



PRE-RELEASE VERSION (FDIS)

Rules for steam turbine thermal acceptance tests – Part 3: Thermal performance verification tests of retrofitted steam turbines

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Attention IEC-CENELEC parallel voting

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TITLE:

Rules for steam turbine thermal acceptance tests - Part 3: Thermal performance verification tests of retrofitted steam turbines

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CONTENTS

FOREWORD.....	8
INTRODUCTION.....	10
1 Scope.....	13
1.1 General.....	13
1.2 Object.....	13
1.3 Matters to be considered in the contract	13
2 Normative references	13
3 Units, symbols, terms and definitions.....	14
3.1 General.....	14
3.2 Symbols, units	14
3.3 Subscripts, superscripts and definitions	14
3.4 Guarantee parameters	16
3.4.1 Guidance on guarantee parameters	16
3.4.2 Thermal efficiency	16
3.4.3 Heat rate	16
3.4.4 Thermodynamic efficiency	16
3.4.5 Steam rate.....	16
3.4.6 Main steam flow capacity.....	16
3.4.7 Power output	16
3.4.8 Guarantee values for extraction and mixed-pressure turbines	16
3.4.9 Thermal Load Capacity (for Nuclear applications).....	16
3.5 Additional guarantee parameters	16
3.5.1 General	16
3.5.2 Cylinder isentropic efficiency – expansion in superheated region.....	16
3.5.3 Cylinder isentropic efficiency – expansion involving wet region.....	17
3.5.4 Pressure loss.....	19
3.5.5 Flow-passing capacity (FPC)	19
4 Guiding principles.....	19
4.1 Advance planning for test.....	19
4.2 Preparatory agreements and arrangements for tests	20
4.3 Planning of the test.....	20
4.3.1 Time for verification tests.....	20
4.3.2 Direction of acceptance tests.....	21
4.4 Preparation of the tests.....	21
4.4.1 Condition of the plant.....	21
4.4.2 Condition of the steam turbine	22
4.4.3 Condition of the condenser	22
4.4.4 Isolation of the cycle.....	22
4.4.5 Checks for leakage of condenser and feed water heaters	22
4.4.6 Cleanliness of the steam strainers	22
4.4.7 Checking of the test measuring equipment	22
4.5 Comparison measurements.....	22
4.6 Settings for test	23
4.6.1 Load settings	23
4.6.2 Special settings	23

4.7	Preliminary tests	23
4.8	Acceptance tests	23
4.8.1	Constancy of test conditions	23
4.8.2	Maximum deviation and fluctuation in test conditions	23
4.8.3	Duration of test runs and frequency of reading	23
4.8.4	Reading of integrating measuring instruments	23
4.8.5	Alternative methods	23
4.8.6	Recording of tests	23
4.8.7	Additional measurement	23
4.8.8	Preliminary calculations	23
4.8.9	Consistency and number of tests	24
4.9	Repetition of acceptance tests	24
4.10	Guidance on retrofit guarantees	24
4.10.1	General	24
4.10.2	Absolute guarantees	25
4.10.3	Relative guarantees	26
5	Measuring techniques and measuring instruments	27
5.1	Overview	27
5.1.1	Instrument accuracy requirements	27
5.1.2	Measuring instruments	27
5.1.3	Measuring uncertainty	27
5.1.4	Calibration of instruments	27
5.1.5	Alternative instrumentation	27
5.1.6	Consistency of pre- and post-retrofit tests	27
5.2	Measurement of power	27
5.2.1	Determination of mechanical turbine output	27
5.2.2	Measurement of boiler feed pump power	27
5.2.3	Determination of electrical power of a turbine generator	28
5.2.4	Measurement of electrical power	28
5.2.5	Electrical instrument connections	28
5.2.6	Electrical instruments	28
5.2.7	Instrument transformers	28
5.2.8	Determination of electrical power of pre- and post-retrofit tests	28
5.3	Flow measurement	28
5.3.1	Determination of flows to be measured	28
5.3.2	Measurement of primary flow	29
5.3.3	Installation and location of flow measuring devices	29
5.3.4	Calibration of primary flow devices for water flow	29
5.3.5	Inspection of flow measuring devices	29
5.3.6	Differential pressure measurements	30
5.3.7	Water flow fluctuation	30
5.3.8	Secondary flow measurements	30
5.3.9	Occasional secondary flows	31
5.3.10	Density of water and steam	31
5.3.11	Determination of cooling water flow of condenser	31
5.4	Pressure measurement (excluding condensing turbine exhaust pressure)	31
5.4.1	Pressures to be measured	31
5.4.2	Instruments	31
5.4.3	Main pressure measurements	31

