

## 4. Industrial noise

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This term covers all disturbing noises from commercial and industrial noise sources. They are usually related to the operation of installations.

The origin of the provisions and the technical set of regulations for noise abatement in the industrial and commercial field (figures 4/1, 4/2 and 4/3) dates back several decades and first concerned issues of worksite protection and worksite medical services. Deafness used to be a common occupational disease as a consequence of workplace nuisances. Technical rules for noise measurement, assessment, prevention and reduction in combination with the accident prevention regulations by professional associations have significantly reduced the risk of coming down with noise-related diseases at one's workplace.

The knowledge of the practical realization of noise abatement in factories gradually gained during the industrialization was a major factor for the development of neighbourhood protection and immission control. And the focus of noise abatement is transferred from measures related to individual projects (immission control, neighbourhood protection) to the field of spatial planning.

Due to the easily applicable polluter pays principle and clear measurement and assessment regulations for installation-oriented industrial noise, existing noise sources of this kind represent a manageable problem as for remedial measures. The costs and restrictions related to acoustic treatment measures may, however, threaten the livelihood of operators of installations.

This is why the field of urban land-use planning must assume the responsibility of preventing the emergence of complaints with subsequent redevelopment requirements. But this is only possible if the local conditions are formed in a way that the operator of an installation meeting the requirement of the best available techniques is able to adhere to the defined immission values as for a neighbourhood requiring protection.

While the immission prognosis for numerous sound sources (especially for road traffic) is very reliable due to established specific emissions, such a projection of noise immissions exists only on the basis of standards or strongly simplifying assumptions as for most of the industrial and commercial installations at the stage of development planning.



Fig. 4/1: Example of a commercial area



Fig. 4/2: Container terminal Kornwestheim



Fig. 4/3: Commerce within a residential area

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### 4.1 Legal foundations

Pollution control rights and building law aspects have to be taken into account during the planning of commercial facilities:

#### Pollution control rights

Besides the planning principle in § 50 of the Federal Immission Control Act, which is significant for all issues in the context of urban land-use planning, especially the installation-oriented provisions in Part II of the Federal Immission Control Act are of importance.

According to § 4 of the Federal Immission Control Act, "the construction and operation of installations which, on account of their nature or operation, are particularly likely to cause any harmful effects on the environment or otherwise endanger or cause any significant disadvantages or significant nuisances to the general public or the neighbourhood ... shall be subject to licensing".

The distinction that is made in the Federal Immission Control Act between installations subject to licensing and installations not subject to licensing enables the planners to consider and classify the ecological relevance of a type of installation also in terms of noise protection. What has to be considered, however, is the fact that the catalogue of installations subject to licensing fluctuates significantly due to the implementation of European law.

It is of practical relevance that the determination of sound immissions and their assessment in terms of pollution control rights complies with the [Technical Instructions on Noise \(TA Lärm\)](#) (available in German) in the case of installations subject and not subject to licensing.

Immission Control Act in combination with the 4th Federal Immission Control Ordinance distinguish between installations subject to a formal licensing procedure and those only requiring a simplified procedure. The allocation to these types of procedures is decided by the placement in "Column 1" or "Column 2" of the index, representing a criterion for the assessment of the immission relevance of a type of installation for the purposes of planning.

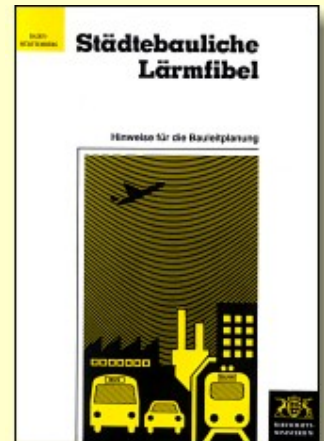
The licensing requirement covers all parts of an installation and all procedural steps necessary for its operation as well as related facilities which are **spatially and technically linked** to these parts of the installation and procedural steps and which can be **significant** for both the emergence and the prevention of harmful effects on the environment.

