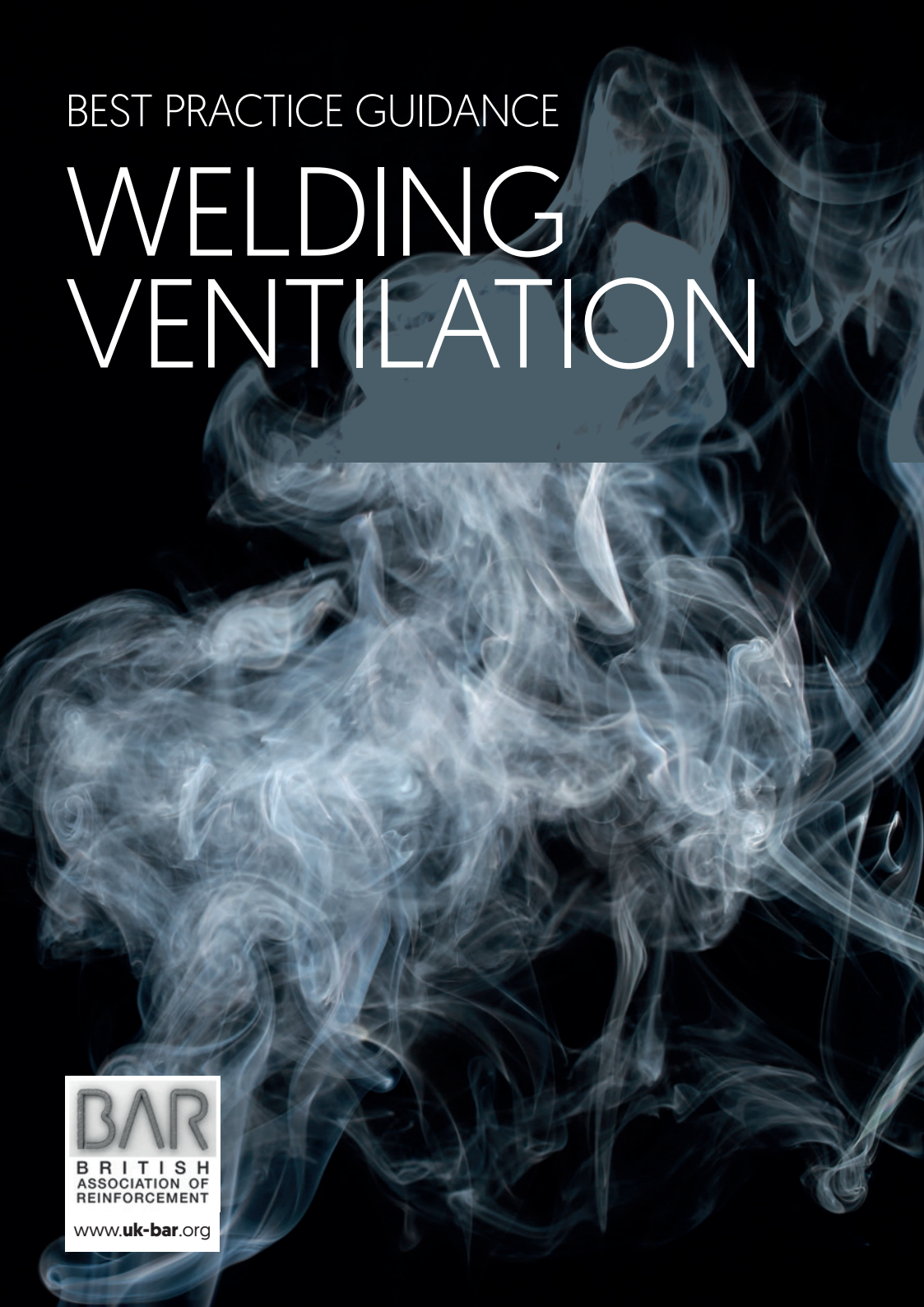
BEST PRACTICE GUIDANCE

WELDING VENTILATION



BAR
BRITISH
ASSOCIATION OF
REINFORCEMENT

www.uk-bar.org

CONTENTS

First published September 2019

Disclaimer

This document has been prepared by the British Association of Reinforcement (BAR) to provide best practice guidance for ventilation during reinforcement welding. All advice and information herein is intended for those who will evaluate the significance and limitations of its contents and take responsibility for their use and application. No liability (including that for negligence) nor any loss resulting from such advice and information is accepted by BAR. Readers should note that this publication is subject to revision from time-to-time and they should, therefore, ensure that they are in possession of the latest version.

www.uk-bar.org

The British Association of Reinforcement (BAR) is the trade association of UK manufacturers and fabricators of steel reinforcement products including cut and bent bar and mesh.