5.4.4	Pressure tapping holes and connecting lines	31
5.4.5	Shut-off valves.....	32
5.4.6	Calibration of pressure measuring devices.....	32
5.4.7	Atmospheric pressure	32
5.4.8	Correction of readings	32
5.5	Condensing turbine exhaust pressure measurement	32
5.5.1	General	32
5.5.2	Plane of measurement.....	32
5.5.3	Pressure taps	32
5.5.4	Manifolds.....	32
5.5.5	Connecting lines	32
5.5.6	Instruments	32
5.5.7	Calibration.....	32
5.6	Temperature measurement	33
5.6.1	Points of temperature measurement	33
5.6.2	Instruments	33
5.6.3	Main temperature measurements.....	33
5.6.4	Feed train temperature measurements (including bled steam)	33
5.6.5	Condenser cooling water temperature measurement	33
5.6.6	Thermometer wells	33
5.6.7	Precautions to be observed in the measurement of temperature	33
5.7	Steam quality determination.....	33
5.7.1	General	33
5.7.2	Tracer technique.....	33
5.7.3	Condensing method.....	33
5.7.4	Constant rate injection method	33
5.7.5	Extraction enthalpy determined by constant rate injection method	33
5.7.6	Tracers and their use.....	34
5.7.7	Use of tracer techniques in retrofit applications	34
5.8	Time measurement	34
5.9	Speed measurement.....	34
6	Evaluation of tests	34
6.1	Preparation of evaluation	34
6.2	Computation of results	35
6.2.1	Calculation of average values of instrument readings	35
6.2.2	Correction and conversion of averaged readings	35
6.2.3	Checking of measured data	35
6.2.4	Thermodynamic properties of steam and water	36
6.2.5	Calculation of test results	36
7	Corrections of test results and comparison with guarantee	39
7.1	Guarantee values and guarantee conditions	39
7.1.1	Guarantee values and guarantee conditions specific to retrofits.....	39
7.2	Correction of initial steam flow capacity	40
7.3	Correction of output	40
7.3.1	Correction of maximum output	40
7.3.2	Correction of Output with specified initial steam flow	40
7.4	Correction of the thermal performance	40
7.5	Definition and application of correction values	40
7.6	Correction methods.....	40

