INTERNATIONAL STANDARD

ISO 22955

First edition
2021-05

Acoustics — Acoustic quality of open office spaces

Acoustique — Qualité acoustique des espaces de bureaux ouverts

Reference number
ISO 22955:2021(E)

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

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 (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).

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

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 *43*, *Acoustics*, Subcommittee SC 1, *Noise*.

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

Open-plan offices are increasingly common. They can cause apprehension from users due to noise and the difficulty of performing two theoretically contradictory activities in terms of acoustics: oral communication and focused individual work. In this type of space, disturbance caused by speech can result in tension between people who want to concentrate and people who are required to talk to perform their activity.

This document is concerned with the acoustics of open-plan spaces and, more specifically, cognitive effects of noise, i.e. acoustic comfort and noise disturbance linked to the obligations of the activity.

It is intended for stakeholders working in the planning, design, construction or layout of open-plan offices. Its aim is to help them provide users with a good level of acoustic comfort. It is meant as a basis for discussion and dialogue between the stakeholders involved in creating office spaces. In particular, it is intended for project owners to fine-tune the drafting of the acoustic specifications and help project management companies decide upon their objectives and the resources linked to the architecture and layout of open-plan offices.

The aim of this document is to offer principles, descriptors and measurement methods to characterise acoustics, which are easy to use and correspond to the perception of the acoustical environment by the occupants of the spaces.

Studies[3] to [5] have shown that noises that are uncontrollable, intelligible and with no link to the activity of an individual are the most disturbing and shall be minimised. They most often come from adjacent workstations, recreational areas, shared areas or neighbouring offices. For this reason, this document is focused on containing speech propagation.

The approach chosen for open-plan spaces is to limit disturbance between adjacent workstations but also to optimize comfort for short-distance conversations. The underlying idea is that a high level of intelligibility in the area of communication (near to the workstation) results in less disturbance at more distant workstations. This document addresses the issues of noise comfort, in particular via the concepts of "discretion" and "distraction reduction".

This document provides an opportunity to reflect further, by including an analysis of activities that involve more or less collaboration on the one hand, and by addressing everything that constitutes an open-plan space on the other, in particular in terms of surface treatments and additional office layout such as furniture, acoustic screens or low dividers, etc.

This document establishes a link between acoustic quality and the acoustic performance to be achieved in an open office. The principles and descriptors apply to usual situations in terms of acoustic disturbance, privacy and discretion. They also include the working practices inherent to these spaces and the expectations of the organisations that use them regarding productivity and the well-being of employees.

This document reflects the technological and economic context of office construction in relation to both operations in unfurnished offices and resulting layout practices. In addition, this document reflects the expectations of the end users, based on the experience from the members of the commission and publications available at the date the text was drafted.

Acoustics — Acoustic quality of open office spaces

1 Scope

This document provides technical guidance to achieve acoustic quality of open office spaces to support dialogue and formal commitment between the various stakeholders involved in the planning, design, construction or layout of open-plan workspaces: end customers, project owners, prescribers, consultants, etc.

It is applicable to all open-plan offices in which the following activities are performed:

— Space type 1: activity not known yet – vacant floor plate;

— Space type 2: activity mainly focusing on outside of the room communication (by telephone/audio/video);

— Space type 3: activity mainly based on collaboration between people at the nearest workstations;

— Space type 4: activity based on a small amount of collaborative work;

— Space type 5: activity that can involve receiving public;

— Space type 6: combining activities within the same space.

More specifically, this document applies to refitting projects of existing business sites (renovation and/or change or add activities) and layout projects for new spaces and spaces delivered unfurnished.

It covers both the activities and the operations of the following stakeholders:

— end customers: diagnosis, survey, expression of needs in keeping with their knowledge in the area of acoustics;

— project owners: drafting contract specifications;

— project management companies (architects, acousticians, ergonomists, economists and consulting engineers): indicating the performance of acoustic solutions and the layout principles used to achieve the result expressed in the specifications;

— building traders: reaching a clear and verifiable target with respect to the choices of materials and implementation;

— Building developer: promoting indoor environmental quality, including acoustic comfort, in estate operations in order to use it as a competitive element;

— specialists in occupational health, safety and quality;

— expert assessments and consultancy.

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 354, *Acoustics — Measurement of sound absorption in a reverberation room*

ISO 11654, *Acoustics — Sound absorbers for use in buildings — Rating of sound absorption*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1 General terms

3.1.1
target value
value set as an indication in order to evaluate a situation and act upon it

Note 1 to entry: Compliance with a target value is not a requirement of this document.

3.1.2
required value
value set as an objective

Note 1 to entry: Compliance with required values is a requirement of this document.

3.2 Terms related to the workspace layout

3.2.1
office
space where professional or administrative duties are performed

3.2.2
open-plan space
open-plan office
open space
shared space
workspace designed to accommodate multiple persons working without full separation between workstations

Note 1 to entry: The activities performed in an open-plan space can be discriminated: telephone, administrative work, etc.

3.2.3
workstation
position occupied to perform a task

3.2.4
workspace
open-plan space (3.2.2), in which the workstations required to perform the activity are distributed

3.2.5
open-plan space area
total floor area, in square metres, of the open plan office

EXAMPLE Areas, floorplates.

3.2.6
occupancy ratio
number of workstations occupied at a given time, divided by the total number of workstations

3.2.7
divider and screen
vertical partition, which partially divides the space and crosses the virtual line joining a noise source (e.g. someone speaking) and a reception point

Note 1 to entry: It can be composed of several assembled items. In particular, it is used to:

— reduce sound propagation between workstations;

— provide extra absorption;

— delimit a route for movement between a set of workstations;

— delimit acoustically an area for informal, short discussions in an open-plan space;

— confine a source of occasional noise, such as a photocopier, fax machine, water fountain, etc.

3.2.8
screen fixed to the worktop
low divider
vertical item held by the worktop, used to delimit the workstation visually, reduce noise between workstations and can provide acoustic absorption close to users

Note 1 to entry: This screen can be installed in front or to the side of the user.

3.2.9
activity
physical actions and interactions that people undertake in the workplace environment

EXAMPLE Individual work, collaboration, communication, recreation and restoration.

3.3 Terms related to acoustics

3.3.1
intelligibility
percentage of speech understood

3.3.2
noise disturbance
physiological (sensory) and psychological (perceptual and cognitive) process incurred by intrusive unwanted sound, which tends to create a situation of unease or discomfort by disturbing the concentration of an individual

Note 1 to entry: Among others, it depends on physical factors such as noise level, frequency and repeatability of the acoustic phenomena, to which the individual is subjected. Different sources cause different disturbances. It is noted that other non-acoustic factors can affect noise disturbance. Generally, individuals' sensitivity to noise disturbance is not the same.

3.3.3
discretion
situation obtained when an effort is required to understand the content of a conversation emitted from a neighbouring workstation

Note 1 to entry: Under these conditions, conversation is not a cause of distraction. A high level of discretion reflects low intelligibility and rapid decrease in the energy coming from the source workstation.

