Noise risk as described in instructions for printing machinery supplied in Europe

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Summary
The European Machinery Directive was introduced to facilitate free trade of work equipment and prevent inconsistent standards of safety becoming a barrier to trade. It establishes essential health and safety requirements for machinery and these include general and specific requirements regarding noise. A study of markets across Europe, of the noise-related content of instruction manuals supplied with machinery, found that 80% did not meet legal requirements. This paper describes work that was carried out to assess the compliance and value of noise information supplied with printing machinery used in Great Britain. In-use noise levels were measured at printing premises between 2010 and 2011. The noise-related content of instruction manuals, for printing machinery installed on these sites, was collected for assessment against the noise requirements of Machinery Directive 2006/42/EC. The majority of the instructions contained noise emission values that were credible as an indicator of real use risk. The approach to writing standards for printing machinery has been to have machinery operating under realistic conditions during standard noise tests; this has produced noise emission data representative of real use noise levels. The noise information provided in printing machinery instruction manuals can help the user assess and adequately manage the noise risk.

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1. Introduction

The European Machinery Directive 2006/42/EC [1] and its predecessors were introduced to facilitate free trade of work equipment and prevent inconsistent standards of safety becoming a barrier to trade within the European Economic Area (EEA). It establishes essential health and safety requirements for machinery and these include general and specific requirements regarding noise.

The main requirements of the Directive are to minimize noise at source, reduce noise by protective measures and, if risk remains, provide information about that risk. The Directive requires manufacturers to provide noise emission values in the instructions accompanying the machinery. These values can be used to verify that the noise is adequately controlled by design and construction. Where noise risk remains, the manufacturer should provide information about the risk and protective measures.

A European project (referred to as NOMAD [2]) was carried out to assess the compliance of the noise-related content of more than 1500 sets of instructions, from machines covering 40 machine families and from 800 different manufacturers. The content included noise emission values and information about noise risk. The assessment showed that the noise content of 80% of the instructions was inadequate and did not meet the legal requirements with regard to noise. The main failings were: absent or incomplete declared noise emission values; absent or incomplete traceability to operating conditions or measurement methods for declared noise emission values; and declared noise emission values that were not credible either against stated operating conditions or as warnings of likely risk in real use.

The results from NOMAD suggested that, based on the noise information provided with machinery, it is highly likely that purchasers and users of machinery will be unable to make informed choices regarding the risks from noise associated with potential purchases. Nor will they understand what control measures are necessary to mitigate the risks from noise during real use.

The purpose of the work described here was to look at how the findings of NOMAD reflect the situation in the printing industry, a traditionally noisy industry. The industry was visited during 2010 and 2011 to assess the usefulness of noise information provided with printing machinery.

2. Printing Processes

Six main processes are used in the printing industry, using different methods of image transfer and different types of image carrier. Image transfer can be direct or indirect (commonly known as offset). The printing processes are:

- Lithography is an offset printing technique, using both sheet-fed and web-fed presses. It is well suited for printing both text and illustrations, for example newspapers, books, forms and documents.
- Flexography is a direct form of printing, in which the image is printed as the substrate is pulled through a series of print units. It is the main method used to print packaging materials.
- Gravure (rotogravure) printing is an example of intaglio printing, in which an image is etched into metal cylinders. It is usually used for printing high-volume material like colour magazine supplements, where it is cost-effective and produces good results on lower quality paper stocks.
- Letterpress printing is applied to the raised areas of a printing plate, or forme, and the image is transferred directly from those areas to the paper or substrate. It has largely been superseded by offset printing techniques for general commercial printing.
- Screen printing is a versatile printing process and can be used to print on a wide variety of substrates. The process involves passing ink, or any other printing medium, through a mesh or screen that has been stretched on a frame and to which a stencil has been applied. It is used for printing small runs of posters, fabrics, wallpaper, and control panels of electronic products.
- Digital printing has a computer front-end linked directly to the press, so that information can be transferred directly to the paper without using traditional film or plates. It is ideal for short runs, quick turnaround work and print-on-demand.

3. Standards

3.1. Safety standards

The Machinery Directive sets out the mandatory essential health and safety requirements for machinery. The Directive is supplemented with detailed technical specifications to fulfill these requirements, which are given in European harmonised standards. Application of a harmonised standard is not mandatory but it can provide manufacturers with a presumption of conformity with the essential health and safety requirements.

