GUIDELINES

Guidelines on Periodicity of Examinations

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Foreword

The purpose of these Guidelines is to provide practical information on the recommended intervals between successive examinations of pressure systems undertaken in accordance with the Pressure Systems Safety Regulations 2000 (PSSR 2000). The Guidelines also provide information about the factors to be considered when assessing whether it is appropriate for an existing interval between successive examinations to be amended.

These Guidelines, which are based on the collective experience of Safety Assessment Federation (SAFed) member companies, should only be adopted after proper consideration has been given to the individual circumstances pertaining to each system.

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Chapter

0. BACKGROUND

0.1 Flexibility of periodicity within the scope of PSSR

Guidance contained in the L122 PSSR ACOP puts into context, examples of the expected type and periodicity of inspection carried out under the Written Scheme of Examination

> ***106.*** *The nature of the examination should be specified in the written scheme. This may vary from out-of-service examination with the system stripped down, to in-service examination with the system running under normal operating conditions.*
>
> ***108.*** *When deciding on the periodicity between examinations, the aim should be to ensure that sufficient examinations are carried out to identify at an early stage any deterioration or malfunction which is likely to affect the safe operation of the system. Different parts of the system may be examined at different intervals, depending on the degree of risk associated with each part.*
>
> ***115.*** *There are many factors to be considered by the competent person when deciding the maximum interval between examinations under the written scheme of examination (see paragraph 110). The competent person should use their judgement and experience to determine the appropriate interval based on the relevant information. Earlier legislation set out maximum examination intervals for some types of equipment. The competent person may wish to consider using these as a guide when drawing up or certifying the written scheme of examination, if appropriate for that system. For steam plant the period was usually 14 months with more frequent examinations specified where operating conditions were arduous. The examination period for steam receivers linked to such plant was generally in the range of 26–38 months. Air receivers on compressed air systems were generally examined every 24–48 months, with examinations taking place less frequently, ie every 72 months where corrosion was minimal and maintenance of safety standards was high.*

This guidance finds that the overall Written Scheme of Examination can include regular in-service and out-of-service undertakings, together with review points where the WSE is reflected upon, to ensure it remains appropriate for application. For further guidance on types of Examinations refer to PSG 06 - Guidelines for the examination of pressure systems in accordance with Written Schemes of Examination (WSEs).

0.2 Who determines and amends the Periodicity

Under PSSR, the person determining intervals/ periodicity would be the CP who devises the Written Scheme.

0.3 Commissioning

Paragraphs relating to Regulation 8 of L122 PSSR ACOP puts into context, the point at which a WSE should be created and how this may be applied to commissioning of a pressure system:

> ***96.*** *Before a pressure system is operated the user/owner must ensure that a written scheme of examination has been prepared. The written scheme of examination should be drawn up by a competent person, or if drawn up by someone other than a competent person, certified as suitable by a competent person.*
>
> ***107.*** *Where appropriate, the requirement for an examination before the system is first taken into use should be specified in the written scheme of examination.*

This guidance finds that a WSE should be devised before operation/partial operation to validate the safety of the overall pressure system before it is energised under its own power, resulting in pressurisation.

0.4 Determining maintenance safety standards

Interaction between Examination and maintenance will be key to ensure the ongoing safety of pressure equipment.

The Provision and Use of Work Equipment Regulations (PUWER) 1998 Approved Code of Practice (L22) states,**" the extent of the inspection required will depend on the potential risks from the work equipment. Inspection should include, where appropriate, visual checks, functional checks and testing".**

1. EXAMINATIONS

The Pressure Systems Safety Regulations 2000 (PSSR 2000) and the associated Approved Code of Practice recognise and reinforce the safety provided previously by statutory in-service examinations at prescribed intervals. Under the Regulations the range of pressure systems requiring regular examination by a competent person has been increased and flexibility in setting the intervals between examinations has been introduced. The Regulations also contain a requirement for a **Written Scheme of Examination (WSE)** that specifies the nature of and frequency with which examinations should be carried out.

The derivation of examination intervals requires all relevant factors to be taken into account, including consideration of:

- design details
- method of construction
- conditions of use
- standards of maintenance
- the safety record of the system
- its current condition, and
- an evaluation of the conditions of operation of the system, based on information provided by user/owner.

