Pressure Guidelines

GUIDELINES

Guidelines for the Production of Written Schemes of Examination and the Examination of Pressure Vessels Incorporating Openings to Facilitate Ready Internal Access

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1. INTRODUCTION

The purpose of these Guidelines is to provide guidance for the drawing up of Written Schemes of Examination (WSE) in accordance with the Pressure Systems Safety Regulations 2000 (PSSR 2000) and the associated examination of pressure vessels incorporating means for ready internal access. They are intended to assist competent persons when assessing the protective, safety and control devices fitted to such pressure vessels. The introduction of more complex control/safety devices such as programmable logic controllers has brought about the need to clearly define the scope of examination for safety devices. The aims of these Guidelines are therefore to provide good practice guidance on:

- Contents of WSE
- Examination/Testing Requirements
- Reporting
- Requirements of Health and Safety Executive (HSE) Guidance Notes PM73 and Safety at high temperature textile dyeing machines http://www.hse.gov.uk/textiles/high-temperature.htm

2. SCOPE

These Guidelines address a range of types of quick–opening doors and also refer to other types of closures such as bolted covers fitted to pressure vessels.

Examples of vessels that may be fitted with such closures are:

High Temperature Dyeing Machines
Steam and Gas Autoclaves including Retorts
Bench Top Type Autoclaves and Sterilisers
Pressurised Jacketed Pans
Reactor Vessels
Curing Kilns
Timber Impregnation Vessels
Pressurised Road and Rail Tankers
Pressurised Storage Tanks/Vessels

Examples of closures that may be fitted to the above vessels include:

Quick-Opening Doors
Single and Multi-Bolted Covers
Clamps and Clamp Rings

These Guidelines are not intended as a specification for safety devices for new installations. These should be manufactured in accordance with the Pressure Equipment Directive and should comply with the requirements of relevant Harmonised European Standards supporting the directive. However, at the time of placing pressure equipment into service the competent person has to take account of the identified hazards and appropriate protective devices in order to draw up a WSE in accordance with PSSR 2000.Hazards associated with the toxic/corrosive properties of the vessel contents are not considered within these Guidelines. The user will need to address these aspects, together with levels of supervision and training in their risk

assessment in accordance with Regulation 3 of the Management of Health and Safety at Work Regulations 1999.

3. HAZARD ASSESSMENT FOR WRITTEN SCHEME OF EXAMINATION

3.1 Hazards

The hazards associated with access doors for pressure vessels are primarily concerned with the sudden release of stored energy, violent displacement of doors and fastenings under residual pressure and the release of high temperature liquids or gases. The identification of common hazards related to these types of pressure systems are shown below. These should be assessed at the time of drawing up the WSE.

Sudden release of stored energy

Sudden release of stored energy can occur under the following circumstances:

- Pressure is applied to the vessel before the door is properly closed and secured
- The door is opened whilst there is still pressure in the vessel
- The door securing devices fail
- An overpressure situation arises where the pressure relief devices cannot discharge a rapid build up of pressure following a reaction between the vessel contents, or sudden decomposition of those contents

Residual pressure

Danger to personnel due to the violent displacement of doors and fastenings may occur with the sudden release of stored energy in the following situations:

- For large diameter doors when even a very low residual pressure in the vessel can cause large forces on the door if the fastenings are released
- If the door seal or joint causes the door to stick in position after the fastenings have been removed and it is subsequently dislodged when residual pressure is present

Discharge of high temperature contents

High temperature liquids and gases could create an additional hazard when:

- The door of a vertical vessel is opened with liquid contents at or near to its atmospheric boiling point. The hot liquid can flash into vapour and sudden boiling of the liquid causes the contents to erupt violently from the vessel
- The door of a horizontal vessel is opened whilst hot liquid, e.g. process fluid or condensate, is still contained in the vessel
- Hot liquid is ‘trapped’ in the vessel and subsequently released after the door is opened;
- Operators are inside a vessel and hot fluids enter from other vessels or connections
- Sealed glass or other containers explode due to excess pressure in the containers when the pressure in the vessel is released
- There is a discharge of high temperature gases due to covers not being properly secured with the chance of scalding operators

3.2 Application of hazard assessment

The results of the hazard assessment should be used to determine the suitable protective /safety devices and operating procedures that need to be in place so that the risks due to these hazards

are minimised. Experience has shown that reliance should not be placed entirely on operating procedures and that suitable interlocks are necessary to prevent dangerous situations.

