
British Standard Guide for

Steam turbines procurement

Guide d'achat des turbines à vapeur

Leitfaden für den Erwerb von Dampfturbinen

Contents

	Page		Page
Foreword	Inside front cover	14. Tests	10
Cooperating organizations	Back cover	15. Delivery and installation	10
Guide		16. Information necessary to design the plant, to be supplied by the purchaser	11
1. Scope	1	17. Turbines with regenerative feedwater heating	12
2. Definitions	1	Appendix	
3. Guarantees	3	A. Electronic governors	13
4. Governing	4	Tables	
5. Operation and maintenance	5	1. Typical vibration values for turbines in good balance	10
6. Components	6	2. Performance characteristics for electronic governing systems for turbines	14
7. Foundations and buildings	7	3. Classification of environmental conditions for turbines	14
8. Feedwater pump drives	7		
9. Turbine auxiliary systems	7		
10. Instrumentation	8		
11. Protection	9		
12. Vibration	10		
13. Noise	10		

Foreword

This British Standard was prepared under the direction of the Mechanical Engineering Standards Committee and was first published in 1920. Subsequent revisions were made in 1930, 1951 and 1965. Since then intensive development has resulted in the availability of more highly rated turbines. The development of turbines suitable for use with water-cooled nuclear reactors has proceeded in parallel, resulting in the production of large turbines for use with steam which is initially dry-saturated or slightly wet. The demands made upon turbine control systems have increased simultaneously with the development of new control technologies, such as electro-hydraulic systems. Increased reliability, higher standards of dynamic performance, suitability for two shift operation, and

increased attention to health and safety are among the aspects now requiring high standards of achievement. It has therefore become necessary to specify a turbine in more detail than was formerly needed. In consequence, this British Standard has been completely re-written, and is accordingly more comprehensive than earlier editions. Wherever practicable, the standard takes into account the scope for applying to smaller turbines developments originally intended for large machines, without implying that such applications would always be necessary or advantageous.

Compliance with a British Standard does not of itself confer immunity from legal obligations.



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Guide for steam turbines procurement

Corrections

AMD 6146
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Clause 13. Noise

At the end of the first sentence delete 'personal access' and substitute 'access of personnel'.

AMD 6146
February 1990

Clause 15.2 Erection and commissioning

In first sentence delete 'It is recommended that where erection and commissioning form part of the contract,' and substitute 'It is recommended that where erection and commissioning do not form part of the contract,'.

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British Standard Guide for

Steam turbines procurement

1. Scope

This British Standard provides guidance on the procurement of steam turbines for electrical power generation applications, or for mechanical drive applications so far as they are appropriate. It does not apply to steam turbines used for marine propulsion.

The purpose of the standard is to enable an intending purchaser to state his requirements clearly to potential suppliers, and to make him aware of options and alternatives which he may wish to consider.

NOTE. The titles of the publications referred to in this standard are listed on the inside back cover.

2. Definitions

For the purposes of this standard, the following definitions apply.

2.1 Turbine types

2.1.1 superheat turbine. A turbine whose initial steam is superheated.

2.1.2 reheat turbine. A turbine from which steam is extracted part-way through the expansion, reheated and readmitted to the turbine.

2.1.3 saturated steam turbine; wet steam turbine. A turbine whose initial steam is saturated or slightly wet.

2.1.4 mixed-pressure turbine. A turbine provided with separate inlets for steam at two pressures.

2.1.5 back-pressure turbine; non-condensing turbine. A turbine which is designed to operate with an exhaust pressure above atmospheric pressure.

2.1.6 condensing turbine. A turbine which is designed to operate with an exhaust pressure below atmospheric pressure.

2.1.7 regenerative turbine. A turbine from which some of the steam is extracted part-way through the expansion in order to heat feedwater.

2.1.8 extraction turbine. A turbine in which some of the steam is extracted part-way through the expansion in order to provide process steam. If there is an automatic means for controlling the pressure of the extracted steam, the turbine is called a controlled automatic extraction turbine.

NOTE to 2.1. The terms in 2.1.1 to 2.1.8 may be combined to define the features of any particular unit. For example a large steam turbine in a coal-fired power station normally will be a superheat/reheat condensing regenerative turbine.

2.2 Methods of steam admission

2.2.1 throttle governing; full-arc admission. A method of

steam admission in which all of the governing valves operate in unison to supply steam uniformly to the inlet belt to the first stage.

2.2.2 nozzle governing; partial-arc admission. A method of steam admission in which the inlet belt to the first stage is divided into discrete arcs of admission, steam being supplied separately to each arc through one governing valve. The governing valves operate wholly or partially in sequence.

2.3 Conditions

2.3.1 terminal conditions. The conditions imposed on the plant at the terminating points of the contract. These may typically comprise:

- main and hot reheat steam conditions;
- cold reheat pressure;
- exhaust pressure.

2.3.2 specified or rated terminal conditions. The conditions at the terminating points of the turbine or turbine-generator contract, with which specified output and/or heat rate are to be stated and/or guaranteed.

2.3.3 design terminal conditions. The values of terminal conditions used in design calculations, such as the design pressure for a pressure vessel.

NOTE. Use of the word 'design' in respect of any steam condition, power output, speed, etc. should be avoided in the contract documents.

2.3.4 steam conditions. The conditions which define the thermodynamic state of steam, normally pressure and temperature or dryness fraction (or quality).

2.3.5 main steam conditions. The steam conditions measured at inlet to the main stop valves.

2.3.6 maximum steam conditions. The highest main steam conditions at which the turbine is required to operate continuously.

2.3.7 dual steam conditions. The combination of steam conditions appropriate to a mixed-pressure turbine.

