

THE ENGINEERING EQUIPMENT AND MATERIALS USERS ASSOCIATION

GUIDE FOR HOT TAPPING ON PIPING AND OTHER EQUIPMENT

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AMENDMENT No 1, DECEMBER, 1997

The amendment listed below is authorised by the EEMUA Piping Systems Technical Committee (PSC).

Page 28 (§9.4): *Delete* first sentence in its entirety ('Agitating welding.')

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FOREWORD

This document has been developed by the EEMUA Piping Systems Technical 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, the document 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, the document does not impose mandatory requirements (avoidance of '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 Guide employs SI units, but additionally includes Imperial units where appropriate to common usage. *Note:* 'bar' signifies bar gauge.

1. INTRODUCTION

1.1 Scope

This Guide 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. BIBLIOGRAPHY

2.1 Publications Referred To in the Text

ASME* Code for Pressure Piping (B31):

- B31.3 — Process Piping[†]
- B31.4 — Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids[‡]
- B31.8 — Gas Transmission and Distribution Piping Systems.

BS 6990: Code of Practice for Welding on Steel Pipes Containing Process Fluids or their Residuals.

EEMUA Pub 149: Code of Practice for the Identification and Checking of Materials of Construction in Pressurised Systems in Process Plants.

* Formerly ANSI.

[†] New title; was *Chemical Plant and Petroleum Refinery Piping*.

[‡] New title (similar to old).

2.2 Other Applicable Publications

API Publ 2201: Procedures for Welding or Hot Tapping on Equipment in Service.

2.3 Abbreviations Used Above

ANSI American National Standards Institute

API American Petroleum Institute

ASME American Society of Mechanical Engineers

BS British Standard

3. SAFETY CONSIDERATIONS

3.1 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.

3.2 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 BS 6990.

3.3 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. (In the UK a certificate of exemption is required under Sec. 31 of the Factories Act 1961 before welding is permitted on lines and equipment that are not free of flammable substances.) 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
- communication 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
- weather protection.

4. 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 cognisance of any other pertinent factors.

4.1 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 MEA, DEA, caustic soda, caustic potash, ammonia, hydrofluoric acid, sour gas (H_2S) and any other fluid known or believed to cause stress corrosion cracking.

4.2 Process Fluid Limitations

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

- a) Flammable gas and air mixtures.
- b) Compressed air where oil or oil vapour used for lubrication of equipment may be present, or where the absence of hydrocarbons cannot be assured.
- c) Chlorine or chlorine compounds.
- d) Oxygen or oxygen-enriched air.
- e) 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.
- f) 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 4.2.2 e)).

4.2.2 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 below.

- a) 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.
- b) Gaseous ammonia: 2.75 bar or 37°C.
- c) Liquid ammonia: 13.8 bar or 37°C.

- d) Petroleum liquids and vapours and natural gas: 38.0 bar or 100°C. It should also 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.
- e) Ethylene and butadiene: 20.0 bar, providing a positive flow of at least 3.0 m/s is maintained throughout the welding operation.
- f) Steam and other non-flammable fluids: 38.0 bar.
- g) Flare lines where the precise fluid analysis is not known (see 9.2).
- h) Pyrophoric deposits.
- j) Any fluid which may cause degradation or decomposition of gland packing in the hot-tapping equipment.

4.3 Materials of Construction

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

- 4.3.1 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 Pub. 149 Appendix II.

- 4.3.2 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:
- a) material requiring stress relief due to wall thickness
 - b) air hardening materials such as low alloy steels
 - c) piping where the nature of the contained fluid would impose a requirement for stress relief, for example caustics, amines etc.
- 4.3.3 Welding to carbon steel at a wall temperature below 7°C or to materials operating below their ductile-brittle transition temperature is not recommended. Carefully controlled preheat may be considered, if necessary, using oxy-fuel gas or electrical elements.
- 4.3.4 Hot tapping should be avoided on austenitic stainless steel if there is a subsequent risk of stress corrosion cracking or metallurgical degradation.

4.4 Physical Restraints and Limitations

Regardless of chemical and metallurgical factors, there are certain physical restraints to hot tapping which should be considered.

4.4.1 Nozzle Size

Generally on piping the size of hot-tap nozzles should be at least one standard pipe size less than that of the run pipe. Connections using nozzles the same size as the run pipe should be avoided whenever possible.

4.4.2 Lined Equipment

Hot tapping of internally lined equipment is not advisable. If to be performed, it requires very careful consideration and should only be used as a temporary measure.

- a) *Metallic linings.* Examples are: carbon steel equipment integrally clad, strip lined or weld overlaid with stainless steel or other corrosion resistant alloys; galvanised or electroplated equipment. The cladding or lining normally provides corrosion resistance. Hot-tapping will destroy the continuity and integrity of the protective layer.
- b) *Non-metallic linings.* Examples are PVC, PTFE and glass. In addition to destroying the continuity and integrity of the lining local to the hot tap, there is also the risk of damage over a wider area. Also, PVC (and similar) linings may become detached and block the line; glass fragments may be carried downstream and cause equipment damage.
- c) *Refractory-lined flue gas ducts.* Hot tapping of carbon steel refractory-lined flue gas ducts is feasible. Here the problems of internal debris may not be critical, but the exposed carbon steel duct wall adjacent to the tapping still remains vulnerable to corrosion.