Autoclaves and similar vessels

Generally, the interlocks and fittings specified in HSE Guidance Notes PM73 and Safety at high temperature textile dyeing machines should be provided, as a minimum, on autoclaves and similar vessels. In addition, the examination/testing of these interlocks and fittings should be included in the WSE. Where this is not the case, a risk assessment is necessary to ensure that identified hazards have been suitably addressed. Written operating procedures and instructions to operators should also be provided.

Other vessels

Many vessels other than autoclaves or similar vessels have doors fitted for internal access, for example, charging or cleaning openings on chemical reactor vessels or access lids on pressurised road tankers. Even though these doors may be relatively small compared to the vessel diameter there may still pose a hazard when they need to be opened regularly as part of the process.

It may be necessary to determine if additional door protective/safety devices are necessary to enable the plant to be operated safely and, where appropriate, such devices should be included in the WSE. The following considerations should be included in the assessment:

- Is the door fitted internally or externally?

[Note: Internally fitted doors that are retained in position by pressure in the vessel are inherently safer and normally do not need additional safety devices.]

- How often is the door opened?
- What warning would the operator have should there be pressure in the vessel?
- What would be the consequences of opening the door under foreseeable conditions?
- Could residual pressure cause danger to the operator whilst they are opening the door?
- Are suitable operating instructions in place?

4. TYPES OF PROTECTIVE AND SAFETY CONTROL DEVICES

A protective device is, for the purposes of these Guidelines, any device which has a primary safety function in relation to the door operation for pressure vessels with ready internal access.

These can be grouped as follows:

Mechanical interlocks and fittings

These are direct acting mechanical devices or linkages. Examples include:

- Steam inlet cock with handle that cannot be opened until the door is fully secured and must be closed before release of the door can commence
- Vent/drain cock, which can only be closed when the door is fully secured and must be open before release of the door can commence
- Pressure loaded bolt engaging in the door, which prevents the door being opened whilst there is pressure in the vessel
- Tapered retaining lugs and stops which require the door to be moved against the internal pressure when it is opened

- Secondary catch to restrain the door after all other fastenings have been removed and which cannot be released until the door is opened by a small amount
- A captive bolt which ensures that the door is opened by a small amount as the bolt is unscrewed and whilst it is still engaged
- Sequential locking system – this is typical of a 'Castell' type interlocking key system. All critical components associated with the opening/closing of a door are sequentially interlocked by the use of a single mechanical key. The key must be physically released, removed and then relayed to the next 'locked' component in order to enable actuation of the release mechanism. This will usually consist of several numbered mechanical sequences in order to safeguard against inadvertent opening of the door under pressure or premature application of pressure on a start cycle

Control-activated devices

These are usually in-direct acting devices responding to signals from control measuring or switching transducers. It should be noted that all such control-activated devices should be installed to provide 'fail safe' operation in the event of loss of signal or power.

Examples include:

- Pneumatic systems that prevent air being supplied to control systems or door actuators until the correct conditions are established
- Hydraulic systems which prevent fluid being supplied to door actuators until the correct conditions are established
- Pressure or temperature activated transducers to mechanical or electro-mechanical devices
- Solenoid operated devices

Electronic control and safety interlock systems

These can be the most complex control and safety systems used on modern autoclaves and process machines. They are normally used in conjunction with mechanical or electro-mechanical devices. Programmable electronic systems still require sensors and limit switches to establish the current status of the equipment. In most cases these will require either redundancy or diversity to permit operation. For example, two limit switches must both be activated before the programme can proceed or both a negative and a positive response from two switches are necessary.

[Note: Door open limit switch is negative and door closed limit switch is positive.]

The programming of electronic systems is inherently a design feature and the suitability of such should be considered against the requirements of Regulations 4 and 5 of PSSR 2000 and the Pressure Equipment Directive. The integrity of the control system should be appropriate to the hazards of the operation and risks associated with failure.

Examples include, hard-wired electrical control panels incorporating micro-switches and sensors, solid state electronic microprocessor cards and fully programmable logic controllers.

5. WRITTEN SCHEME OF EXAMINATION (WSE)

5.1 Responsibility

Under PSSR 2000 the responsibility for identifying pressure vessels and the associated protective devices and ensuring their inclusion in the scope of the WSE rests with the user/owner. Once the scope has been established it is then the responsibility of the competent

person to certify that the content (including the extent and frequency of examination) of the WSE is suitable. In practice, the user/owner may request advice from the competent person as to which items should be included in the scope and to draw up the WSE.

