COMAH Control of Major Accident Hazards

COMAH Competent Authority

Ageing Plant Operational Delivery Guide

the Competent Authority

HSE Environment Agency SEPA

COMAH Control of Major Accident Hazards

1. Purpose

1.1 This Delivery Guide (DG) underpins the Competent Authority's programme to prevent, control and mitigate major accidents at COMAH sites; it does this by ensuring ageing mechanisms which could cause plant deterioration and increased major hazard risks are recognised and are being managed effectively. The COMAH Competent Authority has identified ageing plant as a strategic priority within the CA's workplan.

1.2 Ageing mechanisms such as corrosion, erosion, fatigue, obsolescence and calibration failure should form part of a site's asset integrity management system. The issue of ageing plant is just part of the overall management of the integrity of a site's assets, and is closely linked to the effectiveness of the inspection, testing, maintenance and calibration regimes. In practice, ageing plant issues may be best tackled as part of overall inspection plans related to asset integrity management.

1.3 This DG is provided to help identify those sites where ageing plant may be a priority, and to assess the extent of ageing issues and how well these are being managed. It should enable operational teams to:

- identify COMAH sites where ageing plant is an issue with the potential to give rise to a major accident;
- target inspections and interventions;
- assess how well an operator is managing ageing plant and record their performance in a consistent way; and
- identify issues, secure improvements or arrange further interventions as required.

1.4 The DG may also be useful when assessing sub-COMAH or non-COMAH sites where ageing plant could present a significant risk.

2. Scope

2.1 The key focus is on COMAH sites. This guide should be followed where there is a significant risk of a major accident due to ageing plant.

2.2 The CA's ageing plant programme comprises three main elements:

a) June 2010 – **publication of new guidance** for industry;

b) July – Nov 2010 – an **intelligence gathering exercise** at sites where the CA has little or no information on ageing plant; and

c) June 2010 onwards – **an inspection programme** during 2010/11 based on what is already planned on ageing plant issues, followed in 2011 by further targeted inspection based on improved intelligence from (b).

d) June 2010 onwards – a gap analysis on sites where the CA has carried out previous interventions on ageing plant issues.

2.3 The main controls expected to be in place to manage ageing plant risks are Risk Control Systems (RCS), with a focus on the prevention, control and mitigation of major accident hazards (MAH) arising from potential ageing related deterioration in, or failure of, plant or system performance. These include systems and procedures for:

- hazard identification and risk assessment;
- planned maintenance;
- examination and testing of safety-critical plant (i.e. systems and procedures for preserving the integrity of structures, plant, equipment, process control and instrumentation, etc);
- testing and calibration of safety-related electrical, control and instrument, EC&I, equipment; and
- management of change.

2.4 Ageing mechanisms leading to deterioration can affect a wide variety of plant systems and features.

2.5 Asset types susceptible to ageing can be segregated into four basic categories:

- primary containment systems;
- structures;
- prevention, control and mitigation safeguards (non EC&I); and
- EC&I systems.

2.6 EC&I systems can be considered as a type of safeguard. However, given the different nature and relative importance of the functions performed by this type of equipment, it is considered desirable to highlight this category specifically.

2.7 The structural integrity factors that should be considered are structures and civil engineering features designed to protect people on plant or provide access for people, structures which could impact the plant if they fail or collapse, and those structures protecting the plant from environmental hazards (e.g. flooding or subsidence) as well as the primary structures supporting the plant, fire and blast walls, emergency shelters, bunds and drains.

2.8 An overview guide entitled Managing Ageing Plant: A Summary Guide has been published to promote an awareness of ageing mechanisms and how to manage these effectively. The guide has been designed to work alongside this Delivery Guide. Reference to further relevant guidance is in Appendix 1.

3. Justification

3.1 Plant ageing, leading to an increased risk of loss of containment and other failures due to plant and equipment deterioration, has been shown to be an important factor in incidents and accidents. Recent research shows that 50% of European major hazard loss of containment events arising from technical plant failures were primarily due to ageing plant mechanisms such as erosion, corrosion and fatigue. Between 1980 and 2006, there have been 96 major accident potential loss of containment incidents reported in the EU Major Accident Reporting System (MARS) which are estimated to be primarily caused due to ageing plant mechanisms. This represents 30% of all reported major accident loss of containment events, and 50% of the technical integrity and control and instrumentation-related events. These 'ageing' events equate to an overall loss of 11 lives, 183 injuries and over 170€m of economic loss.

3.2 The UK RIDDOR data shows that between 1996 and 2008 there have been 173 loss of containment incidents that can be attributed to ageing plant mechanisms.

4. What is meant by 'Ageing Plant'?

4.1 The term 'ageing plant' can be misleading; it is not just related to the age and design life of a plant, system or piece of equipment. Research Report 509 'Plant ageing: Management of equipment containing hazardous fluids or pressure' defined ageing and ageing plant as:

"Ageing is not about how old your equipment is; it is about its condition, and how that is changing over time. Ageing is the effect whereby a component suffers some form of material deterioration and damage (usually, but not necessarily, associated with time in service) with an increasing likelihood of failure over the lifetime.

Ageing equipment is equipment for which there is evidence or likelihood of significant deterioration and damage taking place since new, or for which there is insufficient information and knowledge available to know the extent to which this possibility exists.

The significance of deterioration and damage relates to the potential effect on the equipment's functionality, availability, reliability and safety. Just because an item of equipment is old does not necessarily mean that it is significantly deteriorating and damaged. All types of equipment can be susceptible to ageing mechanisms".

4.2 **Overall, ageing plant is plant which is, or may be, no longer considered fully fit for purpose due to deterioration or obsolescence in its integrity or functional performance. 'Ageing' is not directly related to chronological age.** There are many examples of very old plant remaining fully fit for purpose, and of newer plant showing evidence of accelerated or early ageing, e.g. due to corrosion, fatigue, erosion failures or out of calibration incidents.

4.3. Operators who utilise plant and equipment subject to ageing should adopt a risk-based approach that entails:

- recognition of ageing and where this is or may be occurring;
- increased coverage, frequency and depth of inspection and maintenance; and
- re-rating or replacement.

5. Identifying where ageing plant may be an issue

5.1 Ageing is more likely to be an issue on sites that have processes with:

- a high cycling rate of extreme temperatures, pressures loads or flexing (which may lead to fatigue);
- a history of operating at the limit of, or beyond, its original design envelope;
- a high operating temperature;
- aggressive chemicals (corrosive or abrasive);
- use of many different materials or construction (indicator of aggressive conditions and potential for interface corrosion issues);
- aggressive environmental conditions (e.g. salty atmosphere, hot and/orhumid conditions, fumes, standing water);
- insulated pipework and equipment with potential for corrosion under the insulation;
- key parts of the plant difficult to access or inspect;
- a history or poor maintenance and inspection; and
- EC&I equipment that is obsolescent or no longer supported by the manufacturer or supplier.

5.2 Equipment such as pumps, compressors, furnaces, orifice plates, injection points, poorly supported small bore pipework, pipework/equipment under lagging, and buried pipelines, may be particularly prone to ageing mechanisms such as corrosion, erosion and fatigue.

5.3 The clearest evidence will be where:

- there are frequent or recurring defects and failures, or increasing trends of unplanned maintenance and repair work and breakdowns;
- there are signs of ageing e.g. cracking, corrosion, creep and increasing corrosion rates;
- plant has had to be re-rated (i.e. where plant has had to be downgraded to a lower rating, e.g. pressure, temperature, loading, stream concentration or flow due to deterioration); and
- operators have had to increase the frequency of their inspection and testing regimes for specific components or plants, or operators have moved from a same period/same inspection regime to a risk-based one where periodically and depth of inspections have changed.

5.4 The following could indicate situations where the potential for ageing is not being identified or monitored:

- records of corrosion monitoring activities and pressure vessel inspections and their findings are not being kept and reviewed for lessons, trends or important issues. An extreme case of this is that these monitoring activities and inspections are not being carried out at all.
- operators are not using the findings of plant tests and inspections to check/modify their testing and inspection frequencies.
- significant safety-related equipment is not listed on the asset register or in the maintenance management system.
- there is no procedure for assessing under insulation corrosion, for example.

5.5 For all top tier sites, ageing plant is also addressed in the COMAH Safety Report Assessment Manual (SRAM), [see Table 1]. Assessment of COMAH Safety Reports against these criteria should indicate whether the operator has ageing plant issues at their site. Control of modifications is also important to ensure the plant integrity is not compromised by equipment, process or operating and maintenance system changes. Safety Report assessment guidance for mechanical systems assessment directs that the safety report should describe:

- the specified design basis and the assessment that has been made of the impact for continued operations, inspection, testing and maintenance;
- equipment condition derived from known inspection history e.g. the corrosion history, operational performance, how the plant has degraded;
- processes that need to be gone through for determining and carrying out more detailed inspections, and to positively justify what is needed to keep the plant going (as opposed to rebuilding it);
- reviews to compare the original design with up-to-date design principles and the consideration of measures to reduce risk to ALARP where appropriate; and
- use of fitness-for-service and remnant life assessment techniques in re-evaluation of structural integrity.

Table 1: COMAH SRAM Criteria

Maintenance	Criterion description
Criterion 12.2.4.1	The safety report should show that an appropriate maintenance scheme is established for plant and systems to prevent major accidents or reduce the loss of containment in the event of such accidents
Criterion 12.2.4.3	The safety report should show that systems are in place to ensure that safety-critical plant and systems are examined at appropriate intervals by a competent person
Criterion 12.2.4.4	The safety report should show that there is a system in place to ensure the continued safety of the installations based on the results of periodic examinations and maintenance
Modifications	**Criterion description**
Criterion 12.2.5.1	The safety report should describe the system in place for ensuring modifications are adequately conceived, designed, installed and tested

6. The CA Ageing Plant Programme

6.1 The programme has four main elements:

a) publication of new guidance;

b) intelligence gathering;

c) inspection programme consisting of seven elements; and

d) gap analysis.

These are discussed in more detail below.

a) Publication of new guidance – June 2010 – HID CI4

The new guidance booklet 'Managing Ageing Plant: A Summary Guide' is based on research undertaken by ESR Technology. The full research report is also being published. The new guidance will be supplemented by a summary question set to help dutyholders assess compliance with the guidance. The question set is at Appendix 2.

By the end of June 2010 HID CI4 will publish Managing Ageing Plant: A Summary Guide together with the self assessment question set in Appendix 2 and supporting research reports. Use of the guidance and details of the CA's inspection programme will be published to key stakeholders.

b) Intelligence gathering exercise – June – December 2010 – CI 1-3/HSL

This will use the questionnaire in Appendix 4, developed from the new guidance. The aim is to identify dutyholders where ageing plant may be an issue relating to major hazard potential, but for which the CA currently holds little information. The results of the survey will be used to develop a targeted inspection programme to be undertaken from 2011 onwards.