Several (smaller) installations of the same type form a joint installation (subject to licensing) if they are located on the same company site, are linked by joint company facilities, serve a joint technical purpose and jointly meet or exceed the performance limits or sizes of an installation relevant for the licensing obligation.

According to § 5 para. 1 of the Federal Immission Control Act, the operator of an installation subject to licensing has the obligation to construct and operate the installation "in such a way that ... harmful effects on the environment or any other hazards, significant disadvantages and significant nuisances to the general public and the neighbourhood are avoided and **precautions** are taken to prevent any harmful effects on the environment ... in particular by such measures as are appropriate according to the best available techniques".

§ 22 of the Federal Immission Control Act poses obligations on operators of installations not subject to licensing as well. According to para. 1, they "shall be constructed and operated in such a way that any harmful effects on the environment which are avoidable with the use of the best available techniques are prevented and any harmful effects on the environment which are unavoidable with the use of the best available techniques are kept to a minimum".

§ 26 of the Federal Immission Control Act regulates that "the competent authority may order that the operator of an installation subject to licensing or ... of an installation not subject to licensing shall have the nature and type of the emissions released from such installation and the immissions occurring within the sphere of influence of such installation determined by one of the agencies designated by the authority responsible pursuant to Land law if there is reason to fear that any harmful effects on the environment may be caused by such installation".



The index for the emission and immission determination agencies for Baden-Württemberg designated by the authorities pursuant to § 26 of the Federal Immission Control Act is cited in [section 2.4.4.1](#).

Despite the definition of the term "installations" given in § 3 of the Federal Immission Control Act, we have to decide in everyday life whether noises are the result of individual behaviour and therefore represent a public nuisance or whether they are installation noises and are significant in the context of pollution control rights and building law. In the majority of the cases we find an answer when we deliberate whether **technical measures** were able to prevent the disturbing noise. Noise pollution resulting from individual behaviour usually cannot be prevented through technical measures as the noises cannot be influenced by the "best available techniques".

The expression "**best available techniques**" anchored in the field of pollution control rights always causes interpretational difficulties in practice when it comes to assessing installations whose technical purpose is to produce sound and be as loud as possible. Examples for this are the hour strike of tower and church clocks (the ringing of the bell for liturgical services is not subject to the requirements of immission control), call and warning signals as well as loudspeaker announcements.

The following important aspect must be considered in the context of the "installations" term, which also covers certain types of **craft** (those not participating in public road traffic, like forklifts or building machines):

The noises of cars and vehicles, which are not included in the definition of "installations" (passenger cars and trucks), are by no means unconsidered in the context of installation noises. What has to be added to the installation noises is the noises from cars and vehicles on the company site, especially of trucks, which have a function for the operation of an installation. It is of no significance whether the cars are company-owned or belong to customers, collectors or suppliers. The traffic-related components of installation noises (running engines, shunting and loading noises, the banging of doors) are of primary importance especially for forwarding companies, bus companies, commercial parks, wholesale firms but also for nearby supermarkets, drinks cash-and-carry and car parks in front of hotels in a residential area.

Building noise as a particular case of industrial noise is also subject to the immission control rights. Requirements for the operation of building machines on building sites are defined pursuant to the Ordinance on Noise from Building Machines (15th Federal Immission Control Ordinance) as well as to the [General administrative regulation on the Protection from Building Noise Immissions](#) ([Allgemeine Verwaltungsvorschrift zum Schutz gegen Baulärm - Geräuschimmissionen](#)) (available in German).

## Building law

Especially the Federal Building Code (Baugesetzbuch) and the Federal Land Utilisation Ordinance (Baunutzungsverordnung) treated in [section 2.3.2](#) must be considered in the context of commercial uses from the point of view of urban land-use planning.