5.2 Scope and content of the WSE

The intention of this section of the Guidelines is to assist competent persons when assessing the scope and content of the WSE with respect to protective and door safety devices fitted to pressure vessels incorporating means for ready internal access.

The WSE should include the following:

- Specification of the type of plant/closure together with a description of the process/operation
- Identification of all protective and safety devices to be examined within the scope of the written scheme of examination (See Note)
- An appropriate procedure of examination/testing together with a suitable periodicity of examination for all identified vessels and associated protective devices
- Any special examination or testing requirements associated with the particular equipment
- Any specific preparatory work that will be required to safely and effectively facilitate the competent person's examination

[Note: Although the ACoP to PSSR 2000 does not directly call for the listing of excluded items, it does make reference to the need for justifying the decision to exclude items from the scope of examination. In the context of protective and safety devices associated with openings to facilitate ready internal access, it is prudent to demonstrate that all items/devices have been assessed. These Guidelines therefore recommend that the competent person identifies other devices or items that have been excluded on the grounds that they are not considered to be protective devices, for example controlling devices.]

5.3 Protective, safety and control devices

PSSR 2000 requires that all 'protective devices' are included in the scope of the WSE. These Guidelines consider primary safety devices related to the door operation to be classed as protective devices and included as examinable items within the WSE.

In order to conclude whether a particular device should be included in a WSE, the competent person should consider the function of the device.

Protective devices would, for example, be:

- Any device or mechanism that is designed to prevent a quick opening door from opening unintentionally and releasing the contents of the vessel under pressure or, whilst the temperature of the liquid in the vessel is above its boiling point at atmospheric pressure
- A test cock may be classed as a 'protective device' where it is designed to give warning that opening of the vessel door will result in releasing the contents of the vessel under pressure
- A captive nut arrangement fitted to a single or multi-bolted quick opening door

It should be noted that a safety device designed to prevent door closure whilst there are personnel within a vessel would not normally be classed as a protective device under PSSR 2000 as it has no bearing on the release of stored energy.

In addition, a control device designed to set the process timing or temperature in the vessel/system and not intended to protect against system failure would not normally be included in the WSE. However, where no other protective device is fitted and total reliance

has been placed upon such a control device for safe operation then this may then need to be included as an examinable item within the WSE.

5.4 Primary/secondary protective and safety devices

Vessels with ready internal access may in some circumstances be fitted with a primary and a secondary protective/safety device giving protection from the same system failure scenario. Where this arrangement is designed to provide redundancy then both devices should be included in the WSE, otherwise the secondary device may be included at the discretion of the user/owner.

5.5 Extent of Examination of Door Protective and Safety Devices

The extent of the examination of protective and safety devices included in the WSE will vary with the type and operation of the device. Typical devices and basic examination requirements are as shown in the following non exhaustive table:

Device	*Extent of Examination*
Seal Breaking *– Multi-Bolted Door*	*Detailed visual examination with functional check at nil pressure – exposure of critical parts*
Door restraint *– Multi-Bolted Door or Quick Opening*	*Detailed visual examination with functional check at nil pressure – check clearance of opening whilst under restraint*
Test cock *– Multi-Bolted or Quick Opening*	*Detailed visual examination and prove clear under nil pressure*
Lock before Pressurise, Depressurise before Unlock and Temperature Interlocks	
Mechanical Interlock	*Detailed visual examination with – exposure of critical parts – functional check at nil pressure. Check freedom of operation and that housings are in-line and clear. Functional check under controlled conditions or simulation.*
Sequential Mechanical Locking System	*Detailed visual examination with exposure of critical parts – functional check of sequencing*
Electro-Mechanical Interlocks	*Detailed visual examination with exposure of critical parts – functional check at nil pressure - functional check under controlled conditions or simulation.*
Electronic Control Interlocking	*Confirmation of dedicated electronic control circuitry for safety critical systems or if integrated with main*

Device	*Extent of Examination*
	process control. In the case that it is integrated, confirm if an engineer's test mode facility has been provided. *Functional check under controlled conditions or simulation.*
Interlock Microswitches	*Visually examine switches. Check security of mountings. Examine connectors and wiring for security and general condition as accessible. Functional check under controlled or simulated conditions.*
Electrically Interlocked Valves	*Check security of actuator mountings. Examine connectors and wiring for security and general condition. Check wiring for insulation breaches. Functional check under controlled or simulated conditions. Check power off position*

5.6 Periodicity of examination for protective and safety devices

The ACoP to PSSR 2000 states that protective devices are to be examined at least as frequently as the item they protect. SAFed '*Guidelines on Periodicity of Examinations (PSG1)'* advises that the period between examinations for protective devices should not exceed 26 months for systems that are on clean non corrosive duties. Where protective devices are liable to corrosion, seizure, choking or failure of component parts then the period between examinations should not exceed 14 months.

