Review of Current ONR Guidance & Relevant Good Practice on Beyond Design Life Expectations for Mechanical SSCs Related to Safety

[redacted]

Version Number Version 1.0

Contents

1 Introduction

The overall objective of the project is to produce a new good practice guide for Beyond Design Life (BDL) expectations of mechanical Structures, Systems and Components (SSCs) important to Nuclear Safety. The methodology adopted includes assurance processes to provide confidence to the nuclear industry that the good practice guide is authoritative. To achieve the overall objective, the project has been split in to several phases; this report represents the outcome of the first phase.

The objectives for this phase of the project, Phase 1, include:

- Review of the Office for Nuclear Regulation (ONR) Safety Assessment Principles (SAPs) (Reference 1) to identify current ONR guidance on BDL expectations for mechanical SSCs.
- Review of ONR Technical Assessment Guides (TAGs) and Technical Inspection Guides (TIGs) to identify additional ONR guidance on BDL expectations for mechanical SSCs.
- Identification of other nuclear industry and other high-hazard industry Relevant Good Practice (RGP) relating to BDL expectations, and associated topics such as Long-Term Operations (LTO), Ageing Management and Periodic Safety Review (PSR).

Across various documents the terminology used can have subtly different meanings. To support this and future phases of the project, it is necessary to define some of the common terms that will be used. Section 2 provides a list of key terms used and provides definitions for how they will be used in this project. In addition, this section also provides an overview of the approach adopted in delivering this phase of the project.

To demonstrate that the objectives for this phase have been met, this report presents an overview of the information identified against each of the areas listed above. As a result, the sections that summarise the reviews have been structured as follows:

- Section 3 – Review of SAPs (with detailed findings presented in Appendix A)
- Section 4 – Review of TAGs and TIGs (with detailed findings presented in Appendix B)
- Section 5 – Identification of RGP (with detailed findings presented in Appendix C)

Further information on the documents identified and reviewed is tabulated in the relevant appendices. These tables provide useful information on each document, to permit future referencing, and include a high-level outline, plus any comments relating to the relevance of the source material.

The latter sections of this report draw together the information presented to provide considerations and input to future phases of the project. Where appropriate, observations and recommendations are also made for consideration.

2 Definitions & Overview of Approach

2.1 Definitions

To establish a common understanding of the terminology used in this report and for future phases of the project, it is considered appropriate to define several commonly used terms. The definitions for some of the terms do vary and, in some cases, terms are interchangeable with others depending on the source. The terms, abbreviations and definitions are outlined in the table below:

Term / Abbreviation	Definition
Ageing Management	IAEA SSG-48 (Reference 2) identifies that Ageing Management covers all activities that aim to prevent or control ageing effects, within acceptable limits, throughout the entire lifetime of the nuclear power plant (i.e. design; fabrication or construction; commissioning; operation, including Long Term Operation (LTO); and decommissioning, including long term shutdown).
Asset Management	The integration of ageing management and economic planning to optimise the operation, maintenance, and service life of SSCs; maintain an acceptable level of performance and safety; and maximise return on investment over the service life of the plant.
Beyond Design Life (BDL)	A period of an SSCs lifetime that exceeds the original design life of the item. Please see Figure 1.
Design Life	The ONR SAPs (Reference 1) identifies the Design Life as the period of time during which a facility or component is expected to perform according to the technical specifications to which it was produced.
International Generic Ageing Lessons Learned (IGALL)	The objective of the IGALL publication (Reference 3) is to provide a technical basis and practical guidance on managing ageing of mechanical, electrical and instrumentation and control (I&C) components and civil structures of nuclear power plants important to safety.
Lifecycle	The ONR SAPs (Reference 1) identifies that Lifecycle is defined as all the stages in the life of a facility from conception through to delicensing. This includes design, build, commissioning, operation, maintenance, closure, decommissioning, disposal of waste and the return of a site to a safe state.
Long Term Operation (LTO)	IAEA SSG-48 (Reference 2) identifies that LTO of a nuclear power plant is operation beyond an established time frame defined by the licence term, the original plant design, relevant standards or national regulations.
Periodic Safety Review (PSR)	IAEA NP-T-3.24 (Reference 4) identifies that a PSR is a comprehensive safety review of all important aspects of safety, carried out at regular intervals, typically every 10 years. It also notes that a PSR may be used in support of the decision making process for licence renewal or LTO, or for the restart of a

Term / Abbreviation	Definition
	nuclear power plant, following a prolonged shutdown or lay-up period.
Plant Life Extension (PLEX)	Plant Life Extension, similar in meaning to LTO; however, LTO is now more commonly used than PLEX.
Plant Life Management (PLiM)	IAEA NP-T-3.24 (Reference 4) identified that Plant Life Management is defined as the integration of ageing and economic planning to optimise NPP investments in favour of safety, commercial profitability and competitiveness, while providing a reliable supply of electrical power.
Structures, Systems and Components (SSCs)	The ONR SAPs (Reference 1) identifies that an SSC is an item important to safety within the facility design which provides a safety function. It is a general term encompassing all of the elements (items) of a facility or activity that contribute to protection and safety. IAEA SSG-48 (Reference 2) identifies that the following SSCs should be included in the scope of ageing management: a) SSCs important to safety that are necessary to fulfil the fundamental safety functions. b) Other SSCs whose failure may prevent SSCs important to safety from fulfilling their intended functions. c) Other SSCs that are credited in the safety analyses (deterministic and probabilistic) as performing the function of coping with certain types of event, consistent with national regulatory requirements.
Stated or Claimed Life	The period for which an SSC has been demonstrated, through testing, analysis or experience, to be capable of functioning within acceptance criteria during specified operating conditions while retaining the ability to perform its safety functions in a design basis event.
Time-Limited Ageing Analyses (TLAA)	IAEA SSG-48 (Reference 2) identifies that TLAA should demonstrate that the analysed ageing effects will not adversely affect the capability of a structure or component to perform its intended function(s) throughout an assumed period of operation

Table 1: List of Definitions

Further information on common terminology can be found in the ONR SAPs (Reference 1), the IAEA Safety Glossary (Reference 5) or the Glossary of Nuclear Power Plant Ageing from the Organisation for Economic Cooperation and Development (OECD), Nuclear Energy Agency (Reference 6).

To further ensure a common understanding, Figure 1 has been prepared to illustrate common terms used in sources of RGP. The simplified figure presents key stages over

the operating lifetime of an SSC, identifying BDL aspects to be considered through operation and in to decommissioning. Figure 1 could also include the design, manufacture, installation and commissioning as these steps will also contribute to the lifetime expectations of the SSC.

Figure 1 represents an individual SSC that operates over a considerable life (some 70+ years) when extended operation and decommissioning is factored in. It is recognised that many SSCs would probably be subject to some level of replacement or renewal over such a period, but there may be SSCs that are required to operate over a similar lifetime. This may include SSCs in areas with limited access, or components within larger SSCs, like certain parts associated with cranes. However, this figure could be applied to SSCs with shorter lifetimes; for instance, an SSC installed initially for a 5-year period either on a temporary basis, or in close proximity to the claimed end of life.

It is recognised that the level of degradation recorded against an SSC will vary depending on the nature of the SSC. Therefore, the performance and subsequent life of the SSC may be determined by individual parameters or a collection of mechanisms that contribute to the overall performance of the SSC. In addition, for complex SSCs modification or replacement of accessible components is likely to alter the rate of degradation. The simplified figure assumes a relatively constant level of degradation for the SSC over the life of the item. Factors that will influence the shape of Figure 1 include (but are not limited to):

- What the degradation mechanisms are for the SSC.
- How the degradation is affected by time, considering (but not limited to):
  - The materials used;
  - The environment it will operate in;
  - The impact changes to operation may have;
  - Factors that could increase or decrease the rate of degradation;
  - Non-conformities that may have occurred during manufacture.
- The material properties or parameters that can be used to monitor the rate of degradation.
- The assessment or analysis tools or techniques that demonstrate current and future performance. This may also include:
  - Assumptions used as input values in original design analyses, for instance relating material properties.
  - Use of original certified values from build records compared to assumed values.
  - Assumptions or conservatisms that are within the tools and codes use to extrapolate future performance.
- Any Research & Development (R&D) programmes that can provide additional information to support any of the points above.

A number of supporting notes are presented below Figure 1 to provide further clarification.

Figure 1: Simplified Figure to Support Beyond Design Life Definitions & Discussion

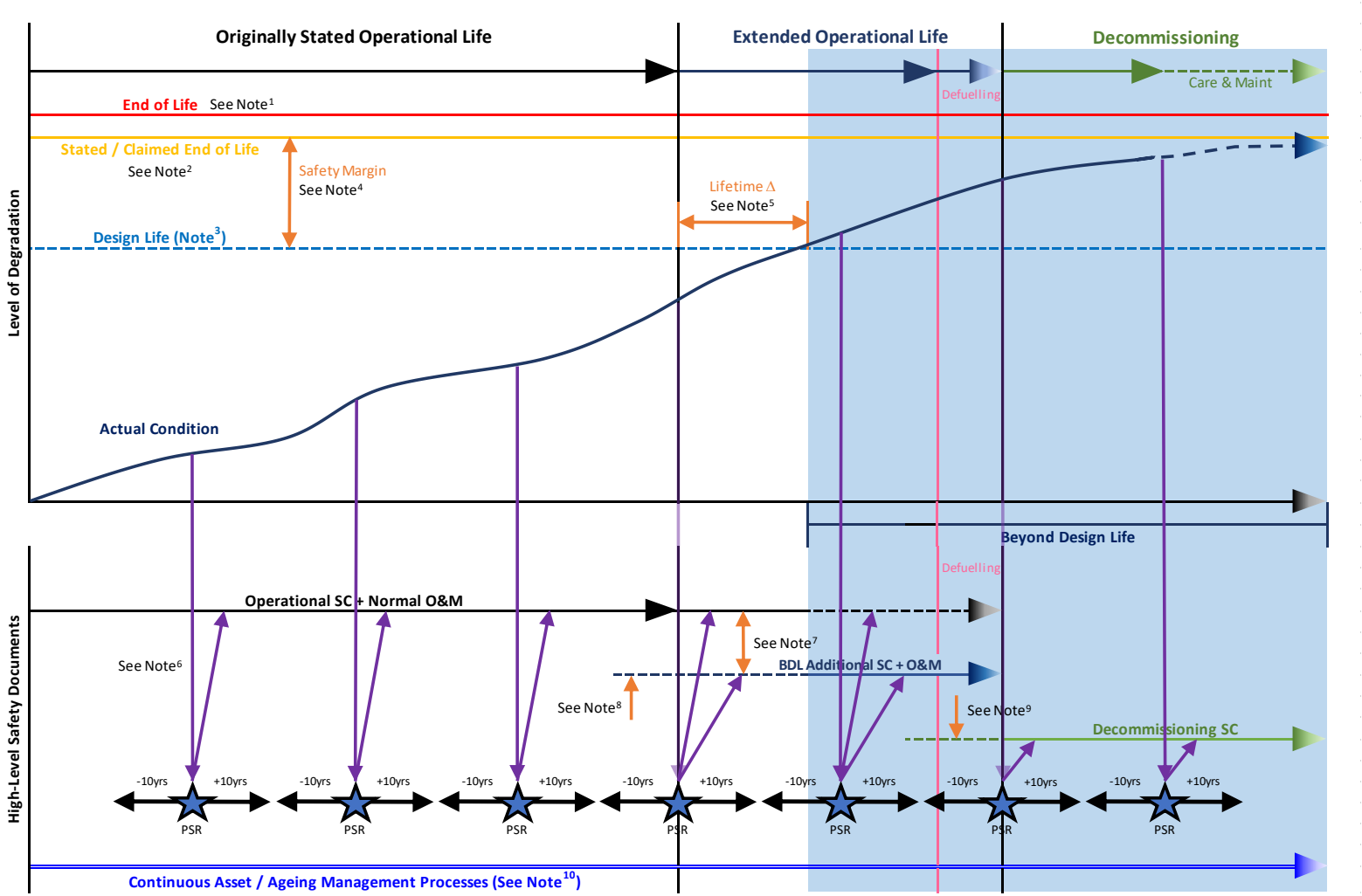


Figure 1 Notes

Note 1: The point at which an SSC fails, beyond which no corrective actions are possible, in many instances will be unknown. The point at which an SSC will fail is subject to significant uncertainty that must be taken into account in any BDL decision making process. Defined as **End of Life** this is based on several different criteria specific to the SSC and will relate to the identified ageing & degradation mechanisms. This will be based on specific material properties and parameters.

Note 2: The **Stated** or **Claimed End of Life** is the point at which an SSC is claimed or stated within the Safety Case (SC) as no longer fit for service. This value may reflect uncertainties introduced during the manufacture process that resulted in non-conformities being raised. As with End of Life, this may be based on different criteria specific to the individual SSC and the identified ageing & degradation mechanisms. However, as there may be some conservatism in the supporting analysis or assessments, the stated value could differ from the point at which the actual End of Life occurs.

Note 3: The **Design Life** - The life specified in the original design the SSC should operate safely for. The design life may have had an influence on the materials used, manufacturing process and Examination, Inspection, Maintenance and Testing (EIMT) over the life of the SSC.

Note 4: The **Safety Margin** - The margin between the original design life and stated or claimed end of life. The knowledge on what this margin is will vary due to several factors such as the nature and Class of the SSC and the age of design and manufacture. For instance, the Safety Margin should be greater & better defined for safety significant SSCs, while less significant items may have less of a gap between the two points. The Safety Margin may also be influenced by the degree of redundancy in the total system for delivery of a Safety Function. Building in additional redundancy at the design stage will reduce the reliance (and potential safety significance) of an individual SSC, so that (for instance) a replacement strategy could be used to mitigate the impact of ageing.

Note 5: The **Lifetime** Δ - The gap between the actual condition at the end of the originally stated operational life and when the SSC reaches the end of the design life will vary due to various factors. For instance, how effective the asset / ageing management has been, actual environment compared to the design intent, actual utilisation compared with the original design intent, the development of ageing mechanisms not considered during design, and potential changes to the operation. This difference will also be linked to how well the Operations & Maintenance (O&M) have been carried out over the life of the SSC compared to the original design intent. It will represent the difference between the validity period of the SC and the plant life expectations of the dutyholder based on changes to the O&M during the operational life of the SSC.

Note 6: A PSR includes a comprehensive assessment of the facility's condition, operating experience, SC, safety management arrangements, and culture, looking forward at least the next ten years and normally to the end of life. The review is carried out at appropriate intervals through the different lifecycle phases of the facility, usually every ten years starting at the commencement of active commissioning. The PSR process will review how the actual condition of the SSC is managed, identify if there were significant plant performance issues over the previous 10 years, and provide statements of confidence for operation over the next 10 years. This will be achieved by review of various EIMT results or dedicated inspections for the PSR that are specific to the SSC. The output of the PSR process, across all aspects of the review (including changes relating to the condition of the SSC) will need to be reflected in the applicable SC. At the transition from the Operational SC to the additional BDL SC, and from this combination into the Decommissioning SC, the output from the PSR should be incorporated in to the extant SC. It should be noted that the BDL SC is the 'Operational SC' that incorporates BDL elements and may not significantly differ to the Operational SC if existing analyses are still valid; however, the process to determine that additional substantiation is not required should still be recorded.

Note 7: The additional effort required to support / substantiate BDL will vary depending on the nature and Class of the SSC. Associated Ageing Management Plans will also vary in detail according to the nature and Class of the SSC. The process for BDL should take input from the PSR process, the Asset / Ageing Management processes and existing O&M regimes. It is noted that the level of effort required to substantiate BDL will depend on various factors including the relevance of original safety justification, Time-Limited Ageing Analyses (TLAAs), validity of original assumptions and relevance of extant O&M to BDL operation. The gap between the extant O&M and the BDL O&M may relate to changes in the operating conditions or environment, increases in dose, or other unforeseen challenges that may alter the way EIMT is carried out. The Δ between the two will inform the level of effort required to demonstrate operation BDL is ALARP.

Note 8: The work to prepare BDL submissions will be required to commence during the originally stated operating life. This may relate to the complexity of the SSC; alternatively, it may be due arbitrary dates associated with anticipated operational life within the extant SC. The originally stated lifetime limits (defined by fatigue life, cycle limits, calendar limits etc.) are often imposed due to limited knowledge, or an inability to predict material properties with high confidence for long periods of operation. Other factors that influence early BDL assessment / investigation of SSCs may include a lack of evidence on the actual condition of the SSCs, and this may require extended outages to provide confidence. PSR also provides a mechanism to identify life limited SSCs well ahead of the need to extend into the BDL region.

Note 9: The Decommissioning SC must be reviewed and updated to reflect changes that arise due to extended operation and the information included in the BDL SC. This may be due to changes in the level of radioactive waste or SSCs having a greater dose then expected.

Note 10: Asset & Ageing Management Processes run continuously throughout the whole life of the SSC. The specific strategies employed for SSCs should evolve and change to reflect the age of the SSC, level of degradation, obsolescence, loss of knowledge (Suitably Qualified & Experience Persons (SQEPs) or Original Equipment Manufacturers (OEMs)), changes in operational demands, or changes in safety function. In addition, advances in tools & techniques to minimise the effects of ageing and degradation or more accurately measure the actual condition and ensure continued reliability should be reviewed on a routine basis (e.g. as part of PSR).

As previously noted, Figure 1 is a simplified overview to identify different elements to be considered as part of the BDL expectations.

2.2 Overview of Approach

As it can be seen in Figure 1, there are many factors that affect and can influence what needs consideration within the BDL expectations, and there is a significant amount of material available from within the nuclear and other high hazard industries. As such it was necessary to adopt an approach that would allow a significant volume of information to be identified and reviewed in an appropriate timescale. To facilitate the initial review, the following approach was adopted:

- Perform a high-level review of known international RGP on LTO and Ageing Management.
- Identify keywords for further reviews and searches focused on expectations for BDL operation.
- Undertake a review of the SAPs using the identified keywords listed below.
- Identify and review TAGs and TIGs using the identified keywords listed below.
- Use the identified keywords to undertake further searches for RGP. The searches initially to focus on nuclear specific information and then extended to cover other high-hazard industries.
- Undertake a high-level review of the identified material to determine relevance for future phases of the overall project.

