EEMUA 231 Edition 2 / SAFed IMG1

Addendum 1

Following the publication of Edition 2 of EEMUA 231 / SAFed IMG1 by EEMUA in February 2019, there have been some queries raised regarding the relationship between the Integrity Assessor and the Competent Person who fulfils duties in the Pressure Systems Safety Regulations (PSSR). This addendum has been produced to provide clarity and help explain how the process can vary to meet the differing organisational arrangements that may occur.

In considering the roles defined in the Terms and Definitions sections, 1.2.1 and 1.2.2, it should be remembered that the working relationship between the Integrity Assessor and the PSSR Competent Person may be very close as the PSSR Competent Person may form part of the team that fulfils the role of Integrity Assessor. This is explained under Roles and Responsibilities in section 5.4.

However, it should be noted that: **The examination report provided by the PSSR Competent Person is a formal report under the regulations and cannot be ignored**. **It should be considered by the Integrity Assessor in assessing the integrity and use of the equipment examined, but its conclusions cannot be over-ridden.**

This latter point is also relevant to Integrity Assessment, Section 8.3, in situations where stored energy and steam are the only hazards. Here, the PSSR report will itself provide the final adjudication of the examination and test findings providing its own formal documented statement upon the suitability of the equipment to return to service or not.

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The mechanical integrity of plant containing hazardous substances

A guide to periodic examination and testing

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SAFed Publication IMG1
Edition 2

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Foreword

This document has been developed and written by the Safety Assessment Federation (SAFed) and the Engineering Equipment & Materials Users' Association (EEMUA) in consultation with the Health and Safety Executive's Hazardous Installations Directorate, together with other interested stakeholders who use such plant, including operators, inspection bodies (including 'competent persons') and providers of specialist services to the process.

The Health and Safety Executive (HSE) considers maintenance of the integrity of plant containing hazardous substances to be a fundamental element of good process safety management. To this end, we believe this document provides a sound basis from which to develop arrangements for the management and delivery of periodic examinations aimed at achieving this.

The guidance contained within this document should not be regarded as an authoritative interpretation of the law, but if you follow the advice set out in it, you will normally be doing enough to comply with health and safety law in respect of those specific issues on which the guidance gives advice.

Paul Logan
Head of Chemicals,
Explosives and Microbiological Hazards Division,
Health and Safety Executive

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Contents

FOREWORD **3**

1 INTRODUCTION **8**

1.1 SCOPE 8
1.2 TERMS AND DEFINITIONS 9

2 OVERVIEW OF INTEGRIGY MANAGEMENT THROUGHOUT THE PLANT LIFECYCLE **12**

2.1 SPECIFICATION 12
2.2 DESIGN 14
2.3 CONSTRUCTION 14
2.4 COMMISSIONING/RE-COMMISSIONING 14
2.5 OPERATING LIFE CYCLE & OPERATING HISTORY 15
2.6 OPERATIONAL EXCURSION AND AD-HOC FITNESS FOR SERVICE (FFS) EXAMINATION/ASSESSMENT 15
2.7 PLANNED/REACTIVE MAINTENANCE TASKS/MAINTENANCE HISTORY 15
2.8 WRITTEN SCHEME OF EXAMINATION (SECTION 6) 16
2.9 EXAMINATION (SECTION 7) 16
2.10 REPORTING OF EXAMINATIONS (SECTION 8) 16
2.11 ASSESSMENT OF EXAMINATION RESULTS & FITNESS FOR SERVICE DECLARATION (SECTION 8) 16
2.12 REPAIR, RE-RATE OR RETIRE 17
2.13 MODIFICATION 17

3 LEGISLATIVE CONSIDERATION **18**

3.1 COMPARISON OF DUTIES RELATING TO INSPECTION OF PLANT CONTAINING HAZARDOUS SUBSTANCES 18
3.2 REASONABLE PRACTICABILITY 19
3.3 OTHER ACTIVITIES AND REGULATIONS 20

