Ceiling Performance Requirements

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ACTIVATE YOUR CEILING

Contents

Acoustics

Achieving the right acoustics plays an important part in the creation of a good indoor environment. Acoustics, because it does not appeal to our aesthetic senses, can be often overlooked in building design. Good acoustics are essential in many applications to ensure the correct levels of privacy, speech intelligibility, sound quality and personal well being.

The following information provides an overview, and explains some of the acoustic terms commonly referred to in relation to suspended ceilings and good acoustic design.

Sound

What is sound, and how is it measured?

Sound is a form of energy, which is transmitted through the air and perceived by the human ear. Sound is described by its ''sound pressure level" which is measured in decibels (dB) and its ''frequency" which is measured in Hertz (Hz), the No. of cycles per second.

The human ear can typically hear sounds in the decibel range 0 - 120 dB, and can detect sounds in the frequency range 20 - 20,000 Hz, but it is not equally sensitive across these ranges.

Fig. A shows how the decibel and frequency ranges relate to common everyday sounds.

It also shows an ear sensitivity and threshold of hearing curve. Sounds below this curve would not be heard by the human ear.

Due to the physical size and shape of the human ear, it is most sensitive at around 4000 Hz. This means that high sound absorption is required around 4000 Hz. This is particulary important in schools, kindergartens etc. where childrens voices are particulary dominant in this frequency area.

Room acoustics

The term ''room acoustics" deals with the behaviour of sound in a room or a specifically defined area. The most important criteria are that sounds such as music or speech eg. in a lecture theatre, can be heard and perceived as precisely and clearly as possible, and interrupting background sound eg. in an open plan office, is controlled to ensure as much privacy as possible.

The behaviour of sound within rooms is linked to the room size and shape, together with the performance of the internal surfaces and the construction type. It is important to use the most suitable materials and obtain the right ''acoustic balance" between the different surfaces. The use of the correct mixture of acoustically ''hard" and ''soft" materials will create the ''room acoustics" appropriate for the purpose of the room.

The most common terms used in connection with ''room acoustics" include, sound absorption, reverberation time, speech intelligibility and sound insulation between rooms. These are explained below:

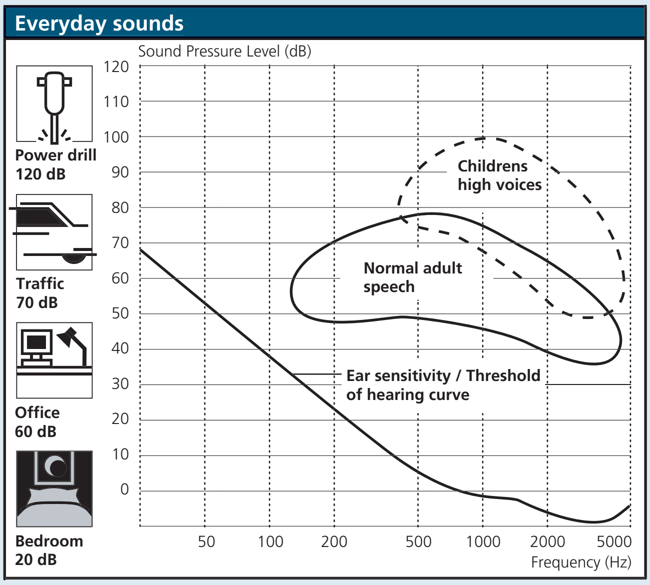


Fig. A. *The human ear responds to decibel changes in broadly the following way:*

- *A 1 dB increase is the smallest audible change in level. It would only be noticed if the two sounds were presented in quick succession.*
- *A 3 dB increase is the smallest audible change which could be detected over a period of time.*
- *A 10 dB increase represents a doubling of loudness to the ear.*

Sound absorption

The sound absorption property of a material expresses the ratio of incident sound and absorbed sound. The efficiency of sound absorption is expressed by the term sound absorption coefficient α at a specific frequency. It should be noted that the sound absorption of a material can vary depending on how it is installed and the depth of any air space behind it.

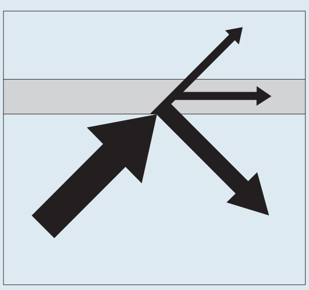


Fig. B

α is a ratio between 0 & 1.

$$\alpha = \frac{\text{Absorbed sound energy}}{\text{Incident sound energy}}$$

All sound absorbed α = 1 (100% efficiency).

No sound absorbed α = 0 (0% efficiency).