BAR aims to add value to the reinforcement industry through market and product development, promotion of good industry and health and safety practices and forwarding the development of the reinforced concrete industry as a whole.

BAR is a member of CARES and all BAR members are CARES approved.

INTRODUCTION

This best practice guidance is intended for reinforcement suppliers and fabricators in order to provide a safe working environment for all those involved in the welding of steel reinforcement. The guidance aims to avoid the potential health hazards resulting from exposure to welding fumes and explains how mechanical ventilation can limit over exposure to the fumes and gases resulting from cutting and welding by removing those fumes and gases from the welder's breathing zone.

It includes:

- Outline of main welding processes for steel reinforcement
- Description of potential fume hazards
- Examination of natural and mechanical ventilation

The guidance offered in this document relates generally to the welding of carbon steel reinforcement and whilst the same principles apply to the welding of stainless steel and galvanised reinforcement further advice should be sought when welding these materials.

The guidance is aimed at those responsible for health and safety within a company to enable them to meet their obligations to complete risk assessments and provide a safe working environment. It is part of a suite of health and safety best practice guidance available as free downloads at: www.uk-bar.org.

WELDING PROCESSES FOR STEEL REINFORCEMENT

The use of factory welded prefabricated reinforcement is increasing as designers, engineers and contractors realise the benefits that prefabrication can make towards improving on-site productivity. Typical pre-assembled units include:

- Pile cages
- Beam and column cages
- Shear head reinforcement
- Diaphragm walls
- Carpet reinforcement

The main welding processes used for welded prefabricated reinforcement are:

- Gas shielded metal arc welding: metal inert gas (MIG) and metal active gas (MAG)
- Manual arc welding (MMA)
- Electrical resistance welding

MIG AND MAG WELDING

With MIG and MAG welding an electric arc is maintained between a continuous solid wire electrode and the reinforcement bar. The process melts and fuses metals using the intense heat generated by the arc between the metals to be joined and a filler wire. The wire is progressively melted at the same speed at which it is being fed by the wire feeder and forms part of the weld pool. Both the arc and the weld pool are protected against atmospheric contamination by a shield of either inert or active gas.

Typical MAG shielding gases are mixtures of argon, carbon dioxide and oxygen. MAG has been developed primarily for welding steels and the majority of prefabricated reinforcement elements tend to be produced using this method.

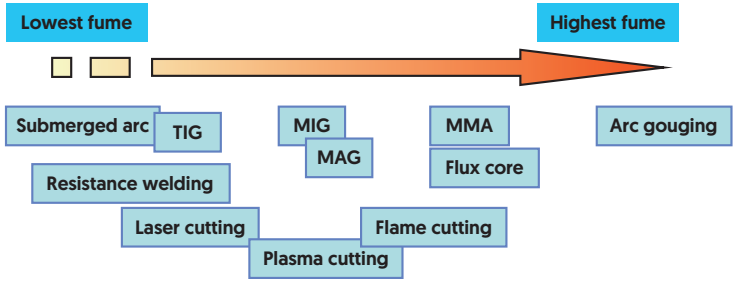
MMA WELDING

Manual metal arc (MMA) or 'stick' welding involves maintaining an electric arc between the end of a coated metal electrode and the work piece. Molten metal droplets from the electrode are transferred across the arc and into the molten weld pool. They are shielded from the atmosphere by the gases produced from the decomposition of the metal electrode coating. The process is used from reinforcing steel and ferrous alloys. Although a relatively slow process because of the required electrode changes and slag clearance, it is a useful technique for areas of restricted access.

ELECTRICAL RESISTANCE SPOT WELDING

Electrical resistance spot welding is used primarily in a factory environment. The required heat for welding is generated at the welding interface by the electrical resistance of the joint. Welds are fast and use a low-voltage, high current power source with force applied to the joint via two copper electrodes, one on each side. Steel has a higher electrical resistance and thermal conductivity than copper making the welding relatively easy.

The welding process used to weld steel reinforcement can affect the amount of fume generated, the diagram below taken from an HSE document gives an indication of this.



Wherever practicable a fabricator should select the welding technique that produces the least amount of fume, although just like any process the set up of the welding equipment affects the amount of fume produced, such as excess current and long duty cycles.

POTENTIAL HAZARDS

The welding process produces a visible smoke that contains harmful metal fume and gas by-products. The fume may include a number of metal particles such as: arsenic, beryllium, chromium, iron, lead, manganese, titanium, vanadium and zinc, the most common elements in steel reinforcement being iron and manganese with chromium, nickel, copper and vanadium to a much lesser extent.

Gas by-products may include: argon, nitrogen, nitric oxide, carbon dioxide, carbon monoxide, and ozone.