4 EXAMINATION POLICY **21**

4.1 OBJECTIVES OF EXAMINATION 21
4.2 TYPES OF EXAMINATION 21
4.3 STRATEGIES FOR DETERMINING EXAMINATION INTERVALS 22
4.4 EQUIPMENT AGE 23
4.5 ADMINISTRATIVE ARRANGEMENTS 23
4.6 NON DESTRUCTIVE EXAMINATION TECHNIQUES 24

Documents
Document Sharing Hub

Full document details: EEMUA 231-2019 (2020)

5 ORGANISATIONAL ARRANGEMENTS FOR INTEGRITY MANAGEMENT 25
5.1 LEADERSHIP 25
5.2 TYPES OF INSPECTION BODIES 25
5.3 COMPETENCE 26
5.4 ROLES AND RESPONSIBILITIES 27
6 WRITTEN SCHEME OF EXAMINATION 30
6.1 PURPOSE OF WRITTEN SCHEME OF EXAMINATION 30
6.2 CONTENT OF WRITTEN SCHEME OF EXAMINATION 30
6.3 PREPARATION 34
6.4 APPROVAL 35
6.5 REVIEW OF THE WSE 35
6.6 DIFFERENT REGIMES 36
6.7 PROPORTIONALITY 36
7 DELIVERY OF PERIODIC EXAMINATIONS 38
7.1 INDIVIDUALS INVOLVED 38
7.2 EXAMINATIONS CARRIED OUT DURING PLANT SHUTDOWNS 38
7.3 COMMUNICATION OF INITIAL FINDINGS FROM AN EXAMINATION 39
8 REPORTING OF EXAMINATIONS AND INTEGRITY ASSESSMENT 40
8.1 EXAMINATION REPORTS 40
8.2 REPORTING ON COMPLEX EXAMINATIONS 41
8.3 INTEGRITY ASSESSMENT 42
8.4 ASSESSMENT OF DETERIORATION 42
8.5 INTERACTION WITH THE WRITTEN SCHEME OF EXAMINATION 43
8.6 REPAIRS 43
8.7 OTHER REMEDIAL ACTION 43
8.8 INCOMPLETE EXAMINATION 44
9 POSTPONEMENT OF EXAMINATION 46
9.1 FACTORS TO CONSIDER 46
9.2 TIMING 47
9.3 AGREEMENT TO THE POSTPONEMENT 47
9.4 POSTPONEMENT WHEN THE EXAMINATION DATE HAS PASSED 47
10 RECORD KEEPING 49
11 CHANGE, REVIEW AND AUDIT 50
11.1 INTRODUCTION 50
11.2 CHANGE 50
11.3 REVIEW 51
11.4 AUDIT 52

Documents
Document Sharing Hub

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Full document details: EEMUA 231-2019 (2020)

APPENDIX 1 – OVERVIEW OF RELEVANT LEGISLATION (AND THEIR INTERACTION) 53

APPENDIX 2 – OVERVIEW OF ISSUES TO CONSIDER IN A WRITTEN SCHEME OF EXAMINATION ... 56

APPENDIX 3 – OVERVIEW OF RISK BASED INSPECTION 58

REFERENCES 60

Documents
Document Sharing Hub

Full document details: EEMUA 231-2019 (2020)

1 INTRODUCTION

A range of plant and equipment is used in chemical plants, factories and depots for the storage, transfer and processing of hazardous substances. The mechanical integrity of vessels, pipework and other items of equipment containing these substances is the primary barrier against a loss of containment, and the potential realisation of inherent hazards those materials possess.

This document aims to provide guidance on managing the mechanical integrity of such equipment. This is a matter for the whole lifecycle, from original specification and design, through its operation to decommissioning. However, this guidance focuses on the issue of ensuring integrity through periodic examination and testing.

This guidance is published in the UK and therefore refers to the regulatory framework of that country. However, much of the description of good practice it contains will be relevant further afield.

This guide refers to various regulations, standards and guidance. It is the reader's responsibility to check for the latest edition of all documents referenced.

1.1 SCOPE

This guidance covers all onshore equipment that provides the primary containment boundary to hazardous substances, which will include pressure vessels, relief streams, atmospheric storage tanks, reactors and pipework. It will cover machines such as pumps, agitators, valves and compressors in so far as they are required to maintain primary containment. It does not cover the maintenance of such machines necessary to ensure their continued operation.