The high-level review of international RGP helped contribute to the development of Table 1 and Figure 1. During the production of the table and figure a simple list keywords were developed to aid further searches and reviews. Keywords (in no particular order) included:

- ‘Design Life’
- ‘Life Extension’
- ‘Ageing & Degradation’

- ‘Ageing Management’
- ‘Actual Condition’
- ‘Long-Term Operation’
- ‘Plant Life Extension’
- ‘Plant Life Management’
- ‘Life-Cycle’
- ‘Safety Margin’
- ‘Periodic Safety Review (PSR)’
- ‘Time-Limited’

The identified keywords were used as the search criteria for publicly available source material or from Wood Library Services (which include codes, standards and various technical journals). Once potentially relevant documents were identified, they were reviewed at high-level to refine the list of documents further. The following sections present the findings of the reviews identified in the steps noted above.

3 Review of Relevant ONR Safety Assessment Principles

Review of the 2014 SAPs (Reference 1) has been split into two parts; the first looks at the introductory text (paragraphs 1-46); and the second at the principles themselves (paragraphs 47 onwards). The introductory text identifies information around the applicability of the principles, the impact of ageing and the need for continuous improvement. Individual principles determined to have some applicability to BDL operation are included in Appendix A along with explanatory notes.

3.1 Review of Introduction

The 2014 SAPs (Reference 1) were reviewed focussing on aspects associated with 'life' and 'ageing' to identify parts of the document that are associated with BDL operation. Within the introductory sections of the SAPs it states that the principles are designed to support regulatory assessments throughout the full lifecycle of nuclear facilities. Although there are specific sections that are devoted to individual stages, (for instance siting and decommissioning); in general, the principles have the potential to apply to all stages of a facilities lifecycle. However, not every principle will apply to all lifecycle stages. Instead the principles are a reference set from which an inspector should select those relevant to a particular situation or stage in the lifecycle. This is no different for BDL expectations; and the review has focussed on what may contribute to informing decisions and submissions to operate SSCs beyond their original life.

The SAPs (Reference 1) also recognises that as a facility ages and the potential exists for SSCs to operate beyond the original design life, safety margins may be eroded and a dutyholder may argue that making improvements is not worthwhile. The short remaining lifetime of the facility may be invoked as part of the ALARP demonstration. However, this factor should not be accepted to justify the facility operating outside legal requirements, or at levels of risk that are unacceptably high (for instance compared with the SAPs Numerical Targets). A SC which argues for not making an improvement based predominantly on limited future lifetime should only be accepted where the maximum extent of the future operational life is irrevocably fixed and provides a suitable margin of safety. In cases where the planned lifetime is not irrevocably fixed, a minimum period of ten years (or the unavoidable necessary life of the facility, if longer) should be considered for the purposes of judging whether the ALARP demonstration is acceptable.

In addition, the introductory paragraphs to the SAPs also identify that the principle of continuous improvement is central to achieving sustained high standards of nuclear safety. The SAPs record that the legal requirements for risk reduction So Far As Is Reasonably Practicable (SFAIRP). Application of this principle ensures that, no matter how high the standards of nuclear design and subsequent operations are, improvements should always be sought. Seeking and applying lessons learned from events, new knowledge and experience, both nationally and internationally, must be a fundamental feature of the safety culture of the nuclear industry. With respect to SSCs and BDL operation, continuous improvement should contribute to improving confidence in the actual condition of SSCs or to gain greater knowledge of what contributes to the Safety Margins, and how extended operation will impact on these margins.

The SAPs are also intended to be applied in the assessment of PSRs. A PSR includes a comprehensive assessment of the facility's condition, operating experience, SC, safety management arrangements, and culture, looking forward at least the next ten years and normally to the end of life. The review is carried out at appropriate intervals through the different lifecycle phases of the facility usually every ten years starting at the commencement of active commissioning.

The introduction to the SAPs identifies that PSRs are more wide ranging than a restatement of the SC and instead provide a systematic review of whether the SC remains adequate in all situations that may affect safety. This entails reviews that consider all levels of Defence in Depth from the robustness of the facility's design through to the resilience of its emergency preparedness arrangements. As such the PSR provides an opportunity to consider BDL operation across the whole facility and the cumulative impact this may have on safety. While individual submissions will often relate to specific SSCs or specific operations, the PSR should review the totality of SSCs including the actual condition, interactions between systems, across all operation modes and looking forward, including the impact on future lifecycle stages.

3.2 Review of Principles

Review of the SAPs has identified a number of principles that are relevant to BDL substantiation. These SAPs are listed in Appendix 1. In order to support future phases of this task, the SAPs identified in Appendix 1 have been categorised into the following three groups:

A. Principles that apply over the whole lifecycle of a facility and would therefore include extended operation and operation beyond the original design life of SSCs.

B. Principles that will require revalidation to support a specific submission to substantiate BDL operation. These principles focus on the assessments or analyses that underpin safety performance, which may include Time-Limited Ageing Analyses.

C. Principles that apply over the whole lifecycle and would be evaluated as part of the PSR or normal operation, which would also support BDL substantiation. These principles focus on determining the actual condition of the SSC and predicting future condition.

It should be noted that individual SAPs may fall in more than one of the three categories identified above.

Appendix 1 does not include all items that fall in the first group, Group A, for instance the numerical targets that have to be demonstrated throughout life (extended or otherwise). The principles included are those that will need some consideration and planning as SSCs approach operation beyond the original design life. Group A includes principles associated with the SC or SSCs, which do not explicitly identify extended operation, but will require some level of review to support continued operation. For instance, the SC will need to demonstrate that the level of risk is not significantly increased by BDL operation of an SSC. The SC will also need to demonstrate that all other principles relevant to BDL

operation have been met. This includes the need to address the impact BDL operation may have on future stages of the lifecycle and decommissioning (e.g. additional waste, potentially degraded margins, effect on decommissioning or increased levels of contamination).

Group B focusses on those principles that will require analyses or assessments to be reviewed and updated to demonstrate that safety will not be adversely affected by BDL operation. This may include Time-Limited Ageing Analyses or demonstrating safety margins are acceptable for the extended operation period and beyond. Although these principles may be addressed by the PSR, gaps associated with BDL operation may not represent a shortfall during the originally stated operating life. These may only become a shortfall as the facility (or individual SSCs) approach the end of the originally stated life when existing analyses potentially become invalid.

Group B also includes principles relating to the control of nuclear matter. For an individual SSC, substantiation of BDL operation should identify if there is an increase in the amount of nuclear material produced, via refurbishments or consumables, with some consideration of the storage requirements. Whilst the amount of additional nuclear material from individual SSC may be relatively insignificant, an assessment of the total impact of all SSCs within the facility should also be undertaken, which is linked to some of the wider SC considerations identified within Group A.

Group C includes those principles that apply over the whole lifecycle and would be evaluated as part of the PSR or normal operation. These principles focus on specific materials (e.g. metal components or graphite) and include aspects associated with design, manufacture, installation, monitoring, and assessment throughout life. In some cases, where failure of an SSC may have considerable safety significance and financial implications, this may be life-limiting for a facility. SSCs related to these principles may be under regular surveillance or monitoring with access to perform detailed inspection being limited to shutdown or outage periods. In addition, the PSR will be used to review the current maintenance programme to identify any underlying trends and the adequacy of the programme.

In many cases maintenance programmes may be supported by associated research and development, that combined with information from inspections and surveillance, will inform the expected lifetime of the SSCs. To support BDL decisions and justification, this information will need to be reviewed to form a judgement. Most of this information should be available via the PSR, which looks forward 10-years, as well as historical performance.

It is noted that while the PSR will look at the facility in totality, the timing may not align with when operations approach or go beyond the original design life of an SSC. Depending on the timing of the PSR for the facility, information may need to be reviewed outwith the PSR process to inform BDL decisions[1].

[1] Dedicated reviews to support extended operation of the Magnox stations were carried out in the mid to late 1990's. Each review demonstrated the plants capability to be safely operated for at least the period of future operation being requested by the Licensee. These reviews were known as Long Term Safety Reviews (LTSRs).

3.3 SAPs Review Summary

None of the SAPs (Reference 1) currently identify explicit requirements for operation beyond the original design life of an SSC or the need for the assessment of the cumulative effect extended operation might have on the facility. However, there are a number of SAPs that will need to be addressed as part of a BDL submission or assessed across the whole facility as part of a PSR. It is recognised that the SAPs provide a means for aiding the assessment of SCs produced in a goal setting regulatory regime. Goal setting, by its nature, does not account for the concept of time and ageing of SSCs but the validity of the SC can be challenged by these factors. Consequently, a SC that justifies operation BDL must demonstrate that all relevant SAPs have been met and the review undertaken in this phase has identified that the SAPs remain a useful and important part of the assessment process.

4 Review of Relevant ONR Technical Guidance

The TAGs and TIGs were reviewed in a similar approach to the SAPs to identify aspects that have potential applicability to BDL expectations and substantiation. The results of the reviews are included in Appendix B along with review notes which explain why the documents were considered applicable. The list of TAGs and TIGs that were assessed were those identified as available on the ONR website at the time of writing. At the time the searches were done, a number of TAGs were not reviewed as the documents had been 'withdrawn pending review'. However, in some cases the documents have still been included in Table B-1 of Appendix B as there is a potential that the TAGs will relate to BDL expectations.

4.1 Review of Technical Assessment Guidance

The results of the TAG reviews are included in Table B-1 of Appendix B. A total of twenty-eight TAGs were considered relevant to this review, which can be grouped into several areas. The identified groups include:

- TAGs that provide additional guidance for a number of the SAPs identified in Section 3 and Appendix A;
- TAGs that provide additional guidance on individual Licence Conditions, such as Licence Condition 15 - Periodic review;
- TAGs that identify and provide guidance on aspects of nuclear safety, from SSCs to the SC, that need to be monitored and managed over the whole life-cycle of a facility. The areas highlighted, to a greater or lesser degree, will also need additional consideration to support a BDL submission;
- TAGs that provide additional guidance on aspects that may support a BDL submission, for instance deterministic or probabilistic safety assessment or demonstration of ALARP.

In addition to the documents that were identified against each of these groups, there was also one TAG identified that could be equally applicable to all groups. The TAG, which covers nuclear SCs (Reference 7), provides guidance of the purpose, scope and content of them. The TAG identifies that the SC should demonstrate that the facility will remain safe throughout a defined life-time, which would include extended operation and beyond. It also notes that the SC should detail any constraints that will apply in the facility's life-time and take account of the effects of ageing and degradation on the facility. Furthermore, the SC should identify the important aspects of operation and management that need to be implemented to maintain safety, including EIMT regimes and Operating Conditions and Limits (OCLs).

4.2 Review of Technical Inspection Guidance

The TIGs identified as being relevant to BDL issues are all related to guidance to support ONR Inspectors determining if individual Licence Conditions have been met. These are all listed at the end of Table B-1 in Appendix B. The Licence Conditions identified include:

- Licence Condition 14 - Safety documentation
- Licence Condition 15 - Periodic review
- Licence Condition 22 - Modification or experiment on existing plant
- Licence Condition 23 - Operating rules
- Licence Condition 28 - Examination, inspection maintenance and testing (EIMT)
- Licence Condition 29 - Duty to carry out tests, inspections and examinations
- Licence Condition 30 - Periodic Shutdown
- Licence Condition 32 - Accumulation of Radioactive Waste

The above Licence Conditions have been identified as they include aspects that will require review or update to support BDL operation. The focus of these TIGs relate to the SC, PSR, modifications, and EIMT all of which will require some consideration in BDL decisions for individual SSCs, or the cumulative affect these changes have across the whole facility.

One of the conditions selected (LC30) identifies that the Licensee shall, if so specified by ONR, ensure that when a plant or process is shut down it shall not be started up again thereafter without the consent of ONR. When safety significant SSCs are approaching BDL there should be sufficient confidence the SSC will continue to fulfil its safety functions for consent to restart to be given. Confidence in the individual SSC should be demonstrated through a range of analyses and evidence identified by the applicable SAPs and TAGs. However, what is considered ‘sufficient’ will vary depending on the nature and Class of the SSC.

4.3 TAGs & TIGs Review Summary

None of the documents identified within the list of TAGs or TIGs include explicit requirements for BDL operation of an SSC or the need for the assessment of the cumulative effect extended operation might have on the facility. Nevertheless, there are aspects of the guidance that should be addressed as part of a BDL submission or assessed across the whole facility as part of a PSR. However, these are spread across a range of documents and in some cases are not explicitly identifiable as BDL considerations.

5 Identification of Relevant Good Practice

Appendix C includes a table of identified RGP from the nuclear industry and other high-hazard industries. Searches across a number of sources identified a significant number of potential documents including papers from various journals, papers to support conferences, and presentations that relate to the topics covered by this task. For each document, a high-level review was undertaken to identify the scope or purpose of the document and a summary of the RGP was added to the table in Appendix C. In some cases, this involved simply looking at the abstract, while for others a slightly deeper review was undertaken. The next step was to determine if the document was of significant interest to merit a more detailed review in future phases.

The high-level reviews highlighted a number of documents, which for various reasons, were not considered appropriate for future phases of the project. The reasons for excluding documents include examples such as the document being superseded, information being based on other RGP (for instance from the IAEA), or the document being too high-level or adding little or no value to the task. Documents excluded from further review in future phases are also identified in Table C-1.

In addition to this research task, Wood are supporting another research task for the ONR (ONR376) that is to look at the SAPs for Ageing & Degradation (EAD.1 to EAD.5) and review the current principles against RGP. Consequently, several documents identified in Appendix C have the potential to support both this task and ONR376 and these have been identified in Table C-1. This applies to material identified from both the nuclear industry and other high-hazard industries.

The justification for not considering documents further, applicability to ONR376 and any other points of interest are provided in a notes field in Appendix C.

5.1 Nuclear Industry RGP

The identified nuclear industry RGP falls into two broad categories, which are discussed in the sub-sections below, these include:

- Process related documents that focus on LTO or Ageing Management. This includes reviews of individual country experiences on the topics or studies on the overall application of these processes.
- SSC related documents that look at various (common) SSCs, the observed degradation mechanisms and some potential strategies to tackle these. Much of this documentation is focused on SSCs associated with Light Water Reactors (LWRs).

5.1.1 Process Related Documents

The concepts and principles of LTO and Ageing Management have evolved over time since initial concerns were first raised in the mid to late 1990's. The processes to address initial concerns on these topics, at an international level, can be traced back to the early-2000's, which largely developed independently and continued for many years. However,

through various studies and sharing of experience the processes have advanced, as described in the recently issued IAEA guidance (Reference 2). The principles, processes and tools that support Ageing Management will run throughout the whole life of a facility. However, the information and data gathered through these processes and tools form a fundamental part of the justification for LTO.

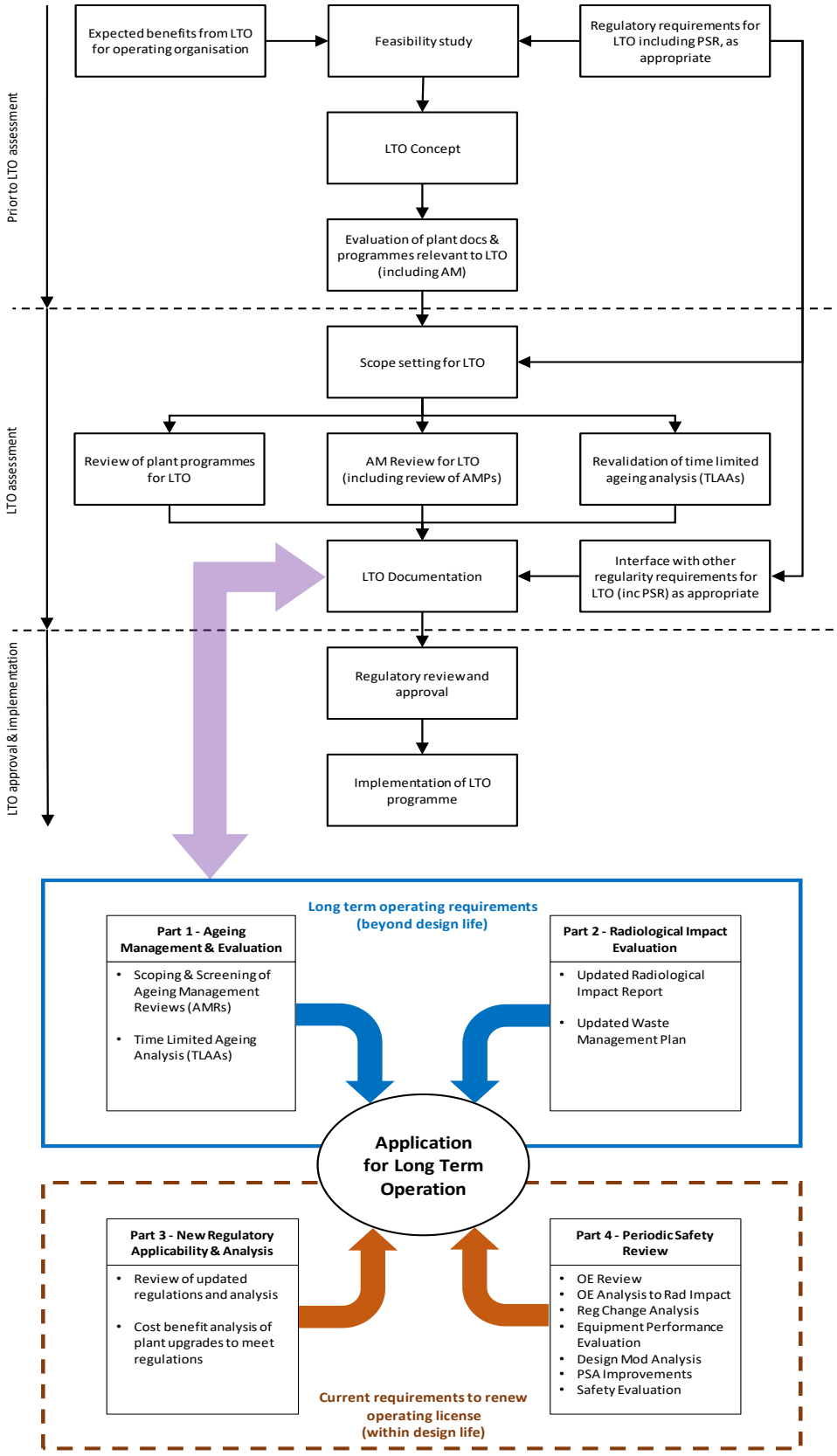
From the high-level review of the RGP it was identified that there are two key approaches to how LTO is handled, and the approach adopted will depend largely on the licencing arrangements for a country. LTO, which covers the extended operation element in Figure 1 is also generally justified across the whole facility, rather than on a case-by-case basis for individual SSCs. The approaches include:

- If a fixed term licence (for instance 40 years) is granted by the regulator then a stand-alone LTO Submission for a fixed term (10 or 20 years) is presented to the regulator for approval.
- If licence renewal is linked to the submission of a PSR to the regulator, then this becomes the vehicle through which approval for LTO is sought.