Between June - July 2010: Regulatory inspectors in CI 1-3 operational teams, in consultation with specialist mechanical and C&I inspectors, will identify COMAH sites where ageing plant may be a feature in relation to the risk of a major accident, and for which CI operational teams currently hold no information on where there are no interventions planned for 2010/11. Paragraph 5 above provides guidance on the factors to be considered when identifying sites for inclusion in the survey.

By end of July 2010: Regulatory inspectors in CI 1-3 operational teams should send a list of target sites for survey to HSL using the structured format in Appendix 3.
Between August – October 2010: HSL will send out the survey questionnaire and analyse the returns. A copy of the Managing Ageing Plant: A Summary Guide will also be sent to target sites.

By end of October 2010: HSL will forward the results of the survey to CI 1-3 operational team leaders. The results will be tabulated with suggested priority sites and issues to be reviewed during the subsequent 2011/12 inspection programme. The sites will be categorised as high, medium or low priority with respect to ageing plant issues. HSL will send an acknowledgement to dutyholders submitting a return and inform the site operator that the results will be used to inform the CA's future intervention programme. Sites surveyed who choose not to respond will be notified to operational teams.
November – December 2010: CI 1-3 operational teams will review the prioritised list of survey returns and incorporate ageing plant as an inspection item for 2011/12 onwards when undertaking the annual review of intervention plans. High priority sites identified via the survey should be included within the 2011/12 inspection programme and medium priority sites identified for inclusion at the latest within the 2012/13 work year. If resources permit, operational teams should also aim to include medium priority sites within the 2011/12 inspection programme. Operational teams should exercise discretion based on their original assessment of ageing plant risk on whether to include sites that fail to respond to the survey in the subsequent inspection programme. Low priority sites need not be included in the intervention programme.

c) Inspection Programme – June 2010 onwards

A targeted inspection programme will be developed to assess compliance with the new guidance.

From June 2010 onwards - CI 1-3 Mechanical and C&I specialist inspectors in consultation with regulatory inspectors will assess the issues set out in Appendix 5 at sites where ageing plant and plant integrity is included within inspection plans within 2010/11. These priority topics have been drawn from the summary question set in Appendix 2. Where there have been previous interventions on plant integrity or C&I issues at the site, a gap analysis should be carried out against the information in Appendix 5 in order to target future interventions effectively. Some elements of work may be incorporated into inspections already planned for 2010/11. Other elements will be added to intervention plans for future years. Where appropriate inspectors may wish to send the Site Operator Self Assessment Question Set (Appendix 2) to sites in advance of the visit.

Inspection should provide assurance of the following:

i) **There is coordination, leadership, ownership and senior management engagement in the topics which follow.** The effective management of plant ageing is fundamental to the maintenance of process safety on a high hazard site. As such, it is imperative that the operator has a clear understanding of the processes in place to manage the issue and that they monitor their effectiveness. Key elements in this will be the presence of suitable Key Performance Indicators (KPIs) and evidence of commitment from the leadership team to the maintenance of the integrity of plant across the site. For less complex sites this element may be incorporated into inspection of the topics that follow – but may need a separate intervention at complex sites.

ii) **There is an Asset Register for the site.** Key to the effective management of plant ageing is the ability to identify the equipment on the site that, if it were to fail, could impact on process safety. This is normally achieved through keeping an Asset Register in which safety-critical equipment (SCE) is flagged. It is important that the process of identifying SCE is carried out effectively, and inspection of this is a key aspect of this topic. Normally, this will be addressed as part of interventions dealing with mechanical maintenance and EC&I inspection and test.

iii) **There is a plant inspection regime** that is aimed at providing assurance of the continuing integrity of the primary containment boundary of all areas of the site handling hazardous fluids. This regime should use staff with appropriate competence and experience to both set the scope and periodicity of inspection, and to deliver those inspections.

Inspection results should be appropriately analysed and acted on prior to the equipment being approved as fit for further service. Where degradation is such that the original design basis is no longer met, there should be evidence of appropriate assessment to determine fitness for service. Roles and responsibilities should be clearly defined and understood.

It is important that the inspection regime is designed to address all potential hazards that might result from the loss of containment of process fluids, not solely that resulting from the release of stored energy. This can be a particular issue at sites employing third party inspection bodies to deliver their duties under Pressure Systems Safety Regulations (PSSR) and can result in a failure to fully discharge COMAH duties. This issue is addressed in a paper by CI's Mechanical Engineering Team (Mechanical Integrity: Use of Third Party Expertise on High Hazard Sites, Health and Safety Executive. 2010, Web: http://www.hse.gov.uk/comah/guidance.htm).

In addition, the inspection should confirm that this process is being effectively delivered and on schedule. At all sites, the identification of the degradation mechanisms that could threaten the integrity of the plant primary containment boundary will be fundamental to the delivery of an effective inspection regime and, other than for the simplest of sites (e.g. LPG storage), is likely to require specific assessment of individual vessels and pipework systems. Increasingly, sites are adopting risk-based inspection (RBI) to address this requirement.

Whatever approach is adopted, it is important that inspection teams carry out sufficient depth of inspection to provide assurance that the identification of active degradation mechanisms and inspection methods by which they can be monitored is being carried out effectively. These inspections will normally involve discipline specialists' input.

iv) **There is a planned plant maintenance system which is also being delivered on schedule** by competent people, with results appropriately analysed and acted upon. The CA's interest here is restricted to the effective delivery of the maintenance of safety-critical equipment (SCE) and should address issues such as the identification of SCE (although this may be covered more generally in assessing the Asset Register), the setting of maintenance scope and interval, assessment of adverse maintenance findings, and the management of delays to SCE maintenance. In some instances (depending on the expertise of the inspector and complexity of the plant) it may be possible for this topic to be Regulatory Inspector-led.

v) **There is an effective Electrical Inspection and Testing regime and it is being delivered.** A good testing regime should record the values measured, rather than just pass/fail, in order to track deterioration of the plant. Testing of safety-related functions should be from end to end whenever possible, to confirm that they work as designed. Test intervals should be reviewed periodically, unless specified during the design process, to maintain the integrity of the system.

vi) **There is a regime for management of obsolescent EC&I plant and systems in place.** At sites where there may be instrumentation systems that are obsolete, there should be a procedure in place to identify those instruments, and either hold a stock of suitable spares or define what the instruments should be replaced with when they fail. Replacement of individual instruments will require an assessment as a modification, but replacement of a complete safety related control or protective system will require an assessment in accordance with BSEN 61511.

vii) **There are sufficient and competent resources available to manage plant ageing issues.** The individual topics above associated with mechanical and C&I systems will provide basic information on resources which may be sufficient. However, at more complex sites or where the mechanical or C&I topic inspection indicates potential issues, there may be a need to carry out a deeper inspection of resourcing issues.

In some cases the seven topics may all be very small and the whole intervention may be done at once, whereas in very complex sites it may be further divided. How this is done will be determined by Inspection Teams through local liaison between Inspection Team Regulatory and Discipline Specialists.

The above inspections will touch on issues of control and use of third parties (contractors), competence of these and in-house staff, and management of change. If very significant and serious deficiencies are found, these elements may need to be addressed more thoroughly by follow up inspection. In other instances where the elements are found to be worthy of further inspection, but are not so seriously deficient as to demand immediate more detailed inspection, this should be recorded and fed into the intelligence gathering arrangement through which future CA strategic priority topics are identified.

d) **Gap Analysis** to benchmark compliance with 'Managing Ageing Plant: A Summary Guide' at COMAH sites where the CA already has information on ageing plant issues but has planned no inspection activity during 2010/11.

From June 2010 – March 2011 - CI 1-3 mechanical and C&I specialist inspectors in consultation with regulatory inspectors. Where there is a history of intervention on plant integrity or C&I inspection and test at sites, RI, ME and EC&I inspectors will liaise to conduct a gap analysis against the inspection programme topics outlined in Appendix 5 to identify what is left to examine (or may need to be re-examined if the history is not considered sufficiently recent). Any topics identified as requiring examination should be added to the Intervention Plan. The operator's performance will be scored, so far as possible, on the basis of the gap analysis using the criteria set out in Table 2.

6.2 **Performance Recording** – dutyholders' performance against the topics listed in paragraph 6.1 (c) should be recorded on COIN IRF tab using the performance criteria set out in Table 2.

7. Success criteria for COMAH sites that have ageing plant

7.1 Site operators' performance should judged against the following criteria:

- site operators recognise where ageing plant gives rise to a potential major accident and can demonstrate that they have adequate controls in place to prevent such an accident. Compliance with good practice as set out in 'Managing Ageing Plant: A Summary Guide' would form the basis of that demonstration.
- where self-assessment against the guidance or a CA inspection reveals that improvements are needed to meet good practice, site operators draw up and implement an appropriate improvement plan.
- site operators plan and prioritise inspections and maintenance of ageing plant, including completion of improvement actions as part of their life-cycle interventions for the site.
- site operators utilise key leading and lagging indicators to review the performance of their risk control systems in place to manage ageing plant issues.
- clear roles, responsibilities and demarcations are established for site staff and third party personnel relating to asset inspection and maintenance.
- site operators can demonstrate, when they have moved to a risk-based asset inspection regime in relation to ageing plant, that there is:
  - a rationale for the changes made;
  - ownership of the process;
  - an audit trail for the changes made; and
  - transparency in the records to show what was done, when and by whom.
- clear roles, responsibilities are established for site staff and third party personnel responsible for design, inspection and maintenance of EC&I systems (especially safety instrumented systems).
- operators have a clear policy for replacement of out-of-date or obsolescent EC&I equipment to ensure their integrity and performance (including equipment that may no longer be supported by the supplier or manufacturer).
- site operators ensure that EC&I equipment systems are tested and calibrated regularly.

8. Judging success and moving on

8.1 All sites subject to an ageing plant inspection should have their performance rated using the criteria in Table 2, and the result recorded on the COIN IRF tab. These judgments should be linked, where necessary, to the relevant enforcement action and the Enforcement Management Model (EMM) as appropriate.

8.2 It is important to understand that the Performance Rating Table only provides indicative guidance on suggested benchmark scenarios and appropriate actions to consider, taking account of the overall inspection findings. It does not offer guidance on specific issues that may arise, requiring singular action. Assessment using the EMM and local factors will be ultimately what determines appropriate action and the close-out of an inspection. Where inspection findings arise that may be in the 'Poor', 'Very Poor' or 'Unacceptable' categories, or where a specific issue warrants consideration of enforcement, it should be discussed with the relevant discipline specialist inspector(s) to help determine if and what enforcement action may be applicable.