Planning legislation includes a general permissibility of commercial enterprises in areas pursuant to § 9 (industrial areas) and § 8 (commercial areas) of the Federal Land Utilisation Ordinance. Commercial enterprises are also permitted in Special residential areas (§ 4a of the Federal Land Utilisation Ordinance), in village areas (§ 5) and in mixed and core areas (§§ 6 and 7) as long as they do not substantially disturb the residents. Non-disturbing commercial enterprises can be permitted exceptionally in small housing estates (§ 2 of the Federal Land Utilisation Ordinance) and in general residential areas (§ 4).

We also want to point out to § 15 para. 3 of the Federal Land Utilisation Ordinance, which regulates that the permissibility of installations in building areas shall not only be assessed pursuant to procedural classifications within the Federal Immission Control Act and the ordinances issued on its basis. This makes clear that an "installation subject to licensing" in the context of pollution control (e. g. a carwash) does not exclusively have to be placed in an industrial area.

The possibility to structure building areas as presented in § 1 para. 4 of the Federal Land Utilisation Ordinance plays a major role for the planning of commercial and industrial areas, which shall account for the requirements of noise protection. This means that the legally binding land-use plan can define the structuring of a building area according to the type of firms or installations and their particular needs and characteristics for example.

This allows for the distribution of the generally or exceptionally authorized firms and installations to particular parts within the building area. What must be preserved, however, is the sum of the permitted uses pursuant to the building area standards for the area as a whole. A distribution of the permitted uses and installations to separate areas is only possible for commercial and industrial areas. In these cases, the above-mentioned requirement only refers to the sum of all commercial and industrial areas within a municipality (RIST, 1990).

The far-reaching possibilities to structure industrial and commercial areas can be used to effectively regulate the settlement of noisy installations in due consideration of the local noise situation and the distances to other uses. The definition of maximum values for sound emissions in the form of an area-related sound power level (definition of the average radiated sound power per square metre area) also answers this purpose. The limitation of the noise potential from settling firms in the legally binding land-use plan corresponds to the principle according to which new problematic situations shall not be created in the context of the planning of development areas (prohibition of deterioration).

Problematic immission conditions are a typical feature of conflict situations. § 1 para. 10 of the Federal Land Utilisation Ordinance shall facilitate the planning of such areas by generally or exceptionally permitting expansions, alterations, changes of use and modernizations of installations even if particular building installations or other installations were inadmissible in a predominantly built-up area according to §§ 2 to 9 of the Federal Land Utilisation Ordinance.



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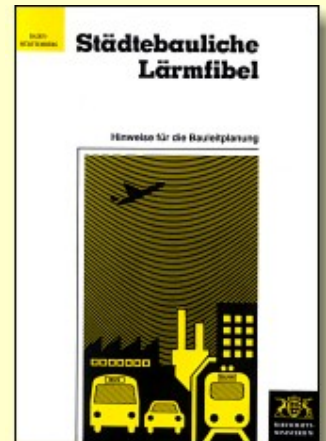
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### 4.2 Calculation and assessment foundations

DIN 18005-1 (Noise abatement in town planning) gives planning-related indications for industrial noise and its calculation. The administrative regulation TA Lärm (Technical Instructions on Noise), however, treats pollution control rights and matters to planners especially because of the used terms, measurement methods and assessment criteria.

The planning and construction of operating plants concern technical questions of immission control at the source of emission. This problem is treated in the VDI manual on noise reduction (VDI-Handbuch Lärminderung) including installation-specific guidelines. Even if VDI guideline 2571 (Sound radiation from industrial buildings) is of rather technical importance, it comprises the aspect of the immission prognosis, which is relevant for planning, and is therefore included in the following consideration.



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### 4.2.1 DIN 18005-1 Noise abatement in town planning

Commercial installations are treated only shortly in DIN 18005-1.

Pursuant to TA Lärm (Technical Instructions on Noise), the rating level within the sphere of influence of commercial installations shall be calculated in combination with DIN ISO 9613-2.

