

# **Airborne noise emitted by earth-moving machinery**

## **Part 3. Method of measurement of exterior noise in dynamic test conditions**

ICS 17.140.20; 53.100

## Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Environment and Pollution Standards Policy Committee (EPC/-) to Technical Committee EPC/1, upon which the following bodies were represented:

Association of Consulting Engineers  
British Broadcasting Corporation  
British Occupational Hygiene Society  
British Telecommunications plc  
Department of Health  
Department of the Environment (Building Research Establishment)  
Department of Trade and Industry (Air Division)  
Department of Trade and Industry (National Physical Laboratory)  
Engineering Equipment and Materials Users' Association  
Health and Safety Executive  
Incorporated Association of Architects and Surveyors  
Institute of Acoustics  
Institute of Civil Engineers  
Institute of Occupational Hygienists  
Institute of Physics  
Institute of Sound and Vibration Research  
Institution of Electronic and Radio Engineers  
Royal Institute of British Architects  
Transmission and Distribution Association (BEAMA Ltd.)

The following bodies were also represented in the drafting of the standard, through subcommittees and panels:

AFRC Institute of Engineering Research  
Advanced Manufacturing Technology Research Institute  
Agricultural Engineers' Association  
British Cement Association  
British Compressed Air Society  
British Hydromechanics' Research Association  
British Steel Corporation  
Business Equipment and Information Technology Association  
Construction Industry Research and Information Association  
Department of Trade and Industry (National Engineering Laboratory)  
Federation of Associations of Specialists and Sub-contractors  
Federation of Manufacturers of Construction Equipment and Cranes  
Federation of Piling Specialists  
Hevac Association  
Institution of Mechanical Engineers  
Institution of Production Engineers  
Rotating Electrical Machines Association (BEAMA Ltd.)  
Society of Motor Manufacturers and Traders Ltd.

This British Standard, having been prepared under the direction of the Environment and Pollution Standards Policy Committee, was published under the authority of the Standards Board and comes into effect on 30 September 1991

© BSI 09-1999

The following BSI references relate to the work on this standard:  
Committee reference EPC/1  
Draft for comment 86/50554 DC

ISBN 0 580 20056 6

### Amendments issued since publication

| Amd. No. | Date           | Comments                |
|----------|----------------|-------------------------|
| 10551    | September 1999 | Indicated by a sideline |
|          |                |                         |
|          |                |                         |
|          |                |                         |
|          |                |                         |

# Contents

| Committees responsible                                                                                                                           | Page |
|--------------------------------------------------------------------------------------------------------------------------------------------------|------|
| Inside front cover                                                                                                                               |      |
| National foreword                                                                                                                                | ii   |
| <b>Method</b>                                                                                                                                    |      |
| 0 Introduction                                                                                                                                   | 1    |
| 1 Scope                                                                                                                                          | 1    |
| 2 Field of application                                                                                                                           | 1    |
| 3 References                                                                                                                                     | 1    |
| 4 Definitions                                                                                                                                    | 1    |
| 5 Instrumentation                                                                                                                                | 1    |
| 6 Test environment                                                                                                                               | 2    |
| 7 Measurement of equivalent continuous A-weighted sound pressure levels                                                                          | 2    |
| 8 Acoustic measurements                                                                                                                          | 5    |
| 9 Calculation of A-weighted sound power level using equivalent continuous A-weighted sound pressure levels averaged over the measurement surface | 6    |
| 10 Information to be recorded                                                                                                                    | 6    |
| 11 Information to be reported                                                                                                                    | 7    |
| 12 Bibliography                                                                                                                                  | 7    |
| <b>Annexes</b>                                                                                                                                   |      |
| A Excavators (hydraulic or rope-operated)                                                                                                        | 8    |
| B Tractors with dozer equipment                                                                                                                  | 10   |
| C Loaders                                                                                                                                        | 11   |
| D Backhoe loaders                                                                                                                                | 13   |
| E Additional guidelines for the measurement of exterior noise emitted by earth-moving machinery — Dynamic test                                   | 14   |
| <b>Figures</b>                                                                                                                                   |      |
| 1 Excavator                                                                                                                                      | 3    |
| 2 Tractor with dozer equipment                                                                                                                   | 3    |
| 3 Loader                                                                                                                                         | 3    |
| 4 Backhoe loader                                                                                                                                 | 4    |
| 5 Microphone array on the hemisphere                                                                                                             | 4    |
| 6 Travel path                                                                                                                                    | 5    |

## National foreword

This part of BS 6812 has been prepared under the direction of the Environment and Pollution Standards Policy Committee and is identical with ISO 6395 : 1998 "Acoustics — Measurement of exterior noise emitted by earth-moving machinery — Dynamic test conditions" and its amendment 1, published by the International Organization for Standardization (ISO). ISO 6395 was prepared by Subcommittee 1, Noise, of ISO Technical Committee 43, Acoustics, with the active participation and approval of the UK.

