Occupational Exposure to Physical Agents: The New Italian Database for Risk Assessment and Control

Pietro Nataletti
Department of Occupational Hygiene, National Workers’ Compensation Authority (INAIL), Rome, Italy

Andrea Bogi
Local Health Service, Siena, Italy

Massimo Borra
Department of Occupational Hygiene, National Workers’ Compensation Authority (INAIL), Rome, Italy

Domenico Gioia
Local Health Service, Siena, Italy

Rosaria Falsaperla
Enrico Marchetti
Andrea Militello
Department of Occupational Hygiene, National Workers’ Compensation Authority (INAIL), Rome, Italy

Omar Nicolini
Local Health Service, Modena, Italy

Paolo Rossi
Floriana Sacco
Department of Occupational Hygiene, National Workers’ Compensation Authority (INAIL), Rome, Italy

Nicola Stacchini
Iole Pinto
Local Health Service, Siena, Italy

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Correspondence should be sent to Pietro Nataletti, INAIL, Via Fontana Candida 1, 00040 Monte Porzio Catone, Italy. E-mail: p.nataletti@inail.it.
This article presents the new Italian database of physical agents, which is available at http://www.portaleagentifisici.it. It supports in risk assessment employers who have to comply with Italy’s Legislative Decree 81/2008 (transposing into law European Union Directives 2003/10/EC, 2002/44/EC, 2004/40/EC and 2006/25/EC). The database currently contains measurements and declared European Community (EC) values from over 2540 machines; in particular, the database hosts data on mechanical vibration from over 1430 hand-held power tools (e.g., pneumatic and electric hammers, chainsaws, grinders, drills, sanders and saws) and from over 1020 whole-body machines (e.g., buses, fork lifts and wheel tractors). The database is continuously updated as soon as new experimental and declared data are acquired.

1. INTRODUCTION

Despite a decline in the proportion of the workforce employed in traditional, physically demanding sectors, e.g., manufacturing, construction, agriculture and mining, some physical risks such as mechanical vibration and noise are still prevalent. In 2010, ~22% of Italian workers, i.e., over 5 million people, were exposed to potentially harmful mechanical vibration and noise at the workplace for at least a quarter of their working time. Moreover, the trend showed a slight flat behaviour across Eurofound’s surveys since 1990 [1].

Regarding mechanical vibration, there is strong epidemiological evidence of a relationship between occupational exposure to hand–arm vibration (HAV) and a number of health effects and injuries referred to as the HAV syndrome [2]. There is also epidemiological evidence of a relationship between occupational exposure to whole-body vibration (WBV) and a number of health effects and injuries of the spine. Hence, the Italian Workers’ Compensation Authority (INAIL) recognizes and compensates vascular, neurological and musculoskeletal disorders of the hand–arm system, the carpal tunnel syndrome and diseases of intervertebral discs. At present, physical agents rank first in compensation for occupational diseases in Italy.

Publication of European Union (EU) Directives 2002/44/EC [3], 2003/10/EC [4], 2004/40/EC [5] and 2006/25/EC [6] resulted in the Italian government bringing them into force with Legislative Decree 81/2008 [7]. Thus, for the first time, Italy has a regulation specifically dedicated to occupational exposure to physical agents at work. According to Legislative Decree 81/2008, employers have to implement a programme of prevention and reduction measures in the workplace. In particular, they need to assess the levels of physical agents to which workers are exposed and, if necessary, measure these levels with specific apparatus and appropriate methodologies. On the basis of the results, employers should determine what measures to take: informing and training workers, ensuring health surveillance, making provisions aimed at avoiding or reducing exposure, or providing personal protective equipment (PPE).

Even though physical agents are traditional risk factors, in Italy there are still no competent services and technicians able to measure and assess the levels of physical agents to which workers are exposed. Hence, Legislative Decree 81/2008 [7] allows employers to use manufacturers’ data on emission and national databases established by the former National Institute of Occupational Prevention and Safety (ISPESL) [8] as sources of information of the magnitude of vibration.

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2 now part of the INAIL
This article presents the new database of physical agents, a centralized Italian database, which supports Legislative Decree 81/2008 [7] and replaces a database on mechanical vibration [8]. This database (supported jointly by the Tuscany Region and the Ministry of Health) was started in 2008 by three Italian partners: the INAIL and the local health services of Siena and Modena. It fulfills the following requirements:

- data are presented in a clear, understandable and useful way;
- it is easily accessible;
- measurement data pass through quality control before insertion;
- data are based on measurements conducted in accordance with standards of the European Committee for Standardization (CEN) or International Organization for Standardization (ISO);
- new data are quickly accessible;
- corrections and additions are easy to make;
- it is easy to manage and maintain.