The question of whether the construction and operation of commercial installations are authorized depends on the adherence to the requirements of TA Lärm. When drawing up legally binding land-use plans for industrial and commercial areas, those responsible must take care that the immission guide values cannot be fully exhausted by installations covering only parts of the area as this would limit the intended use of the other parts of the area.

If the nature of the settling installation is not known, an area sound source with the following area-related sound power levels must be set for the calculation of the rating levels expected in the surrounding region of a planned industrial or commercial area without emission limitation: 65 dB in industrial areas for day and night, 60 dB in commercial areas for day and night. This norm also contains a clearance table (table 4/1), which lists the approximate clearances required for adhering different rating levels in the case of undisturbed sound propagation.

| Area<br>(ha) | Rating levels of noises<br>from industrial areas/commercial areas (dB) |        |        |        |        |         |
|--------------|--|--------|--------|--------|--------|---------|
|              | 60/ 55   | 55/ 50 | 50/ 45 | 45/ 50 | 40/ 35 | 35/ ... |
|              | Clearance from the border of the area (m)                              |        |        |        |        |         |
| 1            | 25   | 50     | 100    | 200    | 350    | 600     |
| 2            | 30   | 70     | 150    | 300    | 500    | 800     |
| 5            | 35   | 95     | 200    | 400    | 700    | 1200    |
| 10           | 40   | 100    | 300    | 550    | 950    | 1500    |
| 20           | 50   | 150    | 400    | 700    | 1200   | 1900    |
| 50           | 60   | 200    | 550    | 1000   | 1700   | 2600    |
| 100          | 70   | 300    | 700    | 1300   | 2100   | 3100    |
| 200          | 80   | 350    | 850    | 1600   | 2500   | 3600    |
| 500          | 95   | 450    | 1100   | 2000   | 3100   | 4400    |

**Table 4/1:** Approximate clearance from the border of a planned rectangular industrial or commercial area required for not exceeding an indicated rating level in the case of undisturbed sound propagation (line-of-sight) without noise allotment

If the clearances from areas requiring protection listed in the norm cannot be maintained for a planned industrial or commercial area, the Federal Land Utilisation Ordinance (§ 1 para. 4 sentence 1 No. 2) regulates that the area must be subdivided in sectors whose permitted emissions are limited by the setting of noise allotments (DIN 45691).

The designation of new areas requiring protection without sufficient clearance from existing commercial installations, industrial or commercial areas may lead to a restriction of the commercial use.

Calculations lead to the determination of rating levels, which shall be compared with the "acoustic orientation values" in Supplement 1 of DIN 18005-1 (see [section 3.1.2.1](#)) indicated in [section 2.5](#). The orientation values are to be applied in town planning, especially for the planning of development areas with uses requiring protection and for the replanning of areas with sound emissions, which can have an influence on existing or planned uses requiring protection. The supplement also indicates that it may be necessary in particular cases to stay below or exceed the orientation values due to local conditions. Pursuant to § 1 para. 6 of the Federal Building Code, orientation values are to be duly weighed.

"Acoustic orientation values" differ from fixed pollution control values according to purpose and



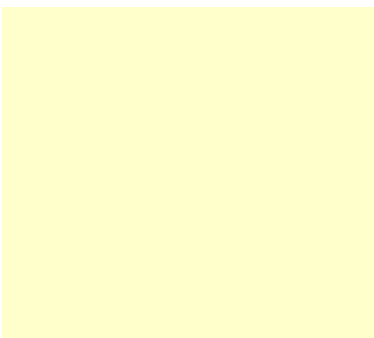
content. The latter are relevant for the permissibility of individual projects and for the protection of individual objects (e.g. the dwelling of an appellant).



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### 4.2.2 TA Lärm

The [Technical Instructions on Noise \(TA Lärm\)](#) contain protective and precautionary measures against harmful effects on the environment caused by noise. They shall be applied to installations subject to licensing and those not subject to licensing meeting the requirements of Part II of the Federal Immission Control Act.