4.4.3 Underground Piping

Care should be taken when hot tapping underground piping to ensure that the hot-tap nozzle is welded to the piping itself and not to an external sleeve or casing. Thickness checks may provide a positive but misleading indication.

4.5 Location

4.5.1 Ideally, hot-tapping should be performed perpendicularly (at 90°) to the tapped surface.

4.5.2 On horizontal surfaces tapping is best performed in the vertically downward position (see Fig. 1). The greater the deviation from this position, the more difficult it becomes to support the hot-tap machine and to fit and weld the nozzle. Tapping in positions significantly below the 90° and 270° positions, where the machine is pointed upwards, is to be avoided because of the possibility of swarf and debris collecting in the nozzle attachment and possibly preventing closure of the isolating valve.

- 4.5.3 Selection of the hot-tap location should avoid high points where pockets of vapour might collect.
- 4.5.4 Adequate safety precautions should be taken when performing hot taps in pits or confined spaces where there is the risk of an accumulation of toxic, asphyxiant or flammable gases.

4.6 Wall Thickness, Material Temperature and System Pressure

- 4.6.1 It is recommended that the guidance given in Section Three, §7 of BS 6990 : 1989, quoted below, be followed:

It is necessary to ensure that during the welding operation the material in the region of the weld pool has sufficient strength to contain safely the internal pressure and avoid a blow-out. The risk of blow-out is [dependent upon] a complex interaction of welding conditions, pipe material, pipe thickness, pipe temperature and hoop stress. Experience and research show that for materials of yield strength not greater than 450 N/mm², operating at temperatures of not greater than 350°C and with a hoop stress of not greater than 72% of the specified minimum yield stress, blow-out can be prevented during welding provided the minimum pipe thickness is not less than 5 mm. For other materials or conditions, a minimum pipe thickness of 5 mm or greater should be agreed between the contracting [or other responsible] parties, based on either specific previous experience and/or data from trials.

Note. For some products, due to chemical reaction, the safe pipe temperature may be much lower than 350°C, see 5.4 [of BS 6990].

- 4.6.2 The nozzle attachment should be designed and fabricated in accordance with a recognised national or international code such as ASME B31.3 to ensure pressure and temperature requirements are satisfied.

4.7 Flow

- 4.7.1 No-flow conditions, whether in liquid or gaseous service, are potentially hazardous during hot-tapping operations. The system fluid acts as a heat sink and consequently a no-flow condition will result in the depth of the heat affected zone being extended. In consequence the inside wall may reach a temperature such that chemical decomposition of the fluid takes place or, possibly and more seriously, blow through occurs. If a no-flow condition is unavoidable, a purge of at least 0.4 m/s velocity should be maintained in the line. (See also Section 9.)

An excessive flow rate should also be avoided as this may extract heat too quickly and quench the welding area, creating hard zones susceptible to cracking.

The suggested flow rate limits during welding are:

- | | | |
|----|----------|-------------------------------------|
| a) | liquid — | 0.4 m/s minimum
1.22 m/s maximum |
| b) | gas — | 0.4 m/s minimum
no maximum. |

- 4.7.2 For very low or very high flow rates specialist advice should be sought, e.g. from The Welding Institute.

4.8 Debris from Tapping Operation

A primary concern when considering hot tapping is the subsequent effects of debris entering, or other possible contamination of, the process stream. Since this debris or other contamination can only originate from the tapping operation itself there are several precautions to be taken.

- 4.8.1 As stated in 4.5, hot-tapping is best performed on horizontal surfaces at right angles to the pipe axis and in the vertically downward position. The reason for this is to allow swarf and metal chippings to fall clear of the isolation valve and not become lodged in the seats. Unfortunately this also allows debris to enter the process stream, and the potential damage this may cause to downstream equipment should therefore be considered.

Ideally, hot tapping should not be performed upstream of rotating equipment unless there is protection by strainers or dirt traps capable of removing swarf and metal chippings. Similarly the risk of fouling orifice plates and heat exchanger or condenser inlets should be considered.

- 4.8.2 Valves used for hot tapping should be in accordance with the line (or other appropriate) specification and should have clear, full round openings at least 3 mm greater than the diameter of the drill or cutter. Some valves have seat ring lugs which may interfere with the cutter. It should be confirmed that all chips and cuttings have been removed from the valve seats before installation. It is also recommended that the valve be hydrotested, specifically including a closure test, before installation.

- 4.8.3 Finally there is always the risk that the coupon will fall into the equipment. Although the coupon may remain where it drops it is more likely to be swept along with the process stream.

Normal practice is to retain the recovered coupon to confirm successful completion of the hot-tap. In addition the coupon may provide valuable metallurgical or corrosion information and confirm the actual thickness of the run pipe.