Two series of safety standards (C-Type) exist for printing machinery: the EN 1010 series [3] applies to printing and paper converting machines and the EN 1034 series [4] applies to paper-making and finishing machines. Noise is identified as a significant hazard for the families of machines covered by these standards.

Both series of standards require noise emission values to be determined in accordance with EN 13023 [5]. The standards also require the instruction manual to give declared noise emission values (including uncertainty values) and information on the protective measures to be taken by the user, for example personal protective equipment, sound hoods, noise enclosures.

3.2. Noise test codes

EN 13023 is a harmonised standard, which defines a noise test code for machinery used in the printing industry. The standard requires the measurement of emission sound pressure level, L_{pA}, at workstation(s) and the sound power level, L_{WA}. For large machines, instead of L_{WA}, the standard allows determination and declaration of L_{pA} values at specified measurement points around the machine. Measurement positions are generally specified at 1.6 m above the floor or access level and 1 m away from the machine surface. Note: “Large machines” as defined by EN 13023 are those where the greatest linear dimension exceeds 15 m.

Operating conditions with significant noise emission are specified in the normative annexes A to J of EN 13023. The annexes cover a range of machines including finishing machines, printing presses and paper converting machines. For each machine, operating conditions and measuring points at workstations are defined. The operating conditions defined include speed, substrate size and quality, web width, cutting

angle, and material feeding. The measurement positions include the control desk, delivery unit, feeding unit, winding unit, and unwinding unit. For some machine types the operating conditions are as agreed between the manufacturer and user.
EN 13023 also requires that the noise emission values are declared as a dual-number declaration in accordance with EN ISO 4871 [6]. The noise test code and any other standards that have been used must also be referenced.

4. Noise Information and Control of Workplace Noise

4.1. Background

The Health and Safety Executive and the Health and Safety Laboratory carried out a series of visits to printing premises in the United Kingdom, which were identified through the British Printing Industries Federation. The work was carried out between 2010 and 2011. During each visit in-use noise levels were measured and the noise-related content of instruction manuals was collected. This information was assessed against the noise-related requirements of the Machinery Directive. The value of the information, to assist use of the machinery without risk from noise, was also assessed.

4.2. Noise information in instructions

Instruction manuals should include numerical values, with reference to the measurement methods and operating conditions under which these values were obtained. In many cases, information can appear in different sections of an instruction manual. For some printing machinery the manual consisted of many volumes. Complete instruction manuals were not collected and it is possible that not all the noise-related information was collected.
The noise-related content of 15 instruction manuals was obtained for printing machinery, which included printing presses (lithography, flexography, web-fed), inserters, folding and gluing machines, balers, cutters and sheeters.

4.3. Workplace noise

Visits were made to a range of printing premises, whose operations included printing advertising inserts for magazines, passport application forms, magazines, newspapers, telephone directories and the production of packaging and labels.
Measurements were made at each site using logging dosemeters and a sound level meter to determine noise levels at operator positions.
Information was also gathered on noise control measures, use of hearing protection, and the condition of the installed machinery.

4.4. Assessment of the noise-related content of instruction manuals

The assessment covered: provision of numerical data, including uncertainty; traceability of numerical data to a measurement method and operating conditions; credibility of numerical data with regard to operating conditions under which they were obtained and as an indicator of real use risk; provision of information on protective measures, including hearing protection; and provision of information on any noise risk that was not evident from the numerical data. The assessment was informed by measurements and observations made during site visits.

5. Noise Content of Instruction Manuals

5.1. Noise emission values

Table I provides a summary of the measured in-use noise levels obtained during site visits to printing premises. These are compared with the declared noise emission values provided in the instruction manuals for the same machinery.
All the instruction manuals assessed contained emission sound pressure levels; none provided sound power levels. For some machines, it is likely that sound power levels were not provided because the machines have been treated as "large" according to the definition in EN 13023. For other machines, sound power levels may not have been required based on the declared emission sound pressure levels. Sound power levels can help a purchaser in the selection of quieter machinery. However, in the printing industry the emission sound pressure levels at the workstations of large machinery will be of more value for assessing and controlling the noise risks associated with that machinery.
The Machinery Directive 2006/42/EC requires that the uncertainties associated with the emission values are specified. Earlier versions of the Machinery Directive did not explicitly require the provision of *uncertainty data. However, EN 13023 requires a dual-number noise declaration in* accordance with EN ISO

Table I. In-use and declared noise emission values for printing machinery.