Fig. C gives some examples of the sound absorption of common materials

Sound absorption can be measured and classified in many different ways. The following information explains some of the most popular classifications:

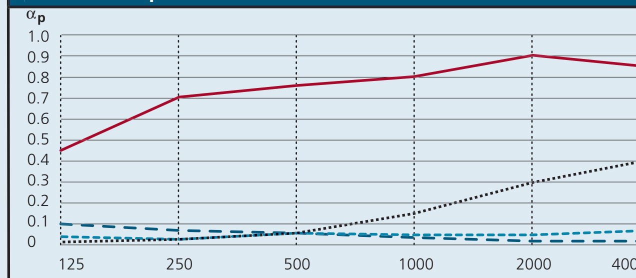
α_s

Fig. D shows the sound absorption coefficient at 1/3 octave band centre frequencies, and is an exact value and is measured in accordance with ISO 354. α_s is the most detailed method of recording sound absorption and forms the basis for other more useable and compact building acoustic sound absorption classifications.

α_p

Fig. E shows the practical sound absorption coefficient used for reverberation time estimates in building acoustics. α_p is quoted at octave band centre frequencies and is the average of the three 1/3 octave values centred on the quoted octave band centre frequency. It is calculated in accordance with ISO 11654 from α_s values and is a more practical but nonetheless accurate value.

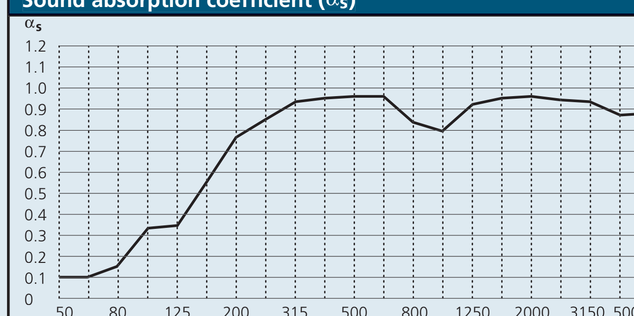
Sound absorption coefficients



Frequency (Hz)	125	250	500	1000	2000	4000
Rockfon Sonar	0.45	0.70	0.75	0.80	0.90	0.85
Double glazed window	0.10	0.07	0.05	0.03	0.02	0.02
Stone/linoleum	0.02	0.02	0.05	0.05	0.05	0.07
Carpet	0.01	0.02	0.05	0.15	0.30	0.40

Fig. C

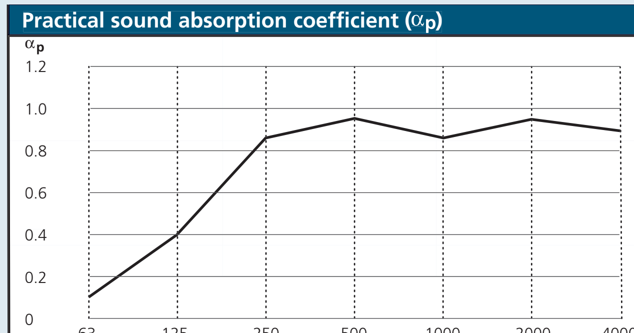
Sound absorption coefficient (α_s)



(Hz)	50	63	80	100	125	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000	5000
α_s	0.10	0.10	0.16	0.33	0.35	0.56	0.77	0.85	0.93	0.95	0.96	0.96	0.84	0.80	0.92	0.95	0.96	0.94	0.93	0.88	0.89

Fig. D. α_s for typical Rockfon ceiling.

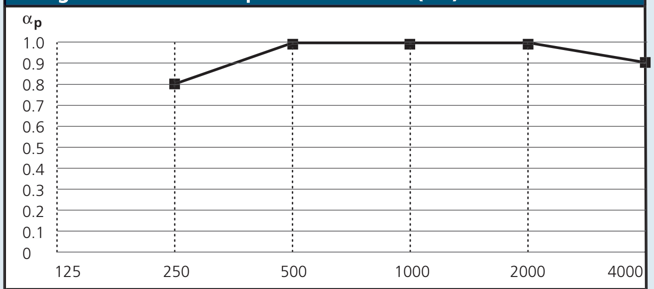
Practical sound absorption coefficient (α_p)



(Hz)	63	125	250	500	1000	2000	4000
α_p	0.10	0.40	0.85	0.95	0.85	0.95	0.90

Fig. E. α_p for typical Rockfon ceiling.

Weighted sound absorption coefficient (α_w)



Frequency (Hz)	250	500	1000	2000	4000
Value	0.80	1.00	1.00	1.00	0.90

Fig. F. *Reference curve for evaluation of weighted sound absorption coefficient,* α_w

