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Extensive survey of occupational noise exposure in the metal working industry

J.H. Granneman, J.P.J. Oostdijk and F.A.G.M. Schermer

Peutz bv, PO Box 696, 2700 AR Zoetermeer, The Netherlands

info@zoetermeer.peutz.nl

Abstract [265] Many workers in the metal working industry are exposed to high noise levels. An extensive survey regarding occupational noise in this industry has been done to provide adequate information for a proposed agreement between the government of The Netherlands and the representative branches of this industry. The obtained information concerns noise levels due to different activities, average exposure times in relation to the specific type of work, room acoustical characteristics in practice, the state of the art of sound reducing measures, general application of specific sound reducing provisions in practice in relation to cost and benefits a.s.o. A specific part of this research concentrates on grinding, welding, punching, cleaning with compressed air and transport of materials because of the high contribution to the noise exposure of workers in this type of industry. Nine sub-divisions of this branch were selected based on dominant occurrence of these activities and the relatively high number of exposed workers. To obtain reliable data many questionnaires were sent and evaluated, companies were visited and experts were consulted. From this information the average daily dose of workers and the contribution of each selected activity has been determined. Practicable sound reducing measures have been evaluated with respect to:
- the sound reduction that can be achieved;
- the technical, operational and economic feasibility;
- the absolute and relative costs;
- the (positive or negative) side effects.
The research gives recommendations with respect to certain measures that could be stimulated in a special way to reduce the exposure to noise of workers in the metal working industry.

1 INTRODUCTION

In order to reduce the risk of noise induced hearing loss, agreements are made and planned between the Dutch government and different branches in which occupational noise is considered one of the major risks. Such an agreement was also planned for the metal working industry, and should be based on adequate information regarding the noise levels at working places, the average exposure time for each relevant activity and state of the art of sound reducing measures.
Similar research has been done by our company in other branches; see for instance [1, 2].

2 AIM OF THE STUDY

The study had to provide relevant information to decision makers from government, and representatives of branch organisations and trade unions regarding an agreement about optimal ways to reduce the risk of occupational noise.
The sound levels due to different activities in the metal working industry, and possible noise reducing measures and their effect can be found in literature. As starting point of this research an extensive literature survey was carried out, summarising existing knowledge on this subject. However, from literature no representative information about average exposure times and frequency of occurrence of specific activities, and the number of exposed workers can be derived. To be able to assess the situation regarding occupational noise this information was considered essential. Furthermore, general application of specific sound reducing provisions in practice in relation to cost and benefits a.s.o. had to be determined in order to be able to consider certain obligations as part of the intended agreement.
The research concentrates on grinding, welding, punching, cleaning with compressed air and transport of materials because of the high contribution to the noise exposure of a relative large number of workers in this type of industry.

3 METHODOLOGY

Because the variety in types of firms in the metal working industry is huge, it was decided to limit the study to those firms in which the combination of selected activities is dominant. For this purpose an estimate of the number of workers was made for the main branches combined with the relative importance of the selected activities.
In deliberation with the advisory committee nine sub-divisions were selected for the study, such as construction yards, ship yards, firms manufacturing equipment, machinery and vehicles, a.s.o.
Questionnaires were send to 3000 firms, subdivided in four categories:

- very small companies: up to 4 workers
- small companies: 5 to 19 workers
- middle sized companies: 20 to 99 workers
- big companies: 100 workers or more

The number of questionnaires to each category was related to the number of companies per category.
In the questionnaires information was asked regarding the specific characteristics of the firm (production, number of workers, equipment), the way the noise item is dealt with (selection of low noise equipment, education and instruction to employees), average exposure times and number of exposed workers, the application of the different type of noise reducing measures (especially regarding the selected five noise activities), noise investigations in the firm and practical use of personal hearing protection. In total 324 received questionnaires were evaluated.
In total 30 companies were visited to obtain additional information. The number of visits to companies in each category were not exactly related to the different sizes of companies. More large firms were selected because it was expected that larger firms would have implemented more sound reducing provisions, so that there was more to learn from their experience.
In total 15 experts were consulted from manufacturers of low noise equipment and specific sound reducing provisions, branch education institutes, health and safety inspection and consultants.