8.3 Where ageing plant deficiencies are identified that may indicate COMAH serious deficiencies, give possible rise to matters of immediate evident concern, and/or warrant consideration of an Improvement Notice, the relevant discipline specialist inspector(s) should be consulted to confirm whether the evidence supports the service of a COMAH Prohibition Notice, a HSW Prohibition Notice or an Improvement Notice as appropriate, before enforcement action is considered.

Table 2: Performance Rating: Where there is an identified major accident risk associated with ageing plant

Performance Rating	Description	CA action to consider	Score
Exemplary	Good practice or above in all respects. All success criteria fully met. Robust and effective ageing plant management regime in place. The rationale for the regime can be demonstrated.	No action required.	10
Good	Good practice in most respects. Most success criteria met. Effective ageing plant management regime in place, but some potential weakness. The rationale for the regime can be demonstrated. Inspections and maintenance of ageing plant are planned and prioritised. Key leading and lagging indicators are used to monitor performance. Site and third party staff have clear roles and responsibilities. Clear demarcation of site and third party responsibilities for asset inspection and maintenance including EC&I equipment. The operator has a clear policy for replacement of out-of-date or obsolescent EC&I equipment. Site operators ensure that EC&I equipment systems are tested and calibrated regularly.	Provision of advice or confirmatory letter only with no plans for followup in the short term.	20
Partially Compliant	Some success criteria not fully met. Ageing plant management regime in place with some gaps and weaknesses. Inspections and maintenance of ageing plant are planned and prioritised. Key leading and lagging indicators are known but may not be effectively used to monitor performance. Not all site and third party staff may have clear roles and responsibilities. Demarcation of site and third party responsibilities for asset inspection and maintenance may not be entirely clear. Site has unclear policy for replacement of out-of-date or obsolescent EC&I equipment. Only some EC&I equipment systems are tested and calibrated regularly. Further work to close out improvement actions.	Written confirmation of work required and agreed timetable. Short term followup action required.	30

Table 2: Performance Rating: Where there is an identified major accident risk associated with ageing plant			
Performance Rating	**Description**	**CA action to consider**	**Score**
Poor	Many success criteria not met/fully met. Ageing degradation mechanisms only partially identified. Ineffective ageing plant management regime in place. Inspections and maintenance of ageing plant are poorly planned and prioritised. Key leading and lagging indicators not fully understood and not used to monitor performance. Site and third party staff have no distinct roles or responsibilities. No demarcation of site and third party responsibilities for asset inspection and maintenance. The operator has no clear policy for replacement of out-of-date or obsolescent EC&I equipment. Only some EC&I equipment systems are tested and calibrated regularly but no records kept. Little progress with improvement actions. Failure to adequately manage ageing plant may have potential to give rise to major accident if improvements not sustained.	Enforcement action likely – Improvement Notice. Refer to HSE Specialist(s).	40
Very Poor	Majority of success criteria not met/fully met. Ageing degradation mechanisms only partially identified. No ageing plant management regime in place. Largely reactive inspection and maintenance or ageing plant. Key leading and lagging indicators not identified. Site and third party staff have no distinct roles and responsibilities. No demarcation of site and third party responsibilities for asset inspection and maintenance. The operator has no policy for replacement of out-of-date or obsolescent EC&I equipment. No EC&I equipment systems are tested and calibrated regularly. No progress with improvement actions. Possible matters of immediate evident concern. Failure to adequately control and manage ageing plant has potential to give rise to major accident.	Enforcement action very likely – Improvement Notice, HSW or COMAH Prohibition Notice, consider prosecution. Refer to HSE Specialist(s).	50
Unacceptable	No success criteria met. Ageing degradation mechanisms not identified. No ageing plant management regime in place. No Inspections or maintenance of ageing plant. Possible matters of immediate evidence concern. Failure to adequately control and manage ageing plant has potential to give rise to major accident.	Enforcement action inevitable – Prosecution, Improvement Notice, HSW or COMAH, Prohibition Notice. Refer to HSE Specialist(s).	60

9. COIN Inspection Report

9.1 It is very important that all site-related work on ageing plant is correctly recorded on the COIN Service Order.

9.2 For each intervention where progress with ageing plant is assessed, a keyword corresponding to the programme stage should be added in to the inspection Service Order Notes 'Summary' field relating to the intervention, as illustrated below. **Please note the keyword should contain no spaces.**

For the intelligence gathering stage for a site	AP_INTELL
Where an initial targeted inspection has been completed	AP_INSP
If follow-up of improvement actions completed	AP_FOLLOWUP
If a gap analysis is completed	AP_GAP

9.3 Following the completion of an initial inspection, a follow up inspection, or the completion of a gap analysis, scores from the Performance Rating Table should be entered on the Performance Data Template on COIN, as illustrated below. **Please note scores should not be entered at completion of the intelligence gathering stage.**

10. COIN Time Recording

10.1 In order that the Competent Authority can demonstrate the deployment of resources to strategic topics, there has been a slight alteration to the way we record time spent on these inspections on COIN:

- for strategic topics there should be an entry made in the 'Category' box of the Time Line via a drop down menu;
- the category selection will be restricted to the strategic topics and the relevant one should be selected when completing the timeline;
- all other time line instructions are as before.

Business unit (BU)	Work Desc	Activity	Category	Work context	Type
COMAH	Company	INSP_COMAH	StratTop emer onsite StratTop emer off-site StratTop PSPI KPI **StratTop Ageing Plant** StratTop Buncefield PSLG StratTop Containment	ELSE/ OFFCO/ OFFNC/ OSITE/	Case/ Service Order

11. Review and Evaluation

11.1 Field Progress, including issues that have arisen shall be reviewed and evaluated by CI4 during Q3 of Work Year 2010/11.

Contact: HID CI4(b)
VPN: 523 4078

Appendix 1

Supporting information

- HSE Workstream 2h Inspection – Plant life cycle – Maintenance of integrity (Operational DG) **http://intranet/strategy/hidci/idg2h.htm**
- Managing Ageing plant: A Summary Guide *[add web address when published]*
- Plant Ageing Study – Phase 1 Report *[add web address when published]*
- Research Report 509 Plant ageing: Management of equipment containing hazardous fluids or pressure (HSE, 2006) **http://www.hse.gov.uk/research/rrhtm/rr509.htm**
- SPC/Enforcement/133 **http://intranet/operational/hid_circs/enforcement/spc_enf_133.htm**
- SRAM Criteria 12.2.4.1 – 4 and Item 17, P70 **http://www.hse.gov.uk/comah/sram/s8-15.pdf**
- Enforcement Management Model (EMM) **http://intranet/legal/emm/index.htm**
- Use of the Enforcement Management Model by the COMAH Competent authority **http://intranet/comah/docs/guidance/use_EMM.pdf**
- HSG254 Developing process safety indicators: A step-by-step guide for chemical and major hazard industries (HSE, 2006)

Appendix 2

Ageing Plant: Site Operator Self-Assessment Question Set

1. This appendix contains a question set to help operators assess compliance against 'Managing Ageing Plant: A Summary Guide'.

2. In the question set, each high-level question is provided with benchmarks to indicate what would typically be expected to manage the issue. It should be noted that the way these arrangements or systems are developed, provided and implemented will vary greatly depending on the nature and ways of working of the operator, and the hazards, size and complexity of the plant being managed.

3. Some supplementary questions are also provided which address the key underlying issues relevant to each high-level question.

Key Questions on Ageing Plant

Question 1. Plant and Equipment on Site

What plant and equipment is involved at the site?

Rationale: It is important to know what plant and equipment is present on site, how important it is to safety, and whether it may be subject to ageing mechanisms, so it can be managed effectively.

Benchmark

There should be an asset register that lists important plant and equipment and its location.

There should also be information on relevant hazardous fluids present within plant and equipment, together with their hazardous properties i.e. Material Safety Data Sheets (MSDSs).

Most sites will have both computer and hard copy records containing this information but often it will be kept in different formats, and records may be fragmented. The format is not critical providing that information on hazardous fluids and the hazardous fluids operating envelope is easy to access and use.

It is also important that the Asset Register is kept up-to-date and mirrored by accurate up-to-date process and instrumentation diagrams, P&IDs, and other plant or process documentation.

The Asset Register should clearly identify all primary containment safety-critical mechanical equipment (tanks, vessels, pumps, piping etc) which if they failed could give rise to a major accident. There should also be a register of safety-related electrical, control and instrumentation and prevention/control/mitigation safeguards equipment for major hazard plant.

There should be some form of prioritisation or risk ranking system within the asset register or maintenance management system to highlight safety-critical plant and equipment associated with major hazard plant.

There should be arrangements for identifying and highlighting equipment found to be subject to significant ageing, either through inspection reports, written schemes of examination or integrity reviews, so these can be monitored and managed effectively.

Underlying Key Issues

- Do you have an Asset Register?
- How is the Asset Register kept up-to-date?
- Does it include electrical, control and instrumentation, EC&I, prevention, control and mitigation safeguards, and structures (this can be particularly important where the safety of the plant relies on instrumented protective systems e.g. Safety Integrity Level (SIL) 1 or higher rated systems)?
- Are safety-critical items highlighted together with all the relevant assets that comprise this, support it, or are necessary for it to function?
- Are items found to be suffering from ageing identified, highlighted and given specific attention e.g. in risk-based inspection, RBI, reports, inspection reports or written schemes of examination?

Key Questions on Ageing Plant

Question 2. Plant and Equipment Exhibiting Signs of Ageing

Are arrangements in place to identify and assess the condition of plant and equipment that may be showing signs of ageing, or which may be approaching or beyond its original design life or calculated remnant life, and to justify continued operation or down-rate/decommission this?

Rationale: Plant and equipment exhibiting signs of ageing, such as corrosion, erosion, fatigue, creep, obsolescence, etc should be identified so it can be monitored/assessed to check it is still fit for purpose. If the deterioration is significant, then plant and equipment may have to be down-rated, removed from service, or other measures introduced so it can continue operation.

Benchmark

Reviews of documented information about the plant, including reassessments of design in relation to operating history, is a useful way to identify the potential for ageing after a period of service. An appraisal of operations, maintenance, inspection, and test and repair records could reveal trends in ageing.

There should be processes to identify plant that is either showing degradation or malfunctioning (e.g. inspection regimes or maintenance and test routines). Where plant is showing significant degradation or approaching its design life, there should be clear justification for continued operation.

In the first instance, this may be based on a calculation of the remaining life. This process is described in published guidance on inspection and should be carried out by a competent person and recorded. Where calculated remnant life extends beyond design life, then there should be a formal mechanism for approving this life extension (most likely by a senior manager within the organisation). This applies wherever it is intended to use equipment beyond its originally specified design life.