Pursuant to TA Lärm No. 1, exceptions are made for:

- a) sports facilities subject to the Ordinance on the Prevention of Noise from Sports Facilities (18th Federal Immission Control Ordinance)
- b) other leisure facilities not subject to licensing as well as open-air restaurants
- c) agricultural installations not subject to licensing
- d) shooting ranges where weapons as from a calibre of 20 mm are used
- e) surface mines and the installations needed for their operation
- f) building sites
- g) transshipment ports
- h) installations for non-profit purposes

These exceptions are made as the installations are assessed pursuant to other regulations or only with reference to TA Lärm due to their specificity (e.g. surface mines or the shooting with firearms).

The protection from harmful environmental effects is ensured as far as the total pollution, e.g. the sum of the noises from all installations to which TA Lärm is applied, does not exceed the immission guide values at the relevant place of immission. The relevant place of immission is that place in the neighbourhood of installations requiring protection where the highest total pollution is expected. As for built-up areas, this place can be situated in front of the windows of rooms requiring protection or, as for undeveloped areas, at the border of areas on which buildings with rooms requiring protection may be constructed. The immission guide values for both the rating level and the maximum level of single sound events are graduated according to the degree of protection required for each territorial category, which corresponds to the classification made in the Federal Land Utilisation Ordinance. The allocation complies with the designations in legally binding land-use plans or, if those are not available, with the degree of protection required for the actual use of the territory.

Section 6.1 of TA Lärm specifies the following immission guide values for places of immission outside buildings:

- |    |  |  |
|----|--|--|
| a) | in industrial areas                                    | 70 dB(A)                                     |
| b) | in commercial areas                                    | at daytime 65 dB(A)<br>at nighttime 50 dB(A) |
| c) | in core areas, village areas and mixed areas           | at daytime 60 dB(A)<br>at nighttime 45 dB(A) |
| d) | in general residential areas and small housing estates | at daytime 55 dB(A)<br>at nighttime 40 dB(A) |
| e) | in purely residential areas                            | at daytime 50 dB(A)<br>at nighttime 35 dB(A) |
| f) | in spa areas, for hospitals and nursing homes          | at daytime 45 dB(A)<br>at nighttime 35 dB(A) |

Single short-time peak values may not exceed the immission guide values by more than 30 dB(A) during the day and more than 20 dB(A) at night.



The term "immission guide value" implies that the values according to TA Lärm do not represent the limit of relevance (reasonableness) in any case. A number of factors, which do have an influence on the nuisance but whose weighing can differ significantly in a given case, is included in the assessment procedure. With its assessment of special cases, TA Lärm provides a basis of decision-making for such situations. A situation of that kind is given in the conflict situation at the border between commercially or industrially used areas and residential areas. The immission guide values can be raised to an appropriate intermediate value, if this is required due to the obligation to mutual consideration, but they may not exceed the values of mixed areas in category c).

Installation noises are assessed on the basis of the rating level and the maximum value of single sound events. The following factors must be determined:

- existing pollution (immissions from installations within the scope of TA Lärm without the amount of the installation which is to be authorized)
- additional pollution (immission from the installation which is to be authorized)
- total pollution (sum from existing and additional pollution)

The rating level consists of the average sound level during the assessment period (the average value over the 16 hours from 6 am and 10 pm and the average value over the loudest hour between 10 pm and 6 am), of additions for discrete components, information incorporation, impulsive characteristics and daytimes with increased sensitivity and of meteorological corrections pursuant to DIN ISO 9613-2.

The rating level calculated in a sound immission prognosis is compared with the immission guide value when the immission control authorities check whether the obligation of protection is complied with in the case of installations subject to licensing; the same applies to the building control authorities in the context of installations not subject to licensing. A distinction is made between detailed prognoses with a high degree of accuracy, usually required for installations subject to licensing, and rough prognoses with a lower degree of accuracy for installations not subject to licensing. A prognosis is generally established according to the provisions in VDI guideline 2571 in connection with the method of calculation for sound propagation outdoors pursuant to DIN ISO 9613-2 as presented in [section 4.2.3](#).