3.3.4
Lombard effect
phenomenon of a person unconsciously altering his/her way of speaking (adaptation of fundamental frequency, sound level and articulation) to make up for the presence of surrounding noise and to be better understood by his/her conversation partners

3.3.5
social and welfare spaces
spaces designed specifically for social interaction

Note 1 to entry: These type of spaces may not be compatible with operation of open plan offices, if the spaces are physically connected, used simultaneously and without regard to normal working operations.

Note 2 to entry: Game areas utilising table tennis, table football or with gym equipment can be very disruptive to office working and need to be carefully managed and/or physically separated.

3.3.6
signal-to-noise ratio
arithmetical difference between the signal level and the disturbing noise level

Note 1 to entry: The signal-to-noise ratio is given in dB.

3.4 Acoustic descriptors and related terms

3.4.1
workstation noise level
$L_{\mathrm{Aeq},T}$
LAeq is the A-weighted, equivalent continuous sound level in decibels measured over a stated period of time T:

$$L_{\mathrm{Aeq},T} = 10\lg\left[\frac{1}{t_2 - t_1}\int_{t_1}^{t_2}\left(\frac{p_{\mathrm{A}}^2(t)}{p_0^2}\right)\mathrm{d}t\right]\ \mathrm{dB}$$

where

T is a time interval starting at t_1 and ending at t_2 (s);

p_0 is the reference acoustic pressure value ($p_0 = 2 \times 10^{-5}$ Pa);

$p_{\mathrm{A}}(t)$ is the instantaneous A-weighted sound pressure at the workstation (Pa).

Note 1 to entry: The noise level at the workstation is measured with normal activity in the room (with office equipment operating and a human presence).

Note 2 to entry: The measurement is performed as described in Annex E.

3.4.2
spatial decay rate of speech
$D_{2,\mathrm{S}}$
rate of spatial decay of A-weighted sound pressure level of speech per distance doubling

Note 1 to entry: Spatial decay rate of speech is expressed in decibels (dB).

Note 2 to entry: S refers to "speech".

[SOURCE: ISO 3382-3:2012, modified — Original Note deleted, new Notes to entry 1 and 2 were added.

3.4.3
reverberation time
T_{r}
time, in seconds, required for the existing noise level inside a room to decrease by 60 dB, when the noise source is instantly interrupted

Note 1 to entry: Reverberation time is determined by octave bands for frequencies from 125 Hz to 4000 Hz and is defined in ISO 3382-2:2008.

Note 2 to entry: In this document, Engineering level accuracy should be used for the measurement of reverberation time according to ISO 3382-2.

Note 3 to entry: Microphone positions should be between 2 m and 8 m from the sound source, while still respecting the minimum distance described in ISO 3382-2.

3.4.4
in situ acoustic attenuation of speech
$D_{A,S}$
difference, in decibels, between an A-weighted speech source spectrum at 1 m from an omni-directional source in the free field and the A-weighted sound pressure level at a reception point

Note 1 to entry: Calculation method is detailed in Annex A.

Note 2 to entry: S refers to "speech".

3.4.5
A-weighted sound pressure level of speech at a distance of 4 m
$L_{p,A,S,4\ m}$
nominal A-weighted sound pressure level of normal speech at a distance of 4 m from the sound source

Note 1 to entry: The measurement position does not need to be located at this distance from the sound source. $L_{p,A,S,4\ m}$ is obtained using a linear regression line from the spatial sound distribution of the A-weighted sound pressure level (SPL) of speech.

Note 2 to entry: S refers to "speech".

[SOURCE: ISO 3382-3:2012, modified — Note to entry 2 was added.

3.4.6
A/S_{Floor}
equivalent absorption area divided by the floor surface area

3.4.7
weighted standardized level difference
$D_{nT,w}$
single indicator constituted by the value at 500 Hz, expressed in decibels, of a reference curve, applied to standardized level difference, D_{nT}

Note 1 to entry: The reference curve is as defined in ISO 717-1.

Note 2 to entry: The standardized level difference, D_{nT}, is defined by ISO 16283-1 as the difference between the sound pressure levels created by a source in one of the rooms affected by the reverberation time T in the receiving room applied to a reference reverberation time T_0.

3.4.8
insulation from internal airborne noise
$D_{nT,A}$
sum of the *weighted standardized level difference* (3.4.7) and matching factor C

Note 1 to entry: The matching factor C is defined in ISO 717-1.

3.4.9
normalized flanking level difference
$D_{n,f}$
difference in the space and time averaged sound pressure level produced in two rooms by one or more sound sources in one of them, when the transmission only occurs through a specified flanking path and the result is normalized to an equivalent sound absorption area in the receiving room according to:

$$D_{n,f} = L_1 - L_2 - 10\lg\frac{A}{A_0}$$

where

L_1 is the average sound pressure level in the source room, in dB;

L_2 is the average sound pressure level in the receiving room, in dB;

A is the equivalent sound absorption area in the receiving room, in m^2;

A_0 is the reference equivalent sound absorption area, in m^2; $A_0 = 10\ m^2$.

Note 1 to entry: This quantity is expressed in decibels.

Note 2 to entry: For clarity, the term $D_{n,f}$ is used when only one flanking path determines the sound transmission (such as with suspended ceilings) and the term $D_{n,f,ij}$ is used when only one specified transmission path *ij* out of several paths is considered (such as with structure-borne sound transmission on junctions of three or four connected elements).

[SOURCE: ISO 10848-2:2017, 3.1]

3.4.10
maximum sound level
L_{max}
Maximum A weighted sound level, during a measurement period or a noise event.

4 General approach

4.1 Introduction to the general approach

An open-plan space is often promoted as a flexible space, a space for communication (visual and oral) and activity associated with a job, and for discussion, where information flows freely. However, not all the speech generated in an open-plan office is always helpful to the work of persons in every area of this space. As such, open-plan office acoustics involves combined management of co-occupancy, communication and concentration options required for performing individual activities. To find an optimum solution in an open-plan space and fully understand the complexity of its acoustics, employee activity, interactions and relative distances between workstations, work teams and departments should be taken into account for a given open-plan space. Site environment and the technical and architectural constraints should also be considered.

4.2 Methodology

This document aims to guide the design, building and layout of open-plan workspaces. It makes no recommendation on adopting or modifying the individual or social behaviour of people at work. However, it takes them into account as determining elements of the acoustic environment.

This document defines six types of open-plan space covering all existing activities and to which the reader shall refer for subsequently applying the related acoustic criteria. For each type of activity, this document sets target values and required values (see 3.1.1 and 3.1.2).

To comply with this document, all the required acoustic criteria defined shall be met for each space type. In the case of combining multiple activities, it is intended to respect set up values defined for each activity when defined. The chosen criteria are simple and verifiable, so they can be included and used in a contractual framework by all parties responsible for an open-plan space building or renovation process.

This document cannot anticipate individual perception, which is also linked to working conditions and the way rooms are used. The document therefore offers a comprehensive approach to assisting management of the acoustic component in open-plan projects.

It includes the following tools that shall be implemented:

— calculation method on $D_{A,S}$: specified in Annex A

— a flow chart summarising the whole approach: specified in Annex B, in B.1 (renovation) and B.2 (new building),

— an aid to analysing layouts: Workspace layout and room acoustics, specified in 6.1, 6.2 and 6.3,

— an aid to identifying existing acoustic treatments and priorities: specified in 6.4.