The hazardous substances considered include those with the potential to cause harm (either to people and/or the environment) because of their toxicity, flammability or other form of chemical reactivity (including explosivity). This includes the dangerous substances listed in the Control of Major Accident Hazards (COMAH) Regulations. COMAH is the implementation of the Seveso III Directive in the UK.

The guidance is aimed at sites which handle, process and store such dangerous substances. This includes establishments where the COMAH Regulations apply. It may also be relevant to sites outside the scope of COMAH where there are hazardous substances present.

All those involved in some part in the management of mechanical integrity of plant and equipment should find the guidance relevant. This will include site operators, inspection bodies (including Competent Persons, as defined by relevant regulations) and those offering specialist services to the process.

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1.2 TERMS AND DEFINITIONS

1.2.1 Integrity Assessor

The Integrity Assessor is the person, team or corporate body that takes overarching responsibility for all the elements of an examination (including those parts carried out by another person or body) together with the interpretation of the results, and the formulation of conclusions and recommendations that may follow. As a person, team or corporate body, the Integrity Assessor may be either directly employed by, or contracted to the site operator. In all cases the Integrity Assessor should be competent (having the necessary knowledge and experience to carry out the role) and independent (see Section 1.2.5).

The Integrity Assessor should be determined prior to the commencement of the examinations.

The term Integrity Assessor is created and used within this guidance to recognise that there are responsibilities within managing the mechanical integrity of plant containing hazardous substances that go beyond those of the Competent Person under the Pressure Systems Safety Regulations (PSSR), both for the reasons explained in Section 3 and because some plant sits beyond PSSR.

The Integrity Assessor is therefore seen as the umbrella term to cover all responsibilities, although it is recognised that where PSSR applies some of these responsibilities will be taken on by the PSSR Competent Person to meet their duties under those regulations. In fact, in some situations the PSSR Competent Person may fulfil all the responsibilities of the Integrity Assessor. Under such arrangements, the person or body of persons who fulfils the role of Competent Person under PSSR, may be the same person or body of persons fulfilling the role of Integrity Assessor. Equally the Competent Person may be a separate person or body of persons reporting to the Integrity Assessor. Whichever arrangements are used, Site Operators retain their duties under Health and Safety legislation for the safe operation of the plant, which will extend to ensuring the role and responsibilities of the Integrity Assessor are satisfactorily fulfilled.

EEMUA[1] and CDOIF[2] provide guidance on the use of third party services.

1.2.2 Competent Person

The term has a specific role within PSSR, and is given the following definition;

'competent person' means a competent individual person (other than an employee) or a competent body of persons corporate or unincorporate; and accordingly, any reference in these Regulations to a competent person performing a function includes a reference to his performing it through his employees; The competent person is appointed by the user.

The Approved Code of Practice (ACoP) to the regulations gives comment on the role as follows;

The term 'competent person' is used in connection with two distinct functions:
a) drawing up or certifying schemes of examination (regulation 8); and
b) carrying out examinations under the scheme (regulation 9).

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And;

In general terms, the competent person should have:
a) staff with practical and theoretical knowledge and actual experience of the relevant systems;
b) access to specialist services;
c) effective support and professional expertise within their organisation; and
d) proper standards of professional probity.

However, the term 'competent person', has also been used in other publications in a context much wider than PSSR.

Whilst the Integrity Assessor has, in this guidance, a wider remit than the Competent Person we have retained the use of Competent Person when reference is made to the PSSR.

1.2.3 Inspection / Examination

Within this guidance these are considered interchangeable terms to describe various activities aimed at assessing the integrity of plant and equipment.

Inspection and examination are considered as focussed activities that lead to a report on the condition of a piece of equipment and its suitability, or not, for further service. They may consist of a single part of an activity, e.g. a visual examination, or be the sum of several parts, e.g. a visual examination and a range of non-destructive examination techniques (ultrasonic thickness measurements, crack detection, etc.).

The reader should be aware that other documents may use these terms in other contexts, or as interchangeable terms.