Machine Type	*In-use L_{Aeq} dB*	*Declared noise emission*
baler	84	<80 dB(A)
die cutter	79 – 84	81 – 85 dB(A) (Slow)
digital sheeter	87 – 89	78 dB(A)
envelope inserting machine	81 – 86	83 – 87 dB(A)
flexo label press	80 – 84	<85 dB(A)
folder gluer	86	80 dB(A) feeding unit, 73 dB(A) delivery unit
folding carton gluer	78 – 85	<= 84 dB(A)
folding machine	80 – 83	<87 dB(A)
inserter	80 – 84	85 dB(A) vacuum pump, 82 dB(A) silencer
lithopress	84 – 87	80 – 84 dB(A)
lithopress	83 – 98	83 – 85 dB(A)
printing press	80 – 84	81 dB(A) delivery, 83 dB(A) feeder control
roto-gravure press	77 – 83	85 – 105 dB(A)
roto-gravure press	73 – 84	84 – 105 dB(A)
web press	73 – 100	>85 dB(A)

4871, that is a measured noise emission value and its associated uncertainty (both rounded to the nearest decibel). None of the instruction manuals provided uncertainty data for the declared noise emission values. The lack of uncertainty data will hinder verification of the declared emission values by interested parties, for example enforcement authorities, notified bodies and maybe purchasers.

5.1.1. Traceability to measurement method and operating conditions

The noise emission values in 9 of the 15 instruction manuals were traceable to an appropriate measurement method and operating conditions. The manuals either referenced an appropriate safety standard or noise test code, or included a description of the measurements made and operating conditions during these noise tests. In practice, unless the user has access to the referenced standards, then the measurement method and operating conditions are not readily available.

EN 13023 defines operating conditions with "significant noise emission" for use in standard noise emission tests for printing machinery. Where EN 13023 has been successful in representing normal running of the machine, the declared noise emission data should be comparable with in-use noise levels and be a credible indicator of real use noise risk.

The noise emission data in 7 of the 15 instructions were credible with regard to the specified operating conditions and when compared with the in-use noise levels for the same machinery installed in working premises.

The instruction manuals for 6 of the 15 machines contained no information on how the noise data were measured or the operating conditions under which they were obtained. Therefore the credibility of the declared noise emission values against the specified operating conditions could not be assessed. However, the declared noise emission values in 4 of these 6 manuals were comparable with in-use noise levels. This suggests that a test method with appropriate

operating conditions was used to obtain these declared noise emission values.
In accordance with EN 13023, the noise emission data for many printing machines are obtained with the machine running at 80% of maximum speed. It is probable that noise levels will be higher for faster machine speeds.
The declarations in 5 of the 15 instruction manuals stated that noise emission values were greater than or less than a specified level, for example "< 87 dB(A)" and "> 85 dB(A)". This is not a standard format for a noise declaration, and it is unclear what guidance these machinery manufacturers were following. While some of these non-standard declarations were credible, others were not; all failed to provide sufficient detail to help the user assess and manage real use risk.
Emission tests use new machinery, therefore declared noise emission values relate to well-maintained equipment. The noise declaration for the digital sheeter was approximately 10 dB lower than the in-use noise level. However, the condition of this machine in-situ was observed to be poor, with missing and broken panels. This may explain the discrepancy between declared and in-use values.

5.2. Supplementary noise information

5.2.1. Noise control measures

The safety standards for printing machinery identify methods for reducing noise. In 5 of the 15 instruction manuals there was information about noise control measures, for example sound-damping covers and noise enclosures. The effectiveness of recommended noise enclosures was quantified in some instruction manuals.
While noise enclosures can be very effective at controlling workplace noise, they need to be installed properly, regularly maintained and used effectively. The following problems were observed during site visits: partial noise enclosure installed without a roof, poorly fitted doors, and doors to enclosures permanently propped open.
Noise havens in modern premises were observed to be very effective at providing plant operators with a relatively quiet workspace.