Shorter intervals between examinations may be appropriate for systems operating under more arduous conditions.

1.1 INITIAL EXAMINATION (Prior to placing into service)

A written scheme of examination (WSE) is required to be in place before the pressure system is operated under normal conditions. It is noted that commissioning may involve undertaking functional checks and trial running, without ALL of the normal safeguards in place.

Upon completion of the commissioning process it would be expected that the WSE would be reviewed by the Competent Person devising the document, prior to placing in-service.

This review process may be termed "initial examination" and should review the overall integrity of the pressure system taking into account:

- whether suitable criteria for design and manufacture have been adopted and implemented to an appropriate standard *e.g.* a recognised British or International Standard
- pressure, temperature and loading parameters
- fitness for purpose
- the characteristics of the foundations, supporting steelwork, holding down bolts and pipework loads
- the condition of external finishing e.g. painting and lagging
- whether there is appropriate provision of valves, plugs, blanks, drain legs *etc*

- ❖ whether appropriate protective devices and instrumentation have been fitted.

An initial examination may additionally be required to establish:

- ❖ base line data for corrosion/erosion monitoring facilities
- ❖ the safe operating limits of a pressure system e.g. a full dimensional survey, calculation of stress levels, non-destructive and hydraulic testing

The requirement and/or extent of an initial examination should be considered when preparing a WSE, based on the complexity of the system.

1.2 FIRST OUT OF SERVICE EXAMINATION

The first examination has particular significance; any deficiencies in the system design, manufacture and installation may be revealed during the initial period of service. The pressure system will be taken out of service, cleaned and made ready to allow this examination to take place.

This examination significantly influences the subsequent periodicity and may also involve a review of what components are examined. With environmental considerations changing the nature of damage mechanisms, it is emphasised that this examination is crucial and delay or postponement in this first examination should not be undertaken.

1.3 SUBSEQUENT EXAMINATIONS

The timing of subsequent examinations should be determined by the intervals recommended in these Guidelines, considering the results of the first examination and the significance of any changes in operating parameters, changes in operating regime, defects or deterioration and any other relevant factors (in particular, those established from the previous examination).

1.4 IN-SERVICE EXAMINATIONS AND VERIFICATION OF PROTECTIVE DEVICES

The importance of In-service examinations and verification of correct operation of protective devices should not be overlooked and be completed as soon as practicable after the Out of service Examination.

1.5 ADDITIONAL EXAMINATIONS

When significant changes are made to a pressure system - e.g. the addition of new vessels or pipework, or changes to the operating conditions or safe operating limits - the competent person must review the WSE.

1.6 PIPEWORK EXAMINATIONS

The nature of Regulation 8 of the PSSR 2000 and its associated Approved Code of Practice is to enable the exclusion of low risk pipework from the WSE (See PSG 5 - Guidelines for Competent Person In-service examination of pressure systems pipework).

2. REVIEW OF INTERVALS BETWEEN EXAMINATIONS

2.1 GENERAL

Before an examination interval is changed or the content modified over that currently set, both the user/owner and the competent person should perform an authoritative review. The purpose of this review is to enable the user/owner and the competent person to satisfy themselves that the safety of the system will not be prejudiced if the interval between examinations is extended.

The authoritative review is led by the Competent Person, however factors relating to the maintenance and operational regime in place, i.e. how the system is being operated can only be led by the user/ owner. Therefore, reliance on providing accurate key information is placed on the user/ owner and it is the responsibility of the CP to record the information provided by the user/ owner, as a basis for determining the periodicity.

2.2 FACTORS TO BE CONSIDERED

It will be the responsibility of the user/owner to ensure that the competent person is aware of all the features and operating conditions of the pressure system that could affect the intervals between examinations – in particular how the pressure system is performing (operational and maintenance history).

In individual cases, particular circumstances that are not covered in this section of the Guidelines may need to be considered.

The relevance of factors to be considered when undertaking an authoritative review will vary with each case; the competent person will need to make a case-by-case assessment and discount factors which would not influence the examination requirements.