TA Lärm allows for exceptions in the context of establishing a sound immission prognosis and of adhering to the immission guide values, which may be exceeded under certain conditions, e.g. in an assessment of special cases.

Special provisions are also to be applied to rare events for which exceedances of the immission guide values during the operation of an installation are allowed on up to 10 days or nights of a calendar year (up to 14 in the case of several installations) due to the predictability of the particular situation. The allowance of exceedances is attached to strict assessment criteria (best available techniques, exhaustion of all operational and organizational noise reduction measures, reasonableness in a given case). Rating levels of 70 dB(A) at daytime and 55 dB(A) at nighttime are permitted for rare events in areas with a higher protection claim than industrial areas. Furthermore, sound level ranges are determined for this areas, specifying the short-time exceedances of the rating levels for single peak noises during rare events.

Another special provision is applied to traffic noises in the context of the operation of installations. Vehicle noises coming from the company site are added to the installation noises. Start-up and drive-off noises on public circulation areas are separately determined pursuant to the method of calculation in the 16th Federal Immission Control Ordinance. These noises shall be reduced through organizational measures near the company site (up to a distance of 500 m) if

- they increase the rating level by at least 3 dB during the day or night,
- they are not mixed with the other traffic and
- the immission limit values of the 16th Federal Immission Control Ordinance are exceeded.

The principle saying that the total pollution must not exceed the immission guide values (also called acceptor reference), which is anchored in the Federal Immission Control Act and adopted by TA Lärm for installations within its scope, requires the examination whether an installation assimilates acoustically into the existing situation before it is authorized. An immission guide value percentage for the additional pollution on the basis of the existing pollution must be determined to this end. Noise allotment (see [section 6.3.2](#)) has proved to be an appropriate instrument for the determination of immission guide value percentages for larger commercial areas, where a number of installations from different operators has an impact on one place of immission.

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### 4.2.3 VDI guideline 2571 (Sound radiation from industrial buildings)

VDI guideline 2571 contains rules of how to approximately determine the sound levels in the neighbourhood of commercial and industrial areas. This allows for an estimation of the sufficiency of the designated sound-proofing measures with reference to the immission guide value valid at this place or the question of whether a costlier type of construction will be necessary for the isolation of building components. The extent of the calculated immission levels reveals which of the individual sound sources or building components of an installation contributes most to the total immissions.

The following conditions are the basis for calculating the sound levels expected in the proximity of planned industrial and commercial areas:

The sound power radiated from the installed machines and the acoustic properties of the place where the machines will be installed determine the sound level within the relevant building (factory hall) near its exterior shell. The interior sound level values and the sound isolation of the exterior shell (walls, roofs, windows, gates, openings) amount to the sound power radiated from the single building components of a building.

The resulting sum level for selected places of reception in the neighbourhood can be calculated through energetic addition of the examined individual levels in due consideration of the sound propagation principles pursuant to DIN ISO 9613-2 and VDI 2720-1 (see [section 2.4.2](#)).

As the calculation turns out to be very complicated, an expert opinion is often necessary even for known installation conditions. The following findings from VDI guideline 2571 are of importance for city planning:

- The sound level at places of immission without a direct line of sight to the considered element or sound source is lower than that at places of immission with a direct line of sight.
- Minimum shielding effect values as indicated in figure 3 of the guideline can be expected for sound sources situated at that side of the building which is not visible from the considered place of immission, as long as there are no larger sound-reflecting surfaces at the side of the sound-radiating element, e.g. in the form of other buildings.
- If additional obstacles, like walls or buildings, are situated between the individual sound sources, a shielding effect of about 5 dB(A) can be achieved by interrupting at least the line of sight between these obstacles.





**Fig. 4/1: Example of a commercial area**



Fig. 4/2: Container terminal Kornwestheim



**Fig. 4/3: Commerce within a residential area**