24th INTERNATIONAL CONGRESS ON SOUND AND VIBRATION
23–27 July 2017, London

NOISE REDUCTION PROGRAM FOR EMPLOYEE EXPOSURE IN WORKPLACE

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This work shows an example of a noise reduction plan in a car production plastic shop. The main sound sources were evaluated, and mitigation actions have been designed. The execution priority is chosen by cost – benefit ratio evaluation. The actions, once completed, will ensure a noise reduction about 10-15 dBA emitted by specific sources. The noise reduction plan provides also to an information / training session for workers.
Keywords: employee, exposure, workplace, plastic shop

1. Introduction

Among the most important requirements of European legislation, there is a requirement for the industrial activities noise risk, to draw up appropriate programs to reduce worker noise exposure. According to the norm 2003/10 /EC, and the UNI 11347/15 standard, here we will present the case study of a plastic shop of a leading establishment in car production. The company noise reduction plan, is based on the plastic shop risk areas identification, and the workstations noise exposure evaluation. It is then carried out the study of the noise main sources, with the acoustic characterization indispensable to define the appropriate mitigation actions. The schedule of operations has to consider their cost and benefits. The company shall appoint in the prevention and protection service, a delegate for the priority management of the technical and organizational measures execution.

2. Main Objectives

In the case study, using the noise reduction plan, we want to eliminate as a priority the "undue" exposures noise. It is noise sources that also act on the workers not connected directly to the production cycle. The results of the acoustic measurements of identified sound sources, were used for the design and implementation of the appropriate sound and noise insulating works. The realization of the interventions is made difficult by the coexistence of the manufacturing necessity. More complex sound sources are the *lift station* and *large and small resin distribution networks* to printing presses.

The list of programmed technical interventions is the result of a compromise between the mentioned requirements and the cost benefit of each intervention. When we talk about costs and benefits, we refer to the cost of the improvement measures, compared to the number of decibels reduced per worker.

3. Plastic Shop Area

The plastic shop covers an area of 41000 sqm, and produces 69 car plastic part:

- front and rear bumpers (23 pieces);

- dashboard (24 pieces);
- central, front and rear tunnel (19 pieces);
- interior finishes (21 pieces);
- tank (1 piece).

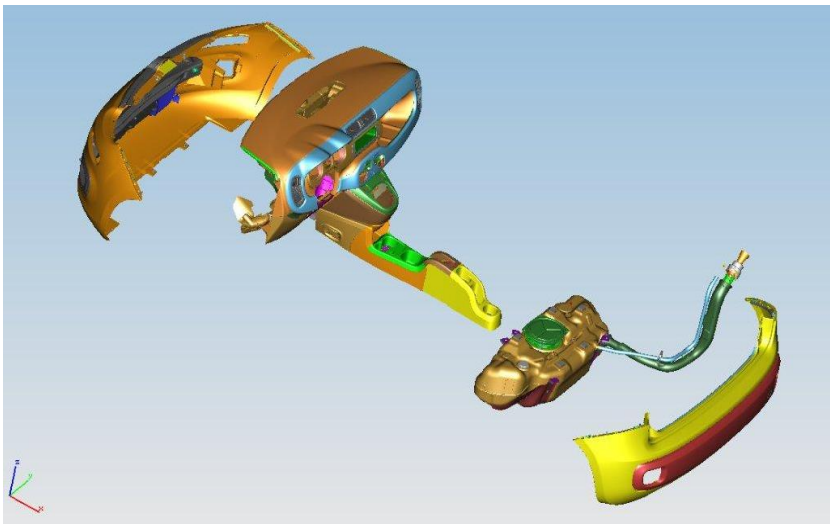

Figure 1: Exploded car plastic part

The machines used are: n. 19 large Presses, n. 14 small presses; n. 112 Molds and n. 36 robot.