Absorption classes

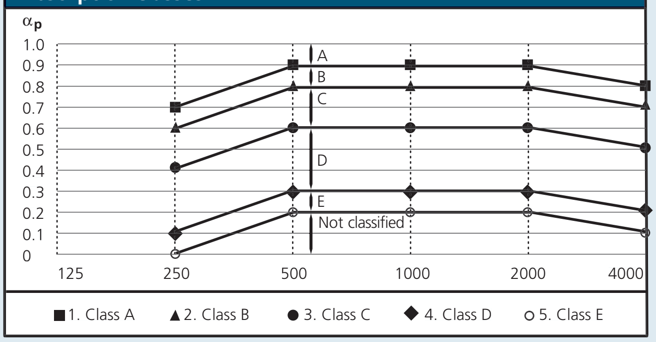
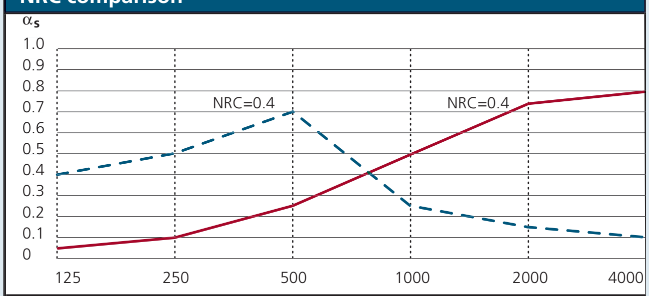


Fig. G

NRC comparison



(Hz)	125	250	500	1000	2000	4000
— (solid red)	0.05	0.10	0.25	0.50	0.75	0.80
- - (dashed blue)	0.40	0.50	0.70	0.25	0.15	0.10

Fig. H

Reverberation time

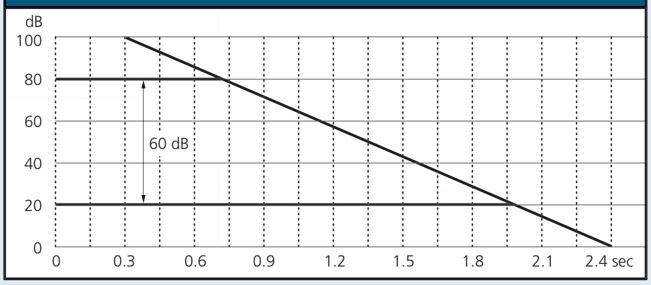


Fig. I

α_w

Fig. F. This is a single figure weighted sound absorption coefficient. It is calculated in accordance with ISO 11654 using α_p values and comparing them with a reference curve. The reference curve is shifted so that the unfavourable deviations are ≤ 0.10. The value for α_w is recorded as the value of the reference curve at 500 Hz. It is a useful single figure classification, but it has the draw back that the reference curve drops between 2000 Hz and 4000 Hz, and it is at around 4000 Hz that the human ear is most sensitive and high sound absorption is required in many applications.

Absorption classes

Fig. G. Absorption classes A to E are another classification method described in the International Standard ISO 11654. The α_p values are compared to a series of fixed reference curves. However, due to the wide range between each reference curve, these classes are an unprecise way of defining sound absorption requirements.

NRC-Value

Fig. H. The Noise Reduction Coefficient (NRC) calculated in accordance with ASTM C423 is a mathematic average of α_s values at the frequencies: 250 - 500 - 1000 and 2000 Hz. Due to the fact that this method does not include the 4000 Hz value which is critical to ear sensitivity and speech intelligibility, and gives equal weighting across the frequency range, it is an unsuitable method of defining sound absorption requirements. The illustration shows the sound absorption of two materials that have the same NRC but have completely different acoustic characteristics.

Rockfon recommend that the most appropriate way of defining ceiling sound absorption requirements is to state the required α_p values at specific frequencies or the α_w value.

Reverberation time

The acoustics of a room can be described by its reverberation time. Reverberation time is defined as the time it takes for the sound pressure level to drop by 60 dB. See **fig. I.**

A short reverberation time gives the best possibilities for a clear and distinct sound picture, good speech intelligibility and minimising annoying background noise. Long reverberation times that are typical in rooms with too many "hard" surfaces leads to poor speech intelligibility and often echo's which contribute to create poor room acoustics.

Typical reverberation times range from 0.3 seconds e.g. in cinemas with modern surround sound systems to approximately 7 seconds in large cathedrals. Just like sound absorption, reverberation time is frequency dependent. Therefore, it is important to state the required reverberation time at the relevant frequencies.

For more information regarding recommended reverberation times for a variety of applications, please refer to the Rockfon Application Guides in section 3 of the Rockfon Binder.

Reverberation time estimates

Most rooms with normal sound absorption can be estimated according to Sabines formula:

$$T = 0.16\,\frac{V}{A}$$

where

T= Reverberation time (s)

A= Equivalent absorption area of the room (m^2) (Sabines)

0.16= Empirical constant (s/m)

V= Volume of the room (m^3)

Equivalent absorption area (A)

The equivalent absorption area is an expression for the total sound absorption of the room. It is calculated by multiplying the area of all sound absorbing surfaces by their absorption coefficient.