5. DESIGN

- 5.1 The design and detailed drawings of the connection should be approved by a competent person.
- 5.2 Typical connections are shown in Fig. 2. These should normally be of a set-on branch type or a proprietary integrally reinforced branch fitting. For branches approaching run pipe size, a preformed split tee should be used.
- 5.3 Welding over existing seams should be avoided wherever possible; if however this is unavoidable, the weld seam should be completely straddled. Where there are no alternative options, special NDT tests need to be specified (see 6.4.6).
- 5.4 Strength calculations should be carried out covering:
- pressure containment
 - branch reinforcement
 - superimposed loads from hot-tapping equipment
 - operating system load
 - test pressure.
- 5.5 The addition of a branch to a piping system constitutes a modification to the system; therefore design checks should be carried out, for example of existing and new supporting arrangements, thermal flexibility analysis, etc.
- 5.6 The calculations should determine the required thicknesses for pipe, nozzle necks, reinforcement, and weld attachments using the appropriate design code, e.g.
- for on-plot piping — ASME B31.3
 - for off-plot piping — ASME B31.4 (liquid lines) or B31.8 (gas lines).
- 5.7 Detailed drawings should be produced to include at least the following:
- piping contents
 - run pipe nominal size and actual measured thickness
 - exact location of proposed work
 - material specifications
 - reinforcement details
 - weld details (including reference to weld procedure)
 - modifications to pipe supports/ restraints
 - non-destructive testing details
 - pressure testing details
 - design conditions
 - operating conditions.

6. WELDING

6.1 Welding Procedure

An approved welding procedure appropriate to the special circumstances of the hot-tapping operation should be used. For critical applications, consideration should be given to performing a simulated hot-tap operation as a trial. This may be advisable, in order to qualify the welding procedure, for example where cooling rates are expected to be high, or to qualify the welder, for example where the welding position is awkward.

To minimise the risk of hydrogen cracking (see 6.2) use of procedures based on low hydrogen welding consumables is recommended.

6.2 Buttering

Buttering (weld overlaying) the surface of the run pipe prior to attaching a hot-tap nozzle or fitting is beneficial. It is particularly recommended when attaching a nozzle to pipe fabricated from plate material to prevent lamellar tearing of the pipe where the thickness is such that this may occur as the result of weld shrinkage stresses.

With on-line welding there is the risk of high hardness and subsequent hydrogen cracking taking place in the heat affected zone of the parent material. Buttering allows heat input in the parent material to be more closely controlled, and also allows a temper bead approach to be adopted in which the heat affected zone of the parent material is tempered back during the deposition of the second run of weld. Using such an approach reduces the heat affected zone hardness and hence the risk of cracking in the parent material, particularly where the cooling effect of the process fluid present is high.

Buttering allows a balanced welding sequence to be used, and if correctly applied can reduce the potential distortion of the pipe after welding.

Where buttering is to be applied, at least two layers of weld metal should be deposited. The final thickness of the weld deposit at the location of the nozzle-to-pipe weld should, after grinding, be not less than 3 mm. The width of the buttering should be sufficient to overlap the nozzle attachment weld by 6 mm on both the inside and outside diameters. Similarly, buttering should be deposited under any reinforcement plate-to-pipe welds.

The surface of the buttering should be ground smooth, the edges de-burred and both the weld and the pipe local to the weld inspected by appropriate crack detection and ultrasonic methods.

6.3 Welding Preparation

6.3.1 Coating Removal

Paint, coating or wrapping material should be carefully removed in the area of the proposed hot tap for a length extending 0.5 m either side of the branch location.

6.3.2 Surface Cleaning

The area local to the proposed weld should be thoroughly cleaned with a wire brush (a clean austenitic wire brush for austenitics) or by light grinding, as appropriate.

6.3.3 Inspection

The area local to the proposed weld should be visually examined externally for laps, cracks, pitting and signs of mechanical damage.

6.3.4 Roundness Test

The roundness of the run pipe should be checked where preformed split tees or sleeves are to be fitted.

6.3.5 Internal Condition

The presence of fouling or build-up of deposits, including pyrophoric material, inside the pipe should be considered. Radiography may be used to detect such deposits. Furthermore, previous inspection reports should be evaluated in order to assess the soundness of the area to be welded.

6.4 NDE of Pipe and Weld

6.4.1 NDE is an essential requirement of any hot-tapping procedure particularly because of the difficulty in carrying out a post-hot-tap pressure strength test on the system. Even before any detailed inspection is performed there is a primary requirement to ensure that the piping material has been correctly identified. Hot tapping should not be carried out where the metallurgical composition and grade of a material cannot be positively identified.

6.4.2 An initial check of materials records and hard stampings should be made to confirm that the pipe material is weldable. Where there is any doubt, the material should be checked using appropriate analytical techniques/ equipment (see 4.3.1).

6.4.3 Once the proposed hot-tap location has been marked, and before any welding is carried out, checks should be made of the wall thickness of the material and for the presence of laminar defects. This is normally accomplished ultrasonically. On no account should a hot tap be performed on piping where NDE suggests the presence of laminar defects.

