

SEPTEMBER 2015
DG EMPLOYMENT, SOCIAL AFFAIRS AND INCLUSION

Evaluation of the Practical Implementation of the EU Occupational Safety and Health (OSH) Directives in EU Member States

REPORT BY DIRECTIVE: DIRECTIVE 2013/35/EC ON THE MINIMUM HEALTH AND SAFETY
REQUIREMENTS REGARDING THE EXPOSURE OF WORKERS TO THE RISKS ARISING
FROM PHYSICAL AGENTS (ELECTROMAGNETIC FIELDS)

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List of abbreviations

Acronym	Definition
AL	Action Level
AOR	Artificial Optical Radiation
CPM	Common processes and mechanisms
DVS	German Welding Society
ELV	Exposure Limit Value
EMF	Electromagnetic Fields
EQC	Evaluation question Coherence
EQE	Evaluation question on Effectiveness
EQR	Evaluation question on Relevance
ESAW	European Statistics on Accidents at Work
EU	European Union
EU-OSHA	European Agency for Safety and Health at Work
EWCS	European Working Conditions Survey
EWF	European Federation for Welding, Joining and Cutting
ILO	International Labour Organisation
KR	Key Requirement
LFS	Labour Force Survey
MQ	Mapping Question
MRI	Magnetic Resonance Imaging
MS	Member State
NACE	Nomenclature of Economic Activities
NIR	National Implementation Report
OSH	Occupational Safety and Health
PPE	Personal Protective Equipment
RMM	Risk Management Measures
SBS	Structural Business Statistics
SME	Small and Medium Enterprises
WHO	World Health Organisation

Executive summary

Introduction and background

This report is exceptional in that the subject to which it relates has been the subject of a series of Directives, each of which has been repealed and replaced before its provisions have fully come into force in all MSs.

As a result, the current version has not yet been implemented (MSs have until 1 July 2016 to do so). Some MSs have implemented earlier versions and some do not currently have any specific national legislation transposing its provisions.

Nevertheless, during the present evaluation, comments and recommendations have been received which should be documented.

This report therefore focusses specifically on selected aspects of the Directive (principally its relevance) without exploring all of the issues relating to its coherence and effectiveness.

Objectives

The provisions of the EMF Directive specifically target the risk of injury arising from exposure to EMFs through defining a hierarchy of measures including:

Assessment of risks and determination of exposure;

Avoiding or reducing risks;

Worker information and training;

Consultation and participation of workers;

Health surveillance

As part of this the EMF Directive provides for the employer to devise and implement an action plan that shall include technical and/or organisational measures to prevent exposure exceeding the health effect ELVs and sensory-effect ELVs, and to minimise the risks of indirect effects. It does not currently cover suggested long-term effects. However, the preamble to the Directive acknowledges that, if well-established scientific evidence on such effects emerges, the Commission will consider the most appropriate means for addressing such effects.

Methodology	<p>Findings are based on an analysis of the OSH legislation in each of the MSs (embodied in Country Summary Reports (CSRs) prepared by national experts for the project), official statistics at national and EU level, National Implementation Reports (NIRs) (submitted to the Commission by the MSs by end of 2013) as well as on scientific articles, existing studies and interviews with both national and EU stakeholders.</p>
Implementation	<p>As noted above, this Directive is unique in that it has been the subject of a number of iterations and has yet to be implemented in most MSs. As a result only limited information is available regarding its implementation and compliance.</p> <p>Five MSs have implemented more detailed requirements regarding Article 4 (Conducting risk assessments) and Article 8 (Health surveillance) in relation to the EMF Directive.</p> <p>In relation to the risk assessments, in two MSs (Italy and Lithuania) employers are required to submit their risk assessments on request of Labour Inspectors/National Authorities. Both MSs require a level of content which is more detailed than the provision in the Directive.</p> <p>For Article 8 on health surveillance three MS (Italy, Romania and Lithuania) provided more details on preventive medical examinations, types of health surveillance records and frequency of health surveillance. Focusing on periodicity of health surveillance Lithuania specified two years whereas in Austria more stringent and broader requirements can be found.</p>
Limited information on compliance	<p>Data on the levels of compliance with the requirements of the Directive is quite sparse, as National authorities do not keep account of levels of compliance and national stakeholders consider their knowledge on the specificities to be limited. The available data indicates that the level of OSH compliance in general increases with the size of establishment. However, as the EMF Directive has not been implemented in the vast majority of the MSs, there is little specific material on compliance. There were no responses in the NIRs for the EMF Directive in relation to any issues for SMEs in implementing the provisions of the Directive.</p>
Directive relevant to around 4% of the EU workforce.	<p>There are a variety of sectors and occupations where exposure to EMFs is possible. EMFs are generated and used in many work activities, including manufacturing processes (e.g. welding), research, communication, medical applications, power generation, transmission and distribution, broadcasting, aeronautical and marine navigation, and security. However, with the exception of incidental exposures, which are difficult to estimate, each of these tends to represent a specialist sub-group within a sector making it difficult to establish the numbers of workers potentially exposed. A procedure was adopted whereby the whole employment figure was adopted for those sectors where the majority can be assumed to be at risk of exposure (not necessarily exposed) and to omit those in relatively small subsectors. It was considered that this provided a reasonably accurate overall estimate where the intention was to provide a broad view of the proportion of the workforce covered, rather than any detailed calculation.</p> <p>Through investigating SBS and LFS data it can be estimated that the EMF Directive can be regarded as relevant to 7,994,934 workers in the EU-27 workforce (3.71%), this includes the sectors of manufacturing, electricity, gas, steam and air</p>

conditioning supply, information and communication and human health and social work activities. Although welders are regarded as a significant subgroup in respect of potential exposure to EMFs, adding an estimate of their number does not markedly influence this estimate.

No data on health effects and uncertain evidence on the extent of specific risks

The ESAW data for 2008 (onwards) does not contain any category of injury appropriate to EMF exposure and the LFS data is not sufficiently specific to allow data relating to EMF exposures to be extracted. The EWCS (2010) contains materials relating to the employment environment and employment health. However, neither of these sections includes any material from which data relating to EMF exposure can be derived.