2.2.1 History/documentation

a) Previous examination reports
Previous examination reports should be reviewed to establish whether any trends in the deterioration of the system are detectable; any trends detected should be assessed to ensure, as far as possible, that the system shall remain safe throughout the proposed extended examination interval.

b) Non-destructive testing (NDT) records
NDT records should be reviewed; the significance of any existing defects should be assessed, and the frequency of future NDT should be established as part of the assessment. Details of the origin of the NDT report (qualifications of the author) should be included with the relevant reports.

c) Modifications/repairs
Documentation associated with previous modifications and repairs should be reviewed to ensure that the work was undertaken satisfactorily; the period of operation prior to modification/repair should be established.

d) Safety record of the system
Details of any safety-related incidents involving the system under review should be assessed to establish whether there are any factors - such as operation and maintenance - which would indicate that the examination interval should not be increased.

e) Experience with similar types of systems
Where information is available for similar types of system, either at the same location or at other locations, this information should be reviewed to establish whether there are any additional factors that need to be considered in the assessment.

f) Technical Guidance Notes/Codes of Practice
Technical Guidance Notes and/or Codes of Practice should be referenced and any relevant information taken into account when determining the examination interval.

The relevance of the above factors will vary with each case; the competent person will need to make a case-by-case assessment and discount factors that would not influence the examination requirements.

g) How the pressure system is operated and maintained. This will require demonstration of the training and supervision of operational staff, together with access by the CP to the maintenance history and production logs. This work will require extensive review and will be additional to contract in many cases.

Alternatively, for user/ owners who operate a predictive maintenance regime, they may take the lead in identifying relevant demonstration of the effectiveness of the maintenance regime in place, including how fault-finding and rectification by design-out are undertaken.

2.2.2 Safe operating limits

a) Change of safe operating limits
Consideration should be given to any changes that have been made to the safe operating limits and the effects that such changes may have on the system.

b) Fatigue assessment
Assessment will require identification of relevant structural, fixed and moving parts of the pressure system, including safety devices. A combination of theoretical analysis, review of operating history, consideration of similar applications, etc. should then permit the review to be undertaken by the Competent Person. Where significant concern remains, the User/Owner should be approached with a recommendation to undertake a thorough design review over the ongoing suitability (for application) of the pressure system.

c) Creep life
The creep life of components operating within the creep range should be established by calculation; where appropriate, metallurgical and non-destructive testing should be undertaken to confirm the remnant life.

NB: There may be other factors to consider, the above list is NOT Exhaustive.

2.2.3 Operation and maintenance (user/owner responsibilities)

By using the information in the points listed below, the CP must satisfy themselves that there is sufficient operational/maintenance history and that any unplanned interruptions have been dealt with effectively, such that repeat breakdowns have not occurred.

a) Operation of the system
The user/owner has responsibility for the method of operating the system and the user /owner must review this to ensure it is operating satisfactorily; any manufacturers' recommendations should be considered and possible future changes in system operation should also be considered by the user/owner.

b) Technical supervision
The experience of staff and management involved in the operation and maintenance of the system, as well as their level of training, should be considered.

c) Maintenance procedures
The maintenance system should form part of the review.

The CP is only present during the period of the Examination, so would not be able to undertake a full review of how the pressure system is being continuously maintained.

However, the user/ owner should be able to demonstrate a preventive/ predictive maintenance system is in place and be able to provide supporting evidence in the form of maintenance history of the subject pressure system, to include as a minimum:

i. Record of unplanned interruptions to plant availability (i.e. breakdowns) for the previous 24-month period
ii. Record of routine service inspections undertaken for the previous 24-month period
iii. Evidence of root-cause failure analysis/ design review to address any unplanned outages.