6.4.4 Irregular or erratic ultrasonic readings may suggest internal pitting and corrosion. In this case the ultrasonic examination may best be supported, if possible, by radiography.

6.4.5 It is also recommended that after cleaning the external surface of the run pipe a crack detection examination be performed at the proposed weld area.

6.4.6 If the hot-tap branch is to be welded over an existing seam weld (see 5.3) the appropriate area of the seam weld should be ground flush and subjected to crack detection examination supported by ultrasonic flaw detection or radiography as appropriate.

- 6.4.7 On completion of the welding operation the weld should be visually inspected externally, followed by magnetic particle or liquid penetrant examination.
- 6.4.8 If the hot-tap nozzle is fabricated rather than being a one piece forging, the relevant fabrication specification will determine the extent of any NDE requirements. Magnetic particle or liquid penetrant examination should also be performed on reinforcing pad welds.

6.5 Check on Welding Current

To reduce the risk of burn-through of the run pipe during the actual welding operation, it is recommended that immediately before welding is commenced a test be carried out to check the amperage of the welding current. This may be done by striking an arc on a suitable piece of material, similar to that of the run pipe.

7. LEAK TESTING

7.1 General

All hot-tap fittings, nozzles, sleeves and preformed spilt tees should be leak tested after completion of all welding, but before commencing the drilling operation, in order to demonstrate as far as possible the integrity of the installation. The test medium should normally be water. In some applications, for example when using a split tee, it is desirable to avoid water, which could become trapped in the annulus between split tee and pipe wall leading to subsequent corrosion. In such cases the use of liquid hydrocarbons may be suitable, subject to acceptable safety precautions. When the temperature of the process fluid is above 93°C and the saturation pressure of steam is above the test pressure, the test should be performed with a suitable grade of oil.

The objective of the test is primarily to indicate leak tightness of the hot-tap branch weld at system test pressure. Consideration should be given to the possibility of buckling of the pipe due to the application of external pressure.

7.2 Procedure and Test Pressures

The general testing procedure to be followed should be:

- a) Leak testing of the hot-tap valve, preferably with the valve not installed on the branch (so that the correct seal is tested).
- b) Testing of the branch connection, with the valve installed and in the open position, to demonstrate leak tightness and integrity.
- c) Leak testing of the hot-tapping machine mounted on the valve (with valve closed).

Leak test pressure for tests a) and c) should be equal to the highest operating pressure in the run pipe which could occur during the hot-tap operation. The pressure of test b) should be as high as practicable and normally not less than the system test pressure. However in no case should the pressure applied in the test exceed the maximum allowable external pressure for the run pipe.

8. PROCEDURE

Note. The sub-sections that follow list the various topics and points which are recommended to be communicated, documented and/or checked. It should not be assumed that the lists are exhaustive: there may be other considerations of relevance in particular circumstances.

8.1 Planning the Operation

Detailed planning is essential to ensure the success of the operation.

8.1.1 Typical information required and which may need to be provided to the specialist company carrying out the operation is as follows:

- a) actual wall thickness, material and grade of run pipe to be hot tapped
- b) external and internal diameters
- c) operating pressure and temperature
- d) particulars/ properties of process fluid
- e) type, class and bore of branch connection; also position of branch, e.g. horizontal, vertical or other angle
- f) distance from inner wall of the run pipe to flange face of isolating valve
- g) minimum bore of isolating valve
- h) whether run pipe is capable of being pigged, and if so whether a guide bar or coupon plug is required to be fitted to the branch connection.

8.1.2 The operator/ supplier of the hot tapping equipment should provide on request as appropriate:

- a) weights and dimensions of equipment to be used — see Appendix A for typical weights and dimensions
- b) requirements which need to be supplied, e.g. suitable craneage, nitrogen for pressure testing of the assembly (fitting, valve and machine) prior to drilling.

8.1.3 The operator/ supplier also needs to approve and agree the procedures to be used.

8.2 Documentation and Checklists

8.2.1 Documentation

Approval of the operation should be documented recording the following pertinent data:

PLANT
DATE
DRAWINGS AND DESIGN CALCULATIONS
SYSTEM/ SERVICE
SERVICE FLUID
EQUIPMENT ITEM/ LINE No.
RUN PIPE NOMINAL SIZE

DESIGN PRESSURE
DESIGN TEMPERATURE
OPERATING PRESSURE
OPERATING TEMPERATURE
FLOW RATE/ VELOCITY
BRANCH SIZE
TYPE OF REINFORCEMENT
LOCATION OF HOT TAP

See Appendix B for typical 'approval' document.

8.2.2 Checklist for Proposed Hot-Tap Operation

The following should be checked/ confirmed by the person responsible for authorising the hot-tap operation:

- a) the contents can be safely hot-tapped — are there any special considerations?
- b) thickness of run pipe wall — a minimum thickness of 5 mm is recommended
- c) materials of construction to ensure that they are compatible with the design and operating conditions
- d) required flow rate can be maintained during the welding operation (see 8.2.4 f))
- e) the hot-tapping machine is suitably rated for the temperature and pressure of the process fluid
- f) the hot-tapping equipment is suitable for the process fluid (e.g. will the fluid degrade the packing or corrode the equipment?)
- g) a risk assessment has been carried out and is fully documented
- h) there is adequate access to carry out the full operation (welding, assembly, drilling, testing and NDE).