Although research by Franco et al (2010) suggests that the use of MRI scanners in hospitals can have acute, cardiovascular and memory effects, the authors concluded that they are uncertain whether the data on effects of EMF exposure are sufficient to determine whether the evidence is enough to take action. This was mirrored by EU-OSHA in concluding that more research is needed and was supported by the WHO who noted that there was not sufficient scientific data to establish what the health risks are. As identified in this report the EMF directive specifically only addresses any short-term risks and does not include longer-term effects.

Doubts over future relevance

In relation to the future relevance of the Directive comments from EU stakeholders, national stakeholders, expert reviews and NIRs identified concerns that this Directive was based on concerns of possible effects, rather than tangible evidence. It was suggested that there is no proof of the proposed risks of EMFs on humans and that further research is needed. As well as research in this area it was suggested that, as static fields are an emerging risk in technologies such as tablet devices, contactless charging or hybrid car batteries, then research on the potential risk of long term exposure is necessary.

One of the EU Stakeholders also suggested that the EMF Directive is subject to economic interests in that the cost of the burden imposed outweighs the exposure risks.

One MS (UK) specifically recommends the repeal of this Directive in its NIR.

No analysis of effectiveness

The EMF Directive has not been implemented in the vast majority of the MSs therefore there is no data available to assess the effectiveness of the Directive.

Coherence

No analysis of coherence is presented.

Recommendations

There appear to be considerable scientific doubts over the value and validity of the EMF Directive and whether the requirements it imposes (and resultant costs) are proportionate to the extent of any risk to health or safety. Consideration should therefore be given to opening a debate on the value and merit of retaining this Directive and whether it should be repealed and not replaced.

Several reviews have questioned the evidence-base for the EMF Directive and called for more scientific data to establish what the health risks are. Given the

uncertainty over the nature and extent of any risks therefore, requiring employers to assess and manage them seems premature.

It is recommended that the rationale for retaining this Directive, which has already been re-examined and reviewed on several occasions, should be reconsidered.

Such a review should consider:

- **What clear evidence is there for adverse health and safety effects of EMF exposure?**
- **To what extent are these adequately addressed by existing safeguards?**
- **Do the residual effects justify the use of legislative measures for their control?**

1 Introduction

About this report

This report is a Directive-specific report which forms part of the reporting of an overall evaluation of 24 Directives on Occupational Safety and Health (OSH) commissioned by DG Employment. The report concerns Directive 2013/35/EU on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (electromagnetic fields, EMF) from here on referred to as the "EMF Directive".

The evaluation of 24 OSH Directives was initiated in 2013 and finalised in June 2015. The evaluation produced cross-cutting findings on the implementation of the 24 Directives, which are documented in the Main Report. Annexed to this Main Report are Directive-specific reports for each of the 24 Directives (Annex A) and reports on the implementation of the 24 Directives in the Member States (MSs) (Annex B comprising 27 reports as Croatia was excluded from the study).

Objective of the evaluation

The objective was to evaluate the practical implementation of EU OSH Directives in the EU Member States with a view to assessing their impacts and with a view to identifying their strengths and weaknesses with the aim of possibly putting forward improvements to the regulatory framework. The evaluation was guided by a set of questions and evaluation criteria, which were to be addressed for all Directives and Member States. There are two main sets of questions.

The first set relates to the implementation of the Directives in the Member States:

- › **Implementation:** MQ1-MQ7 are mapping questions that as part from addressing the overall implementation of the Directives look into specific implementation issues such as derogations, transitional periods, compliance and enforcement:

MQ1: Across the Member States, how are the different Common Processes and Mechanisms foreseen by the Directives put in place, and how do they operate and interact with each other?

MQ2: What derogations and transitional periods are applied or have been used under national law under several of the Directives concerned?

MQ3: What are the differences in approach to and degree of fulfilment of the requirements of the EU OSH Directives in private undertakings and public-sector bodies, across different sectors of economic activity and across different sizes of

companies, especially for SMEs, microenterprises and self-employed?

MQ4: What accompanying actions to OSH legislation have been undertaken by different actors (the Commission, the national authorities, social partners, EU-OSHA, Eurofound, etc.) to improve the level of protection of safety and health at work, and to what extent are they actually used by companies and establishments to pursue the objective of protecting safety and health of workers? Are there any information needs that are not met?

MQ5: What are the enforcement (including sanctions) and other related activities of the competent authorities at national level and how are the priorities set among the subjects covered by the Directives?

MQ6: What are the differences of approach across Member States and across establishments with regard to potentially vulnerable groups of workers depending on gender, age, disability, employment status, migration status, etc., and to what extent are their specificities resulting in particular from their greater unfamiliarity, lack of experience, absence of awareness of existing or potential dangers or their immaturity, addressed by the arrangements under question?

MQ7: What measures have been undertaken by the Member States to support SMEs and microenterprises (e.g. lighter regimes, exemptions, incentives, guidance, etc.)?

The second set addresses the three main evaluation criteria of relevance, effectiveness and coherence (a total of 11 evaluation questions):

- › **Relevance:** EQR1-EQR2 relate to the extent to which the provisions of the Directive are relevant for the current as well as future risks and composition of industry sectors:

EQR1: To what extent do the Directives adequately address current occupational risk factors and protect the safety and health of workers?

EQR2: Based on known trends (e.g. new and emerging risks and changes in the labour force and sectoral composition), how might the relevance of the Directives evolve in the future, and stay adapted to the workplaces of the future in light of the horizon of 2020? Does the need for EU level action persist?

- › **Effectiveness:** EQE1-EQE7 explore whether the introduction of the Directive has led to changes to enterprise behaviour and the occupational safety and health of workers:

EQE1: To what extent has the Directive influenced workers' safety and health, the activities of workers' representatives, and the behaviour of establishments?

EQE2: What are the effects on the protection of workers' safety and health of the various derogations and transitional periods foreseen in several of the Directives concerned?

EQE3: How and to what extent do the different Common Processes and Mechanisms that were mapped contribute to the effectiveness of the Directives?

EQE4: To what extent do sanctions and other related enforcement activities contribute to the effectiveness of the Directives?

EQE5: What benefits and costs arise for society and employers as a result of fulfilling the requirements of the Directives?

EQE6: To what extent do the Directives generate broader impacts (including side effects) in society and the economy?