1.2.4 Test

An element of an examination and a discrete activity aimed at providing information for an examination report. However, in itself, it would not usually provide information into all aspects of the current condition or assessment of ongoing equipment integrity. Examples include a hydraulic test, a holiday test (standard practice for checking for discontinuities in a coating) or a thickness test.

1.2.5 Independence

Independence is the management structure that ensures that the individuals and teams making key decisions relating to integrity management are impartial and isolated from other factors that might result in a conflict of interest. For example, a desire to maximise production may create pressure to operate equipment beyond the time for which its integrity may be assured. Alternatively, if the person responsible for maintenance is carrying out the statutory inspection then their impartiality may be questioned because they would be inspecting their own work.

1.2.6 Written Scheme of Examination (WSE)

A plan used to define the scope and frequency of examinations to be carried out. (NB There are specific requirements for a WSE within the Pressure Systems Safety Regulations, where they apply.) It should be noted that different terms may be used for this 'plan' where PSSR does not apply. For example, EEMUA 159 (Above ground flat bottomed storage tanks, guide to inspection, maintenance and repair) refers to an equivalent document called the Specific Inspection Plan.

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1.2.7 Operator or User of the plant and equipment

Operator is a term used in the COMAH regulations and means the person (i.e. individual, corporate body or partnership) who is in control of the operation of an establishment, and the term is used in the guidance to cover that person who is in control of operations on the site whether it is a COMAH establishment or not. User is a term used in PSSR, and relates to a pressure system, and has a similar meaning to Operator, i.e. employer or self-employed person who has control of the operation of a pressure system or vessel. COMAH and PSSR provide formal definitions of each term. There is greater flexibility within the term user, to recognise that the person in control of a pressure system, may not be in control of the site as a whole. This term is also used within this guidance, as the User has important responsibilities within PSSR.

Overall, within this guidance, where PSSR applies, the Operator or User are likely to be the same person or body, however the term Operator is more often used to cover the wider responsibilities outside of PSSR. The term User is also used in places to remind the reader of the specific responsibilities of PSSR where appropriate.

Further information is given in Section 5.4.2 on the role and responsibilities of the person in control of the site or equipment.

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2 OVERVIEW OF INTEGRITY MANAGEMENT THROUGHOUT THE PLANT LIFECYCLE

Successful management of plant integrity requires a clear strategy; not just for periodic examination, but for the whole plant lifecycle. This is especially important on sites storing and processing hazardous substances, where the consequences of integrity failure can be major.

Whilst this guidance is focused towards examination, it is very useful to put this into context, as this is only one element of an integrity management strategy. If the plant specification, design or construction was less than ideal, ongoing integrity management may require a unique approach and be a challenge. Also, key to maintaining integrity, is the assessment of the results of examinations and the appropriate action taken, especially where the inspection report states that the equipment has defects.

Diagram 1 shows an 'Overview of integrity management throughout the plant lifecycle'. This flowchart provides an overview of the different elements of the strategy, and how they link together and inform one another. All elements of the flowchart are discussed briefly in this chapter, but some are beyond the main scope of this guidance document. Those elements are shown shaded in yellow.

2.1 SPECIFICATION

Getting the original plant specification correct is key, so that plant is designed to be suitable for the intended duty. Some of the issues that need to be addressed include:

- How big does the vessel / storage tank need to be?
- What will it contain in normal use?
- What will it contain during other operating circumstances, such as during start-up, shut-down and cleaning?
- What are the hazards of this substance?
- How might the contents affect the vessel / tank / pipe-work?
- What temperature and pressure range will it operate at?
- If control of the process is lost, what extreme temperatures and pressures might it be exposed to?
- What Pressure Relief arrangements and associated devices are required (relief stream)?
- What operating cycles will it be exposed to?
- How long a life is required?
- What degradation mechanisms might arise given the process conditions?
- What degradation mechanisms might arise given the environmental conditions near the vessel?

Plant can frequently be put to new duties partway through its life, e.g. when a process is reconfigured. The matters above need to be considered again at this time.