2.2.4 Service conditions to be considered by the CP

a) Current condition and age of the system
The current condition of the system should be determined to ensure that it has been well maintained and that there is no evidence of misuse or neglect; special considerations may apply if the system is approaching the end of its useful life.

b) Environmental conditions
Systems which are not protected from the environment and systems which operate in an aggressive atmosphere - *e.g.* high salinity or humidity ~ will require special consideration.

c) Nature of system contents
The nature of substances that will be introduced into the system needs to be considered to ensure that they are compatible with the materials of construction; the effects of corrosive, unstable or contaminated fluids should be taken into account.

d) Facilities for interim examination
Consideration should be given to the possibility of undertaking interim examinations in order to give an indication of any deterioration in the condition of parts that may affect the integrity or safety of the system.

e) On-stream monitoring
Any available data from existing on-stream monitoring devices should be considered; it may be appropriate to investigate the fitting of on-stream monitoring equipment to provide additional justification for extending the examination interval.

f) Type and condition of protective devices
The type and condition of protective devices should be reviewed to establish their suitability and appropriateness for the extended examination interval.

NB: Protective devices present particular problems when extending examination intervals; they are often mechanical devices that operate infrequently, they may be subjected to variable environmental conditions and be affected by the contents of the system when operated.

It is therefore recommended that any proposed extensions to examination intervals should be justified by testing and verifying calibration in the 'as removed' condition.

2.2.5 Failure modes
All foreseeable failure modes should be considered; where appropriate, examination intervals that give a suitable safety margin against a failure occurring should be specified.

Failures that could potentially lead to an unintentional release of stored energy need to be addressed.

Defects which could lead to minor leakage and other, non-serious defects, would not preclude extension of examination intervals provided that: continued operation would not lead to a dangerous situation, and the process is unaffected by, for example, contamination.

2.2.6 Examples of damage mechanisms (non-exhaustive list)

a) Corrosion/erosion
Current material thicknesses should be determined and reviewed against the original values to ascertain any reduction; this information should be used to establish that the predicted thickness at the next examination shall still be sufficient to withstand pressure and other loadings.

b) Fatigue
The system should not normally be operated beyond the fatigue life unless there is evidence to do otherwise.

c) Corrosion fatigue
The operating conditions and environment need to be considered; crack growth rates can be greatly increased in a corrosive environment.

d) Stress corrosion cracking
The susceptibility of the materials of construction - including welds and heat affected zones - to stress corrosion cracking from either internal or external sources should be considered.

e) Brittle fracture
The possibility of reduced ductility at low temperatures, or the effects of strain ageing of materials raising brittle/ductile transition temperatures should be considered, particularly where a crack growth situation can occur.

f) Overpressure
The potential for failure of protective devices to limit operating conditions to safe levels should be addressed when examination intervals for protective devices are extended.

g) Overheating
Where maximum temperatures could be exceeded due to operational effects, loss of contents, build-up of scale or other causes, precautions to maintain temperatures within safe operating limits will be necessary; examination periods should take into account the need to prevent overheating.

2.3 RELEVANT INFORMATION

The following information should be provided by the user/owner to the competent person:

2.3.1 All Pressure Systems

Characteristics of relevant fluid e.g.
- Boiling point
- Pressure/temperature relationships
- Corrosive effects
- Likelihood of stress corrosion cracking.

Actual operating conditions e.g.
- Maximum and minimum pressure
- Maximum and minimum temperature
- Frequency and range of pressure/temperature cycles
- Frequency and range of filling/emptying cycles
- Details of any sudden changes of pressure or temperature.

Safe operating limits e.g.
- Pressure
- Temperature
- Capacity
- Fatigue and/or creep design.

Protective devices e.g.
- Type
- Size
- Location
- Capacity
- Setting
- Manufacturers' recommendations.

History
- Previous examination reports
- Records of non-destructive testing
- Experience with similar systems
- Safety record of the system
- Any changes to safe operating limits.

2.3.2 Components of the pressure system

Unfired Pressure Vessels
- Manufacturer
- Serial Number
- Design standard and category/class

- Date of manufacture
- Hydraulic test pressure and date of last test
- Maker's drawings and test certificates
- Construction details (from maker's drawings where available or from a dimensional survey)
- Details of any repairs or modifications
- External environment
- Significant vibration.

Boilers
- Manufacturer
- Serial Number
- Design standard and category/class
- Date of manufacture
- Hydraulic test pressure and date of last test
- Maker's drawings and test certificates
- Construction details (from maker's drawings where available or from a dimensional survey)
- Details of any repairs or modifications
- Type of fuel and firing
- Method of burner operation e.g. on/off or modulating
- Method of water-level control e.g. on/off or modulating
- Water treatment system and records
- Frequency and nature of boiler water tests
- Quality and amount of condensate return
- Manning of boiler house
- Qualifications and experience of operators and supervisors.