Where the remnant life calculation does not justify continued operation (for example where there is no remaining corrosion allowance), then a fitness for service assessment may be used, providing that it too is carried out to a recognised standard, by a competent person, recorded and approved. In all cases the methods for continued condition assessment and monitoring of such plant should be identified.

Leading and lagging performance indicators should be set for monitoring the effectiveness of ageing plant controls. Leading indicators could include a 'cyclic' environment, information that staff responsible for equipment on a day-to-day basis are competent and aware of the tell tale signs of ageing from plant performance.

Key Questions on Ageing Plant

Lagging indicators could include repeated service problems and unplanned shutdowns, leakage, surface damage such as blistering or corrosion, or reductions in plant efficiency or lack of process stability. The latter could indicate pipe fouling or valve pump/seizure, or excessive vibration and movement.

While fatigue (cycling), creep, cracking and corrosion are typical features of ageing they manifest themselves in different ways. Visible deterioration e.g. leakage, surface damage, blistering and corrosion are obvious enough but there are others that are equally revealing. Internal inspections/non-destructive testing, NDT techniques will show what is happening in places that cannot be seen and can measure rates of corrosion and other changes.

The stability of the process is another indicator. Repeated service problems and unplanned shutdowns all provide useful information. It is unlikely that the plant was designed to do this and there must be a reason that could be age-related for these unplanned events and excursions.

Where plant items are removed from service, there should be arrangements to ensure that they are managed and maintained so that they remain safe and do not present a hazard to people, the environment and or other equipment.

Underlying Key Issues

- Are there arrangements to identify plant and equipment that may be showing signs of ageing?
- Are there arrangements to identify plant and equipment approaching or beyond its original design life or calculated remnant life?
- How is their condition assessed and monitored?
- What leading and/or lagging indicators are used to indicate assets that may not be performing as required or showing signs of deterioration in their integrity or performance?
- Is the remnant life calculated for items showing significant degradation?
- Where remnant life calculation suggests an extension of service beyond design life, or the design life is approaching, are formal life extension studies conducted?
- Who is responsible for conducting plant life extension studies/justifications, etc?
- Who is responsible for approving the use of such equipment or plant and determining conditions for its continued use, e.g. setting the inspection/review periods, allowable service limits, etc?
- Are there arrangements in place to manage items ‘removed from service’? These still need to be managed and maintained to ensure they remain safe and do not present a hazard to people, the environment or other equipment.

Key Questions on Ageing Plant

Question 3. Plant and Equipment Change Management

How are changes to plant and equipment assessed and are ageing issues addressed as part of this?

Rationale: new plant and equipment, changes to existing plant and equipment, or changes to the conditions under which they operate need to be identified and assessed. If these could detrimentally affect the integrity or performance, breach safe operating and design limits, introduce new ageing mechanisms or exacerbate deterioration due to existing ageing mechanisms, then suitable safeguards would need to be identified and provided to manage the situation.

Benchmark

Some form of hazard studies (e.g. HAZOP) would be expected for new plant designs and modifications to assess the hazards and risks.

There should be a formal change management system and procedures for plant changes to ensure these are identified, assessed and approved at the relevant level.

A change approvals procedure should require specialist safety and mechanical engineering input/checks.

A good change management system should also capture changes to safety-related control and instrument systems including software changes.

There should be some mechanism for the changes approved by the change management system to result in an update of the asset register and to ensure drawings (P&IDs or process flow diagrams, PFDs) or plans are updated to show the changes.

Underlying Key Issues

- Are plant design reviews and hazard studies carried out for new plant and major modifications?
- Does the change management system address alterations, temporary changes, modifications and repairs to plant and equipment including EC&I (including software/control systems), safeguards, and structures?
- How do you check that changes proposed do not impact the original design basis/specification or the intended operating envelope of the process and plant or equipment?
- Are these changes recorded/logged, safety-assessed, and approved before the changes are implemented?
- Are specialists such as mechanical integrity, engineers, corrosion specialists, EC&I specialists and health/safety/environmental specialists consulted as part of the assessment and approvals process?
- Who can approve the changes and are they competent to do this?
- How are changes fed in to the asset register(s) to keep it up-to-date?
- How are plant drawings, data sheets, operating manuals, maintenance manuals and other key documents and procedures kept up-to-date with changes or new additions?

Key Questions on Ageing Plant

Question 4. Managing the Integrity of Plant and Equipment

Is there an Integrity Management System in place and who is responsible for managing the integrity of the plant at the site?

Rationale: Asset integrity management is a significant task that needs to be properly managed. Over the years sites may have changed, organisation and management reorganised and duties reallocated. There has also been an increase in the use of independent bodies for the management of integrity.

It is important to establish who has the responsibility onsite for managing the assets and what demarcation there may be between them and independent bodies or other bodies who have a role in asset integrity assurance.

Benchmark

There should be a clearly defined Integrity Management System in place at the site covering policy, strategy, responsibilities and arrangements for the management of integrity of all major hazard assets.

The maintenance, inspection and testing requirements set out in the Integrity Management System should be based on appropriate information, e.g. equipment supplier advised requirements, historically developed requirements, reliability or risk-based assessments, etc.

Ownership of the process and clarity in the responsibilities should be clearly set out in the procedures or organisational arrangements.

It should be clear who is responsible for the integrity of the plant, does this include the safeguards and EC&I equipment, if not – are responsibilities clearly assigned for these?

Uncertainty in responsibilities, or gap and overlaps may indicate a defective system.

It should be clear who has the responsibility onsite and what the demarcation is between them and independent bodies or other parties who have a role in plant integrity assurance.

Underlying Key Issues

- Who is responsible for the maintenance management system (MMS), and keeping this up-to-date?
- Are there clear interfaces and no significant gaps/omissions between responsibilities for integrity e.g. if use third parties or contractors or if other companies/sections share assets on the site – what do they cover, is this clear?
- Are there clear interfaces and allocation or responsibility for pipelines, vehicles, transportable containers or other transport features coming on to or leaving the site?
- Are all the assets/asset types covered, including EC&I (including software/control systems), safeguards, and structures?
- Are there good lines of communication between operators, maintenance technicians and managers covering inspection, testing, maintenance, and repair activities and requirements so that everyone is clear about their role and responsibilities and so issues can be quickly identified and resolved?
- How are the requirements for maintenance, testing and inspection set?
- Some testings, e.g. functional testing, may be conducted by operators. If so, is this logged in the MMS or some other system to plan and log the tests and record the findings?

Key Questions on Ageing Plant

Question 5. Changes to the Integrity Management System

How are changes to the asset management system assessed, controlled and communicated?

Rationale: Over the years there are likely to be many changes to the asset integrity management systems, arrangements, and procedures as requirements, ideas and practices change. There may be changes to the inspection periods, the type and scope of testing, use of different inspection bodies, or a move to a risk based inspection method or changes to Written Schemes of Examination. These changes need to be controlled, assessed and recorded to ensure the systems continue to be fit for purpose and effective.

Benchmark

Changes to the Integrity Management System could involve changes in methods and scope e.g. as a result of inspection findings (day-to-day changes) or more comprehensive changes to the system e.g. organisational changes or a move to a RBI based inspection strategy (strategic changes). The standard of assessment and authorisation would be different for more strategic changes.

For day-to-day changes:

Fitness-for-service assessment, repair and revalidation need to be supported by on-going schemes of examination that address the age and condition of the plant and equipment and the risk of failure.

This process should be managed transparently. It should be clear who has the authority to revise and change written schemes of examination.

It may be useful to check when the written schemes of examination were last revised to see both what was done and who on site was responsible for it, and who approved the change or revision.

If the scheme(s) was (were) not changed in line with changes to the plant and equipment, then the extent, nature or frequencies of the inspection need to be reviewed and revised or the operator needs to justify why no change is needed.

For more strategic changes:

There should be evidence of assessments being carried out of the impact of recent organisational changes; did these check for implications for the integrity management systems, including the loss of key skills or knowledge needed to maintain integrity?

There should be evidence of changes being communicated to the workforce and relevant contractors or other external bodies, or of training, so they are aware of new arrangements, responsibilities or standards/procedures/requirements.

Changes to the integrity management systems should be identified, assessed, managed and approved through the change management systems.

Key Questions on Ageing Plant

Underlying Key Issues

- Do the change management systems address changes to:
  - The organisation, responsibilities, persons and competence?
  - Inspection, testing and maintenance procedures?
  - Asset integrity or operational priorities?
  - Change in examination, inspection or testing arrangements scope and frequencies?
  - A move to a risk-based inspection regime(s)?
  - A change in the competent body(s) or their scope of work?
  - Changes in international, national, company and local codes, standards, practices or guidance?
- How do you ensure that key skills, knowledge and experience relevant to asset integrity management and ageing is not lost when people leave, retire, move to a new position in the company etc?
- Are the changes recorded/logged, assessed, and approved before the changes are implemented?

Key Questions on Ageing Plant

Question 6. Resources

Are integrity management resources monitored to ensure the required level of attention, focus, skills and knowledge are maintained?

Rationale: Asset integrity management is a significant task that needs to be properly managed and resourced. Over the years sites may have changed, organisation and management reorganised, personnel changed and duties reallocated. There has also been an increase in the use of independent bodies for the management of integrity.

It is important to establish that those with responsibility for managing the assets and undertaking the maintenance, testing, inspection, are suitably competent and that the overall allocation of resources is adequate to maintain the integrity, functionality and safety of the plant and equipment.

Benchmark

Those responsible for managing and undertaking maintenance, testing and inspection should be competent for this. Someone with an engineering qualification would be expected to manage the maintenance, inspection and testing systems and arrangements. Technicians should also have suitable NVQ. SVQ or similar qualifications or experience or specific training to meet the company requirements. Supervision should be in place for those not yet assessed as fully competent, newcomers, or those in training. Some companies will have recruitment, training and development competence assessment systems in place. Important attention should be paid if a new inspection body or contractor for maintenance has been appointed, or where experienced staff are due to retire, or other organisational changes may be underway. Where key people are about to leave, arrangements to retain or plug gaps in skills and knowledge should be in place.

Checks should be in place to confirm the competency of third parties involved in asset integrity management. These should include competence checks as part of the selection and monitoring processes for contractors.

Inspection bodies should be registered and certificated as such, e.g. to BS EN ISO/IEC 17020:2004 and UKAS accreditation.

The level of backlogs in the maintenance management systems may give an indication as to whether the overall levels of resources are suitable. This can be a particular issue if there has been recent downsizing of maintenance staff and managers in the company.