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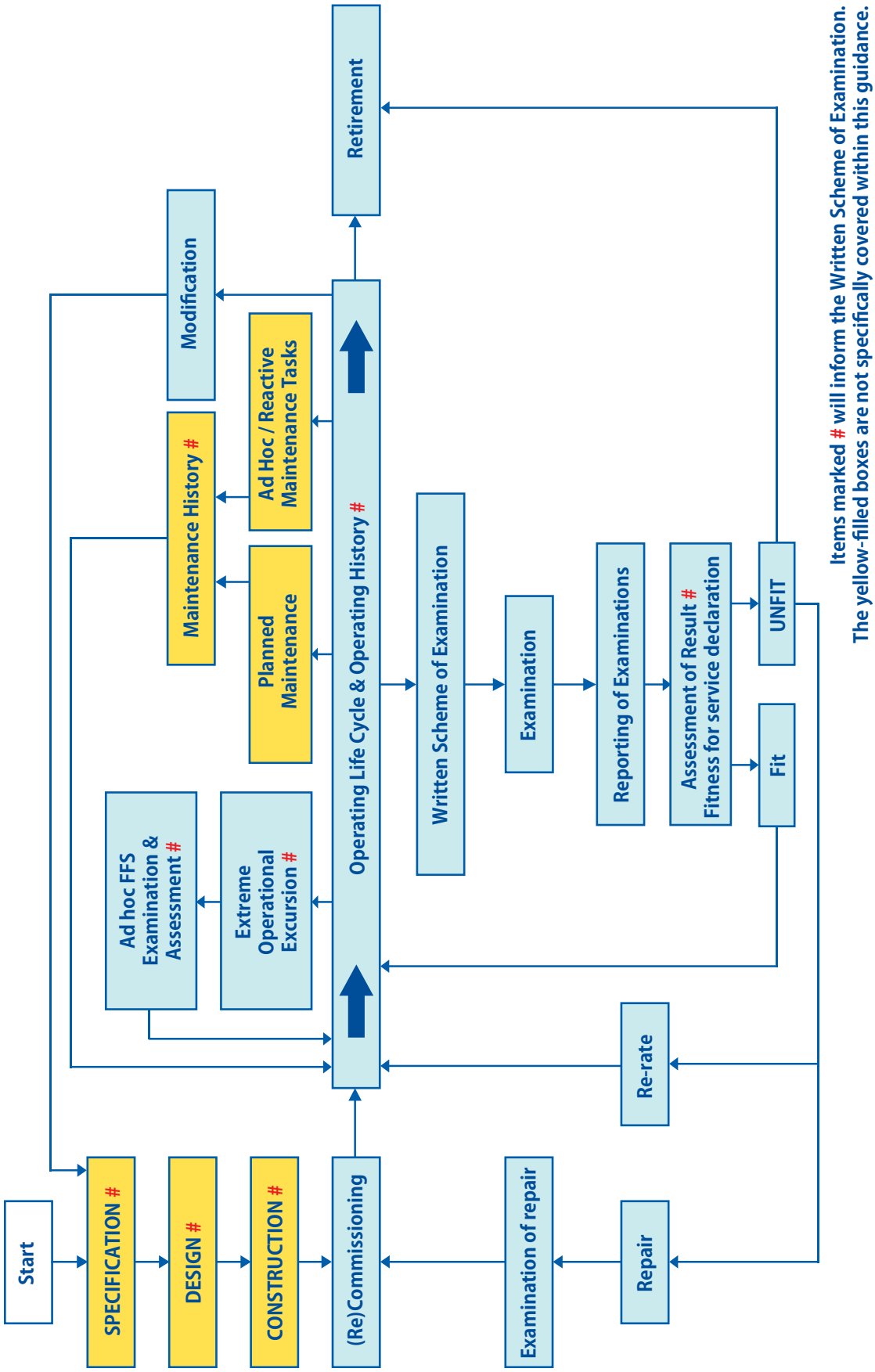
DIAGRAM 1: OVERVIEW OF INTEGRITY MANAGEMENT THROUGHOUT THE PLANT LIFECYCLE



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2.2 DESIGN

This is where the specification is translated into a physical detailed design that is fit for the intended duty. Up to this point the design has been more of a concept, but now it will take shape. The designer should consider matters such as:

