Guidelines for Competent Person
Repairs or Modifications to Pressure Systems

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1. **INTRODUCTION**

Repairs or modifications are often required on pressure systems. It is essential that they are carried out to suitable standards and that they are safe. The purpose of this document is to provide guidance for Competent Persons on repairs or modifications to pressure systems under the Pressure Systems Safety Regulations and other repairs where the same integrity is required. It will also be helpful to users, owners and repair companies in providing documentation for the work and the level of detail required. It addresses like for like repairs and modifications that do not change the function or purpose of the system.

Most repairs to pressure equipment will involve welding of pressure parts so this document focuses on this aspect.

Repairs or modifications that change the original characteristics of pressure equipment may need to be subject to the requirements of the Pressure Equipment Regulations.

Any repairs that will change the original design may require justification from the repair company including calculations that will need to be verified by the Competent Person e.g. compensation for larger openings.

2. **SCOPE**

This document specifies the requirements for repairs and modifications that involve welding on pressure containing parts of the system or other primary containment applications.

Other types of repairs or modifications not involving welding should be carried out to similar control and documentation requirements.

Welding on structural parts should be carried out to suitable standards but is outside the scope of this document.

3. **PRESSURE SYSTEMS SAFETY REGULATIONS 2000**

Whilst all the Regulations should be considered when assessing the requirements for repairs and modifications to pressure systems, the following are particularly relevant:

**Regulation 13:** “The employer of a person who modifies or repairs a pressure system at work shall ensure that nothing about the way in which it is modified or repaired gives rise to danger or otherwise impairs the operation of any protective device or inspection facility”

**Guide 13 para 177:** The duty holder for this regulation is the employer of the person engaged to carry out the repair or modification.

**ACOP para 178:** When designing any modifications (including extensions or additions) or repairs to the pressurised parts of the system, whether temporary or permanent, the following should be taken into account:

- The original design specification
- The duty for which the system is to be used after the repair or modification, including any change to relevant fluid
- The effects any such work may have on the integrity of the pressure system
- Whether the protective devices are still adequate
- Continued suitability of the Written Scheme of Examination

**ACOP para 180:** Any repair or modification (including extensions or additions) should be designed in accordance with appropriate standards, taking into account the expected future duty of the system as well as the original design specification. It should be done by a person competent to do such work.

**ACOP para 181:** Where substantial modifications or repairs (including extensions or additions) are to be carried out which might increase the risk of system failure, the user should consult a person who is competent to advise before work begins.

The user/owner must also take into account paragraph 118 of the ACOP to Regulation 8

**ACOP - Repair/modification**

118 The scheme should, where necessary, specify the type of repair or modification which needs to be examined by the competent person carrying out examinations under regulation 9 before the system is put back into use. Alternatively, the user/owner may decide to draw up a
comprehensive written method to be followed for certain specified repairs or modifications to all or some of the systems.

This will generally require the owner/user to contact the Competent Person before the repairs or modifications are carried out.

**Regulation 14:** “The user of an installed system and the owner of a mobile system shall keep:
...any such previous reports if they contain information which will materially assist in assessing whether - ...any repairs or modifications to the system can be carried out safely”

**ACOP para 183:** The user / owner should keep the following documents readily available:
...all other reports which contain information relevant to the assessment of matters of safety.

Sections 5 and 6 give examples of documents that may require to be kept and should be retained for the life of the component.

**ACOP para 184:** In deciding whether a report contains relevant information, the user / owner should take account of ...previous history of repair and any significant modifications to the system.

### 4. PED / PER

Pressure Equipment Directive (PED) (97/23/EC) transposed into UK Law as The Pressure Equipment Regulations 1999 [PER]:

Repair of plant ‘in-service’ will come within the scope of the Pressure Systems Safety Regulations Regulation 13.

Guideline 1/3 to PED advises that pressure equipment subject to modification that changes its original characteristics, purpose or type, after being put into service may need to be considered a new product and potentially require the involvement of a Notified Body.

Generally repairs will not require consideration under the PER. e.g. The replacement of a complete superheater would require CE marking; however the replacement of the complete tube-bank using the original headers would not.

### 5. REPAIR DOCUMENTATION

PSSR Regulation 14 requires that documentation is kept that will enable the Competent Person to assess whether a pressure system is safe for continued use.

This section outlines and describes the typical documentation required from a suitable repair company when proposing to carry out repairs to the pressure envelope of pressurised plant.