Additional recommendations and information:

— a charter on collective use of open-plan spaces: etiquette, see Annex C,

— a model survey of the acoustics of open-plan offices for users: see Annex D,

— minimum optional requirements for measuring $L_{Aeq,T}$ during the activity: see Annex E,

— sound masking systems: see Annex F,

— acoustic indicators and values when the activity is not known yet: see Annex G.

The following tools can be used to support every step of a project as defined in Annex B.

5 Typology, acoustic challenges and requirements

5.1 General

Open-plan spaces shall be adapted to support the activities undertaken therein. The noise environment (number of noise sources, noise source level, etc.) can be very different depending on the type of activities.

The acoustic challenges specific to these spaces call upon closely linked notions of intelligibility and discretion: the same words can convey a helpful message for one employee and be a source of disturbance for another. A compromise between intelligibility for communication helpful to an activity and discretion shall therefore be sought in order to reduce disturbance at more distant workstations.

This document defines below six types of open-plan space, which cover all existing activities and to which the reader shall refer for subsequent application of the related acoustic criteria.

Open plan offices are not suitable for activities, which require confidential communication.

5.2 Space type 1: activity not known yet – vacant floor plate

5.2.1 Description

In this particular situation, the activity is not yet precisely defined. This is the case when property developers or a landholding trust are building office spaces. Yet, some attention needs to be brought to some basic acoustic criteria so that the offices are acoustically acceptable.

5.2.2 Noise environment characterising this type of space

Any future fit-out is reliant on the basic provision of the base build. The base build therefore requires adequate flexibility to accommodate a diverse range of tenancy and fit-out requirements. The less flexible the base build provision, the less attractive it is to property agents who market it, and tenants who may want to fit out the space.

5.2.3 Acoustic challenges

A blank office space is developed to be later partitioned and furnished depending on the end user. Thereby, the main acoustic challenge is to create adequate condition for a later office planning corresponding to desired objectives. Assuming that external noise intrusion and building services

noise are adequately controlled, and there is a good provision of sound insulation between adjacent tenant areas, the room acoustics requires consideration. For basic informative values, refer to national regulations or refer to Annex G.

5.3 Space type 2: activity mainly focusing on outside of the room communication (by telephone/audio/video)

5.3.1 Description of the activity

The activities performed are diverse and mainly performed over the telephone: sales, technical assistance, information services, prospecting, surveys, emergency services, etc.

They can be defined as non-diverse and non-collaborative.

The spaces accommodating these activities are often referred to as customer relations centres, call centres, contact centres, etc.

5.3.2 Noise environment characterising this type of space

There are multiple noise sources and they generate a significant ambient noise level, which can affect the vocal effort of all employees due to the Lombard effect.

Oral communication between employees can take place between calls.

Conversations within a team (colleagues, supervisor or manager) take place at the workstation (short conversations) or in areas adjacent to the open-plan space (long conversations, training sessions, etc.).

The general acoustic environment shall enable performance of intellectual work requiring a medium-to-high concentration level. It shall limit fatigue by ensuring the operator's comfort, knowing that vocal effort is all the greater when ambient noise level is high.

5.3.3 Acoustic challenges

The main acoustic challenge is to limit aural exposure to the ambient noise and to the noise level of the personal telephone system.

The aim is to obtain a high level of intelligibility with a telephone conversation partner to minimise noise level in the ear and operator vocal effort.

There is little requirement for collaborative work, so greater discretion between workstations is sought. The method involves controlling and minimising reverberation and sound propagation phenomena.

5.3.4 Acoustic indicators and values

See Table 1.

Table 1 — Acoustic indicators and values — Activity mainly focusing on outside of the room communication (by telephone/audio/video)

Interaction	Acoustic challenges	Description, criterion	Target values	Required values
At workstation	Improving intelligibility at workstation (telephone activity: frequent short conversations) Limiting noise exposure	Achieving a suitable signal-to-noise ratio	$L_{Aeq,T} \leq 55$ dB [a]	
Between workstations	Reducing disturbance between adjacent workstations	Increasing discretion by reducing intelligibility between workstations		Attenuation $D_{A,S} \geq 6$ dB
On the floorplate	Minimising effect of many simultaneous sources Preventing "Lombard" effect Reducing voice-related disturbance	Attenuating amplification inherent to room as much as possible by reducing reverberation Reducing voice propagation in room		$T_r \leq 0{,}5$ s [b] $T_r \leq 0{,}8$ s at 125 Hz Noise reduction inside room $D_{2,S} \geq 7$ dB $L_{p,A,S,4\,m} \leq 47$ dB

[a] During activity (see Annex E).

[b] Arithmetic mean of times for octave bands centred on 250 to 4 000 Hz.

5.4 Space type 3: activity mainly based on collaboration between people at nearest workstation

5.4.1 Description of activity

This type of space is laid out mainly for collaborative or project group work. Communication between employees is often spoken aloud but also comprises telephone conversations. Persons can also be required to perform short individual tasks requiring limited concentration.

This type of space is suitable for advertising agencies, creative/marketing departments, consulting engineers, etc.

The work performed is varied and collaborative.

5.4.2 Noise environment characterising this type of space

Simultaneous sources can be relatively numerous and, above all, vocal behaviour fluctuate, giving a lively atmosphere involving multiple interactions.

The general acoustic environment shall support oral collaborative work between persons from the same team. On the other hand, acoustic discretion between teams should be optimized.

5.4.3 Acoustic challenges

A high level of intelligibility between workstations within a single team is required. Acceptable intelligibility with respect to telephone conversations is also required.

On the assumption that the teams perform independent activities, they shall not interfere with each other. A high level of acoustic discretion between two teams operating close to each other should therefore be achieved.

5.4.4 Acoustic indicators and values

See Table 2.

Table 2 — Acoustic indicators and values — Activity mainly based on collaboration between people at the nearest workstation

Interaction	Acoustic challenges	Description, criterion	Target values	Required values
At workstation	Ability to communicate without raising voice	Good to excellent intelligibility at workstation when speaking normally	$L_{Aeq,T} \leq 52$ dB [a]	
Between workstations	Communicating between team members Satisfactory intelligibility within team when speaking normally	Moderate attenuation between same team workstations		Attenuation $D_{A,S} \geq 4$ dB
On floorplate	Reducing disturbance between teams	Attenuating amplification inherent to room as much as possible by reducing reverberation Reducing noise in room by doubling distance		$T_r \leq 0{,}5$ s [b] $T_r \leq 0{,}8$ s at 125 Hz $D_{2,S} \geq 8$ dB $L_{p,A,S,4\ m} \leq 48$ dB

[a] During activity (see Annex E).

[b] Arithmetic mean of times for octave bands centred on 250 Hz to 4 000 Hz.

5.5 Space type 4: activity based on a small amount of collaborative work

5.5.1 Description of activity

This type of space is laid out for mainly individual work, which may involve very occasional, short discussions. Typically, it is used for performing jobs that involve administration, accounting, human resources, procurement, etc.

There is a high level of employee concentration. The tasks may be varied within a team and there is not much collaborative work.

Discussions cannot be held in this type of space to avoid disturbing colleagues and for reasons of privacy. Private areas shall therefore be provided.