Figure 2 below, (adapted from Reference 2), presents a high-level overview of an LTO process, in this case more aligned to the first approach described above. Figure 2 highlights that the LTO submission draws on information from various sources that includes information on individual SSCs, for instance discrete Ageing Management Reviews, and the whole facility, such as the PSR.

Within the UK the licencing arrangements are different and neither approach above would be applicable. It is likely that justification for individual BDL operation of an SSC would be identified on a case-by-case basis as part of the modification process. This would then be supplemented by the PSR, which would assess the cumulative effect of all the modifications across the whole facility. This difference in the UK approach means that the review of RGP needs to recognise that not all the processes will be applicable. However, the assessments and analyses identified as supporting LTO may also be applicable for a BDL submissions for individual SSCs; and the whole facility assessments may reflect requirements identified in the PSR.

Figure 2: Simplified LTO Process



5.1.2 SSC Related Documents

The SSC related documents provide information on BDL considerations for a range of mechanical components. In addition, several documents have been highlighted specific to other disciplines (e.g. civil and electrical); these have been included as there may be some cross over with mechanical SSCs, and the interfaces between them.

It is noted that much of the identified documentation is focused on SSCs associated with LWRs. Given the range of SSCs within the UK compared to other countries there may be limited value in reviewing all of these documents as part of future phases. As such, it is not proposed that these documents should be reviewed in detail. However, some level of review may highlight learning from experience that can be applied within the context of this task. One of the key messages that comes across in the high-level reviews undertaken, is that sharing information and experiences is actively encouraged.

5.2 Other High-Hazard Industries RGP

Searches for documents relating to the issues around extended operation and BDL expectations was widened to consider other high-hazard industries in order to identify considerations and learning from experience that may be applicable to the nuclear industry. The initial searches identified a significant number of potential documents, but while most might be considered 'Relevant', it was not always clear if the documents reviewed represented acknowledged RGP. Therefore, the starting point was to review documents that were produced by (or in association with) the UK Health & Safety Executive (HSE).

The HSE documents cover a range of industries, such as Oil & Gas, Nuclear Chemical Facilities, and industries that have equipment containing hazardous fluids or pressure. High-level reviews of the identified documents, particularly relating to Oil & Gas, indicated that the HSE had worked in partnership with the Petroleum Safety Authority – Norway. As a result, further searches of Petroleum Safety Authority – Norway documents were carried out around the topics of life extension and BDL operation. Searches against these two key sources identified a total of twenty documents, all of which have been included (and are highlighted) in Table C-1 of Appendix C.

Within the Oil & Gas documentation ageing management and BDL operation have been brought together as Ageing and Life Extension (ALE). One of the significant documents identified related to the findings of the HSE's Energy Division's (ED's) Key Programme 4 (KP4) (Reference 8) covering the ALE challenges facing hydrocarbon exploration and production installations on the UK's Continental Shelf (UKCS). The KP4 programme investigated the impact of ALE on the risk of major accidents involving the death or serious personal injury to people on an offshore installation. The KP4 programme was a forward-looking programme of work. Its purpose was to:

- Raise awareness of ALE in the offshore industry and the need for specific consideration of ageing issues as a distinct activity within the Asset Integrity Management process;

- Undertake a programme of inspections of dutyholder approaches to ALE management;
- Identify areas for the improvement of ALE management;
- Encourage the development and sharing of good practices.

The findings of KP4 were broken down into a series of strategic issues identified below and made a number of recommendations, the strategic areas included:

- Leadership and preparedness for ALE;
- Asset integrity management;
- Obsolescence;
- Audits and Key Performance Indicators;
- Data management;
- Development of ALE guidance.

This document, along with many of the documents identified, contains information about ageing and degradation and therefore all may have some relevance to the other ONR task identified previously (ONR376). All these documents have been considered relevant for further review in later stages of this task.

In addition to this, within the wider Wood there are parts of the organisation that work in various high-hazard sectors, such as Oil & Gas and Mining. To support this task during the initial phase a request was made to identify if any additional sources of RGP could be identified. This information is expected to arrive prior to the end of this phase or early in the next, to include comparison in future phases of the overall task.

5.3 RGP Identification Summary

Appendix C identifies a significant number of potential items that could be viewed as RGP covering both nuclear and other high-hazard industries. The documents broadly fall into two groups; those focussed on processes and the other focussed on SSCs. Within the nuclear process documents many of the long-term operation documents reflect the licencing arrangements in other parts of the world and not necessarily the UK position. In addition, within the SSC focussed documents the emphasis is on life-limiting or long-lead SSCs predominantly for LWRs.

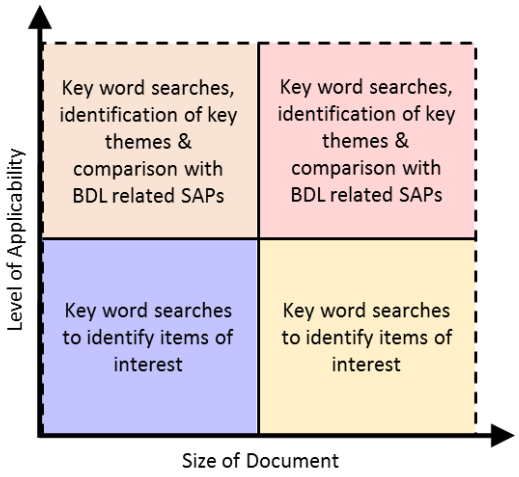
The list of potential documents, papers from various journals, papers to support conferences and presentations identified in Appendix C contains most of the recognised RGP that relates to the topics covered by this task. However, given the nature of the subject there is always the possibility that other relevant material exists, which provides useful and usable information. Additional sources may be identified during the future phases and these will not be excluded from review. It is assumed that any new documents identified can be reviewed relatively quickly to determine the value to the overall task.

As part of the high-level review in generating Appendix C a number of documents within Table C-1 have been ruled out from further review due to various reasons. In addition, the high-level review has identified the potential value the RGP may include to compare with the information presented in Appendix A and B. For instance, a document focussed on SSCs with little UK relevance may have little or no value in future phases; conversely, documents focussed on LTO justification may provide greater detail on the expectations for BDL submissions. To support the future phases, it is proposed that the depth a document is reviewed, and hence the time taken to do it, will be based on the expected value it might bring to the overall task. This may be simplified to indicating a banding for each document, based on the value, which equates to an approximate time to review. For instance, limited value documents would be given a couple of hours to review; while documents that may provide a greater contribution will be given of the order of one or two days (depending on size) to review.

As part of this phase high-level reviews were undertaken across a range of documents, reports, conference or journal papers and presentations to identify potential RGP associated BDL expectations. The total number of potential sources identified exceeded 100 items that record something of interest or value to the task. However, it is not appropriate to review all documents with the same level of rigour due to variations in applicability and the size of the documents compared with others.

Therefore, to support the future phases of the task a simple matrix has been developed to identify the level of effort based on the applicability (potential value to the task) and the size of the document. This is presented in Figure 3 below. It should also be noted that due to the size and number of documents identified it is unrealistic to read documents cover to cover, line by line; as such it is intended to use key word searches to focus in on important areas.

Figure 3: Proposed Matrix for the Review of RGP



In addition, as noted above, a number of documents were identified as no longer being relevant to the task or determined to be excluded from further investigation. This was due to a number of factors (such as documents being superseded) and the reason for the exclusion is identified in the 'Notes' column of Table C-1.

6 Summary & Conclusions

This report presents the outcome of reviews of ONR documentation (SAPs, TAGs and TIGs) that relate to BDL expectations. In addition, the report identifies RGP that potentially relate to BDL expectations from the nuclear industry and other high-hazard industries. This report represents the output from the first phase of a project to produce a new good practice guide for BDL expectations of mechanical SSCs important to Nuclear Safety.

With reference to the three objectives identified in Section 1 of this report:

- Review of the extant ONR SAPs shows that there are no SAPs specifically associated with BDL expectations. Nevertheless, there are a significant number of related SAPs that would need to be considered as part of a BDL submission for an individual SSC, or assessed across the whole facility as part of a PSR. ONR SAPs relating to BDL expectations are identified at Appendix A along with supporting comments.
- Review of the extant ONR guidance contained in the TAGs and TIGs shows that although there is some guidance associated with BDL expectations, it varies in detail, and is fragmented across a significant number of TAGs and TIGs. TAGs and TIGs that include guidance associated with BDL expectations are identified at in Appendix B along with supporting comments.
- Searches for RGP associated with BDL expectations from other nuclear and high-hazard industries, has identified a large number of documents. High-level review of these documents has not revealed any significant differences or omissions relating to BDL expectations promulgated in ONR guidance, however more detailed reviews would be needed to ensure that some of the more specific considerations are adequately covered. Identified RGP associated with BDL expectations is presented in Appendix C along with supporting comments.

7 Considerations for Future Phases

The following aspects are presented for consideration in future phases of the project:

1. Existing ONR documentation includes a number of principles and guidance that would be applicable to the justification of BDL operation an SSC. However, this information is fragmented across the SAPs, TAGs and TIGs. Production of a good practice body of knowledge guide and/or dedicated TAG, as part of a future phase of the project should consolidate BDL considerations with clear reference to where the key themes and considerations relate to extant ONR guidance. Key themes and considerations from other nuclear and high hazard industry guidance identified under point 4 below should also be included.
2. The wording of the extant SAPs may need to be amended to reflect certain key themes and considerations identified during future phases of this task. In most cases this will largely be focused on the supporting paragraphs rather than the wording of the SAP itself. However, in a small number of cases, consideration should be given to the amendment to the wording of the SAP, or inclusion of an additional SAP.
3. Most of the principles and guidance identified within the current ONR documentation is largely focussed on individual SSCs, with the facility-wide impact assessed as part of the PSR. This does not align with International RGP for LTO, which generally includes an assessment of the impact of BDL operation across the whole facility as part of the LTO Submission. While this may be assessed as part of a PSR, the 10-year cycle means that this assessment may need to be updated to support a BDL submission.
4. A more detailed comparison of extant ONR guidance against other guidance from within the nuclear and other high-hazard industries requires further review of identified RGP. Even with a number of documents already excluded, this would entail the review of 80 plus documents. This would represent a potentially significant amount of effort, which (depending on the document) may only add limited value to the assessment. To address this issue, it is proposed that:
    a. Confirm that no other significant RGP is missing from the list.
    b. The identified list of RGP is banded, based on potential value to the task and the size of the document, to determine an approximate level of effort to review.
    c. The use of the banding will be used estimate the level of effort to complete future phases of the overall task.
5. In order to establish the good practice body of knowledge guide as a piece of credible, authoritative and valued output, further engagement with industry outlining the approach taken in completing the work and communicating the outcomes is required. Subject to agreement and support from ONR it expected that the route by which feedback form Industry will be sought is via the Nuclear Safety Forum (NSF) or Engineering Directors Forum (EDF).
6. The items for consideration listed above will influence the scope of future phases of the project both in terms of the deliverables and the approach to their production. These considerations should be discussed between stakeholders at ONR in order to inform the approach to deliver future phases of the project.

8 References

1. ONR Safety Assessment Principles for Nuclear Facilities, 2014 Edition, Revision 0
2. Ageing Management and Development of a Programme for Long Term Operation of Nuclear Power Plants, Specific Safety Guide, No. SSG-48, International Atomic Energy Agency, 2018
3. Approaches to Ageing Management for Nuclear Power Plants - International Generic Ageing Lessons Learned (IGALL) Final Report, IAEA-TECDOC-1736, International Atomic Energy Agency, 2014
4. Handbook on Ageing Management for Nuclear Power Plants, IAEA Nuclear Energy Series, No. NP-T-3.24, International Atomic Energy Agency, 2018
5 IAEA Safety Glossary, Terminology used in Nuclear safety and Radiation Protection, 2007 Edition
6. Glossary of Nuclear Power Plant Ageing, Nuclear Energy Agency, Organisation for Economic Co-Operation and Development, 1999
7. The Purpose, Scope, and Content of Safety Cases, Nuclear Safety Technical Assessment Guide, NS-TAST-GD-051 Revision 4, Office for Nuclear Regulation, 2016
8 Key Programme 4 (KP4), Ageing and life extension programme, A report by the Energy Division of HSE's Hazardous Installations Directorate, Published by the Health and Safety Executive 05/14

Appendix A – Review of ONR Safety Assessment Principles

The review of the SAPs was undertaken to identify items that have a direct or indirect link to BDL. Table A-1 identifies the SAPs determined to be applicable to this review and against each a brief note is provided to demonstrate applicability.

Table A-1: Review of Safety Assessment Principles (SAPs)

ID	Principle	Sub-Area	SAP ID	SAP Requirements	Notes	Group
THE REGULATORY ASSESSMENT OF SAFETY CASES						
A-01	The regulatory assessment of safety cases	Safety case process outputs	SC.2	The safety case process should produce safety cases that facilitate safe operation.	Safety case should ensure safe operation throughout operational life including BDL.	A
A-02	The regulatory assessment of safety cases	Lifecycle aspects	SC.3	For each lifecycle stage, control of the hazard should be demonstrated by a valid safety case that takes into account the implications from previous stages and for future stages.	The lifecycle stages include BDL and using historical performance / reliability should support the continued operation beyond the original design life. In addition, this information along with the expectations of BDL should identify the impact on the future stages.	A
A-03	The regulatory assessment of safety cases	Safety case characteristics	SC.4	A safety case should be accurate, objective and demonstrably complete for its intended purpose.	This should also cover when operations are moving in to long-term operation, where SSC are potentially moving beyond the original design life.	A
A-04	The regulatory assessment of safety cases	Optimism, uncertainty and conservatism	SC.5	Safety cases should identify areas of optimism and uncertainty, together with their significance, in addition to strengths and any claimed conservatism.	As SSC move towards BDL this becomes a very important part of the justification, as safety margins will be eroded with time. Additional measures (e.g. additional inspections, analysis or assessments) may be required to provide the evidence for the arguments underpinning long-term operation.	A

ID	Principle	Sub-Area	SAP ID	SAP Requirements	Notes	Group
A-05	The regulatory assessment of safety cases	Safety case content and implementation	SC.6	The safety case for a facility or site should identify the important aspects of operation and management required for maintaining safety and how these will be implemented.	RGP often identifies the need in an organisation to allocate resources to support long-term operation. Recognising the potential for a significant increase in effort to support certain SSCs moving beyond the original design life (along with obsolescence programmes and replacement / refurbishment programmes) these additional demands should be recognised in the management & work force.	A
A-06	The regulatory assessment of safety cases	Safety case maintenance	SC.7	A safety case should be actively maintained throughout each of the lifecycle stages, and reviewed regularly.	This includes BDL aspects.	A
ENGINEERING PRINCIPLES						
A-07	Engineering principles: safety classification and standards	Codes and standards	ECS.3	Structures, systems and components that are important to safety should be designed, manufactured, constructed, installed, commissioned, quality assured, maintained, tested and inspected to the appropriate codes and standards.	The intent of this SAP is that the range of lifecycle activities associated with an SSC are controlled by codes and standards appropriate to its class. They will be reviewed throughout the lifetime of the SSC as part of the PSR and, depending on the PSR timing, may need to be reviewed for specific SSC (depending on class) to support BDL submissions.	C
A-08	Engineering principles: equipment qualification	Qualification procedures	EQU.1	Qualification procedures should be applied to confirm that structures, systems and components will perform their allocated safety function(s) in all normal operational, fault and accident conditions identified in the safety case and for the duration of their operational lives.	This applies to BDL as well as any other stage of the operational lifecycle. Additional measures (e.g. additional inspections, analysis or assessments) may be required to provide the evidence for the arguments that underpin equipment qualification.	A

ID	Principle	Sub-Area	SAP ID	SAP Requirements	Notes	Group
A-09	Engineering principles: reliability claims	Measures to achieve reliability	ERL.2	The measures whereby the claimed reliability of systems and components will be achieved in practice should be stated.	The appropriate measures should be taken to ensure that the onset of failures will be detected, and that the consequences of failure are minimised. Such measures may, for example, include planned replacement after a fixed lifetime, or be achieved through a programme of examination, maintenance, inspection and/or testing. Where a decision is taken to extend the operating life of a facility then the BDL submissions should consider what action can be taken, over and above the existing measures, to achieve reliability claims.	B
A-10	Engineering principles: reliability claims	Margins of conservatism	ERL.4	Where safety-related systems and/or other means are claimed to reduce the frequency of a fault sequence, the safety case should include a margin of conservatism to allow for uncertainties.	As SSC move towards BDL this becomes a very important part of the justification, as safety margins will be eroded with time. Additional measures (e.g. additional inspections, analysis or assessments) will be required to provide the evidence regarding the extent that the margins have been eroded, demonstrating sufficient margin remains for the duration of long-term operation and that any increased risk is ALARP.	B
A-11	Engineering principles: maintenance, inspection and testing	Identification of requirements	EMT.1	Safety requirements for in-service testing, inspection and other maintenance procedures and frequencies should be identified in the safety case.	As SSCs operate beyond the original design life additional EIMT may be required to demonstrate that safety requirements will be met. However, these EIMT should not accelerate degradation. This may require the licensee to look at alternative techniques, potentially using new or novel equipment, to provide the evidence required.	A
A-12	Engineering principles: maintenance, inspection and testing	Frequency	EMT.2	Structures, systems and components should receive regular and systematic	As above; however, the focus is on frequency and often the EIMT should be performed.	A