It should be noted that the documents outlined below would be required prior to commencement of any repairs; the possible exceptions are materials and consumable certificates that may be submitted for review later in the process.

#### 5.1 Method statement

This document details a step by step procedure for the repair being carried out. It would typically contain the following information:

- Plant identification including manufacturer, design standard, original materials of construction, serial/plant number, safe operating limits, etc.
- Location.
- Details of the repair being undertaken including a sketch of the location.
- Repair procedure including preparation, inspection requirements, proposals for NDE and hydraulic testing (including pressure to be applied) on completion.
- Any special procedures required – for example specific bending requirements, pre or post weld heat treatment.
- Confirmation that repair materials are compatible with the component.

The Competent Person will review the method statement and specify inspection stages and tests to be witnessed where required.

**Note 1:** This does not remove the responsibility of the repairer to complete stage testing to ensure the integrity of the completed repair.
Note 2: NDE required by the Competent Person must be carried out by a suitably qualified person, (normally PCN level2) approved by the Competent Person. The Competent Person will generally require to witness the final hydraulic test (if required) on completion of the repairs.

5.2 Welding Documentation

5.2.1 Welding Procedure Specification (WPS)

The WPS gives details of how the welding is to be performed giving information on the specific welding task to be completed and is job specific.

Its purpose is to aid the planning and quality control of the welding operation. This documentation will be supported by the welding certification forms. (SAFed forms are numbered E1 to E4).

Note. Sometimes a repairer will send copies of all their weld procedures. This is not satisfactory as it is necessary to specify the actual procedures to be used and not for the competent person to attempt to interpret which procedure is to be used by the welder.

5.2.2 Welding Certification (Reference SAFed Guidelines on Approval Testing)

When reviewing welding certification the accreditation of the issuing company and the companies issuing prolongations should be assessed. In all cases the Competent Person will satisfy themselves with the competence of the organisations involved before proceeding, i.e. the organisation is accredited for witnessing / certifying procedures and certifying welders, as opposed to being a test house that only does the mechanical tests etc.

Welding certification comprises of:

Certificate E1 — Welding Procedure Approval Test Certificate.

This gives details of the specific type of weld a procedure has been certified to carry out in accordance with EN 15614 range of approval.

Certificate E2 — Details of Weld Test.

This gives details of what actually took place during the test weld it is similar to a welding procedure specification but should not include ranges of welding parameters.

Certificate E3 — Test Results, gives details of NDE and Mechanical testing results.

The above three certificates all relate to the weld procedure.

Certificate E4 — Welder Approval Test Certificate - This is the individual welder approval part of the qualification. There must be an E4 certificate for each welder that uses the weld procedure. The E4 contains the information relating to the welders competence and is detailed below.

The Competent Person shall check that the weld documentation is fit for use on the repair/modification. Where ASME IX is used for weld procedure and welder approval testing and certification the Competent Person should ensure that the qualification, testing and documentation are suitable for the equipment to be repaired.

5.2.3 Detailed Information on the E4 Welder Approval Test Certificate

The certificate will indicate the range of designated variables that have been addressed in an individual approval, these will include:

Product type e.g. plate, tube

Type of weld e.g. butt or fillet weld

Welding positions e.g.

Flat (PA)

Horizontal vertical (PB)

Horizontal (PC)

Horizontal overhead (PD)

Overhead (PE)

Vertical up (PF)

Vertical down (PG)
Weld details e.g.

bs  welding from both sides
lw  leftward welding
mb  welding with backing strip
ml  multi layer
nb  no backing
rw  rightward welding
sl  single layer
ss  single side welding

Welding process e.g.

111  manual metallic arc welding
121  submerged arc welding with one wire electrode
125  submerged arc welding with tubular cored electrode
131  metal inert gas welding (MIG)
135  metal active gas welding (MAG)
141  tungsten inert gas welding (TIG)
15   plasma arc welding
311  oxy-acetylene welding

Material group according to CR ISO 15608 Some common examples are:

1.0  carbon steel
1.1  Re ≤ 275 N/mm²
1.2  275 N/mm² < Re ≤ 360 N/mm²
1.3  Re > 360 N/mm²

8.0  Austenitic stainless steels Ni ≤ 31%
8.1  Cr ≤ 24%
8.2  Cr >19%

10  Austenitic ferritic stainless steels (duplex)
21  Pure aluminium
22  Aluminium manganese alloys
31  Copper
32  Copper-zinc alloys
33  Copper-tin alloys

Welding consumables e.g. solid wire, electrode core basic
Dimensions, thickness & pipe diameter.