Pipework
- Size and extent
- Design specification
- Parts included in a WSE
- Hydraulic test pressure and date of last test
- Construction details (from maker's drawings where available or from a dimensional survey)
- External environment
- Type and condition of lagging
- Provision for flexibility
- Details of any repairs or modifications.

Protective devices
- Record of examination e.g. interim lift tests and tests in the 'as removed' condition.

The relevance of the items of information listed will vary for each case; the competent person will need to make a case-by-case assessment and discount those which would not influence the examination requirements.

In individual cases, particular circumstances which are not covered here may need to be taken into account; it is the responsibility of the user/owner to ensure that the competent person is aware of all the features and operating conditions of his system which could affect the intervals between examinations.

2.4 ASSESSMENT OF THE SYSTEM

This assessment should consider the likely condition of the system at the end of the proposed examination interval. Only if the safety of the system at the end of the interval would be comparable with normal pressure equipment codes should the interval be extended.

2.5 RECORD KEEPING

Regulation 14 of the PSSR 2000 requires the user/owner of a pressure system to keep certain relevant documents; such documents should include the supporting information and conclusions relating to the assessment of extended examination frequencies.

2.6 RESPONSIBILITY

2.6.1 User/owner
The user/owner is responsible for the accuracy of the information provided to the CP.

Where the user/owner does not have the necessary technical expertise to ensure the above, the competent person may assist in obtaining some of the information.

2.6.2 Competent person
The competent person is responsible for:

- reviewing the information provided
- determining the suitability of the proposed examination interval
- identifying any additional examination requirements, and
- certifying the amended WSE.

3 RECOMMENDED MAXIMUM INTERVALS BETWEEN OUT OF SERVICE EXAMINATIONS

3.1 Examination Classification

The below examination classifications are based on historical experience as proven over time to produce risk classification.

Class A
Vessels should be allocated to this class where there is little evidence on which to predict their behaviour in service.

Vessels subjected to a daily pressure cycle would normally be allocated to this class.

Class B
This class is appropriate for vessels that are not expected to deteriorate significantly but where there is insufficient evidence to justify allocation to Class C. When examination over an extended period has proved that significant deterioration is not taking place, Class B vessels may be transferred to Class C.

If, on examination, unexpected deterioration is found in any vessel, the examination class and the periodicities must be reviewed; if necessary, the classification should be changed to Class A.

Class C
This classification permits examination intervals up to a maximum of 12 years.

Allocating equipment to Class C may be justified as follows:

a. Equipment has been examined on successive occasions and no deterioration found after a total of at least 72 months and no significant changes to the preceding operating conditions and operating regime are anticipated over the next planned operating period.

   The equipment may be specified as Class C and the next examination scheduled after an interval that does not exceed the total service life of the vessel up to the last examination.

   This principle may be applied to a group of vessels.

b. A new or recently installed vessel:

   - performs a duty similar to that of an existing Class C item.

   - is substantially the same as an existing item in terms of material of construction, design details, pressure, temperature and nature of contents.

3.2 Operating conditions

Pressure systems will be operated at either:

a. Steady conditions

b. Variable conditions
Where the operating cycle is significantly variable, with unknown number of changes in operating starts and shutdowns. The power source will potentially be unreliable (i.e. household waste, etc. where the calorific value/ content can change load by load).

3.3 EXAMINATION INTERVALS OF 12-14 MONTHS

Steam and hot water boilers operating under variable service conditions, and pressure vessels where rapid deterioration can be expected, should be subject to examination intervals of no more than 12-14 months.

3.3.1 Steam and hot water boilers operating under variable service conditions

Experience with this type of plant has shown that rapid deterioration can occur. Additionally, safety devices may be fitted to a common manifold, resulting in the potential that where the common pipework attaching to the manifold scales up/ becomes blocked, it renders all safety devices inoperative.

