakage tests	41
A.1	Feedwater heater leakage tests	41
A.2	Condenser leakage tests	41
Annex B (normative)	Evaluation of multiple measurements, compatibility	42
Annex C (normative)	Mass flow balances	43
C.1	Multiple mass balances (normative)	43
C.2	Flows for further evaluations (informative)	43
Annex D (informative)	Short-statistical definition of measuring uncertainty and error propagation in acceptance test	44
Annex E (informative)	Temperature variation method	45
E.1	Description of the problem	45

E.2	Possibility to determine the leakage flow	45
E.3	Applied example	45
Bibliography		46
Figure 1 – typical configuration of a flow section with an orifice and a throat tap nozzle and flow straightener		24
Figure 2 – Basket tip		30
Figure 3 – Guide plate		30
Table 1 – Maximum deviations and fluctuations in operating conditions		18
Table 2 – Recommended uncertainties of measured variables		20
Table 3 – Apportionment of unaccounted leakages		33
Table 4 – Guiding values for the uncertainty of test results		37
Table 5 – Example uncertainty calculation for reheat cycle with calibrated primary flows measurements		37
Table 6 – Example uncertainty calculation for wet nuclear cycle with calibrated primary flow measurement		39

INTERNATIONAL ELECTROTECHNICAL COMMISSION

Rules for steam turbine thermal acceptance tests - Part 1: High accuracy for large condensing steam turbines –

FOREWORD

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IEC 60953-1 has been prepared by subcommittee WG11/MT14: Thermal Acceptance Test, of IEC technical committee TC 5: Steam turbines. It is an International Standard.

This second edition cancels and replaces the first edition published in 1990. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) ...;

The text of this International Standard is based on the following documents:

Draft	Report on voting
XX/XX/FDIS	XX/XX/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

This part of IEC 60953 is to be read in conjunction with IEC 60953-0:2022, and the words 'high accuracy acceptance test' should be read in place of 'acceptance test' IEC 60953-0:2022 is taken as a Reference Standard.

A list of all parts in the IEC 60953 series, published under the general title *Rules for steam turbine thermal acceptance tests*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

INTRODUCTION

Following the publication of the Reference Standard IEC 60953-0:2022 it was considered necessary to draw up a Supplementary Standard (this document) for guidance on the thermal acceptance tests where a high degree of accuracy is required replacing the first edition of IEC 60953-1:1990.

However, a large number of the provisions and recommendations of IEC 60953-0:2022 are still applicable and, therefore, in order to avoid a repetitive and bulky document, only the high accuracy-specific addenda will be found in this document.

Although this document is intended to apply to large condensing steam turbines, it can nevertheless be used for other types and sizes of turbines to define the basis of a specific procedure to be agreed upon by the parties involved.

The structure and clause numbering of this document follow that of IEC 60953-0:2022. Subclauses found in this document supersede the whole of the equivalent subclause in IEC 60953-0:2022. Subclause numbering has been extended whenever new items have been included.

The main differences between this document and IEC 60953-0:2022 are listed below.

Clause 1: Scope

This document provides for very accurate testing of steam turbines to obtain the level of performance with minimum test uncertainty. The operating conditions during the test are stringent and compulsory.

This document is based on the exclusive use of the most accurate calibrated instrumentation and the best measuring procedures currently available. The test uncertainty shall not be larger than 0.3 % for a fossil fired unit and 0.4 % for a nuclear unit. To motivate both parties to achieve the highest accuracy possible it is recommended that the test uncertainty is not considered in the comparison between test result and guarantee value unless otherwise agreed in the contract.

These criteria must be met to achieve a code compliant test.

Clause 4: Guiding principles

This document gives further guidelines on the timing of the tests, the test isolation and necessary secondary flow measurements, the test duration and allowable test conditions.

Clause 5 Measuring techniques and measuring instruments

This document gives further advice regarding instrument accuracy and calibration requirements with the aim to reduce the overall measurement uncertainty. A particular focus is given to the selection, installation and inspection of primary power and flow meters.

Clause 6 Evaluation of tests

This document gives further advice on the evaluation of the test results, test isolations and allowable cycle leakages.

Clause 8 Measuring uncertainty

This document gives further guidance on reducing the overall test measurement uncertainty.

Rules for steam turbine thermal acceptance tests - Part 1: High accuracy for large condensing steam turbines –

1 Scope

1.1 General

This part of IEC 60953 establishes a Supplementary Standard for thermal verification tests for high accuracy for large condensing steam turbines.

The rules given in this document follow the guidance given in IEC 60953-0:2022 , but contain amendments and supplements regarding guarantees and verification of the guarantees for high accuracy thermal acceptance tests.

The rules given in this document are applicable primarily to thermal acceptance tests with high accuracy for large condensing steam turbines for power generation applications. It can nevertheless be used for other types and sizes of turbines to define the basis of a specific procedure to be agreed upon by the parties involved. Only the relevant portion of these rules will apply to any individual case.

The rules provide for the testing of turbines, whether operating with either superheated or saturated steam.

Uniform rules for the preparation, carrying out, evaluation, comparison with guarantee and calculation of measuring uncertainty of acceptance tests are defined in this standard. Details of the conditions under which the acceptance test shall take place are included.