2.3.8 reheat steam conditions; hot reheat steam conditions. The steam conditions measured at the inlet to the reheat stop valves.

2.3.9 cold reheat steam conditions. The steam conditions measured at the outlet of the turbine preceding the reheater.

2.3.10 extraction steam conditions. The steam conditions at the extraction connections of the turbine, of steam extracted for feed-heating or process purposes.

2.3.11 exhaust conditions. The steam conditions at the final exhaust flange or equivalent position, or terminating

point if the condenser is outside the turbine contract.

NOTE. It is normally necessary to state whether the values are 'static' (corresponding to the static enthalpy) or 'total' (corresponding to the static enthalpy plus the kinetic energy of the steam).

2.4 steam tables. Printed tables or algebraic formulations of the values of all thermodynamic properties of steam and water as a function of any two of them.

NOTE. The steam tables or formulations to be used for the guarantees and the computation of test results are to be consistent with the International Skeleton Tables established at the sixth International Conference on the Properties of Steam (ICPS) in 1963, and should preferably be based on the 1967 International Formulation Committee (IFC) Formulation for Industrial Use that was approved at the seventh ICPS in 1968.

2.5 Speeds

2.5.1 rated speed. The speed at which the turbine is specified to operate at its maximum continuous rating.

2.5.2 maximum continuous speed. The upper limit of the operating speed of the turbine for continuous service.

2.5.3 emergency trip speed. The speed at which the overspeed trip is set to operate.

2.5.4 temporary speed rise. The transient increase in turbine speed following a load rejection. The rated temporary speed rise applies if the rated output is rejected from the rated speed.

2.5.5 permanent speed rise. The speed rise which results when the load is reduced slowly from full load to no load. This is identical to 'overall speed droop' (see 2.12.5) and to the steady state increase in speed following a load rejection (see note to 2.12).

2.6 Powers

2.6.1 power output. The power supplied by the turbine or its driven machine.

NOTE. It is essential that the position of measurement is stated and any deductions for auxiliary power agreed.

2.6.2 net power at coupling. The power at the turbine coupling, less the power supplied to turbine auxiliaries if driven separately.

2.6.3 generator power. Power at the generator terminals.

2.6.4 auxiliary power. Power taken by turbine and generator auxiliaries not driven by the turbine. This may include auxiliaries in addition to those defined under maximum continuous rating, for example, a motor-driven boiler feed pump.

2.6.5 net electrical power. The generator power minus the auxiliary power.

2.6.6 maximum continuous rating; rated output.

(1) Of electrical generating turbines. The power output assigned to the turbine-generator by the supplier, at which the unit may be operated for an unlimited time, not exceeding the specified life, at the specified terminal conditions. This is the rating which should appear on the nameplate, and it will normally carry a guarantee of heat consumption. The governing valves will not necessarily be fully open. The power is that delivered at the generator terminals after deducting all electrical power used for excitation, control, lubrication, generator cooling and sealing.

(2) Of other than electrical generator drives. The power output assigned to the turbine by the supplier, at which the unit may be operated for an unlimited time, not exceeding

the specified life, at the specified terminal conditions and speed. This is the rating which should appear on the nameplate, and it will normally carry a guarantee of heat consumption. The governing valves will not necessarily be fully open. The power is that delivered at the turbine coupling, or the coupling of the driven machine, as may be agreed.

2.6.7 maximum capability; valves wide open capability.

The power output the turbine or turbine-generator can produce with the governing valves fully open and at the specified main steam conditions.

2.6.8 maximum overload capability. The maximum power output the unit can produce with the governing valves fully open, and with terminal conditions specified for overload, e.g. with final feedwater heater isolated, or with increased steam pressure.

2.6.9 economical rating. The output at which the minimum heat rate or steam rate is required. This is frequently chosen to be the same as the maximum continuous rating, and for a throttle-governed machine is always the same.

2.7 Steam flow rate

2.7.1 inlet steam flow. The flow of steam to the turbine, including any steam supplied to valve stems, glands or balance pistons, and any steam supplied to auxiliary plant such as boiler feed pump turbines and steam-steam reheaters.

2.7.2 steam rate. The inlet steam flow to the turbine, divided by the power output.

2.8 Heat rates

2.8.1 heat rate. The net heat flow to the turbine, divided by the power output.

NOTE. The drive adopted for the feedwater pump, e.g. steam driven or motor driven, will affect the numerical value of the heat rate.

2.8.2 guarantee heat rate. The heat rate upon which the guarantee or offer is based for a stated output with the specified terminal conditions.

NOTE. It is essential that any assumption with regard to extraneous flows, make-up, heat addition or removal is stated.

The formula used to derive the heat rate is to be stated in the contract.

2.8.3 uncorrected test heat rate. The heat rate obtained by inserting test values in the contract formula.

2.8.4 fully corrected test heat rate. The heat rate which would have been achieved during the test if the terminal conditions had been as specified, all ancillary plant outside the turbine-maker's supply had performed exactly in accordance with the guarantee, and all extraneous flows, make-up, etc. had been as specified in the contract.

2.9 Efficiencies

NOTE to 2.9.1 and 2.9.2. In addition to the following definitions, 'efficiency' is also used to denote the performance of turbine blading, and the performance of a total power station. The term should therefore never be used without being qualified.

2.9.1 thermal efficiency. The ratio of power output to heat input. This quantity is the reciprocal of the heat rate.

NOTE. A definition is possible corresponding to each of the heat rates.

2.9.2 thermodynamic efficiency. The ratio of power output to the product of steam mass flow and isentropic enthalpy drop between any two stations in a turbine, where no steam is admitted or extracted between stations.