$A = \alpha_1 S_1 + \alpha_2 S_2 + \ldots\ldots\ldots \alpha_n S_n$

Where α_1, α_2 ...... α_n = Sound absorption coefficients of the different surfaces in the room

S_1, S_2 .... S_n = The respective surface areas (m^2) of the different surfaces. The total surface area $S = S_1+S_2+ \ldots\ldots S_n$

Sabines formula should only be used for rooms with a mean absorption coefficient α_m of max. 0.35. If this value is exceeded, the Sabine-Eyring formula shown below should be used:

$$T = 0.16\,\frac{V}{S \times \ln\left(\frac{1}{1-\alpha_m}\right)}$$

where

$$\ln\left(\frac{1}{1-\alpha_m}\right)$$

is determined from a standard curve when the mean absorption coefficient α_m is known.

$$\alpha_m = \frac{A}{S}$$

Surface positioning

In some applications it is necessary to not only achieve the correct reverberation time but also to position surfaces with different absorption characteristics in different areas of the room.

Fig. J is an example of acoustic regulation in a lecture theatre where a reflecting area is integrated in the ceiling in order to reinforce the sound level to the audience. A highly sound absorbing ceiling would be installed in the remaining ceiling area and sound absorbing material is often necessary on the back wall. This could be achieved by using a combination of standard Rockfon tiles and Rockfon Tenor or Alto products.

Speech intelligibility

Speech intelligibility defines how clear speech communication is, and it is directly related to the reverberation time and the background noise level in a room. It can be measured in any room and analysed using computer software. It can be quantified by the Rapid Speech Transmission Index (RASTI) value which is quoted between 0 and 1. **Fig. K** shows how the RASTI value compares with a subjective speech intelligibility scale. For example, good speech intelligibility would be required in lecture theatres, special education classrooms, swimming pools etc.

Airborne Sound insulation

Airborne sound insulation is a measure of the ability of a construction to reduce sound levels due to airborne sources, such as voices, loudspeakers and service installations.

In relation to suspended ceilings, airborne sound insulation can be measured from “room to room” or from “plenum to room” and

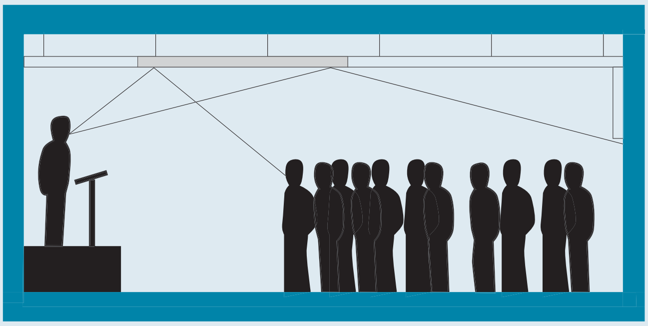


Fig. J. *Lecture theatre.*

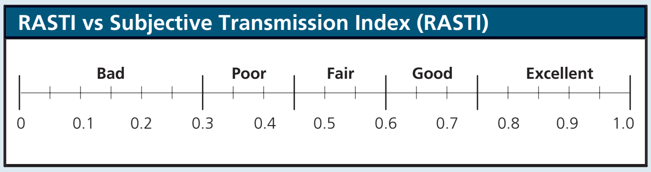


Fig. K

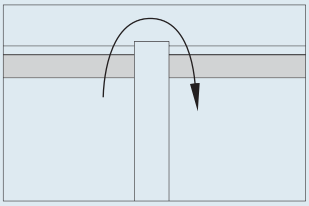


Fig. L. *Room to room*

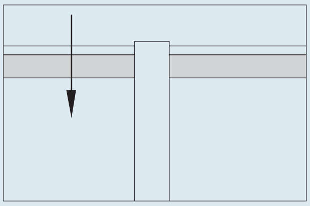


Fig. M. *Plenum to room*

is recorded in dB. See **Figs. L and M.**

Airborne sound insulation can be expressed by the weighted sound reduction index R_w. R_w is determined by measurements at 1/3 octaves in the range 100 - 3150 Hz. The measured values are compared to a reference curve, whereupon Rw is determined. In this way the sound insulation is expressed by only one figure instead of 16. Measurements on ceilings are normally completed in accordance with ISO 140/9.

Typically, for a reasonable degree of privacy, the minimum ‘’room to room” sound insulation value between adjoining rooms eg. cellular offices should be 35 dB.

In areas where it is necessary to have higher levels of sound insulation, it is possible to use full height wall constructions or a combination of high performance partitions and Rockfon Silence products.

Acoustic ceilings

In many ways a ceiling is the most appropriate location for high sound absorption. Generally, unlike walls and floors, ceilings have a large uncluttered surface area, and provided they have a good sound absorption performance, they can greatly contribute to getting the acoustic balance right and achieving good room acoustics.

Rockfon ceilings provide high levels of sound absorption and can be used to create good ‘’room acoustics”.

Fire Performance

The importance of fire safety in all buildings can never be understated. Fire destroys buildings, cripples business and endangers life.

It is essential that buildings are protected against the onset and spread of fire. Such protection and the use of fire safe materials makes them safer places to visit, work and recuperate in.

The following information provides an insight into some of the most important factors regarding fire and suspended ceilings. The relevant standards, and a comparison of how pure 100% stone wool (resin bonded mineral wool) based materials and other common materials behave in fire are also covered.