5.2.4 Prolongation/validation of the E4 — Welder Approval Test Certificate

The certificate should be prolonged for use by the Employer/Supervisor at 6 monthly periods for a total of 2 years – this is provided that the welder is still regularly working within the initial range of qualification, it should be noted that a prolongation sheet identifying EN 287 Part 1:1992 would be acceptable.

Note 1: EN 287-1 is due to be replaced by BS EN ISO 9606-1 which has significant changes to the requirements of prolongation.

The Competent Person should ensure that the E4 certificate has been signed by the Employer/supervisor within the last 6 months, if this is not the case then the certificate is out of date.
Every two years from issue the Inspecting authority may approve an additional 2 year prolongation, provided that documentary evidence is in place to support the welder’s continued skill in using the welding procedures and volumetric or destructive tests have been carried out on samples of the welder’s production.

The Competent Person should check to ensure that the E4 certificate has both the 6 monthly signature from the Employer/Supervisor and where required the signature for any prolongation.

The Competent Person should see a copy of this documentation when available and a copy should be kept with the repair documentation.

Note 2: Care should be taken to verify the welder identification and the form for any evidence of unauthorised editing.

5.2.5 Material certificates

The material used for the repair must be suitable for the required duty and of the required thickness. Normally this will be the same or equivalent specification to that used in the original manufacture unless a change of material has been agreed by the Competent Person.

The material certificate(s) should be from the original manufacturer and not from the supplier. It should clearly show that the material matches that given in the method statement. Where practical the material should be identifiable through all stages of the repair.

5.2.6 Consumables details

Consumables should be supplied with material certification which will match that shown in the E1 Certificate or the WPS.

6. REPORTS OF TESTING

Any reports and certificates issued during the repair process should be kept. At the end of the repair, the Competent Person should issue a report of examination stating the following:

- The repair has been completed in accordance with supplied documentation.
- All testing is now complete
- The component is safe to return to service following any examination requirements in accordance with the Written Scheme.

Note: For complex, long running repairs, where a number of key personnel may have changed e.g. the Competent Person, there should be inter stage reports issued which document progress.

7. CHANGES TO THE WRITTEN SCHEME OF EXAMINATION

Any repairs to a pressure vessel that may result in a modified examination or increased NDE requirement should be noted and reviewed within the Written Scheme of Examination.

8. TEMPORARY REPAIRS

Where circumstances prevent an immediate permanent repair from being carried out (Procurement of repair material etc.) then temporary repairs can be considered. Similar requirements to those for permanent repairs will apply and it must be ensured that the plant is safe to operate until the opportunity arises for a permanent repair to be carried out. The temporary nature of these repair needs to be addressed in the documentation supplied and referenced in a report for the item, including the date by which the permanent repair is to be carried out. There may be a need to reduce the safe operating limits of the system and or the periodicity for future examinations.
Appendix 1  Competent Person involvement in repairs or modifications to PS

A.1 Boilers and Pressure Vessels

Whilst it is important to repair all vessels in a proper and safe manner, the Competent Person has an involvement in those parts of the system which are examined in accordance with the written scheme. Most design and construction codes for boilers and pressure vessels require the involvement of an independent third party in the design and construction. Also for most boilers and pressure vessels covered in a WSE the Pressure Equipment Directive is likely to require the involvement of a Notified Body in their original construction. Hence it is both appropriate and logical to apply similar requirements when these boilers and pressure vessels are subsequently repaired or modified. The Competent Person should therefore approve all repairs to boilers and pressure vessels covered by the WSE. Depending on the complexity of the work the involvement would normally commence prior to the work being undertaken so that the method of repair can be agreed. This is then followed by inspections during the work itself.

There could well be some smaller vessels (particularly steam vessels) included in the WSE which would only be classified as PED risk category I or SEP. A review of the repair documentation on completion will probably suffice in most cases, although small steam boilers may need to be considered more closely.

A.2 Protective Devices

The protective device is the most critical item in a pressure system as it is the ultimate protection against exceeding the safe operating limits. Hence great care needs to be taken when considering repairs. It is normal practice on an item such as a safety valve to replace it rather than attempting a repair, unless it is simply the replacement of a part. However care should be exercised with both replacement of parts and replacement of the entire valve to ensure like for like replacement is achieved. The wrong spring will result in a completely different set of characteristics and a different valve of the same nominal size could have a considerably different discharge capacity. The published data from a manufacturer’s catalogue below illustrates the point.