7.6.1	General	40
7.6.2	Correction by heat balance calculation	40
7.6.3	Correction by use of correction curves prepared by the manufacturer	41
7.6.4	Tests to determine correction values	41
7.7	Variables to be considered in the correction of specific turbine cycles.....	41
7.7.1	Scope of corrections	41
7.7.2	Turbines with regenerative feed-water heating.....	41
7.7.3	Turbines which have no provision for the addition or extraction of steam after partial expansion	41
7.7.4	Turbines with steam extraction for purposes other than feed-water heating (extraction turbines)	41
7.7.5	Other types of turbine	41
7.8	Guarantee comparison.....	41
7.8.1	Tolerance and weighting.....	41
7.8.2	Guarantee comparison with locus curve.....	41
7.8.3	Guarantee comparison with guarantee point	41
7.8.4	Guarantee comparison for turbines with throttle governing.....	41
7.8.5	Guarantee comparison for extraction turbines.....	41
7.8.6	Additional consideration for retrofit guarantee comparison.....	42
7.9	Deterioration of turbine performance (ageing).....	42
7.9.1	Timing to minimise deterioration	42
7.9.2	Correction with comparison tests	42
7.9.3	Correction without comparison tests	42
7.9.4	Deterioration of performance of retrofitted components.....	42
8	Measuring uncertainty	43
8.1	General.....	43
8.2	Determination of measuring uncertainty of steam and water properties	43
8.2.1	Pressure.....	43
8.2.2	Temperature.....	43
8.2.3	Enthalpy and enthalpy difference.....	43
8.3	Calculation of measuring uncertainty of output.....	43
8.3.1	Electrical measurement	43
8.3.2	Mechanical measurement	43
8.3.3	Additional uncertainty allowance because of unsteady load conditions	43
8.4	Determination of measuring uncertainty of mass flow.....	44
8.4.1	Measuring uncertainty of mass flow measurements	44
8.4.2	Measuring uncertainty of multiple measurements of primary flow	44
8.4.3	Uncertainty allowance for cycle imperfections.....	44
8.5	Calculation of measuring uncertainty of results	44
8.5.1	General	44
8.5.2	Measuring uncertainty of thermal efficiency	44
8.5.3	Measuring uncertainty of thermodynamic efficiency	44
8.5.4	Uncertainty of corrections.....	44
8.5.5	Guiding values for the measuring uncertainty of results	44
8.6	Example uncertainty calculation.....	44
Annex A (normative)	Feedwater heater leakage and condenser leakage tests	45
A.1	Feedwater heater leakage tests	45
A.2	Condenser leakage tests	45
Annex B (normative)	Evaluation of multiple measurements, compatibility.....	46

Annex C (normative) Mass flow balances.....	47
C.1 General.....	47
C.2 Flows for further evaluations (informative)	47
Annex D (informative) Short-statistical definition of measuring uncertainty and error propagation in acceptance test	48
Annex E (informative) Temperature variation method.....	49
E.1 Description of the problem	49
E.2 Possibility to determine the leakage flow.....	49
E.3 Applied example	49
Annex F (normative) Measuring uncertainty of results – retrofit application	50
Annex G (informative) Retrofit improvement calculation – numerical examples (fossil and nuclear)	53
G.1 General.....	53
G.2 Example of retrofitting a fossil-fired reheat turbine	53
G.2.1 General	53
G.2.2 HP cylinder retrofitting	57
G.2.3 LP cylinder retrofitting with relative guarantee on heat rate(treated separately from the HP case).....	58
G.2.4 Effect of retrofit on associated plant performance	59
G.3 Example of retrofitting a nuclear turbine.....	65
G.3.1 General	65
G.3.2 Retrofit scenario and testing procedure	66
G.3.3 Correction curves	66
G.3.4 Application of correction curves	67
G.3.5 Comparison of the measured values to the guarantees.....	69
Annex H (informative) Uncertainty calculation – numerical examples (fossil and nuclear)	78
H.1 General.....	78
H.2 Fossil case study	78
H.2.1 General	78
H.2.2 Evaluation	79
H.3 Nuclear case study	90
H.3.1 General	90
H.3.2 Evaluation	90
Figure 1 – Isentropic efficiency of the HP cylinder.....	17
Figure 2 – LP turbine expansion line	18
Figure G.1 – HP cylinder expansion.....	54
Figure G.2 – LP cylinder expansion	55
Figure G.3 – Original heat balance diagram (or base line)	60
Figure G.4 – Correction curves	61
Figure G.5 – Pre-retrofit test	62
Figure G.6 – Pre-retrofit test: HP cylinder replaced.....	63
Figure G.7 – Pre-retrofit test: LP cylinder replaced	64
Figure G.8 – Leaving loss curve.....	65
Figure G.9 – Correction curve of heat rate due to live steam pressure	70
Figure G.10 – Correction curve of heat rate due to thermal power.....	71

