



U I C CODE

Leaflet to be classified in Volumes :

IV - OPERATING

VII - WAY AND WORKS

7 5 7

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1st edition, 1-1-67

Brought up to date on

INSTALLATION OF PUBLIC ADDRESS SYSTEMS AT PASSENGER STATIONS

1. Introduction

The object of the present leaflet is to formulate considerations of a general nature concerning the benefits which can be derived from public address systems at stations and, in addition, to establish general directives concerning the overall characteristics specified for such installations, with a view to achieving a basic qualitative standard valid for all countries.

Recommendations concerning the various component parts of these installations (microphones, amplifiers and loudspeakers) and the manner in which these are satisfactorily matched together, are only given insofar as they are necessary or desirable for the purposes of obtaining the overall characteristics mentioned above.

(Reprint, 1-11-1990)

2. Purpose of a public address installation

The primary purpose of a station loudspeaker system is as follows :

- to broadcast public announcements concerning the running of trains, or messages of a personal nature ;
- to convey service messages to staff.

The installation can also be used for other purposes, particularly for reproducing music.

3. Considerations of a general nature affecting public address installations

3.1 Nature of the problem which arises

The first concern is to ensure that announcements are reproduced by the system in a satisfactory and intelligible manner under the interior acoustic conditions obtaining at stations. Spoken announcements generally require to be diffused over areas where the reverberation time is rather lengthy (covered platforms, station concourses) and where the high noise level is subject to considerable variations (trains and passengers). Due allowance must also be made for reverberation and noise inside the announcer's cabin, since these factors can be introduced via the microphone and influence the quality of the sound transmitted. Since reverberation and noise both detract from speech intelligibility, they must be reduced as far as possible by applying suitable acoustic measures both inside the announcer's cabin and in the area covered by the loudspeakers. The public address equipment should be designed to be as insensitive as possible to these sources of interference.

3.2 Acoustic measures applicable to buildings

The noise on station platforms comes mostly from trains, railway service vehicles (luggage trolleys) and postal vehicles, and from crowds.

Train noise depends to a large extent on the nature and quality of the rolling stock. There are, for example, service regulations

against allowing steam or air to escape in stations, and routings are carefully considered with a view to fast trains bypassing the stations, thus contributing to an appreciable reduction in noise production.

By ensuring that the method of laying track at stations gives a shock-absorbing effect, and by fitting the walls of raised platforms with soundproof linings (porous concrete, for example), a definite reduction in the noise produced by wheels and brakes is obtained.

In order to reduce the noise of service vehicles, it is possible to deaden the motors, select carefully the kind of tyres, and finally, to give suitable instructions to driving staff.

It does not suffice merely to reduce the sources of noise, and construction should be carried out in such a way as to localise and deaden the noise produced ; this can be done by using soundproof materials. These measures should be aimed particularly at low frequency noises, which contain most of the energy and determine the sound intensity of the noise. The low tones are absorbed by slits arranged in the platform roofs, and by using slit-type absorption devices, perforated acoustic plates and resonance boards. It should be noted that these devices usually have a hard surface, and they can therefore be easily cleaned. In order to absorb higher frequency noises, the walls (if possible high enough to be out of reach) and ceilings are covered with porous acoustic materials, which lose only a small part of their absorbing power when covered with perforated plates. The aesthetic aspect hardly suffers therefore, and cleaning can be achieved without difficulty. The porous materials absorb a very large part of the low tones if they are some distance away from the hard wall ; it is therefore preferable to position them in this way. In addition, the noise absorption is helped with a reduction in the reverberation time if the awnings are made no higher than necessary.

What has been said above concerning platforms also applies to station concourses, waiting rooms, buffets, stairs and subways. Premises should not have ceilings which are too high, and it is particularly advisable for the ceiling to be of a noise-absorbing nature. A short reverberation time in stations limits not only the noise level of the trains, but also that emanating from the public. The psychological effect plays an important part, since experience

shews that in spaces where the reverberation time is long, people tend to speak louder, thus creating noisy conditions; when the reverberation time is short, on the other hand, conversation tends to be quieter. A reduction in reverberation time therefore has a twofold advantage on noise emanating from the public; not only does its level become less, as a direct result of absorption, but the noise production itself also decreases.

