Safety Services Guidance

Guidance on Welding

Key word(s):	Design, weld failures, structural design, load, fatigue, competent persons
Target audience:	Principal Investigators, Senior Academics, Workshop Managers, Workshop Supervisors, Coded Welders

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Introduction

1. The aim of this guidance is to provide people who may be involved in welding with an aid to carry out these tasks correctly and safely.

2. Welding is the most common method used for joining steel fabrications largely because of the speed at which joints can be made and the reliability and strength of these joints in service. However because most welding operations are now relatively simple to perform it is all too easy to forget the complexity of the chemical and metallurgical actions that are taking place when the weld is being deposited. Therefore not surprisingly welds can occasionally fail. The most common causes of weld failures can be attributed to:

    - **Overload** – Failure to design the work properly and take into account the stresses likely to occur can lead to welds being of insufficient strength to cope with the stresses and loads imposed on them.
    - **Joint design** – Due to the design of the equipment / fabrication, the welder is unable to manipulate the welding electrode adequately and is therefore unable to ensure good fusion is obtained, leading to a weld of insufficient strength.
    - **Bad welding practices –**When carrying out welding it is important to ensure that the work is done in accordance with good practices, and that consideration is given to all aspects of the welding and the environment in which it is performed.
    - **Metallurgical Failure –** Materials that are to be welded have to tolerate severe thermal changes created by the welding process without deterioration of their mechanical properties. The metallurgical composition of certain types of metal may make them unsuitable to weld or may require special controls to be imposed during the welding operation. Where this is not taken into account failures can occur.
    - **Weld Defects –** These are usually attributed to the welder's inability to set up and manipulate the welding equipment, although bad joint design and faulty welding equipment can also be responsible.

3. To prevent these occurring welding should be undertaken by competent persons, using the right equipment and materials correctly in the right environment.

Competence

4. Anyone undertaking welding should be competent to do so, competence can be defined in many ways, but a competent person should have: -

    - Technical knowledge of the process being undertaken;
    - Adequate experience;
    - Understanding of the systems involved;
    - Understanding of the hazards that may be present;
    - Ability to recognise if it is safe for work to continue;

- Awareness of one's own limitations;
- Willingness and ability to supplement existing experience and knowledge;
- Knowledge of legislation and good practice.

5. These can all be gained from training and experience, training in welding varies, however it is preferable if the person carrying out the welding has been formally trained in the process. For supervisors to check on competence the questions in Appendix 1 can be used.

Planning a Weld (See flow chart in Appendix 2 for details)

6. Before any welding is undertaken the process being employed should be thought through, if the welding to be undertaken is for a specific purpose the weld requirements should be identified which should cover the type and size of the weld, materials needed, welding process to be used etc. The Guidance for Specifying Safety Critical Welds should be followed if the welding involves any of the following: -

   - Work involving pressure vessels;
   - Work where safety and strength are critical;
   - Work where equipment is subject to stresses and failure of weld could cause injury;
   - Work where equipment needs mechanical lifting;
   - Load bearing structures;
   - Equipment to be used or sold to outside bodies.

7. Where the work does not include any of the points above ie small tasks then the weld requirements still need to be identified and a risk assessment needs to be done before the welding is undertaken. These should both consider: -

   - Materials involved including any manual handling that may be involved;
   - Welding process to be employed including types of weld consumables to be used;
   - Type of joint to be made;
   - Any preparation of material required;
   - Welding technique;
   - Type of equipment to be used;
   - Environment where welding is to take place ie fire risks, other who could be affected;
   - Precautions to be taken to prevent injury to person undertaking the welding e.g. personal protective equipment, fume extraction, fire precautions, prevention of electric shock, prevention of exposure to hazardous substances;
   - Specific skills needed to undertake this work.

8. Undertaking this process would not involve the same degree of preparation that the Code of Practice for Specifying Welds requires for safety critical work. If the process being undertaken is consistent then the same risk assessment and specification can be used repeatedly.

Hazards Present When Undertaking Welding

9. There are a number of hazards present during welding, these include: -

   Fumes
   Gases both toxic and / or asphyxiating
   Radiation – ultra violet, visible and infrared
   Spatter and hot components
   Fire and explosion
   Electric shock and burns

Fumes

10. These are a mixture of fine airborne particles which arise from the vaporisation of the consumable electrode, wire or rod as material transfers across the arc. The inhalation of the fume can lead to: -

    - Irritation of the respiratory tract;
    - Metal fume fever;
    - Exposure to hazardous substances.

11. Where fume control is needed, local exhaust ventilation (LEV) should always be used to control exposure. If this is not possible or there is still unacceptable exposure then respiratory protective equipment (RPE) should be used, this is the least preferred means of control because it only protects the wearer. If using respiratory protective equipment you should ensure :-

    - Expert advice is sought when selecting suitable RPE;
    - Each person carrying out welding should be personally fitted with RPE to ensure that it provides adequate protection;
    - Employees should be trained in the correct use;
    - RPE needs suitable storage;
    - Managers should ensure systems exist for the selection and maintenance of RPE.