Changes to resources or responsibilities should be identified, assessed, managed and approved through the change management systems

Key Questions on Ageing Plant

Underlying Key Issues

- Who is responsible for monitoring and maintaining the maintenance, inspection and testing programme and ensuring this is delivering the required performance?
- Are those responsible suitably qualified in terms of professional qualifications, experience and skills?
- How are contractors or other bodies involved in asset integrity management or inspection and testing activities selected, and how are they assessed for competency and managed/monitored to check they are working to the required scope and standards?
- How do you ensure you retain the skills and experience to maintain, test, (re-program?) and repair unusual, novel, old or obsolete plant and equipment (include EC&I systems and equipment) still in use on site?
- How are Maintenance Management System (MMS) backlogs monitored, priorities assigned and addressed?
- Are job/skills continually addressed when changing personnel or plant and equipment?
- How is the adequacy of overall resource levels assessed? Is the completion and close out of tasks and actions and MMS backlogs used as KPIs?

Key Questions on Ageing Plant

Question 7. Awareness of Ageing

Are those responsible for ensuring asset integrity aware of ageing mechanisms, and what plant and equipment may be particularly prone to this type of deterioration?

Rationale: It is important that those responsible for managing the integrity of the assets and conducting maintenance, inspection and testing, are aware of the potential ageing mechanisms relevant to the assets on site, the conditions under which these can occur and the types of deterioration they can cause. This is a key issue if ageing issues are to be identified early and managed effectively.

Benchmark

This is vital to making decisions about ageing plant. The decisions made here are only as good as the information available and the soundness of the process used to apply it.

Those who are responsible for assessing the fitness for purpose of plant should be aware of its age, likely damage mechanisms, current condition, and rate of ageing and remaining life.

Are key issues, signs or symptoms being communicated to operations or maintenance personnel so they are aware of what to be alert to as indicators of ageing plant?

It is likely that only the largest and international multi-site operators will have fully developed formal systems. Smaller less complex sites should take a proportionate approach based on:

- asset management planning;
- periodic reporting on condition indicators;
- identification of key equipment performance indicators along with availability/reliability targets;
- comparative equipment performance reviews;
- reporting analysis of lost production, incidents, and failures;
- holding plant integrity review meetings;
- knowledge about industry codes and guidance through trade associations and standards bodies; and
- access to specialist skills and knowledge on ageing mechanisms and their management.

Underlying Key Issues

- Do those responsible for maintaining, testing and inspecting plant and equipment, and managing these activities, have an understanding of ageing issues?
- Are they aware of the key indicators to show that a plant is ageing?
- Are those responsible aware of current standards and guidance and are they applying these?
- Do they have access to mechanical engineers and corrosion/asset integrity specialists, electrical, control and instrumentation specialists, for specialist advice?
- Do they carry out reviews of the operational history to identify equipment that may have been subject to ageing-related deterioration, or prolonged service, or operated at or above its design limits?

Key Questions on Ageing Plant

Question 8. Out-of-date or Obsolescent Plant and Equipment

How is out-of-date or obsolescent plant and equipment, particularly EC&I equipment, identified and managed to ensure their integrity and performance (including equipment that may no longer be supported by the supplier or manufacturer)?

Rationale: Some of the assets on site, including electrical, instrument and control systems may be very old, or essentially obsolete, or no longer supported by the manufacturer or supplier. This may not necessarily mean that they are no longer fit for purpose, but it could affect the ability to maintain, test and repair these items.

Benchmark

There should be a list of equipment that is obsolete or no longer supported by the manufacturer/supplier. This may be indicated in the Asset Register and maintenance procedures.

There may be special arrangements for repairing, maintaining or replacing such equipment, for example to have access to other suppliers of parts or to access software programmes with the right experience.

A programme of replacement may be needed where equipment is approaching the end of its useful life and/or is obsolete or no longer supported by the manufacturer/supplier.

Where EC&I equipment is to be replaced with modern digital equipment, this will need to be carried out in accordance with the requirements of IEC 61508/IEC 61511 (including change management). If the in-house specialist resources and competency in these key areas is not available, then consideration should be given to bring in specialist contractors to advise and assist.

Underlying Key Issues

- How is the condition of out-of-date or obsolescent plant and equipment identified? (This can be a particularly important issue for EC&I equipment and systems, which may also have a shorter design life than mechanical equipment.)
- How is equipment maintained, repaired and tested where there is difficulty in accessing detailed information on its design and maintenance requirements, difficulty in obtaining spares, or a lack of expertise/skills or knowledge, for example, to maintain, change/debug software etc?
- How do you access specialist skills or knowledge needed about these items?
- What is the replacement strategy for such plant and equipment?
- Where EC&I equipment is to be replaced with modern digital equipment, is the company aware of the requirements of IEC 61508/IEC 61511, and the implications of these, particularly regarding specialist resources and competency to deal with these?

Key Questions on Ageing Plant

Question 9. Monitoring the Condition of Plant and Equipment

How is the condition of plant and equipment monitored?

Rationale: The asset integrity management system needs to include arrangements to check/assess the condition and performance of the assets on an ongoing basis to make sure they remain fit for purpose and to identify items needing non-routine maintenance, repair or replacement etc. Various methods can be used to monitor the condition of the assets depending on the circumstances. The information gathered is also important to allow the overall effectiveness of the asset integrity management system to be assessed and to identify areas for improvement.

Benchmark

There should be an inspection and testing plan in place which shows what needs testing, and at what interval. This should also record the test/inspection dates and a summary of links to the conclusions (pass/fail). This plan should include all safety-critical equipment including prevention, control and mitigation safeguards and structural elements as well as the primary containment and motive equipment such as pumps, compressors, etc. Some form of documented scheme of examination should be in place for safety-critical equipment, especially where this is for major hazard plant.

As a minimum, there should be formal records of all inspections of pressurised equipment and the testing of safety related devices such as SIL-rated instrumented safety systems, pressure relief valves etc. Pressure systems should have up-to-date written schemes of examination in place.

The maintenance management system should also contain logs of remedial work or repairs undertaken.

There should be a clear process to ensure that reviews of inspection reports and maintenance activity are carried out. As a minimum this should be undertaken by a competent engineer; more complex sites may employ a formal team-based site-wide review. There should also be a process for senior management review for key issues arising.

There should be a process in place for identifying changes in codes, standards and practices relevant to integrity management and assessing the impact of these, including adapting plant, equipment or procedures as appropriate.

There should be evidence of changes to the inspection and testing arrangements for equipment that has been found to be suffering unacceptable levels of deterioration.

Key Questions on Ageing Plant

Underlying Key Issues

- Are records kept of all maintenance, inspections, testing/proof testing, calibrations and repairs? [see Research Report 509 Plant ageing: Management of equipment containing hazardous fluids or pressure (4), Section 2.4 page 32].
- Are all the assets/asset types covered, including EC&I (including software/control systems), safeguards, and structures?
- What methods are used to indicate trends or issues in the condition of the assets, e.g. regular reviews of data, use of key performance indicators (KPIs) benchmarking of performance etc?
- Are reviews conducted to assess the implications of revised/new codes and standards etc, and adapt plant, equipment or procedures where appropriate?
- Are regular integrity reviews conducted by suitably qualified persons to look for trends and issues, and are significant issues referred to and given attention by senior management? For more complex high hazard sites, might expect formal integrity reviews attended by senior management.
- Has plant or equipment been identified as ageing, and if so, how was this identified/discovered and what is being done to manage this?

Key Questions on Ageing Plant

Question 10. Feedback, Review and Continuous Improvement

How are the findings of inspections, tests, maintenance and repairs used to manage and improve the integrity of the assets?

Rationale: It is important that information is gathered and used to allow the overall effectiveness of the asset integrity management system to be assessed and to identify areas for improvement. Useful data could be collected from a variety of sources, not just the inspections and test records.

Benchmark

Integrity reviews should be carried out for equipment to assess the overall adequacy of the integrity assurance arrangements.

The findings of the tests and inspections should be used to review performance and improve the arrangements and inspection/testing periods etc. Use leading and lagging key performance indicators (KPIs) to assess the integrity of the assets with objectives/targets set and reviewed annually for these KPIs.

Plant and equipment approaching or past its design life or calculated remnant life should be identified and given specific attention in integrity/asset reviews.

Lessons and trends from incident, accident and near miss reporting systems should also be being used to improve the asset management systems.

Senior managers and plant/asset managers should be aware of the status of the assets and being involved in reviews or audits of the integrity management systems.

Underlying Key Issues

- Are integrity reviews conducted on a regular basis using information from the maintenance, testing and inspection systems and reports?
- Are key performance indicators (KPIs) set for reviewing the condition of the assets and the effectiveness of the maintenance, testing and inspection regimes?
- Are known problems, changes in inspection, testing or maintenance regimes or changes in priorities communicated to plant/asset managers and to staff and contract personnel involved in operations, maintenance and testing/inspection?
- How are lessons learned from incidents/accidents and near miss reports used to improve integrity management?
- Are there safety suggestion schemes, plant defect reporting schemes, to encourage personnel to report problems or observations or suggest ways to improve the systems and arrangements?
- Is this information from integrity reviews, KPIs, incidents, fed back to senior management?

Appendix 3

Request to HSL to include sites in Ageing Plant Survey

1. Each field team is asked to produce a list of sites to which they wish HSL to send the Ageing Plant survey questionnaire in Appendix 4. Details of sites should be entered into the request form that has been created for the purpose – see below. This is available as a separate Excel spreadsheet.

2. Selected sites should include those for which we currently have little or no knowledge about ageing plant AND at which no relevant interventions have been planned for the current (2010/2011) work year.

3. Where possible, teams are asked to provide some indication of why they think ageing plant might be an issue at the identified sites. This does not need to be detailed information, but may include basic details about the nature of the activities and the types of plant and equipment known/likely to be present on site.

4. Sites where ageing plant is unlikely to be an issue, such as warehouses, should be excluded.

5. The field team leader is responsible for sending a collated list of sites (ie one list per team) to Justin Holroyd at **HSL by 23 July 2010 at the latest**. Lists should be forwarded by e-mail to justin.holroyd@hsl.gov.uk.

6. The site will then be sent a copy of the questionnaire by HSL together with a covering letter, see below a copy of 'Managing Ageing Plant: A Summary Guide' and the Self Assessment Questions in Appendix 2.

7. By the end of October 2010 HSL will forward the results of the survey to CI 1-3 team leaders. The results will be tabulated with suggested priority sites and issues.