In the light of experience with protective and safety devices fitted to individual vessels the period between examinations may need to be reduced. The aim should be to ensure that sufficient examinations are carried out to identify at an early stage any deterioration or operational malfunction which may affect the safe operation of the vessel.

6. EXAMINATION, TESTING AND REPORTING REQUIREMENTS

6.1 Health and safety requirements for examinations

Vessels with doors for ready access present additional hazards for personnel carrying out examinations.

Tests of door securing mechanisms under pressure could lead to sudden release of stored energy if the mechanism failed to function correctly. The function of door mechanisms should be confirmed without attempting to open doors under pressure.

Where vessels are large enough to permit entry, hazards from moving parts of doors and hinges, filling and emptying systems (e.g. racks of product on rail mounted vehicles) and hazards of being trapped in the vessel if the door is closed need to be addressed.

If full body access inside the autoclave is possible it is recommended that a safety alarm or pull cord is fitted inside the vessel to automatically engage the stop circuit.

Where a permit to work system for entry into confined spaces is in place, the competent person should ensure that these additional hazards are addressed where appropriate and suitable controls are in place to minimise risks. In the absence of a permit to work system it will be necessary to ensure that a safe system of work is in place together with any additional hazards identified, for example:

- Any moving parts of doors that could cause injury are secured
- Where appropriate, physical barriers are erected to prevent vehicles or movable racks entering the vessel
- Warning notices and/or physical stops are in place to prevent the door being closed with personnel still in the vessel

6.2 Preparation

The user/owner should ensure that any necessary preparation work is completed in order that the competent person may carry out the examination safely. Preparatory work additional to standard practice may be specified in the WSE.

6.3 Testing - General

Prior to testing any protective devices the competent person should confirm that this can be carried out safely and a risk assessment should be carried out confirming any elements of testing that may expose personnel to danger.

It is strongly recommended that any testing of controls, safety devices and limiters be recorded for future reference. A dedicated logbook suitably prepared to record date and outcome of each test is considered to be the best way of maintaining this type of information. The logbook should be kept by the user and made available for inspection by the competent person.

6.4 Testing of interlocks

The operation and effectiveness of an interlock that relies upon the interaction of mechanical components, can normally be determined by visual examination. The examination should evaluate wear, security of component parts and effective operation.

Equipment identified as requiring interlocks may incorporate the use of electrical switches and latterly electronic devices.

In the case of electronic control and safety interlock systems it is necessary for the user to supply such information so as to enable the competent person to ascertain the following details:

- Are the safety aspects of the electronic circuitry dedicated or integrated with the main process control
- If system is fitted with dedicated safety circuits then a functional or simulated test may be carried out
- If safety circuits are integrated within the main process control is an engineers test mode facility available to perform a functional test
- If safety circuits are integrated within the main process control and no engineers test mode facility then the most onerous machine process cycle should be selected at the time of the functional check of safety circuits

6.5 Reporting

Where an item has been examined in accordance with a WSE then a written report will be issued after completing the examination. The report will state which parts of the pressure system have been examined, the condition of those parts and the results of the examination.

The results of the examination and testing of the door protective safety devices should be clearly stated on the report. Where protective devices are detailed in the WSE, reporting of these items may be done by exception. However, in the case that an examination of a protective device has proved it to be unsatisfactory, then it should be detailed separately on the report together with:

- Examinations and tests carried out
- General condition
- Confirmation of correct function
- Any additional tests necessary to complete the examination

7. DUTIES OF USER/OWNER

7.1 Training

Operators must be given adequate training, which should be updated as required to ensure that they are fully conversant with the door safety and protective devices.

All training should be documented and designed to ensure that operators understand the procedures and the dangers that may arise from incorrect operation or defective controls.

