

THE ENGINEERING EQUIPMENT AND MATERIALS USERS ASSOCIATION

ON-LINE LEAK SEALING OF PIPING: GUIDE TO SAFETY CONSIDERATIONS

EEMUA PUBLICATION No 199 : 2000

AMENDMENTS No 1, NOVEMBER 2002

The amendments set out below are authorised by the EEMUA Piping Systems Technical Committee which has responsibility for the maintenance of this publication.

1/1 Page 4, Section 3 Risks

Add new paragraph:

- g) Degradation of a pipe within a leak sealing repair clamp may reduce the pipe wall to an extent where the remaining thickness can no longer resist the piping system loads (e.g. axial load due to pressure, thermal expansion loads, weight of the clamp). This may result in structural failure of the pipe if the repair clamp is designed only to seal the leak and not to provide strengthening of the pipe.

1/2 Page 5, subsection 4.1.5

In the first sentence, after 'joint' *insert*: 'or piping'.

1/3 Page 5, subsection 4.1.8

In the second sentence, after 'bolting' *insert*: 'and any structural restraint'.

1/4 Ibid.

Add new second paragraph (rest of subsection unchanged):

The design of the clamp should take into account the pipe size and geometry (e.g. ovality). It is important to consider the ability of the remaining pipe wall thickness to accommodate the imposed axial and other loadings, particularly where ongoing internal metal loss is likely.

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12.11.02

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45 Beech Street
LONDON
EC2Y 8AD

Telephone: 020 7628 7878
Fax: 020 7628 7862
e-mail: sales@eemua.co.uk
website: www.eemua.co.uk



THE ENGINEERING EQUIPMENT AND MATERIALS USERS ASSOCIATION

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FOREWORD

Although certain companies may have their own guides to on-line leak sealing of piping, there is, as far as is known, no publicly available document containing advice on the pertinent safety factors that need to be considered in preparing for and executing the technique. The present Guide has accordingly been developed by the EEMUA Piping Systems Technical Committee to meet this perceived need. It should be noted that the term 'piping' includes valves.

1 INTRODUCTION AND SCOPE

Certain leaks from pressurised piping may be effectively contained by on-line sealing methods involving injection of elastomeric compounds. The methods, originally developed for application to leaking steam or condensate systems, may also be applied to process piping leaks but additional precautions are usually necessary. Because of the inherent risks, such methods should only be carried out by trained personnel working to an agreed procedure. Also, since leakage indicates deterioration of the pressure-containing material, all repairs by these methods should be regarded as temporary. It is therefore essential that records of such repairs are maintained.

This publication is applicable to industrial piping in which leaks are to be temporarily sealed whilst in service by the injection of a suitable compound. It gives guidance on the limits of application of the technique, the factors to be considered when evaluating the feasibility of its use, and the preparation and execution of the procedure. It also provides the information necessary for an appropriate multi-skills team to conduct a detailed risk assessment in order to decide whether the technique should be applied in a particular case.

Injection techniques should not be used for the repair of cracks as effective penetration by the sealant is unlikely to be achieved. Neither are the techniques suitable for repairs to special joints such as those employing pressure energised gaskets or lens rings. In these cases the sealant pressure may affect the alignment of the gasket or lens ring and cause the joint to fail.

2 LEAK SEALING TECHNIQUE

A temporary repair by leak sealing normally involves one of the following:

- a) installation of injection nozzles into a valve packing area
- b) fitting caulking wires, bands or simple clamps on the perimeter of flanges for retaining injection compound, together with injection nozzles
- c) purpose built clamps and boxes.

3 RISKS

Leak sealing techniques involving the injection of elastomeric compounds frequently require the use of injection pressures greater than the design pressure of the component that is leaking. In addition, an on-line modification to the pipework is necessary to enable injection to take place (e.g. fitting a clamp box, drilling a valve stuffing box). Hazardous incidents can result from the over pressurising or overloading of equipment during leak sealing operations. The following are examples of such incidents.—

- a) Caulking compounds, wire and shaped inserts used to retain injected sealing compound may be ejected by the line and sealant pressure causing injury to personnel and damage to equipment.
- b) Clamps and boxes around the leaking area may fail catastrophically under product and sealant pressure, creating projectiles which may injure personnel and damage equipment.