ID	Principle	Sub-Area	SAP ID	SAP Requirements	Notes	Group
				examination, inspection, maintenance and testing as defined in the safety case.		
A-13	Engineering principles: maintenance, inspection and testing	Validity of equipment qualification	EMT.4	The continuing validity of equipment qualification of structures, systems and components should not be unacceptably degraded by any modification or by the carrying out of any maintenance, inspection or testing activity.	As SSCs operate beyond the original design life additional EIMT maybe require do demonstrate suitable and sufficient margins remain and the SSC remains qualified against certain hazards or environment. As noted above the EIMT should not accelerate degradation in-line with this principle. This may require the licensee to look at alternative techniques, potentially using new or novel equipment, to provide the evidence required.	A
A-14	Engineering principles: maintenance, inspection and testing	Reliability claims	EMT.6	Provision should be made for testing, maintaining, monitoring and inspecting structures, systems and components (including portable equipment) in service or at intervals throughout their life, commensurate with the reliability required of each item.	The SAPs that in especially difficult circumstances where this cannot be done, either additional design measures should be incorporated to compensate for the deficiency, or it should be demonstrated that adequate long-term performance would be achieved without additional measures. If the operational life of an SSC is extended, then further consideration maybe required on this matter, for instance, if items can no longer be inspected due to increases in dose to operators.	A
A-15	Engineering principles: maintenance, inspection and testing	Continuing reliability following events	EMT.8	Structures, systems and components should be inspected and/or re-validated after any event that might have challenged their continuing reliability.	For SSC in extended operation that operating beyond the original design some consideration for how this may be achieved is potentially required from the outset. The BDL submission should outline inspections or revalidation required following an event. For instance, if items can no longer be inspected in the same to early life what options are available.	A

ID	Principle	Sub-Area	SAP ID	SAP Requirements	Notes	Group
A-16	Engineering principles: ageing and degradation	Safe working life	EAD.1	The safe working life of structures, systems and components that are important to safety should be evaluated and defined at the design stage.	The BDL substantiation will need to re-evaluate the initial assessments to define a revised safe working life that meets the period of long-term operation.	A
A-17	Engineering principles: ageing and degradation	Lifetime Margins	EAD.2	Adequate margins should exist throughout the life of a facility to allow for the effects of materials ageing and degradation processes on structures, systems and components.	As SSC move towards BDL this becomes a very important part of the justification, as safety margins will be eroded with time. Additional measures (e.g. additional inspections, analysis or assessments) will be required to provide the evidence regarding the extent that the margins have been eroded, demonstrating sufficient margin remains for the duration of long-term operation and that any increased risk is ALARP.	A
A-18	Engineering principles: ageing and degradation	Periodic measurement of material properties	EAD.3	Where material properties could change with time and affect safety, provision should be made for periodic measurement of the properties.	As SSCs operate beyond the original design life additional EIMT maybe require do demonstrate suitable and sufficient margins remain. However, these EIMT should not accelerate degradation in-line with this principle EMT.4. This may require the licensee to look at alternative techniques, potentially using new or novel equipment, to provide the evidence required.	A
A-19	Engineering principles: ageing and degradation	Periodic measurement of parameters	EAD.4	Where parameters relevant to the design of plant could change with time and affect safety, provision should be made for their periodic measurement.	As SSCs operate beyond the original design life additional EIMT maybe require do demonstrate suitable and sufficient margins remain. However, these EIMT should not accelerate degradation in-line with this principle EMT.4. This may require the licensee to look at alternative techniques, potentially using new or novel equipment, to provide the evidence required.	A

ID	Principle	Sub-Area	SAP ID	SAP Requirements	Notes	Group
A-20	Engineering principles: ageing and degradation	Obsolescence	EAD.5	A process for reviewing the obsolescence of structures, systems and components important to safety should be in place.	The obsolescence of SSCs important to safety has the potential to lead to those items operating beyond the original design life to meet long-term operation requirements. This will result in the potential for interim justification until replacement can be procured & installed or further substantiation if a credible alternative cannot be sourced.	A
A-21	Engineering principles: external and internal hazards	'Cliff-edge' effects	EHA.7	A small change in design basis fault or event assumptions should not lead to a disproportionate increase in radiological consequences.	As SSCs degrade with time the BDL substantiation should ensure that any erosion of safety margins does not introduce any unexpected cliff-edges.	B
A-22	Engineering principles: external and internal hazards	Weather conditions	EHA.11	Facilities should be shown to withstand weather conditions that meet design basis event criteria. Weather conditions beyond the design basis that have the potential to lead to a severe accident should also be analysed.	The SAPs note that reasonably foreseeable effects of climate change over the lifetime of the facility should be taken into account, particularly during Periodic Safety Reviews. If the extended operational life of the facility is expected to be significant then some consideration may need to be included in a BDL submission. This information may be taken from the PSR or as part of tasks specifically to support BDL decisions / submissions.	C
A-23	Engineering principles: integrity of metal components and structures: highest reliability components and structures	Safety case and assessment	EMC.1	The safety case should be especially robust and the corresponding assessment suitably demanding, in order that a properly informed engineering judgement can be made that: (a) the metal component or structure is as defect-free as possible; and	This principle should be part of the BDL substantiation. Original assessments, analysis and justification should be revisited to demonstrate reliability has not been significantly degraded with time and the assessments will be valid for the long-term operation period.	A

ID	Principle	Sub-Area	SAP ID	SAP Requirements	Notes	Group
				(b) the metal component or structure is tolerant of defects.		
A-24	Engineering principles: integrity of metal components and structures: highest reliability components and structures	Use of scientific and technical issues	EMC.2	The safety case and its assessment should include a comprehensive examination of relevant scientific and technical issues, taking account of precedent when available.	This principle should be demonstrated in the substantiation of SSCs beyond the original design life. In some areas this may lead to the development of research programmes to support specific SSC not readily assessed in wider scientific or technical communities.	B
A-25	Engineering principles: integrity of metal components and structures: highest reliability components and structures	Evidence	EMC.3	Evidence should be provided to demonstrate that the necessary level of integrity has been achieved for the most demanding situations identified in the safety case.	As SSC move beyond the original design life this principle will need consideration as part of the substantiation for long-term operation. Additional measures (e.g. additional inspections, analysis, research programmes or assessments) will be required to provide the evidence to demonstrate that the necessary level of integrity has been achieved for the duration of long-term operation and that any increased risk is ALARP.	A, B, C
A-26	Engineering principles: integrity of metal components and structures: general	Defects	EMC.5	It should be demonstrated that components and structures important to safety are both free from significant defects and are tolerant of defects.	This principle should be part of the BDL substantiation. Original assessments, analysis and justification should be revisited to demonstrate reliability has not been significantly degraded with time and the assessments will be valid for the long-term operation period.	A, B
A-27	Engineering principles: integrity of metal components and structures: general	Defects	EMC.6	During manufacture and throughout the full lifetime of the facility, there should be means to establish the existence of defects of concern.	This principle should be part of the BDL substantiation to demonstrate that this capability would not be undermined by long-term operation period.	A, C

ID	Principle	Sub-Area	SAP ID	SAP Requirements	Notes	Group
A-28	Engineering principles: integrity of metal components and structures: design	Failure Modes	EMC.11	Failure modes should be gradual and predictable.	As SSCs go beyond the original design life degradation over the operational life will reduce some design margins, which lead to failures no longer being gradual or predictable. The BDL substantiation should demonstrate that the principle will still be met over the period of long-term operation and, in some cases, beyond.	A, B, C
A-29	Engineering principles: integrity of metal components and structures: manufacture and installation	Materials	EMC.13	Materials employed in manufacture and installation should be shown to be suitable for the purpose of enabling an adequate design to be manufactured, operated, examined and maintained throughout the life of the facility.	For new facilities while operation beyond the original design life might seem far off in the future; however, this principle applies to the whole life of the facility. Therefore, the assessments to demonstrate this principle has been met should consider long-term operation. It should be noted that this does not mean designers need to design for long-term operation (e.g. 40yrs Ops + 20yrs LTO), designer should look at strategies for SSCs over the whole life of the facility.	A, C
A-30	Engineering principles: integrity of metal components and structures: manufacture and installation	Records	EMC.20	Detailed records of manufacturing, installation and testing activities should be made and be retained in such a way as to allow review at any time during subsequent operation.	This capability will form a fundamental part of the evidence to substantiate operation beyond the original design life. Comprehensive records that also document use / cycles and defects during operation will provide further support. All information relating to the original design assumptions and how these change with time over the operational life of the facility will have some value in the BDL substantiation.	A, C

ID	Principle	Sub-Area	SAP ID	SAP Requirements	Notes	Group
A-31	Engineering principles: integrity of metal components and structures: operation	Safe operating envelope	EMC.21	Throughout their operating life, components and structures should be operated and controlled within defined limits and conditions (operating rules) derived from the safety case.	This principle should be part of the BDL substantiation to demonstrate that limits and conditions are suitable for the period of long-term operation. In addition, historical information on where limits and conditions have potentially been exceeded over the life of the facility will support assessment of SSC degradation.	A, B
A-32	Engineering principles: integrity of metal components and structures: monitoring	Forewarning of failure	EMC.26	Detailed assessment should be carried out where monitoring is claimed to provide forewarning of significant failure.	The SAPs note that Detailed assessment should be carried out where monitoring is claimed to provide forewarning of significant failure. These assessments should show that the: (a) means of monitoring; (b) frequency of monitoring; and (c) actions to be taken in response to monitoring results; are consistent with the degradation mechanism in question, the anticipated rate of degradation and the estimated time from detection of degradation to an unsafe state arising BDL substantiation will need to review any existing assessments to determine validity for BDL and identify any changes. There may also be a requirement to determine if new or additional assessments are required.	A, B, C

ID	Principle	Sub-Area	SAP ID	SAP Requirements	Notes	Group
A-33	Engineering principles: integrity of metal components and structures: manufacturing, pre- and in-service examination and testing	Examination	EMC.27	Provision should be made for examination that is capable of demonstrating with suitable reliability that the component or structure has been manufactured to an appropriate standard and will be fit for purpose at all times during future operations.	Similar to EMC.13 the duration an SSC has to remain fit for purpose may also consider long-term operation, depending on the strategy for the item (i.e. design for whole life including LTO or design for replacement at some appropriate time over the whole life).	A, C
A-34	Engineering principles: integrity of metal components and structures: manufacturing, pre- and in-service examination and testing	Margins	EMC.28	An adequate margin should exist between the nature of defects of concern and the capability of the examination to detect and characterise a defect.	This principle should be part of the BDL substantiation. Original assessments, analysis and justification should be revisited to demonstrate that an adequate margin still exists, and this has not been significantly degraded with time and the assessments will be valid for the period of long-term operation.	A, B, C
A-35	Engineering principles: integrity of metal components and structures: monitoring	Operation	EMC.24	Facility operations should be monitored and recorded to demonstrate compliance with, and to allow review against, the safe operating envelope defined in the safety case (operating rules).	This principle should be part of the BDL substantiation to demonstrate compliance with the safe operating envelope for the period of long-term operation. In addition, historical information on how well the compliance has or has not been met over the life of the facility will support assessment of SSC degradation.	A, C
A-36	Engineering principles: integrity of metal components and structures: analysis	Stress analysis	EMC.32	Stress analysis (including when displacements are the limiting parameter) should be carried out as necessary to support substantiation of the design and should demonstrate the component has an adequate life, taking into account time-dependent degradation processes.	This principle should be part of the BDL substantiation. Original or updated analysis should be revisited to demonstrate the SSC has an adequate life for the period of long-term operation.	A, B

ID	Principle	Sub-Area	SAP ID	SAP Requirements	Notes	Group
A-37	Engineering principles: integrity of metal components and structures: analysis	Use of data	EMC.33	The data used in analyses and acceptance criteria should be clearly conservative, taking account of uncertainties in the data and their contribution to the safety case.	This principle should be part of the BDL substantiation. Original or updated analyses should be revisited to demonstrate that initial conservatism has not been significantly eroded or uncertainties increased with time.	A, C
A-38	Engineering principles: integrity of non-metallic components and structures	Examination through life	ENC.2	The design of non-metallic components or structures should include the ability to examine the item through life for signs of degradation.	This principle should be part of the BDL substantiation to demonstrate that this capability would not be undermined by long-term operation period.	C
A-39	Engineering principles: graphite reactor cores	Safety cases	EGR.1	The safety case should demonstrate that either: (a) the graphite reactor core is free of defects that could impair its safety functions; or (b) the safety functions of the graphite reactor core are tolerant of those defects that might be present.	This principle should be part of the BDL substantiation. Original assessments, analysis and justification should be revisited to demonstrate the safety functions have not been significantly degraded with time and the assessments will be valid for the long-term operation period.	A, C
A-40	Engineering principles: graphite reactor cores: design	Demonstration of tolerance	EGR.2	The design should demonstrate tolerance of graphite reactor core safety functions to: (a) ageing processes; (b) the schedule of design loadings (including combinations of loadings); and (c) potential mechanisms of formation of, and defects caused by, design specification loadings.	This principle should be part of the BDL substantiation. Original assessments, analysis and justification should be revisited to demonstrate the safety functions have not been significantly degraded with time and the assessments will be valid for the long-term operation period.	A, B, C

ID	Principle	Sub-Area	SAP ID	SAP Requirements	Notes	Group
A-41	Engineering principles: graphite reactor cores: design	Monitoring	EGR.3	There should be appropriate monitoring systems to confirm the graphite structures are within their safe operating envelope (operating rules) and will remain so for the duration of the life of the facility.	This principle should be part of the BDL substantiation to demonstrate compliance with the safe operating envelope for the period of long-term operation. In addition, historical information on how well the compliance has or has not been met over the life of the facility will support assessment of degradation.	A, C
A-42	Engineering principles: graphite reactor cores: component and core condition assessment	Materials properties	EGR.7	Analytical models should be developed to enable the prediction of graphite reactor core material properties, displacements, stresses, loads and condition.	The BDL substantiation should evaluate if these models are fit for purpose.	A, B
A-43	Engineering principles: graphite reactor cores: component and core condition assessment	Predictive models	EGR.8	Predictive models should be shown to be valid for the particular application and circumstances by reference to established physical data, experiment or other means.	The BDL substantiation should include validation of the models for the period of long-term operation.	B
A-44	Engineering principles: graphite reactor cores: component and core condition assessment	Materials property data	EGR.9	Extrapolation and interpolation from available materials properties data should be undertaken with care, and data and model validity beyond the limits of current knowledge should be robustly justified.	This principle should be demonstrated as part of the BDL substantiation.	A, B, C
A-45	Engineering principles: graphite reactor cores: defect tolerance assessment	Safe working life	EGR.11	The safe working life of graphite reactor cores should be evaluated.	The BDL substantiation will need to re-evaluate the initial assessments to define a revised safe working life that meets the period of long-term operation.	A, C

ID	Principle	Sub-Area	SAP ID	SAP Requirements	Notes	Group
A-46	Engineering principles: graphite reactor cores: defect tolerance assessment	Operational limits	EGR.12	Operational limits (operating rules) should be established on the degree of graphite brick ageing, including the amounts of cracking, dimensional change and weight loss. To take account of uncertainties in measurement and analysis, there should be an adequate margin between these operational limits and the maximum tolerable amount of any calculated brick ageing.	This principle should be part of the BDL substantiation to demonstrate compliance with the safe operating envelope for the period of long-term operation. In addition, historical information on how well the compliance has or has not been met over the life of the facility will support assessment of SSC degradation.	A, B, C
A-47	Engineering principles: graphite reactor cores: defect tolerance assessment	Use of data	EGR.13	Data used in the analysis should be soundly based and demonstrably conservative. Studies should be undertaken to establish the sensitivity to analysis parameters.	This principle should be part of the BDL substantiation. Original or updated analyses should be revisited to demonstrate that initial conservatism has not been significantly eroded with time.	A, B, C
A-48	Engineering principles: graphite reactor cores: examination, inspection, surveillance, sampling and testing	Extent and frequency	EGR.15	In-service examination, inspection, surveillance and sampling should be of sufficient extent and frequency to give confidence that degradation of graphite reactor cores will be detected well in advance of any defects affecting a safety function.	The BDL substantiation will need to re-evaluate the arrangements to determine what, if any, changes are required to support the period of long-term operation.	A, B
A-49	Engineering principles: control of nuclear matter	Strategies for managing nuclear matter	ENM.1	A strategy (or strategies) should be made and implemented for the management of nuclear matter.	If the life of the facility is extended then the strategy will need to be reviewed, for individual SSC BDL submissions any additional material produced as a result of the extended operation should be identified. The SAP notes that the strategy(ies) should be consistent with Government policy and integrated with other relevant strategies.	A, B

ID	Principle	Sub-Area	SAP ID	SAP Requirements	Notes	Group
A-50	Engineering principles: control of nuclear matter	Provisions for nuclear matter brought onto, or generated on, the site	ENM.2	Nuclear matter should not be generated on the site, or brought onto the site, unless sufficient and suitable arrangements are available for its safe management on the site.	As noted above, for individual SSC BDL submissions any additional material produced as a result of the extended operation should be identified and suitable & sufficient storage should be identified.	A, B
A-51	Radiation protection	Shielding	RP.6	Where shielding has been identified as a means of restricting dose, it should be effective under all normal operation and fault conditions where it provides this safety function.	The SAP notes that the safety case should take into account the possible faults that may arise and changes of radiation types and levels during the lifetime of the facility, including any post-operational period prior to final decommissioning. For individual SSCs this may lead to changes in maintenance practices recognising increase levels, consideration of the total effect operation beyond the original design life has will also need to be considered in the appropriate part of the Safety Case.	A

Appendix B – Review of ONR Technical Guidance

The review of the TAGs & TIGs was undertaken to identify items that have a direct or indirect link to BDL. Table B-1 identifies the TAGs & TIGs determined to be applicable to this review and against each a brief note is provided to demonstrate applicability. The review of TAGs & TIGs identified a number of documents that had the potential to be linked with BDL but were unable to be evaluated during Phase 1 of the task. In general, this was due to the documents being withdrawn pending review, to assist the Table B-1 has been colour coded to identify these as per the table below.