7.2 Operation

Manufacturer's instructions and/or suitable operating procedures should be readily available to operators. It is considered good practice to carry out periodic operational audits to ensure compliance.

Operators and their managers should be fully aware of the dangers of bypassing or interfering with safety devices or of other malpractice. For example, where an operator suspects that leakage at the door may be taking place and attempts to tighten the fastenings whilst the vessel is under pressure.

[Note: This is particularly hazardous with single bolted fastenings where the leakage may be caused by partial failure of the bolt or nut thread.]

7.3 Maintenance

Maintenance should follow written procedures that take account of the manufacturer's instructions, any special factors relating to the particular use of the pressure equipment and frequency of operation. A record of such maintenance and any remedial actions required should be kept by the user/owner.

7.4 Routine testing of interlocks

A properly trained and authorised person should check at regular intervals that the interlocks function correctly and have not been overridden or defeated: where a vessel opening is in constant use, it is good practice to perform these checks at the beginning of each shift.

Any faults or defects with the vessel or its protective/safety devices, should be promptly reported to a responsible person and remedied before the pressure equipment is used again.

Records of routine testing and faults identified should be entered in the vessel logbook and made available to the competent person on request.

7.5 Modifications and repairs

Where modifications and repairs may affect the integrity and/or safety of the vessel, its protective or safety devices (including any associated software), then they need to be considered and the competent person should be involved as appropriate.

Suitable records of such modifications/repairs should be maintained.

7.6 Records

The following records should be kept on site or at a designated central location and be available for inspection by the competent person, responsible person or other interested parties:

- Examination reports
- Records of periodic tests
- WSE
- Records of servicing, repairs and modifications
- Records of any maintenance undertaken on controls
- Training records for operators
- Audit reports for operators
- Test log

8 REFERENCES

The following are applicable at the time of preparation of these Guidelines:

- The Pressure Systems Safety Regulations 2000 (SI 2000 No 128)
- Pressure Systems Safety Regulations (Northern Ireland) 2004
- Pressure Equipment Directive 2014/68/EU (Implemented in the UK by the Pressure Equipment (Safety) Regulations)
- Provision and Use of Work Equipment Regulations 1998
- HSE Guidance - Safety at high temperature textile dyeing machines HSE Guidance Note: PM73 – Revision 3 2012Management of Health and Safety at Work Regulations 1999
- Health and Safety at Work etc. Act 1974
- SAFed Guidelines on Periodicity of Examinations (PSG1)

Further Reading:

- Health and Safety Executive Document: Best practice for risk-based inspection as part of plant integrity management
- Safety of machinery BS5304: 1988 (withdrawn)
- Safety of machinery- Interlocking devices BS1088:1996
- Safety of machinery – Electrical equipment BSEN 60204-1: 1995
- Safety of machinery – Principles for risk assessment. BS EN1050:1997
- Safety of machinery – Safety related parts of control systems – Part1. General principles for design.
- Autoclaves for sterilization in laboratories. BS2646:1993, Part 1
- Domestic pressure cookers BS1746: 1987
- Sterilizing and disinfecting equipment BS3970: 1990, Part1

EXAMPLES

Example 1: Self Generating Bench-top Autoclave/Steriliser

A. Plant Description:

- Self-generating bench-top autoclave/steriliser with quick opening /single bolted door
- Process: Steam sterilising process (this is implicit within the plant description title)
- Safe Operating Limits: 2.62 bar 134 deg C

B. Hazard Assessment (Section 3 of Guidelines):

Sudden release of stored energy: this may occur due to:

- door not being properly closed and secured
- door being opened under pressure
- failure of door securing devices

Residual pressure: Due to the smaller diameter of doors and volumes of the pressure chambers normally associated with these types of autoclaves, residual pressure is not considered to be a significant factor.

Discharge of high temperature contents: Steam is generated from a pre-determined amount of feed water and no further water is added during the cycle. Steam is subsequently safely discharged so that build-up of hot condensate within the chamber is not considered to pose any significant hazard.

C. Door Protective and Safety Devices (Section 4 of Guidelines):

- Door closed limit switch – to ensure that the door is closed before programme starts
- Door bolt, solenoid operated – this fails safe on loss of power – remains engaged, interlocking the door during cycle operation
- Door bolt, pressure operated – mechanically locks the door whilst the chamber is under pressure
- Pressure and Temperature Indicator(s) – provides visual warning to operator of the conditions existing in the autoclave pressure chamber

[Note: In some instances the microprocessor control may need to be considered as a door safety device, for example where the electronic control and safety interlocks are integrated and can only be tested through a dedicated test mode facility.]