4. Noise source

We investigated the main sources of noise emission and critical spectral frequency, the installations capable of influencing the working environment, including workstations that are not directly involved in noisy phases of the production cycle.

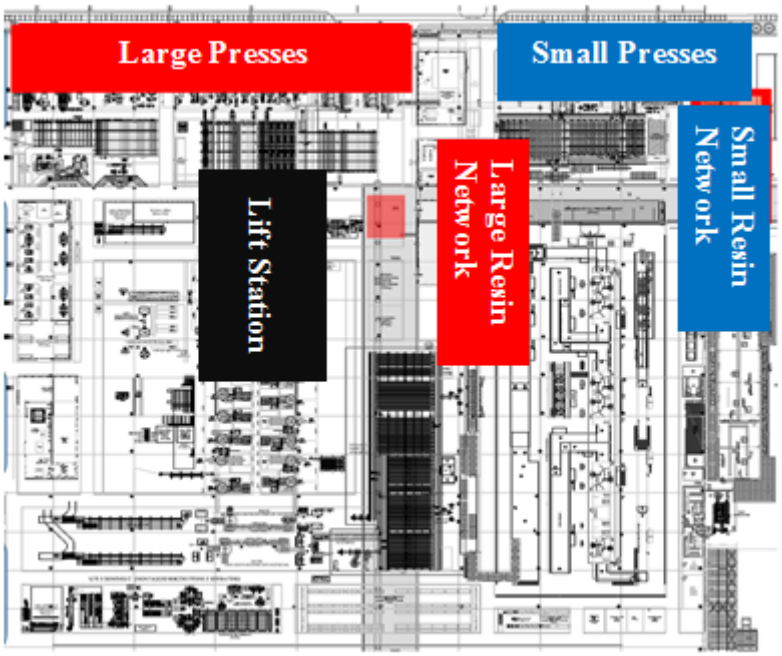

Figure 2: Plastic shop noise risk area

Large and small resin distribution networks have a propagation path extended in the entire shed, carrying the suction from the hoppers to the various presses. The aspirated material is selected manually by moving the suction hose from the distribution stations. *Resin distribution networks* are divided into three for the high bay and two for the low bay. In each span may be a suctioned only one container at a time by engaging a single tube of material. Obviously always the air turn in the vacuum hose when there is suction. For each container must be adjusted the suction time and cleaning of pipelines according to the type of aspirated material and the length of the pipeline. adjusting the proper suction time is very complex. The parameters are set with the aid of computers.

Figure 3: Large and small resin distribution networks

The lift station handles the loading between the external silos and drying hoppers and diverter valves. Both the lift station and the distribution networks will be subject to noise mitigation interventions.

Figure 4: Lift Station

4.1 Acoustic characterization

To obtain information on specific sources of noise, we have carried out source sound-oriented measures in near field (about one meter). This in order to minimize the contribution of sound reflections and other sound sources present in the shed. The measurements were carried out, in the factory night shift, with selective ignition of the plants. It is very difficult to identify accurate values, because the sound levels depend on many variables. The variables are: suction time of the conduct, the number of beams and pipe length and type of resins sucked. The technician has carried out the measures placed on a lifting platform near the pipes. He has repeatedly initiated the sound re-

cording of the event on the sound level meter, when it detect the passage of the material in the pipes. Values Measured in Proximity of sources, were rather variable.

Figure 5: Source sound-oriented measures in near field (1 meter).