Figure G.11 – Correction curve of heat rate due to exhaust pressure	71
Figure G.12 – Correction curve of heat rate due to quality of live steam.....	72
Figure G.13 – Correction curve of heat rate for Δp of the moisture separator/reheaters	72
Figure G.14 – Correction curve of heat rate due to temperature of the reheat steam.....	73
Figure G.15 – Correction curve of heat rate due to quality of steam after the moisture separator	73
Figure G.16 – Curve of live steam pressure before the valves of the turbine as a function of thermal power.....	74
Figure G.17 – Baseline heat balance	75
Figure G.18 – Guarantee heat balance	76
Figure G.19 – Post-retrofit test re-calculated heat balance.....	77
Figure H.1 – Instrumentation for a fossil plant.....	81
Figure H.2 – Instrumentation for a nuclear plant	92
Table 1 – Maximum deviations and fluctuations in operating conditions from specified and relative data	21
Table 2 – Guarantee alternatives	25
Table 3 – Apportionment of unaccounted leakages	36
Table 4 – Typical effects of cylinder efficiency on heat rate.....	43
Table G.1 – Main parameters of the heat balances (Figure G.17 to Figure G.19).....	68
Table G.2 – Comparison between guaranteed and post-test re-calculated heat balance	68
Table G.3 – Measured and corresponding calculated values from the post-test.....	69
Table G.4 – Corrections due to differences between measured and calculated values (from post re-calculated heat balance, Figure G.19).....	69
Table G.5 – Summary of corrections	70
Table H.1 – Assumed total measured variable uncertainty for pressure, temperature and generator output.....	78
Table H.2 – Uncertainty percentage of calculated results at different flow measurement uncertainty levels for a fossil plant.....	80
Table H.3 – Uncertainty percentage of calculated results at different correlation levels for a fossil plant	80
Table H.4 – Heat Rate uncertainty of a fossil plant.....	82
Table H.5 – HP isentropic efficiency uncertainty of a fossil plant.....	84
Table H.6 – IP isentropic efficiency uncertainty of a fossil plant	86
Table H.7 – LP isentropic efficiency uncertainty of a fossil plant	88
Table H.8 – Uncertainty percentage of calculated results at different flow measurement uncertainty levels for a nuclear plant.....	91
Table H.9 – Uncertainty percentage of calculated results at different correlation levels for a nuclear plant.....	91
Table H.10 – Heat Rate uncertainty of a nuclear plant	93
Table H.11 – HP isentropic efficiency uncertainty of a nuclear plant	95
Table H.12 – LP isentropic efficiency uncertainty of a nuclear plant.....	97

INTERNATIONAL ELECTROTECHNICAL COMMISSION

RULES FOR STEAM TURBINE THERMAL ACCEPTANCE TESTS –

Part 3: Thermal performance verification tests of retrofitted steam turbines

FOREWORD

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IEC 60953-3 has been prepared by subcommittee WG11/MT14: Thermal Acceptance Test, of IEC technical committee 5: Steam turbines. It is an International Standard.

This second edition cancels and replaces the first edition published in 2001. This edition constitutes a technical revision.

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

- a) The Reference Standard has changed from IEC 60953-2 to IEC 60953-0 and therefore all changes made in IEC 60953-0 are relevant to this revised Supplementary Standard;
- b) Further detailed guidance is given for guarantee types in Clause 4.10;
- c) Annex H – Measuring uncertainty of results has been revised to more closely align with the ISO/IEC Guide 98: Uncertainty of measurement;
- d) Annex K – Tracer technique has been deleted;
- e) Annex L – Temperature variation method has been moved to IEC 60953-0.