<table>
<thead>
<tr>
<th>Valve</th>
<th>size mm</th>
<th>set pressure bar</th>
<th>capacity kg/hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fig 542</td>
<td>50</td>
<td>10</td>
<td>2350</td>
</tr>
<tr>
<td>Fig 500</td>
<td>50</td>
<td>10</td>
<td>5925</td>
</tr>
</tbody>
</table>

Documentation and records relating to such repairs/replacements should be retained and whilst the Competent Person does not normally need to be directly involved it is important to ensure he is made aware of any such work. Depending on the adequacy of the documentation provided he may require a test of the protective device to demonstrate satisfactory functionality. This would certainly apply if the level controls on a steam boiler were replaced for example.

A.3 Pipework

A lot of pressure systems pipework is excluded from the WSE on the basis that a defect giving rise to danger is unlikely to occur and the energy involved is low. Pipework that is included in a WSE and undergoes repair probably does not pose the same level of risk as would a boiler or pressure vessel under repair. Also unlike pressure vessel codes piping codes do not normally specify the involvement of an inspection body. However it needs to be recognised some pipework can potentially pose as much risk as a pressure vessel if it failed.

PSSR only addresses the dangers arising from the sudden release of stored energy and the scalding effects of steam. Nevertheless the risks arising from the leakage of a hazardous fluid from pipework cannot be ignored. In order to set some form of benchmark where the competent person should be directly involved in the repair process, the Pressure Equipment Directive again serves as a useful guide. Where the PED risk category for a particular piping system requires the involvement of a notified body during manufacture (risk category II and above) then the Competent Person should have some direct involvement in the repair. Even when the Competent Person is not directly involved they should undertake some form of review of the documentation relating to the repair.
Appendix 2

Documents normally supplied with a welded repair.

a) Method statement, including sketches / drawing
b) Material Certificate(s)
c) Welding Procedure(s) and welder qualification(s)
d) Welding consumable certificate(s)
e) Results of Non Destructive Testing
f) Non Destructive Testing Personnel certification
g) Hydrostatic Test Certificate(s)
h) Pressure Gauge calibration certificate(s)
i) Results of any PWHT.
j) Reports of any concession(s)

Table 1 – Group 1 Gases (Toxic, Oxidising, Flammable, Explosive)

Please note that this is an extract from Chart 6 of the PER, piping above the line needs full involvement of the Competent Person in the repair/Modification.

Table 2. Group 2 Gases (everything else)

Please note that this is an extract from Chart 7 of the PER, piping above the line needs full involvement of the Competent Person in the repair/modification.
Appendix 3 — Temporary and permanent repairs

A.3.1 Introduction
This appendix addresses the subject of temporary and permanent repairs in more detail; it also identifies some commonly used repair techniques and gives guidance to their application and suitability.

A.3.2 Temporary and permanent repairs
In addition to the information contained in this document, further guidance relating to temporary and permanent repairs can be found from various sources, including but not limited to the following:
- ASME PCC-2: 2011, Repair of pressure equipment and piping.

A.3.3 TEMPORARY REPAIRS
Temporary repairs should be removed and replaced with suitable permanent repairs at the next maintenance opportunity, they may only remain in place for a longer period of time if evaluated, approved, and documented by the person competent to do so.

Any temporary repair applied to a pressure vessel may require a review of the Written Scheme of Examination to ensure all relevant parts are examined adequately.

A.3.3.1 Fillet welded patches
In general, fillet welded patches will not normally be accepted as a suitable repair technique for crack like defects, some of the reasons for this are shown below:
- The damaged material may not be removed from the item.
- The patch can effectively become a projectile that could be forced off the item due to the stresses imposed.
- The geometry of the patch (importantly the lack of a full penetration weld) imposes local bending stresses in the region of the weld and early failure.
- The defect remains under the patch – it is virtually impossible to establish further growth either visually or by using an NDT technique.

Use of a fillet welded temporary repair over corroded region of heat exchanger
Evidence of a crack like defect

Fillet-welded patches may be used to make temporary repairs to damaged, corroded, or eroded areas of pressure vessel components. Cracks shall not be repaired in this manner, unless:

- The crack growth has stopped, been arrested or can be accurately predicted for all potential forms of propagation.
- The effect of the crack like defect is evaluated using detailed analyses (e.g. Finite element analysis, linear elastic fracture mechanics, or similar engineering critical assessment).