- c) The hammering of wire and shaped inserts between flanges may significantly overstrain individual bolts leading to sudden failure of all bolting, and catastrophic failure of the equipment joint.
- d) Injecting sealant under a clamp or caulked wire around the circumference of the flange may result in temporary increase of the axial load on flange bolting which may cause bolting failure.
- e) The pressure of the injected compound, or the weight of the clamp, may be sufficient to cause failure or collapse of the piping, particularly if corroded.
- f) Drilling into a valve stuffing box may result in a leak at full line pressure if the valve packing is in poor condition.

4 PREPARATION

4.1 Risk Assessment

4.1.1 General

As described in the previous section, carrying out temporary repairs to leaking equipment can be a potentially hazardous operation. Consequently the utmost care needs to be taken when considering, planning and executing a job. A risk assessment should first be made by the plant engineer in consultation with the Operations department and the leak sealing contractor. Such an assessment should take into account the factors set out in 4.1.2 to 4.1.11 below.

4.1.2 Nature and Cause of Leak

It is important to determine the cause of the leak. For example, a leaking flange joint may be due to gasket failure or to bolt relaxation. The factors causing the leak may increase the possibility that the leak sealing operation results in failure of the equipment. In addition, the likelihood of further deterioration of the pipework after leak sealing should be assessed.

4.1.3 Extent of Damage

It is important to establish the full extent of the damage to the equipment prior to determining the suitability of a particular type of repair. This may involve establishing the thickness of adjacent material, the presence of any cracking, corrosion of the bolting, deterioration of the gasket etc.

4.1.4 Operating Conditions

Process operating conditions have a major influence on the suitability of repair by sealant injection. Normal operating pressures and temperatures, cyclic conditions, and shutdown or upset conditions should be taken into account. Reductions in temperature and pressure during the repair are generally beneficial.

4.1.5 History: Leak Records, Bolt Re-tightening and/or Previous Leak Sealing

A history of bolt re-tightening or sealant re-injection may indicate deterioration of a joint, requiring remedial action. If it is found necessary to re-inject sealant, consideration should be given to shutting down and effecting a permanent repair.

It is prudent to check with local supervisors, operators, and maintenance staff for general information on plant item history, particularly as bolt re-tightening may not have been recorded.

4.1.6 Condition of Piping, Bolting and Gaskets

Consideration needs to be given to the possibility of corroded and eroded piping, flanges and bolts, particularly where re-injection at a previously sealed leak position is contemplated.

As a precaution against failure, the condition of piping, flanges, bolting and gaskets should be confirmed and assessed as being suitable for the leak sealing operation. It is common for the bolting to be replaced in a controlled manner prior to leak sealing (see EEMUA Information Sheet No 17, Pub. 195 *Compendium of EEMUA Information Sheets on Topics Related to Pressure-Containing Equipment*). Where this is impractical, the bolts should be visually examined, supplemented where possible by ultrasonic or other non-destructive examination. When a joint leaks, it is possible for an environment to develop within the joint which promotes stress corrosion cracking of the bolting material. For example, in steam/feedwater duties, free caustic can concentrate to levels sufficient to induce caustic embrittlement (cracking) of common bolting materials. Other factors that can affect bolting are:

- a) poor supporting of piping
- b) external dynamic loads
- c) fatigue due to vibration.

In assessing the condition of gaskets, the type, age, and service conditions should be considered.

4.1.7 Contents of Piping System

It is important to check the chemical compatibility of the clamp or band and sealing compound with the fluid inside the piping system. Incompatibility could lead to problems such as corrosion of the clamp or band, degradation of the sealant (rendering it ineffective), and contamination of the fluid stream.

The nature of the process fluid (toxicity, flammability) will determine the need for and type of protective clothing, and for air breathing equipment, nitrogen purge, and the use of special or non-spark tools.

4.1.8 Clamp Design

Other than standard flange clamps/ bands, each leak sealing clamp should be of a purpose-built design, in accordance with recognised piping and vessel codes and good engineering practice. The clamp, including the bolting, should be designed to suit the piping design parameters and the injection pressure of the sealing compound.

