CASE STUDIES

WELDERS EMF – REDUCTION OF WELDERS´EXPOSURE TO MAGNETIC FIELD FROM INDUCTION HEATERS USED IN POWER STATIONS

1. Organisations involved

BOT Elektrownia Bełchatow S.A.

2. Description of the case

2.1. Introduction

Electromagnetic fields (EMF) are present in the work environment as a result of the use of electrical devices. Industrial devices for induction heating are examples of common sources of exposure to EMF. A strong magnetic field (MF) exists in the vicinity of induction heaters, used for the pre-heating of high-mass arc-welded metal elements and supplied by a high electrical current, usually from 50 Hz to 10 kHz. EMF exposure may cause various biological effects with a variety of consequences for human beings which may lead to health hazards. To protect against the adverse health effects of EMF, the exposure limits are defined as national regulations or international guidelines published by scientific bodies. National Occupational Safety and Health (OSH) legislation in Poland has covered EMF produced by induction heaters since 1995. The Directive 2004/40/EC on health and safety requirements for workers exposed to EMF was adopted in 2004.

The source of EMF exposure (induction heaters used for pre-heating arc-welded pipes) was identified as part of a workplace evaluation of health and safety conditions at a power station in the context of reinforcing Polish national legislation. The action was taken by the management of BOT Elektrownia Bełchatow Power Station S.A. at the initiative of welders who work in the vicinity of induction heaters pre-heating arcwelded pipes, and focused on EMF exposure from inductors. Following the assessment, it was decided to take measures to reduce exposure by reducing EMF at its source. The company funded the costs of the exercise, and called in the help of experts from CIOPPIB (the Central Institute for Labour Protection – National Research Institute).

2.2. Aims

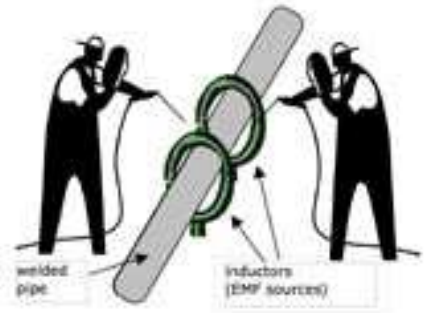
The main aims of the project were:

- to determine the characteristics and level of welders' exposure to EMF from inductors pre-heating arc-welded pipes;
- to reduce workers' EMF exposure level to make it compliant with legal requirements;
- The practical use of electromagnetic shielding as a technical means of reducing electromagnetic hazard at source.

2.3. What was done, and how?

Power stations use metallic pipes that are multiple kilometres in length for water transportation as cooling and water vapour as the driving medium of electric turbo generators. These pipes are constantly being repaired or replaced, which necessitates the use of arc welding. Induction heating is used to pre-heat connecting sections of pipes to obtain the best quality arc welds. Inductors comprising a few wire coils have to be mounted at a distance of a few centimetres from the ends of welded pipes. The inductors and cables supplying them with electric current are sources of strong magnetic field (MF) of intermediate frequency (usually from 50Hz – 10 kHz). The welding process is commonly hand operated by two welders, who work approximately 30-50 cm from the work surface.

Figure 1. EMF exposure conditions during arc welding of pipes pre-heated by inductors



The first step was to identify the EMF exposure characteristics and assess the welders' exposure level. Measurements and assessment of electromagnetic hazards showed that in the above mentioned conditions workers can be exposed to MF of magnetic flux density up to a few tens of microteslas. It means that the level of welders' exposure to MF from inductors exceeds limits set by Directive 2004/40/EC of the European Parliament and of the Council on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (electromagnetic fields) as well as OSH legislation laid down in Poland. The results of the initial assessment led to the second step of the action. The company decided to design and make electromagnetic shielding to reduce EMF risk at source and reduce welders' exposure to an acceptable level. An analysis of the distribution of MF in the vicinity of induction heaters and the characteristics of a welder's activity showed that an electromagnetic shield of inductors would be the best technical solution to reduce exposure level. Electromagnetic shielding of EMF sources is an effective technical method for elimination or reduction of workers' exposure. This method is recommended by the Directive 2004/40/EC and the International Labour Organisation as a reliable way to reduce electromagnetic hazards.

Consequently, a shielding structure was designed to accommodate the ergonomic characteristics of welders' activities in the vicinity of inductors. The shields were then manufactured. Next, the EMF exposure level of welders present in the vicinity of shielded inductors was measured. Measurements of shielding effectiveness of prototype shields confirmed the appropriateness of the selected method. Shields made from various materials were then tested and a final version decided upon.