	Document has the potential to be directly or indirectly linked to BDL, but unable to review as document withdrawn at time of assessment.

Table B-1: Review of Technical Assessment Guides & Technical Inspection Guides

ID	Ref No.	Review Date	Title	Summary	Notes	Group
B-01	NS-TAST-GD-002 (Rev 6)	May-19	Radiation Shielding	This document provides guidance to ONR inspectors in respect of the assessment of nuclear licensees' arrangements for radiation shielding as described in outline in ONR Safety Assessment Principle RP.6 and its associated supporting text in paragraphs 602 – 604 of the SAPs. As with all guidance, inspectors should use their judgement and discretion in the depth and scope to which they employ this guidance.	This TAG identifies the potential for changes of radiation types and levels during the lifetime of the facility. In addition, the need for demonstration that the shielding materials are fit for purpose throughout the lifetime of the facility.	SAPs
B-02	NS-TAST-GD-003 (Rev 8)	Mar-21	Safety Systems	Safety Systems represent a central pillar of the 'Defence in Depth' safety philosophy that is insisted upon in UK nuclear plants. The main aim of this philosophy is to avoid situations where an initiating fault can lead directly to an accident with nothing able to prevent it.	Much of the advice contained in the TAG is also reflected in BS EN 61508:2010 - Functional Safety of Electrical / Electronic / Programmable Electronic Safety Related Systems. The scope of that standard is wider than this guide, covering in detail all lifecycle aspects. In general, this TAG notes that potential changes through the lifetime and that provision should be made for controlling changes throughout the life of the SS in a manner that preserves its integrity. The TAG also identifies that a through-life monitoring system should be set up to record all failures and causes of failures affecting SSs.	Through Life Monitoring or Management

ID	Ref No.	Review Date	Title	Summary	Notes	Group
B-03	NS-TAST-GD-005 (Rev 9)	Mar-21	Guidance on the Demonstration of ALARP (As Low As Reasonably Practicable)	This Technical Assessment Guide (TAG) represents specific guidance for ONR inspectors on what they should expect of a nuclear licensee or duty holder in meeting its legal requirement to reduce risks so far as is reasonably practicable (SFAIRP). The concept of SFAIRP is normally expressed in terms of reducing risks to "As Low As Reasonably Practicable" (ALARP).	The lifetime of a facility will be one factor that informs the estimation of risk and the benefits. In addition, remaining lifetime way also for an integral part of the arguments for not implementing reasonably practicable improvements. Changes in lifetime may not only require ALARP to be made for the proposed extensions but may also impact existing arguments within the facility that need to be identified and reviewed.	BDL Substantiation
B-04	NS-TAST-GD-006 (Rev 4)	Withdrawn pending review	Deterministic Safety Analysis and The Use of Engineering Principles in Safety Assessment		Has the potential to include aspects associated with BDL and TLAA or other assessments linked to demonstrating safety beyond the originally designed life of an SSC.	BDL Substantiation
B-05	NS-TAST-GD-009 (Rev 4)	Nov-21	Examination, Inspection, Maintenance and Testing of Items Important to Safety	This TAG directly addresses those ONR SAPs which relate to in-service and throughout facility life EIMT; EMT.1 to EMT.8. It has been written primarily in general terms so that it applies to all engineering disciplines. It should also be noted that EIMT is considered to be an integral part of the operation of a nuclear facility.	The TAG identifies that the reliability of the facility will only be assured through the facility's full lifecycle by a process of maintenance which may include refurbishment or replacement of SSCs. This process is based upon a sound understanding of the facility, the identification of SSCs important to safety, knowledge of the equipment's ageing mechanisms and the support of a programme of Examination, Inspection, Maintenance and Testing (EIMT). Any BDL submission will need to consider EIMT aspects, which may relate to changes to existing EIMT or the inclusion of new items.	SAPs

ID	Ref No.	Review Date	Title	Summary	Notes	Group
B-06	NS-TAST-GD-011 (Rev 2)	Withdrawn pending review	The single failure criterion		Not anticipated to be extensively linked to BDL; however, the impact of ageing & degradation may need to review items previously considered robust do not introduce SPVs with time.	BDL Substantiation
B-07	NS-TAST-GD-013 (Rev 7)	Oct-21	External hazards	This TAG considers the SAPs in relation to EHs in detail and forms the principal interpretation of these principles by ONR.	The assessments need to take into account the projected future life of the facility, in determining the risks and the presented ALARP arguments. BDL assessments should consider continued demonstration of Equipment Qualification (EQ) requirements for hazards.	BDL Substantiation
B-08	NS-TAST-GD-014 (Rev 4)	Sep-19	Internal Hazards	This TAG explains the approach adopted by ONR in its assessment of licensees' safety submissions that relate to internal hazards that could have a detrimental effect on nuclear safety and are described in the SAPs.	BDL assessments should consider continued demonstration of EQ requirements for hazards.	BDL Substantiation
B-09	NS-TAST-GD-015 (Rev 2)	Withdrawn pending review	Electromagnetic compatibility		Not anticipated to have any connection with BDL; however, need to demonstrate no issues arise as a result of ageing & degradation as plant moves into extended operation.	Through Life Monitoring or Management
B-10	NS-TAST-GD-016 (Rev 5)	Mar-20	Integrity of Metal Components and Structures	This TAG provides ONR inspectors with additional guidance and interpretation of SAPs EMC.1 to EMC.34 which are concerned with the integrity of metal structures, systems and components (SSCs).	The TAG largely covers Incredibility of Failure (IoF) components. IoF safety cases are particularly susceptible to BDL considerations because the demonstration is usually time based by virtue of the inclusion of a defect tolerance arguments. It identifies various aspects, including assessments, that consider end of life and would need to be reviewed / updated to support BDL justification.	SAPs

ID	Ref No.	Review Date	Title	Summary	Notes	Group
B-11	NS-TAST-GD-017 (Rev 3)	Withdrawn pending review	Civil Engineering		Although Civil engineering is not included in the scope of what is a mechanical task; however, the interfaces between civil & mechanical SSCs need to be considered. For instance, interface between a building and the rails for a crane.	Through Life Monitoring or Management
B-12	NS-TAST-GD-019 (Rev 3)	Jul-19	Essential Services	The purpose of this TAG is to provide guidance to ONR assessors on the interpretation and application of the relevant SAPs when judging the adequacy of the essential services in a nuclear installation.	The fundamental purpose of essential services is the provision of those services necessary to support safety functions which may be called on to ensure safety on the nuclear installation throughout its lifecycle. Any changes to plant lifetimes will need to ensure essential services are maintained over the extended period, this may either be on a system by system basis or to support individual SSCs.	SAPs
B-13	NS-TAST-GD-020 (Rev 4)	Dec-20	Containment for Reactor Plant	The purpose of this TAG is to provide assessors with guidance on the interpretation and application of the SAPs that relate to civil engineering nuclear containments.	The TAG identifies various aspects, including assessments, that consider end of life. These would all need to be reviewed / updated to support BDL justification.	SAPs
B-14	NS-TAST-GD-022 (Rev 5)	Apr-20	Ventilation	This TAG covers the Principles for Ventilation of the designated radioactive areas within the buildings on nuclear licensed sites, from the point where air is drawn into the building, to where it is discharged to atmosphere after appropriate conditioning, filtration and monitoring.	Any changes to plant lifetimes will need to ensure appropriate ventilation is maintained over the extended period, this may either be on a system by system basis or to support individual SSCs.	Through Life Monitoring or Management

ID	Ref No.	Review Date	Title	Summary	Notes	Group
B-15	NS-TAST-GD-023 (Rev 4)	Aug-19	Control of Processes Involving Nuclear Matter (SAP - ENM.1 to 8)	This Technical Assessment Guide (TAG) provides guidance on ONR's approach to the control of nuclear matter and on the relevant engineering in the SAPs.	The TAG notes that a strategy should exist, to ensure that unwanted material is not generated, and that matter is controlled to prevent harm and to ensure control can be maintained. The strategy will take account of the lifetimes of plant and requirements for control consistent with safety cases. Extended lifetimes will require a review of the strategy to consider, for example, the potential for additional unwanted material or the need for further on-site storage for material generated during this period.	SAPs
B-16	NS-TAST-GD-024 (Rev 5)	Aug-19	Management of radioactive materials and radioactive waste on nuclear licensed sites	The scope of this TAG is the management of nuclear matter, including fissile material and all other radioactive material, which is currently being, or may in the future be, accumulated on nuclear licensed sites. It covers the management of radioactive material and radioactive waste throughout their life cycle from creation, through treatment, accumulation, storage and, finally, disposal or some other long-term solution.	Similar to above.	Through Life Monitoring or Management
B-17	NS-TAST-GD-029 (Rev 4)	Nov-21	Graphite reactor cores	The purpose of this TAG is to provide additional guidance and interpretation; and explain the application of ONR's SAPs, for graphite reactor cores, principally for operating reactors and, to a lesser extent, for reactors during decommissioning.	The TAG identifies various aspects, including assessments, that consider end of life. These would all need to be reviewed / updated to support BDL justification.	SAPs

ID	Ref No.	Review Date	Title	Summary	Notes	Group
B-18	NS-TAST-GD-030 (Rev 5)	Jun-19	Probabilistic Safety Analysis	The purpose of this TAG is to provide an interpretation of those SAPs related to PSA and to provide specific guidance to inspectors engaged in the assessment of PSAs and PSA related submissions (from Licensees, Licence Applicants or Generic Design Assessment (GDA) Requesting Parties. All these are referred to as duty-holders in this TAG).	Can be used to support BDL assessments.	BDL Substantiation
B-19	NS-TAST-GD-031 (Rev 5)	Sep-21	Safety Related Systems & Instrumentation	This TAG provides guidance to aid Inspectors in the interpretation and application of SAPs related to, the assessment of nuclear licensees' safety submissions in the area of Safety Related Systems (SRS) and Safety Related Instrumentation (SRI). The broad class of systems that comprise SRS and SRI are defined and discussed. The close relationship between SRS, SRI and Safety Systems (SS) is explored, and the associated Safety Assessment Principles explained. As for all guidance, inspectors should use their judgment and discretion in the depth and scope to which they apply this guidance.	The TAG identifies various aspects, including assessments, that consider end of life. These would all need to be reviewed / updated to support BDL justification.	SAPs
B-20	NS-TAST-GD-035 (Rev 5)	Aug-21	The Limits and Conditions for Nuclear Plant Safety	This guide provides advice to inspectors on operational safety limits and conditions implemented at nuclear facilities and their relationship with the underlying safety case. It is intended for use during ONR's assessment of safety cases to assist when judging the adequacy of safety case implementation and	The TAG notes that the safety case should identify limitations on the usable lifetime of the equipment and / or its components taking account of prevalent cumulative wear / damage mechanisms. If recorded, then it would support	LC & SAPs

ID	Ref No.	Review Date	Title	Summary	Notes	Group
				for LC23-related compliance inspections. It also provides guidance to aid regulatory decision making in the nuclear Permissioning process when assessment includes consideration of whether limits and conditions applied at or proposed for nuclear facilities have been adequately underpinned in the safety case.	identification of those items that require substantiation beyond the design life.	
B-21	NS-TAST-GD-050 (Rev 6)	Jul-20	Periodic safety reviews (PSRs)	The purpose of this Technical Assessment Guide (TAG) is to: • Provide good practice expectations to assist the Office for Nuclear regulation's (ONR) Inspectors in judging the adequacy of a licensee's arrangements and outputs under Licence Condition (LC) 15, which requires the licensee to periodically review safety cases (see the Licence Condition Handbook). • Add more detailed guidance to the How2 Business Management System Guide Guidance: LC15 Periodic review. Site Inspection and Enforcement.	PSR is a process that will assess ageing & degradation every 10 years (as a minimum) and review these against expected outcomes. It also will review 'current' expectations for plant life that should reflect changes in stated lifetime for individual SSCs. It will also look to compare current arrangements (process, operational, environmental, assessment to support substantiation and EIMT) with updated RGP identified since the previous review. The PSR will also look forward 10 years and may be used to identify SSC that will potentially go beyond the original design life.	LC Related

ID	Ref No.	Review Date	Title	Summary	Notes	Group
B-22	NS-TAST-GD-051 (Rev 4)	Jul-19	The purpose, scope and content of nuclear safety cases	The purpose of this document is to provide ONR inspectors with broad guidance on safety cases. The guide sets out the purpose of nuclear safety cases and expectations on how they are used, their overall qualities, how they may be structured and what information they should contain. Guidance is also provided on common problems with safety cases based on ONR's experience. Safety case shortcomings identified in the Nimrod Review are also set out in the document. The scope covers safety cases for the different phases in the life cycle of facilities, e.g. design, construction, commissioning, operation, decommissioning. Guidance is given to inspectors on the issues that should be addressed in safety cases for the different phases of operation.	This TAG notes that the safety case should demonstrate that the facility will remain safe throughout a defined life-time. To achieve this, a safety case: • Should demonstrate adequate control of radiological hazards before any associated risks actually exist. • Identify the important aspects of operation and management that need to be implemented to maintain safety, including maintenance, inspection and testing regimes and operating limits and conditions. • Detail any constraints that will apply in the facility's life-time. • Should take account of the effects of ageing and degradation on the facility. • Should identify the radioactive waste management arrangements e.g. disposal routes for waste. • Consider the safety case for decommissioning to an adequate extent. • Identify any unresolved issues along with the timescale for their resolution. Any further work, analytical or physical (e.g. inspections) needed to support the through-life safety case should be identified with the timescale for completion.	All

ID	Ref No.	Review Date	Title	Summary	Notes	Group
B-23	NS-TAST-GD-056 (Rev 5)	Oct-21	Nuclear Lifting Operations	This TAG is intended to support ONR's SAPs. Providing guidance on the assessment of safety submissions relating to lifting operations and lifting equipment on or adjacent to nuclear licensed sites. In this guide, "lifting equipment" means work equipment for lifting or lowering loads and includes the attachments used for anchoring, fixing or supporting the load. The integrity of the load affects the safety of the lifting operation and must also be considered.	The TAG notes that the safety case should demonstrate that the integrity of the lifting system SSCs is adequately managed throughout the projected life of the installation and that this should take account of potential ageing and degradation mechanisms. BDL assessment should include any applicable lifting operations and equipment. Knowledge of the applicable design codes is required to understand any inbuilt design margins and the impact on these in operation beyond the original design life.	SAPs
B-24	NS-TAST-GD-057 (Rev 4)	Dec-20	Design Safety Assurance	This TAG discusses ONR's approach to the assessment of design arrangements and processes for nuclear facilities, and how safety is integrated into the design production process. In particular, the design arrangements should demonstrate how integration with procurement, site construction/installation and final commissioning is achieved, leading into operations and associated maintenance and inspection, as well as the safety case development process.	The design process for new facilities or supporting modifications to existing facilities need to consider aspects of BDL. For a new facility, considerations include ensuring there is sufficient margin to support extended life, or robust EIMTs in place to make informed decisions around operating beyond the original design intent. While the design should reflect the lifetime expectations within the design process, some recognition the operation beyond the original design intent may occur may be needed and the impact this may have on decommissioning. For modifications then identification of interfaces with SSCs already beyond the original design life will be important to the overall justification.	Through Life Monitoring or Management

ID	Ref No.	Review Date	Title	Summary	Notes	Group
B-25	NS-TAST-GD-094 (Rev 0)	Nov-18	Categorisation of Safety Functions and Classification of Structures, Systems and Components	The purpose of this TAG is to provide advice to ONR inspectors on the expectations of the licensee's arrangements for identifying and categorising safety functions and classifying the SSCs that deliver them. Guidance is provided on the factors which ought to be considered in each stage of this process and relevant good practice (RGP) for the categorisation and classification methodology used.	The TAG notes that the provision of properly defined safety functions and SSCs are fundamental for the development of robust safety cases and well-engineered protective measures for all of the possible states in the lifecycle of a facility. This will also be included extended operation and BDL submissions. As certain SSCs age and degrade then greater importance may be placed on other SSCs to mitigate the consequence of failures. As such the Cat & Class of some SSCs may need to be reviewed to mitigate the consequences of failures in other degraded SSCs.	Through Life Monitoring or Management

ID	Ref No.	Review Date	Title	Summary	Notes	Group
B-26	NS-TAST-GD-098 (Rev 0)	Oct-19	Asset Management	Asset management has been identified by ONR as a key strategic factor to the safe and secure management of the UK's new and existing nuclear infrastructure. ONR considers Asset Management to be important for duty-holders in order to effectively manage all facilities on a nuclear licensed site that have the ability to result in significant consequences. ONR understands the need to support UK duty-holders in applying asset management effectively. This guide sets out what ONR considers relevant good practice (RGP) taken from national and international guidance. This guidance may be used for assessment of activities and safety submissions such as: periodic reviews of safety cases, construction or installation of new plant, modification or experiment on existing plant or changes to examination, inspection, maintenance and testing.	Asset management requirements need to be met throughout the lifetime of the SSC, including any potential extended period of operation. The asset management process should also change and adapt to support operation of SSCs beyond the original design life to ensure safety is maintained. It should also be noted that other than SAPs EAD.5, this is one of the few guidance documents (if not the only one) that identifies obsolescence as a consideration. This issue will need some consideration as part of any submission for BDL.	Through Life Monitoring or Management
B-27	NS-TAST-GD-067 (Rev 1)	Nov-20	Pressure Systems Safety	The purpose of this TAG is to expand on the SAPs by identifying legal requirements and sources of relevant good practice to assist and inform ONR Inspectors tasked with assessing compliance arrangements for pressure systems.	The TAG notes that inspectors should ensure that the duty holder has systems in place for through life management of plant such that procedures will be in place as the plant ages. This will also cover extended operation and BDL elements.	SAPs