5.2.2. Hearing protection

The harmonised safety standards for printing machinery (EN 1010 and EN 1034 series) require instruction manuals to include information on personal protective equipment (hearing protection). Information on hearing protection was provided in 9 of the 15 instruction manuals. However, in 6 of these instruction manuals the hearing protection information was either incorrect, "at noise levels less than or equal to 80 dB(A) hearing protection is recommended", or not machine specific, "hearing protection is advised, depending on the total noise level of the machine and its environment".
One of the instruction manuals contained exemplary guidance on using hearing protection: "hearing protection is required when working near the folder or, more generally, inside the acoustic enclosure surrounding the press. Considering the acoustic pressure levels that can be reached in the worst case conditions, medium to heavy duty hearing protectors are recommended (for example SNR = 27 dB)". It should be noted that operators needed to enter the enclosure of the machine, for which these instructions were provided, to carry out occasional inspections.
Hearing protection zones were observed around 6 of the machines whose instructions advised the use of hearing protection. The zones included printing areas, finishing areas, and inside acoustic enclosures. At many of the printing sites visited during this project, hearing protectors were available from dispensers. Operators were observed using hearing protection (earmuffs and earplugs) with varying degrees of success.

5.2.3. Residual risk

For 11 of the 15 machines assessed, the declared noise emission values were comparable with the in-use noise levels. The emission values can therefore inform the user of the level of risk that needs to be managed. For many of the machines considered, the noise emission information shows that a risk remains despite the manufacturers' efforts to reduce noise by design, construction and engineering protective measures.
The noise emission values contained in 4 of the 15 instruction manuals did not represent in-use noise levels; in-use levels were higher by between 4 and 15 dB. It is not clear if the standard has been mis-applied or if the specified tests under-represent workplace noise for the observed application of these machines, for example operating at a faster speed than the standard test. Where the standard test is known to under-represent real use noise, information is required to inform the user of the gap between

the risk associated with the declared noise emission values and the actual risk during real use.

5.2.4. Other requirements of the Machinery Directive applicable to noise

Some instructions included general guidance on noise risk, for example: "carry out a workplace-related noise measurement on installation"; "noise levels will be higher if the machine is located in a reverberant room, and for different operating conditions"; and "noise exposure assessments must take into account all the machines in use as well as the length of time the operator spends working in each noisy area". Such guidance is insufficient to meet some of the other Machinery Directive requirements for the content of the instructions. For example, if the standard test produces an emission sound pressure level of 85 dB(A) but the machine produces 98 dB(A) in normal use, the manufacturer should provide both a warning of the actual risk and information on how to use the machine without risk from noise.

6. Conclusions

A European study of the noise-related content of instruction manuals supplied with work equipment found that 80% did not meet legal requirements. However, the reliability of noise information was suspected to vary across different industries.

An assessment of the noise-related content of instruction manuals supplied with a sample of printing machinery used in Great Britain suggests a much higher level of compliance with the requirements of the Machinery Directive. The noise emission values contained in 11 of the 15 (approximately 75%) instructions were credible as an indicator of real use risk.

The approach to writing standards for printing machinery has been to have machinery operating under realistic conditions during standard noise tests. The resultant noise emission data are therefore representative of real use noise levels. Specifying testing of machines at 80% of rated speed may lead to under-reporting the noise risk in some cases.

For the printing industry, the majority of instruction manuals provide noise information that will help the user identify and manage the risk associated with noise generated by printing machinery.

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References

[1] Directive 2006/42/EC of the European Parliament and of the Council of 17 May 2006 on machinery, and amending Directive 95/16/EC (recast).

[2] "Report on the NOMAD project – A survey of instructions supplied with machinery with respect to noise and the requirements of the Machinery Directive" May 2012, www.hse.gov.uk/noise/nomad-report.pdf.

[3] EN 1010-1: 2004 + A1: 2010 Safety of machinery – Safety requirements for the design and construction of printing and paper converting machines – Part 1: Common requirements.

[4] EN 1034-1:2000 + A1:2010 Safety of machinery – Safety requirements for the design and construction of paper-making and finishing machines – Part 1: Common requirements.

[5] EN 13023:2003 + A1:2010 Noise measurement methods for printing, paper converting, paper making machines and auxiliary equipment - Accuracy grades 2 and 3.

[6] EN ISO 4871:2009 Acoustics - Declaration and verification of noise emission values of machinery and equipment.