Activity in such spaces may be defined as individual, less diverse and less collaborative.

5.5.2 Noise environment characterising this type of space

Personnel are mainly grouped into services of around ten people, who may occasionally communicate with each other. Oral communication between these persons takes place in a quiet voice and is quite short (sporadically, among colleagues or by telephone). As such, the ambient noise level is low.

The general acoustic environment shall support performance of intellectual work requiring a high level of concentration by curtailing disturbance by conversations in other departments.

5.5.3 Acoustic challenges

The acoustic challenge is to achieve a high level of intelligibility at the workstation, reduce intelligibility between adjacent workstations (except for occasional conversations) and reduce distraction between different services operating on the same floorplate.

5.5.4 Acoustic indicators and values

See Table 3.

Table 3 — Acoustic indicators and values — Activity mainly based on a small amount of collaborative work

Interaction	Acoustic challenges	Description, criterion	Target values	Required values
Workstation	High level of intelligibility at workstation	Low ambient noise Intelligibility good to excellent when speaking at normal level	$L_{Aeq,T} \leq 48$ dB [a]	
Between workstations	Need for discretion among workstations Average intelligibility among workstations	High level of attenuation		Attenuation $D_{A,S} \geq 6$ dB
On floorplate	Reducing disturbance from conversations in other services	Attenuating amplification inherent to room as much as possible by reducing reverberation Reducing noise in room by doubling distance		$T_r \leq 0{,}5$ s [b] $T_r \leq 0{,}8$ s at 125 Hz $D_{2,S} \geq 7$ dB $L_{p,A,S,4m} \leq 47$ dB

[a] During activity (see Annex E).

[b] Arithmetic mean of times for octave bands centred on 250 Hz to 4 000 Hz.

5.6 Space type 5: activity that can involve receiving public

5.6.1 Description of activity

This type of space can correspond to reception areas at public organisations, insurance agencies, banks, shops, etc.

Organised for personal meetings, this space shall enable lots of interaction between site personnel and customers. It is laid out to accommodate visitor reception and individual work. Visitors may be received standing up, facing "counter"-type workstations, or seated at "desk"-type workstations. Staff may have to enter data and draft reports between meetings; this requires a fairly sustained level of concentration.

Most of the time, there is little collaborative work and discussions are mainly held face to face with the customer.

Discussions between employees and customers are often directly linked to personal life and therefore a high level of discretion shall be ensured.

5.6.2 Noise environment characterising this type of space

The main sources of noise are located in the outside environment (music, traffic and events), equipment noise, incoming call signals and discussions among persons in the room.

Voice levels in this type of space may vary significantly depending on the job and the variation in room activity (e.g. busy periods).

The ambient noise level is generally very high. Noise emissions are regular and are sometimes very distinct.

5.6.3 Acoustic challenges

The ambient noise level shall not disturb intellectual work and shall allow concentration.

Intelligibility shall be excellent at the "customer reception" workstation, low between waiting areas and "customer reception" workstations and low between different "customer reception" workstations.

5.6.4 Acoustic indicators and values

See Table 4.

Table 4 — Acoustic indicators and values — Activity can involve receiving public

Interaction	Acoustic challenges	Description, criterion	Target values	Required values
Workstation/ counter	High level of intelligibility at workstation	Acceptable ambient noise	$L_{Aeq,T} \leq 55$ dB [a]	
Between workstations	Need for discretion between workstations	High level of attenuation		Attenuation $D_{A,S} \geq 6$ dB
On the floorplate	Ensuring that ambient noise level at reception workstations shall not disturb intellectual work or concentration and shall ensure a high level of comfort. Providing adequate isolation from outside noise Minimising extent of disturbance due to noise emissions (customer, incoming call, signals, etc.)	Attenuating amplification inherent to room as much as possible by reducing reverberation Providing adequate isolation from outside noise		$T_r \leq 0{,}8$ s [b] $T_r \leq 1{,}0$ s at 125 Hz $L_{Aeq,1hr} \leq 50$ dB - unoccupied

[a] During activity (see Annex E).

[b] Arithmetic mean of times for octave bands centred on 250 Hz to 4 000 Hz.

5.7 Space type 6: combining activities within the same space

5.7.1 Description of activities

This type of space is laid out to accommodate a variety of activities within the same space. Activities can include:

— Focused individual work in a designated focus area for greater noise control;

— Individual task-based work at a workstation, in an area with small amounts of collaboration, talking, discussion;

— Collaboration, either focused or creative, in a one-to-one situation, informal meeting area or chat booth;

— Telephone/communication with people who are not adjacent;

— Informal working, which may involve collaboration or individual work, in an area that does not have noise control etiquette;

— Non-work activity, which may include refreshment, recuperation, physical and wellbeing;

— Formal meeting spaces which are not provided with acoustic privacy from the remaining spaces;

— Formal meeting spaces which are provided with acoustic privacy from the remaining spaces, usually with full height partitions and a door;

— Social and welfare.

5.7.2 Source/receiver

The variation of activity source levels, and corresponding sensitivity to noise emission and intrusion, means that attention to the potential noise impacts is vital to enable these spaces to work effectively as intended.

5.7.3 Noise environment characterizing this type of space

Noise levels and sensitivity to noise of the activities listed above are different. Adjacencies between areas intended for increasingly different activities would require increasing acoustic separation. Different activities best suited to different acoustic environments can co-exist if suitably separated from one another.

5.7.4 Acoustic challenges

Enabling a lively atmosphere in one area while simultaneously maintaining a calmer environment in other parts of the space requires sufficient acoustic separation. The acoustic design can support reasonable proximity between different types of spaces.

5.7.5 Acoustic indicators and values

The greater the difference in activity and sensitivity to noise, the greater the attenuation that is appropriate between activities. For example, the impact from activities that involve continuous talking should be mitigated to a greater degree than noise from activities that involve intermittent or occasional talking.

Table 5 — Workstation noise levels assumed for different types of activity

Receiver space type	Informal meetings (open plan)	Outside of the room communication (phone)	Collaborative	Non-collaborative	Focused phone	Focused individual work
Workstation noise level (dBA)	48	48	45	42	42	40

If suitable workstation noise levels are assumed for each type of space, as noted in Table 5 above, the in situ level difference $D_{A,S}$ can be determined between different types of spaces based on an A-weighted source speech level of 57 dB at 1 m. See Table 6.

Table 6 — Potential $D_{A,S}$ ratings between different types of spaces[6]

Source/receiver space type	Informal meetings (open plan)	Outside of the room communication (phone)	Collaborative	Non-collaborative	Focused phone	Focused individual work
Social and welfare	15	15	18	24	27	32
Informal meetings (open plan)	15	12	15	21	24	29
Outside of the room communication (phone)			12	18	21	29
Collaborative				18	21	26
Non-collaborative					18	23
Focused phone					21	26
NOTE 1 In order to keep the noise level within the social and welfare space under control and avoid Lombard effect, a certain amount of absorption is needed. It is recommended to have an absorption area of at least 90 % of the floor surface. A/S_{Floor} = 0,9.						
NOTE 2 These values are derived based on assumptions regarding background sound levels, source vocal effort, and proposed signal to noise ratios. These values may vary depending on the context.						