D. Scope and Content of WSE (Section 5 of Guidelines):

All of the above devices are classified as **Protective Devices** with the exception of the microprocessor control. In the event that the microprocessor control provided primary protection for the door interlocking it would have required inclusion to the WSE.

Electronic safety control systems

The electronic control system for this autoclave is integrated and is provided with an engineer's test mode facility. The door interlocks on this autoclave are designed to fail-safe conditions and the safety aspects of the electronic control system are therefore considered to provide a secondary role only as a protective device. The functionality of the control system may be determined during the operation of one of the process cycles.

Procedure for the examination and testing of the door protective devices

- Examine all mechanical linkages and attachments for mechanical damage and security of fastening
- Where limit switches are fitted as part of the interlocking mechanism, the competent person shall visually examine the security of fastening of the switch, as well as any operating arm, pin or cam including any locking nuts fitted. Where reasonably practicable, external wiring, sheathing or conduit should be visually examined for indication of mechanical damage
- Calibration checks of pressure gauges or transducers as appropriate
- Witnessing functional tests of the interlocks and any associated limit switches

Periodicity of examination

In accordance with *'SAFed Guidelines on Periodicity of Examinations (PSG1)'* 14 months is considered to be an appropriate examination periodicity. No intermediate working/functional examination is deemed to be necessary.

Preparatory work

There are no identified safety related specific hazards – standard safe systems of work for preparation in accordance with manufacturer's instructions and company health and safety procedures.

Special examination or testing requirements

None.

E. Examination, Testing and Reporting (Section 6 of Guidelines):

Examination and testing should be carried out in accordance with the WSE.

The report of examination should adequately cover the condition and function of all door protective and safety devices as identified in the WSE.

In the case where it is considered that the door protective devices do not meet with the requirements of HSE Guidance Note PM73, then this should be drawn to the user's attention within the examination report. Where the competent person is of the opinion that this could give rise to danger then he should notify the user and local enforcing authority in accordance with the requirements of the PSSR 2000 Regulation 10.

Such observations may also include maintenance and operating instructions provided by the user.

Example 2 – Brick-curing Autoclave

A. Plant Description:

- Horizontal, steam heated brick-curing autoclave with quick opening doors and rail mounted loading facilities
- The autoclave is supplied with steam at a gauge pressure of 14.5 bar. The product is loaded into the vessel by means of rail mounted trolleys, the door is secured and the process cycle of approximately 6 hours duration is commenced. The load is gradually cooled at the end of the process cycle. The process control is fully manual and is carried out by trained operators
- Safe operating limit is 15 bar

B. Hazard Assessment (Section 3 of Guidelines):

Sudden release of stored energy: this may occur due to:

- door not being properly closed and secured
- door being opened under pressure
- failure of door securing devices.

Residual pressure: due to very large diameter doors associated with this type of autoclave, there is the potential for significant forces to be exerted on the door.

Discharge of high temperature contents: In this example, the length of process and differential temperatures that can exist throughout the chamber leads to the collection of large volumes of condensate. The discharge of condensate by flooding out or 'flash–off' is a potential hazard.

C. Door Protective and Safety Devices (Section 4 of Guidelines):

- Pressurisation interlock – mechanically interlocked with steam supply valve
- Door safety catch (door seal to be broken before catch can be released)
- Vent cock and rod arrangement – mechanically interlocked with the door closing mechanism
- Door 'open' securing safety lock - to prevent door closure whilst personnel are inside the vessel
- Condensate high level alarm
- Pressure and temperature indicator- provides visual warning to operator of the conditions existing in the autoclave pressure chamber

D. Scope and Content of WSE (Section 5 of Guidelines):

All of the above devices are classified as **protective devices** with the exception of the door 'Open' securing safety lock. This is classed as a safety device.

The door 'Open' securing safety lock is considered to be a safety device because it is designed to protect against trapping of operators inside the vessel and does not protect against any of the identified hazards, this will therefore be excluded from the WSE. Reference to this particular safety device may be made within the WSE in the section detailing safe preparation of the pressure plant for examination.