EQE7: To what extent are the objectives achieving their aims and, if they are not,

what cause could play a role? What factors have particularly contributed to the achievement of the objectives?

- › **Coherence:** EQC1-EQC2 concern the extent to which the objectives and actions from a given OSH Directive interact or overlap with other OSH Directives and/or with other EU policies:

EQC1: What, if any, inconsistencies, overlaps, or synergies can be identified across and between the Directives (for example, any positive interactions improving health and safety outcomes, or negative impact on the burdens of regulation)?

EQC2: How is the interrelation of the Directives with other measures and/or policies at European level also covering aspects related to health and safety at work, such as EU legislation in other policy areas (e.g. legislation: REACH, Cosmetics Directive, Machinery Directive, policy: Road Transport Safety, Public Health, Environment Protection), European Social Partners Agreements or ILO Conventions?

Methodology and sources of information

This report is exceptional in that the subject to which it relates has been the subject of a series of Directives, each of which has been repealed and replaced before its provisions have fully come into force in all MSs.

As a result, the current version has not yet been implemented. Some MSs have implemented earlier versions and some do not currently have any specific national legislation transposing its provisions.

Nevertheless, during the present evaluation, comments and recommendations have been received which should be documented.

This report therefore focusses specifically on the issue of relevance (addressing questions EQR1-EQR2).

This Directive report is based on the analysis of the National Implementation Reports (NIRs) submitted to the Commission by each of the MSs by end of 2013 as well as scientific articles, existing studies and interviews with both national and EU stakeholders.

- › Chapter 2 presents the overall understanding of the Directive, i.e. its rationale, its provisions, and its intervention logic.
- › Chapter 3 provides the relevant findings with regard to the relevance of the Directive
- › Chapter 4 presents a general discussion and draws the main conclusions emanating from the findings.

2 The Directive

2.1 Background and objective

Background

Under the Treaty on the Functioning of the EU, and in particular Article 153(2) thereof, the European Parliament and the Council may, by means of directives, adopt minimum requirements for the encouragement of improvements, in particular of the working environment, to guarantee a better level of protection of the health and safety of workers.

In September 1990 the European Parliament adopted a resolution inviting the Commission in particular to draw up a specific directive on the risks caused by noise and vibration and by any other physical agents at the workplace. Following the preparation of Directives on exposure to vibration and noise it was considered necessary to introduce measures protecting workers from the risks associated with EMFs, owing to their apparent effects on the health and safety of workers.

The first such directive (2004/40/EC) attracted serious concerns from stakeholders, in particular those from the medical community, as to the potential impact on the use of medical procedures based on medical imaging of the implementation of that Directive. Concerns were also expressed as to the impact of the Directive on certain industrial activities.

As a result, the Directive was amended (by Directive 2008/46/EC and subsequently by Directive 2012/11/EU) before being repealed and replaced by the present Directive (Directive 2013/35/EU – referred to henceforth as the EMF Directive). Although some MSs might have transposed one or other of these earlier Directives on EMFs, few are believed to have implemented this latter version, and MSs have until 1 July 2016 to so do.

Objective

The objective of the EMF Directive, as noted above, is to address all known direct biophysical effects and indirect effects caused by EMFs, in order not only to ensure the health and safety of each worker on an individual basis, but also to create a minimum basis of protection for all workers in the Union, while reducing possible distortions of competition.

2.2 Risks

As noted above, the EMF Directive addresses the known risks associated with exposure to EMFs.

As such it encompasses risks to the health and safety of workers due to known short-term adverse effects in the human body caused by the circulation of induced currents and by energy absorption as well as by contact currents.

The EMF Directive aims at protecting workers from excessive exposure to EMFs, which can affect the human body via two frequency-dependent mechanisms. At frequencies <10Mhz, time-varying electric fields are induced in the body which may affect the electrical properties of living cells and alter their function (Reilly, 1998)¹. In the case of frequencies >100kHz the induced electrical fields generate an oscillating current, which transfers energy to the body and may increase local or whole body temperature (Challis, 2005)².

In addition to direct risks, this includes any indirect effects, such as:

- interference with medical electronic equipment and devices (including cardiac pacemakers and other implanted devices);
- the projectile risk from ferromagnetic objects in static magnetic fields with a magnetic flux density greater than 3 mT;
- initiation of electro-explosive devices (detonators);
- fires and explosions resulting from ignition of flammable materials by sparks caused by induced fields, contact currents or spark discharges.

Table 2-1 summarises the relevant risks to health and safety which the EMF Directive addresses.

¹ Reilly JP (1998) Applied Bioelectricity: From electrical stimulations to electropathology. New York: Springer-Verlag.

² Challis LJ (2005) Review: Mechanisms for interaction between RF fields and biological tissue. Bioelectromagnetics, Suppl 7: S98-S106.

Table 2-1 Acute and long-term risks

Risks
<p>Acute risks</p> <p>Thermal effects, such as tissue heating through energy absorption from EMFs in the tissue;</p> <p>Non-thermal effects, such as the stimulation of muscles, nerves or sensory organs. These effects might have a detrimental effect on the mental and physical health of exposed workers.</p> <p>The stimulation of sensory organs by EMFs may lead to transient symptoms, such as vertigo or phosphenes. These effects might create temporary annoyance or affect cognition or other brain or muscle functions, and may thereby affect the ability of a worker to work safely (i.e. safety risks);</p> <p>Limb currents;</p> <p>Indirect risks (see above)</p> <p>Long term risks</p> <p>The Directive does not cover suggested long-term effects, including the possible carcinogenic effects, of exposure to time-varying electric, magnetic and EMFs, for which there is currently no conclusive scientific evidence establishing a causal relationship.</p>

2.3 Provisions

Scoping and definitions

The EMF Directive specifically targets the risk of injury arising from exposure to EMFs. It does so through defining a hierarchy of measures including:

- Assessment of risks and determination of exposure;
- Avoiding or reducing risks;
- Worker information and training;
- Consultation and participation of workers;
- Health surveillance

In particular, the Directive provides for the employer to devise and implement an action plan that shall include technical and/or organisational measures to prevent exposure exceeding the health effects Exposure Limit Values (ELVs) and sensory effects ELVs (see below), and to minimise the risks of indirect effects.