ID	Ref No.	Review Date	Title	Summary	Notes	Group
B-28	NS-TAST-GD-103 (Rev 0)	Feb-22	Emergency Power Generation	The purpose of this TAG is to provide guidance to assist ONR inspectors in the assessment of Emergency Power Generation systems (EPGS). An EPGS comprises of the prime mover, generator together with its auxiliaries up to the generator terminals, and the electrical equipment that enables installation of a generator(s), as necessary, to the plant and its structures, systems and components (SSCs). The guidance in this TAG is also applicable to mobile generators. The adequacy of the transport, connection and re-fuelling provisions should also be considered.	The TAG identifies that the operating life of a nuclear facility may exceed the normal life expectancy of an EPGS or the time period that an OEM is willing to provide technical support and replacement parts. The licensee should have an appropriate strategy in place to manage ageing and obsolescence. As part of LTO and BDL assessments EPGS requirements need to be considered for extended operation and beyond. The strategy to extend the operational life of the facility should include the EPGS and include a strategy ensure that the safety function is not undermined.	Through Life Monitoring or Management
B-29	NS-INSP-GD-014 (Rev 3)	May-19	Licence Condition 14 - Safety documentation	This guide has been prepared to facilitate a consistent approach to Licence Condition (LC) 14 compliance inspections and to provide assistance to inspectors carrying out interactions with licensees on safety cases. The guide is focused on the whole process to deliver fit for purpose, 'right first time' safety cases. Guidance on the purpose, scope and content of safety cases is provided in NS-TAST-GD-051.	Safety Documentation requirements will not change in BDL and in certain areas may become more onerous to demonstrate the extended operation is ALARP.	LC Related

ID	Ref No.	Review Date	Title	Summary	Notes	Group
B-30	NS-INSP-GD-015 (Rev 3)	Apr-19	Licence Condition 15 - Periodic review	The purpose of this guidance is to facilitate a consistent approach to LC15 compliance inspection and to provide assistance to inspectors while carrying out their duties in this area. The guidance should not be regarded as either comprehensive or mandatory. There is also technical assessment guidance available for periodic safety reviews, which should also be consulted; this is available via How2 as NS-TAST-GD-050.	See NS-TAST-GD-050 (Rev 6) above.	LC Related
B-31	NS-INSP-GD-022 (Rev 4)	Jan-21	Licence Condition 22 - Modification or experiment on existing plant	The purpose of this guidance is to promote a consistent approach to Licence Condition 22 (LC22) compliance inspection and to provide guidance to inspectors in carrying out their duties in this area. It is intended to assist inspectors in making informed judgements and decisions on the adequacy of the licensee's arrangements and their implementation, to ensure that hazards and risks associated with activities involving modifications or experiments on existing plant or process are adequately controlled.	Extended operation that results in SSCs continuing to operate beyond the original design life would be considered a modification to existing plant. The modification proposals will vary in complexity depending of the SSC and purpose of the submission. This may range from demonstration that actual operating demands (hours or cycles) for an SSC are below the original design limits to demonstrating safety requirements will still achieved beyond the original design life. These modifications will include cases where the operating demands approach the limits originally specified in the original design and there is an expectation they will be exceeded in the future for some reason.	LC Related

ID	Ref No.	Review Date	Title	Summary	Notes	Group
B-32	NS-INSP-GD-023 (Rev 4)	Mar-19	Licence Condition 23: Operating rules	This guide has been prepared to facilitate a sound basis and consistent approach to Licence Condition (LC) 23 compliance inspections and to provide guidance to inspectors whilst inspecting licensees' arrangements in this area. The guide is complementary to NS-TAST-GD-035, which gives guidance concerning the identification and derivation of limits and conditions from safety cases, as required by LC23.	See NS-TAST-GD-035 (Rev 5) above.	LC Related
B-33	NS-INSP-GD-028 (Rev 5)	Jul-19	Licence Condition 28 - examination, inspection maintenance and testing (EIMT)	The purpose of this guidance is to promote a consistent approach to Licence Condition 28 (LC28) compliance inspection and to provide guidance to inspectors in carrying out their duties in this area. The guidance should not be regarded as either comprehensive or mandatory. The guidance provided is divided into 4 main elements: 1) Purpose of the Licence Condition. 2) Guidance on arrangements for LC28. 3) Guidance on inspection of arrangements. 4) Guidance on inspection of implementation of arrangements.	See NS-TAST-GD-009 (Rev 4) above.	LC Related

ID	Ref No.	Review Date	Title	Summary	Notes	Group
B-34	NS-INSP-GD-029 (Rev 4)	Oct-21	Licence Condition 29 - Duty to carry out tests, inspections and examinations	The purpose of this guide is to facilitate a consistent approach to LC29 inspection and both clarify and provide advice to inspectors while carrying out their duties in this area. The guidance is in two parts: 1) Purpose of the Licence Condition 2) Guidance on LC29 inspection.	Similar to above.	LC Related
B-35	NS-INSP-GD-030 (Rev 3)	Dec-21	Licence Condition 30 - Periodic Shutdown	The purpose of this guidance is to facilitate a consistent approach to LC 30 compliance inspection and to provide assistance to inspectors while carrying out their duties in this area. The guidance should not be regarded as either comprehensive or mandatory. The guidance provided is split into four main elements: 1) purpose of the licence condition; 2) guidance on arrangements for LC 30; 3) guidance on inspection of arrangements; and 4) guidance on inspection of implementation of arrangements.	This condition also notes that the licensee shall, if so specified by ONR, ensure that when a plant or process is shut down it shall not be started up again thereafter without the consent of ONR. When significant items are approaching BDL there should be sufficient confidence the SSC will fulfil its safety functions for consent to be given.	LC Related
B-36	NS-INSP-GD-032 (Rev 4)	Jul-19	Licence Condition 32 - Accumulation of Radioactive Waste	This Technical Inspection Guide (TIG) has 3 main purposes: • To assist inspectors in carrying out their duties relating to Licence Condition 32 (LC32);	This TIG covers various aspects associated with Radioactive Waste; however, there are specific elements that have relevance to BDL Submissions. The TIG notes that new processes or modifications (which would include operating beyond the original design life) should be so designed and controlled that they do not give rise to any unnecessary radioactive waste and	LC Related

ID	Ref No.	Review Date	Title	Summary	Notes	Group
				• To facilitate a consistent approach to LC32 Compliance Inspection, benchmarked against IAEA safety standards; • To identify further sources of guidance that inspectors may choose to reference prior to inspecting particular aspects of a licensee's arrangements for complying with LC32.	that they do not unnecessarily give rise to radioactive waste for which no feasible disposal route currently exists. In addition, the TIG identifies areas relating to decommissioning and BDL substantiation should include the impact operation BDL will have.	

Appendix C – Identified Relevant Good Practice

Searches were undertaken to identify documents and RGP that had potential a direct or indirect links to BDL. Table C-1 identifies the various documents identified and includes some notes on the relevance. To further assist the table has been colour coded as per the table below.

	1. Considered not relevant to this task and will not be assessed further.
	2. Document includes information relevant to this task that should be reviewed as part of future phases.
	3. Includes information relating to Ageing & Degradation and can potentially be used for task ONR376.
	4. Similar to 2 above but represents information from other high-hazard industries.

Table C-1: Identified Documents & RGP

ID	Source	Ref No.	RGP Title	RGP Summary	Notes
C-001	ACI	ACI 349.3R-18	Report on Evaluation and Repair of Existing Nuclear Safety-Related Concrete Structures	This report provides recommendations for the evaluation of existing nuclear safety-related concrete structures. The purpose of this report is to provide the owner, owner's engineering staff, consultants, and others with an appropriate procedure and background for examining concrete structural performance and taking appropriate actions based on observed conditions. Methods of examination, including visual inspection and testing techniques and their recommended applications, are cited. Guidance related to acceptance criteria for various forms of degradation and methods for repair are provided.	Document to be reviewed as part of future stages of the overall task.
C-002	AREVA	PESS-G/2010/en/0041	Ageing Management Review - Methodology Report	The Ageing Management Review is part of the LTO Process outlined in IAEA NS-G-2.12. This step of the LTO Review Process involves evaluation to demonstrate that the effects of ageing on in-scope structures and components will be adequately managed so that the intended function(s) will be maintained consistent with the NPP licensing basis for the designated period of extended operation. This process involves the performance of a detailed technical evaluation of structures and components determined to be in-scope. The purpose of this document is to outline the general scope and methodology to perform the Ageing Management Reviews for Mechanical, Electrical and C&I as well as SSCs.	AMR support LTO submission, which is not applicable to the UK. AMRs identified in Figure 2.

ID	Source	Ref No.	RGP Title	RGP Summary	Notes
C-003	ASME	N/A	16th International Conference on Nuclear Engineering	Various Conference Papers relating to Plant Ops, Maintenance, Life Cycle, Etc.	Includes generic aspects, or even specific elements for specific SSCs, that are also applicable to Ageing & Degradation SAPs (EA.1 to EA.5) and would support ONR376 list of RGP. ASME docs so will potentially need to be purchased or access via technical library. The effort to search through the various documents to identify aspects of valuable to the task is questionable. SSC specific OpEx or presentation of new or emerging maintenance processes may have value for individual BDL submissions, but for this task the value may be limited.
C-004	ASME	OMAE2008-57451	Assessment of Offshore Structures for Life Extension	Taken from the Proceedings of the ASME 27th International Conference on Offshore Mechanics and Arctic Engineering. This paper discusses aspects of ageing that may reduce safety of offshore facilities, maintenance needs for ageing facilities, and propose general principles of assessment of ageing facilities for life extension. The paper is a summary of the research performed by and for the Petroleum Safety Authority - Norway.	The paper from Petroleum Safety Authority - Norway provides an overview of research on ageing and life extension, many of the individual reports and papers that feed this summary are listed elsewhere in this table. As this provides an overview there is some value in reviewing this document to determine if any learning can be applied to this task or ONR376. Information may be a summary of the detailed work undertaken by PSA-Norway, which is presented further on in the table (starting A-108).
C-005	British Standards	IEC 62402:2007	Obsolescence management — Application guide	This International Standard gives guidance for establishing a framework for obsolescence management and for planning a cost-effective obsolescence management process that is applicable through all phases of the product life cycle, the term 'product' includes: • capital equipment; • infrastructure; • consumer durables; • consumables; • software products. Obsolescence management covers the following areas: a) design of new products; b) new technology insertion into existing products; c) support and maintenance of legacy products.	The focus on obsolescence is probably more of a consideration to ONR376 (specifically EAD.5). However, there maybe some insight that is applicable to the BDL expectations. For instance, if or how obsolescence is managed for extended operation or for specific SSCs is operation beyond the original design life required because of an obsolescence problem.

ID	Source	Ref No.	RGP Title	RGP Summary	Notes
C-006	British Standards	IEC 62342:2007	Nuclear power plants – Instrumentation and control systems important to safety – Management of ageing	With the majority of NPPs over 20 years old, the management of the ageing of instrumentation is currently a relevant topic, especially for those plants that have extended their operating licences or are considering this option. This standard is intended to be used by operators of NPPs (utilities), systems evaluators, and by licensors. It is important to note that this standard establishes no additional functional requirements for safety systems. Ageing mechanism has to be prevented and thus detected by performance measurements. Aspects for which special recommendations have been provided in this Standard are: • criteria for evaluation of ageing of I&C equipment in NPPs; • steps to be followed to establish an ageing management program for NPP I&C equipment; • tracking of performance indices such as response time and calibration stability as the means to manage the ageing of sensors and transmitters.	The focus on this document is probably more of a consideration to ONR376, which focuses on ageing and degradation. However, there maybe some insight that is applicable to the BDL expectations.
C-007	CNSC	N/A	Canadian Regulatory Oversight of Ageing Management for Nuclear Power Plants	This paper provides an update on Canadian Nuclear Safety Commission (CNSC) staff perspectives on managing the safety aspects of ageing of structures, systems, and components (SSC) of nuclear power plants (NPP). Managing the safety aspects of NPP ageing requires a proactive, systematic, and integrated ageing management approach for the coordination of all activities relating to the understanding, control, monitoring, and mitigation of ageing degradation of SSC through the lifecycle of an NPP. A CNSC regulatory document on ageing management based on modern international guidelines is described.	The presentation identified below is dated June 2016 it is assumed this paper supports the presentation and was produced around this time. Document to be reviewed as an overview of Canadian Regulator view on the topic.

ID	Source	Ref No.	RGP Title	RGP Summary	Notes
C-008	CNSC	e-Doc 5008579	Canadian Regulatory Oversight of Ageing Management for Nuclear Power Plants	Technical and Regulatory Issues Facing Nuclear Power Plants: Leveraging Global Experience	At the time the presentation was made key challenges identified as: - Fitness for service of aging components - Refurbishment projects - Fukushima action items - Regulatory effectiveness and transparency - Public awareness and acceptance Presentation to be reviewed as an overview of Canadian Regulator view on the topic. Review to be performed with the conference paper noted above.
C-009	CNSC	REGDOC-2.3.3	Periodic Safety Reviews	Regulatory document REGDOC-2.3.3, Periodic Safety Reviews, sets out the CNSC's requirements for the conduct of a periodic safety review (PSR) for a nuclear power plant (NPP). It is consistent with the IAEA SSG-25, (Periodic Safety Review for Nuclear Power Plants). In addition, REGDOC-2.3.3 supersedes RD-360, Life Extension of Nuclear Power Plants. A PSR involves an assessment of the current state of the plant and its performance to determine the extent to which it conforms to applicable modern codes, standards and practices, and to identify any factors that would limit safe long-term operation.	Document aligned with SSG-25, while this document will not be assessed further it is interesting that this is identified as superseding RD-360.

ID	Source	Ref No.	RGP Title	RGP Summary	Notes
C-010	CNSC	REGDOC-2.6.3	Fitness for Service: Aging Management	REGDOC-2.6.3, Aging Management, sets out the requirements of the CNSC for managing aging of structures, systems and components (SSCs) of a power reactor facility. It also provides guidance as to how these requirements may be met. Aging management is the set of engineering, operational, inspection and maintenance actions that control, within acceptable limits, the effects of physical aging and obsolescence of SSCs that occur over time or with use. An aging management program or plan is a set of policies, processes, procedures, arrangements and activities for managing the aging of SSCs of a reactor facility. Effective aging management ensures that required safety functions are reliable and available throughout the service life of the facility, in accordance with the licensing basis.	This document notes that it is consistent with the philosophy and technical content of modern codes and standards. In particular, this regulatory document was based in part on the following international publications: - Ageing Management for Nuclear Power Plants, Safety Guide NS-G-2.12 from the International Atomic Energy Agency (IAEA) - Safe Long Term Operation of Nuclear Power Plants, Safety Report Series No. 57, from the IAEA - Glossary of Nuclear Power Plant Ageing from the Organisation for Economic Cooperation and Development (OECD), Nuclear Energy Agency It essentially uses these documents and looks to incorporate them into Canadian Regulations, with added information largely focussed on local technology (CANDU's in the main). Based on a high-level review this document does not appear to offer anything significantly different to SSG-48 and will not be considered further.
C-011	CSA	N287.8-15	Aging management for concrete containment structures for nuclear power plants	The purpose of this Canadian Standards Agency (CSA) document is to provide aging management requirements to ensure that concrete containment structures satisfy their functional and performance requirements in all different phases of their life cycle and to ensure that for new concrete containment structures, aging is addressed during design and construction phases.	While this document is focused on containment and concrete structures there may be some cross over with mechanical aspects of the structures and the interfaces between them. However, this document may be more applicable to ONR376 and the review of Ageing & Degradation SAPs.
C-012	EPRI	TR-106109	Nuclear Plant Life Cycle Management Implementation Guide	The objective of this document is to provide background information and guidance to those NPPs beginning to implement dedicated LCM plant programmes and to others desiring to improve existing LCM programmes.	Document issued in 1998 to align with LCM aspects of the INPO AP-913 ER Process. While this document might have limited value to either task, given that it relates to a key part of the ER Process there might be some merit in doing a lighter review of the document.

ID	Source	Ref No.	RGP Title	RGP Summary	Notes
C-013	EPRI	TR-1001413	Safety System Obsolescence and Maintainability	The nuclear power industry is currently facing increasing obsolescence issues with original instrumentation and control (I&C) equipment, particularly in safety system applications. These systems, often more than thirty years old, are based on analogue technology, relays, and other discrete components, which are becoming difficult to maintain and replace with like equipment. This report helps utilities understand their options and choose the most cost-effective strategies for maintaining and replacing obsolete equipment in safety-related applications, where both technical and regulatory issues come into play. The objectives of the document are: • To develop an obsolescence and maintainability program approach. • To test the approach on CE plant reactor protection (RPS) and plant protection systems (PPS).	The focus on obsolescence is probably more of a consideration to ONR376 (specifically EAD.5). However, there maybe some insight that is applicable to the BDL expectations. For instance, if or how obsolescence is managed for extended operation or for specific SSCs is operation beyond the original design life required because of an obsolescence problem.
C-014	EPRI	TR-1007933	Aging Assessment Field Guide	Aging-related degradation continues to cause equipment reliability problems in nuclear power plants. Effective strategies to address aging issues are not consistently applied. There are two major obstacles to forming an effective aging management strategy: 1) plant personnel lack the ability to identify leading indicators of aging degradation and 2) there is a lack of simple methodologies to support plant staff's application of this knowledge. This field guide provides plant engineers with a pocket reference to carry with them into the plant during a system walkdown.	The focus on this document is probably more of a consideration to ONR376, which focuses on ageing and degradation. However, there maybe some insight that is applicable to the BDL expectations.