Procedure for the examination and testing of the door protective devices

- Examination of all mechanical linkages and attachments for mechanical damage and security of fastening;

- Visual examination of the condensate level alarm mechanism together with any associated limit switches. Where reasonably practicable, external wiring, sheathing or conduit should be visually examined for indication of mechanical damage;
- Calibration checks of pressure gauges or transducers as appropriate.
- Witnessing functional tests of the interlocks and condensate level alarm mechanisms.

Periodicity of examination

In accordance with *'SAFed Guidelines on Periodicity of Examinations (PSG1)'* a period of 26 months is considered to be an appropriate examination periodicity. Depending upon the operating conditions it may be necessary to specify intermediate working/functional examinations.

Preparatory work

There are a number of identified safety related specific hazards associated with this type of pressure equipment in addition to the standard safe systems of work for safe vessel entry namely;

- The door must be mechanically secured in the 'open' position
- Provision to be in place to prevent loading of autoclave – loading rails to be removed where appropriate
- Adequate ventilation of the internal pressure chamber due to the large internal volume

Special examination or testing requirements

The competent person may require additional non-destructive testing on door components as necessary.

E. Examination, Testing and Reporting (Section 6 of Guidelines):

Examination and testing should be carried out in accordance with the WSE.

The report of examination should adequately cover the condition and function of all door protective and safety devices as identified in the WSE.

In determining how the protective devices as fitted to the machine address the identified hazards, the fitting of a temperature interlock should be considered. This would act as a further safeguard against the potential hazard posed by the release of high temperature contents of the vessel and would also meet with the recommendations laid down in Paragraph 29 of HSE Guidance Note PM73. However, subject to risk assessment, the condensate level alarm, together with other protective devices and operating procedures may adequately address the hazard. Suggested report wording could be; *'The users attention is drawn to Paragraph 29 of HSE Guidance Note PM73 regarding the recommendation for fitting a temperature interlock'.*

Example 3: High Temperature Dyeing Machine

A. Plant Description:

- 1200mm diameter vertical high temperature dyeing machine with quick opening door
- Process: Indirect Steam Heated Yarn Dyeing
- Safe Operating Limits: 2.5 bar 139 deg C

B. Hazard Assessment (Section 3 of Guidelines):

Sudden release of stored energy: this may occur due to:

- door not being properly closed and secured;
- door being opened under pressure;
- failure of door securing devices.

Residual Pressure: due to the diameter of the door and volume of the pressure chamber associated with this vessel, residual pressure is considered to be a factor requiring consideration.

Discharge of high temperature contents: Contents are water based and subject to heating by steam coil. Dyeing temperatures are significantly above 100ºC. Residual contents can flash off to steam on door opening.

C. Door Protective and Safety Devices (Section 4 of Guidelines):

- Door closed limit switch – to ensure that the door is closed and locked before steam is admitted to heating coil
- Door bolt, pressure operated – mechanically locks the door whilst the chamber is under pressure
- Pressure and Temperature Indicator(s) – provides visual warning to operator of the conditions existing in the pressure chamber
- Door to vent interlock to ensure that vent is open before door can be opened. Requires door to be closed and locked before vent can be closed.
- Secondary catch to restrain lid
- A temperature sensitive interlock to prevent door being opened whilst contents of liquor is above 80°C

D. Scope and Content of WSE (Section 5 of Guidelines):

All of the above devices are classified as **Protective Devices and should be** include in the WSE.

Procedure for the examination and testing of the door protective devices

- Examine all mechanical linkages and attachments for mechanical damage and security of fastening
- Where limit switches are fitted as part of the interlocking mechanism, the competent person shall carefully examine the security of fastening of the switch, as well as any operating arm, pin or cam including any locking nuts fitted. Where reasonably practicable, external wiring, sheathing or conduit should be examined for indication of mechanical damage
- Calibration checks of pressure gauges as appropriate
- Vent valve to be proven clear under nil pressure
- Witnessing functional tests of the interlocks and any associated limit switches

Periodicity of Examination

In accordance with 'SAFed Guidelines on Periodicity of Examinations (PSG1)' 26 months is considered to be an appropriate examination periodicity.

Preparatory Work

- Vessel entry is required for examination, therefore entry should be undertaken in accordance with 'SAFed Guidelines for the application of a safe system of work for entry into a confined space PSG 10'.
- Vessel should be safely isolated from steam and electrical supplies
- Trapping hazard should be considered and door closure restraint provided
- There are no other identified safety related specific hazards – standard safe systems of work for preparation in accordance with manufacturer's instructions and company health and safety procedures

Special examination or testing requirements

None.