COMAH CA AGEING PLANT PROGRAMME: OPERATOR QUESTIONNAIRE – request to HSL for operators to be included in the survey								
The field team leader is responsible for sending a collated list of sites (ie one list per team) to Justin Holroyd at HSL by 23 July 2010 at the latest. Lists should be forwarded by e-mail to **justin.holroyd@hsl.gov.uk**								
HID Unit/ Field Team	**Name of Field Team Leader**	**Office Address**			**Telephone Number**	**e-mail**		
Name of Operator	**Address of Site**	**TT/LT**	**Name and position of person to contact**	**e-mail address**	**Brief details of why you think ageing plant may be an issue at this site**	**COIN Company**	**COIN Site ID ID**	**INTERVENTION Plan Inspection Case Number (Optional)**

Appendix 4

Questionnaire to assess if plant may be prone to ageing

1. The questions set out below are to help identify if you have the types of major hazard plant more likely to develop signs of 'ageing', whether or not the effects of ageing have been detected at your site, and the extent to which your management systems address these.

2. The questionnaire addresses three broad questions:

- Is the plant and equipment on site prone to ageing mechanisms?
- Is there evidence of ageing-related deterioration?
- Do the asset management arrangements in place cover the full range of asset types that might be subject to ageing?

3. The focus of this questionnaire is on plant with a major hazard potential. Low hazard or non-hazardous plant and equipment need not be included.

4. As mentioned in the attached letter, the information you supply will be used to plan and prioritise follow-up inspection work.

5. The 'Indication of Extent' is only intended to provide an overall indication of how much of your plant and equipment is relevant to the question/conditions. The percentages provided are indicative only and should be used as a guide. Please place your cursor over the chosen response and select (if completing manually please mark the chosen box with a cross or a tick).

6. Please use section 4 at the end of the questionnaire to provide further information or comments that you feel may be relevant to the management of ageing plant or your site, for example, details of actions you have carried out in relation to the issues covered by the questionnaire.

Name of COMAH Operator	
Address of Site	
Name of person to contact	
e-mail address	
Telephone number	

Please use the table below to provide a brief list of the major hazard plant, processes, storage and loading facilities etc at the site and indicate which of these you consider to be the most important from a major hazards perspective. This will provide an overview of the activities at the site and help in interpreting the responses to the questions on plant ageing. Please add further rows to the end of the table if necessary.

Plant name	Processes, storage and loading facilities etc

		None	Minimal	Some/Little (5-30%)	Considerable Amount (30-60%)	Most/All (>60%)	Not Known
1	**How much of your major hazard plant:**						
1.1	Is exposed to regular/frequent load, temperature or pressure cycling (for example, several times per shift)?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
1.2	Has a history of operating at the limit of, or beyond, its original design envelope?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
1.3	Has a demanding (very high or very low) pressure and temperature envelope? (e.g. above 20barg, below -0.1barg, above 200oC, below – 10oC)?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
1.4	Uses substances (e.g. corrosive, abrasive materials), or is in an environment (e.g. humid, salty air) that can attack or exacerbate an attack on the containment?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
1.5	Is difficult to access, test or inspect, e.g. buried or under insulation or in an inaccessible location?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
1.6	Is reliant on instrumented protective systems and control systems (C&I) or safety related electrical equipment (see Note*) that utilise hardware or software that is obsolescent or no longer supported by the manufacturer or supplier?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
1.7	Is reliant on safety-related instrumented protective systems assessed at Safety Integrity Level (SIL) 1 or greater?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
1.8	Is dependent on safeguards such as bunds, fire walls, blast walls, relief panels, suppression systems and other structural or mechanical features to control and mitigate the hazards?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
1.9	Is approaching or beyond its original design life?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6

	None	Minimal	Some/Little (5-30%)	Considerable Amount (30-60%)	Most/All (>60%)	Not Known
2. For how much of your major hazard plant have you:						
2.1 Found signs of plant ageing such as: creep, cracking, erosion, corrosion or changes in corrosion rates?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
2.3 Experienced recurring defects, or increasing trends of unplanned work and breakdowns?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
2.4 Had to increase the inspection depth and/or frequency or have had to change your inspection regime from a set period/depth inspection to a risk-based regime?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
2.4 Re-rated plant to keep it in service?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
2.5 Had to upgrade or closely monitor control systems or safety related instrumentation due to:						
■ deteriorating performance	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
■ difficulty in demonstrating suitable reliability						
■ change management issues, or accessing spare parts?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6

	None	Few (<30%)	Some (30-60%)	Most (60-99%)	All (100%)	Not Known
3. Do your inspection, testing and maintenance arrangements cover:						
3.1 Primary containment for process and key utilities e.g. pipework, vessels, tanks, pumps, valves, flanges, instrument connections etc?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
3.2 Structures and civil engineering features supporting plant, equipment, and safeguarding systems e.g. vessel and piping supports, pipe-bridges, structural steelwork, walls, process buildings, etc?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6

		None	Few (<30%)	Some (30-60%)	Most (60-99%)	All (100%)	Not Known
3.3	Structures and civil engineering features for personnel protection and access/egress e.g. occupied buildings, control rooms, access ways, stairs, escape routes, bridges, fixed ladders, fire walls, blast walls, shelter areas, etc?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
3.4	Process safeguarding systems e.g. pressure relief and venting systems, flares, mechanical overfill protection and overflows, bunds, drains, heating and cooling systems, earthing systems, inerting systems, fire and blast walls, relief panels, suppression systems, fire protection systems, effluent treatment facilities, lagoons, etc?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
3.5	Safety-related EC&I equipment and systems,including hardware and software trips, alarms, controls Disturbed Control Systems (DCS), Supervisory Control and Data Acquisition (SCADA), Safety Programmable Logic Controllers (PLC), sensors, actuators, safety-related High Voltage (HV) electrical equipment, general alarms/sirens/personal address (PA) systems, emergency communication equipment etc?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6
3.6	Anything else e.g. tall structures (masts, chimneys, stacks), retaining walls or features such as floor protection barriers that could impact the plant were they to collapse or fail?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6

Note* including hardware and software trips, alarms, controls, Distributed Control Systems (DCS), Supervisory Control and Data Acquisition (SCADA) systems, Safety Programmable Logic Controllers (PLC), sensors, actuators, etc) or safety-related High Voltage (HV) electrical equipment.

4 **Please use the space below to provide further information or comments.**

Please return your form by email to justin.holroyd@hsl.gov.uk

If you are returning a paper copy in the post please send to

Justin Holroyd
Health and Safety Laboratory
Harpur Hill
Buxton
Derbyshire
SK17 9JN

Appendix 5

Ageing plant inspection topics

1. This Appendix defines the topics to be addressed at sites identified for ageing plant inspection, aiming to do so in a way that allows a gap analysis to be carried out against information obtained during previous interventions at the site.

2. Where there is a history of previous intervention on some or all of the topics (likely to have been carried out by, or with the support of, Mechanical Engineering or C&I Discipline Specialists) the Inspection Team should assess the current knowledge on the site in a gap analysis against the topics identified in this appendix. The results of this gap analysis should be used to define the detail of future interventions such that all topics are addressed and an overall view of the performance of the site can be taken.

3. Initial inspections should be aimed at providing sufficient knowledge of systems, and their operation, at the site to enable Field Teams to gauge the extent to which the arrangements are suitable, and to identify issues requiring further intervention. For more complex sites it is expected that further Discipline Specialist interventions will be required to follow up specifically identified issues in more detail.

Ageing Plant: Key Inspection Topics

Topic 1. Leadership

To what extent are the site senior managers aware of the performance of the systems designed to maintain the integrity of safety-critical assets, and what is their commitment to ensuring that such assets remain fit for service at all times?

Rationale: It is important that the site leadership team have clear visibility of the performance of the various systems that deliver continuing asset integrity in order that they have confidence that the site remains in a fit state to operate. In addition it is important that those in ultimate authority demonstrate a commitment to asset integrity by providing independence to those who are charged with making key decisions regarding fitness for service and supporting the decisions they make.

Benchmark

There should be a clear set of Key Performance Indicators that provide the leadership team with information on the performance of the various systems delivering asset integrity. These should be reviewed on a regular basis, with evidence that poor performance is subject to challenge.

Where ageing has progressed to the extent that equipment is nearing the end of its useful life there should be evidence that the leadership team are aware of this and supporting plans to provide replacement equipment when necessary. For example, where significant repair work or fitness for service assessments are required to enable equipment to return to service this should be clearly visible to the leadership team.

Where difficult integrity decisions have been necessary, there should be evidence that the leadership team have supported the independence of those charged with making such decisions.

Ageing Plant: Key Inspection Topics

Underlying Key Issues

- Do the leadership team regularly review KPIs relevant to asset integrity?
- Is poor performance indicated by KPIs subject to challenge?
- Where ageing issues have progressed to the point where equipment is nearing the end of its life, are the leadership team aware of this and supporting plans to replace the equipment?
- How are lessons learned from incidents/accidents and near miss reports used to improve integrity management?
- Are there safety suggestion schemes, plant defect reporting schemes etc to encourage personnel to report problems or observations or suggest ways to improve the systems and arrangements?
- Is there evidence of the leadership team supporting the independence of those charged with making key decisions on asset integrity?
- How does leadership know if sufficient resources are assigned to this effort on an ongoing basis?
- How does leadership establish the resource requirements to ensure an effective integrity/maintenance system?
- How does leadership know that the people involved in this effort are competent to perform the duties that leadership expect them to perform?
- In addition to changes to process technology and equipment, does leadership recognise that subtle changes to people and management processes can affect the integrity/maintenance performance, and how do they manage these changes?
- How does leadership reconcile potential conflicts between releasing equipment for integrity management/maintenance needs versus production needs?
- How does leadership ensure that process safety-critical equipment inspection/examination deferrals are technically sound and approved by appropriately qualified and sufficiently independent persons?

Ageing Plant: Key Inspection Topics

Topic 2. Plant and equipment on site – the Asset Register

Does the site have a comprehensive Asset Register that contains all its equipment? If so, does it identify and differentiate its process safety critical equipment, so that appropriate operating, maintenance and integrity management strategies can be applied? Does this register include mechanical, electrical, control and instrumentation and structural equipment?

Rationale: Sites may already have asset registers that include both equipment that is not process safety-critical and that which is. However, their resources will invariably be limited, so it is important to know not only what plant and equipment is present on site, but also how important it is to safety. This will allow maintenance and integrity management systems and processes to prioritise and focus on effectively controlling major accident hazards.

Benchmark

There should be an Asset Register that lists equipment, where it is, and indicates its safety significance. It is imperative that process safety-critical equipment is/has been identified by a multi-disciplinary team, which should include, but not be limited to, a professional process engineer with intimate knowledge of the process under discussion, an experienced operator, and suitably experienced and qualified maintenance/integrity engineers or control and instrumentation engineers as appropriate. Note: Field Teams may choose to explore this aspect of the asset register during separate inspections involving Mechanical and C&I Specialists.

There should also be information on the hazardous 'fluids' along with their hazardous properties i.e. Material Safety Data Sheets (MSDSs) as a minimum.