The acoustical comfort afforded to passengers as a result of these constructional measures itself produces a twofold improvement in the quality of loudspeaker announcements. Intelligibility is less affected by reverberation, also the transmission has a lower noise level to overcome and is thus of better quality, since the sound level required is less.

Noise and reverberation inside the announcer's cabin can adversely affect the intelligibility of the reproduction to a great extent. These parasitic noises are picked up by the microphone and reproduced by the loudspeakers. By virtue of the ability to orientate one's hearing, a person is able to concentrate on an announcement emanating from a given direction, by creating a **kind** of psychological screen against noises occurring around him or coming from other directions; conversely, a person is not able to isolate himself from parasitic noises transmitted by the loudspeaker itself and originating in the announcer's cabin: for this reason these noises are much more unpleasant to the ear of the listener than those originating around him.

In view of this it is necessary to place the announcer's microphone in a quiet place with good acoustic absorption; it is even recommended that an insulated cabin should be provided.

Failing this, if the announcements are to be made in a place occupied by several persons undertaking various types of work, it is necessary to install a protective screen against parasitic noise (telephonic screen). If the official responsible for announcements is obliged to move for other requirements, this measure is also impractical and the last resort is then to fit the loudspeaker equipment with a suitable device (see section 4).

3.3 Overall frequency characteristic for spoken announcements

If the principal object is to transmit speech, a flat characteristic should be avoided, for the following reasons :

- the voice intensity is determined in most cases by low-pitched sounds of less than 1000Hz, while the intelligibility of the words is determined by high-pitched sounds of more than 1000Hz. It is this latter range which contains the characteristic harmonic groups of certain phonemes, such groups being known as "formants" ;
- in the announcing room, as in the loudspeaker area, the reverberation takes its sound level particularly from low frequency components. The reverberation, which degrades the transmission quality, will therefore be mainly due to the reproduction of low-pitched sounds ;
- in the announcing room, as in the loudspeaker area, the noise possesses a characteristic spectrum, the energy distribution of which generally decreases by at least 4dB per octave with increase of frequency. In addition, the noises extend their masking effect over a wide frequency band in the high frequency direction, but not in the direction of the low frequencies of their own frequency band.

For the announcements to be clearly understood, it is essential for the high frequency voice sounds to be more than 6 to 10 dB above the parasitic noise level in the same frequency band. However, in view of the low degree of intelligibility of low pitched voice sounds, there is no purpose in dominating the noise level in their frequency range, since this would lead to a needlessly loud and unpleasant transmission ; further, low pitched voice sounds, reproduced strongly and strengthened further by reverberation, would run the risk of masking the high pitched sounds and of jeopardising the intelligibility of the announcement ;

- the reproduction of the speech must generally be stronger than ordinary conversation. A flat frequency characteristic would result in a particularly intense physiological perception of low pitched sounds, and the voice reproduction would appear unnatural.

For all these reasons, it is therefore necessary to attenuate the low frequencies and to amplify the high frequencies to achieve the clearest reproduction possible. It goes without saying that the optimum form of the overall frequency characteristic depends on the reverberation, the noise level and the sound intensity of the transmission.

The frequency characteristic represented in figure 1 can serve as a model for the overall characteristics to be adopted so as to obtain a reproduction that is intelligible and sounds natural under the average acoustic conditions obtaining at stations.

This frequency characteristic gives a transmission band of 250 to 7000Hz, outside of which, it falls, while within it, it has a rising characteristic with increase of frequency. The object of this characteristic is especially to attenuate the frequency band between 250 and 630Hz which, while contributing only very little to intelligibility, contains a large part of the voice power and thus produces reverberation phenomena in the loudspeakers area.

This characteristic is the sum of the characteristics of the microphone, the amplifier and the loudspeakers.