6 Workspace layout and room acoustics

Workspace layout and work organisation shall correlate closely. An open-plan space is only successful if there is coordination and convergence of viewpoints among line management, facility or furnishing services, occupational physicians, prevention specialists and open-plan space users. Workstations in this space are organised on a team-by-team basis after analysing flows and interactions between activity-related teams and production or department objectives.

General recommendations:

— all cooperating workstations should be grouped together (teams, projects);

— different teams or services should be separate, even if occasional cooperation is possible;

— movements between workstations and supporting spaces such as a photocopying area, meeting rooms, etc. should be optimized. Distinction should be made between supporting spaces directly available to open-plan space users (nearby supporting areas including break areas and meeting rooms) and supporting spaces that do not need to be directly associated or on the same floor as the relevant open-plan space (e.g. cafeterias or training rooms);

— adjacent supporting spaces should be used as much as possible to structure the open-plan space. Separations may be used, if distance is lacking;

— movement areas should be delimited visually (marked) to separate the workspaces from movement flows through the open-plan space;

— doors should be used to isolate supporting areas from the open-plan space are designed not to cause disturbance (clearance or acoustic insulation).

These measures can be taken while in compliance with usual regulations governing workspace design, particularly in relation to personal safety and accessibility.

6.1 Dimensions and geometry of open-plan space

It is indisputable that the area per occupant is a determining factor for the ambient noise level: for the acoustician, this surface makes it possible to calculate the density of noisy sources (the occupants) in the room. It is obvious that it participates in determining the overall noise but it is difficult to set a

value because it is not the only factor. Some ergonomic national standards recommend between 10 m^2 and 15 m^2 per occupant.

The geometry of the open-plan space may have a significant impact on the acoustic environment. It shall therefore be optimised such that cooperating workstations are near to each other and independent workstations are as far away as possible.

Open-plan spaces are geometrically characterised by a ceiling height that is much lower than the length and width of the room. This geometric relation is to be conserved as far as possible to increase the decay rate by doubling distance. Shaped corridors (walls too close) are to be avoided because they encourage voice propagation, which may affect cognitive activity.

6.2 Position of support spaces with respect to open-plan space

Coffee machines, break and recreational areas shall be located outside the open-plan space. Moreover, they shall be isolated by walls featuring suitable acoustic insulation. There shall be no direct access from one space to another and a buffer space, a minima, shall be integrated between them.

Private offices and small meeting rooms can be located near to the open-plan space. Their number can vary, depending on the activity, from 1 to 3 private rooms per 15 workstations. When directly linked to the open-plan space, these spaces shall meet lateral insulation requirements $D_{nT,A} \geq 40$ dB.

If the open-plan space is accessed from a floor landing door, which is used as a fire door, provision of an airlock entrance may be judicious because of the noise generated by forced closure of such doors. In all cases, great care should be taken in respect of potential noise, which may be generated by accessing the open-plan space, noise from adjacent spaces, which may be transmitted when opening an access door of this type, and noise caused by staff movements.

Oftentimes circulations within the open-plan can cause significant distraction, both from acoustical and a visual standpoint. Precautions should be taken regarding the position and the visibility of circulation path within the open-plan.

6.3 Distance between workstations in open-plan spaces

Distraction distance is the distance beyond which speech distraction reduces. Sound level decay shall be increased in order to reduce distraction distance. This may be achieved by implementing suitable acoustic treatment. This document aims to achieve this reduction without the use of sound masking systems (see Annex F).

The purpose of the required values quoted in this document is to limit the distraction distance below 5 m in recommended usage situations (target values). Beyond this distance, there is a reduction of disturbance from speech.

6.4 Principles of room acoustic treatment

6.4.1 General

The acoustic treatment of a room involves covering its surfaces (ceiling, floor and walls) with absorptive acoustic material to limit sound reflection. The more efficient the material (i.e. high absorption coefficient) and the larger and more uniform the treated surface, the more effective the acoustic treatment. Control of room acoustics results from a combination of the effects of each treated surface and partition. Surfaces exposed to a sound field should be treated as a priority. The values quoted in 6.4.2, 6.4.3 and 6.4.4 are provided for information purposes only and shall be subject to a study specific to each project.

6.4.2 Ceiling treatment

The ceiling is the most important reflecting surface in open plan offices; it should be as absorptive as possible. A full coverage of the ceiling should be preferred. A high weighted absorption coefficient is close to 1. Weighted Absorption coefficient needs to be calculated according to ISO 11654

NOTE The ceiling surface cannot be fully treated, when trying to take advantage of the building thermal inertia. In this case, treatment methods using suspended absorptive elements covering approximately 50 % to 60 % of the open-plan space ceiling surface is preferred. To increase spatial decay, treatment elements are placed as low as ergonomic requirements permit because floating island solutions of this type are all the more effective when their top surfaces are exposed to the sound field.

6.4.3 Wall treatment

The proportion of wall surfaces compared to the ceiling is low in an open-plan space. However, use of wall absorbers can limit reflections for workstations close to walls and especially at corners in the open-plan space. Such absorbers can be useful for curtailing flutter echo between parallel walls. This is also a good way to reduce reverberation, if diffusion is low (little furniture).

If there is a risk of absorptive material damage, stress-resistant treatments should be favoured and should be positioned above potential impact level. Wall coverings should be installed at approximately 1,2 m above the floor: the height of a seated person's ears.

6.4.4 Floor treatment

Floor covering absorption performance is limited, so its contribution to general absorption inside the room is not usually significant. Special coverings with acoustics layers in the floor cover can support mid and high frequency absorption. Perforated cavity flooring systems can deliver broad band absorption.

The main benefit of proper floor covering selection for acoustic treatment is less impact noises associated with movement of people and furniture.

In the case of the use of access flooring, a special attention should be brought to the use of structure insulation to prevent impact noise and limit resonance of footsteps throughout the office.

6.5 Effect of type of furniture

6.5.1 Principle

In general, furniture is insufficient for overcoming the acoustic challenges of an open-plan space, so room surface treatment shall be prioritised.

On the other hand, choice of furniture has an impact on the distribution of people and the room sound field. The use of furniture with sound absorbing surfaces can reduce the need for additional sound absorbing surfaces.

Furniture should reflect the work and activity organisation model.

It should be suitable for collaborative work, when this is necessary.

For workstations not used for collaborative work, furniture shall be selected to create as much distance as possible between workstations and shall include items favouring attenuation, such as workstation dividers and workspace dividers or high storage furniture (over 1,3 m) to maximize sound attenuation between workstations.

Cabinets and storage furniture may be used to separate visually office areas from movement areas or to delimit spaces dedicated to each team/activity. Such items may also be treated (perforations, coverings) to make them partially absorptive and therefore increase the absorption quantity in the room. Materials shall be tested in accordance with ISO 354 and rated according to ISO 11654 to be considered as absorptive.

Furniture (low dividers, screens or cabinets) integrating absorptive materials should be used.

6.5.2 Screen fixed to worktop (low divider), free-standing screens and suspended screens

Screens shall be high enough to interrupt direct path of speech from one workstation to another or between clusters of workstations; and so that sound diffracted over is sufficiently reduced to allow acceptable speech privacy. To reduce sound propagation across the space, screens extending below the desk can complement the screen above the desk[1].