ID	Source	Ref No.	RGP Title	RGP Summary	Notes
C-015	EPRI	TR-1009743	Aging Identification and Assessment Checklist (Mechanical Components)	Aging-related degradation continues to cause equipment reliability problems in nuclear power plants, in part because effective strategies to address aging issues are not consistently applied. Two major obstacles to forming an effective aging management strategy are a lack of understanding by plant personnel of the leading indicators of aging degradation and a lack of simple methodologies to support plant staff's application of this knowledge. This report contains component-level checklists that present likely visible indicators of aging degradation, the degradation mechanisms likely to be occurring, and the potential ramifications of such degradation. The following components are covered in this report: pumps and compressors, valves, piping and piping supports, and tanks and pressure vessels.	The focus on this document is probably more of a consideration to ONR376, which focuses on ageing and degradation. However, there maybe some insight that is applicable to the BDL expectations.
C-016	EPRI	TR-1011223	Aging Identification and Assessment Checklist (Electrical Components)	Aging-related degradation continues to cause equipment reliability problems in nuclear power plants, in part because effective strategies to address aging issues are not consistently applied. Two major obstacles to forming an effective aging management strategy are a lack of understanding by plant personnel of the leading indicators of aging degradation and a lack of simple methodologies to support plant staff application of this knowledge. This report contains component-level checklists that present likely visible indicators of aging degradation, the degradation mechanisms likely to be occurring, and the potential ramifications of such degradation. The following components are covered in this report: Cables, conduits, cable trays, buses, terminations, and splices, Transformers, Motors and generators, Breakers and switches	The focus on this document is probably more of a consideration to ONR376, which focuses on ageing and degradation. However, there maybe some insight that is applicable to the BDL expectations.

ID	Source	Ref No.	RGP Title	RGP Summary	Notes
C-017	EPRI	TR-1011223	Aging Identification and Assessment Checklist (Civil and Structural Components)	Aging-related degradation continues to cause equipment reliability problems in nuclear power plants, in part because effective strategies to address aging issues are not consistently applied. Two major obstacles to forming an effective aging management strategy are a lack of understanding by plant personnel of the leading indicators of aging degradation and a lack of simple methodologies to support plant staff application of this knowledge. This report contains component-level checklists that present likely visible indicators of aging degradation, the degradation mechanisms likely to be occurring, and the potential ramifications of such degradation. The following components are covered in this report: Concrete structures and supports, Steel structures	The focus on this document is probably more of a consideration to ONR376, which focuses on ageing and degradation. However, there maybe some insight that is applicable to the BDL expectations.
C-018	EPRI	TR-1016692	Plant Support Engineering: Obsolescence Management Program Ownership and Development	This report describes the results of research conducted as part of EPRI Plant Support Engineering's Obsolescence Initiative. The objective of the initiative is to develop methodologies that can be used to minimize the impact that obsolescence has on plant production and cost. This report discusses plant organizations that should be involved in a comprehensive obsolescence management program, and the role(s) each organization plays in ensuring the effectiveness of the program. It also discusses considerations for developing and implementing an obsolescence management program. In addition, the report emphasizes that although identification of the population of obsolete items is a good starting point, the key to an effective obsolescence management program lies in the ability to effectively identify and prioritize known obsolescence issues. Although one plant organization may own the obsolescence management program, successful prioritization involves input to and from several plant organizations, including the engineering, maintenance, and supply chain organizations.	The focus on obsolescence is probably more of a consideration to ONR376 (specifically EAD.5). However, there maybe some insight that is applicable to the BDL expectations. For instance, if or how obsolescence is managed for extended operation or for specific SSCs is operation beyond the original design life required because of an obsolescence problem.

ID	Source	Ref No.	RGP Title	RGP Summary	Notes
C-019	EPRI	TR-1019161	Plant Support Engineering: Proactive Obsolescence Management Program Implementation and Lessons Learned	This report provides additional insight to the basic process developed in TR-1016692 for managing the impact of obsolescence	As above for TR-1016692
C-020	ENSREG	HLG_p(2016-33)_345	ENSREG Stakeholder Engagement Plan - Topical Peer Review on Ageing Management of Nuclear Power Plants	For the ENSREG Members there is a great deal of public interest in the "National Assessment Reports", their outcome and follow up and therefore it is important that the communication regarding the process and its outcome enhances public understanding of the nuclear safety regime and the role of the regulatory authorities. This stakeholder engagement plan identifies activities to strengthen engagement with all stakeholders including the public, industry and governments.	Engagement plan for Peer Reviews, not relevant to this this task.
C-021	ENSREG	HLG_p(2016-33)_348	Topical Peer Review 2017 Ageing Management of Nuclear Power Plants - Terms of Reference for Topical Peer Review Process	This paper provides the terms of reference for the peer review of national assessment reports on the topic of ageing management of nuclear power plants, prepared in accordance with article 8e (2) of the 2014 Nuclear Safety Directive.	ToR for Peer Reviews, not relevant to this task. The individual reports from member countries may provide some insight, but as they focus on Ageing Management significant effort may be needed to go through all of them to identify BDL information.
C-022	Eskom	N/A	Koeberg Nuclear Power Station: Plant Life Extension and Ageing Management 1st NNR Regulatory Information Conference – Pretoria, Centurion	The presentation provides an overview of the plant outline areas to be considered for extending the plant, including: 1. Updates to the design 2. Ageing Management	Presentation outlines the SA approach to LTO, including: - Replacement programme for significant (NS & Cost) SSCs; - Development of AM programmes - Proposed plan for LTO documentation Presentation consistent with Figure 2 and not applicable to UK licencing model.

ID	Source	Ref No.	RGP Title	RGP Summary	Notes
C-023	EU	EUR 22483 EN - 2007	Models and data used for assessing the ageing of systems, structures and components (European Network on Use of Probabilistic Safety Assessment (PSA) for Evaluation of Ageing Effects to the Safety of Energy Facilities)	This report summarizes and presents the results of the studies conducted in the frame of European Network on Use of Probabilistic Safety Assessment (PSA) for Evaluation of Ageing Effects to the Safety of Energy Facilities (EC JRC IE Ageing PSA Network). The Network was initiated and will be operated within the framework of the JRC FP-6/7 Institutional Action "Analysis and Management of Nuclear Accidents" (AMA). Report is focussed on the reliability models and data that could be used for assessing the ageing of systems, structures and components including statistical and physical ones.	This document contains detailed information that may provide an approach around using PSA to support BDL decisions and submissions. The use of PSA may help provide some additional information that support evidence around predicted condition over the extended lifetime of the SSC, in conjunction with other analyses.
C-024	EU	EUR 25142 EN - 2011	Operation of Ageing Reactors: Approaches and associated Research in the European Union	This report aims to provide overview of approaches proposed or followed in the USA and in EU countries when longer term operability (LTO) is considered as part of PLiM. A special attention is given to discussing existing regulatory framework available, as well as requirements set for ageing reactors in the corresponding IAEA safety reports and safety guides. A comparison of the US Licence Renewal Rule and Periodic Safety Review as a tool for assessment of Structure, Systems and Components (SSC) for PLiM and LTO is provided too. This report was prepared before the Fukushima Daiichi event. Lessons need to be learned from the event that will have impact on the methodologies traditionally used in the safety evaluation of aged nuclear power plants, not captured.	Overview of regulatory approach to extended periods ,periods, focussing on license renewal and the vehicle to enable this (i.e. PSR or Station-Wide LTO submission). Limited value for this task or ONR376; however, elements of LTO Submission may have some relevance to requirements for BDL substantiation.

ID	Source	Ref No.	RGP Title	RGP Summary	Notes
C-025	HAEA	Guideline 1.28	Regulatory procedures of operation beyond design lifetime	This Guideline describes the regulatory procedures related to operation beyond the design lifetime of a nuclear power plant unit, and formulates recommendations on preparation of the programme and the license application required by Section 20 of Govt. Decree 118/2011 (VII.11.) Korm. The objectives of the Guideline are to make the regulatory expectations unambiguous by the recommendations included, and to facilitate the supervision of compliance with the nuclear safety criteria during legally required procedures.	The document outlines the items to be included in an LTO Submission, which is a single submission for the station as a whole (covering all nuclear safety significant SSC), which is not applicable to the current UK licencing arrangements Limited value for this task or ONR376; however, elements of LTO Submission may have some relevance to requirements for BDL substantiation.
C-026	HSE	2001/088	Beyond lifetime criteria for offshore cranes	The offshore oil and gas industry has been operating in the North Sea for the past 30 years, with the consequence that many of the early platforms are approaching the end of their design life. However, the economics of the offshore industry are such that there is a drive by Duty Holder's to maximise their assets by extending their use. This report presents a review of current regulatory requirements and best practice to enable checklists to be produced to assist HSE (OSD) inspectors when reviewing/auditing a duty holder's safety case justifying the continued operation of a pedestal crane once it has gone beyond its design life.	Includes generic aspects, or even specific elements, that are also applicable to Ageing & Degradation SAPs (EA.1 to EA.5). In addition, would be considered as part of the benchmarking exercise against other high hazard industries. Both of these would mean this RGP would also support ONR376 task.

ID	Source	Ref No.	RGP Title	RGP Summary	Notes
C-027	HSE	EEMUA Publication 231 (Ed 1)	The mechanical integrity of plant containing hazardous substances A guide to periodic examination and testing	This document has been developed and written by the Safety Assessment Federation (SAFed) and the Engineering Equipment & Materials Users' Association (EEMUA) in consultation with the Health and Safety Executive's Hazardous Installations Directorate, together with other interested stakeholders who use such plant, including operators, inspection bodies (including 'competent persons') and providers of specialist services to the process. The Health and Safety Executive (HSE) considers maintenance of the integrity of plant containing hazardous substances to be a fundamental element of good process safety management. To this end, we believe this document provides a sound basis from which to develop arrangements for the management and delivery of periodic examinations aimed at achieving this. The guidance contained within this document should not be regarded as an authoritative interpretation of the law, but if you follow the advice set out in it, you will normally be doing enough to comply with health and safety law in respect of those specific issues on which the guidance gives advice.	The document from HSE covers other (on-shore) high-hazard industries and the document includes a section on an overview of integrity management throughout the plant lifecycle. As such there is some value in reviewing this document to determine if any learning can be applied to this task or ONR376.
C-028	HSE	HS073 ISBN: 1 903 003 816	Guidance on the Management of Ageing and Life Extension for UKCS Oil and Gas Installations	This guidance document outlines guidance for the management of ALE for UKCS Oil and Gas Installations	The document from HSE covers (off-shore) Oil and Gas Installations on the subject of Ageing & Life Extension (ALE) and as such there is some value in reviewing this document to determine if any learning can be applied to this task or ONR376.

ID	Source	Ref No.	RGP Title	RGP Summary	Notes
C-029	HSE	Key Programme 4 (KP4)	Ageing and life extension programme A report by the Energy Division of HSE's Hazardous Installations Directorate	This report communicates the results and recommendations of the Ageing and Life Extension Key Programme (KP4) carried out between 2011 and 2013 by the Health and Safety Executive's Energy Division. This is a report of the inspection findings of the Health and Safety Executive's (HSE's) Energy Division's (ED's) Key Programme 4 (KP4) covering the ageing and life extension (ALE) challenges facing hydrocarbon exploration and production installations on the UK's Continental Shelf (UKCS). The programme investigated the impact of ALE on the risk of major accidents involving the death or serious personal injury to people on an offshore installation.	The document from HSE covers (off-shore) Oil and Gas Installations on the subject of Ageing & Life Extension (ALE) and as such there is some value in reviewing this document to determine if any learning can be applied to this task or ONR376.
C-030	HSE	Offshore Information Sheet 4/2009	Guidance on management of ageing and thorough reviews of ageing installations	This information sheet provides guidance for asset managers, safety managers and safety engineers in the offshore industry on taking account of ageing of the installation during thorough review, which is required by the Offshore Installations (Safety Case) Regulations 2005 (SCR05).	The information sheet from HSE provides guidance to the off-shore industry on the subject of Ageing & Life Extension (ALE) and as such there is some value in reviewing this document to determine if any learning can be applied to this task or ONR376.
C-031	HSE	CRR 363/2001	Best practice for risk based inspection as a part of plant integrity management	This report discusses the best practice for the application of Risk Based Inspection (RBI) as part of plant integrity management, and its inspection strategy for the inspection of pressure equipment and systems that are subject to the requirements for in-service examination under the Pressure Systems Safety Regulations 2000 (PSSR). It can also apply to equipment and systems containing hazardous materials that are inspected as a means to comply with the Control of Major Accident Hazards Regulations (COMAH). One of the main themes of the report is the amount of information that is known about an item of equipment and conversely the identification of where there is a lack of information, which may make the RBI invalid. The report considers the application, data requirements, team competences, inspection plan (including NDT techniques and reliability) and overall management of the RBI process.	The research report from the HSE notes that risk changes with time either because the equipment or plant conditions physically alter, or because new information becomes available. The report highlights the importance of feedback and the re-assessment of risk during plant life. There is value in reviewing this document in more detail to see if there is learning from other high-hazard industries that can be applied to this task or ONR376.

ID	Source	Ref No.	RGP Title	RGP Summary	Notes
C-032	HSE	RR509	Plant ageing - Management of equipment containing hazardous fluids or pressure	The purpose of this report is to increase awareness of the factors to consider when managing equipment containing hazardous fluids or pressure, and to help those responsible for equipment to understand and assess the risks of accumulated damage and deterioration. The information is at a general rather than an equipment-specific level, and can be applied to a wide range of static equipment and associated machinery.	There is value in reviewing this document in more detail to see if there is learning from other high-hazard industries that can be applied to this task or ONR376.
C-033	HSE	RR823	Plant Ageing Study - Phase 1 Report	The HSE have commissioned this study with the objectives to: · Identify whether or not ageing is an issue contributing to plant HSE performance. · Determine which types of assets are affected and in what way. · Define “ageing” in general terms and, if appropriate, for specific asset types. · Establish ways in which HSE inspectors can identify ageing issues on sites. · Identify risks associated with plant ageing. · Identify best practices in management of ageing issues. · Understand any differences in plant ageing that may exist in different locations throughout the UK. · Develop a Delivery Guide on Plant Ageing for use by HSE Inspectors.	There is value in reviewing this document in more detail to see if there is learning from other high-hazard industries that can be applied to this task or ONR376.
C-034	HSE	RR912	Management of ageing - A framework for nuclear chemical facilities	The report focuses on the competencies and processes required to proactively managing ageing in nuclear chemical facilities. Rather than being a prescriptive set of rules this report is intended as a hands-on resource, describing what is required to effectively manage ageing within the wider context of asset management.	There is value in reviewing this document in more detail to see if there is learning from other high-hazard industries that can be applied to this task or ONR376.

ID	Source	Ref No.	RGP Title	RGP Summary	Notes
C-035	HSE	RR1075	Benefits of data management and data trending in the UK Continental Shelf oil and gas industry	To improve the management of risks associated with ageing and life extension (ALE) of the oil and gas infrastructure on the UK Continental Shelf, HSE launched the 'Key Programme 4' (KP4) of targeted inspections in 2010. Two key findings were that industry could make better use of data trending and had not identified leading key performance indicators (KPIs) suitable to support ALE decision making. This report describes research to identify the barriers to the take-up of data trending to support ALE decision making, in order to identify issues that industry could address.	There is value in reviewing this document in more detail to see if there is learning from other high-hazard industries that can be applied to this task or ONR376.
C-036	HSE		Managing Ageing Plant A Summary Guide	This report, being published to augment the existing RR509, provides an overview of ageing plant mechanisms and their management and presents the findings of an analysis of loss of containment events to indicate the extent to which ageing plant mechanisms are a factor.	There is value in reviewing this document in more detail to see if there is learning from other high-hazard industries that can be applied to this task or ONR376.
C-037	IAEA	DS485	Ageing Management and Development of a Programme for Long Term Operation of Nuclear Power Plants	See SSG-48	Draft Specific Safety Guide DS485 (Revision of NS-G-2.12), superseded by SSG-48; therefore, no need to review this document.
C-038	IAEA	N/A	Material Degradation and Related Managerial Issues at Nuclear Power Plants Proceedings of a Technical Meeting, Vienna, 15–18 February 2005	This publication presents the main results and lessons learned from the IAEA Technical Meeting on Material Degradation and Related Managerial Aspects held on 15–18 February 2005. Managerial aspects and influences are seen to be just as important to the safe and reliable operation of nuclear power plants (NPPs) as technical issues and are frequently the root cause of incidents that occur.	While this may not be directly related to BDL expectations, most RGP focusses on AM or LTO management processes or the SSCs, managerial aspects have not really stood out. This document may give some insight that links BDL with Leadership & Management for Safety and is therefore worth a more detailed review in future phases.

ID	Source	Ref No.	RGP Title	RGP Summary	Notes
C-039	IAEA	IAEA-CN-155-069	Russian Regulatory Approach to Extension of Nuclear Power Plant Service Life	The report presents not only general system of regulatory legislative acts in the field of nuclear and radiation safety but also all legislative acts and regulatory documents concerning plant life extension (PLEX) in the Russian Federation.	A presentation summarising this information has also been identified, although it is not clear if the two are directly related. Paper to be reviewed as part of future stages of the overall task.
C-040	IAEA	IAEA-CN-194-0XX	Risk Informed Safety Margin Characterization for Effective Long Term Nuclear Power Plant Safety Management	Maintenance of safety margins has served as a foundational principle of plant operation and regulation since the advent of commercial nuclear power. As the current generation of operating nuclear power plants (NPPs) ages, the enhanced capability to evaluate and manage safety margins will be a critical element in their continued safe operation. Additionally, operating commercial NPPs continue to undergo design and operational changes to support cost effective long term operation such as power up-rates and extended operating cycles. These operational enhancements also have the potential to impact plant safety margins. Thus, a critical element to achieve safe long-term NPP operation will be the development and application of a robust method to perform safety margin evaluations in a manner that is technically accurate and economically efficient. This paper presents an approach that meets these objectives by describing the successful pilot application of the Risk-Informed Safety Margin Characterization (RISMC) framework to analyse and obtain important insights into a significant issue in NPP safety risk management. This pilot effort demonstrated that the RISMC framework can be used to identify important contributors to plant safety margins, both positive and negative, from which useful information can be obtained to support the development of strategies to enhance NPP safety. Additionally, the research also demonstrated that this approach can be applied using a reasonable level of resources and within a timeframe that supports effective NPP decision-making.	All papers can be accessed via: https://inis.iaea.org/search/search.aspx?num=10&orig_q=source%3a%22IAEA-CN--194%22&lang=en-US&login=false&user=External&src=ics&sort=date:D:L:d1&start=0. Paper to be reviewed as part of future stages of the overall task.