Building Regulations

The current Building Regulations only call for ceilings and wall linings to be Class 0 for most applications.

A ceiling having just class 0 is not enough

Current Building Regulations in general only cover the escape of occupants, surface spread of flame (as part of the Class 0 requirement) and accessibility for fire tenders. Unfortunately, they are not concerned with accurately defining maximum allowable levels of smoke and toxic emissions, and do not focus on the total fire protection of buildings which would help reduce the downtime and loss of production and revenue which often occur as a result of fire.

Building insurers and many clients are now not surprisingly encouraging the use of truly fire safe materials.

By using truly fire safe ceiling materials, it is possible to enhance the fire safety of your building and provide much more than just the minimum Class 0 legal requirement.

Smoke and toxic emissions

Smoke and toxic emissions are involved in approximately 50% of all fire fatalities, and the primary cause of death in over a third. To ensure products are safe, they should have a low rate of both smoke and toxic emissions.

Fire resistance and structural fire protection

In order to further enhance building fire safety, the stability and integrity of ceilings when subjected to fire is also an important factor. This can have a great influence on the effectiveness of escape routes, and the ease with which fire f ighters can enter and save buildings on fire.

Structural fire protecting/ resisting ceiling systems that have been tested in accordance with BS 476 Parts 21,22 and 23 can be used to satisfy the requirements of parts of the Building Regulations.

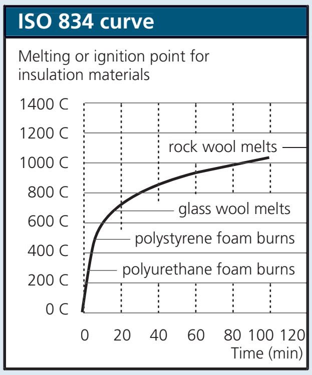


Fig. N

Whilst not every application requires the use of fire protecting ceilings, the above tests, together with a knowledge of the high temperature stability and melting point of ceiling materials provide useful performance indicators.

Rockfon recommend that in all buildings, ceilings should have a low smoke and toxic emission and be constructed from materials that have been proven to be capable of achieving a minimum of 30 minutes fire resistance in accordance with BS 476.

The most important factor to ensure this standard can be achieved is for ceilings to be made from materials capable of withstanding high temperatures for long periods of time without losing their stability and melting or burning.

In applications where ceilings are not installed specifically for fire protection purposes, if they are made from materials capable of achieving the above performance they will provide an extra margin of safety and enhance the fire safety of any building.

Rockfon products have a high melting point and can be used to provide structural fire protection.

Humidity Resistance

As building construction times become shorter and heating regimes are further stretched, it is of major importance that products used in the constructi-on process and in the finished building are completely humidity/ moisture resistant.

These days products can be subjected to relatively large temperature and humidity changes during construction and if the building is left unheated or they are in contact with outdoor air. Typically, on a dry day with a temperature of 15ºC and a relative humidity (RH) of 50%, this can change to a temperature of 6ºC and a relative humidity of 92% at night.

In application areas which can be subject to constantly high humidity levels typically above 95% RH and 25°C eg. wet rooms, kitchens, swimming pools, industrial applications etc, the need for ceilings which have high humidity/moisture resistance is further reinforced.

In addition, because bacteria and fungi need organic material, moisture and heat to grow; ceiling products that are inorganic, non hygroscopic (do not absorb moisture from the air) and remain stable over a wide temperature and relative humidity (RH) range are the most appropriate option for all applications.

For the best long term performance and ease of use during construction, ceiling products that are inorganic, non hygroscopic and humidity/moisture resistant up to 100% RH at 40ºC provide the safest option.

Rockfon products meet the above performance standards.

Cleaning

The ability to clean a ceiling when required can have an effect on the long term performance and economics of the installation together with the ability to maintain good aesthetics and a healthy indoor environment in any application area.

Ceilings that can be cleaned regularly using a variety of methods provide many advantages.

Typical cleaning methods

Vacuum cleaning
Use a vacuum cleaner with low vacuum and soft brush attachment.

Wet wiping
Wet wipe with a cloth and water/soap solution, incorporating disinfectant where required, (pH value 8-11) 1:100 concentration. Wipe off with a cloth or sponge.

Foam cleaning
Apply cleaning foam, incorporating disinfectant where required, on the surface. Wipe off with a cloth or sponge.

High pressure cleaning
Generally the need for high pressure cleaning is limited to a very small number of specialised applications. This is due to the fact that if not done in a very controlled way, this method can actually spread fungi and bacteria around a ceiling and ultimately not remove them.

Maximum water pressure should be 65 bar. Spray with 30° spread at nozzle, at a distance of 1m with a 1:100 cleaning agent solution concentration. After cleaning, wipe dry with a cloth or sponge.

When cleaning Rockfon products, soap solutions should be 1:100, and high concen tration spirit, chlorine, and sal ammoniac should not be used.