8.2.3 Checklist before Commencing the Operation

The following should be checked before commencing the work:

- a) a 'safe system of work' has been produced and communicated — see 3.3
- b) the exact location of the hot-tap has been identified
- c) the area to be welded has been fully inspected as recommended in 6.3.3
- d) the hot-tap branch is the correct length to accommodate the operation of the hot-tap machine
- e) an emergency shutdown procedure is in place
- f) a Permit to Work has been issued.

8.2.4 Checklist before Commencement of Welding

The following should be checked before commencing welding:

- a) an approved welding procedure has been authorised
- b) the welders are qualified for the above procedure
- c) the branch is correctly positioned
- d) the necessary safety requirements are being complied with, e.g. protective equipment, shields etc.

- e) emergency escape routes have been identified and properly communicated to personnel
- f) the plant operators have been informed and permission to commence work obtained
- g) immediately prior to welding on the run pipe the amperage of the welding current has been tested (see 6.5).

8.2.5 Checklist on Completion of Welding

The following should be checked after completing the welding operation:

- a) the welds have been examined by the appropriate methods
- b) a pressure test of the fitting has been carried out (see Section 7)
- c) the block valve has been checked for cleanliness.

8.2.6 Checklist before Commencement of Cutting

The following should be checked before the commencement of cutting:

- a) the hot-tap machine and associated equipment have been properly installed and suitably pressure tested (see Section 7)
- b) the pilot bit and cutter are in good condition (no missing teeth) and secure in their position
- c) all bolts on the cutter and pilot bit are tight
- d) the pilot bit is of sufficient length to catch the coupon
- e) the cutting depth has been calculated
- f) the cutter will pass through the assembled valve and fitting
- g) the tapping machine assembly can be mounted with the valve in the closed position
- h) the bleed off valve is tight and not plugged.

8.2.7 Checklist before Removing the Hot-tap Machine

The following should be checked before removing the hot-tap machine:

- a) the boring bar of the hot-tap machine is fully retracted
- b) the hot-tap block valve has been closed
- c) the bleeder valve has been opened
- d) all the pressure has been bled from the hot-tap machine before removing any bolts from the flange.

9. SPECIAL APPLICATIONS

9.1 General

The information in this Guide is generally intended to be used for hot tapping into pipes. However, the principles may also be applied to vessels, tanks or other equipment.

9.2 Flare Lines

Due to insufficient flow and unstable operation conditions, welding hot-tap branches on flare lines is feasible only with the following special precautions:

- flushing the flare line with steam or inert gas during welding operations to create a minimum gas velocity of 0.4 m/s
- employing additional instrumentation, including a quick-acting warning system.

9.3 Pressure Vessels

It is strongly recommended not to carry out hot taps on pressure vessels.

9.4 Tanks

The main danger in applying external heat to tanks is either ignition of a flammable atmosphere in the vapour space or release of flammable vapour from vents.

Welding should not be carried out on stress relieved tanks.

On no account should a hot tap be performed on plate where NDE suggests the presence of laminar defects.

The lower strakes in large storage tanks may be made of impact-tested steel to prevent brittle fracture. In this case, all major wall penetrating nozzles are very often concentrated in one or two plates which are post-weld heat-treated. Hot tapping should not be carried out on these plates because the integrity of the construction could be compromised due to welding locally reducing toughness.

At least 1 m of liquid head should be maintained above the hot-tapping area when welding is being carried out.

The maximum nozzle diameter and the need for reinforcement should be determined by the requirements of the applicable design code.

Filling of or discharging from tanks should not be carried out while the hot tapping operation is in progress.

Hot tapping should not be carried out on a tank roof.

9.5 Miscellaneous Equipment **(Valves, Pumps, Strainers, Mixers, Turbine Housings)**

Hot-tapping on such equipment is possible but not recommended because of material characteristics, complicated shapes and the possible ingress of swarf.

In the case of rotating equipment the manufacturer of the equipment should be consulted on the feasibility of the operation.