Table 1: Resin distribution networks acoustic measurement in near field

Ref.	Plastic shop corridor	Measure	Start	End	Duration	Leq dBA	Predominant Frequency Band
1	13/25	0035.S3D	22.42.27	22.42.45	0.18	79,4	80-100
		0036.S3D	22.42.52	22.43.12	0.20	79,0	80-100
		0038.S3D	22.47.44	22.48.25	0.41	77.0	80-100
		0038.S3D	22.49.24	22.50.17	1.34	84,2	80-100
2	9/23	0039.S3D	22.57.14	22.57.49	0.35	85,3	80-100
		0042.S3D	23.03.26	23.04.18	0.52	76,1	80-100
3	20/21	0046.S3D	23.04.58	23.05.21	0.23	78,7	80-100
		0047.S3D	23.05.47	23.06.12	0.25	81,9	80-100
		0048.S3D	23.06.50	23.07.21	0.31	78,0	80-100
		0049.S3D	23.13.43	23.14.08	0.25	89,1	80-100
4	7/9	0050.S3D	23.14.37	23.15.09	0.32	78,2	80-100
		0052.S3D	23.18.03	23.19.07	1.04	81,1	80-100; 200-250
5	7/22	0053.S3D	23.23.08	23.23.41	0.33	78,1	200-250;500
		0054.S3D	23.24.07	23.24.52	0.45	93,2	100
6	Back wall	0055.S3D	23.34.13	23.35.43	1.30	80.2	80-100
		0056.S3D	23.36.32	23.37.07	0.35	81.9	80-100
		00.57S3D	23.37.25	23.41.10	3.45	78,6	80-100

The LeAq parameter detected approximately 1 m, range from 78 to 85 dBA, and the predominant frequency bands are 80 and 100 Hz.

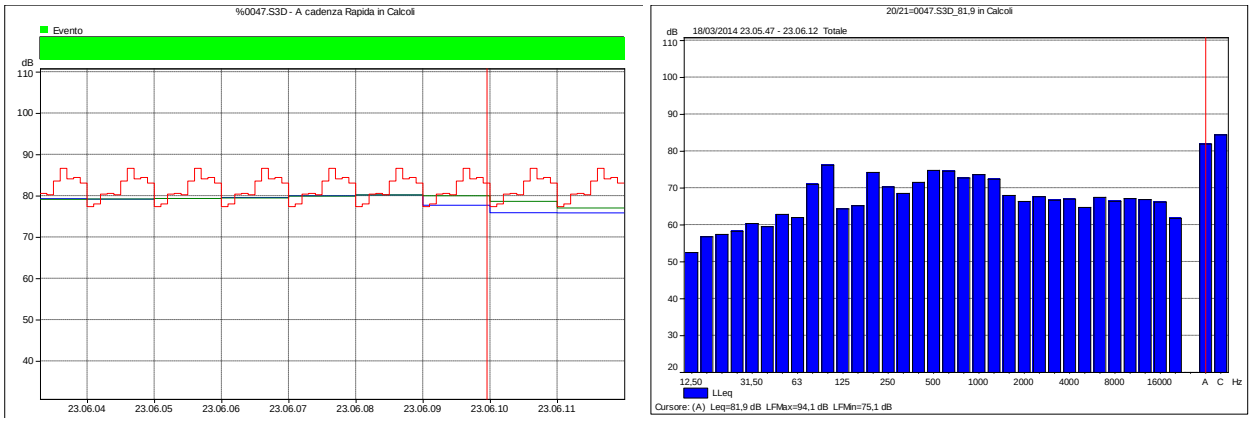

Figure 6: resin distribution networks sound profile and spectrum

5. Workers Exposure Average Level

From the data of the last noise exposure assessment, carried out in the plastic shop, according to the Italian safety law (D.Lgs. 81/08), the noise levels are as follows (for all workstations) generally below the action threshold limits, with an average value of 76.1 dBA. This shows that the background noise due to the plants analyzed, conditions with an undue noise exposure, even the work places not engaged in noisy activities. Are workers who perform low-noise auxiliary activities (eg cleaning, maintenance, organization of production, testing and product quality)