Gases

12. Gases encountered in electrical arc welding include: -

    - Shield gases such as argon, helium and CO_2 either alone or mixed with oxygen or hydrogen;

- CO_2 and CO produced by the action of heat on the welding flux;
- Nitrogen oxides and ozone produced by the action of heat or UV radiation on the atmosphere surrounding the welding arc;
- Gases caused by the action of heat on solvent vapours or surface contaminants.

13. These can be either toxic and / or asphyxiating and precautions such as the use of local exhaust ventilation need to be considered.

Radiation

14. Arc welding can generate 3 types of radiation that may be direct or reflected from bright surfaces and can cause injuries in the following ways: -

- Ultra Violet – causes damage to the skin in the form of severe sunburn and to the eyes;
- Visible Light – dazzles eyes and can impair vision;
- Infra-Red – damages skin and eyes.

15. The following protection should be used against welding radiation: -

- The face and eyes protected by using a suitable shield equipped with eye protection;
- Wearing suitable clothing;
- People in the vicinity should be protected by suitably positioned non-reflective curtains or screens.

Spatter and Hot Components

16. Incorrect welding parameters can generate excessive spatter, however it will always be present so appropriate personal protective equipment will be needed. Welded components will remain hot for some time so avoid handling them.

Fire

17. Arc welding generates sparks and hot spatter that can ignite combustible materials. The following precautions will help prevent fire:-

- Move the work piece to a safe location where there are no fire risks;
- Remove combustible materials from the welding area and cover the remaining flammable material with fire resistant materials;
- Use covers to prevent spatter passing through openings in floor and walls;
- Keep appropriate firefighting equipment nearby;
- After welding, observe surrounding work area for at least an hour afterwards to ensure no fire is developing.

Explosion

18. There is a danger of explosion when welding tanks or drums that previously contained flammable substances. Gas cylinders associated with welding or cutting activities can also present an explosion risk.

Electric Shock

19. Essentials of safe practice to prevent electric shock are: -

    - Welding equipment which conforms to the appropriate standards;
    - Installation of welding equipment should be carried out by suitably qualified staff who check that the equipment is suitable for the operation and connected as recommended;
    - Electrode holders are insulated so no bare or exposed metal can be inadvertently touched;
    - Welding leads and return leads are insulated and thick enough to carry the current safely;
    - Connectors are also insulated to avoid inadvertent access and are adequately rated for the current carried;
    - The welder is responsible for checking the equipment carefully for damage and reporting defects. Damaged or worn components should be repaired or replaced;
    - All external connections are clean and tight and checked before each reconnection.

20. In all manually operated arc welding processes the principal risk is electric shock from contact with bare or exposed live parts of the welding circuit. Every effort should be made to prevent this risk occurring.

Further Information

The control of exposure to fume from welding, brazing and similar processes, HSE Guidance Note EH55 – HSE Books

Safe use of compressed gases in welding, flame cutting and allied processes HSE publication HSG 139 – HSE Books

Safety Services Guidance: Safety Critical Welds

Appendix 1

Welder Competence Check

The following questions / checks can be made to ascertain the knowledge of a welder; these are based on the requirements specified in BS EN 278-1.

General

Oxy-acetylene Welding

- Correct identification of gas cylinders
- Correct identification and assembly of essential components
- Selection of correct nozzles and welding torches

Arc Welding

- Correct identification and assembly of essential components and equipment.
- Identification of correct welding current.
- Correct connection of welding return

Welding Process

Oxy-Acetylene Welding

- Gas pressure
- Selection and type of nozzle
- Type of gas flame
- Effect of over heating
- Use of flashback arrestors
- Lighting up and shutting down sequences

Metal Arc Welding with Covered Electrode.

- Handling and drying of electrodes
- differences of types of electrode

Shielded Metal Arc Welding

- Types and sizes of electrode
- Identification of shielding gas and flow rates
- Type, size and maintenance of nozzles / contact tip
- Selection and limitation of mode of metal transfer
- Protection of the welding arc from draughts

Submerged Arc Welding

- Drying, feeding and correct use of flux
- Correct alignment and travel of welding head

Parent Metal

- Identification of material
- Methods of control of pre-heating
- Control of interpass temperature

Consumables

- Identification of consumables
- Storage, handling and condition of consumables
- Selection of correct size
- Control of wire spooling
- Cleanliness of electrode filler wire
- Awareness of welding environment

Safety and Accident Prevention

General

- Safe assembly, setting up and closing down procedure
- Safe control of welding fumes and gases
- Personal protection
- Fire hazards
- Welding in confined spaces
- Awareness of welding environment

Oxy-acetylene Welding

- Safe storage, handling and use of compressed gases.
- Leak detection on gas hoses and fittings
- Procedure to be taken in the event of a flashback

All Arc Processes

- Environment of increase hazard of electric shock
- Radiation from arc
- Effects of stray arc

Shielded Gas Arc Welding

- Safe storage, handling and use of compressed gases.
- Leak detection on gas hoses and fittings

Welding Sequence / Procedures

- Appreciation of welding procedure requirements and the influence of welding parameters.