Should any complex or special case arise which is not covered by these rules, appropriate agreement shall be reached by manufacturer and purchaser before the contract is signed.

1.2 Object

The purpose of the thermal acceptance tests of steam turbines and turbine cycles described in this document is to verify guarantees given by the manufacturer of the equipment concerning the following parameters.

Efficiency guarantees:

- a) Thermal efficiency,
- b) Heat rate,
- c) Power output.

Capacity guarantees:

- d) Maximum power output at specified steam conditions according to [IEC 60045-1:2020 \[1\]](#) (other than steam flow),
- e) Nuclear: thermal load capacity of the steam turbine under defined conditions.

The guarantees with their provisions are formulated completely and without contradictions (see **Error! Reference source not found.**). The acceptance tests may also include such measurements as are necessary for corrections according to the conditions of the guarantee and checking of the results.

1.3 Matters to be considered in the contract

Subclause 1.3 of IEC 60953-0:2022 applies.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60953-0:2022, *Rules for steam turbine thermal acceptance tests - Part 0: Wide range of accuracy for various types and sizes of turbines*

IEC 60953-1:1990, *Rules for steam turbine thermal acceptance tests. Part 1: Method A - High accuracy for large condensing steam turbines*

3 Units, symbols, terms and definition

Subclause of IEC 60953-0:2022, 3.0 applies.

3.1 General

Subclause of IEC 60953-0:2022, 3.1 applies.

3.2 Symbols, units

Subclause of IEC 60953-0:2022, 3.2 applies.

3.3 Subscripts, superscripts and definitions

Subclause of IEC 60953-0:2022, 3.3 applies.

3.4 Guarantee parameters

3.4.1 Guidance on guarantee parameters

Subclause of IEC 60953-0:2022, 3.4.1 applies.

3.4.2 Thermal efficiency

Subclause of IEC 60953-0:2022, 3.4.2 applies.

3.4.3 Heat rate

Subclause of IEC 60953-0:2022, 3.4.3 applies.

3.4.4 Thermodynamic efficiency

Subclause of IEC 60953-0:2022, 3.4.4 is not applicable.

3.4.5 Steam rate

Subclause of IEC 60953-0:2022, 3.4.5 is not applicable.

3.4.6 Main steam flow capacity

Subclause of IEC 60953-0:2022, 3.4.6 is not applicable.

3.4.7 Power output

Subclause of IEC 60953-0:2022, 3.4.7 applies.

3.4.8 Guarantee values for extraction and mixed-pressure turbines¹

Subclause of IEC 60953-0:2022, 3.4.8 is not applicable.

3.4.9 Thermal Load Capacity (for Nuclear applications)

Subclause of IEC 60953-0:2022, 3.4.9 applies.

¹ Mixed pressure turbines - several inlets at different pressures during the expansion.

4 Guiding principles

4.1 Advance planning for test

The parties to any test under these rules shall reach agreement, when the plant is being designed, as to the testing procedure, the interpretation of guarantees, the number, location and arrangement of measuring points and measuring devices, valves and piping arrangements. This especially applies to steam turbines in nuclear power stations where subsequent modifications are often impracticable and the measuring points are not always accessible once the plant has started to operate. It is recommended that for the most important measurements special connection facilities such as flanges and thermometer wells be provided for the measuring equipment so that the acceptance tests can be carried out without impairing the instruments for normal operation.

The instrumentation has to be selected in such a way that power and heat flows which enter and leave the "system", as defined in the contract, and the conditions at its boundaries, can be determined. It is the responsibility of the steam turbine supplier to propose the required accuracy of all instrumentation including that which is supplied by others.

By testing in accordance with this document the parties interested in the test agree to achieve a high accuracy test by:

- a) Improving instrument accuracy and calibration
- b) Minimise deviations from guarantee reference conditions
- c) Minimise cycle deviations from design intent including cycle imperfections and internal and external leakages
- d) Minimise fluctuations of the plant operating conditions
- e) Minimise the operating time before the test is conducted

The following is a list of typical items upon which agreement should be reached during the plant design:

- f) Type and location of the primary and secondary flow measuring devices upon which the test calculations are based, considering the upstream and downstream piping arrangements including flow straightening devices and in relation to the sensitivity of the measured flow to the test result.
- g) Number and location of valves required to ensure as far as practicable that no unaccounted-for flow enters or leaves the test cycle or bypasses any cycle component. In a nuclear plant there may be some make-up line or emergency valving that cannot be isolated and for which the method of accounting the leakage has to be agreed.
- h) Number and location of temperature wells and pressure connections required to ensure correct measurements at all measurement points.
- i) Number of multiple instrument connections required to improve the accuracy for high sensitivity test points.
- j) Handling of leak-off flows to avoid complications in testing or the introduction of errors.
- k) Means of measuring pump shaft leakages, if necessary.
- l) Method of determining steam quality, including sampling technique as required. The recommended methods are given in the RS.
 - 1) Method in order to determine steam turbine internal leakage flows has to be defined and agreed by both parties considering the sensitivity of the internal leakage to the test result (direct measurement, values determined from the heat balance diagram or conducting a temperature variation test see RS).

4.2 Preparatory agreements and arrangements for tests

Subclause of IEC 60953-0:2022, 4.2 applies.