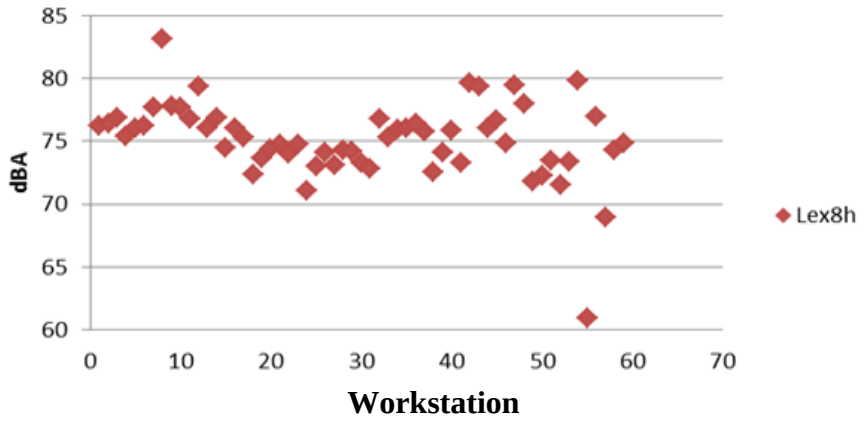

Figure 7: Lex_{8h} distribution value for workstation in plastic Shop

6. Synthetic statement of technical interventions

6.1 Insulating Cabin for lift station

Installation of insulating walls perimetrically between mezzanine and floor. The modular cabin, allows the removal of one or more modules to allow ordinary and extraordinary maintenance activities. The support structure made with modular elements, with box-shaped profiles made from galvanized steel sheet press-formed, shaped in quadrangular section.

The housings of the panels in double-strike are treated internally with rolled damping and sound-insulating EPDM-based resins. The internal filling material is made from non-combustible height density mineral fibers. The thickness of the panels is 100 mm.

The panels will be assembled with the interposition of closed cell rubber seals expanded consists of EPDM elastomer neopreme (synthetic rubber made by a chemical process).

The ventilating section in the cabin will be constituted by a centrifugal fan with single inlet impeller with reversed blades driven by three-phase electric motor.

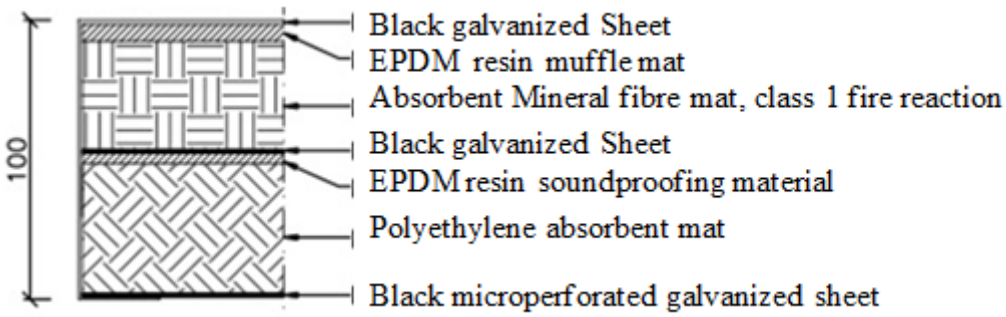

Figure 8: Wafer panel composition

6.1.1 Cost – benefit ratio

The cost-benefit ratio of the intervention is described by the formula 4.3.2.3 of the UNI 11347, reported to follow.

$$h = \frac{c}{\sum_{i=1}^{N} \Delta dB_i \cdot n_i} \qquad \text{Eq. (1)}$$

C = cost of the work including all expense items: installation, testing, maintenance, etc.
ΔdB_i = attenuation in dB assured by the intervention to an *i-th* group of workers.
n_i = number of worker an i-th group.
N = number of worker group who get acoustic benefit.

Table 2: Insulating Cabin for lift station: Cost – benefit ratio

Action	Surface	Efficacy	c	ΔdB_i	n_i	N	η (€/dB)
Insulating Cabin for lift station	120 sqm	15 dBA	10.200,00€ (All materials, ventilation system, labor, maintenance and preservation)	15 dBA	8	2	85

6.2 Acoustic reduction Shell for resin distribution networks to printing presses

Isolation of the tube bundle, with double shell external containment galvanized sheet at bent-treated with damping laminate made of EPDM resins.