2. DATABASE CONTENT

To be used throughout the EU, the portal has been translated into English; this is the version this article presents.

The database currently contains measured data (collected by the INAIL, the local health services of Siena and Modena, and some public and private companies) and declared European Community (EC) values relative to over 2540 machines. The greater part of the database regards mechanical vibration: it hosts over 1430 hand-held power tools (e.g., pneumatic and electric hammers, chainsaws, grinders, drills, sanders and saws) and over 1020 whole-body machines (e.g., buses, fork lifts and wheel tractors). The database has four menus: noise, vibration (HAV

Figure 1. Home page of the Italian database of physical agents.
and WBV), electromagnetic fields (EMF), and natural and artificial optical radiation (AOR). After entering the home page (Figure 1), users are directed to the main menus of each physical agent.

Once a physical agent has been selected, a list of items appears: risk description, guide to using the database, the database, assessment procedure, legislation, exposure calculator, prevention and protection measures, and documentation. The guide explains how the database should be used; this is important as assessing physical agents with databases is difficult, with measurement remaining the reference method. The guide also helps users to properly use manufacturers’ declared emission values to determine admissible daily exposure to physical agents established by the relevant directives.

2.1. Noise

The main feature of the noise section is the proposal of a standardized procedure for risk assessment of noise exposure, in compliance with the requirements of Legislative Decree 81/2008 for small and medium enterprises (SMEs) employing up to 10 workers [7], which account for 90% of all enterprises in Italy. It is possible to calculate online the level of personal exposure to noise, $L_{eq}$ (dB(A)), set by Directive 2003/10/EC [4], using data input into the database by the Territorial Joint Committee for the Prevention, Hygiene and Work Environment of Turin and Province or data collected by the company.

2.2. Vibration

The section on vibration of the portal contains a wealth of information and data. It includes an earlier vibration database set up by the ISPESL and Italian regions, quoting all previously measured and declared vibration data, and adding recently collected new data. Figure 2 shows the HAV menu.

A brief description of risk is followed by a guide on using the database, which leads users to assessing daily exposure to mechanical vibration resulting from using hand-held power tools and hand-guided machines. The guide helps users to correctly use the manufacturer’s declared values reported in manuals, in accordance with Directives 98/37/EC [9] and 2006/42/EC [10]. In the former case, recommendations given in Technical Report No. CEN/TR 15350:2013 [11] hold: the total value of vibration can be estimated with the aid of the correction factor $c$ to be multiplied by the declared vibration data. In the latter case, users are told to add to the declared total value $a_{hv}$, the uncertainty factor $k$, obtained in accordance with the new CEN ISO standards released to comply with the requirements set by Directive 2006/42/EC [10, 12] and 12 standards No. EN ISO 28927 published in 2009–2012.

The tool list can be browsed page by page (Figure 3a). Each page reports a list of tools identified by the constructor, model, tool category and power supply. Users can also search the tool database using a number of filters (brand, model, type and power); further, they can also do an advanced

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3 http://www.cpt.to.it
4 Hand-held portable power tools—test methods for evaluation of vibration emission.
Figure 3a. Sample browse page of the hand–arm vibration database.

Figure 3b. Details of a tool.
search, requiring the database to search for all tools that emit a specific measured or declared value. This feature implements the law that allows the employer to select tools that produce lower exposure.

Once a tool has been found, clicking on the photograph opens a technical sheet with a complete set of data including declared EC values and values measured in the field (Figure 3b). The declared value includes the correction factor $c$ or $k$, in accordance with the relevant CEN ISO standard; the measured values are complete with the extended uncertainty given by 1.65 times the standard deviation of the measures.

At the end, the guide directs users to anti-vibration gloves, PPE that reduces exposure to HAV. These gloves, which have to be CE (Conformité Européenne) marked and certified in accordance with Standard No. EN ISO 10819:2013 [13], show values of effective reduction measured in the field ranging from 10% for percussion tools to 60% for some rotating tools.

WBV has a menu like the one for HAV; it leads to a number of browse pages like those in Figures 4a–4b.

2.3. EMF

The database of sources of EMF contains measured data relative to over 60 sources. It is currently under development to

- guarantee easy retrieval of exposure values related to electromagnetic radiation produced by common industrial, health and research machinery, equipment and sources, to promote as far as possible the implementation of interventions aimed at reducing and preventing risk still in the course of risk assessment, without having to recourse to measures that are often expensive and complex;

Figure 4a. Sample browse page of the whole-body vibration database.
allow employers and their consultants to identify, when purchasing new machinery, machines or sources that reduce the risk of exposure to EMF to a minimum.

