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

Règles pour les essais thermiques de réception des turbines à vapeur – Partie 3: Essais de vérification des performances thermiques des turbines à vapeur rénovées



IEC 60953-3:2022-07(en-fr)

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RULES FOR STEAM TURBINE THERMAL ACCEPTANCE TESTS –

Part 3: Thermal performance verification tests of retrofitted steam turbines

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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
5/249/FDIS	5/252/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.

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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.

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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.

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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
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RULES FOR STEAM TURBINE THERMAL ACCEPTANCE TESTS –

Part 3: Thermal performance verification tests of retrofitted steam turbines

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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. 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.*