- Selection of appropriate design code(s) and appropriate guidance from recognised bodies.
- What materials will be used for construction, and how do they impact inspection?
- What design loads (e.g. temperatures and pressures) to feed into design codes?
- Additional thickness for corrosion allowance?
- What fatigue life has been calculated based on loads and cycles?
- What creep life has been calculated based on time at temperature?
- If subject to Pressure Equipment (Safety) Regulations (PESR) and / or Supply of Machinery (Safety) Regulations (SMSR), how will conformity with the relevant legal requirements be ensured?
- What documentation should be supplied to the end user, for example to help evaluate future changes in duty?
- How will the end user (and the manufacturer) examine and maintain the equipment?

2.3 CONSTRUCTION

The physical construction needs to meet the detailed design intent, and there needs to be means to ensure this. The construction may be in a fabrication shop or built out on site, and these present different issues to be overcome.

Control measures to ensure sound construction may include:

- Suitable welding procedures and welder qualifications;
- Casting procedures with appropriate examination and testing of the components;
- Traceability of materials to demonstrate compliance with design specification / code;
- Non-destructive testing to meet requirements of customer and design code;
- Assessment of defects found at examination, leading to re-work where necessary;
- Hydro-testing;
- Nameplate fixed to equipment bearing required information;
- Conformity procedures, including Notified Body as required, to meet requirements such as Pressure Equipment (Safety) Regulations (PESR) or Supply of Machinery (Safety) Regulations (SMSR) etc.

2.4 COMMISSIONING / RE-COMMISSIONING

It is essential to ensure that all equipment is working correctly before starting the process. It is during start-up that a plant can see some of the most extreme transient operating conditions, before settling into steady state conditions. It is also likely that this is the operation that staff are least familiar with. Similarly, during cleaning and shutdown, equipment can be subjected to unexpected short-term but significant conditions.

A commissioning / start-up plan should be produced in advance to document all steps that should be taken to ensure a safe and orderly commissioning. This would include checks to instruments and control loops, as well as mechanical equipment. This could be the initial commissioning after construction, or recommissioning following a plant outage. For re- commissioning it will be necessary to reverse some of the steps taken during the earlier shut-down process, for example checking that all spades and isolations have been removed.

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2.5 OPERATING LIFE CYCLE & OPERATING HISTORY

This forms the bulk of the 'life' of the asset, frequently lasting for decades. After the initial commissioning the brand new asset will enter service and be subject to operating loads. Over years of service the asset will be examined and maintained, and will age and deteriorate in condition.

It is important to keep records of the operating history and problems encountered during the life, for example running hours, duty cycles, operational excursions, changes in duty or process (See Section 11). This information may inform the Written Scheme of Examination (WSE) and will also be important in any transfer of ownership of the asset.

2.6 OPERATIONAL EXCURSION AND AD-HOC FITNESS FOR SERVICE (FFS) EXAMINATION / ASSESSMENT

Ideally, actual operating conditions will never exceed those originally envisaged at the specification stage. However, this is frequently not the case, and often there are operational excursions where the actual operating conditions can exceed those for which the equipment was designed, e.g. temperatures and pressures beyond the design scope, and this can cause permanent damage.

Where an operational excursion has occurred, the owner / operator should consult with the Integrity Assessor and jointly agree if a formal fitness for service assessment is required. This inspection is outside the normal schedule of examinations as specified in the WSE, and is designed to detect and assess if the asset has been damaged as a result of the excursion. Where damage has taken place, does the asset remain fit for further service, and does the WSE need updating to look at this damage more closely in future? Has the excursion 'used up' years of fatigue life and creep life?

2.7 PLANNED / REACTIVE MAINTENANCE TASKS / MAINTENANCE HISTORY

Routine 'Planned Preventative Maintenance' tasks are primarily designed to ensure the ongoing safe use and availability of the asset. These will include 'servicing' and operator routine check sheets that form the lowest level of inspection.

Reactive Maintenance Tasks are not performed routinely – these may be breakdown or other remedial works that have been found necessary to correct a problem.