Boilers would normally have some or all the following conditions or features:

- Cyclic operation through repeated shut-down and start-up and/or significant pressure cycles during operation
- Burner operation on/off or high/low from pressure switch
- Water level control by start/stop of feed pump
- Water treatment by non-specialist personnel with occasional monitoring by chemical supplier
- Quality of condensate return not monitored
- Boiler house not continually manned to provide supervised firing up from cold or immediate response to sudden pressure variations, trips and alarms or failure of water treatment

The above circumstances have given rise, in similar plants, to the following types of defect:
❖ **CORROSION** *fireside, waterside, general pitting, blotching* ❖ **EROSION** ❖ **THERMAL FATIGUE** ❖ **CORROSION FATIGUE CRACKS** ❖ **GROOVING**

Additional conditions or features.

- Flat set-in or set-on endplates/tubeplates
- Corner welded fire boxes
- Flat stayed plates.
- Hard stamping of boiler tubes manufactured to BS EN 10217-2: (2002+A1:2005)

Examples of boilers within this group include:
❖ **SHELL BOILERS** *fired or unfired, horizontal or vertical* ❖ **LOCOMOTIVE BOILERS** ❖ **WATERTUBE BOILERS** ❖ **CAST IRON SECTIONAL BOILERS** ❖ **SELF GENERATING AUTOCLAVES OR JACKETED PANS** ❖ **COIL STEAM GENERATORS** ❖ **SUPERHEATERS AND ECONOMISERS** *connected to boilers in this group* ❖ **STEAM TUBE OVENS/HOT PLATES**

3.4 EXAMINATION INTERVALS OF 24-26 MONTHS

Plant for which examination intervals of 24-26 months would be appropriate include steam and hot water boilers operating under steady conditions, and certain categories of pressure vessels and pipework.

3.4.1 Steam and hot water boilers operating under controlled service conditions

Boilers in this category would normally have some or all the following features:

- A record of operation for extended periods without problems
- Steady load conditions
- Fully modulating burner control system
- Fully modulating water level control system
- Regular monitoring of water treatment by in-house specialist staff
- Monitoring of condensate return for contamination - where appropriate
- Boiler house continually manned by staff fully trained for immediate response to alarm conditions

Examples of boilers within this group include:
❖ **LARGE WATERTUBE BOILERS** *closely controlled and supervised operation* ❖ **WASTE HEAT BOILERS** *Integral to continuous flow installations* ❖ **SUPERHEATERS AND ECONOMISERS** *connected to boilers in this group*

NOTE

Consideration should be given to an interim in-service examination under normal operating conditions at the mid-point of any examination period that exceeds 12-14 months.

3.4.2 Pressure vessels potentially subject to rapid deterioration

Vessels in this category would normally have some or all the following conditions or features:

- Contents which cause rapid corrosion/erosion
- Potentially corrosive external environment
- Vessel subject to significant vibration
- Vessel subject to significant cyclic pressures
- Vessel subject to significant cyclic temperatures and/or thermal shock
- Safety valves or other protective devices susceptible to blockage
- Rivetted seams
- Inwardly dished ends
- No reinforcement of mounting plates
- Removable covers for charging purposes.

Examples of vessels within this group include:
❖ **CLASS A PROCESS VESSELS** ❖ **RIVETTED AIR RECEIVERS** ❖ **VESSELS WITH ONE OR BOTH ENDS INWARDLY DISHED** ❖ **AIR RECEIVERS** *not regularly drained* ❖ **AIR/PAINT CONTAINERS** ❖ **SHOT BLAST VESSELS** ❖ **STEAM RECEIVERS** ❖ **AUTOCLAVES/MEDICAL STERILISERS** ❖ **JACKETED PANS** ❖ **STEAM ACCUMULATORS**

3.4.3 Pipework potentially subject to rapid deterioration
Pipework in this category would normally have some or all the following features:

- ❖ Contents which can cause rapid corrosion/erosion
- ❖ Potentially corrosive external environment
- ❖ Pipework subject to significant vibration
- ❖ Pipework subject to significant cyclic pressures
- ❖ Pipework subject to significant cyclic temperatures and/or thermal shock.

3.5 EXAMINATION INTERVALS OF 26-48 MONTHS
Plant to be considered for examination intervals of 26-48 months could include: watertube steam boilers operating under the highest level of supervision.