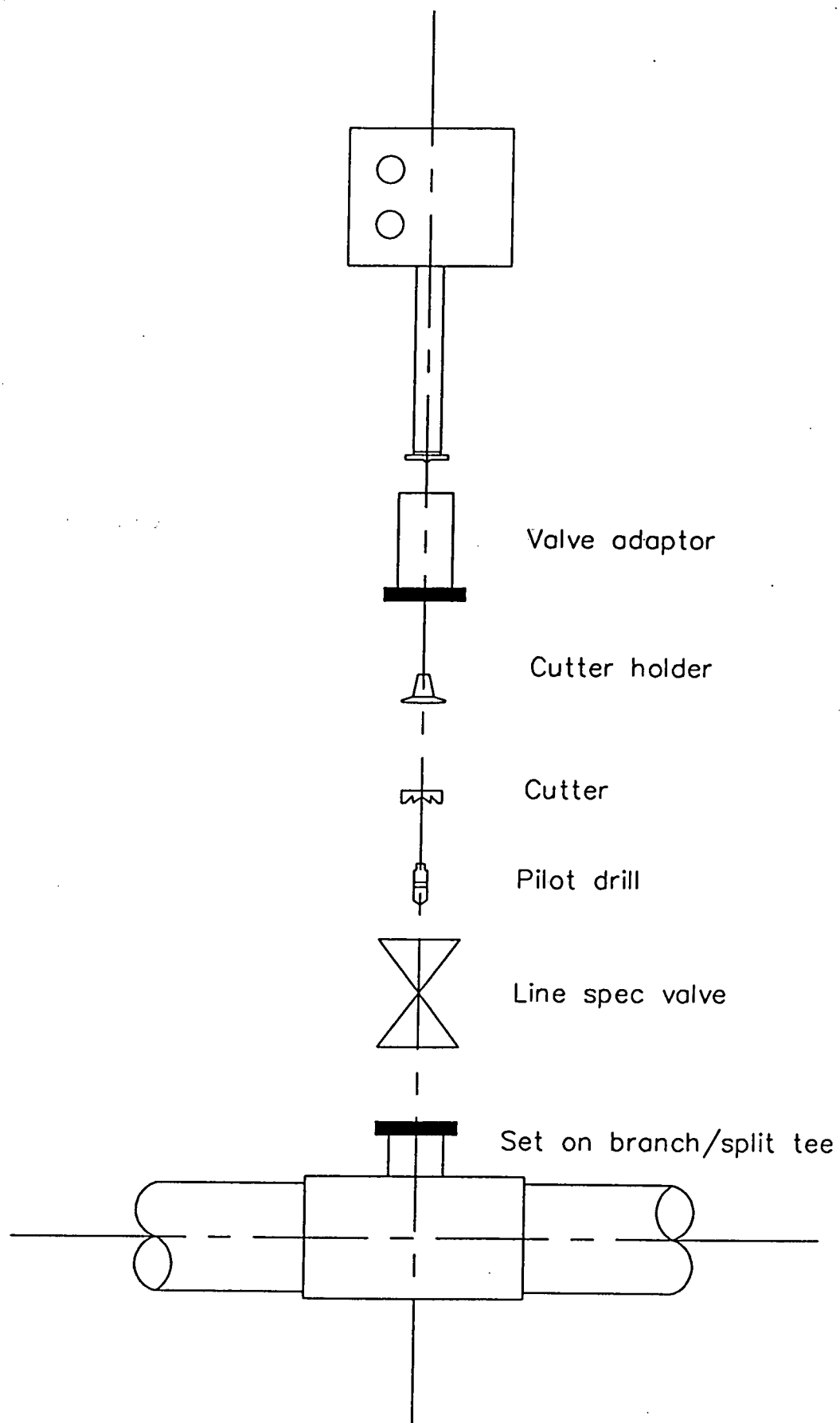
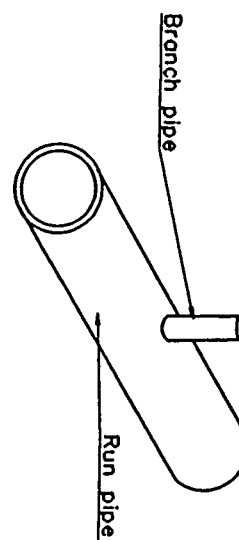
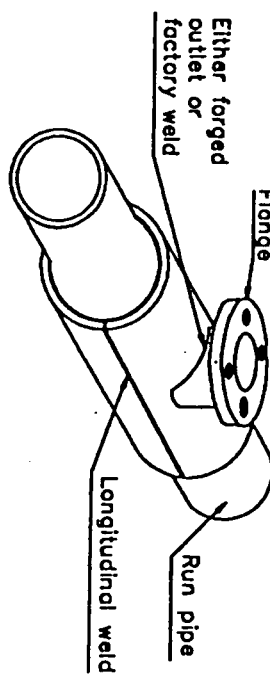