Most sites will have both computer and hard copy records with this information but often in different formats, some collected together others not. Format is not an issue as long as the information about the 'hazardous fluids' and the 'hazardous fluids' envelope is easy to access and use.

It is also important that the asset register is kept-up-to-date and mirrored by accurate up to date P&IDs and other plant or process documentation. The importance of these information system updates should be recognised in a documented management of change of system for the site.

The asset register should clearly identify all primary containment safety-critical mechanical equipment (tanks, vessels, pumps, piping etc) which, if they fail, could give rise to a MAH. There should also be a register of safety-related electrical, control and instrumentation and prevention/control/mitigation safeguards equipment for major hazard plant.

There should be some form of prioritisation or risk ranking system within the asset register or maintenance management system to highlight safety-critical plant and equipment associated with major hazard plant.

There should be some mechanism for identifying and highlighting equipment found to be subject to significant ageing, either through the inspection reports, written schemes of examination or integrity reviews, so these can be monitored and managed effectively – the existence and operation of these systems will be tested by later questions in this Appendix.

Ageing Plant: Key Inspection Topics

Underlying Key Issues

- Is there an Asset Register in place?
- How is the Asset Register kept up-to-date?
- Does it include EC&I, prevention, control and mitigation safeguards, and structures (this can be particularly important where the safety of the plant relies on instrumented protective systems e.g. Safety Integrity Level (SIL) 1 or higher rated systems)?
- Have safety-critical items been identified by an appropriately qualified team?
- Are safety-critical items highlighted together with all the relevant assets that comprise this, support it, or are necessary for it to function?

Ageing Plant: Key Inspection Topics

Topic 3. Assuring the integrity of the primary containment boundary

Are arrangements in place to identify and assess the condition of the primary containment boundary that may be showing signs of ageing, or which may be approaching or beyond its original design life or calculated remnant life, and to justify, continued operation or down-rate/decommission this? In this context the primary containment boundary should be taken to include all vessels and pipework (rigid and flexible elements), mechanical protective devices such as bursting discs and pressure relief valves and structural items (e.g. support structures, pipe hangers) which if they were to fail or not function correctly, could cause failure of the primary containment boundary.

Rationale: Degradation of the primary containment boundary through mechanisms such as corrosion, erosion, fatigue, creep etc needs to be identified so that it can be monitored and assessed to check whether it is still fit for purpose. If the deterioration is significant, then the equipment may have to be down-rated, removed from service, or other measures introduced so it can safely continue in operation. For items that are required to function (e.g. PRVs, BDs) to prevent a loss of containment there should be arrangements in place to provide assurance that this functionality is present at all times.

Benchmark

All sites should have a management system designed to ensure that plant and equipment forming the primary containment boundary remains fit for service at all times. In the vast majority of cases this will lead to periodic examination of equipment to a scheme of examination. This will be designed to monitor the degradation mechanisms that have been assessed as being a credible threat to the integrity of each specific item forming the primary containment boundary.

The management system will define the following key processes:

- Roles and responsibilities – at its most basic level this will be a declaration as to whether the integrity management function will be provided by in-house personnel (a second party arrangement) or by an external body (a third party arrangement). It should be clear what the responsibilities of each party involved in delivery of the system are, in particular it should be clear who is ultimately responsible for certifying that an item of plant or equipment is fit to return to service following examination. Where third parties are involved, both the dutyholder and the third party should be clear as to what the roles and responsibility of each are. It should be clear that there is independence of the integrity management function from day-to-day operational management of the site; where a second party arrangement is in place this would be supported by UKAS Accreditation to ISO 17020.
- Scope of equipment covered – there should be integrity management arrangements in place to cover all equipment where the failure of the primary containment boundary could result in a hazard, or where failure of the item could lead to subsequent failure of the primary containment boundary. In the main this hazard will result from the release of stored energy (pressure) or the hazardous nature of the released fluid, but in some cases may be due to the dynamic effects of an otherwise benign fluid (e.g. a large water storage vessel).

Ageing Plant: Key Inspection Topics

- Definition of inspection scope and periodicity – a fundamental requirement of a system design to provide assurance of the integrity of the primary containment boundary is that it is able to identify the degradation mechanisms which may threaten the integrity of each element forming that boundary. It must then define the examination technique to be adopted to monitor these mechanisms, together with the periodicity with which they should be applied. This may range from the application of industry standard procedures at simple sites (e.g. LPG storage) to the use of Risk-Based Inspection (RBI) techniques at more complex installations. Whatever approach is adopted, it must be appropriate to the situation. Where RBI is used, it is likely that a more detailed inspection by a Mechanical Engineering Specialist will be appropriate at a later stage but the key features that should be evident at this initial stage are:
  - A team-based approach utilising members with expertise in the process technology under consideration, inspection, operations and materials/corrosion as a minimum.
  - Appropriate levels of expertise – for example many smaller sites would not have materials/corrosion expertise within their own resources so would have to seek external support in this area.
  - A process that reviews examination results to both confirm that the equipment remains fit for service and assess the potential implications of adverse finding on other areas of the plant. Where equipment has a specific design life, this review process should ensure that action to validate continued operation is taken as equipment approaches this life.
- Delivery of the examination process – it should be clear how the examination schemes developed for each item of equipment will be implemented, and by whom. Where external resource is utilised, as will often be the case for the delivery of non-destructive testing, it should be clear what their role is. In all cases level of detail required in reporting of examination results should be clear.
- Dealing with adverse findings – there should be clear arrangements for assessing examination reports to confirm whether or not the equipment concerned remains fit for service. As a minimum, it should be clear that reports are checked against original design requirements (e.g. where corrosion has been found) to confirm that the design minima have not been breached. Where degradation is a significant issue it is likely that the site will, at times, need to carry out fitness for service assessments to support continued service. Where evidence of such practices are found, these are likely to warrant follow-up inspection by a Mechanical Engineering Specialist.
- Postponement of examinations – there should be a clear process in place for the approval of postponement of examinations. This should ensure that approval is obtained before the examination becomes overdue and include assessment to confirm that the delay in examination will not result in a significant increase in likelihood of failure of the containment boundary. This process should consider the need (where appropriate) for partial or supplementary inspections in lieu of the documented requirements, before the actual inspection due date. This will allow a more quantitative assessment of the comptemporary equipment condition and help provide a more detailed technical basis to support deferment.

Ageing Plant: Key Inspection Topics

- Repairs – there should be arrangements in place to control the specification and implementation of repairs, both permanent and temporary. Key features are that repairs are not permitted to be implemented unless a system of quality control of maintenance materials is applied, the repairs have been shown to be like for like and fit for purpose. Where they are temporary or not like for like, they should be subject to a documented management of change procedure that makes a technical assessment and defines the justified lifespan of each repair.
- Performance monitoring – there should be performance measures in place to monitor the operation of the system, these are likely to include regular monitoring to confirm that equipment is not allowed to go overdue without prior approval and monitoring of 'procedural' near misses. Loss of containment incidents, temporary repairs still in place within or out of their agreed lifespan, inspections awaiting final reports etc.
- Interface with operations – the work of the Integrity Management team needs to interface effectively with the Operations and Maintenance departments to ensure that equipment is released for examination as required, and that it is not returned to operation until the Integrity Department have confirmed in writing that it is fit for continued service. In addition, there should be arrangements in place to ensure that changes to operating parameters are advised to the Inspection Department.

It is expected that an initial inspection will establish how the system is structured and whether key elements are absent, providing information around which to structure further detailed intervention as necessary. The inspection should not be restricted to discussion of the systems in place but should test practical delivery by detailed assessment of the examination schemes, reports etc of sample vessels and pipework systems. The level of sampling should be sufficient to enable intervention topics requiring more detailed scrutiny (or confirmation that no further intervention is required at this stage) to be identified. These may include, for example, issues such as, operation of the RBI system, strategy for dealing with Corrosion Under Insulation (CU), the use of non-invasive techniques, fitness for service assessment procedures.

Ageing Plant: Key Inspection Topics

Underlying Key Issues

- Is there a clear structure to the integrity management system?
- Are roles and responsibilities, including those of third parties clearly defined?
- Is the system able to effectively identify degradation mechanisms that will credibly threaten the integrity of the containment boundary?
- Does the system ensure that inspection schemes effectively monitor the credible degradation mechanisms?
- Is it clear who is responsible for confirming that equipment remains fit for service?
- Are fitness for service assessments carried out?
- Are arrangements in place to approve the postponement of examinations when necessary?
- Are performance measures in place to monitor the effective performance of the system?
- How are repairs managed to ensure they are fit for purpose and meet the original design intent? If they don't meet the original design intent, have management of change procedures been applied?
- Is there a process to control the quality of key process safety-critical maintenance materials and spare parts?
- Is there a process that provides assurance of the continued functionality of safety devices such as PRVs and BDs?
- Is there a process that manages the condition of support structures that could affect the integrity of the primary containment boundary?
- Are effective interface arrangements in place that ensure that equipment is released for examination when required and not allowed to return to service until approved by a designated person?
- Are there features of the system that warrant further, deeper, intervention activities?

Ageing Plant: Key Inspection Topics

Topic 4. Assuring the integrity of safety-critical mechanical equipment

Does the mechanical maintenance system effectively identify and manage the maintenance of equipment that, if it were to fail, could initiate, fail to mitigate or cause escalation of a major accident?

Rationale: On most sites there will be equipment of which failure could initiate a major accident or contribute to the escalation of such an accident. This equipment will not normally be covered by the management system dealing with the primary containment boundary, yet could lead to a hazard from failures resulting in a loss of containment and/or loss of functionality.

Benchmark

The site maintenance management system will normally cover a vast array of equipment, much of which will either not be of interest from a mechanical engineering perspective and/or will not have safety significance. The objective of this question is to confirm that mechanical equipment of safety significance is properly identified and flagged in the Asset Register (generally referred to as safety-critical equipment) and then that its maintenance is managed such that the potential for failure in service is kept to an acceptably low level.