BS 6812 at present comprises the following Parts which have been published.

Part 1 Method of measurement of exterior noise in a stationary test condition

Part 2 Method of measurement at the operator's position in a stationary test condition

Part 3 Method of measurement of exterior noise in dynamic test conditions

### Cross-references

| International standard | Corresponding British Standard                                                                                                                                                                                                                           |
|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ISO 6165 : 1987        | BS 6914 Terminology (including definitions of dimensions and symbols) for earth-moving machinery<br>Part 1 : 1988 Glossary of terms for basic types of earth-moving machinery<br>(Identical)<br>BS 6812 Airborne noise emitted by earth-moving machinery |
| ISO 6393 : 1985        | Part 1 : 1987 Method of measurement of exterior noise in a stationary test condition<br>(Identical)                                                                                                                                                      |
| ISO 6394 : 1985        | Part 2 : 1987 Method of measurement at the operator's position in a stationary test condition<br>(Identical)                                                                                                                                             |
| IEC 651 : 1979         | BS 5969 : 1981 Specification for sound level meters<br>(Identical)                                                                                                                                                                                       |
| IEC 804 : 1985         | BS 6698 : 1986 Specification for integrating-averaging sound level meters<br>(Identical)                                                                                                                                                                 |

The Technical Committee has reviewed the provisions of ISO 1585 and ISO 4872 to which reference is made in the text and has decided that they are acceptable for use in conjunction with this standard.

ISO 6396 is also referred to, but as it is given for information only, it does not affect the use of this Part of BS 6812.

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

### Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 15, and a back cover.

The BSI copyright notice displayed in this document indicates when the document was last issued.

Sidelining in this document indicates the most recent changes by amendment

## 0 Introduction

This International Standard is a special test code for specific types of earth-moving machinery.

A simulated dynamic rather than an actual work cycle test condition is chosen. Dynamic test conditions provide acceptable noise emission data which are repeatable and representative. Actual work cycle tests are complex and repeatability can be a problem.

Specific procedures are described in this International Standard to enable the sound power emission in dynamic test conditions to be determined in a manner which is repeatable. Attachments (bucket, dozer, etc.) for the manufacturer's production version are to be fitted since this is the configuration most likely to exist when the machine is in actual use.

This International Standard enables compliance with noise limits to be determined. It can also be used for evaluation purposes in noise reduction investigations.

An additional special test code is given in ISO 6396. This other special test code is intended to be used to determine the noise emitted by earth-moving machinery, with the machine in dynamic test conditions, measured at the operator's position in terms of the equivalent continuous A-weighted sound pressure level.

Corresponding measurements of noise emitted to the environment and noise at the operator's position under stationary test conditions are described in ISO 6393 and ISO 6394, respectively.

## 1 Scope

This International Standard describes a method for determining the noise emitted to the environment by earth-moving machinery in terms of the A-weighted sound power level while the machine is working under dynamic test conditions.

## 2 Field of application

This International Standard is applicable to the following specific crawler and wheeled types of earth-moving machinery (see also the annexes): excavators (hydraulic or rope-operated), tractors with dozer equipment, loaders, and backhoe loaders (also known as excavator-loaders) (see figures 1 to 4).

## 3 References

ISO 1585, *Road vehicles — Engines test code — Net power.*

ISO 3744 : 1994, *Acoustics — Determination of sound power levels of noise sources using sound pressure — Engineering method in an essentially free field over a reflecting plane.*

ISO 6165, *Earth-moving machinery — Basic types — Vocabulary.*

IEC Publication 651, *Sound level meters.*

IEC Publication 804, *Integrating-averaging sound level meters.*

## 4 Definitions

For the purposes of this International Standard, the definitions given in ISO 3744, together with the following, apply

**4.1 equivalent continuous A-weighted sound pressure level,  $L_{pAeq,T}$ :** The A-weighted sound pressure level averaged on an energy basis over the whole measurement period.

**4.2 A-weighted sound power level,  $L_{WA}$ :** The A-weighted sound power level using equivalent continuous A-weighted sound pressure levels averaged over the measurement surface and averaged on an energy basis over the whole measurement period.