A vent branch and valve should be provided on the clamp to direct the leak away from the technicians in a controlled manner during the installation procedure.

The design of the clamp should be reviewed by the responsible plant engineer.

4.1.9 Valve Glands

When sealing valve glands, it is important to have knowledge of the valve's construction, in particular the valve gland housing. This can often be obtained by:

- a) inspection of a valve of identical design
- b) radiography of the gland area
- c) examination of valve drawings.

The greatest concern is often the gland bolts. Final bolt loads should be determined. A prudent precaution is to fit a spacer to prevent the gland follower being ejected in the event of bolt failure.

Where the stuffing box wall thickness is not sufficient to allow an injection adapter to be used, a suitably designed strongback should be fitted, or a G-clamp injection unit used.

Certain leak sealing activities (e.g. of valve glands) may constitute a 'hot tap' in that the pressure envelope, i.e. the stuffing box, is breached by the drilling equipment during the leak sealing operation. It is important to note that there is no seal or gland on the drilling equipment: reliance is placed on the valve stem packing. In such a case there is a need to evaluate the adequacy of the existing valve packing (perhaps involving non-destructive testing). Other important considerations are contained in EEMUA Pub. 185 (*Guide for Hot Tapping on Piping and Other Equipment*).

4.1.10 Site Access

Consideration should be given to the consequences of failure in terms of the hazards to personnel in the vicinity of the leak sealing operation, and the consequences to plant operation.

Safe access and egress, and where possible alternative evacuation routes, should be provided.

4.1.11 Other Considerations

- a) Consideration should be given to the possibility of excess sealant preventing free operation of valves both in the immediate locality of the leak and also downstream of it. There is also the possibility that excess sealant, carried away from the leak location by the product stream, could block strainers, orifice flanges and small connections, and prevent the correct functioning of control valves. It is important that the amount of sealant needed to repair the leak is estimated before the repair operation commences (if the calculated quantity is exceeded during the operation thought will need to be given to what is actually happening to the injected material).
- b) The expected service life for the temporary repair should be considered.

4.2 Work Authorisation

Before commencement of the work, a clear, concise, written job procedure should be prepared, and this authorised in accordance with the site plant modification procedure. This should be agreed by the responsible plant engineer and leak sealing contractor, and should be part of the permit to work.

The technicians carrying out the work need to be fully conversant with the detailed procedure, and also made aware of the nature of the service on which they are to work, including temperature and pressure, and of any other potential hazards.

4.3 Emergency Procedures

If a leak sealing operation goes wrong, it may rapidly escalate into a major incident. Risks therefore need to be properly evaluated and contingency plans established. It is expected that the Operations department will have procedures in place to deal with emergency situations such as a major release of fluid. Such procedures would include rapid isolation of equipment, and an evacuation plan with which all personnel should be fully conversant.

5 EXECUTION

- 5.1 Personnel involved in the execution of the work should be provided with suitable, protective safety equipment.
- 5.2 Consideration should be given to the best approach for executing the work, and a plan drawn up. Factors to be borne in mind include leakage path, wind direction, and ensuring that a suitable means of escape is available in an emergency.
- 5.3 No deviation from the agreed sealing method should be allowed unless the risk has been assessed by the responsible plant engineer. Trial and error solutions by the technicians should not be permitted.
- 5.4 Technicians should be monitored to ensure they observe all precautions associated with the work, and immediate corrective action taken in the event of deviations from procedure.

6 FOLLOW-UP

- 6.1 A report should be produced by the leak sealing contractor on completion of the repair, confirming satisfactory execution of the work and recording any observations (e.g. problems found after the leak has been sealed).
- 6.2 The plant engineer should record the repair in a leak sealing register. The leak sealing repair and the register should be reviewed on a regular basis, especially prior to unit shutdowns, in order that a permanent repair can be carried out.
- 6.3 Provision should be made for permanent repair at the first opportunity. It is worth noting that as the sealant cures hard it loses resilience, and as a consequence leakage may recur, particularly where there is thermal or pressure cycling.

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