The Directive adopts the following definitions:

"electromagnetic fields": static electric, static magnetic and time-varying electric, magnetic and EMFs with frequencies up to 300 GHz;

"direct biophysical effects": effects in the human body directly caused by its presence in an electromagnetic field;

"indirect effects": effects, caused by the presence of an object in an electromagnetic field, which may become the cause of a safety or health hazard;

"exposure limit values" (ELVs): values established on the basis of biophysical and biological considerations, in particular on the basis of scientifically well-established short-term and acute direct effects, i.e. thermal effects and electrical stimulation of tissues;

"health effects ELVs": those ELVs above which workers might be subject to adverse health effects, such as thermal heating or stimulation of nerve and muscle tissue;

"sensory effects ELVs": those ELVs above which workers might be subject to transient disturbed sensory perceptions and minor changes in brain functions;

"action levels (ALs)": operational levels established for the purpose of simplifying the process of demonstrating the compliance with relevant ELVs or, where appropriate, to take relevant protection or prevention measures specified in this Directive.

As noted in Table 2-1, the EMF Directive does not cover suggested long-term effects of exposure to EMFs, since there is currently no well-established scientific evidence of a causal relationship. However, the preamble to the Directive acknowledges that, if well-established scientific evidence for such risks emerges, the Commission shall consider the most appropriate means for addressing such effects.

Common processes and mechanisms and other KRs

The provisions of the Directive can be summarised in a series of Key Requirements as summarised in Table 2-2. Amongst these KRs are the so-called Common Processes and Mechanisms (CPMs).

- › CPMs are the KRs that derive from the framework Directive 89/391/EEC and that are included in all or several of the individual Directives (i.e. specific Directives such as the EMF Directive).

Other KRs are the Directive-specific provisions that, in addition to the CPMs, are considered to be central for generating workplace impacts and safety and health impacts, e.g. provisions on limit values.

Table 2-2 shows that all of the six CPMs are included in the articles in the EMF Directive.

Table 2-2 Key requirements for the EMF Directive

Directive 2013/35/EC on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (electromagnetic fields)						
Key requirements: Scoping and definitions						
Scope of application Arts 1 and 2(a)	The Directive relates to the protection of workers from risks to their health and safety arising or likely to arise from exposure to EMFs defined as static electric, static magnetic and time-varying electric, magnetic and EMFs with frequencies up to 300 GHz. It is restricted to known short-term adverse effects in the human body caused by the circulation of induced currents and by energy absorption as well as by contact currents and does not address 'suggested' long-term effects.					
Key requirements: Common processes and mechanisms						
CPM	Conducting a risk assessment	Ensuring internal and/or external preventive and protective services	Information for workers	Training of workers	Health surveillance	Consultation of workers
Relevant Articles	4	4(4)	6	6	8	7
Key requirements: Directive-specific provisions						
Exposure limit values and action levels Art. 3	The Directive provides for a set of ELVs and ALs in respect of EMFs which are wavelength dependent.					
Provisions aimed at avoiding or reducing risks Art. 5	<p>The Directive requires the employer shall take the necessary actions to ensure that risks arising from EMFs at the workplace are eliminated or reduced to a minimum.</p> <p>The reduction of risks arising from exposure to EMFs shall be based on the general principles of prevention set out in Article 6(2) of Directive 89/391/EEC.</p> <p>Once the relevant ALs, are exceeded and unless the assessment carried out in accordance with Article 4(1), (2) and (3) demonstrates that the relevant ELVs are not exceeded and that safety risks can be excluded, the employer shall devise and implement an action plan that shall include technical and/or organisational measures to prevent exposure exceeding the health effects ELVs and sensory effects ELVs.</p>					
Derogations Art. 10	<p>The Directive allows for derogations:</p> <ul style="list-style-type: none"> • if the exposure is related to the installation, testing, use, development, maintenance of or research related to Magnetic Resonance Imaging (MRI) equipment for patients in the health sector; • for personnel working in operational military installations or involved in military activities, including in joint international military exercises; 					

	<ul style="list-style-type: none"> • for the ELVs to be temporarily exceeded in specific sectors or for specific activities outside the scope of the above points under 'duly justified circumstances'.
Practical guides Art. 14	The Commission are required to make available non-binding practical guides (at the latest six months before 1 July 2016) on a number of aspects of the Directive.
Non-key Directive-specific provisions	
<p>The following Directive-specific provisions are not considered to constitute KRs in the context of the evaluation:</p> <ul style="list-style-type: none"> › provisions that do not have a direct impact on limiting the risk from exposure to EMFs, such as penalties (Art. 9), technical amendments (Art. 11), exercise of the delegation (Art. 12), urgency procedure (Art. 13) › and provisions of a technical nature (committee procedure, transposition, reporting to the Commission, Arts. 15-19). 	

2.4 Intervention logic

Impact logic

Figure 2-1 illustrates the logical steps of how the EMF Directive – represented by its KRs – would be expected to leads to impacts, i.e.:

- › **CPMs and other KRs** are, as discussed above, the provisions of the Directive that during the analysis have been identified as the ones that in particular need to be addressed when assessing impacts. The figure illustrates that, because of the multifaceted nature of the Directive, it is not possible to identify how each of the KRs in themselves will impact. In other words, the KRs work in unison to produce impacts and so they are analysed as such.
- › **Workplace impacts** constitute the direct changes/improvements that occur at the workplace as a result of implementing the KRs. These changes come at a cost to the workplace, but are also the drivers by which the safety and health impacts occur.
- › **Safety and health impacts** constitute the actual removal and/or reduction in safety and health risks arising from EMF exposure resulting in reductions in injuries or disease. These impacts occur as a result of the Directive (KRs) through the above-mentioned workplace impacts.
- › **Broader impacts** constitute the impacts that may occur more broadly speaking as a result of the above mentioned safety and health impacts.

Figure 2-1 EMF Directive Intervention Logic



3 Assessment of relevance

Relevance in relation to relevant work and workforce

In this section, the relevance of the Directive in relation to the coverage of workforce and MSs, and the severity and extent of risks covered are investigated. The conclusions from the five parameters used to assess relevance are summarised in the table below.