Screen performance is assessed in relation to absorption and attenuation. It depends on type of screen facing material, their surface density and screen dimensions.

In situ performance of screens and low dividers also depends on the absorption performance of ceilings and adjacent wall surfaces.

Depending on the activity, the height of acoustic screens separating workstations shall be retained to obtain the best compromise between acoustic attenuation and visibility[2]. Opaque screen above 110 cm will be satisfactory for 95 % of the population where visual interaction is required whilst seated. Whereas above 140 cm it will only be satisfactory to 5 % of the population.

Ergonomic parameters associated with heights of screens fixed to worktops are laid down in EN 527-1:2011.

Table 7 — Attenuation values, $D_{A,S}$, (for information only) measured in a semi-anechoic chamber at French National Research Institute for the Prevention of Occupational Accidents and Diseases (INRS)

Separating screen height Cm	Attenuation between workstations without absorptive treatment (plaster ceiling) dB	Attenuation between workstations with ceiling treatment where Alpha w = 1 dB
110 (35 cm above the table)	1,1	3,6
120 (45 cm above the table)	1,7	4,5
130 (55 cm above the table)	2,4	5,4
140 (65 cm above the table)	2,9	6,3
150 (75 cm above the table)	3,4	6,5

If visibility isn't the priority suspended screens between clusters are an efficient way to reduce sound propagation.

6.6 Accessibility and special needs

The accessibility of people with impairment in hearing functions, voice or speech should be taken into consideration when acoustically designing office spaces.

Design considerations that can facilitate accessibility with regard to impairment in hearing include the following:

— multiple means of information presentation such as visual (text or pictures) or tactile to supplement or substitute for auditory information;

— appropriate volume, pitch and frequency of spoken announcements, warnings and warning sounds in relation to context of use;

— adjustable volume over a wide range and with multiple frequencies;

— avoidance of sudden changes in volume of auditory signals;

— constant signal-to-noise ratio between the level of an announcement and that of the background noise;

— group assistive listening devices or communication systems such as induction loops, infrared or radio systems;

— emergency announcements that are visual with text, and where appropriate, in sign language, as well as of an appropriate volume and pitch decrease risk for persons with hearing impairment;

— a good acoustic environment, that reduces background sounds and promotes sound that is important to be heard;

— accommodation for and compatibility with relevant assistive products, assistive technology and supports.

NOTE Assistive products, assistive technology and supports for persons with hearing impairments and deafness include sign language, communication assistants, assistive listening devices (ALDs), visual communications technologies, live captioning, telecommunications devices for the deaf (TDD/TTY), text telephones, speech recognition technology, alerting devices with visual signals or vibration, hearing aids (traditional hearing aids and/or implants).

Design considerations that can facilitate accessibility with regard to voice and speech impairment include the following:

— alternative forms of communication such as via text, facial expressions, hand movements or signs, body postures, and other forms of body language;

— augmentative and alternative communication based on symbols, aids, techniques, and/or strategies;

— support for the use of assistive products such as speech synthesizers and communication amplifier and video communication;

— provision of alternative means to interact with interactive voice systems and intercom systems, such as real-time text.

Annex A
(normative)

Detailed definition and measurement method of the $D_{A,S}$ parameter

A.1 Detailed definition

The reasons for determining positions of a sound source and a reception point should be recorded with the measured value. It is considered that in situ acoustic attenuation can be measured between nearby workstations, forming a single work team, as well as from one group of workstations to another, i.e. from work team to work team.

The global A-weighted in situ level difference for a speech spectrum is

$$D_{A,S} = L_{p,A,S,1m} - L_{p,A,S} \quad (A.1)$$

where

$L_{p,A,S,1m}$ is the A-weighted sound pressure level at a distance of 1 m in the free field from the acoustic centre of the loud speaker source for a speech source spectrum;

$L_{p,A,S}$ is the A-weighted sound pressure level at a certain point for the speech source spectrum.

Attenuation is typically measured with a calibrated sound source and an approximately pink noise signal. In this case the sound pressure level in each octave band is measured at a certain point, and the global A-weighted attenuation calculated using the source calibrated data, the octave band in situ levels, and a speech source spectrum. The octave band in situ level difference is

$$D_i = L_{p,S,1m,i} - L_{p,i} \quad (A.2)$$

where

$L_{p,S,1m,i}$ is the sound pressure level at a distance of 1 m from the acoustic centre of the source;

$L_{p,i}$ is the sound pressure level at a certain point;

i is the i^{th} octave band from 125 Hz to 8000 Hz

Use the speech source sound pressure levels (see Table A.1), for an omni-directional source, and add the A-weighting for each octave band. Calculate the level at the receiver position by adding the in situ octave band level difference, D_i to each A-weighted octave band source level:

$$L_{p,A,S,i} = L_{p,A,S,1m,i} - D_i \quad (A.3)$$

where

$L_{p,A,S,i}$ is the A-weighted i^{th} octave band level

$L_{p,A,S,1m,i}$ is the A-weighted sound pressure level at 1 m from an omni-directional source in the i^{th} octave band.

Table A.1 — Sound pressure levels of speech at a distance of 1 m in free field
[Source: **ISO 3382-3:2012**]

Band No. i	**Frequency** Hz	**Sound pressure level** $L_{p,S,1m}$ dB re 20 µPa	**A weighting**
1	125	49,9	-16,1
2	250	54,3	-8,6
3	500	58,0	-3,2
4	1 000	52,0	0
5	2 000	44,8	1,2
6	4 000	38,8	1
7	8 000	33,5	-1,1
	A-weighted	57,4	

Finally, the global A-weighted values at 1 m from the source is the sum of the A-weighted octave band levels:

$$L_{p,\mathrm{A}} = 10\lg\left(\sum_{i=1}^{7} 10^{\left(\frac{L_{p,\mathrm{A},S,i}}{10}\right)}\right)\mathrm{dB} \tag{A.4}$$

$$L_{p,\mathrm{A},S,1\mathrm{m}} = 10\lg\left(\sum_{i=1}^{7} 10^{\left(\frac{L_{p,\mathrm{A},S,1\mathrm{m},i}}{10}\right)}\right)\mathrm{dB} \tag{A.5}$$

A.2 Measurement method

When assessing $D_{\mathrm{A,S}}$ values it is not necessary to evaluate all possible combinations of source and receiver workstations. Rather, it is important to identify the combinations which have the most adverse adjacency, and are thus most at risk of yielding $D_{\mathrm{A,S}}$ values outside the required range. Examples of potential low value combinations are workstations in close proximity to each other, without dividing screens in their lines-of-sight, and/or in close proximity of other hard surfaces. The opposite applies where a maximum value is required between workstations. NB: a position in close proximity that has a screen in the line of sight can yield higher $D_{\mathrm{A,S}}$ values than a position further away that has an unobstructed line of sight.

Source and microphone positions should be at positions representative of the source and the receiver positions, respectively. The heights of the respective acoustic centres of the source and the microphone should be 1,2 m above the floor when representing a sitting person and 1,6 m above the floor when representing a standing person. Source positions should be selected within the normal field of space that the person at the source location may occupy. Microphone positions should be selected around the receiving location, representing the typical space which the person at that workstation may occupy. Source and microphone positions should not be at less than 0,5 m from a reflective surface.