Health effects of exposure to and breathing welding fume and smoke include:

- Acute exposure can result in eye, nose and throat irritation, dizziness and nausea
- Prolonged exposure may lead to lung damage and various type of cancer
- Possible side effect of metal fume fever, kidney damage and stomach ulcers
- Prolonged exposure to manganese can result in Parkinson-like symptoms
- Helium, argon and carbon dioxide displace oxygen in the air and can lead to suffocation
- Carbon monoxide gas can result in asphyxiation.

GIVEN THE ABOVE SERIOUS HAZARDS, IT IS IMPERATIVE THAT WELDERS ARE FULLY AWARE OF THE STEPS THAT THEY SHOULD TAKE TO REDUCE EXPOSURE TO THE WELDING FUME AND THAT WELDING AREAS ARE WELL VENTILATED.

WELDER ADVICE

There are a number of actions that the welder can take to reduce exposure to potential welding hazards. These include:

- Have an understanding of the potential hazards of the materials that they are working with and pay attention to the provided safety information,
- Ensure that surfaces are cleaned of any coating, such as paint or solvents, that could create toxic fumes,
- Position themselves so that they avoid directly breathing welding fume and gases,
- Wear all the designated PPE and maintain the PPE as trained,
- Use all welding equipment as directed by the company.

In addition persons supervising welders should have sufficient knowledge of the controls is use, and that welders follow the correct method of work.

ABOVE ALL, IF THE WELDER IS CONCERNED ABOUT ANY SAFETY RELATED ISSUES OR THE AMOUNT OF FUME THEY SHOULD RAISE THOSE CONCERNS WITH HIS EMPLOYER IMMEDIATELY.

VENTILATION

HSE guidance indicates that general ventilation does not achieve the necessary control with respect to welding fume, although good general ventilation will dilute the fume generated in the work area and prevent build during a shift.

Wherever practicable mechanical ventilation should be used to ensure that exposure to welding fume and gases is controlled and minimised to below allowable limits. The type of ventilation is subject to:

- The size and shape of the welding area, especially the height of the building
- Number and type of welding operations
- Contents of the welding fume
- Position of the welder's head

There is a wide range of ventilation systems and the correct solution to take account of the type of welding, the metals being welded and the size of the welding area. The required level of ventilation may be obtained using natural or mechanical means or a combination of both.

NEVER WELD IN AREAS WITHOUT PROPER VENTILATION AND EXHAUST SYSTEMS.

NATURAL VENTILATION

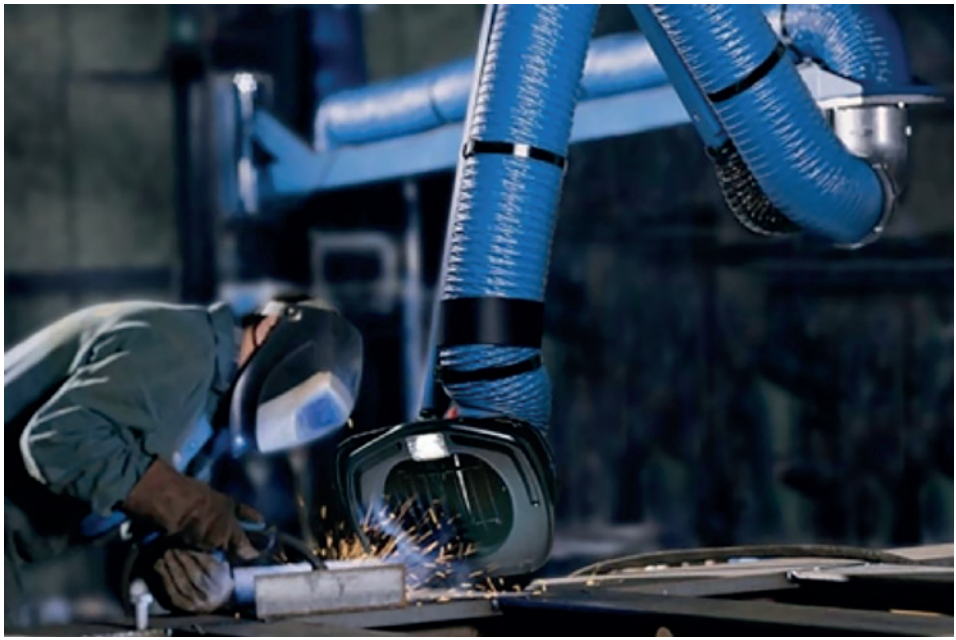
Natural ventilation is the encouragement of air movement through the welding area via roof vents, open windows and doors. The size and layout of the welding area will determine the amount of natural ventilation and whether is it effective enough to ensure that fume contaminants are kept below allowable limits. The calculations made should be checked regularly in conjunction with any air testing results to ensure continued compliance with the relevant regulations.

Calculations should be repeated when there are any changes to welding operations of any type.