Table 4-1 Summary of the five relevance parameters

Coverage of Workforce and Member States		Accidents and health problems		
Number of MS where the Directive is potentially relevant	Proportion of EU workforce to whom the Directive is potentially relevant	Fatal accidents at work (per 100-000 employed)	Non-fatal accidents at work (per 100-000 employed)	Work-related health problems
27	3.71%	n/a*	n/a	n/a

* n/a: not available

Coverage of Member States

As noted above, Directive 2004/40/EC relating to exposure to EMFs has been subject to a number of revisions. Directive 2012/11/EU of 19 April 2012 recognised that this had delayed its adoption indicating that, at the time of publication, the majority of MSs had not transposed Directive 2004/40/EC. Directive 2013/35/EU of 26 June 2013 repeals the earlier Directive and establishes (Article 16) that MSs have to enact the laws, regulations and administrative provisions necessary to comply with this Directive by 1 July 2016. At present therefore, the criterion of adoption into national legislation cannot be applied to this Directive. This view is confirmed by reference to the NIRs³ which indicate that most have not implemented the provisions of either Directive, have repealed their transposition of the earlier Directive or, even where provisions have been adopted into national legislation; do not actively enforce the provisions made.

The first criterion to be applied is whether there are workers and /or sectors in each of the MSs where EMFs might be encountered. In doing this it is not necessary to identify all such sectors or types of exposure, simply that some at least exist in

³ Individual NIRs

each MS. Exposure to EMFs was not examined in the Fifth European Working Conditions Survey (EWCS).

Electromagnetic fields are produced by a wide range of sources that workers may encounter in the workplace. They are generated and used in many work activities. However, two of the main common industrial sectors where EMFs will be encountered include electrical power generation (low frequencies) and telecommunications (high and very high frequencies). There are also large EMFs associated with some forms of welding operations, but these are not sector-specific and the proportions of workers involved in such activities in any one sector (e.g. parts of the manufacturing and construction sectors) cannot be estimated with any certainty.

Although the numbers are not large, the 4th EWCS survey showed employment in the electricity, gas and water sector in all MSs.⁴ Eurostat data from 2010⁵ shows employment in the electricity, gas, steam and air conditioning supply sector (Nomenclature of Economic Activities (NACE) Code D) in all MS with the exception of Greece and Malta. However, the absence of entries for these two MS in this table should not necessarily be considered to indicate the absence of employment in those sectors. The same data source shows employment in the Telecommunications sector in all MSs, with the exception again of Malta.⁶ Again, this should not necessarily be construed as indicating an absence of employment in this sector in this MS. Separate investigations reveal that Malta is isolated from any other power grid and that two power stations on the Island generate all their electricity.⁷ It would appear therefore that all MSs have workers in the two main industrial sectors where exposure to EMFs might occur.

Workforce coverage

There are a variety of sectors and occupations where exposure to EMFs is possible. They are generated and used in many work activities, including manufacturing processes (e.g. welding), research, communication, medical applications, power generation, transmission and distribution, broadcasting, aeronautical and marine navigation, and security. Electromagnetic fields may also be incidental, such as the fields that are generated near to cables distributing electrical power within buildings, or resulting from the use of electrically powered equipment and appliances.

However, with the exception of incidental exposures, which are difficult to estimate, each of these tends to represent a specialist sub-group within a sector making it difficult to establish the numbers of workers potentially exposed. In order to provide an approximate estimate of the proportion of the EU-27 workforce possibly exposed to EMFs, without estimating numbers in such subsectors, a procedure was adopted whereby the whole employment figure was adopted for those sectors

⁴ <http://www.eurofound.europa.eu/pubdocs/2006/98/en/2/ef0698en.pdf>

⁵ [http://epp.eurostat.ec.europa.eu/statistics_explained/index.php?title=File:Key_indicators,_electricity,_gas,_steam_and_air_conditioning_supply_\(NACE_Section_D\),_2010_A.png&filetimestamp=20130507075746](http://epp.eurostat.ec.europa.eu/statistics_explained/index.php?title=File:Key_indicators,_electricity,_gas,_steam_and_air_conditioning_supply_(NACE_Section_D),_2010_A.png&filetimestamp=20130507075746)

⁶ http://epp.eurostat.ec.europa.eu/statistics_explained/images/f/ff/Key_indicators%2C_telecommunications_%28NACE_Division_61%29%2C_2010_A.png

⁷ <http://www.enemalta.com.mt/index.aspx?cat=2&art=5>

where the majority can be assumed to be at risk of exposure (not necessarily exposed) and to omit those in relatively small subsectors. This will clearly result in, on the one hand, an overestimate of those potentially at risk and, on the other hand, an underestimate. However, it was considered that this provided a reasonably accurate overall estimate where the intention was to provide a broad view of the proportion of the workforce covered, rather than any detailed calculation.

Labour Force Survey (LFS) data⁸ documents that, for 2012, a total of 215,678,600 people were employed within the EU-27 (15-74 years). Consultation with OSH experts highlighted the sectors within which the EMF Directive is particularly relevant because workers in those sectors are more likely to be exposed:

- C24 (Manufacture of basic metals)
- C25 (Manufacture of fabricated metal products, except machinery and equipment)
- D (Electricity, gas, steam and air conditioning supply)
- J61 (Telecommunications)
- Q86 - Human health activities

To calculate the proportion of workers in the manufacturing sector for whom the EMF Directive is relevant Structural Business Statistics (SBS) data⁹ was consulted. In the SBS database the most up to date data was used, which was recorded in 2010. The estimated population of workers in the manufacturing sector was 30,000,000. The relevant sectors described above were estimated to include the following number of workers:

- C24 (Manufacture of basic metals) = 1,000,000
- C25 (Manufacture of fabricated metal products, except machinery and equipment) = 3,571,400

This amounts to 15.23% of the SBS manufacturing sector. By applying this percentage to the figures from the LFS (33,632,500) manufacturing sector, we can estimate that the EMF Directive is relevant to 5,122,230 workers in this sector.

Turning to the LFS data, 1,664,900 workers are employed in the Electricity, gas, steam and air conditioning supply sector (NACE D) and the EMF Directive can be regarded as relevant to all these.