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

Draft	Report on voting
5/XX/FDIS	5/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 part of IEC 60953 is to be read in conjunction with IEC 60953-0, and the words 'verification test' are to be read in place of 'acceptance test'. IEC 60953-0 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.

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/standardsdev/publications.

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,
- replaced by a revised edition, or
- amended.

INTRODUCTION

Retrofitting steam turbines in an existing power plant frequently involves an improvement of performance. IEC 60953-0, which defines the rules for steam turbine thermal acceptance tests in power plants, does not cater for all the requirements specific to retrofit projects. It has, therefore, been deemed necessary to draw up a Supplementary Standard (this document) for guidance on the thermal acceptance tests of retrofitted steam turbines.

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

Although this document is intended to apply to the retrofit of 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 rules given in this document cover all hardware change in the steam turbine equipment. Changes to other hardware components (e.g. boiler, feedwater heaters, etc.) are not covered by this document, although these changes may affect the thermodynamic cycle.

The purpose of this document is to cover the retrofit of steam turbine components which influence the efficiency of the power plant and are subject to a performance guarantee. Many different situations are likely to be encountered: for example, the replacement of steam valves, the replacement of part of the turbine blading, of a rotor, of a complete module, etc. The guarantee values will depend on the retrofit considered and are subject to agreement between the parties involved in the contract. This document helps the parties determine the most appropriate parameters that characterise the retrofit and that could be used as guaranteed values.

A major difficulty in retrofit projects is the choice of parameters to be guaranteed. Although the original manufacturer will generally favour a relative improvement guarantee, another vendor who does not necessarily know all the details of the equipment installed may prefer to have an absolute guarantee value for the retrofitted equipment. This document gives guidance on the parameters to be guaranteed. Once the guaranteed values are established, they may need to be re-evaluated after a pre-retrofit performance test. This document provides such rules required for the verification of the guaranteed values.

The many variations of possible retrofits make it difficult to cover all cases comprehensively but a few detailed examples illustrating the application of this document are presented in the annexes.

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

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

Clause 1: Scope

Specifically, this document requires the definitions of new options regarding guarantees. It is possible to guarantee parameters typical of the retrofitted equipment (turbine cylinder efficiency, pressure drop in valve chest, etc.). IEC 60953-0 defines absolute guarantees that are not suitable for specifying improvements between initial and retrofitted equipment, and therefore, relative guarantee values are introduced in this document.

This document reviews the contractual provisions, which can vary from one case to another, on account of the wide range of feasible retrofits. These will be subject to an agreement between the parties involved at the time the guarantees are defined i.e. during the formulation of the contract prior to the performance of the verification tests.

Clause 3: Units, symbols, terms and definitions

This document includes new concepts and terms associated with the retrofit situation

Clause 4: Guidance on guarantees

This document includes the definition of guarantees which can be offered, either additionally or in lieu of those of IEC 60953-0. A guide matrix has been included to allow the parties involved to choose the parameters to be guaranteed, as appropriate to the project.

The guarantees provided by the manufacturer can be

a) Guarantees of absolute values

- Turbine thermal efficiency or heat rate;
- turbine thermodynamic efficiency or steam rate or power output at specified steam flow conditions;
- main steam flow-passing capacity and/or maximum power output;
- internal efficiency of turbine sections.

b) Guarantees of relative values

- Improvement of turbine thermal efficiency or heat rate;
- improvement of thermodynamic efficiency or steam rate or power output at specified steam flow;
- improvement of main steam flow-passing capacity and/or maximum power output;
- improvement of internal efficiency of turbine sections.

Clause 4: Guiding principles

The majority of the guiding principles contained in IEC 60953-0 are also applicable to the retrofit situation. Amendments or addenda to this clause mainly cover the precautions to be taken when tests are to be run before and after the retrofit, and address the reference to be taken when a guarantee on improvement in performance is offered.