Rockfon products have easily cleanable long lasting surfaces, and can be cleaned using the above methods.

Hygiene and Emissions

With increasing focus on sick building syndrome, alergic reactions and indoor air quality, the above factors play a part in the creation and maintenance of a healthy building.

Emissions

There are many test standards and approvals covering building materials with regard to particle and gas emissions. The most common test standards, and the ones which form the basis for many other approvals are the Scandinavian Standards Nordtest Standard NT Build 347 for fibre emission and the DS/INF 90 Standard which covers formaldehyde emissions. These are complemented by the American Standard ASTM E981 for volatile organic components.

Particle Emission
Generally for most approvals, any particle emissions from products is determined by particle size and the weight per unit area of particles released when a sample of a product is mechanically agitated. Typically, this is quantified by classifications of Low, Medium and High.

To ensure the best performance, products having a ''Low'' classification are the most appropriate for all building applications.
Gas emission

Generally gas emission is determined by using specialised sensors to measure gases emitted from products. This is normally quantified by the type and concentration of gas emitted relative to time. Typically, the time is quoted in days and is a measure of how quickly emissions from products fall below acceptable levels after installation.

To ensure the best performance, products having a classification of ''less than 10 days'' are the most appropriate for all building applications.

The positive results from tests in accordance with the above standards has allowed the following approvals to be granted for Rockfon products:

Indoor Climate Label
The Indoor Climate Label standard has two different categories: Particle emission and Gas emission. The particle emission test used is based on the NT Build 347 fibre emission test.

Gas emission
The declared indoor relevant time value has been determined as: 10 days. This means that the emission time is less than 10 days from the time products are installed.

Particle emission
The emission of particles including fibres has been determined as: low. This means that even with mechanical agitation, there is no significant emission fromRockfon products.

Rockfon products are classified in the best class in both categories.
SIKI (Swedish Indoor Environment Institute)

Siki which is similar to The Indoor Climate Label has classified Rockfon products in class MEC-A. This means that Rockfon products are associated with low indoor environment emissions.

Hygiene

In addition to low particle and gas emissions, to ensure a high level of hygiene in all application areas, it is important that ceiling products remain dimensionally stable in a wide range of environments and that they can be easily cleaned whilst also being rot free and resistant to the growth of fungi and bacteria.

In order to meet the above criteria, and provide good longevity, because bacteria and fungi need organic material, moisture and heat to grow, ceiling products that are inorganic, non hygroscopic (do not absorb moisture from the air) and are able to remain stable over a wide temperature and relative humidity (RH) range are the most appropriate option. In addition, ceiling products that can be easily cleaned as well as resisting bacterial and fungal growth in their own right further enhance their suitability and longevity.

Rockfon products are made from 100% inorganic rock wool and are non hygroscopic, as well as being humidity/moisture resistant up to 100% RH at 40ºC.

Rockfon products are resistant to ubiquitous fungi and bacteria and can be easily cleaned using a variety of methods.

Rockfon products are ideally suited for use in Health applications where the control of bacteria is paramount.

For more specialised applications such as food processing, Rockfon Hygienic panels have been tested by the International Mycological Institute and shown to be resistant to many ubiquitous bacteria and fungi.

Clean room classification

In specific application areas such as operation theatres, pharmaceutical and electronic production plants and food processing areas, it is important to have stringent control of particles in the environment.

The US Federal Standard 209E is the most widely recognised method of classifying the suitability of building materials for use in such areas. This standard describes a test method for determining the number of particles of a specific size released into the air per unit volume when jets of air are passed over the surface of a product sample.

Fig. O shows the classifications required for some specific applications.

To put things into perspective, it is interesting to note that a reasonable quality outdoor air would be classified higher than M6.5/100000 and the Rockfon products listed as low as Class M 2.5/10.

Fig. O also makes a comparison with the now superseded FS 209 D classes, the British clean room standard BS 5295 and the European Good Manufacturing Practice (GMP) guide for the manufacture of pharmaceutical products.

Rockfon Hygienic plus , Hygienic Baffles and Sonar are ideally suited for use in cleanroom applications.

Rockfon products are fully sealed on all edges and exposed and rear surfaces.

The above tests and approvals show that Rockfon products are safe and can contribute to the creation of a healthy building.

Clean room classification

Standard	US FS 209E	US FS 209D	BS 5295	GMP	Area/product examples
Class	M 1.5	1	C		Computer chips (no people allowed)
Class	**M 2.5**	**10**	**D**		**Rockfon Hygienic plus, Hygienic Baffle and Sonar**
Class	M 3.5	100	E/F	A/B	Medicine, fluid packaging, Microbial control room. Personnel wearing desinfected protective clothing
Class	M 4.5	1000	G/H		
Class	M 5.5	10 000	J	C	Operating theatres, electronic production
Class	M 6.5	100 000		D	Tablet coating and colouring
Class	Not classified > M 6.5	Not classified > 100 000			Reasonable quality outdoor air

Fig. O

Lighting

Important factors contributing to a good indoor enviroment are the correct level and type of lighting. Light has a great influence on personal comfort, and the quality and efficiency of human work. These days with computer screens being so widely used, headaches and eye strain caused in part by poor lighting are a widely recognised problem. In addition, greater focus on lighting efficiency and overall electricity costs, place a heavy demand for efficient and effective lighting design.

