

# Acoustic Insulation Design of Noise in Welding Plant through Screens



Alexi Delgado, Areli Luyo, Mario Moreno, Chiara Carbajal

**Abstract:** *Noise is one of the industrial hygiene agents of greatest concern, which explains the large amount of regulations and literature that attempt to reduce it. In most industries in Peru and the world the welding process is indispensable as part of their production process, nevertheless this activity involves several risks for people, not only for those who perform the activity but also those who are adjacent to it, within these risks, exposure to high levels of noise is one of the most difficult to control because the control at the source of noise is almost, one of the great passive controls in noise reduction is the use of screens or acoustic curtains. It is for this reason that the objective of this article is to propose a design of acoustic barriers through screens, responding to the problem of noise generated in welding workshops. The stages in the process of designing acoustic screens for a welding plant are presented in chronological order.*

**Keywords :** *Acoustic Screen, Noise, Sound Level, Welding plant.*

## I. INTRODUCTION

After the industrial revolution, industrial processes are increasingly common, whether in urban or rural areas. However, industries have caused environmental damage to soil, water and rivers [1]. As well as large generators of noise, emitting excessive noises that affect the health of workers and individuals in the surrounding area [2]. Various studies have been conducted to have more information about this phenomenon; demonstrating that chronic exposure to heavy noise for several consecutive hours causes workers to develop a hearing impairment, which results in total hearing loss [3] [4]. This is because continuous or repetitive exposure to high auditory frequencies easily and progressively destroys the cells and nerves of the inner ear. If there is a sufficient number of cells and nerves destroyed, there will be permanent hearing loss [5].

However, while hearing loss is the most common and probably the most serious harmful effect, it is not the only consequence of industrial noise. Other harmful effects include tinnitus (ringing in the ears), interference with oral

communication and the perception of alarm signals, disturbances in work performance, discomfort and extra-auditory effects [6]. It is also responsible for physiological and psychological transformations in the organism that manifests itself in a direct effect on quality of life and behavior [7]. In conclusion, noise not only causes alterations in the auditory apparatus, but also acts on the bulbar centers, vegetative centers, and cortical centers of association and will [8].

And while the high noise levels generated by welding work (peaks of up to 102.8 dB) are meant to be mitigated by the use of EPP earplugs (disposable earplugs of NRR 33dB - auditory adjustment) - whether made disposable by the company or the workers themselves - the discomfort and stress caused by this agent affects workers in the surrounding areas, deteriorating their health indirectly [9].

Therefore, it is crucial to think of other ways of controlling noise or, in other words, the different actions that are taken to combat noise, tackling it from any of its three propagation phases: actions at the source of the noise, in the transmission phase, or acting on the receiver [10].

Generally, when it comes to combating noise generated by the machinery, the most commonly adopted solutions are those that address the problem at the source of the noise, but what to do when the characteristics of the task do not allow the encapsulation of the machinery [11]. In this report, the design of a method of acoustic insulation of noise through screens, which are defined as devices formed by continuous walls, interposing between the noise source and the receiver, is discussed.

In them, the sound is reflected mainly to the emitting source; nevertheless, part of the energy is transmitted through the barrier, and great part of it is diffracted by the edge of the same one, being the use of these screens generally used for the reduction of the traffic noise and sometimes as solutions of industrial [12].

It is worth mentioning that the effect of a screen is not very significant for frequencies whose wavelength exceeds the width or height of the screen. Therefore, a frequency study is needed before deciding to build such an artifact.

## II. METHODOLOGY

Acoustic screens produce a noise attenuation effect in the receiver area. This attenuation depends fundamentally on the dimensions of the screen, which determine the amount of direct and diffracted sound energy [13].

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The efficiency in relation to the transmission of noise is given by the isolation capacity of the screen, which, besides its dimensions, depends on the construction material, as well as its relative location with regard to the situation of the emitting source and the reception area to be protected, as it is shown in Fig. 1. Consequently, the study and development of all types of acoustic screens is growing. Therefore, this is the reason why manufacturers are currently developing and patenting their own construction elements and materials [14].

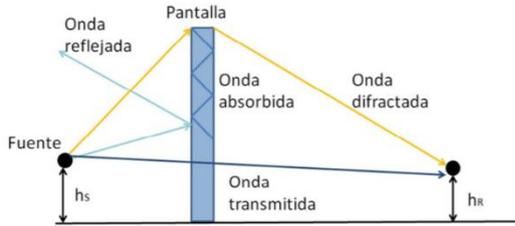


Fig. 1. Functional diagram of a classic acoustic barrier

The methodology used was as follows:

- (1) Noise study in welding workshop
- (2) Analysis of the results obtained in the previous proposal
- (3) Choice of screen material according to the results obtained under (1) and (2).

The choice of material will be made by studying the noise produced by welding in the dosimetry of a worker and the coefficient of acoustic reduction in different materials, as well as the material needed to be resistant to fire and heat due to the innate risks of welding.

- (4) Screen dimensions design

- (5) Choice of the distance between the screens and the noise source
- (6) Design final presentation

## III. CASE STUDY

The case study is presented in Step 1.