4 AVERAGE DAILY DOSE

From the received questionnaires an average exposure time for 4 of the 5 selected activities was derived. The average exposure time related to material transport could not be determined from the returned questionnaires, mainly because of the high diversity in material transport using fork lift trucks, pallet lorries, slides, cranes a.s.o.
In table 1 the most important figures regarding estimated numbers of workers and noise levels are given. The noise levels are based on the extensive literature research and measurements during visits to firms. One should take in mind that these sound levels are average values; a large variation in sound levels can be observed depending on the equipment, the specific handling of equipment and the piece of work.
The number of workers in table 1 is based on the total number of employees in the selected branches and the information derived from the questionnaires.

	Number of workers	Noise level during activity L_{Aeqw} in dB(A)	Average time in minutes	Contribution to daily dose in dB(A)
grinding	35.000	100	99	93
welding	23.000	92	188	88
punching	8.000	90	271	88
cleaning with compressed air	21.000	97	30	85

Table 1 *Average contributions to the daily dose of workers due to the four selected activities (without taking into account the effect of personal hearing protection and without the contribution of activities carried out by colleagues); based on questionnaires*

Despite uncertainties the values in table 1 give a useful estimation of the noise situation in this type of industry.

5 ASSESSMENT OF NOISE REDUCING MEASURES

5.1 General

From the questionnaires, the visits to firms and consultation of experts for each provision the following information was described in separated tables:
- the sound reduction that can be achieved
- present application of the provision
- cost of investment as well as indirect cost (operation less efficient, energy consumption)
- advantages and disadvantages
- technical, operational and economic feasibility
- practical restraints for application
- assessment regarding the state of the art of each provision

This information was related to the so called labour hygienic strategy:
- reduction at the noise source
- reduction in the sound transmission path
- organisational measures
- personal hearing protection

5.2 Reduction at the source

Regarding **grinding** different provisions were considered, such as application of:
- flap grinding discs (see figure 1), flexible grinding discs, low noise (sandwich) grinding discs
- magnetic damping foils
- heavy, damped working tables
- grinding machine with low noise driving unit
- grinding machine with automatic balancing system

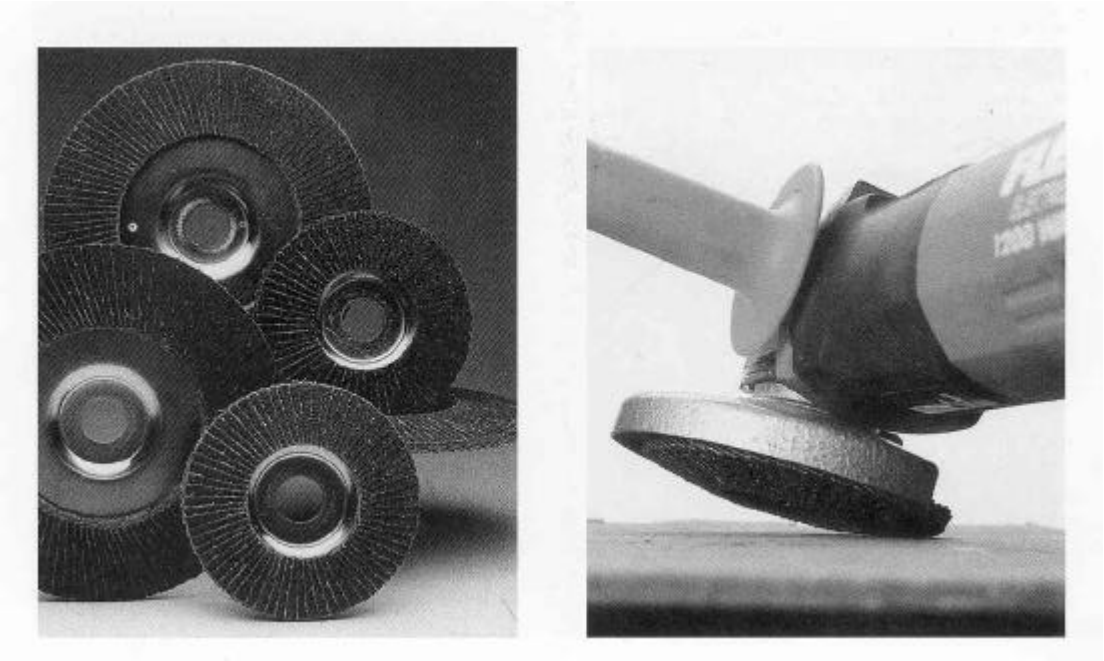

Figure 1: *Flap grinding disc*

Also alternative working methods were examined, such as improving welding skills to reduce the need of grinding, product modification to diminish or prevent grinding or alternative methods to cut materials like laser cutting by which the need for grinding becomes less.
Regarding **welding** especially alternative working methods and equipment were considered, such as:
- application of low noise alternative connection method
- use of low noise cutting device
- alternative welding methods