Both planned and reactive maintenance tasks should build up a written maintenance history over months and years. These entries will typically be far more frequent than any examinations carried out under a WSE, though not normally as thorough. It is important that these maintenance histories are considered when reviewing a WSE, as they can reveal ongoing problems / failure modes with that asset. As a result, the written scheme may be informed to look specifically for certain known problems.

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2.8 WRITTEN SCHEME OF EXAMINATION (SECTION 6)

A WSE is a cornerstone of an examination regime, whether or not PSSR applies. It specifies the minimum examination and testing that will be carried out, how often, and any techniques that may be required.

Before this can be developed, it is necessary to consider how the asset(s) can degrade over time, and which techniques that can detect this.

Diagram 1 shows many boxes labelled with a #. This is to show that these boxes provide an input to the WSE. When developing the WSE many issues should be considered, including past operating, excursion, maintenance and examination history. Integrity issues encountered on similar plants and processes should also be considered.

It shows the WSE acting as a trigger for examination during the operating life. Note however that for new plant, the WSE should generally be developed and approved prior to the plant being commissioned. For plant where PSSR applies, this is a specific requirement.

2.9 EXAMINATION (SECTION 7)

The execution of those examinations specified in the WSE.

Depending on the nature of the plant and the extent of examination, it is likely that various preparation works will be required in advance, particularly for any internal access that may be specified.

Careful prior planning between all interested parties is required to complete the examinations specified in a timely manner, minimising any plant downtime.

2.10 REPORTING OF EXAMINATIONS (SECTION 8)

Reporting of the examinations is necessary to inform the operator, allow assessment of suitability for continued service, and to build up a history for future reference.

2.11 ASSESSMENT OF EXAMINATION RESULTS AND FITNESS FOR SERVICE DECLARATION (SECTION 8)

Examination reports should be assessed to determine whether the plant is fit to return to service, and if so, for how long. These reports may have been produced by specialist contractors, and unless the plant is 'as new', it is likely that defects of varying severity may be reported. These defects should be assessed to determine whether they are of no consequence, or require remediation. There are various methods available to assess defects, including simple screening tools, corrosion allowance, reference to original design codes and other fitness for service codes. Where an asset is not 'fit for service', the options are to repair, re-rate or retire.

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2.12 REPAIR, RE-RATE OR RETIRE

Usually a repair is the preferred route to return the plant to the original duty. Repairs need careful specification and planning to ensure that the original duty can be maintained. On completion further examination will usually be required to verify that the repair is satisfactory. Repair can include the renewal of a specific piece of equipment.

Repairs are not always possible or cost effective, and an alternative is to re-rate the plant and continue to use it for a less arduous application, for example at a less demanding pressure or temperature.

When a repair is not technically possible or cost effective, and re-rating is not possible, retirement of the asset may be the only option, and to replace with new, the old asset being decommissioned.

When an asset is mothballed, retired or decommissioned but not demolished or removed, hazards from residual contents and loss of structural integrity will still need to be managed by some form of continuing examination.

2.13 MODIFICATION

There may be times during the life of the plant when it needs to be modified. The driver for this may be a desired process change, or in response to revised best practice or regulation for that industry. Whatever the driver, it is important that the modification is subject to 'management of change' procedures, including appropriate risk assessments.

So that the Modification is carried out correctly, the Specification, Design and Construction steps discussed earlier should be reconsidered, to ensure that the integrity of the plant is maintained. In addition, where the plant is subject to legislative essential health and safety requirements (e.g. Pressure Equipment (Safety) Regulations or Supply of Machinery (Safety) Regulations) the modification should also conform to this current legislation. These matters will also inform the WSE, which may need revising.

Examples of modifications include:

- Installing an additional nozzle (or enlarging an existing nozzle);
- Installing an agitator to an existing vessel;
- Altering the tank / vessel to make it larger / smaller;
- Change of process conditions;
- Retro-fitting steam coils to heat the contents;
- Installing or removing insulation to / from the exterior of a tank / vessel.