3.5.1 Watertube steam boilers and waste heat boilers
The boilers should meet the appropriate conditions previously listed with the following additions:

- ❖ On-line, continuous, automated monitoring of service conditions
- ❖ Effective control and recording of thermal transients during load changes
- ❖ Highly expert operating and maintenance staff
- ❖ Highly expert engineering support and control
- ❖ Established paths of communication with specialist expertise on:

  Water chemistry
  Failure mechanisms
  Metallurgy
  Fracture mechanics
  Crack growth problems.

Examples of boilers within this group include:
❖ **WATERTUBE BOILERS FOR POWER GENERATION** *established expertise in operation and control* ❖ **WASTE HEAT BOILERS IN PETROCHEMICAL OR AMMONIA SYSTEMS** *integral parts of continuous flow installations*

NOTE
To assess the suitability of watertube boilers above a formal review of relevant factors will need to be carried out and any additional control measures/operational limits identified.

3.5.2 Pressure vessels not expected to deteriorate to danger within the examination frequency

Vessels in this category would normally have some or all the following conditions or features:

- Contents do not cause rapid corrosion/erosion
- External environment is not corrosive, or there is a suitable protective coating in place
- Vessel not subject to significant vibration
- Vessel not subject to significant cyclic pressures
- Vessel not subject to significant cyclic temperatures and/or thermal shock.

Examples of vessels within this group include:

- **CLASS B PROCESS VESSELS**
- **WELDED OR SOLID DRAWN AIR RECEIVERS**
  well maintained, regularly drained, less than one full pressure cycle per day,
- **STEAM RECEIVERS**
  integral to boilers on this examination interval

3.6 EXAMINATION INTERVALS OF 48 - 72 MONTHS

3.6.1. Pressure vessels not susceptible to significant deterioration

For such vessels experience has shown that deterioration does not occur under normal operating conditions; they should meet the conditions above with the following additions:

- A record of similar vessels demonstrates that deterioration does not occur
- Where compressed air is used, condensation in the vessel is prevented by control of relative humidity.

Examples of vessels within this group include:

- **CLASS B AND C COMPRESSED LIQUEFIABLE GAS VESSELS**
- **AIR/OIL RECEIVERS**
- **PRESSURE VESSELS ON AIR BLAST CIRCUIT BREAKERS**
- **CARBON DIOXIDE STORAGE VESSELS**
- **CHLORINE STORAGE VESSELS**
- **AMMONIA VESSELS**
  stress corrosion cracking absent
- **UNDERGROUND OR MOUNDED LPG VESSELS**
- **ABOVE GROUND LPG VESSELS**
  no internal access

3.6.2 Pipework not susceptible to rapid attack

Pipework in this category would have some or all of the following features:

- Contents do not cause rapid corrosion/erosion
- External environment is not' corrosive, or there is a suitable protective coating in place
- Pipework not subject to significant vibration
- Pipework not subject to significant cyclic pressures
- Pipework not subject to significant cyclic temperatures and/or thermal shock.

3.7 EXAMINATION INTERVALS OF 120-144 MONTHS

3.7.1 Pressure vessels

Examination intervals of 120-144 months would be appropriate for pressure vessels where there is extensive, documented experience of satisfactory operation for extended periods without deterioration.

Examples of vessels within this group include:
❖ **CLASS C COMPRESSED LIQUEFIABLE GAS AND PROCESS VESSELS** ❖ **ABOVE GROUND LPG VESSELS** *internal access;* subject to *60* months *external examination* ❖ **LARGE STAINLESS STEEL BREWING VESSELS**

3.8 VESSELS WITH REMNANT LIFE PARAMETERS

Some vessels may have a finite life determined by:

a a requirement to operate at high temperature, coupled with a design life using stresses based on specific creep data
b being subjected to pressure cycling as a result of process conditions or frequent start-up and shutdown; fatigue cracking may be caused if the cyclic design life of the vessel is exceeded.

Vessels subjected to such conditions should be allocated a predicted life based on their design criteria.