The action was carried out by BOT Elektrownia Bełchatow S.A. with scientific support by external experts from CIOP-PIB. These technical experts were responsible for taking EMF measurements, assessing workers' exposure and providing scientific support on shielding design. The shielding design and production were executed by BOT workers. The costs were covered by BOT power station.

2.4. What was achieved?

The main result of the action is the effective use of electromagnetic shielding to reduce the level of MF in the vicinity of induction heaters and hence reduce workers´ exposure level. Workers´ exposure to MF was reduced three to fourfold and fell to an acceptable level. The method used to reduce electromagnetic hazards at EMF source allowed the company to achieve compliance with OSH requirements without significant financial costs. The design of the shielding structure was adapted to the ergonomic characteristics of welders´ activities in the vicinity of inductors and was accepted by workers as routing practice.

Problems faced

Workers and management of the company were fully engaged in the project. As a result, there were no problems relating to financing or level of commitment. However, a significant technical problem arose because of the lack of published recommendations on detailed methods for electromagnetic shielding.

This method of EMF reduction is still a 'work in progress', and assessment of the efficiency of a particular shield is possible only after it has been manufactured and installed in the actual work environment.

The process of shielding structure design was supported by the numerical simulations of EMF distribution in the vicinity of inductors, including a realistic scenario of the workplace.

2.5. Success factors

The main success factors of the project were:

- the reduction of workers' exposure to EMF by the practical implementation of electromagnetic shielding;
- the reduction of welders' exposure to an acceptable level;
- the exchange of experience, knowledge and opinion among the different actors involved in the action — workers, designers, scientific experts and management.

2.6. Further information

Contact information:
BOT Elektrownia Bełchatow S.A.
Rogowiec 97-406
Bełchatow 6
POLAND

Arkadiusz Wdowiak
Tel. +48 447352493
Fax +48 447352075
E-mail: arkadiusz.wdowiak@elb.bot.pl

Bogusław Kołatek
Tel. +48 447354185
Fax +48 447352075
E-mail: boguslaw.kolatek@elb.bot.pl

Central Institute for Labour Protection
National Research Institute (CIOP-PIB)
Czerniakowska 16
00-701 Warszawa
POLAND

Krzysztof Gryz
Tel. +48 226234650
Fax +48 226233693
E-mail: krgry@ciop.pl

Jolanta Karpowicz
Tel. +48 226234650
Fax +48 226233693
E-mail: jokar@ciop.pl
Internet: http://www.ciop.pl

2.7. Transferability

The method of reducing the risk at source described above can be transferred to other enterprises using similar technology of arc welding of pre-heated metal structures. The problem of workers' overexposure to MF is a universal one because of the character of workers' activities during maintenance of pipeline systems. The experience with the use of

electromagnetic shielding can be applied in other workplaces in industries that use induction heating of metallic elements e.g. forging, hardening, cutting, brazing, annealing, tempering and stress relieving. The need for assessment and reduction of workers' exposure to EMF has become a priority throughout all of Europe because of the process of legal transposition of the requirements of Directive 2004/40/EC in every Member State (mandatory until 2012).

3. References, resources:

Directive 2004/40/EC of the European Parliament and of the Council on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (electromagnetic fields) (18th individual Directive within the meaning of Article 16(1) of Directive 89/391/EEC), Official Journal L 184, 18 May 2004.

'International Commission on Non-Ionizing Radiation Protection (ICNIRP) Guidelines for Limiting Exposure to Time-Varying Electric, Magnetic, and Electromagnetic Fields (up to 300 GHz)', Health Physics, 1998, Vol. 74, No 4 (April), pp. 494–522.

Karpowicz, J., and Gryz, K., 'Practical aspects of occupational EMF exposure assessment', Environmentalist, 2007, Vol. 27, No 4, pp. 535–553.

Karpowicz, J., Hietanen, M., and Gryz, K., 'EU Directive, ICNIRP Guidelines and Polish Legislation on Electromagnetic Fields', International Journal of Occupational Safety and Ergonomics, 2006, Vol. 12, No 2, pp. 125–136.

Koradecka, D., Pośniak, M., Jankowska, E., Skowroń, J., and Karpowicz, J., 'Chemical, Dust, Biological and Electromagnetic radiation hazards', Handbook of Human Factors and Ergonomics, 2006, Willey & Sons, New Jersey, pp. 945–964.

Reilly, P.J., 'Applied Bioelectricity', From Electrical Stimulation to Electropathology, Springer-Verlag, New York, 1998.