E. Examination, Testing and Reporting (Section 6 of Guidelines):

Examination and Testing should be carried out in accordance with the WSE and taking note of manufacturer/user instructions.

The report of examination should adequately cover the condition and function of all door protective and safety devices as identified in the WSE.

In the case where it is considered that the door protective devices do not meet with the requirements of HSE Guidance – 'Safety at high temperature textile dyeing machines', then this should be drawn to the user's attention within the examination report. Where the competent person is of the opinion that this could give rise to danger then he should notify the user and local enforcing authority in accordance with the requirements of PSSR 2000 Regulation 10.

Such observations may also include maintenance and operating instructions provided by the user.

Example:

We draw your attention to HSE Guidance - Safety at high temperature textile dyeing machines, in respect of interlocks to be fitted and in plant operation.

Additionally interlocks should function reliably be properly maintained and be kept correctly adjusted strictly in accordance with the manufacturer's instructions. A properly trained and authorised person should check at regular intervals that the interlocks function correctly and have not been overridden or defeated.

Example 4: Steam Heated Retort with Multi-Bolted Door

A. Plant Description:

- Vertical vessel fitted with hinged lid and counterbalance weight, secured by 12 off swing bolts
- Direct steam injection to vessel for cooking food contained in jars within the vessel
- Safe Operating Limit of 6 bar

B. Hazard Assessment (Section 3 of Guidelines):

Sudden release of stored energy: this may occur due to:

- failure of door securing devices.

Residual pressure: due to very large diameter covers associated with this type of retort, there is the potential for significant forces to be exerted on the cover.

Discharge of high temperature contents: Should the lid be removed/opened before the internal contents were sufficiently cooled, any remaining condensate could 'flash off' into steam. There is also a potential risk of the glass food jars exploding under pressure if they are not cooled below a certain temperature. In the case where the cover has not been fully secured, leakage of the process steam could lead to scalding of the operator.

C. Door Protective and Safety Devices (Section 4 of Guidelines):

- Captive nut arrangement fitted on the bolt opposite the hinge – this ensures that the cover seal is broken before the other bolts are disengaged
- Pressure and Temperature Indicator(s) – provides visual warning to operator of the conditions existing in the autoclave pressure chamber

The captive nut arrangement is considered to limit the consequences of sudden flashing of the contents. Although a temperature interlock would provide a further safeguard, in this particular case there are practical difficulties in the fitting of such a protective device. The fitting of a pressurisation interlock to this type of vessel and cover arrangement is also considered not to be reasonably practicable. Suitable operating procedures and effective training of personnel should be in place.

D. Scope and Content of WSE (Section 5 of Guidelines):

All of the above devices are classified as **protective devices** and require inclusion to the WSE.

Procedure for the examination and testing of the door protective devices

- Visual examination of the captive nut and corresponding bolt for mechanical damage, wear and security of fastening
- Calibration checks of pressure gauges or transducers as appropriate

Periodicity of examination

In accordance with *'SAFed Guidelines on Periodicity of Examinations (PSG1)'* 26 months is considered to be an appropriate examination periodicity. This periodicity is dependent upon the observed rate of wear on bolts, nuts, pins and seating locations and may need to be reduced accordingly. Alternatively, an intermediate working/functional examination may be deemed necessary between examinations.

Preparatory work

There are no identified safety related specific hazards – standard safe systems of work for preparation in accordance with manufacturer's instructions and company health and safety procedures.

Special examination or testing requirements

None

E. Examination, Testing and Reporting (Section 6 of Guidelines):

Examination and testing should be carried out in accordance with the WSE.

The report of examination should adequately cover the condition and function of all the protective and safety devices as identified in the written scheme of examination but with particular reference to the captive nut arrangement.

It should be confirmed by the competent person that the user has detailed operating instructions for the retort vessel and that these include specific requirements for the fastening of all the lid retaining bolts. The instructions should also specify a minimum temperature that should be reached before the vessel cover may be removed. In the event that there is no evidence to demonstrate that such training or user instructions are in place then this should be drawn to the user's attention within the examination report. Suggested report wording could be; *'The users attention is drawn to Paragraph 29 of HSE Guidance Note PM73 regarding the recommendation to the fitting of a temperature interlock'.* Where the competent person is of the opinion that this could give rise to danger then he should notify the user and local enforcing authority in accordance with the requirements of the PSSR 2000 Regulation 10.

