

THE ENGINEERING EQUIPMENT AND MATERIALS USERS' ASSOCIATION

Guide for hot tapping on piping and other equipment

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ENGINEERING EQUIPMENT AND MATERIALS USERS' ASSOCIATION

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Comments are considered by the relevant EEMUA Technical Committees and may be incorporated in future editions of this Publication. New editions are publicised on the EEMUA website.

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Foreword

This Publication has been developed by EEMUA and in particular its Piping Systems Committee, to give guidance on the various factors, procedures and activities which need to be considered, implemented and executed before a hot tapping operation can be safely and successfully carried out. As the great majority of hot tapping operations are performed on piping, EEMUA 185 is written with specific reference to that activity. Nevertheless, the principles outlined are generally applicable to hot tapping on other types of equipment, taking due account of obvious differences (for example the absence of fluid flow when hot tapping a storage tank).

Being a guide, this Publication does not impose mandatory requirements (i.e. avoidance of the use of the word 'shall'). However there are situations in which for reasons of safety it would be inappropriate to carry out a hot tap. In such instances wording such as 'safety considerations would preclude ...' is used to draw attention to the potential hazard.

Attention is drawn to the need to observe local statutory or other regulatory requirements. These may impose legal obligations on the 'designer' and/or on other persons involved in the operation.

Units

This Publication employs SI units, but additionally includes Imperial units where appropriate to common usage. *Note:* 'bar' signifies bar gauge.

1. Introduction

1.1 Scope

This Publication applies to hot tapping into **metallic piping systems** containing process fluids or their residues. Additionally, information is provided for special hot tapping applications such as on storage tanks. It covers the welding and cutting (drilling/trepanning) operations and other technical considerations, and gives guidance on how to carry out a safe operation.

1.2 Definition of Terms

1.2.1 Hot Tap

A method of making connections to piping (or other equipment) by attaching a fitting to the system, usually by welding, followed by cutting through the pipe wall at the point of attachment utilising an appropriate ('hot tapping') machine. This operation is generally carried out on a live ('hot') system without decommissioning or interrupting flow.

1.2.2 Coupon

A disc cut out of the wall of the pipe (or other equipment) during the hot tapping operation.

1.2.3 Trepanning

The process of cutting into the wall of the pipe (or other equipment) using shell cutters operated by a hot tapping machine. It is usually carried out on the live system and involves the removal of a coupon of material.

2. Safety Considerations

2.1 General

Hot tapping should be undertaken only when no reasonably practicable alternative is available.

For systems handling flammable and/or toxic fluids, normal procedures require that welding work be carried out only when the system is free of process fluid ('gas free') and open to atmosphere. In some circumstances this requirement may necessitate shutting down a large plant or section thereof, which in itself may introduce hazards for example through the need to remove and store process fluid. In such circumstances there may be justification for giving consideration to hot tapping. This operation, however, introduces its own hazards which demand careful consideration.

2.2 Hazard Assessment and Control

Before undertaking hot tapping, all potential hazards should be identified and assessed, and detailed procedures for their control established.

The principal potential hazards associated with hot tapping are:

- Explosion and fire resulting from the effects of heat on the process fluid contained within the system.
- Burn-through associated with the temporary loss of strength of the pipe wall during welding.
- Loss of integrity of the pressure envelope at the point of hot tap, for example by corrosion or embrittlement of the pipe wall due to reaction with the contents of the process system.
- The release of the system's contents which may be flammable, toxic or asphyxiating.
- Carrying out welding operations in a Hazardous Area.

For systems that contain or have contained only non-flammable substances reference should also be made to British Standard BS 6990⁽¹⁾.

2.3 Safe System of Work

A written 'safe system of work' or 'safety plan' should be produced. This needs to be fully understood by all those involved with the operation. The document should be based upon expert advice, the guidance given in BS 6990, and any legislative requirements. It should anticipate all reasonably foreseeable events and specify the appropriate emergency services required to be in place. It should also define individual responsibilities.

The safe system of work should be prepared for each hot tapping operation by the person responsible for the hot tap or their nominated representative, and this should be agreed by all relevant parties. The plan should be brief, otherwise it becomes self defeating.

Suggested topics are:

- temporary supports and lifting equipment;

- access to site for personnel and equipment;
- communications on site;
- foreseeable hazards and contingency actions;
- roles of dedicated personnel and their responsibilities on site;
- monitoring of process conditions;
- monitoring of welding parameters;
- warning system and emergency shutdown plan;
- means of escape;
- safety equipment and personnel;
- fire-fighting equipment and personnel;
- first-aid facilities; and
- weather protection.