### Step 1: Noise study in welding plant

We studied the results of dosimetries made to the workers of the welding workshop and to workers of nearby workshops as shown in Fig. 2 [15].

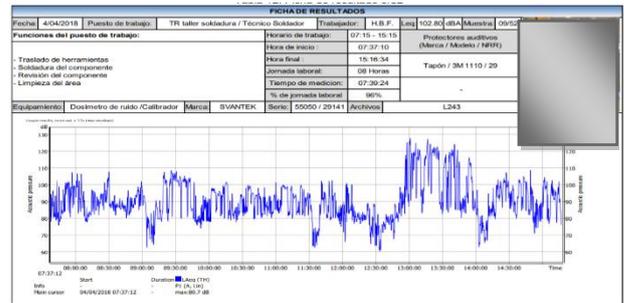


Fig. 2. Dosimetry of the worker in the welding workshop

From the data provided by the records of the workers, welders and technical welders (as shown in Fig. 2), a compilation was elaborated as shown in Table 1. This differentiation should be specified as the job is one of the most prone to industrial noise.

Table I: Statistical Processing of Weld Shop Data

Date	Area	Job Position	Workday	Leq (dBA)	1st Hearing protector (Make/Model/NRR)	2nd Auditory Protector (Brand/Model/NRR)	Leq atenuado (dBA)	LMP per workday RM 375-2008 TR	Exceeds LMP	Peak (dBA)	LMP Peak ACGIH	Exceeds LMP peak	% Dose
3/04/2018	Welding workshop	Welding technician	08 hours	101.5	Plug/ 3M 1110/ 29	-	90.5	85.000	Yes, it surpasses	142.4	140	Yes, it surpasses	356%
3/04/2018	Welding workshop	Welding technician	08 hours	97.4	Plug/ 3M 1110/ 29	-	86.4	85.000	Yes, it surpasses	152.7	140	Yes, it surpasses	138%
4/04/2018	Welding workshop	Welding technician	08 hours	102.8	Plug/ 3M 1110/ 29	-	91.8	85.000	Yes, it surpasses	143.3	140	Yes, it surpasses	481%
4/04/2018	Welding workshop	Welding technician	08 hours	96.1	Plug/ 3M 1110/ 29	-	85.1	85.000	Yes, it surpasses	137.1	140	Does not exceed	102%
20/04/2018	Welding workshop	Welder	08 hours	90.9	Plug/ 3M 1110/ 29	-	79.9	85.000	Does not exceed	145.8	140	Yes, it surpasses	31%
20/04/2018	Welding workshop	Welder	08 hours	95.0	Plug/ 3M 1110/ 29	-	84.0	85.000	Does not exceed	129.0	140	Does not exceed	79%

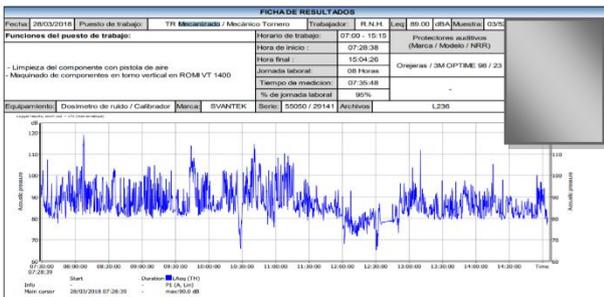


Fig. 3. Dosimetry of the worker in the machining workshop

The records of workers, mechanics, mechanics, turners and rectifiers (such as the one shown in Fig. 3) were used in the same way, providing the following information in Table 2.

**Table II: Statistical Processing of Machining Shop Data**

Date	Area	Job Position	Workday	Leq (dB A)	1st Hearing protector (Make/Model/RR)	2nd Auditory Protector (Brand/Model/RR)	Leq atenuado (dBA)	LMP per workday RM 375-2008 TR	Exceeds LMP	Peak (dBA)	LMP Peak ACGIH	Exceeds LMP peak	% Dose
28/03/2018	TR Mechanized	Mechanical Turnero	08 hours	89.0	Earmuffs /3M OPTIME 98/23	-	81.0	85.000	Does not exceed	132.8	140	Does not exceed	40%
28/03/2018	TR Mechanized	Mechanical	08 hours	88.4	Earmuffs /3M OPTIME 105/27	-	78.4	85.000	Does not exceed	136.1	140	Does not exceed	22%
20/04/2018	TR Mechanized	Rectifier	08 hours	90.8	Earmuffs /3M OPTIME 105/27	-	70.8	85.000	Does not exceed	138.6	140	Does not exceed	4%

**IV. RESULTS AND DISCUSSION**

The results and discussion are presented from Step 2 to Step 6.

**Step 2:** Analysis of the results obtained in the previous proposal

In figures (2) and (3), as well as in table (1) and (2), it can be seen that the dose of noise, coming from welding in the workers of the welding workshop as well as in those in the machining workshop near it, exceeds the maximum permissible noise limit by an average of 90%.