The following key processes should be explored:

- Identification of safety-critical equipment (SCE) – there should be a process in place to enable individual items of equipment to be assessed to establish whether or not they should be classified as safety critical. This process should consider both the potential for failure to lead to a loss of containment (e.g. as a result of a bearing/seal failure) and the impact of a loss of function (e.g. the loss of a critical pump might lead to an inability to control an exotherm – hence, potentially, lead to a major accident). The system (normally a computer-based database system such as SAP) should flag those items of equipment identified as safety critical in such a way that information about them can be extracted from the database. The process adopted for identification of SCE should be appropriate to the site concerned, but would normally be expected to involve a multi-disciplinary team. Other than for very simple sites, it is unlikely that one person alone could effectively carry out this process. This process is also addressed in Topic 2 as, at some sites, Field Teams may wish to address the issue of identification of safety-critical equipment across all disciplines in a single intervention.
- Maintenance of safety-critical equipment – the system should ensure that SCE is maintained in such a way as to minimise the potential for failure in service. Inspection of the system should establish how the scope and periodicity of maintenance for particular equipment is defined (this might range from simply applying manufacturer's recommendations through to the use of Reliability Centred Maintenance (RCM) or Risk-Based Maintenance (RBM) systems) and what the arrangements are for approving this and subsequent changes to it. Where an RCM system is in operation it may be appropriate to carry out a separate follow-up inspection on the operation of the system. A key feature of an effective maintenance system will be a review and feedback process, similar to that expected in the management arrangements for the primary containment boundary.This is to ensure that where degradation of the equipment has been greater than expected, action is taken to address the problem, whether that be by reducing the maintenance interval or other means.

Ageing Plant: Key Inspection Topics

- Performance monitoring – there should be measures in place to monitor the delivery of the maintenance programme overall (large backlogs will be an indicator of resourcing issues that may ultimately lead to an inability to complete safety-critical maintenance on time) and, specifically, delivery of the maintenance of SCE. There should also be a means of monitoring reactive maintenance activities on SCE as this may indicate problems with the scope or periodicity of planned maintenance activities. It is important that the KPIs adopted allow the management team to differentiate between SCE and 'other' equipment.
- Postponement of SCE maintenance – in much the same way as for equipment forming the primary containment boundary, there should be a system is place to ensure that where SCE maintenance is necessarily delayed, an assessment of the potential safety impact is carried out. The proposed delay should be approved in advance by a designated person, who should have a demonstrable level of independence from the operations function.
- Spares holding policy – what arrangements are in place for the provision of spares for SCE, what provision is made for older potentially obsolete equipment? Whilst not of direct interest from a process safety management point of view, poor or inadequate arrangements in this area could lead to pressure to keep equipment in service which should be subject to repair, or to reverse engineer spare parts, and may indicate a need to look more closely at the independence of the process for SCE maintenance deferment and/or the application of the management of change process.
- Spares quality assurance - Making sure that the specified maintenance materials and spares are used, by the application of an effective quality control of maintenance materials process. This should include ensuring that maintenance technicians are able to identify that the correct materials have been supplied to them and aware of what action is required if this is not the case.

Underlying Key Issues

- Is there an effective process in place to identify safety-critical equipment?
- Does the Asset Register (or other database used as part of the MMS) clearly identify equipment that has been classified as safety-critical?
- Is the execution of maintenance on SCE effective?
- Are maintenance backlogs being managed to an acceptable level?
- Are the performance indicators in place to monitor the timely completion of SCE maintenance?
- Is there a process to approve delays to SCE maintenance in advance and is there an appropriate degree of independence in this process?

Ageing Plant: Key Inspection Topics

Topic 5. EC&I Inspection and Test

Are the instrumentation systems tested and calibrated regularly? Are the constituent parts inspected regularly?

Rationale: The instrument systems tell you what is happening on the plant. If they are faulty or out of calibration, you may lose control of the plant. Also, the instrumentation may be used to provide a historical record of the state of the plant. If that historical record is wrong or incomplete, you may not pick up a trend that indicates deterioration of the plant.

Benchmark

The Asset Register and linked documentation should list the equipment, and relevant information about the state of that equipment. Most sites will have both computer and hard copy records with this information but often in different formats, some collected together others not. Format is not an issue as long as the information is easy to access and use.

It is also important that this information is kept up-to-date and mirrored by accurate up to date P&IDs and other plant or process documentation namely operating manuals, loop drawings, maintenance manuals and test procedures etc.

The information held should clearly identify all safety-related electrical, control and instrumentation and prevention/control/mitigation safeguards equipment for major hazard plant. For each instrument and actuator in this category, the defined test interval should be recorded, along with the date of test, measurement results, resulting action and confirmation that the resulting measurement is then within tolerance.

There should be some audit mechanism for identifying and highlighting equipment found to be subject to significant ageing or failing, either than expected, so the situation can be monitored and managed effectively.

There should be some audit mechanism in place to report to a responsible person whenever safety-related items are not tested in accordance with the defined test intervals.

Ageing Plant: Key Inspection Topics

Underlying Key Issues

- Does the asset register and supporting documentation include EC&I, prevention, control and mitigation safeguards? This can be particularly important where the safety of the plant relies on instrumented protective systems e.g. Safety Integrity Level (SIL) 1 or higher rated systems.
- Where safety related systems have been identified, does the test regime identify how the system can be tested, from end to end? Partial testing or component testing may not show some faults, and the disturbance of the system to allow partial testing may of itself cause problems.
- Does the documentation record the actual condition of the equipment when tested, or just confirm that the equipment was working by the end of the test?
- How are the requirements for maintenance, testing and inspection set?
  - Are leading and/or lagging indicators used to indicate whether inspections/tests are being carried out on schedule, what proportion of the items inspected/tested are passing the test etc?
  - Is there a process in place to assess how quickly the instrumentation is deteriorating e.g. by sample inspections to define the appropriate time between inspections of different types of instrumentation?

Are items found to be suffering from ageing, identified and brought to the attention of the responsible member of the management team?

Ageing Plant: Key Inspection Topics

Topic 6. EC&I management of Out-of-date or Obsolescent Equipment

How is out-of-date or obsolescent EC&I equipment, identified and managed to ensure their integrity and performance (including equipment that may no longer be supported by the supplier or manufacturer)?

Rationale: Some of the assets onsite, including electrical, instrument and control systems may be very old, or essentially obsolete, or no longer supported by the manufacturer or supplier. This may not necessarily mean that they are no longer fit for purpose, but it could affect the ability to maintain, test and repair these items.

Benchmark

The company should have a list of equipment that is obsolete or no longer supported by the manufacturer/supplier. This may be indicated in the Asset Register and maintenance procedures.

The company should have a process in place for repairing, maintaining or replacing such equipment, including for example identifying sources of parts or software programmes with the right experience.

The company should have a defined member of the management team who has responsibility for deciding whether to continue to use equipment as it becomes obsolete, or whether to phase in its replacement.

Replacing obsolete instrumentation should be subject to formal change management procedures to ensure that all implications are identified, assessed and approved at the relevant level.

Where safety-instrumented systems with SIL 1 or higher is to be replaced with modern digital equipment, this will need to be carried out in accordance with the requirements of IEC 61508/IEC 61511 (including change management). If the company does not have its own specialist resources and competency in these key areas, then there should be evidence of, or the intention to, bring in specialist contractors etc to advise and assist.

Underlying Key Issues

- How are out-of-date or obsolescent equipment or systems identified?
- How is equipment maintained, repaired and tested where there is:
  - difficulty in accessing detailed information on its design and maintenance requirements;
  - difficulty in obtaining spares; or
  - a lack of expertise/skills or knowledge, for example, to maintain, change/debug software etc?
- How does the company access specialist skills or knowledge needed about these items?
- What is the replacement strategy for such plant and equipment?
- Where safety-instrumented systems with SIL 1 or higher equipment is to be replaced with modern digital equipment, is the company aware of the requirements of IEC 61508/IEC 61511 and the implications of these, particularly regarding specialist resources and competency to deal with these?

Ageing Plant: Key Inspection Topics

Topic 7. Resources

Are the resources available for the management of mechanical integrity, maintenance and C&I system inspection and test of suitable competence and available at a sufficient level to enable effective delivery?

Rationale: Asset integrity management is a significant task that needs to be properly managed and resourced. Over the years sites may have changed, organisation and management reorganised, personnel changed and duties reallocated. There has also been an increase in the use of independent bodies for the management of integrity. It is important to establish that those with responsibility for managing the assets and undertaking the maintenance, testing, inspection etc are suitably competent and that the overall allocation of resources is adequate to maintain the integrity, functionality and safety of the plant and equipment.

Benchmark

The inspections carried out in order to address the structure and operation of the systems delivering plant and C&I equipment integrity and maintenance (Topics 3 – 6 above) will identify major issues with resource competence or availability, and address many of the issue covered by this question. The information obtained by inspecting against Topics 3 – 6 should be considered by the Field Team in deciding the priority and coverage of a specific inspection against this question.

Those responsible for managing and undertaking maintenance, testing and inspection should be competent for this. Someone with an engineering qualification would be expected to manage the maintenance, inspection and testing systems and arrangements. Technicians should also have suitable NVQ, SVQ or similar qualifications or experience or specific training to meet the company requirements. Supervision should be in place for those not yet assessed as fully competent, newcomers, or those in training. The better companies will have recruitment, training and development competence assessment in place. Particular interest should be taken if the company has recently appointed a new inspection body or contractor for maintenance, or is about to lose or has recently lost experienced staff due to retirement, organisational changes etc. Where key people are about to leave, some evidence of activity to retain or plug gaps in skills and knowledge should be evident.

Do staff involved in activities associated with the management of ageing have an appropriate level of knowledge of the relevant company/site procedures and processes, such as management of change, materials quality assurance, pre-operational testing etc?

The company should have checks in place to confirm the competency of third parties involved in asset integrity management. These should include competence checks as part of the selection and monitoring processes for contractors.

Inspection bodies should be registered and certificated as such, e.g. to BS EN ISO/IEC 17020:2004 and UKAS accreditation.

The level of backlogs in the maintenance management systems may give an indication as to whether the overall levels of resources are suitable. This can be a particular issue if there has been recent downsizing of maintenance staff and managers in the company.

Changes to resources or responsibilities should be identified, assessed, managed and approved through the change management systems.

Ageing Plant: Key Inspection Topics

Underlying Key Issues

- Who is responsible for monitoring and maintaining the maintenance, inspection and testing programme and ensuring this is delivering the required performance?
- Are those responsible suitably qualified in terms of professional qualifications, experience and skills?
- What are the key integrity/maintenance/engineering roles that can influence process safety?
- What are the key competencies required for each role (other than professional/vocational qualifications)?
- How do you know these competencies are available and maintained?
- How are contractors or other bodies involved in asset integrity management or inspection and testing activities selected, and how are they assessed for competency and managed/monitored to check they are working to the required scope and standards?
- How do you ensure you retain the skills and experience to maintain, test (re-program?) and repair unusual, novel, old or obsolete plant and equipment (include EC&I systems and equipment) still in use on site?
- How are Maintenance Management System (MMS) backlogs monitored, priorities assigned and addressed?
- Is job/skills continuity addressed when changing personnel or plant and equipment?
- How is the adequacy of overall resource levels assessed? Is the completion and close out of tasks and actions and MMS backlogs used as KPIs?
- Is leadership supportive?