3. Technical Considerations

The considerations which follow are not exhaustive, and due thought should be given to each and every hot tapping operation to identify and take account of any other pertinent factors.

3.1 Chemical Reaction Between Process Fluid and Piping Material

Piping containing fluids which under the influence of heat would react with the metal wall or have a deleterious effect on the physical and mechanical properties of the pipe or weld should not be subjected to hot tapping. Such fluids include monoethanolamine (MEA), diethanolamine (DEA), caustic soda, caustic potash, ammonia, hydrofluoric acid, sour gas (H_2S) and any other fluid known or believed to cause stress corrosion cracking.

3.2 Process Fluid Limitations

Safety considerations would preclude welding on piping containing the fluids listed below.

- Flammable gas and air mixtures.
- Compressed air where oil or oil vapour used for lubrication of equipment may be present, or where the absence of hydrocarbons cannot be assured.
- Chlorine or chlorine compounds.
- Oxygen or oxygen-enriched air.
- Acids, ammonium nitrate, acetylene or any other chemicals where it is known or believed that the heat of welding may result in decomposition or thermal instability.
- Ethylene or other unsaturated hydrocarbons which can at certain temperatures and pressures decompose explosively. This possibility is increased when dienes or acetylenes are present. Some Company codes permit hot tapping into systems containing ethylene but under restricted conditions (see below).

Although not necessarily prohibited by safety considerations, hot tapping into systems containing the fluids and substances listed below should be carried out with extreme caution. However hot tapping should not be carried out where either system pressure or temperature exceeds the values given.

- Toxic fluids: these require special consideration to assess the toxicity and consequent risks. In addition procedures are necessary to ensure the containment or safe release of toxic vapours on completion of the operation prior to removal of the hot tapping equipment.
- Gaseous ammonia: 2.75 bar or 37°C.
- Liquid ammonia: 13.8 bar or 37°C.

Note: With gaseous and liquid ammonia the possible concerns to be considered are: (a) nitrating, resulting in hard zones in the heat-affected zone (HAZ) of the weld and (b) ammonia stress corrosion cracking (SCC) (see Section 3.1 above). The pressures and temperatures quoted are based on experience of an EEMUA member company.

- Petroleum liquids and vapours and natural gas: 38.0 bar or 100°C. Above this temperature limit it should be noted that when the pilot drill

penetrates the pipe wall hydrocarbon will enter the branch. Unless air has been purged from this connection with an inert gas the hydrocarbon-air mixture will pass through the explosive range. Ignition could occur if the temperature is above the auto-ignition temperature. It is feasible to carry out hot tapping on lines with process temperatures up to 370°C; however, for initial wall temperatures above 100°C specialist advice should be obtained from a Materials Engineer. The drilling rig will need to be suitable for the higher temperature and have a facility to be purged with nitrogen. It may be necessary to calculate the total heat input, from the controlled parameters, obtained from the Welding Procedure Specification (WPS) (voltage, current and welding speed), and determine the maximum allowable coincident pressure during welding at the maximum operating temperature. Temperature induced stresses may be significant for hot taps onto high temperature run pipes and will require a stress analysis to be performed to assess the significance of these inherent stresses.

- Ethylene and butadiene: 20.0 bar, providing a positive flow of at least 3.0 m/s is maintained throughout the welding operation. The concerns with hot work on lines containing these process fluids are (a) decomposition (see above) and (b) carburization resulting in local hard zones in welds.
- Steam and other non-flammable fluids: 38.0 bar. At 38 barg the approximate saturation temperature of steam is 130°C this may be a limit on temperature and pressure rating of the hot tap gear. Also at higher temperatures consider working conditions and consequences of a release, for hot tap workers.
- Flare lines where the precise fluid analysis is not known (see Section 8.2).
- Pyrophoric deposits.
- Any fluid which may cause degradation or decomposition of gland packing in the hot tapping equipment.

3.3 Materials of Construction

Metallurgical advice should always be sought where there is doubt concerning the weldability of the piping material.

For metallurgical reasons associated with the welding operation, hot tapping should in general normally be performed only on steels with a carbon content not greater than 0.25% or on stabilised or L grade austenitic stainless steels. The attachment nozzle to be welded to the piping should be of a comparable grade of material.

Where there is doubt regarding the material it should be checked *in situ* using appropriate analytical techniques/equipment. For guidance see EEMUA Publication 149⁽²⁾, Appendix I.

As it is not possible to stress relieve live equipment, metallurgical considerations preclude welding where stress relief would be a requirement of the welding procedure. Hot tapping would therefore not be carried out on:

- material requiring stress relief due to wall thickness;