For measurements between workstations, a minimum of two source positions and three microphone positions for each source position should be used, selected on the above basis. The minimum measurement duration for each microphone position for a steady source level should be 6 s. A moving microphone technique may be used in lieu of fixed microphone positions – in this case, the minimum measurement period should be 15 s.

If the measured values of $D_{\mathrm{A,S}}$ are outside or close to the limit value, more measurements may be needed to identify all combinations with $D_{\mathrm{A,S}}$ values falling outside the required range.

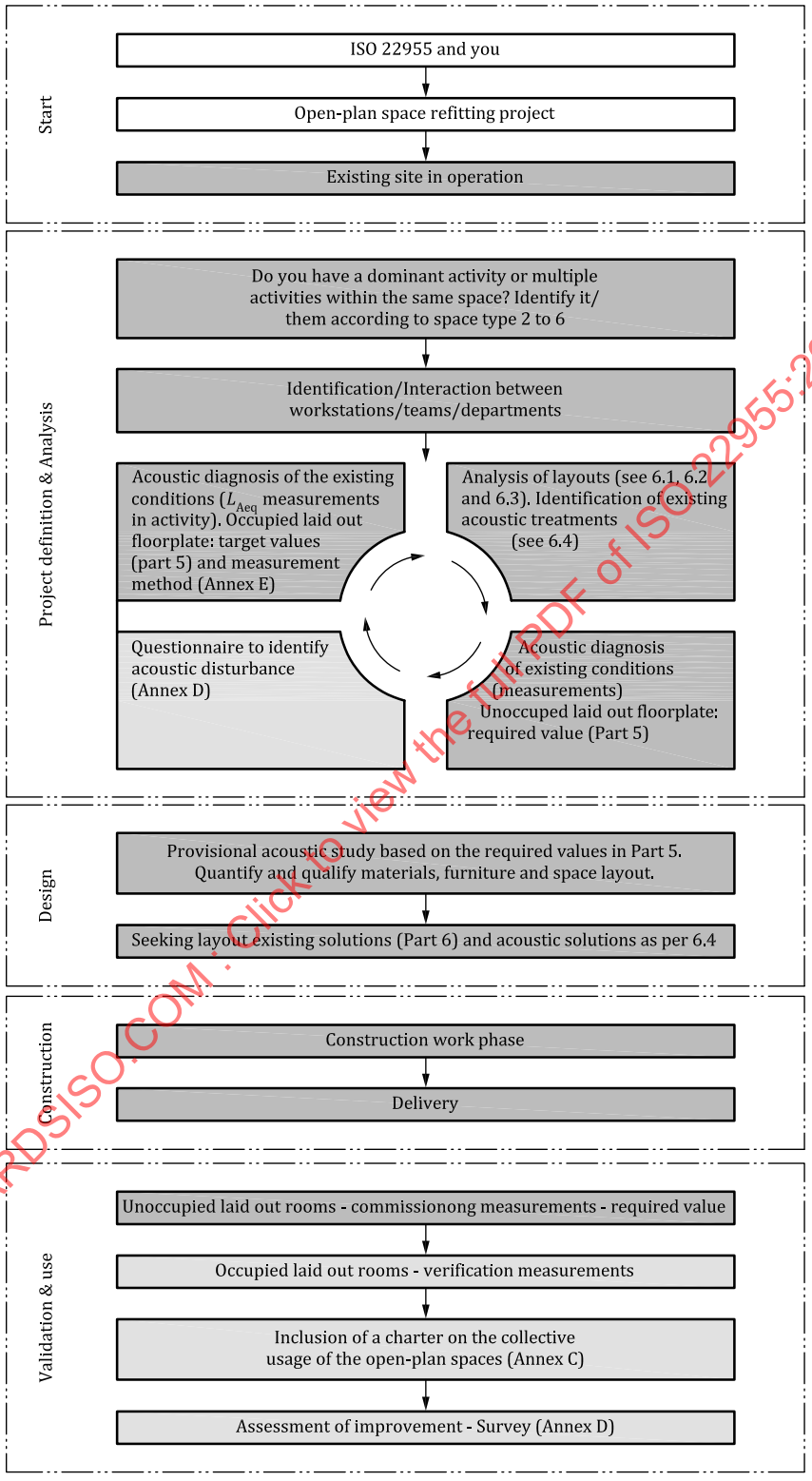
If the work teams are engaged in different activities, the source positions should be at the lively side and the microphone positions at the side requiring more focus. If one or more of the measured $D_{\mathrm{A,S}}$ values

falls outside the required range, mitigation measures should be considered to improve the situation for the whole affected work team area.

Annex B
(normative)