## 5 Instrumentation

The instrumentation shall be capable of carrying out measurements as described in 8.1. Integrating-averaging sound level meters shall meet the requirements of IEC Publication 804 for a type 1 instrument. Alternative instrumentation, including the microphone and cable, shall meet the requirements of IEC Publication 651 for a type 1 instrument.

An omnidirectional microphone shall be used for measurements so as to reduce possible directivity errors. The microphone and its associated cable shall be chosen so that the combined sensitivity does not change significantly over the temperature range encountered during the measurements.

## 6 Test environment

### 6.1 General

The test environment specified in ISO 3744, clause 4 and annex A, applies. Additional requirements for this special test code are given in 6.2 to 6.6.

Humidity, air temperature, barometric pressure, vibration and stray magnetic fields shall be within the limits specified by the manufacturer of the instrumentation.

### 6.2 Test site and environmental correction, $K$

For test site measurement surfaces which consist of a hard reflecting plane, such as concrete or sealed asphalt (6.3.1 a) and b)), and with no sound-reflecting obstacles within a distance from the source equal to three times the greatest distance from the source centre to the lower measurement positions (measurement hemisphere radius), it may be assumed that the environmental correction,  $K$ , is less than or equal to 0,5 dB; it is, therefore, negligible and is disregarded.

For the all-sand test site (6.3.1 c)), an environmental correction  $K$  will have to be determined and used in the sound power calculation.

### 6.3 Test site

#### 6.3.1 General

The following three types of test site measurement surface, described in 6.3.2, 6.3.3 and 6.3.4, are allowed:

- a) hard reflecting plane (concrete or sealed asphalt);
- b) combination of hard reflecting plane and sand;
- c) sand.

The hard reflecting plane shall be used for testing the following:

- rubber-tyred machines: all modes of operation;
- excavators: all modes of operation;
- crawler loaders: stationary hydraulic mode of operation.

The combination of hard reflecting plane and sand shall be used for testing crawler dozers and crawler loaders in the travel mode with the machine operating on the sand surface and with the microphone on the hard reflecting plane.

An alternative test site consisting of all sand may be used for testing crawler dozers and crawler loaders in the travel mode and stationary hydraulic mode, provided that:

- 1) the environmental correction,  $K$ , determined in accordance with ISO 3744, annex A, is less than 3,5 dB;
- 2) if  $K$  is greater than 0,5 dB the correction is accounted for in the calculation of the sound power level.

#### 6.3.2 Hard reflecting plane (Test site measurement surface a)

The test area bordered by the microphones shall consist of concrete or sealed asphalt.

#### 6.3.3 Combination of hard reflecting plane and sand (Test site measurement surface b)

The travel path of the machine shall consist of humid sand of grain size up to 2 mm. The minimum depth of the sand shall be 0,3 m. If 0,3 m is not deep enough for track penetration, the depth shall be increased accordingly. The surface between the machine and the microphone shall be a hard reflecting plane, as described in 6.3.2. This provides a reflecting plane rather than an absorptive surface for the measuring environment.

A minimum size combination site can be used by having just a single reflecting plane with a sand path along the side. Then operate the machine in a forward travel mode twice but in opposite directions for each of the three microphone positions. The reverse travel mode can be done in the same manner.

#### 6.3.4 All-sand site (Test site measurement surface c)

The sand shall be as specified in 6.3.3.

### 6.4 Background noise

Background noise at each measurement position shall be at least 10 dB lower than the noise emitted by the machine.

### 6.5 Climatic conditions

Measurements shall not be carried out under the following conditions:

- a) when precipitation, i.e. rain, snow or hail, is falling;
- b) when ground surface is covered with snow;
- c) when the temperature is below  $-10\text{ }^{\circ}\text{C}$  or above  $+35\text{ }^{\circ}\text{C}$ ;
- d) when wind speed exceeds 8 m/s. For wind speeds in excess of 1 m/s, a microphone windscreen shall be used and appropriate compensation for the effects of its use shall be allowed for in the calibration.

## 7 Measurement of equivalent continuous A-weighted sound pressure levels

### 7.1 Size of measurement surface

The measurement surface to be used for the test shall be a hemisphere. The radius of the hemisphere shall be determined by the basic length,  $l$ , of the machine (see figures 1, 2, 3 and 4).

The basic length of the machine is equal to:

- for excavators: the total length of the upper structure, excluding attachments, main structural moving members such as boom and stick;
- for other machines: the total length of the machine excluding attachments such as dozer blades and bucket.