In each shell it will be inserted sound absorbing mat in medium density polyethylene, non-powdery and water-repellent. The shell thickness will be 30 mm. The shells will be supported by the existing fixture and assembled using galvanized bolts and screws.

Will be established, with special pieces, in correspondence with each press, suitable openings for the engagement of the resin main supply equipped with a valve group.

The paneling will be realized for the distribution network, both Large presses and Small presses. It starts by distributors plans and follows their electrical networks.

Figure 9: Clamping tube bundle and shell Isolation

The insulating panels, with the inner side absorbent characteristics, are designed according to culling of the predominant frequencies and have an adequate weight to be anchored to the clamping already present.

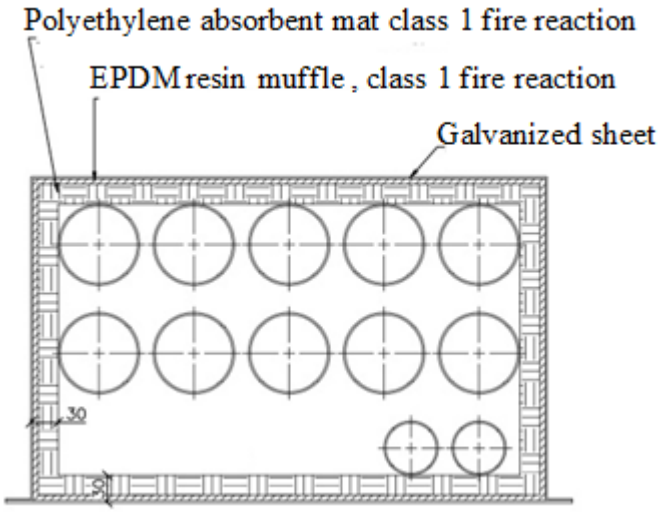

Figure 10: Resin distribution networks reduction Shell

6.2.1 Cost – benefit ratio

Employing the formula (1) quantify to follow the cost-benefit ratio for interventions in resin distribution networks to small and large printing presses. In this case, the labor cost have more influence, because the processing takes place in elevation during the night shift.

Table 3: Acoustic reduction Shell for resin distribution networks large printing presses: Cost – benefit ratio

Action	Surface	Efficacy	c	ΔdB_i	n_i	N	η (€/dB)
Shell for resin distribution networks to large printing presses	750 sqm	10 dBA	30.000,00€ (All materials, labor, maintenance and preservation)	10 dBA	17	2	176

Table 4: Acoustic reduction Shell for resin distribution networks small printing presses: Cost – benefit ratio

Action	Surface	Efficacy	c	ΔdB_i	n_i	N	η (€/dB)
Shell for resin distribution networks to small printing presses	1250 sqm	10 dBA	43.750,00€ (All materials, labor, maintenance and preservation)	10 dBA	25	3	175

7. Conclusions

The actions at the noise source in the case of the Cabin for lift station showing the best cost-benefit ratio and can be completed in less time.

The actions on the propagation path (tube bundles for small and large presses), while being more expensive and with more time to realization, allow to reduce exposure even on those workstations, crossed by the path of the tubes, making a considerable benefit to a significant number of workers.

The mitigation actions, once completed, will ensure a noise reduction about 10-15 dBA emitted by specific sources.

It will be an appreciable improvement of the plastic shop noise. In fact, the exposure levels, will be well below the action limit (80 dBA) and close to comfort ranges recommended for back office activities (70 dBA).

For the execution of the work described, it will be established a head of the procedure and a specific execution schedule.

On completion of this noise reduction program, the plan provides an information / training session for workers. In this session will be illustrate the changes introduced in the equipment / machinery, in the procedures, in the use and maintenance operations and in the workplace.

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