# DRAFT INTERNATIONAL STANDARD
# ISO/DIS 29821-2

ISO/TC **108**/SC **5** Secretariat: **ANSI**

Voting begins on: **2015-09-15**

Voting terminates on: **2015-12-15**

# Condition monitoring and diagnostics of machines — Ultrasound —

## Part 2: **Procedures and validation**

*Surveillance des conditions et diagnostic d'état des machines — Ultrasons —*

*Partie 2: Modes opératoires et validation*

ICS: 17.160





Reference number
ISO/DIS 29821-2:2015(E)

## Contents

Page





 

# 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. 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. www.iso.org/patents

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 108, *Mechanical vibration, shock and condition monitoring*, Subcommittee SC 5, *Condition monitoring and diagnostics of machine systems*.

ISO 29821 consists of the following parts, under the general title *Condition monitoring and diagnostics of machines — Ultrasound*:

— *Part 1: General guidelines*

---- *Part 2: Procedures and validation*

## Introduction

This part of ISO 29821 provides specific guidance on the interpretation of ultrasonic readings and wave files or frequency and time domain printouts (sometimes called "sound images") as part of a programme for condition monitoring and diagnostics of machines. Airborne (AB) and structure-borne (SB) ultrasound can be used to detect abnormal performance or machine anomalies. The anomalies are detected as high frequency acoustic events caused by turbulent flow, ionization events and friction, which are caused, in turn, by incorrect machinery operation, leaks, improper lubrication, worn components, and/or electrical discharges.

Airborne and structure-borne ultrasound is based on measuring the high frequency sound that is generated by either turbulent flow, friction or by the ionization created from the anomalies. The inspector therefore requires an understanding of ultrasound and how it propagates through the atmosphere and through structures as a prerequisite to the creation of an airborne and structure-borne ultrasound programme. Ultrasonic energy is present with the operation of all machines. It can be in the form of friction, turbulent flow and/or ionization as a property of the process, or produced by the process itself. As a result, ultrasonic emissions are created and these are an ideal parameter for monitoring the performance of machines, the condition of machines, and for diagnosing machine anomalies. Ultrasound is an ideal technology to do this monitoring because it provides an efficient way to quickly and non-invasively determine the location of an anomaly with little setup and in a very short period of time.



 

# Condition monitoring and diagnostics of machines — Ultrasound — Part 2: Procedures and validation

## 1 Scope

This part of ISO 29821

— provides guidance on establishing severity assessment criteria for anomalies identified by airborne (AB) and structure borne (SB) ultrasound.

— outlines methods and requirements for carrying out ultrasonic examination of machines, including safety recommendations and sources of error.

— provides information relative to data interpretation, assessment criteria and reporting.

## 2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 13372, Condition monitoring and diagnostics of machines — Vocabulary

ISO 29821-1:2011 Condition monitoring and diagnostics of machines --- Ultrasound ---Part 1: General Guidelines



## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 13372 and ISO 29821-1 apply.

## 4 Ultrasonic condition monitoring

### 4.1 Application of airborne and structure-borne ultrasound within condition monitoring programmes

Ultrasound is not normally used as a primary monitoring technique in typical condition monitoring programmes. The exceptions to this are when ultrasound is preferred as a non-invasive indicator of impending failure or performance deterioration or when rapid pressure or vacuum leak localization is necessary to lessen machine performance degradation.

Examples of such applications are:

— electrical transformers;

— enclosed electrical systems;

— gearboxes;

— motors;

 

— pumps;

— conveyor bearings;

— lubrication failure;

— compressors;

— turbine engines;

— condensers;

— heat exchangers;

— compressed gas systems.

### 4.2 Correlation with other technologies

Traditionally, airborne and structure-borne ultrasound inspection is used in a condition-monitoring programme to detect characteristics of failure modes that have been previously identified by another technology. There are instances where airborne or structure-borne ultrasound is the first indicator of a failure mode, such as in the detection of faulty slow-speed bearings and/or insufficient lubrication in rolling element bearings. Airborne or structure-borne ultrasound can also be used to identify a potential safety hazard to an inspector using an alternate technology, for example in the inspection of enclosed electrical systems. Airborne and structure-borne ultrasound are used to determine if an arc flash hazard is present before opening the cabinet for an infrared thermographic inspection.



## 5 Equipment choice

### 5.1 Kinds of sensors

Airborne ultrasound is propagated through an atmosphere (air or gas) and detected with an ultrasonic microphone while structure-borne ultrasound is generated within and propagated through a structure and is usually detected with a contact module, although other sensors may be used. A guide for which sensor should be chosen can be found in ISO 29821-1:2011, Table 1.

### 5.2 Airborne sensor choice

An ultrasonic instrument with fixed sensors might have limitations with respect to field of reception and might not be suitable for all applications. For ultrasonic instruments with interchangeable sensors, there is normally a choice of two kinds of sensors: wide-angle and parabolic.

For machine condition monitoring, wide-angle airborne sensors are particularly useful for gaining an overall assessment of the machine condition utilizing the maximum machine area for comparison of ultrasonic signatures. This allows the comparison of multiple components in a single machine. This module type is also useful in confined-space areas where the access area can be very small.

Parabolic sensors are useful for remote component locations such as elevated conveyors, equipment, vessels and outdoor substations, where access is limited and the machine, system, or component of either, is a great distance away. The narrow field of reception is helpful especially for pinpointing leaks in piping or in determining which phase in a high voltage tower has an electrical discharge

 

### 5.3 Structure-borne sensor choice

Structure-borne sensors are used to non-invasively detect internal abnormal performance or machine anomalies. There is normally a choice of contact and magnetically coupled sensors.

The contact sensor (stethoscope) is most commonly used when a machine, system or component needs to be quickly scanned to determine where an anomaly or fault condition is located. It is also effectively used to get into tight spaces to gain access to a good monitoring point. For measurement points that are just out of reach, extension contact rods can be used. For measurement points that are in difficult to reach or in unsafe areas, permanent remote contact sensors can be used.

Magnetically-coupled contact sensors remove the measurement variation associated with hand-held contact sensors. They are therefore ideal in circumstances where a long sampling time is required or where there are multiple inspectors taking readings on the same sampling point. An example would be when monitoring an electrical transformer, as a slight movement of a contact sensor can sound very similar to a partial discharge inside the transformer, which would cause a false indication of an anomaly.

### 5.4 Instrument characteristics

#### 5.4.1 General

When selecting an ultrasonic instrument, the sensitivity, frequency response and ability to record the heterodyned (demodulated) ultrasonic signal output should be carefully considered with respect to the intended applications. Some applications require monitoring at different frequencies for the best results. Other applications require a recording of the heterodyned (demodulated) sound signature for further analysis and for reporting.



#### 5.4.2 Frequency response

If using an airborne or structure-borne ultrasonic instrument with heterodyned (demodulated) frequency tuning capability, the ultrasound inspector should be aware that there are certain monitoring frequencies that enhance the data that is acquired for specific applications. These monitoring frequencies are primarily due to the propagation of the ultrasonic wave through specific media, but can also be influenced by the resonance of the ultrasonic sensor. Examples of typical monitoring frequencies are shown in Table 1.

**Table 1 – Typical monitoring frequencies**

| Acquisition method | Application | Frequency (kHz) |
|---|---|---|
| Airborne | Leaks, electrical | 40 |
| Structure-borne | Bearings, mechanical | 30 |
| | Valves, steam traps | 25 |
| | Electrical – sealed leaks- underground | 20 |