To calculate the proportion of workers in the information and communication (NACE J) sector for whom the EMF Directive is relevant SBS data¹⁰ was again consulted. In the SBS database the most up to date data was used, which was recorded in 2010. The estimated population of workers in the information and communication sector was 57,700. The relevant sector described above (NACE J61) was estimated to include 10,908 workers. This amounts to 18.9% of the

⁸ Employment by sex, age and economic activity (from 2008 onwards, NACE Rev. 2) - 1 000 [lfsa_egan2]

⁹ Annual enterprise statistics by size class for special aggregates of activities (NACE Rev. 2) [sbs_sc_sca_r2]

¹⁰ Annual enterprise statistics by size class for special aggregates of activities (NACE Rev. 2) [sbs_sc_sca_r2]

information and communication sector. By applying this percentage to the EU-27 LFS workforce data, employed within the information and communication sector (6,390,500) we can estimate that the EMF Directive is relevant to a further 1,207,804 workers.

To calculate the proportion of workers in the human health and social work activities sector (NACE Q) for whom the EMF Directive is relevant was not possible due to the unavailability of data. While data is available for the whole sector it was not possible to identify the proportion of workers specifically within the human health activities sector (NACE Q86). The whole sector amounts to 0.78% of the workforce, and the human health activities sector will only be a proportion of this. It was therefore concluded that the unavailability of this data was an acceptable loss.

By using the available data described above the EMF Directive can be regarded as relevant to 7,994,934 workers in the EU-27 workforce, or 3.71% of the total.

On the specific issues of welders (who are seen as a group at particular risk), a report financed by German Welding Society (DVS) and by European Federation for Welding, Joining and Cutting (EWF) states that, in 2007, there were nearly 837,000 welders, although the origins of this figure are not given¹¹. This would increase the above figure by less than 0.01%.

3.1 EQR1: Current relevance

EQR1: To what extent do the Directives adequately address current occupational risk factors and protect the safety and health of workers?

Fatal and non-fatal accidents at work

The European Statistics on Accidents at Work (ESAW) database (2008 onwards¹²) does not contain any category of injury appropriate for EMF exposure. Similarly, although earlier data¹³ includes a 'mode of injury' of 'Contact with electrical voltage, temperature, hazardous substances (not specified)' which could possibly include EMF-related injuries it is not possible to identify these from this source. It is likely, for example, that 'contact with electrical voltage' indicates direct contact rather than any influence of EMFs.

The LFS database also includes material on accidents at work, but the classification of data by work sector¹⁴ is not sufficiently specific to allow data relating to EMF exposures to be extracted.

¹¹ Middeldorf K (2009) The economic importance of welding and joining in Europe: Production values, values added and employees. DVS - Deutscher Verband für Schweißen und verwandte Verfahren e.V.(German Welding Society)

¹² Accidents at work by economic activity and type of injury [hsw_n2_07]

¹³ Number of accidents at work by contact - mode of injury, economic activity, sex, age and severity [hsw_aw_co1]

¹⁴ Persons reporting an accident at work in the past 12 months, by sex, age and economic activity sector - % [hsw_ac5]

Work-related health problems

As with the injury data, LFS data on work-related health problems (self-reported) includes material on type of problem¹⁵ but the categories used do not provide any material from which relevant statistics relating to EMF exposures can be derived.

The EWCS 2010 database contains material relating to the employment environment and employment health. However, neither of these sections includes any material from which data relating to EMF exposure can be derived.

One established source of EMFs relates to the use of MRI scanners in hospitals. Franco and co-workers (2010) identify a number of acute effects (vertigo, nausea, metallic taste in the mouth) which they regard as transient but which do present a potential risk of exerting a negative influence on the performance of workers during critical procedures. Further cardiovascular effects (changes in blood pressure and heart rate [within the range of the physiological variability], induction of ectopic heart beats, and increased likelihood of re-entrant arrhythmias) were also identified as were possible dose-dependent decreases in working memory and of eye-hand coordination that may affect the performance of workers executing delicate procedures.

However, the authors conclude that it is uncertain whether the so far available scientific data about health effects of EMF exposure are sufficient to assess whether the evidence is enough to take action. This is mirrored in an EU-OSHA Risk Observatory report on health and safety risks in the healthcare sector¹⁶ which, in respect to EMF exposure (especially from MRI scanners) states:

“The health effects of static magnetic fields have not been thoroughly explored, and the World Health Organisation (WHO) has pointed out that there is not sufficient data derived from scientific research to establish what the health risks are”. (p76)

It should be remembered that the Directive specifically only addresses any short-term risks and does not include longer-term effects such as any putative carcinogenic effects. Much of the research literature examines these longer-term impacts, usually concluding that the evidence is, at best weak or inconclusive (e.g. Wilkins and Wellage (1996)¹⁷ amongst welders and Johansen and Olsen (1999)¹⁸ amongst electricity workers).

A recent UK-based study found that many of the commonly used welding processes should not expose welders and operators to magnetic fields in excess of the Directive ALs although some (less common) process options may lead to the

¹⁵ Persons reporting their most serious work-related health problem work in the past 12 months, by type of problem - % [hsw_pb5]

¹⁶ Current and emerging issues in the healthcare sector, including home and community care. EU-OSHA , 2014

¹⁷ Wilkins JR III, Wellage LC (1996) Brain tumor risk in offspring of men occupationally exposed to electric and magnetic fields. *Scand J Work Environ Health*; 22: 339-45.

¹⁸ Johansen C, Olsen JH. (1999) [Risk of cancer among Danish electricity workers. A cohort study]. [Article in Danish]. *Ugeskr Laeger*. 5; 161(14): 2079-85.

ALs being exceeded¹⁹. It should also be noted that most health concerns amongst welders centre on welding fume and related exposures (e.g. Korczynski, 2000)²⁰.

Kavet and colleagues (2001) question the epidemiological evidence for any tangible health effects (focussing particularly on electricity workers), but do acknowledge the occurrence of safety issues associated primarily with the sudden reflex muscular reactions that can result from perception of, or involuntary reaction to, induced currents or fields²¹. It is understood that there are reports of isolated cases of communications workers being inadvertently exposed to very high fields resulting in their death. However, these appear to occur when existing safeguards fail or are circumvented.