Temporary repairs using fillet-welded patches shall be approved by a Competent Person and Engineer; in addition they require special design consideration, especially related to weld joint efficiency. A fillet-welded patch shall not be installed on top of an existing fillet-welded patch.

Fillet welded patches consist of a repair plate being fitted that closely matches the original component’s exterior or interior surface. The repair plate is sized to cover the area exhibiting damage, both at the time of repair and for that damage anticipated for the repair design life.

The repair shall not be used for high hazard applications or when the damage mechanism, extent of damage or likely future damage cannot be established.

A.3.3.2 Documentation associated with temporary repairs should include:

- Location of the temporary repair.
- Specific details about the repair, e.g. material of construction, thickness, size of welds, NDT performed.
- Details of analyses performed.
- Requirements for future inspections.
- Due date for installing permanent repair.
- The inspection plans should include monitoring the integrity of the temporary repair until permanent repairs are complete.

A.3.4 PERMANENT REPAIRS

Typical methods for permanent repair include:

- Excavating the defect, and blend-grinding to contour.
- Excavating a defect and repair welding of the excavation.
- Replacing a section or the component containing the defect (insert or set-in patch).
- Weld overlay of corroded area.

The repair technique chosen will depend on the nature of the defect, size, location etc. and requires acceptance by the Competent Person prior to the repair commencing.

Particular consideration needs to be given when repairing a crack at a discontinuity, where stress concentrations are high, (e.g. crack in a nozzle-to-shell weld or furnace to end plate weld in shell boiler).

Note: Consideration should also be given to the specific situation with fatigue cracks where a localised welding repair to an excavated crack may result in undetected micro cracks local to the repair site.
propagating into cracks. It is therefore important when performing localised welding repairs to remove sufficient material from the repair site to ensure any weld is deposited on sound metal.

A.3.4.1 Insert plates or set-in patch

This is the preferred method of repairing damaged sections of pressure equipment, in particular those containing crack like defects.

Damaged or corroded shell plates may be repaired by removing a section and replacing it with an insert patch (set-in patch), to suitable standards, taking into account the original design code.

The repair procedure should take account of the following:

- Suitable NDT of welds to confirm integrity of repair should be carried out. Defect acceptance limits of the appropriate design standards should be taken into account.
- All insert plate corners should be rounded to a 25mm minimum radius.
- Weld proximity to existing welds should be detailed in the method statement and reviewed by a Competent Person prior to commencement of the repair. It is not advised to carry out repair welds in close proximity to existing welds, typically less than twice material wall thickness.

A.3.4.2 Weld build up / overlay

This repair technique involves the application of weld metal to restore the thickness of an item of pressure equipment.

Weld overlay is typically applied to areas of general or local loss of wall thickness (e.g. pitting, erosion). The purpose of this repair method is to restore a component’s thickness and / or corrosion allowance to original. Careful consideration should be given when using this method to restore the item’s suitability for pressure containment. Additionally, the technique is not suitable for repairing crack like defects.

When carrying out the technique, it is vital to ensure via NDT that the underlying material is sound and free from defects, this will give confidence in the integrity of the final repaired region.

A.3.4.3 Tube to tube sheet welds

Tube to tube plate welds may be designed as strength welds required to support the tube plate, or seal welds. These joints may be seen by repairers as less significant than other repairs as the potential for catastrophic failure is low but an inadequately made tube to tube sheet weld can have a reduced service life.

From a welding engineering perspective the issue surrounds the very different thicknesses in the tube sheet to tube and the positional requirements which make it difficult for the welder to complete a sound weld.
REFERENCES


2 STATUTORY INSTRUMENTS 1999 No. 2001 HEALTH AND SAFETY The Pressure Equipment Regulations 1999 [as amended by the Pressure Equipment (Amendment) Regulations 2002

3 API 510 : Pressure Vessel Inspection Code: Maintenance Inspection, Rating, Repair, and Alteration

4 API 570 : Piping Inspection Code: Inspection, Repair, Alteration, and Rerating of In-Service Piping Systems

5 ASME PCC-2-2001 : Repair of Pressure Equipment and Piping.

6 SAFed SBG1 Guidelines – shell boilers – Guidelines for the examination of shell to endplate and furnace to endplate welded joints (specifically section 7). – Gives basic guidance relating to applicable repair techniques in furnace to endplate welded joints.