Edge Preparation and Weld Requirements

- Conformity of weld preparation to procedure specification
- Cleanliness of fusion faces

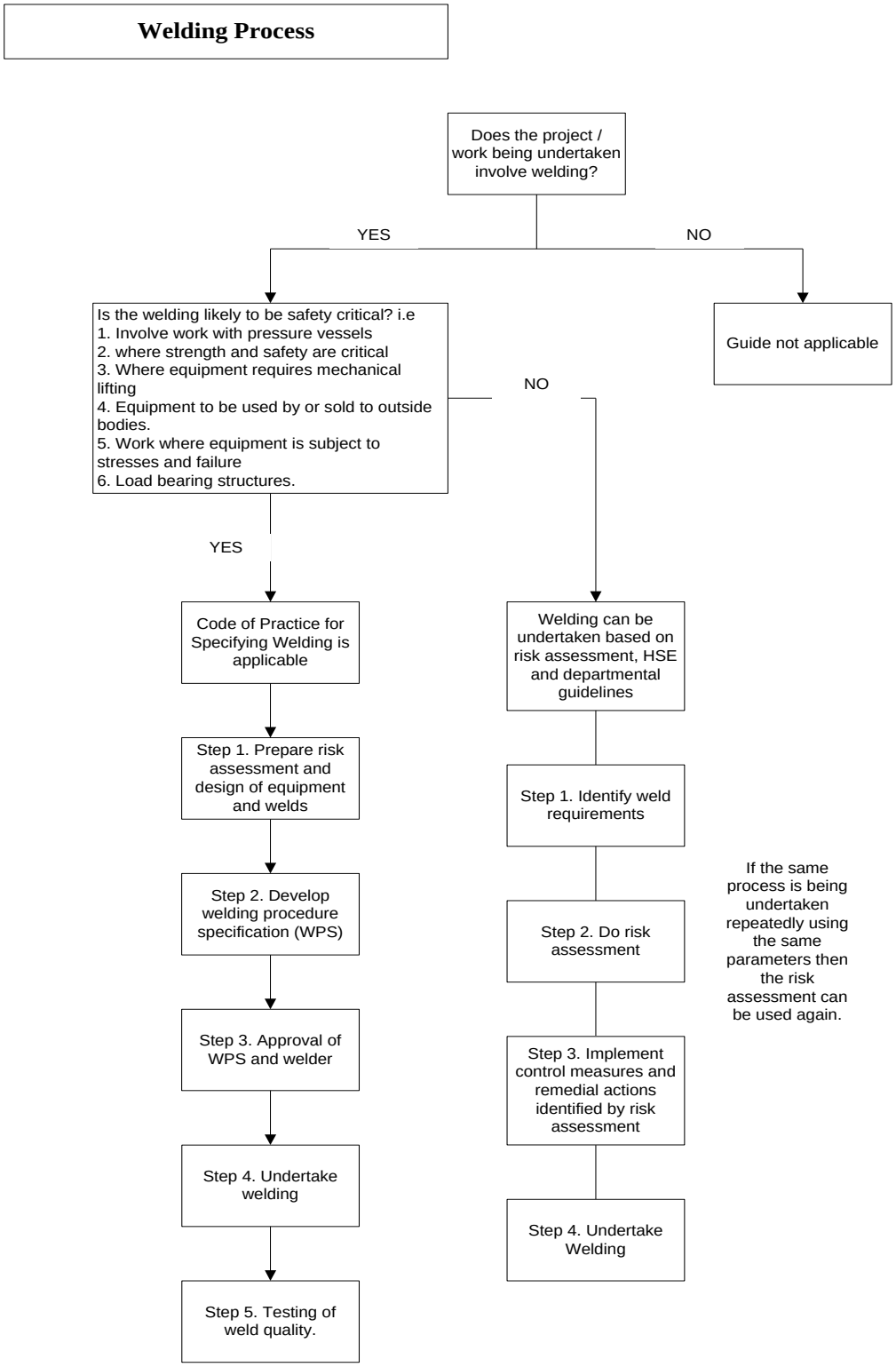
Weld Imperfections

- Identification of imperfections
- Causes
- Prevention and remedial action

Welder approval

- The welder shall be aware of the range of qualifications required to carry various types of welding.

Appendix 2


Welding Process
Does the project / work being undertaken involve welding?
YES
NO
Guide not applicable
Is the welding likely to be safety critical? i.e
1. Involve work with pressure vessels
2. where strength and safety are critical
3. Where equipment requires mechanical lifting
4. Equipment to be used by or sold to outside bodies.
5. Work where equipment is subject to stresses and failure
6. Load bearing structures.
NO
YES
Code of Practice for Specifying Welding is applicable
Step 1. Prepare risk assessment and design of equipment and welds
Step 2. Develop welding procedure specification (WPS)
Step 3. Approval of WPS and welder
Step 4. Undertake welding
Step 5. Testing of weld quality.
Welding can be undertaken based on risk assessment, HSE and departmental guidelines
Step 1. Identify weld requirements
Step 2. Do risk assessment
Step 3. Implement control measures and remedial actions identified by risk assessment
Step 4. Undertake Welding
If the same process is being undertaken repeatedly using the same parameters then the risk assessment can be used again.

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