MECHANICAL VENTILATION

Mechanical ventilation may be as simple as a fan to promote air movement as a supplement to natural ventilation or be more sophisticated and effective local exhaust ventilation (LEV) systems.

LEV systems should be placed to remove the welding fume and gases from the breathing area. The systems include fans to encourage air movement, a capture device such as a hood with filters and ducting to take the air away. Correctly filtered air may be recirculated.



LEV systems suck and remove the welding fume and gases away from the breathing area.

The fume hood should be located as close as possible to the work area and be positioned to draw the welding fume away from the breathing zone. In addition, fume extractor guns and vacuum nozzles should be placed at a distance from the fume source in order that the maximum amount of fume and gases are removed in accordance with the manufacturers' guidance. Incorrect distances may result in the dispersal of the shielding gases which will result in poor welds.

An alternative solution that could be considered is the use of on-gun extraction, although it must be noted that theses systems are not 100% efficient especially when welding awkward structures.

It is important to select the right equipment for the task but is must be noted that with large prefabricated reinforcement units the effective use of LEV systems is problematic as most of the welds are short time tack welds requiring the repositioning of the LEV several times per minute.

ENSURE THAT THE BREATHING AIR IS REGULARLY SAMPLED AND TESTED IN ORDER TO CHECK THE EFFECTIVENESS OF THE VENTILATION AND EXHAUST SYSTEMS.

RESPIRATORY PROTECTION EQUIPMENT

The use of RPE should only be adopted once other controls have been considered.

Respiratory protection equipment (RPE) includes both disposable and non-disposable. Disposable 'FFPS3' dust masks provide reasonable protection for short-term welding jobs. It is important that they are fitted correctly and that is it underlined that one type of mask does not fit all.

Battery-powered RPE filtering welding visors are useful when it is not practical or possible to use full extraction systems.

RPE should be considered for both indoor and outdoor welding.

MAINTENANCE

LEV systems and non-disposable RPE must be regularly checked and maintained. Common issues include blocked filters, split ductwork and damaged extract hoods. Regular flow checks should be carried out to ensure the level of extraction at the hood is above the required level advised by the manufacturer to ensure the extraction of all fumes.

IT IS RECOMMENDED THAT LEV SYSTEMS ARE FULLY CHECKED EVERY 14 MONTHS AS AN ABSOLUTE MINIMUM.

EXPOSURE AND OCCUPATIONAL HEALTH MONITORING

Monitoring the exposure to welding fume is a vital component in the development of the control measures and also confirming that the control measures continue to be effective, as required by the COSHH Regulations. Air monitoring should be conducted by suitably competent personnel using the methods set out in BS EN ISO 10882-1 'Health and Safety in Welding and Allied Processes'.

In support of the personal exposure monitoring it is recommended that a programme of regular occupational health checks are put in place to check the health of individual welders and identify any issues that could potentially be caused by exposure to welding fume as early as possible.

SUMMARY

This guide outlines the types of welding used for steel reinforcement, the potential hazards and how those hazards can be minimised and controlled by:

- An understanding of the potential hazards and what individual steps should be taken
- Provision of natural ventilation that promotes air flow
- Provision of mechanical ventilation to further enhance natural ventilation and remove fumes and gases
- Provision of appropriate respiratory protection equipment
- Regular checking of breathing air quality and effectiveness of ventilation equipment

LEGISLATION AND OTHER GUIDANCE INFORMATION

There are several pieces of legislation and guidance notes that are applicable to addressing the potential risks associated with welding of steel reinforcement. At time of publication, these include:

- **Health and Safety at Work etc. Act 1974**
- **Control of Substances Hazardous to Health Regulations, 2002**
- **Controlling airborne contaminants at work: A guide to local exhaust ventilation (LEV). HSG258**
- **Respiratory Protective Equipment: A practical guide. HSG53**
- **Change in Enforcement Expectations for Mild Steel Welding Fume, HSE Safety Alert STSU1-2019**
- **Welding fume – Reducing the risk (HSE website)**
- **BS EN ISO 10882-1 Health and Safety in Welding and Allied Processes – Sampling of airborne particles and gases in the operators breathing zone. Sampling airborne particles**

RAISE THE BAR

FOR REINFORCED SUCCESS CHOOSE A MEMBER OF THE BRITISH ASSOCIATION OF REINFORCEMENT

- CARES APPROVED
- COMMITMENT TO HEALTH AND SAFETY
- COMMITMENT TO SUSTAINABILITY
- DELIVERING QUALITY AND ADDED VALUE
- RAISING STANDARDS
- PRODUCT INNOVATION AND PROCESS DEVELOPMENT

MBC3068T-2

BAR
BRITISH ASSOCIATION OF REINFORCEMENT

BAR MEMBERS: GIVING YOUR PROJECT A REINFORCED ADVANTAGE

www.**uk-bar**.org