Fig. 1 Exploded Schematic of Hot-tapping Machine Assembly

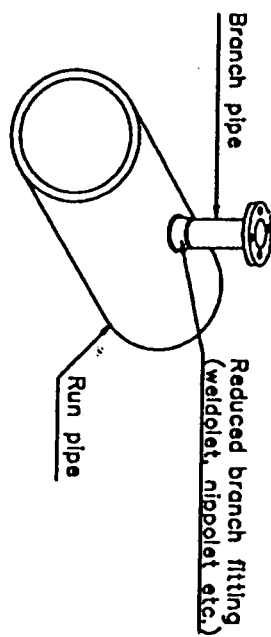
Set-on branch



Preformed split tee



Reduced branch fitting



Reinforced set-on branch

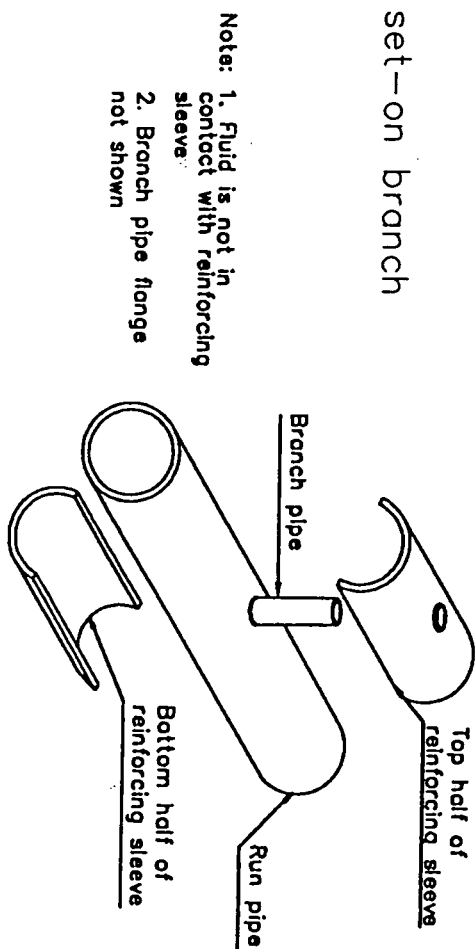


Fig. 2 Typical Connections

APPENDIX A: TYPICAL WEIGHTS AND DIMENSIONS OF HOT-TAPPING EQUIPMENT

Tap size (mm)	Weight (kg)	Max. height (mm)
50	20*	—
80	75*	1270
100	308	2390
150	310	2440
200	312	2440
250	320	2745
300	330	2800
350	1000	3180
400	1004	3180
450	1008	3300
500	1018	3300
600	1090	3400
750	1182	3550
900	1220	3800

Note

The above table applies to conventional hot-tapping machines.

* Indicates air or manually operated machines; other machines are hydraulic.

APPENDIX B: TYPICAL APPROVAL DOCUMENT

(Courtesy of Shell UK)

WELDING AND TREPPANNING ON LIVE LINES AND EQUIPMENT				HOT TAP No.
PLANT		UNIT		
PROJ/PLANT CHG No		PIPING CLASS		
TIE-IN No		DESIGN PRESS	BARG	
PIPE/EQUIP No		OPERATING PRESS	BARG	
BRANCH NOM SIZE	MM	DESIGN TEMP	DEGC	
MAIN LINE NOM SIZE	MM	OPERATING TEMP	DEGC	
MAIN LINE MEAS. THK	MM	WELD INSTRUCTION		
DRAWING No		TEST PRESSURE		
PEFS		BRANCH		
DETAILS		VALVE		
CALCULATION		DRILLING MACHINE		
PRELIMINARY AGREEMENT – PU MANAGER Signed				
SAFETY CERT. REFS		EXEMPTION CERT. REF.		
1) DESIGN CHECK/ PRODUCT & TEST FLUID SUITABILITY		Signed date..... Print name.....		
2) MARK HOT TAP POSITION ON PIPE/EQUIP		Signed date..... Print name.....		
3) MEASURE WALL THICKNESS...MM (5MM MIN)		Signed date..... Print name.....		
4) INSPECT PIPE/EQUIP (VISUAL,PRODUCT BUILD UP) RADIOGRAPHY, U/S, CRACK DETECTION)* *delete as applicable		Signed date..... Print name.....		
5) CHECK WELD PROCEDURE, QUALIFICATION RECORD		Signed date..... Print name.....		
6) INSPECT NOZZLE ASSEMBLY (VISUAL, RADIOG, CRACK DETECTION)		Signed date..... Print name.....		
7) CHECK PERMITRY		Signed date..... Print name.....		
8) CHECK FIT UP (VISUAL, DIMENSIONAL) COMPLETE TONG TEST		Signed date..... Print name.....		
9) MONITOR ROOT WELDING OPERATION		Signed date..... Print name.....		
10) INSPECT ROOT WELD (VISUAL,CRACK DETECTION)		Signed date..... Print name.....		
11) MONITOR FILL AND CAP WELDING OPERATION		Signed date..... Print name.....		
12) POST WELD INSPECTION (VISUAL, U/S, CRACK DET)* *delete as applicable		Signed date..... Print name.....		
13) HYDRO TEST		Signed date..... Print name.....		
14) CHECK TREPPANNING EQPT (TEST VALVE & M/C)/ OPERATOR COMPETENCE & PROCEDURE		Signed date..... Print name.....		
15) CHECK COUPON (DRILLINGS) RECOVERED,BLANKS AND CONNECTIONS FITTED, AREA TIDY.		Signed date..... Print name..... (operation complete)		

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Introductory Note

Publications are listed in numerical order under the following headings: Electrical, Instrumentation & Control, Mechanical Plant and Equipment, Offshore, Storage Tanks and Vessels, Noise, and General. (For further details see website www.eemua.co.uk/publications.)