The EMF database is arranged to report exactly during assessment the features of both the machinery under evaluation and the sources mounted inside. For each piece of machinery or apparatus present in the database, two types of data are provided. Data related to

- proper identification of machinery or apparatus;
- sources or applicators to which the measures in the portal refer. It must be noted that it can happen that the same equipment or machinery has different applicators mounted inside. In this case, it is necessary to look for data related to the applicator of interest.

The database can also contain pdf documents associated with specific machinery. These documents are related to analytical data on field assessments and efficient changes made in machinery to reduce workers’ exposure. Protection measures to be put into place under specifically indicated operating conditions are also reported for each piece of machinery (Figure 5).

Once a tool has been found, by clicking on an active photograph, users open a technical sheet with a complete set of values measured in field (Figures 6a–6c).

The last two columns in Figure 6b show the magnitude of the field measured in terms of percentages of the action values for workers [5] and of the reference levels for general public exposure established in the ICNIRP guidelines [14, 15]. These values make it possible to distinguish two zones: 1 (yellow) and 2 (red) [16]. When the
value of exposure is under the action levels for workers, there is no zone 2. Otherwise, the extension of zone 2 is defined starting at the centre of the applicator. The same procedure is followed to define zone 1 (in the case in Figure 6b, this must be done 2.25 m from the machinery).

Figure 6c shows an example of an exposure evaluation report. The safety distances from the source are evaluated for increasing values of load current on the basis of the reference levels in the ICNIRP guidelines [14, 15, 17].

2.4. Optical Radiation

A database of AOR sources is the main feature of this section. At present, it contains measured data relative to over 40 sources. It is currently under development to

- guarantee easy retrieval of exposure values related to optical radiation produced by common industrial, health and research machinery, equipment and sources, to promote as far as possible the implementation of interventions aimed at reducing and preventing risk, still in the course of risk assessment, without having to recourse to measures that are often expensive and complex [18, 19];
- allow employers and their consultants to identify, when purchasing new machinery, machines or sources that reduce the risk of exposure to optical radiation to a minimum.

For each piece of machinery or apparatus present in the database, two types of data are provided:

- on proper identification of machinery or apparatus;
- on sources or lamps that machinery or apparatus contains.

Then, the specific AOR source mounted inside the apparatus, to which the measures reported in the portal refer, is characterized. It must be noted that it can happen that the same equipment or machinery has different lamps mounted inside. The database reports exactly the features of both the machinery under evaluation and the sources mounted inside when performing the assessment (Figure 7).

For each piece of machinery, the following specific results concerning the machinery or source are provided:

- relevant spectral emissions, e.g., infrared and blue light;
NEW ITALIAN DATABASE OF PHYSICAL AGENTS

NEW ITALIAN DATABASE OF PHYSICAL AGENTS

Machine technical sheet

Brand: KEMPPI
Model: KEMPOWELD PRO 4200
Type: Arc welders
Power: 18 Kw
Power: Electric 220V-380V
Reference standard: CEI EN 50444
Required protection measures:
1. Delimit Zone 1: Exposure values above the reference levels for general public
2. Delimit Zone 2: Exposure values above the action levels for workers
3. The access to the Restricted Access zone is forbidden to persons carrying pacemakers and/or implanted electric devices

Field measurements (Click to view the field measurements)

KEMPPI Power Cable
SECTOR: Metal carpentry
Reference person: IFAC CNR Nicola Zoppeiti (nicola.zoppeiti@gmail.com)

Figure 6a. Sample details of a machine: electromagnetic fields.

Field measurements (Click to view the field measurements)

KEMPPI Power Cable
SECTOR: Metal carpentry
Reference person: IFAC CNR Nicola Zoppeiti (nicola.zoppeiti@gmail.com)

SIZE AND SHAPE OF THE APPLICATOR [m]

<table>
<thead>
<tr>
<th>Measuring point</th>
<th>Reference</th>
<th>Distance Perpendicular [cm]</th>
<th>Distance Parallel [cm]</th>
<th>Height from ground [cm]</th>
<th>Power [W]</th>
<th>Field Electric [V/m]</th>
<th>Field Magnetic [mT]</th>
<th>Action level Worker [%]</th>
<th>Action level Population [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1 (applier)</td>
<td>20</td>
<td>0</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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</tr>
</tbody>
</table>

*The values reported in the two last columns as percent of ICNIRP reference levels refer to the electrical field or to the magnetic field, depending on which of the two resulted to be the most relevant from the exposure point of view.

