
**Mechanical vibration — Torsional
vibration of rotating machinery —**

**Part 1:
Evaluation of steam and gas turbine
generator sets due to electrical
excitation**

*Vibrations mécaniques — Vibration de torsion des machines
tournantes —*

*Partie 1: Évaluation des groupes électrogènes à turbine à vapeur et à
gaz due à l'excitation électrique*





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Contents

Page

Foreword	iv
Introduction	v
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
4 Abbreviated terms and symbols	4
4.1 Abbreviated terms.....	4
4.2 Symbols.....	4
5 Shaft train modelling and uncertainties	5
5.1 General.....	5
5.2 Modelling of the shaft train and the electrical system.....	5
5.2.1 General.....	5
5.2.2 Elastic blade modelling.....	6
5.2.3 Modelling generator rotor windings.....	6
5.2.4 Grid/excitation modelling.....	6
5.2.5 Damping modelling.....	7
5.2.6 Gear box modelling.....	7
5.2.7 Flexible coupling modelling.....	7
5.3 Design element uncertainties.....	7
5.4 Determination of calculation uncertainties.....	8
6 Shaft train evaluation	9
6.1 General.....	9
6.2 Natural frequency assessment.....	11
6.2.1 General.....	11
6.2.2 Torsional frequency margins.....	13
6.2.3 Natural frequency criteria.....	14
6.3 Stress assessments.....	16
6.3.1 General.....	16
6.3.2 Expertise criterion.....	17
6.3.3 Stress/fatigue criterion.....	17
7 Calculation of shaft train torsional vibration	17
7.1 General.....	17
7.2 Calculation data.....	17
7.3 Calculation results.....	18
7.4 Calculation report.....	18
8 Measurement of shaft train torsional vibration	18
8.1 General.....	18
8.2 Method of measurement.....	18
8.3 Measurement report.....	19
9 General requirements	19
9.1 Supplier and customer responsibilities.....	19
9.2 Acceptance criterion.....	20
Annex A (informative) Torsional vibration measurement techniques	21
Annex B (informative) Frequency margin examples relative to grid and twice grid frequencies for shaft train modes	32
Annex C (informative) Commonly experienced electrical faults	34
Bibliography	38

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 108, *Mechanical vibration, shock and condition monitoring*, Subcommittee SC 2, *Measurement and evaluation of mechanical vibration and shock as applied to machines, vehicles and structures*.

This second edition cancels and replaces the first edition (ISO 22266-1:2009), which has been technically revised.

The main changes are as follows:

- terms and definitions revised to account for definitions given in other standards;
- evaluation concept refined and substantiated, contradictory statements removed;
- guidance on modelling uncertainties added;
- annex enhanced to give guidance on measurement equipment for monitoring torsional vibration;
- wording at some instances revised in order to make the content unambiguous;

A list of all parts of the ISO 22266 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

During the 1970s, a number of major incidents occurred in power plants that were deemed to be caused by or that were attributed to rotor torsional vibration. In those incidents, generator rotors and some of the long elastic turbine blades of the LP rotors were damaged. In general, the incidents were due to vibration modes of the coupled shaft and blade system that were resonant with the grid electrical excitation frequencies. Detailed investigations were carried out and it became apparent that the mathematical models used at that time to predict rotor torsional natural frequencies were not adequate. In particular, they did not take into account, with sufficient accuracy, the coupling between long elastic turbine blades and the shaft line. Therefore, advanced research work was carried out to analyse the blade-to-disc-to-shaft coupling effects more accurately and branch models were developed to account properly for these effects in shaft train torsional natural frequency calculations.

In the 1980s, torsional factory tests were developed to verify the predicted torsional natural frequencies of LP rotors. These factory tests were very useful in identifying any necessary corrective actions before the product went into service. However, it is not always possible to test all the elements that comprise the assembled rotor. Hence, unless testing is carried out on the shaft train on site, some discrepancies could still exist between the overall system model and the installed machine.

There is inevitably some uncertainty regarding the accuracy of the calculated and measured torsional natural frequencies. It is therefore necessary to design shaft train torsional natural frequencies with sufficient margin from the grid system frequencies to compensate for such inaccuracies, unless the modes are insensitive to excitation torques. Acceptable margins will vary depending on the extent to which any experimental validation of the calculated torsional frequencies is carried out. The margins should also take into account the sensitivity of the torsional natural frequencies and the modal excitability with respect to modelling uncertainties. The main objective of this document is to provide guidelines for the selection of frequency margins during the design stage and on the fully coupled shaft train on site.

In general, the presence of a torsional natural frequency is only of concern if it coincides with an excitation frequency and has a modal distribution allowing energy to be fed into the corresponding vibration mode (resonance). If either of these conditions is not satisfied, the presence of a natural frequency is of no practical consequence (e.g. a particular mode of vibration is of no concern if it cannot be excited). In the context of this document, the excitation is due to variations in the electromechanical torque, induced at the air gap of the generator. Any shaft train torsional modes that are insensitive to these induced excitation torques do not present a risk to the integrity of the turbine generator, regardless of the value of the natural frequency of that mode.

Mechanical vibration — Torsional vibration of rotating machinery —

Part 1:

Evaluation of steam and gas turbine generator sets due to electrical excitation

1 Scope

This document provides guidelines for the assessment of torsional natural frequencies and component strength, under normal operating conditions, for the coupled shaft train, including long elastic rotor blades, of steam and gas turbine generator sets. In particular, the guidelines apply to the torsional responses of the coupled shaft train at grid and twice grid frequencies due to electrical excitation of the electrical network to which the turbine generator set is connected. Excitation at other frequencies (e.g. subharmonic frequencies) are not covered in this document.

No guidelines are given regarding the torsional vibration response caused by steam excitation or other excitation mechanisms not related to the electrical network.

Where the shaft cross sections and couplings do not fulfil the required strength criteria and/or torsional natural frequencies do not conform with defined frequency margins, other actions shall be defined to resolve the problem.

The requirements included in this document are applicable to

- a) steam turbine generator sets connected to the electrical network, and
- b) gas turbine generator sets connected to the electrical network.

Methods currently available for carrying out both analytical assessment and test validation of the shaft train torsional natural frequencies are also described.

NOTE Radial (lateral, transverse) and axial vibration of steam and/or gas turbine generator sets is dealt with in ISO 20816-2.

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.

ISO 2041, *Mechanical vibration, shock and condition monitoring — Vocabulary*

ISO 11086, *Gas turbines — Vocabulary*

IEC 60050-602, *International Electrotechnical Vocabulary — Chapter 602: Generation, transmission and distribution of electricity – Generation*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 2041, ISO 11086, IEC 60050-602 and the following apply.