The following information considers lighting design and how a ceiling can influence the effectiveness and efficiency of lighting design solutions.

Light reflection, energy and efficiency

Ceilings with a high light reflection can help in the creation of optimum light conditions, and can contribute to reduced energy costs.

For optimum solutions, it is recommended to have a ceiling that has a light coloured matt surface with a light reflection ≤ 80%.

A ceiling with a high light reflection will allow for maximum daylight distribution in a room. It will also reduce the risk of "dark holes" by maximising inter-reflected light whilst lowering the risk of poor contrast ranges on the working plane.

A ceiling that has a combination of both high light reflection and a high light reflection diffusion coefficient ensures that reflected light is spread uniformly and means that energy savings can be achieved due to the reduced number of luminaires required, regardless of which lighting method is used (direct, indirect, mixed).

The following data illustrates the potential for energy and luminaire savings:

• If a ceiling is illuminated with indirect lighting (100% uplighting), the light reflection of the ceiling is generally regarded as being directly proportional to energy consumption. Therefore, increasing the light reflection of the ceiling can give directly proportional reductions in the amount of energy and luminaires required. Eg. by increasing the ceiling light reflection from 70 - 87% would mean a 17% reduction in energy or amount of luminaires required to create the same lighting effect.

• Typically in a room, 10 m x 6 m x 3 m illuminated with direct lighting (100% down-lighting), the interreflecting part of the light on the working plane will be approximately 20%. The importance of the reflection from the ceiling can be shown by changing the ceiling reflection from 50% to 80%. This would reduce the amount of energy and therefore the amount of luminaires required to create the same lighting conditions by 5%.

Generally, as many applications have a combination of natural light, direct and indirect light, the ceiling reflection efficiency plays an important part in the overall lighting conditions and energy consumption. See **Fig. Q.**

Lighting design summary and terminology

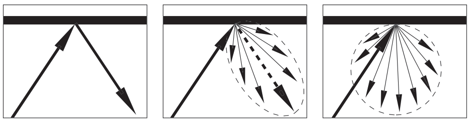
Direct lighting (down lighting)	Relatively low purchase cost but relatively high operating costs. This light will often create disturbing glare on computer screens, thereby affecting employee comfort.
Indirect lighting (up lighting)	Indirect light in combination with a high diffuse light reflecting surface provides a bright uniformly spread light without glare. This creates a very comfortable environment and provides a greater ceiling area which contributes to increased sound absorption.
Direct & indirect lighting mixed)	Optimum lighting solution. Combines the best features of both types. Typically 70% direct & 30% indirect provides a bright interior with low energy consumption, whilst also reducing the risk of glare.
Light reflection (%) (DIN 5036)	The ability of a surface to reflect light. Measured as the ratio of incident and reflected light and quoted as %. See below some typical values: Polished white oak........ 25 - 35% Lime plaster........ 40 - 45% Rough concrete........ 25 - 30% White paper........ 70 - 80% Polished aluminium........ 65 - 75% Perforated gypsum........ 60 - 75% Rockfon Sonar........ 87%
Light reflection diffusion coefficient (%) (DIN 5036)	The ability of a surface to reflect light in a diffuse way. Measured as the ratio of diffused and directly reflected light and quoted as %. See below some typical values: Mirror or highly polished surface........ 0% Painted gypsum wall........ 50 - 90% Rockfon ceiling tiles........ 99.5% Due to their surface structure, Rockfon tiles have almost perfect light reflection diffusion.  *Direct reflection. 0% diffusion. Eg. mirror or highly polished surface* — *Reflection from painted gysum wall. 50 - 90% diffusion* — *Reflection from Rockfon ceiling tiles. 99.5% diffusion*
Light intensity	Luminous flux per area, given in Lux (lx) Typical values/ requirements: Global radiation (clear sky)........ max. 100 000 lux Global radiation (clouded sky)........ max. 20 000 lux Optimal vision........ 2000 lux Tasks requiring high accuracy (precise mounting)...... 750 - 1500 lux Office work........ 500 - 1000 lux Minimum in any work place........ 200 lux Road lighting........ 10 lux Moon light........ 0,2 lux
Lux	SI unit for light intensity. Describes the amount of lumens per square metre (lm/m²).
IP number (nn) (BS 4533)	Luminaire rating system. Defines the degree of protection against the ingress of solid bodies (first number 0-6) and moisture (second number 0-8) in the Ingress Protection (IP) system.