Special attention is directed to the problems of isolation of the cycle, and allowable deviations of measured quantities which can greatly affect the interpretation of results.

Clause 5: Measuring techniques and measuring instruments

In the case of retrofit projects, rigid rules cannot be formulated for measuring techniques and instruments. The instruments are to be chosen to suit the requirements of the installation and the guarantee value to be verified. Guidance is given in Annex H on the sensitivity of the parameters guaranteed to the accuracy of the individual measurements, so that the most appropriate choice of instrumentation can be made.

Since flow is among the most important measurements, this document gives guidance on the necessity to fit additional flow-measuring devices. Methods which allow simultaneous measurement and comparison of primary flows are recommended in this document. The use of flow measurement methods using tracers can be an alternative if the method has shown to be reliable and has been agreed by the parties to the test.

Clause 6: Evaluation of tests

This document gives details of the evaluation of additional guarantees applicable to retrofit projects. Specific rules are also given for unaccounted leakages in retrofit applications.

Clause 7: Correction of test results and comparison with guarantee

The methods of correction defined in IEC 60953-0 are also applicable to this document but are supplemented by specific rules which apply to the new types of guarantee. For delayed testing, guidance is given on ageing considerations.

This clause also covers the validation of the performance values which are used as a reference for determining improvement guarantee values: an amendment to the guarantee value is acceptable when the pre-retrofit tests have revealed that the actual condition of the turbine undergoing retrofit is different from the specified condition.

The retrofit of the steam turbine, or any part of it, may have consequences on the balance of the plant (feedheaters, condenser, boiler). If the retrofit affects conditions beyond the interface, then the manufacturer may be required to indicate the consequences of the modification on adjacent equipment items.

Clause 8: Measuring uncertainty

This clause of IEC 60953-0 is supplemented by provisions for special cases encountered in retrofit projects in Annex G and Annex H. The examples can be used as reference basis.

Annexes:

Annexes A to E of IEC 60953-0:2022 apply.

In this document, three new annexes (Annex F to Annex H) are added.

Annex F deals with uncertainties for retrofit applications and completes the information given in Annex D of IEC 60953-0:2022.

Annex G and Annex H give examples of performance and uncertainty calculations for several retrofit applications, within fossil-fuel and nuclear power plants.

Matters to be considered in the contract:

Some matters in these rules have to be considered at an early stage. Deviations are to be identified and agreement reached between the parties before signing the contract. Such matters are dealt with in the following subclauses:

Clause (subclause)	Paragraph	Remark
Introduction	6	Specific procedure and guarantee value
1.2	2	Guarantee definition
4.10	All paragraphs	
4.1	1 and 4	
4.3.1	3	
7.1.1	Last paragraph	
7.3	–	Guarantee comparison
7.9.4	–	Deterioration of performance of retrofitted components

RULES FOR STEAM TURBINE THERMAL ACCEPTANCE TESTS –

Part 3: Thermal performance verification tests of retrofitted steam turbines

1 Scope

1.1 General

This part of IEC 60953 establishes a Supplementary Standard for thermal verification tests of retrofitted steam turbines.

The rules given in this document follow the guidance given in IEC 60953-0, but contain amendments and supplements regarding guarantees and verification of the guarantees by thermal acceptance tests on retrofitted steam turbines.

General principles for the preparation, performance, evaluation, comparison with guaranteed values and the determination of the measurement uncertainties of verification tests are given in this document.

This document is applicable only when the retrofit involves some hardware change in the steam turbine equipment. Conversely, any modification on the cycle or any retrofit of other equipment of the power plant (e.g. boiler, feedwater heaters, etc.) is not covered by this document.

1.2 Object

The purpose of this document is to establish appropriate guaranteed parameters, to verify these guarantees and to determine measurement uncertainty.

The guarantees with their provisions should be formulated completely and without contradiction (see 3.4 of IEC 60953-0:2022 and 3.5 of this document). The verification 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.*