Regarding **punching** the following measures were considered:
- low noise (hydraulic) punching machine
- specific dampers to reduce force-time-development
- specific low noise punch tools
- application of flexible punching speed to optimise the noise production related to process demands
- application of special brushes in the support table for pieces of work
- sound insulating enclosure around punching machine (see figure 2) or location in a separated room

Figure 2: *Sound insulating enclosure around punching machine*

- complete automation of punching process including transport of materials
- the use of laser cutting machine (or combi-machine) as alternative for punching

Regarding **blowing** with compressed air low noise nozzles are feasible, and should be stimulated by adequate information since only 55% of the firms are using it.
Regarding **material transport**, with a variety of noise sources, in general metal-to-metal contracts have to be prevented. Besides that damping layers, plastic materials a.s.o. can be considered.

5.3 Reduction in the sound transmission path

Reduction of sound levels by provisions in the transmission path by sound absorbing materials (see figure 3 and 4) and screening provisions were considered. Sound absorbing finishing of ceilings and/or wall can achieve 5 to 10 dB reduction of the reverberation sound field. However, the reduction of the daily dose is generally limited to 1 to 2 dB because of the dominant contribution of the activities carried out by the workers themselves.

Figure 3: *Sound absorbing baffles under roof*

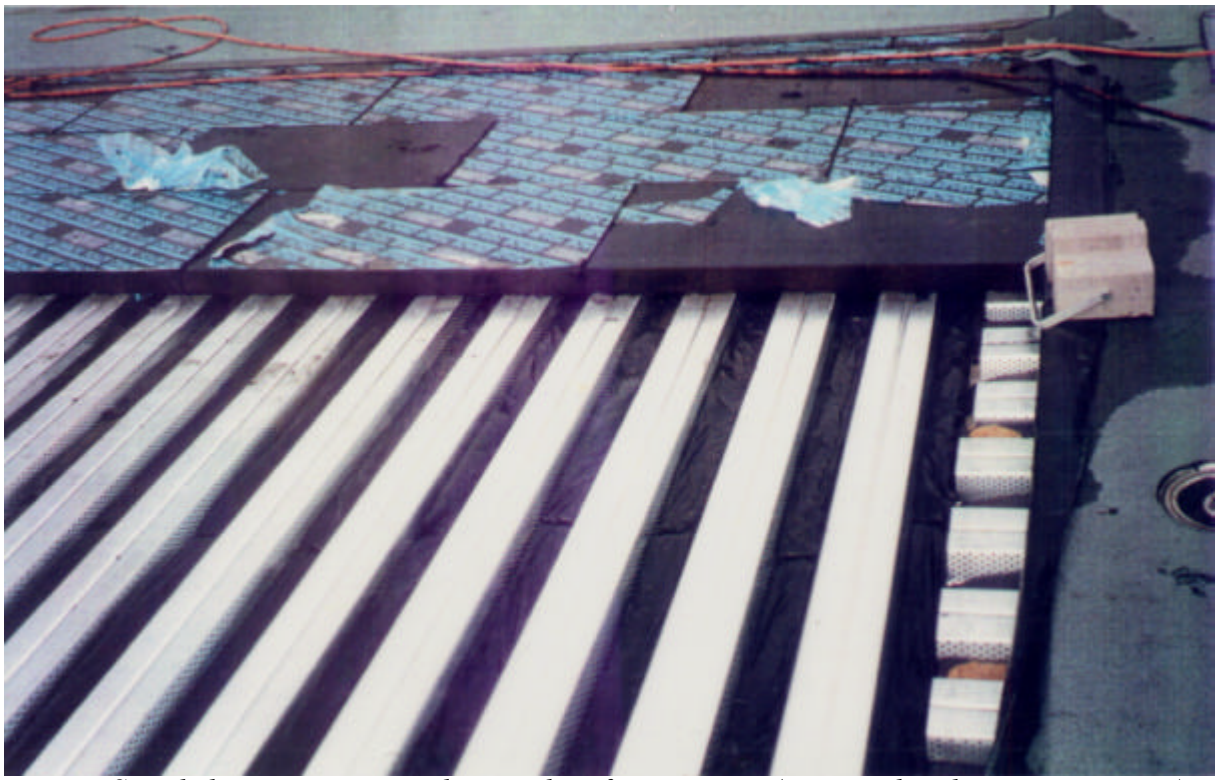

Figure 4: *Sound absorption integrated in metal roof construction (picture taken during construction)*