Fig. P

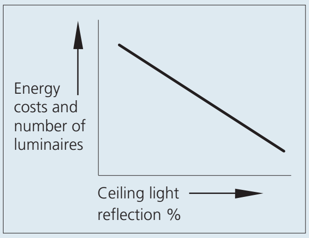


***Fig. Q.** Energy costs vs ceiling light reflection.*

Installation

Design solutions
Natural light is certainly the most economical method of lighting, however, for many fundamental reasons it has to be supplemented with artificial light in most applications.

In the work place, conditions are optimised when artificial lighting is situated at the side of a work area. Luminaires should also simulate daylight, both in the direction of light and luminaire position. The location of work areas relative to windows is also important.To ensure maximum daylight usage, and therefore maximum energy saving with artifical lights, all interior surfaces should have the relevant light reflectance coefficients depending on their location in a room.

Eg.
Floor 10 - 30%
Walls 50 - 70%
Ceiling 80 - 90%.

Equally important is that all main surfaces should reflect light in a diffused way. This creates a better spread of light and prevents temporary blinding and reduces glare.

Rockfon products have light colured matt surfaces and provide high levels of light reflection and reflect light with optimum diffusion.

To ensure a good quality ceiling, emphasis should be placed on the installation quality of the finished ceiling. In addition, to ensure that a ceiling achieves the highest performance levels regarding safety, ease of use, durability and longevity, there are a number of factors relating to installation which should be considered when designing and selecting a ceiling system.

The following information considers some of the factors which influence the ease with which ceilings can be installed and maintained during use.

When to install the ceiling?
To be able to get maximum long term performance during use, and flexibility during the installation period, it is important to be aware of any limitations or restrictions regarding environmental conditions eg. temperature, relative humidity (RH) and product acclimatization requirements.

Ceiling systems that do not absorb moisture (non-hygroscopic), do not require acclimatization and are not affected by changes in temperature and humidity provide long term dimensional stability and maximum flexibility during installation.

Ceiling systems which have these properties provide **no limitations** and are ideally suited for fasttrack development and can be installed at an early stage in the building program.

Ease of installation
Ceiling systems that are light weight and easily cut and handled greatly enhance the speed and efficiency of ceiling installation.

Minimum installation depth (D)
In order to select the most appropriate system, it is important to know what the minimum installation depth can be.

In situations where ceiling height has to be maximised, it is possible to use a ''direct fix '' installation method. This has the advantage of maximising ceiling height, but in some cases this has to be offset against less easy access to services.

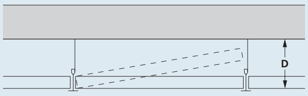


Fig. R

Access
In order to get the maximum usability and longevity from a ceiling system, it is important to determine the size and frequency of access required. The main factors which should be considered include:
- Module size.
- Tile edge detail and weight.
- Installation depth.

Hangers
Ceiling hangers play a very important part in the long term performance and safety of a ceiling.

Generally four types of hanger can be used to install Rockfon Ceiling Systems. See **fig. S.**

Top Fixings
Top fixings are available from many specialist suppliers. It is important to be sure that the top fixings used to support the ceiling are appropriate for the specific soffit and that they provide adequate pull out strength when installed.

Hangers

Ceiling hanger type	Suitability
Mild steel wire	Installation depth: 100 - 6000 mm. Appropriate for most applications.
Adjustable rod hanger	Installation depth: 150 - 2000 mm. Appropriate for most applications.
Direct fix clip	Installation depth: 50, 80 ,100, 120 mm. Appropriate for most applications to minimize installation depth.
Metal angle	Installation depth: 100 - 4000 mm. Appropriate for most applications. Particularly suited where substantial pressure difference may occur between room and ceiling void. Also, enhanced corrosion resistant format perimeter angle can be used as a hanger in harsh environment applications.

Fig. S

ACTIVATE YOUR CEILING

Rockfon® develop intelligent ceiling solutions which actively address a number of important issues in modern buildings and renovation projects.

Rockfon products are known for their design, aesthetics and ease of installation; coupled with the key performance features of superior fire resistance and acoustics.

This ensures that our ceiling solutions are amongst the highest performing, most cost effective and time efficient in today's interiors market.

The comprehensive ceiling solution portfolio from Rockfon ensures that our customers are able to actively add value to the construction process, by ultimately creating superior interior environments.

That is why we say "ACTIVATE YOUR CEILING".

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Environment
Rockfon products are primarily based on natural materials – stone, chalk and clay. They are produced in an environmentally friendly process and can be recycled.

Rockfon ceiling tiles are manufactured from stone wool (resin bonded mineral wool) which fulfils the EU directive 97/69 note Q.

The Indoor Climate Label
Rockfon products have obtained Class 10 emission time for gas emission and "low particle emission" classification, the best classes according to The Indoor Climate Label standard.

BBA BRITISH BOARD OF AGRÉMENT CERTIFICATE No 95/3196

Service
Rockfon has many years of experience in ceiling design and acoustic regulation. We are happy to place our knowledge at your disposal – by documentation and personal service, from the planning stage to the finished building.

ROCKWOOL Rockfon®
ACTIVATE YOUR CEILING