In practice, it is difficult to measure this overall characteristic. It is nevertheless necessary to select the components of the installation (microphone, amplifier and loudspeakers) in such a way as to conform to the overall desired characteristic, and to obtain possibly, by adjustments made during operation, an optimum intelligibility.

3.4 Overall frequency characteristic for music

Generally speaking, only "background music" will be broadcast, particularly in waiting rooms and buffets, by retransmission of radio broadcasts or by use of magnetic tape recordings or records. The sound level will generally be quite low, and preference will be for a type of music of a non-dynamic nature. The overall frequency characteristic of music broadcasts will be preferably flat and will extend over a frequency field from 100 to 10 000Hz.

3.5. Installations for the speech and music

What has been said in the two preceding paragraphs implies that the overall frequency characteristics recommended for speech and for music differ appreciably; similarly the optimum sound level will not be the same for the two kinds of broadcast. If, in a given space, the loudspeakers (the terminal amplifiers and the loudspeakers respectively) broadcast both speech and music, it is necessary to give to these components a flat frequency characteristic within the band from 100 to 10 000Hz. With such an arrangement, speech enters by an input channel with the desired frequency characteristic, while the music enters by another channel with a volume control and sometimes even a tone control, so that the staff can regulate the music without affecting the speech channel.

3.6. Sound level of the reproduction

In order to obtain a satisfactory quality of announcements, it is necessary for the voice, in its own frequency range which is essential for intelligibility of speech, to have a sound level at least 6 dB higher than the noise level. This difference can be increased according to the type of noise existing in the places served by loudspeakers. In addition, announcements should not be broadcast with an unnecessarily high sound intensity, in view of the fact that too noisy a broadcast produces an unpleasant sensation and can even disturb the neighbourhood.

For intelligibility of the speech, it is also necessary for the sound level of the reproduction to be independent of the voice strength of the announcer and of his distance from the microphone. To this end, the amplifier should be fitted with a sound level stabilising device (see §5) ; in addition, the sounds broadcast by the announcer can be reproduced at his own ear (see §4).

In certain cases, it is possible to adapt the sound level to the needs of the moment by means of a programmed adjustment which increases the sound intensity at peak hours and reduces it during the night (and cuts out groups of loudspeakers which are unnecessary).

Instantaneous adjustment is obtained by enabling the announcer to choose between several sound levels (three for example), in accordance with an acoustic or visual indication of the noise level. In this way, it is possible to avoid broadcasting announcements when the noise level is extremely high, e.g. while a shunting locomotive is passing through.

This instantaneous adaptation of the sound level to the noise level can also be obtained by an automatic adjustment (see §5).

As regards the calculation of the amplifier power, a figure of 84dB can be taken as a standard for the maximum sound intensity of the reproduction where the public is situated.

4. Microphone

Arrangement and operation of the microphone in the announcing room

It is recommended that the microphone should be placed in an announcing room insulated from surrounding noise and with a reverberation time as low as 0.75 second, procured by means of walls lined with soundproofing materials. If the room is occupied by several persons, it is necessary to make use of an insulated cabin or to install a noise-resistant screen.

A speech microphone with unidirectional sensitivity, with a frequency characteristic at 0° possessing a transmission band of 250 to 7000Hz should be used; outside the characteristic could be less, while within it an ascending tendency of between 250 and 1600Hz approximately would be advantageous in the case of the application concerned. The directional characteristic would be a cardioid or a hypercardioid; in the frequency zone of the strongest spoken word and noise level (250 to 1000Hz) and for one or more directions within an angle of $180^\circ \pm 60^\circ$, the sensitivity is less by at least 12 dB than that found at 0°. The microphone would then compress the surrounding noises and echoes from 4 to 5 dB.

The microphone should be fixed to its support so that the mouth of the announcer is about 30cm distant when in his normal working position. When speaking normally, he should produce a sound level of 75 dB level in front of the microphone, which can even reach 84 dB for certain syllables; this is equivalent to an acoustic pressure of 1 and 3 microbars.