It is understood²² that, although early designs of medical aids such as pacemakers could be disabled by high EMFs, those currently implanted will fail to a default setting rather than fail completely, thus safeguarding the health of any wearer.

It would seem therefore that, although there does seem to be some evidence of short-term impacts of EMF exposure on the human body, such as those attributable to induced electrical currents, evidence of the extent to which these are a significant problem warranting legislative control in the form of an EU Directive is unclear and the whole rationale for this Directive, which has already been re-examined and reviewed on several occasions, could perhaps be reconsidered.

EQR1: Answer

Through investigating SBS and LFS data it can be estimated that the EMF Directive can be regarded as relevant to 7,994,934 workers in the EU-27 workforce (3.71%), this includes the sectors of manufacturing, electricity, gas, steam and air conditioning supply, information and communication and human health and social work activities. Although welders are regarded as a significant subgroup in respect of potential exposure to EMFs, adding an estimate of their number does not markedly influence this estimate.

No data on health effects and uncertain evidence on the extent of specific risks

The ESAW data for 2008 (onwards) does not contain any category of injury appropriate to EMF exposure and the LFS data is not sufficiently specific to allow data relating to EMF exposures to be extracted. The EWCS (2010) contains materials relating to the employment environment and employment health. However, neither of these sections includes any material from which data relating to EMF exposure can be derived.

Although research by Franco et al (2010) suggests that the use of MRI scanners in hospitals can have acute, cardiovascular and memory effects, the authors

¹⁹ Melton G, Shaw R. (2014) Electromagnetic Fields (EMF) in the welding environment. HSE Books RR 1018.

²⁰ Korczynski RE (2000) Occupational Health Concerns in the Welding Industry. Applied Occupational and Environmental Hygiene; 15: 936-945.

²¹ Kavet R, Stuchly MA, Bailey WH, Bracken TD (2001) Evaluation of biological effects, dosimetric models, and exposure assessment related to ELF electric- and magnetic-field guidelines, Applied Occupational and Environmental Hygiene; 16: 1118-1138.

²² Consultant cardiac surgeon, personal communication.

concluded that they are uncertain whether the data on effects of EMF exposure are sufficient to assess whether the evidence is enough to take action.

This view was mirrored by EU-OSHA in concluding that more research is needed and supported by the WHO that noted more scientific data are needed to establish what the health risks are. Similar views have been reached in published reviews of the field. As identified in this report the EMF directive specifically only addresses any short-term risks and does not include longer-term effects.

It would seem therefore that, given published doubts over the nature and extent of any risks, evidence of the extent to which these risks are a significant problem warranting legislative control in the form of an EU Directive is unclear and the whole rationale for this Directive, which has already been re-examined and reviewed on several occasions, could perhaps be reconsidered.

3.2 EQR2: Future relevance

EQR2: Based on known trends (e.g. new and emerging risks and changes in the labour force and sectoral composition), how might the relevance of the Directives evolve in the future, and stay adapted to the workplaces of the future in light of the horizon of 2020? Does the need for EU level action persist?

Comments were received during interviews with national stakeholders and experts regarding possible additions or adjustments to the EMF Directive. Further comments and suggestions were presented in the NIRs. The comments offered could therefore be useful in considering the future relevance and direction of the Directive if it is retained.

EU stakeholder interviews

There were only two direct comments on the relevance of the EMF Directive argued by the EU stakeholders. One such comment considered how relevant the Directive is at improving or safeguarding the health and safety of workers in the EU. The stakeholder regards the Directive as low frequency, low risk and very high cost, which they consider to be a factor for high levels of non-compliance on this Directive. They followed this comment by considering the importance of basing any new Directives on evidence, rather than as precautionary measures (see below).

The second comment from an EU stakeholder expressed the view that sometimes economic interest can outweigh exposure risks, and that the EMF Directive is subject to this, meaning that the cost of compliance is perhaps disproportionate given the extent of any established risks.

National stakeholder and expert interviews

Responses from national stakeholder and expert interviews addressed the relevance of this Directive in several cases. One stakeholder observed (correctly) that the potential long-term effects of EMFs (including possible carcinogenic effects), which vary in time, are not addressed by the Directive. Furthermore, they expressed the view that current scientific evidence is not capable of demonstrating a causal relationship. It is not clear whether this was intended to indicate that current research methods are inadequate or that the evidence does not demonstrate any effects.

When considering any obsolete or less-relevant provisions on the Directive, interviews with UK stakeholders questioned the evidence base, even for proposed short-term effects. In a similar vein, an expert in Austria expressed the view that there is no proof of the proposed risks of EMFs on humans and that further research is needed.

Regarding new or emerging risks, interviews with stakeholders in Spain identified that EMFs are seen as a new or emerging risk. However, most of the research in this area is private and public information on the risks is limited. Stakeholders interviewed in Spain also regarded EMFs as a potential new or emerging risk, specifically due to technological developments which may expose users to intense magnetic fields that vary over time. Lastly a UK expert considered that static fields are an emerging risk with such technologies as tablet devices, contactless charging or hybrid car batteries. The expert expressed the view that research on the potential risk, if any, of long term exposure to static fields from such devices is necessary.

National
Implementation
Reports

A number of comments have been identified from the NIRs considering the relevance of the EMF Directive. One such example is from the Austrian NIR where two of their national partners indicated their belief that the proposed EMF Directive provides an appropriate instrument for guaranteeing a high level of protection for the EU workforce. However, the Slovakian NIR offered a different perspective in which they consider that the use of MRI machines would come to a halt or be reduced significantly if the Directive were to be fully implemented. Therefore, they included a recommendation that the limit values would not apply to activities associated with MRI use.

Recommendations from
National Implementation
Reports (NIR)

One explicit recommendation for repeal was offered by the UK: 'Repeal in its entirety. It is considered that the risks from electromagnetic fields can be adequately managed under the requirements of Directive 89/391/EEC.'

EQR2: Answer

In relation to the future relevance of the Directive, comments from EU stakeholders, national stakeholders, expert reviews and NIRs identified that there should be a consideration for the importance of basing any new directives on actual tangible evidence, rather than as a precautionary measure where no such evidence is available but where, for some reason, a possible relationship is suspected. In relation to this it was suggested that there is no tangible proof for the proposed risks of EMFs on humans and that further research is needed.