1.15 m
Zone 2 is the area where the exposure levels exceed the action levels set for in the Directive 2004/40/EC for workers

2.25 m
Zone 1 is the area within which the exposure levels exceed the reference levels for the population but are less than or equal to the action values for workers set for in the Directive 2004/40 EC

Note
Typical operating parameters (380 A)
A report is available for this measure

Figure 6b. Details of a report of electromagnetic field measurements.

Figure 6c. Details of an exposure evaluation report.
hazard distance over which exposure to the AOR emitted by machinery is not harmful according to the ICNIRP risk criteria [18, 20];

• protection measures to be adopted in specific cases; these are divided into
  • determination of controlled area;
  • behavioural modes, e.g., avoiding having the source in the field of view at workstations located closer to the source than the hazard distance;
  • modes and criteria of using PPE.

The analytical results of the irradiance and radiance measures performed at different distances and conditions of the use of the apparatus are then reported in terms of

• distance from the source;
• maximum permissible exposure time of an unprotected subject’s eyes or skin. This time does not exceed exposure limit values and considers the level of exposure at specific locations (Figures 8a–8b).

Further, this section also provides two guiding procedures: one for assessing risk associated with light-emitting diode (LED) sources for general lighting, the other for calculating PPE for welding as a function of the distance from the source.

3. INTERNET

The database is available at http://www.portaleagentifisici.it. Over 10000 users per month have consulted the database since it was published on November 1, 2011. There are other international noise and vibration databases on the Internet, too: Sweden’s http://www.vibration.db.umu.se5; Germany’s http://www.las-bb.de/Karla; USA’s http://wwwn.cdc.gov/niosh-sound-vibration; and

5 originally hosted at Sweden’s National Institute for Working Life
Figure 8a. Details of an artificial optical radiation source.

Figure 8b. Details of artificial optical radiation measurements.
4. CONCLUSIONS

The database this paper presents is a single Italian database of physical agents representative of all the main tools and machines used in the various working environments. This Physical Agents Portal includes an earlier vibration database.

The goal was to implement the database with as many existing tools, machines and sources as possible, and to update it with the rapidly changing market. That is why agreements have been signed with some Italian public and private institutes that operate in specific sectors (construction, boating, transportation, etc.) and the INAIL, which also measures exposure to physical agents for research and compensation purposes. Thus, employers can perform systematic and statistically representative measurements of the levels of physical agents to which their workers are exposed and introduce those measurements into the national database (the only database Italian law allows to be used in risk assessment). A severe measurement protocol has been established to fulfil this purpose, together with a format for data entry. Periodic round robin tests will be run by all participants to ensure the same quality levels and metrological standardization of data delivered to the database by the various subjects.

The aim of the database is also to advise employers in purchasing equipment and machinery that produce the lowest possible level of physical agents transmitted to the workers, in compliance with Directives 2002/44/EC [3], 2003/10/EC [4], 2004/40/EC [5] and 2006/25/EC [6]. In fact, among the technical and organizational measures intended to reduce to a minimum exposure to physical agents and the attendant risks, the employer should consider in particular “the choice of appropriate work equipment of appropriate ergonomic design and, taking account of the work to be done, producing the least possible vibration” (p. 3) [3].

The Italian Government’s decision to allow employers to use a centralized database for assessing risk posed by vibration, regardless of the size of company, and to use a standardized procedure for the general assessment of all risks in SMEs, has created an intense debate in Italy, as risk assessment is a difficult and delicate task to be carried out by competent services or technicians, by means of a careful evaluation of workers’ exposure to all risks at the workplace.

The new database is intended to become the centralized Italian database, which supports Legislative Decree 81/2008 [7] in assessing and controlling risk posed by physical agents. That is why programmes are being developed then published in the AOR section of the database; they make it possible to calculate exposure and characteristics of PPE for the eye in different exposure scenarios and for different types of sources or processes widely used in industry, e.g., in welding and melting machines, and laser equipment [21].

Moreover, some online calculation tools will be published for assessing photobiological risk associated with various types of lamps and lamp systems, starting from the database of lighting (with values of colour temperature and illuminance provided by manufacturers). Algorithms that predict EMF emitted by various types of machinery at different distances and operating parameters are also being developed.

REFERENCES


15. International Commission on Non-Ionizing Radiation Protection (ICNIRP). Guidance on determining compliance of exposure to pulsed fields and complex non-sinusoidal