An asterisk (*) indicates a publication in preparation

Amendments Where amendments have been issued, these are listed in bracketed italics after the title of the publication. It is intended that amendments be placed on the website www.eemua.co.uk/publications/amendments.

Publication No.

ELECTRICAL

- 132 : 88 Specification for Three-phase Cage Induction Motors (*Amdt No 1, Mar 02*)
- 133 : 88 Specification for Underground Armoured Cable Protected against Solvent Penetration and Corrosive Attack
- 181 : 95 A Guide to Risk Based Assessments of In-situ Large Ex 'e' and Ex 'N' Machines
- 186 : 97 A Practitioner's Handbook—Electrical Installation, Inspection and Maintenance in Potentially Explosive Atmospheres (*Updated & reprinted 2002*)
- 198* Electromagnetic Compatibility A User Guide to Installations and Standards

INSTRUMENTATION & CONTROL

- 138 : 88 Design and Installation of On-Line Analyser Systems
- 138 S1 : 93 Design and Installation of On-Line Analyser Systems: A Guide to Technical Enquiry and Bid Evaluation
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- 175 : 95 Code of Practice for Calibration and Checking Process Analysers—Formerly IP Code of Practice 340
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- 201: 02 Process Plant Control Desks Utilising Human-Computer Interfaces—A Guide to Design, Operational and Human Interface Issues

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- 107 : 92 Recommendations for the Protection of Diesel Engines for Use in Zone 2 Hazardous Areas
- 143 : 85 Recommendations for Tube End Welding: Tubular Heat Transfer Equipment, Part 1 — Ferrous Materials (*No subsequent parts issued*)
- 151 : 87 Liquid Ring Vacuum Pumps and Compressors
- 153 : 96 EEMUA Supplement to ASME B31.3 —1996 Edition, Process Piping (*Amdts Dec 2000 & Feb 02*)
- 164 : 93 Seal-less Centrifugal Pumps: Class 1
- 167 : 91 Specification for Quality Levels for Carbon Steel Valve Castings
- 168 : 91 A Guide to the Pressure Testing of In-Service Pressurised Equipment
- 169 : 93 Specification for High Frequency Electric Welded Line Pipe (*Obsolescent*)
- 170 : 91 Specification for Production Testing of Valves—Part 1 Ball Valves (*Reprinted 2001 incorporating Amdt No 1 Apr 96 & other minor changes*)
- 171 : 94 Specification for Production Testing of Valves—Part 2 Plug Valves (*Errata & Amdt No 1 Apr 96*)
- 172 : 95 Specification for Production Testing of Valves — Part 3 Gate Valves (*Amdt No 1 Jan 96*)
- 173 : 95 Specification for Production Testing of Valves — Part 4 Butterfly and Globe Valves
- 179 : 96 A Working Guide for Carbon Steel Equipment in Wet H₂S Service (Developed largely from Oil Refinery experience)
- 182 : 95 Specification for Integral Block and Bleed Valve Manifolds for Direct Connection to Pipework (Incorporating Information Sheet No 20: Application Guidelines) (*Reprinted incorporating Amdt No 1 Nov 98*)
- 184 : 96 Guide to the Isolation of Pressure Relieving Devices
- 185 : 96 Guide for Hot Tapping on Piping and other Equipment (*Reprinted 2000 incorporating Amdt No 1 Dec 97*)
- 188 : 99 Guide for Establishing Operating Periods of Safety Valves
- 192 : 98 Guide for the Procurement of Valves for Low Temperature (Non-cryogenic) Service
- 196 : 99 Valve Purchasers' Guide to the European Pressure Equipment Directive (*Reprinted 2002 incorporating Amdts 1–3, Nov 00, Feb 02 & Aug 02, respectively*)

- 199 : 00 On-Line Leak Sealing of Piping - Guide to Safety Considerations
- 200 : 00 Guide to the Specification, Installation and Maintenance of Spring Supports for Piping
- 202 : 01 Guide to the Use of ISO 15649 and ANSI/ASME B31.3 for Piping in Europe in Compliance with the Pressure Equipment Directive (*Reprinted 2002 incorporating Amdt No 1 May 02*)

OFFSHORE

- 144 : 87 90/10 Copper Nickel Alloy Piping for Offshore Applications—Specification: Tubes Seamless and Welded
- 145 : 87 90/10 Copper Nickel Alloy Piping for Offshore Applications—Specification: Flanges Composite and Solid
- 146 : 87 90/10 Copper Nickel Alloy Piping for Offshore Applications—Specification: Fittings
- 158 : 94 Construction Specification for Fixed Offshore Structures in the North Sea (*Reprinted 2000 incorporating Amdts 1 (Rev'd) & 2, Apr 97, & 3 Sep 02, and other minor emendations*)
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- 149 : 97 Code of Practice for the Identification and Checking of Materials of Construction in Pressure Systems in Process Plants
- 193 : 99 EEMUA Recommendations for the Training, Development and Competency Assessment of Inspection Personnel
- 195 : 99 Compendium of EEMUA Information Sheets on Topics Related to Pressure Containing Equipment (*Amdt No 1 Jan 00*)