5.4 Organisational measures

The following organisational measures are considered:
- Circulation of workers performing noisy activities
- Decreasing the exposure time of workers in noisy departments and decreasing the numbers of workers in noisy departments
- Application of acoustically favourable lay out
- Automation of activities, increasing the distance of workers to noisy equipment
- Noisy activities put out to contract to specialised firms

5.5. Personal hearing protection

At all firms personal hearing aids are provided by employers, as is obliged by Dutch law. However, the practical application can be improved. In only 50 to 70 % of the situations in which the employee is obliged to apply these devices according to law (sound levels exceeding 85 dB(A)) this was actually done. The reason for this is partly ignorance about the noise situation and partly nonchalance of workers.
It appeared that workers use personal hearing protection especially when carrying out noisy activities themselves with a duration of minimal several minutes. If adjacent colleagues are carrying out noisy activities these hearing protection aids are far less applied, although noise levels above 85 dB(A) occur.
During activities with short duration, even when high noise levels occur (for instance during cleaning with compressed air) personal hearing protection is in general not applied.

5.6 Information, education, instruction

According to law employers are obliged to investigate the noise situation if noise levels above 80 dB(A) can be expected, which is the case in almost all firms of the metal branch. It appeared that in approximately 60 % of the companies such an investigation had actually been done.
Another obligation concerns education of employees. At approximately 25 % of the firms this has not been done. Of the remaining 75 % about 50 % only gives verbal instructions and 50 % gives verbal and written instructions. The frequency of these instructions is once a year in 25 % of the companies, in 60 % this instruction is given only once, in general when a new employee starts working in the company.

It appears that information, education and instruction can stimulate significantly the application of low noise activities and working methods, for instance in the following cases:
- information to employers about the effects of harmful noise and the possibilities of selecting low noise equipment and provisions in the sound transmission path. To enable employers to assess their own noise situation a special ‘tool kit’ should be developed by which also priorities in noise reduction measures can be determined;
- instruction to employees about low noise working methods;
- improvement of welding skills which decreases the need for grinding;
- education regarding the need and practice of personal hearing protection.

6 CONCLUSIONS

From an extensive literature survey representative information about noise levels due to different activities and equipment in metal working industry was derived. Also noise reducing measures are described in literature. However, from literature no conclusions could be drawn about the average daily dose of workers or the feasibility's of different provisions in practice. Based on the high contribution to the noise exposure of workers in this type of industry and the number of exposed workers, it was decided that additional research would have to focus on five specific noise sources/activities, i.c. grinding, welding, punching, cleaning with compressed air and transport of materials. By means of sending a questionnaire to relevant companies in combination with visits to firms and consultation of experts in this field conclusions could be drawn about different items:

- the average daily dose of workers is significantly above 80 dB(A), and can for that reason be considered as potentially harmful;
- the average contributions of each selected noise source/activity to the daily dose has been derived, from which appears that grinding causes the most dominant part, followed by (in that order) welding, punching, cleaning with compressed air and material transport;
- the feasibility of measures, in general regarded as state of the art, was assessed taking into account technical, operational and financial considerations;
- only for cleaning by compressed air it was possible to conclude that a general obligation for application of low noise devices seems feasible;
- for the other activities such a general obligation was not regarded as useful since other circumstances than the noise source itself have strong influence such as the contribution of the noise radiated by the piece of work, specific demands regarding ways to work on constructions etceteras;
- certain noise source related provisions are not applied in practice due to lack of knowledge; adequate information and education is found very necessary. This information should deal with independent information about noise production of equipment and practical instruction about low noise working methods;
- sound absorbing finishing of ceiling and walls should be highly stimulated, especially in new situations;
- in general sound insulating enclosures around punching machines should become common practice;
- improving the general use of personal hearing protection should be stimulated, since in this type of industry an overall reduction of noise levels to values that exclude risk for permanent hearing loss is not feasible with the present state of technology.

Providing relevant information to this industry in a very practical way is the necessary next step in reduction of the risk for noise induced hearing loss.

7 REFERENCES

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