3.8.1 Up to 80% of limited life

Examination intervals should be based on 20% of the calculated life, subject to the following maximum periods:

❖ Class A	26 months
❖ Class B	48 months
❖ Class C	96 months

3.8.2 More than 80% of limited life

Examination intervals should be based on 10% of calculated life, subject to the following maximum periods:

❖ Class A	14 months
❖ Class B	Not applicable
❖ Class C	Not applicable

Specialist advice should be sought from the competent person for vessels that may be subject to these conditions and are already in service.

When considering the significance of cyclic pressure and temperature conditions, experience with similar plant operating under the same conditions may be considered.

Check that compressor has not been retrofitted with a SS vessel, such that the OEM design has changed.

3.8.3 Temperature limited vessels

The following measures are recommended:

i. base line measurements recorded before the vessels enter into service; these will provide a basis of comparison for subsequent in-service measurements to detect creep
i. records of operating temperature and pressure available for reference during subsequent examinations
iii. a remnant life review of the examination reports and process history of the vessel, carried out when 80% of the predicted life has been used; this will enable the future life of the vessel to

be determined and any necessary changes in the scope or frequency of examinations to be identified.

TABLE 1 A general guide to vessels considered to be temperature-limited.

Material of Construction	Design Temperature
Carbon Steels	**> 400^{0}C**
1/2 Molybdenum Steels	**> 430^{0}C**
Chromium-Molybdenum Steels	**> 470^{0}C**
Austenitic Steels	**> 570^{0}C**
Incoloy, Inconel	**> 600^{0}C**
Aluminium Alloys	**> 100^{0}C**
Copper Alloys	**> 200^{0}C**
Titanium	**> 150^{0}C**

Where the design stress is 66% of the average stress to cause creep rupture in a given number of hours, the predicted life should be taken as that number of hours.
E.g. Design stress 66% of average stress for rupture in 100,000 hours
Predicted life 100,000 hours

3.8.4 Cycle limited vessels
The following measures are recommended:

i. records of the number of in-service pressure cycles to which the vessels have been subjected to be available
ii. highly stressed areas, where cracking is likely to originate, given special attention during examination
iii. formal reviews of the vessel history, including an assessment of the vessel's remaining life, to be undertaken at appropriate intervals when 80% of the predicted life has expired.

3.9 PIPEWORK EXAMINATION INTERVALS

3.9.1 High temperature steam pipework operating in the creep region
For pipework operating under these conditions, the following examination intervals are recommended:

- *up to 80% of design life*
  examination interval 20% of the calculated design life, subject to a maximum interval of 60 months
- *over 80% of design life*
  examination interval 10% of the calculated design life, subject to a maximum interval of 36 months.

3.9.2 Pipework potentially subject to fatigue
For pipework operating under these conditions, the following examination intervals are recommended:

- *up to 80% of design life*
  examination interval 20% of the calculated design life, subject to a maximum interval of 60 months
- *over 80% of design life*
  examination interval 10% of the calculated design life, subject to a maximum interval of 36 months.

3.10 PROTECTIVE DEVICE EXAMINATION INTERVALS

Devices designed to protect the pressure system against system failure

Examples include:

- ❖ safety valves
- ❖ bursting discs
- ❖ vacuum release valves
- ❖ atmospheric and barometric legs.

Devices designed to warn of possible system failure

- ❖ pressure and/ or temperature gauges
- ❖ pressure and / or temperature cut-out devices / alarms
- ❖ overfill devices including load cells, liquid level gauges, and abnormal operation/ condition protection devices.

Protective devices fitted to systems should be examined at least at the same interval as the vessel to which they are fitted.

Some protective devices may need to be examined at more frequent intervals.

Bursting discs should be changed at the intervals recommended by the manufacturer. If no manufacturers recommendation exists, then a maximum of 5 years unless suitable evidence is provided.

Owing to the multiplicity of devices and the wide variety of conditions under which they operate, examination intervals can only be recommended in general terms:

4. **BIBLIOGRAPHY**

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7) PSG 05 - Guidelines – For Competent Persons – In-service examinations of pressure systems pipework

9) PSG 06 - Guidelines – For the examination of pressure systems in accordance with Written Schemes of Examination (WSEs).

10) PSG 09 - Guidelines – The contents of PSSR WSE's.

11) PSG 18 - Guidelines for users and CP's on postponement of examinations.