As well as research in this area, it was suggested that static EMFs are an emerging risk in technologies such as tablet devices, contactless charging or hybrid car batteries and that research on the potential risk of long term exposure is necessary.

One of the EU Stakeholders also suggested that the EMF Directive is subject to economic interests that outweighs the exposure risks. One MS (UK) specifically recommends the repeal of this Directive in its NIR.

It seems to be accepted that there is a need for further research in this area to establish whether a risk exists or whether new technologies present a risk of

introducing new risks. As with opinions on current relevance however the general (but not universal) view is that, at least on the basis of current evidence, the future relevance of the EMF Directive is questionable.

4 Conclusions and recommendations

4.1 Relevance

Current and future
relevance

There are a variety of sectors and occupations where exposure to EMFs is possible. They are generated and used in many work activities. Electromagnetic fields may also be incidental, such as the fields that are generated near to cables or distributing electrical power within buildings.

A procedure was adopted whereby the whole employment figure was adopted for those sectors where the majority can be assumed to be at risk of exposure (not necessarily exposed) and to omit those in relatively small subsectors. This will clearly result in, on the one hand, an overestimate of those potentially at risk and, on the other hand, an underestimate. It was considered that this provided a reasonably accurate overall estimate where the intention was to provide a broad view of the proportion of the workforce covered, rather than any detailed calculation.

On this basis it can be estimated that the EMF Directive can be regarded as relevant to 7,994,934 workers in the EU-27 workforce (3.71%), this includes the sectors of manufacturing, electricity, gas, steam and air conditioning supply, information and communication and human health and social work activities. Although welders are regarded as a significant subgroup in respect of potential exposure to EMFs, adding an estimate of their number does not markedly influence this estimate.

There are no collated datasets from EU sources which include any material from which data relating to injuries or ill-health arising from EMF exposure can be derived.

Primary research (e.g. Franco et al, 2010) as well as authoritative reviews (EU-OSHA and WHO) have questioned the evidence-base to support the need for the EMF Directive. For example, the WHO noted that more scientific data was needed to establish what the health risks are.

It would seem therefore that, given published doubts over the nature and extent of any risks, evidence of the extent to which these risks are a significant problem warranting legislative control in the form of an EU Directive is unclear.

In relation to the future relevance of the Directive comments from EU stakeholders, national stakeholders, expert reviews and NIRs identified that, although exposure to EMFs can have isolated acute effects, the degree of actual risk is minimal and the cost burden on employers potentially considerable. It has been suggested that existing general health and safety legislation, such as that embodied in the Framework Directive, provides sufficient legal protection.

Reflecting this view, one MS (UK) specifically recommends the repeal of this Directive in its NIR.

4.2 Overall discussion

Indistinct overall picture

It is difficult to formulate an overall picture of this Directive because of its chequered history of publication, repeal and replacement, leading to the situation where the current version has over a year before its provisions have to come into force in all MSs and a consequent widespread lack of implementation (although some MSs have implemented previous versions).

Although there are undoubtedly isolated instances of adverse acute effects arising from exposure to high EMFs the circumstances where these occur are well documented and appear to largely arise where existing safeguards fail. It is not clear how legislation would prevent such occurrences. Although some transient effects can occur, these seldom have any direct impact on the health of those affected, although a possibility exists (at least in theory) that if such effects occurred at a safety-critical time then it could have consequences for the safety of others.

There are suggestions that, although the issue of any health and safety effects of exposure to EMFs is a genuine concern, the use of a Directive is disproportionate to the risks involved, and that existing guidance and industry-specific safeguards (such as are already in place in respect of the use of MRI scanners) are sufficient. The adoption of the same 'model' for the EMF Directive as has been used for other physical agents has created some technical inconsistencies but has also contributed to this lack of proportion, potentially requiring the use of poorly understood measurement techniques. Similarly, although a need for health surveillance is included, mirroring the requirement in other physical agents Directives, questions have been asked in published scientific papers over what exactly is being looked for through this surveillance and raising ethical issues over some of the associated problems.

Possibly reflecting such concerns and uncertainties, one MS has specifically recommended the repeal of this Directive. The lack of a clear objective evidence-base, such as would be provided by the systematic collation of statistics on relevant injury, means that this report cannot perhaps go so far as to endorse this view. However, it certainly can endorse the view that the evidence for the need for this directive is unclear and uncertain and warrants re-evaluation.

Wider concerns

Comments from EU stakeholders, national stakeholders, expert reviews and NIRs in relation to the future relevance of the Directive identified an important general principle. It is suggested that there should be a consideration for the importance of

basing any new directives on where there was concrete evidence of adverse effects, rather than where there were concerns that there might be such effects (perhaps because of theoretical projections) - the so-called 'precautionary approach'. In relation to this it was identified that there is no proof of the proposed risks of EMFs on humans and that further research was needed.

As a counter to this, concerns have been expressed about the long latency of some occupational diseases, especially forms of cancer. It was suggested that waiting for clear evidence of a risk to emerge might in such circumstances result in workers being exposed to risks and developing diseases as a result, without precautionary measures being taken.

Clearly, there are no easy answers to this quandary, although medical and scientific technologies are progressively increasing the extent to which sub-clinical changes can be identified at an early stage in the development of many diseases and computer modelling, increasingly employed as a surrogate for traditional animal studies, will further assist in identifying possible adverse health effects at an early stage.

4.3 Recommendations

There appear to be considerable scientific doubts over the value and validity of the EMF Directive. Several authoritative reviews have questioned the evidence-base for the EMF Directive and called for more scientific data was needed to establish what the health risks are. Given the uncertainty over the nature and extent of any risks therefore, requiring employers to assess and manage them seems premature.

One EU stakeholder interviewed questioned whether the requirements (and resultant costs) the Directive imposes are proportionate to the extent of any risk to health or safety. In addition, the NIR of one MS (UK) specifically recommends the repeal of this Directive.

It is recommended that the rationale for retaining this Directive, which has already been re-examined and reviewed on several occasions, should be reconsidered. Such a review should consider:

What clear evidence is there for adverse health and safety effects of EMF exposure?

- **To what extent are these adequately addressed by existing safeguards?**
- **Do the residual effects justify the use of legislative measures for their control?**

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