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WELDING ADDS HAZARDS TO WORK IN CONFINED SPACES

Any work in confined spaces can be hazardous unless adequate steps are taken to assess and control the risks of harm occurring. The aim of this Commission VIII consensus paper is to define hazards which may be added to the general hazards of such work by welding or cutting in the confined space and suggest means of controlling the associated risks to maintain appropriate levels of health and safety at work. It is important to recognise that this paper does not consider the special circumstances of underwater welding.

Definition of a confined work space

For this purpose, a confined space is defined as « a work space, which by its size, site or configuration, has inadequate natural ventilation and/or limited room for welders to work ». Access or egress may be difficult. Examples of « confined work spaces » include storage tanks, tunnels, pipelines, sewers, shafts, boilers, containers, chemical vessels, coffer dams, windowless cellars, between deck spaces and double bottoms of ship.

Welding related hazards of confined space work

Hazards of welding in a confined work space are the general hazards of confined space work plus those generated by the welding process. These welding-derived hazards may be chemical or physical and include :

While oxygen is essential to life, **high concentrations of oxygen** in the work space can result in catastrophic fire and explosion with loss of life. The risk begins to climb with even small increases over the normal concentration of oxygen in air (21%). This situation of oxygen enrichment can arise accidentally through leaking torches, hoses, pipelines and cylinders or through the wholly irresponsible use of oxygen to « freshen » the air in the confined space or blow dirt or moisture from the workpiece. **Accumulated fuel gases** also increase the risk of fire and explosion.

Conversely, **dangerously low concentrations of oxygen** may be caused in the short term, even during the welding task, through its combustion or its displacement by the accumulation of inert or other relatively heavy gases used for shielding gases or maintaining an anti-corrosive environment within pipes. The chemistry of rusting of plates in unventilated spaces such as double bottoms can deplete oxygen levels, posing a serious threat to the unwary who enter without due care.

Fume and gas emissions from the welding process and workpiece may accumulate to reach harmful levels. Experience has shown that nitrogen oxides from oxyfuel processes can be a special risk. Other emissions include materials from consumable and reactions with surface coatings and contaminants including residual previous contents, surface coatings or degreasing agents.

Electricity - The risk of electric shock or electrocution associated with any electric welding process may be increased in a confined space because of the enforced proximity of positive and negative parts of the welding apparatus and of metal structures to the welder ; damp walls, floors or work materials ; and reduced electrical resistance of wet or sweaty skin and work clothes due to raised heat and humidity in the space. **Fields of electromagnetic radiation** may be generated by electric welding power sources and cables. The dose received by the workers may be increased by their proximity to the equipment and by working within loops of cable.

Hot metal and infrared (IR) radiation introduce the risk of burns and increase the risk of dehydration and heat strain. **Ultraviolet (UV) radiation** introduces the risk of arc eye and skin burns which may be increased through reflection of the radiation and/or the inability to wear appropriate protective clothing due to the cramped conditions.

Cramped or distorted postures may induce or aggravate musculoskeletal injury or disease.

High noise levels produced by some welding processes, and perhaps amplified by reverberation in the space, may cause noise induced hearing loss and mental stress.

Health and safety actions - Safe System of Work

All workplaces not in the open air or workshop should be assessed by appropriately trained personnel with clearly defined responsibilities for determining which is a « confined space » and the precautions required when work is done in it. This work should be governed by a written **Safe System of Work** comprising measures for general and process specific (e.g. welding) risk assessment and risk control. The risk control measures should incorporate a **Permit to Work Scheme**. The arrangements should define who is responsible for each of the actions listed in the Safe System of Work. Records of the precautions taken should be made and preserved. All those involved must be trained appropriately and appreciate the importance of their role.

Risk assessment and control of welding hazards

The aim of risk assessment is to quantify the risk of identified potential hazards actually causing harm. This must be done by a competent trained person making a written assessment of the health and safety of the workplace and what is to be done. Once the hazard has been assessed, adequate control measures will be decided to reduce within acceptable limits the risk of these causing harm. This requires considerable technical knowledge and experience of the process(es). In addition to the general assessment and introduction of control measures related to the general hazards of working in the confined space the effects of welding processes must be considered.

Controlling the risks added by welding

Personnel should be selected and trained to ensure that those who are to work in a confined space are fit for the work and will work with due regard to their own safety and the safety of others.

Training should include an appreciation of the hazards of the work and the contribution the worker must make to risk control to ensure adequate health and safety. Refresher training should be given at appropriate intervals.

Selection of welding process, components and equipment should ensure lowest and least hazardous fume and gas emission, low risk of oxygen enrichment, low risk of explosion (e.g. from accumulated acetylene in coffer dams) and low risk of electrocution (e.g. using DC rather than AC, use of circuit breakers and apparatus with low open circuit voltage). There is advantage to be gained by odorising oxygen to make it easier to detect leaks and oxygen accumulation.

Selection and provision of personal protective equipment should ensure provision of overalls which protect against flame, fire and hot metal ; gauntlets, eye/face shield, footwear with electrical insulating soles and, where conditions dictate, electrical insulating mats, heat shields ear defenders or self-contained/pipeline breathing apparatus.

Selection and provision of ventilation equipment should ensure that it is of adequate capacity to reduce the concentration of harmful airborne emissions and products of the welding process to within acceptable limits and is of appropriate construction to permit its use to ventilate a confined space. The noise levels which can be introduced by ventilation equipment must be considered when siting it.

Maintenance of all equipment should be carried out to high standards and to a set programme, be in compliance with the manufacturer's instructions and include checks of safety precautions to ensure that these comply with all related specifications.

Safety checks of equipment should be made before each use.

Site safety precautions specific to welding in confined spaces may have to include :

- Removing explosive materials including accumulated dust.

- Removing combustible materials including claddings and insulation and otherwise covering these with non-flammable materials and keeping the covering damp.

- Providing adequate ventilation of the space or, if this is not practically achievable, appropriate air fed personal respirators supplied through pipelines from the exterior rather than cylinders within the space.

- Keeping compressed gas cylinders out of the space to avoid risk of leaks and their exposure to heat.

- For oxyfuel processes :

    - Closing torch valves to stop the flame between cutting or joining.

    - During other periods when work is not being done e.g. meal breaks and at the end of the work shift or day, at least securely isolating the supply at the cylinder or manifold, and, preferably, removing torches and hoses from the confined space.

- Keeping power sources and, as far as possible, cables, out of the confined space to reduce the risk of electric shock and exposure to electromagnetic fields.

- Removing surface coatings from the required distance from any area on which hot work is to be done so that fume emission is minimised.

- Insulating possible electrical contacts, especially those which are less than 2 metres apart.
- Requiring welders to use ground fault circuit interrupters/circuit breakers.
- Ensuring provision of cooling periods appropriate to the heat load and their use without financial disadvantage to the welder.
- Ensuring adequate fluid intake.