
**Acoustics — Characterization of
sources of structure-borne sound and
vibration — Indirect measurement of
blocked forces**

*Acoustique — Caractérisation des sources de bruit solide et de
vibrations — Mesurage indirect des forces bloquées*

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Published in Switzerland

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Foreword

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This document was prepared by Technical Committee ISO/TC 43, *Acoustics*, Subcommittee SC 1, *Noise*.

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Introduction

This document has been developed in response to demand from mechanical industries for an agreed method of specifying the "source strength" of sources of structure-borne sound and vibration. Quantities which independently characterize a source are the free velocity and blocked force: ISO 9611^[2] specifies a measurement procedure for the former in which the machine, a vibration source, is mounted on soft mounts to approximate free suspension. The blocked forces are the forces the operating machine would exert when constrained by a perfectly rigid foundation. They can potentially be measured directly by inserting force transducers in between the operating machine and a rigid foundation. However, this document describes an indirect method for measurement of blocked forces using an inverse method. Whereas the measurement of free velocity requires the source to be resiliently mounted and direct measurement of blocked forces requires the machine mounts to be blocked, the indirect measurement, as defined in this document, can theoretically be carried out with the source attached to any receiver structure. Essentially the same measurement techniques are used in the diagnosis of structure-borne sound using "transfer path analysis" (TPA), also called "source path contribution" analysis (SPC).

A method of characterizing sources of structure-borne sound and vibration by the indirect measurement of blocked forces at the points of connection to supporting, or receiver, structures is described in this document. The measurement method is applied in situ, which means that the source is connected to a receiver structure while the measurements are performed. In theory, the use of any receiver structure is valid provided the vibration source mechanisms of the specimen remain representative of those in a real installation. Therefore, the receiver structure can be part of a real installation, such as a machine foundation or a building, but can also be a specially designed test stand if it provides representative dynamic loading for the source.

The method specifies a two-stage measurement procedure comprising, first, a passive test in which frequency response functions (FRF) of the assembled source-receiver structure are measured, and secondly, measurement of vibration in an operational test. The blocked forces are obtained by solving the inverse problem. It is well known that inverse solutions of this type can result in very large errors, particularly if there is inconsistency in the input data. Such errors vary significantly depending on the case and the skill of the operator. Therefore, a means of estimating the uncertainties in the blocked force, through a process called on-board validation, forms an essential part of this measurement procedure.

The blocked forces are obtained in narrow frequency bands that can subsequently be converted to approximate octave or third octave frequency bands.

The in situ blocked force method is intended to complement the reception plate method of EN 15657^[3]. The reception plate method offers a simplified approach in which forces and velocities are effectively averaged over the feet of an operating machine by mounting on a standard plate. The approximations allow measurements to be simplified but information about distribution and phase of the forces and velocities is lost. This document aims to provide an alternative for structure borne sound sources not compatible with the reception plate approach or where more detail is needed about the distribution of the forces.

The blocked forces obtained from this document can be used for the following purposes:

- a) obtaining data for preparing technical specifications for vibrationally active components (sources);
- b) obtaining input data for prediction of vibration in, or sound radiated sound from, structures connected to the source;
- c) obtaining diagnostic information about the contribution of particular blocked forces to a target vibration or sound pressure (in situ transfer path analysis).

Prediction of sound and vibration in a new assembly [as in b) above] does not form a normative part of this document, although guidelines for prediction are provided in [Annex E](#). For prediction purposes, extra data are needed in addition to the measured blocked forces. Specifically, the frequency response functions (FRFs) of the new assembly (which consists of the source connected to the new receiver

structure) need to be known. These FRFs can in principle be measured (if the assembly is available for measurement), calculated (for example using numerical methods) or calculated by combining the FRFs of the separate source and the receiver structures (dynamic substructuring) whether measured or calculated.

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