**Step 3:** Choice of screen material

The choice of material will be made by studying the noise produced by welding in the dosimetry of a worker and the coefficient of acoustic reduction of different materials, as well as the material had to be resistant to fire and heat due to the innate risks of the welding process.

Considering the above, safety glass acoustic screens were chosen (see Fig. 4), also called transparent or translucent panels - manufactured by extrusion, in such a way that panels with lengths of up to 5 metres are obtained [16]. Their thickness is usually 15 or 20 mm, depending on the manufacturer. The glass panels are mostly made of acrylic or polycarbonate glass and normally the basis of their operation is that the reflection of the acoustic waves presents an index of acoustic attenuation [RW]: 30.00/31.50 dBA being B3 Class (maximum UNE-EN 1793-2).



**Fig. 4. Transparent acoustic screens**

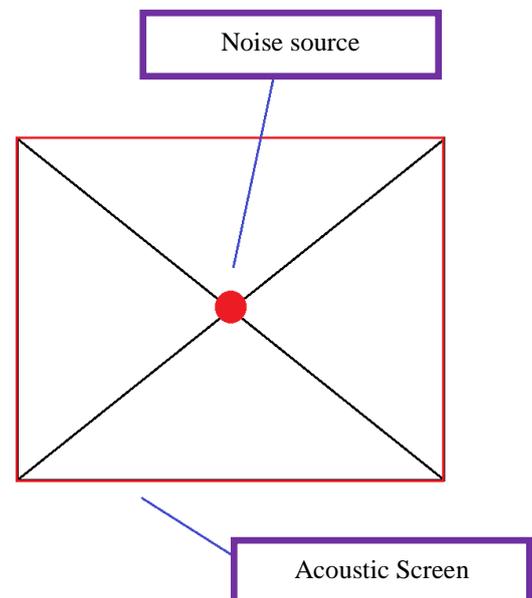
This type of screens are quite used because, in addition to

their acoustic function, they allow the visibility of the areas behind the screens, a fundamental part for the process of supervising the activity, as well as disadvantages we have on the one hand the low resistance of the glass to impacts and on the other hand that the glass does not have the characteristics of absorbing the noise which would not provide a reduction in noise for the welder but for the people close to the welding plant [17].

**Step 4:** Screen dimensions design

This part of the design will be made considering a size of pieces to be welded of 2m x 2m, and the height will be greater than the average height of the workers. In this way, the screen fulfills its function by keeping the adjacent personnel within the acoustic shadow of this screen [18].

The screens were arranged around the noise source simulating an encapsulation, and then the design proposal is presented in Fig. 5.

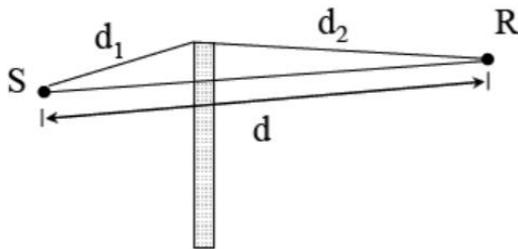


**Fig. 5. Arrangement of acoustic screens around the noise source in the welding workshop**

**Step 5:** Choice of the distance between the screens and the noise source

In order to choose the appropriate distance at which the layout of the screens will achieve the maximum insertion loss, the following formulas were considered (see Fig. 6).

$$N = \left(\frac{2}{\lambda}\right) [+ -] = 10 \log[3 + 10NK]$$

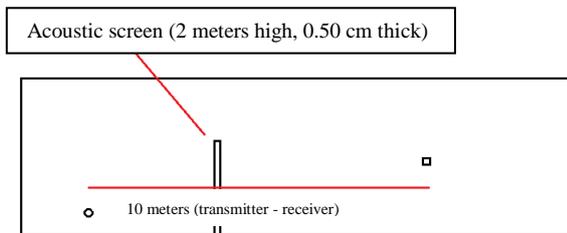


**Fig. 6. Fundamental distances of the method to calculate the IL of a thin screen**

Since the distance of the screens would not be greater than 100 meters, the value of  $A_{soil}$  is equal to 1. The equations are derived and zeroed to find the appropriate distance considering the distance between the noise source and the 10-meter receiver.

### Step 6: Design final presentation

There will be four glass screens around the noise source which will measure 2 meters high and will not have an opening in the lower part, an uneven floor could cause openings between the screens and the floor which would cause a decrease in the level of sound attenuation, the thickness of the glass will be 0.50 centimeters, this would prevent the passage of noise waves, the union between one screen and another will be made by joints that do not allow holes or openings between them. The final design is presented in Fig. 7.



**Fig. 7. Front view of the design**

## V. CONCLUSIONS

The design of 0.50 cm safety glass acoustic screens is presented in order to reduce the sound pressure produced by the welding workshop in 30 dB. The design is in such a way that it surrounds the noise source fulfilling the necessary criteria for this activity, verifying that the use of screens in this activity is a viable and highly effective measure; likewise, it would be necessary to perform a prototype to verify the in situ attenuation of a mobile screen according to UNE-EN ISO 11821:1998; due to the constant technological development it is important to consult with suppliers to find the best material that presents the characteristics of insulator and noise absorber.

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