Flow chart summarising the approach

B.1 Open-plan space refitting project



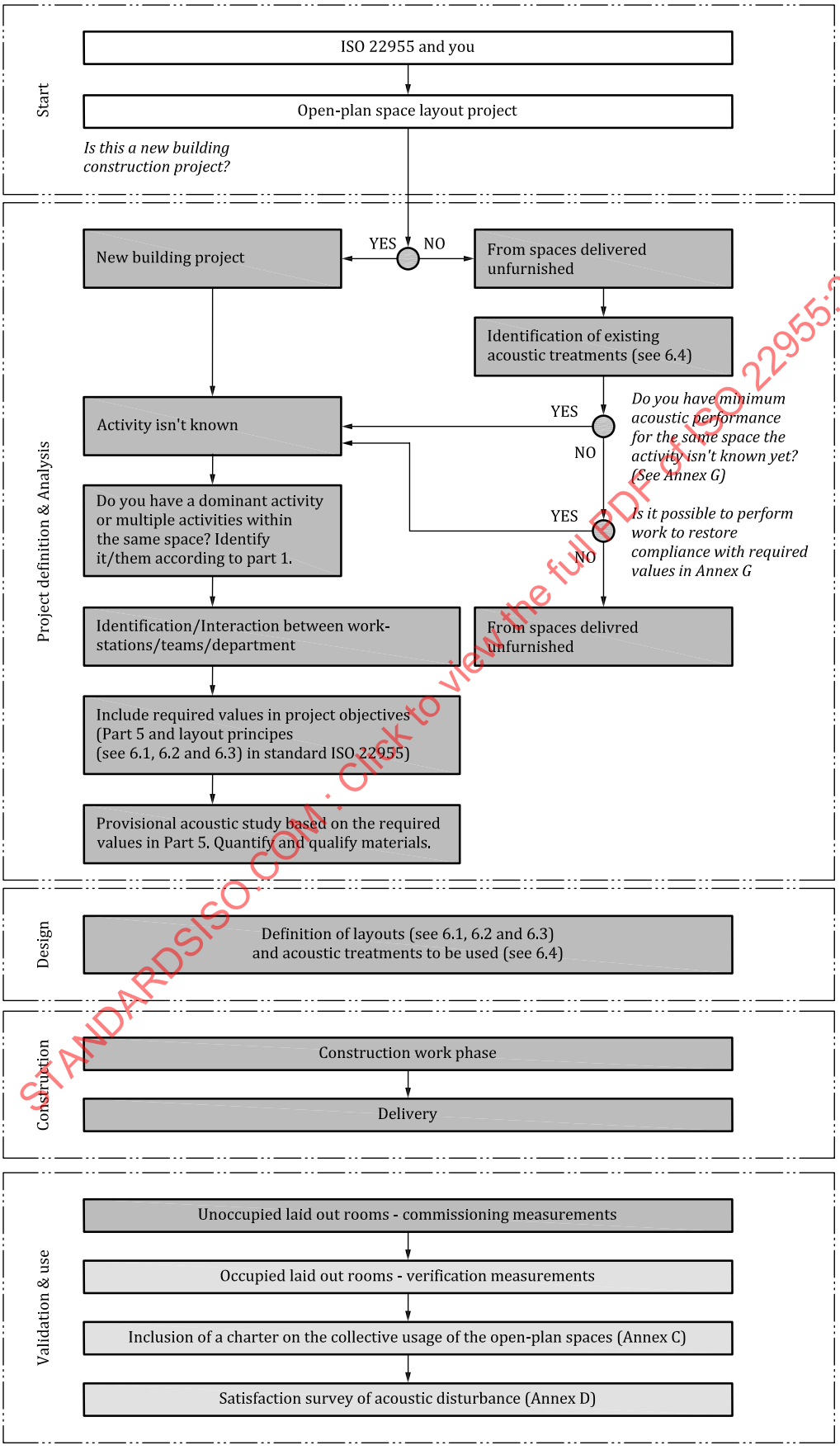
Key

Approach of this document

Recommended additional stages

Figure B.1 — Open-plan space refitting project

B.2 Open-plan space layout project (new construction project or spaces delivered unfurnished)



Key

▭	Approach of this document
▭	Recommended additional stages

Figure B.2 — Open-plan space layout project

Annex C
(informative)

Collective use of open-plan spaces: etiquette

A charter governing the use of open-plan spaces should be provided. Ideally, this should reflect and summarise the design layout support process for the personnel concerned.

It assumes there are training rooms, meeting rooms and rooms for individual work, which requires a high level of concentration, and sufficiently-sized relaxation areas. Application of these collective rules shall therefore be dependent on proper laying out of the open-plan space (see Clause 6) as well as the choice of effective technical equipment and office equipment.

Raising of staff and management awareness of the acoustic challenges of open-plan spaces is essential. This may be reflected in adoption of a charter governing collective behaviour.

Examples of collective working rules:

— avoid long discussions in the area;

— speak quietly on the phone and with colleagues;

— avoid talking when walking;

— hold conference calls and meetings in a closed office or dedicated space;

— avoid discussions with distant workstations, favour instant messaging or meeting rooms;

— adjust sound level on headset (microphone and headphones);

— reduce level of landline ringtone, favour light indicators;

— do not use the telephone loudspeaker;

— set mobile phones to vibrate mode;

— prefer collaborative and adjacent areas for meeting visitors entering the area;

— avoid individual briefings or training at a workstation;

— do not affix documents to low dividers or acoustic wall panels.

Annex D
(informative)

Example of a user survey on open-plan office acoustics

This survey has been devised in partnership with the Vibrations and Acoustics Laboratory at INSA, Lyon and INRS within the framework of the GABO (open-plan office acoustic disturbance) project. It obtained the support of the ANSES Environment, Health and Work programme and that of French environmental and labour ministries.

GABO Questionnaire

The purpose of this questionnaire is to gather information on how you perceive your working environment. Participation in this study is voluntary. Your answers will remain strictly confidential. There are no right or wrong answers. The estimated time required to complete this questionnaire is 15 minutes.

GENERAL INFORMATION ON YOURSELF AND YOUR WORKSTATION

→ *Tick the box corresponding to your situation (or fill in)*

Gender: M ☐ F ☐

Age: ..... years

Years in company: < 1 year ☐ 1 to 5 years ☐ > 5 years ☐

Years at current position: < 1 year ☐ 1 to 5 years ☐ > 5 years ☐

Do you have a permanently allocated workstation in your office? Yes ☐ No ☐

How many people work in the room containing your workstation?

> 50 people ☐

16 – 49 people ☐

7 – 15 people ☐

2 – 6 people ☐

I work alone ☐

Don't know ☐

Your job/position: *(If you think this question jeopardises your anonymity, you may leave it unanswered:*

.....

→ *The following points relate to your working environment. You must assess each point by ticking the box for the figure corresponding to your level of satisfaction on a scale of 1 to 5, where 1 means "**very unsatisfactory**" and 5 means "**totally satisfactory**".*

Noise environment

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

Possibility of concentrating in your workplace

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

Lighting quality

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

The physical position of your workstation

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

Possibility of holding private conversations

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

Your options for controlling noise

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

Furniture at your workstation

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

Possibility of seeing outside

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

Cleanliness of your workstation

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

Equipment available at your workstation

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

Possibility of controlling the temperature

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

Air flow at your workstation

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

Possibility of personalising your workstation (with personal items, photos, *etc.*)

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

Possibility of working out of the view of others

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

NOISE ENVIRONMENT IN YOUR WORKSPACE

Generally, would you say that the level of noise in your working environment is high?

Not at all ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 Very

Generally, would you say that the noise in your working environment is disturbing?

Not at all ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 Very

At your workstation, can you hear machine (fan, computer, printer, etc.) operating noise?

Never ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 Always

If you answered “never”, go to the next set of questions.

Would you say this noise is disturbing?

Not at all ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 Very

If you answered “not at all”, go to the next set of questions.

Is there an activity you perform at work, in which this noise seems to be more disturbing?

Yes ☐ No ☐

If “yes”, which one (reading, writing, data-entry, telephone conversations, etc.)? .....

At your workstation, can you hear the noise of telephone ringtones?

Never ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 Always

If you answered “never”, go to the next set of questions.

Would you say this noise is disturbing?

Not at all ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 Very

If you answered “not at all”, go to the next set of questions.

Is there an activity you perform at work when you find this noise more disturbing?

Yes ☐ No ☐

If “yes”, which one (reading, writing, data-entry, telephone conversations, etc.)?.....

At your workstation, you hear and clearly understand the conversations of your colleagues:

Never ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 Always

If you answered “never”, go to the next set of questions.

Would you say this noise is disturbing?

Not at all ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 Very

If you answered “not at all”, go to the next set of questions.

Is there an activity you perform at work when you find this noise more disturbing?

Yes ☐ No ☐

If “yes”, which one (reading, writing, data-entry, telephone conversations, etc.)? .....

You feel more disturbed when:

You hear all speakers ☐

You hear only one speaker ☐

They are the same ☐

At your workstation, you hear conversations between your colleagues you do not understand:

Never ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 Always

If you answered “never”, go to the next set of questions.

Would you say this noise is disturbing?

Not at all ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 Very

If you answered “not at all”, go to the next set of questions.

Is there an activity you perform at work, in which this noise seems disturbing?

Yes ☐ No ☐

If “yes”, which one (reading, writing, data-entry, telephone conversations, etc.)? .....

At your workstation, you hear the noise of people passing by:

Never ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 Always