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3 LEGISLATIVE CONSIDERATION

UK legislation covers the maintenance of plant and arrangements for the use, handling, storage and transport of substances through the Health and Safety at Work etc Act 1974 (HSWA) and other regulations. These include but are not limited to the following:

- Management of Health and Safety at Work Regulations (MHSWR)
- Provision and Use of Work Equipment Regulations 1998 (PUWER)
- Pressure Systems Safety Regulations 2000 (PSSR)
- Control of Major Accident Hazards Regulations 2015 (COMAH)
- Dangerous Substances and Explosive Atmospheres Regulations 2002 [as amended April and June 2015] (DSEAR)
- Lifting Operations and Lifting Equipment Regulations 1998 (LOLER)
- The Pollution Prevention and Control Regulations, 2000 [as amended to 2016]

Further information on legislation, is given in Appendix 1.

3.1 COMPARISON OF DUTIES RELATING TO INSPECTION OF PLANT CONTAINING HAZARDOUS SUBSTANCES

The PSSR and its associated Approved Code of Practice (ACoP) provide detailed guidance on what is required of an examination regime. These principles are well established and followed. They are often used as a benchmark for maintaining integrity. However, their scope is limited in that they only apply where the substance contained in a pressure system is a relevant fluid (as defined by the regulations) and they do not consider the hazardous nature of the contents (except for steam), only a release of stored energy.

This means that a PSSR regime may not ensure the integrity of all plant containing hazardous substances.

Therefore, compliance with PSSR is unlikely to be sufficient to satisfy more general regulations such as PUWER, the wider duties of COMAH (where it applies) or HSWA. A similar situation exists with LOLER. This is because PSSR and LOLER focus on specific risks and may not consider the effects on containment or process operating conditions.

For example, a relatively small leak of a hazardous substance that may not cause serious injury to persons from release of stored energy (therefore not of concern under PSSR) may still be sufficient to cause harm and compromise any of the general duties of HSWA, MHSWR or COMAH. Such harm would also be relevant when considering the suitability of an inspection regime under PUWER. Therefore, the inspection regime required under PUWER or COMAH, is likely to be wider or more rigorous than one set up purely for PSSR.

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Case Study 1 – Pipework and PSSR

The Operator of a COMAH site has low pressure hydrogen pipework that has been excluded from the requirement for routine examination by a Competent Person under a PSSR WSE.

The Operator, in conjunction with the Competent Person, decided to have the pipework examined to meet his obligations under PUWER, particularly because of the fire risk should leakage occur.

The pipework had very little documentation available and required further assessment by the Competent Person to confirm its suitability for use. Once this had been carried out an inspection plan was derived which included examinations for condition, leakage, earth conductivity, support adequacy, etc. The results of this examination and testing were used by the Operator to help demonstrate his safety case under Regulation 5.1 of COMAH.

3.2 REASONABLE PRACTICABILITY

Many of an employer's duties under HSWA are qualified by the term 'so far as is reasonably practicable'. The concept of reasonable practicability creates a principle of balance between the cost and effort of risk reduction against the benefit to be gained.

(Note: This balance can only be considered where the risk is not intolerable. Where the risk is intolerable all possible risk prevention, control and mitigation efforts should be applied to reduce the risk into a tolerable level.)

The operator of a COMAH site has a duty to take all measures necessary to prevent accidents and limit their consequences to persons and the environment. Guidance to the regulations states 'prevention should be considered in a hierarchy based on the principles of reducing risk to as low as is reasonably practicable (ALARP)' and 'where hazards are high, high standards will be required to ensure risks are acceptably low'.

Application of the principles of reasonable practicability will mean that an integrity management regime needs to consider the likelihood of degradation and all potential consequences. Therefore no one regime will fit all; a high hazard situation will require a more rigorous examination regime than a low hazard one.

The following examples illustrate this point:

- What is considered to be a reasonably practicable examination regime for a simple air receiver in a remote part of a site would be much less than that expected for a reactor vessel, containing hazardous substances, sited in a populated area and which is subject to complex process conditions, giving rise to multiple degradation mechanisms.
- Where the likelihood of a degradation mechanism affecting a vessel is very remote, but the consequences of a release from that vessel are high, it may still be considered reasonably practicable for the examination regime to take it into account and employ inspection techniques to detect it, should it occur.

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