ID	Source	Ref No.	RGP Title	RGP Summary	Notes
C-041	IAEA	IAEA-CN-194-016	Digital Image Correlation (DIC): An Advanced Non-destructive Testing Method for Life Extension of Nuclear Power Plants	A primary focus for the long-term operation of nuclear power plants (NPPs) is the aging of civil structures at the plant. The integrity of the containment building is of primary importance to the continued operation of NPPs. Some degradation mechanisms of concrete manifest themselves via swelling or by other shape deformation of the concrete. The ability to validate that the shape of the concrete is stable is an indication that certain degradation mechanisms are not active. Digital Image Correlation (DIC) is a non-destructive testing (NDT) technique that is non-contact. The use of DIC is a method to precisely determine the change of shape and the change of strain in a structure. This paper describes the technology behind the DIC technique and the use of DIC during a pressure test on the containment vessel at an NPP in the United States.	As Above (IAEA-CN-194-0XX)
C-042	IAEA	IAEA-CN-194-036	Long Term Operation For EDF Nuclear Power Plants : Towards 60 years…	The lifetime extension of the French nuclear fleet, significantly beyond 40 years (initial design basis) is presently one of the major objectives for EDF, in order to smooth the commissioning flow for the new build program. A lifetime extension up to 60 years should be reasonably achieved, owing to the compliance with additional safety and environmental requirements, an adequate LTO strategy including an exceptional maintenance program periodically updated, and an LTO support program (R&D) consisting of aging knowledge improvement and decision–making tools and methods. The LTO program is illustrated with some examples of replaceable components and a focus is placed on the complementary analysis in progress for RPV and containment safety assessment.	As Above (IAEA-CN-194-0XX)

ID	Source	Ref No.	RGP Title	RGP Summary	Notes
C-043	IAEA	IAEA-CN-194-041	Safety requirements for long term operation of NPPs	In the future, the reactors operating at present will run alongside reactors of the EPR type or their equivalent, designed for a significantly higher level of safety. This raises the question of the acceptability of continued operation of reactors beyond 40 years when there is an available technology that is safer. Two objectives are therefore imperative. First, a re-evaluation of the safety level in the light of that required of EPR type reactors or their equivalent is necessary, with proposals to bring about significant and relevant improvements to the reactors. R&D work in France and elsewhere is already indicating orientations that could lead to answers, and improvements that would provide significant reductions in release in case of severe accident are being studied. Second, strict compliance of the reactors with the applicable regulations must be demonstrated. At the same time, ageing and obsolescence of the equipment will have to be managed. Where these two points are concerned, ASN expects far-reaching proposals from the licensee. With a view to a request for continued operation beyond 40 years, ASN has referred the matter to the Advisory Committee for nuclear reactors which will meet at the end of 2011 to establish the safety requirements for reactors at their fourth ten-yearly outage.	As Above (IAEA-CN-194-0XX)

ID	Source	Ref No.	RGP Title	RGP Summary	Notes
C-044	IAEA	IAEA-CN-194-051	Life Limiting Issues for Long Term Operation of Nuclear Power Plants	This paper reports on a study which identified and characterized life limiting issues for consideration by nuclear plant owners in their decision to extend plant life or seek subsequent license renewal. This paper defines “Life Limiting” concepts for nuclear plants. It identifies the highest risk conditions and events that may limit duration of continued operation in nuclear plants and employs a survey to prioritize these concerns. Methods for evaluating these risks and changing the capability of systems, structures, and components (SSC) to reduce and manage this risk in long term operation are presented. Integrated obsolescence –the existence of an accumulation of events or condition that can threaten long term operation– is discussed.	As Above (IAEA-CN-194-0XX)
C-045	IAEA	IAEA-CN-194-1P28	Material aging and degradation detection and remaining life assessment for plant life management	One of the major factors that may impact long-term operations is structural material degradation. Detecting materials degradation, estimating the remaining useful life (RUL) of the component, and determining approaches to mitigating the degradation are important from the perspective of long-term operations. In this study, multiple non-destructive measurement and monitoring methods were evaluated for their ability to assess the material degradation state. Metrics quantifying the level of damage from these measurements were defined and evaluated for their ability to provide estimates of remaining life of the component. An example of estimating the RUL from non-destructive measurements of material degradation condition is provided.	As Above (IAEA-CN-194-0XX)
C-046	IAEA	IAEA-EBP-LTO-23	Long Term Operation – Structures and Structural Components	The report represents the final report of Working Group 4 of the Extrabudgetary Programme on Safety Aspects of Long Term Operation of Water Moderated Reactors on Structures and Structural Components.	Document to be reviewed as part of future stages of the overall task.

ID	Source	Ref No.	RGP Title	RGP Summary	Notes
C-047	IAEA	IAEA-EBP-SALTO	Safety Aspects of Long-Term Operation of Water Moderated Reactors Recommendations on the Scope and Content of Programmes for Safe Long-Term Operation	This report summarizes the major results of the Extrabudgetary Programme on Safety Aspects of Long Term Operation of Water Moderated Reactors (Programme). The objective of the Programme was to establish recommendations on the scope and content of activities to ensure safe long term operation of water moderated reactors. The Programme results should assist regulators and operators of water moderated reactors in ensuring that the required safety level of their plants is maintained during long term operation (LTO), should provide generic tools to support the identification of safety criteria and practices at the national level applicable to LTO, and should provide a forum in which MS can freely exchange information. The scope of the Programme was limited to technical aspects important to safety related physical structures. Further detailed results of the Programme are given in Appendices I–IV which contain Final Working Group Reports of Working Groups 1–4.	Document to be reviewed as part of future stages of the overall task.
C-048	IAEA	INSAG-14	Safe Management of the Operating Lifetimes of Nuclear Power Plants	This report by INSAG deals with a general approach to the safe management of the operating lifetimes of nuclear power plants. It responds to the concerns about maintaining adequate safety levels at ageing plants, even beyond their design lifetimes.	Document to be reviewed as part of future stages of the overall task.
C-049	IAEA	INSAG-19	Maintaining the Design Integrity of Nuclear Installations throughout their Operating Life	This INSAG report discusses the problem of maintaining the integrity of design of a nuclear power plant over its entire lifetime in order to achieve a continuous high level of safety.	Document to be reviewed as part of future stages of the overall task.
C-050	IAEA	INSAG-25	A Framework for an Integrated Risk Informed Decision Making Process	This report is intended to promote a common understanding among the international nuclear community (designers, suppliers, constructors, licensees, support organizations and regulators) of how the concept of risk can be used in making safety decisions relating to nuclear installations.	Familiarity within the UK of the ALARP principles probably mean this document is not relevant. However, ALARP principles will be a fundamental aspects of any BDL process.

ID	Source	Ref No.	RGP Title	RGP Summary	Notes
C-051	IAEA	NP-T-3.2	Heavy Component Replacement in Nuclear Power Plants: Experience and Guidelines	This publication is dedicated on heavy components replacement considered strategic for nuclear power plants life management, but not included in current maintenance activities carried out by utilities.	Document to be reviewed as part of future stages of the overall task.
C-052	IAEA	NP-T-3.5	Ageing Management of Concrete Structures in Nuclear Power Plants	This publication is one in a series of reports on the assessment and management of ageing of major NPP components. This report is an update of IAEA-TECDOC-1025, Assessment and Management of Ageing of Major Nuclear Power Plant Components Important to Safety: Concrete Containment Buildings, published in 1998. It describes current practices for assessment of safety margins (fitness for service) and inspection, monitoring and mitigation of ageing degradation of selected concrete structures related to a variety of NPP designs.	Document to be reviewed as part of future stages of the overall task.
C-053	IAEA	NP-T-3.18	Plant Life Management Models for Long Term Operation of Nuclear Power Plants	Three different plant life management models have been used to qualify plants to operate beyond their operating licence. The models are based on the licence renewal application concept, the periodic safety review process, or a combination of both. In this report, the IAEA has collected samples of licensing practices for LTO from Member States. The various plant life management models used to obtain LTO authorizations are described here and comparisons are drawn against the standard periodic safety review model. Lessons learned and warnings about possible complications and pitfalls are also described to minimize the risk of licensing for LTO applications.	Given the Licencing arrangements in the UK this report may not add value to this task; however, LTO documentation requirements may identify useful items to be considered in a BDL submission.

ID	Source	Ref No.	RGP Title	RGP Summary	Notes
C-054	IAEA	NP-T-3.20	Buried and Underground Piping and Tank Ageing Management for Nuclear Power Plants	This publication is one in a series of reports on the assessment and management of ageing of major nuclear power plant components. Current practices for the assessment of safety margins (fitness for service) and the inspection, monitoring and mitigation of ageing degradation of underground piping related to Canada deuterium–uranium (CANDU) reactor plants, boiling water reactor plants, pressurized water reactor plants and water moderated, water cooled power reactor plants are documented. This information is intended to help all those involved directly or indirectly in ensuring the safe operation of nuclear power plants and to provide a common technical basis for dialogue between plant operators and regulators when dealing with age related licensing issues.	Document to be reviewed as part of future stages of the overall task.
C-055	IAEA	NP-T-3.24	Handbook on Ageing Management for Nuclear Power Plants	This ageing management handbook has been developed in compliance with the requirements of the IAEA safety standards and the safety guide Proactive Management of Ageing for Nuclear Power Plants. The primary safety goal of an ageing management programme (AMP) is to ensure the availability of all required safety functions and the performance of the safety systems throughout the service life of a nuclear power plant, taking into account the changes that occur with time and use.	This document has been superseded by SSG-48, may have limited value if detailed review undertaken.
C-056	IAEA	NS-G-2.12	Ageing Management for Nuclear Power Plants	The objective of this Safety Guide is to provide recommendations for managing ageing of SSCs important to safety in nuclear power plants, including recommendations on key elements of effective ageing management. The Safety Guide mainly focuses on managing the physical ageing of SSCs important to safety. It also provides recommendations on safety aspects of managing obsolescence and on the application of ageing management for long term operation.	This document has been incorporated into and is superseded by SSG-48, may have limited value if detailed review undertaken.

ID	Source	Ref No.	RGP Title	RGP Summary	Notes
C-057	IAEA	SRS-57	Safe Long Term Operation of Nuclear Power Plants	This Safety Report fulfils, in part, the need expressed by Member States for information about international good practices that may be referenced when developing national programmes for LTO that focus on the SSCs of nuclear power plants. It provides operating organizations and regulatory bodies with guidance on how to demonstrate and verify the safety of their nuclear power plants during LTO. This Safety Report is also used as the basis of IAEA peer review missions on safe long term operation (SALTO Peer Reviews).	This document has been incorporated into and is superseded by SSG-48, may have limited value if detailed review undertaken.
C-058	IAEA	SRS-62	Proactive Management of Ageing for Nuclear Power Plants	The objective of this Safety Report is to provide information on good practices for maintaining and improving the safety and performance of nuclear power plants by facilitating proactive ageing management of SSCs throughout their lifetime.	The learning from this document has been incorporated into SSG-48, (or earlier iterations) and as such may have limited value if detailed review undertaken.
C-059	IAEA	SRS-82	Ageing Management for Nuclear Power Plants: International Generic Ageing Lessons Learned (IGALL)	This Safety Report provides detailed information on specific programmes to manage existing and potential ageing and degradation of systems, structures and components (SSCs) that will assist operating organizations and regulatory bodies by specifying a technical basis and practical guidance on managing ageing of mechanical, electric and instrumentation and control components, and civil structures of nuclear power plants important to safety. It also provides a common, internationally recognized basis on what constitutes an effective ageing management programme; a knowledge base on ageing management for design of new plants, design reviews, evaluations of safety analyses and time limits assumed; and a roadmap to available information on ageing management.	Document to be reviewed as part of future stages of the overall task. This document may have limited direct value; however, the review should also consider the IGALL database and AMPs for specific SSCs.

ID	Source	Ref No.	RGP Title	RGP Summary	Notes
C-060	IAEA	SS-26	SALTO Peer Review Guidelines - Guidelines for Peer Review of Safety Aspects of Long Term Operation of Nuclear Power Plants	The guidelines in this publication are primarily intended for members of a SALTO review team and provide a basic structure and common reference for peer reviews of LTO. Additionally, the guidelines also provide useful information to the operating organizations of NPPs (or technical support organizations) for carrying out their own self-assessments or comprehensive programme reviews. The guidelines are intended to be generic, as there are differences between utilities and NPPs.	Peer review guidelines may not add much to this task; however, understanding the elements that make up the Safety Aspects of Long Term Operation may identify some useful BDL information.
C-061	IAEA	SSG-25	Periodic Safety Review for Nuclear Power Plants	The purpose of this Safety Guide is to provide recommendations and guidance on the conduct of a PSR for an existing nuclear power plant. This Safety Guide is intended for use by operating organizations, regulatory bodies and their technical support organizations, consultants and advisory bodies.	While particular focus will be given to aspects associated with the actual condition of the plant and Ageing Management, other aspects of the PSR should also be considered in terms of the expectations for BDL and the aspects that would influence Figure 1.
C-062	IAEA	SSG-30	Safety Classification of Structures, Systems and Components in Nuclear Power Plants	This publication is intended primarily for use by organizations involved in the design of nuclear power plants, as well as by regulatory bodies and their technical support organizations. It can also be applied to other nuclear installations subject to appropriate adjustments relevant to the specific design of the type of facility being considered. The objective of this Safety Guide is to provide recommendations and guidance on how to meet the requirements for the identification of SSCs important to safety and for their classification on the basis of their function and safety significance.	

ID	Source	Ref No.	RGP Title	RGP Summary	Notes
C-063	IAEA	SSG-48	Ageing Management and Development of a Programme for Long Term Operation of Nuclear Power Plants	This Safety Guide supplements and provides recommendations on meeting the requirements relating to ageing management and long term operation that are established in SSR-2/1 (Rev. 1) and SSR-2/2 (Rev. 1). It identifies key elements of effective ageing management for nuclear power plants. This publication revises and supersedes the Safety Guide on Ageing Management for Nuclear Power Plants issued in 2009, and also supersedes two Safety Reports issued by the IAEA in 1999 and 2007. This revision takes into account developments in the ageing management of nuclear power plants worldwide and expands the scope to include provisions for maintaining the safety of nuclear power plants during Long Term Operation.	Document to be reviewed as part of future stages of the overall task.
C-064	IAEA	SSR-2/1	Safety of Nuclear Power Plants: Design	This publication establishes design requirements for the structures, systems and components of a nuclear power plant, as well as for procedures and organizational processes important to safety that are required to be met for safe operation and for preventing events that could compromise safety, or for mitigating the consequences of such events, were they to occur.	Document to be reviewed as part of future stages of the overall task.
C-065	IAEA	SSR-2/2	Safety of Nuclear Power Plants: Commissioning and Operation	The objective of this publication is to establish the requirements which, in the light of experience and the present state of technology, must be satisfied to ensure the safe commissioning and operation of nuclear power plants. These requirements are governed by the safety objective and safety principles that are established in the Fundamental Safety Principles.	Document to be reviewed as part of future stages of the overall task.

ID	Source	Ref No.	RGP Title	RGP Summary	Notes
C-066	IAEA	TECDOC-540	Safety Aspects of Nuclear Power Plant Ageing	The purpose of TECDOC-540 was to increase awareness and understanding of the potential impact of ageing on plant safety; of ageing processes; and of the approach and actions needed to manage the ageing of NPP components effectively. This is a useful reference document, in particular for beginners. It includes a valuable discussion of ageing and NPP safety, equipment qualification as a means of defence against common cause failures, and a review of material ageing mechanisms. The discussion deals with effects of ageing on the integrity of defence in depth, component failure rate and system performance. The review of ageing mechanisms includes metals, concrete structures, electronics, polymers and other non-metals.	The learning from this document has been incorporated into SSG-48, (or earlier iterations) and as such may have limited value if detailed review undertaken.
C-067	IAEA	TECDOC-1025	Assessment and management of ageing of major nuclear power plant components important to safety: Concrete Containment Buildings	The objective of this report is to present the results of the Co-ordinated Research Programme (CRP) on the Management of Ageing of Concrete Containment Buildings (CCBs) addressing current practices and techniques for assessing fitness-for-service and the inspection, monitoring and mitigation of ageing degradation of CCBs. This report aims to provide a technical basis for developing and implementing a systematic ageing management programme and also for dialogue between nuclear power plant (NPP) operators and regulators when dealing with age-related licensing issues.	While this document is focused on containment and concrete structures there may be some cross over with mechanical aspects of the structures and the interfaces between them. However, this document may be more applicable to ONR376 and the review of Ageing & Degradation SAPs.

ID	Source	Ref No.	RGP Title	RGP Summary	Notes
C-068	IAEA	TECDOC-1147	Management of aging of I&C equipment in nuclear power plants	This report is solely concerned with the ageing management of I&C systems. It draws together experience from various nuclear utilities across the world, examining ageing of specific components and also ageing management techniques. This information is distilled into a suggested ageing management strategy and several practical steps are suggested. I&C ageing management is a developing field and, as yet, there is no one accepted and definitive solution. However, the increasing severity of the problem and on-going work justifies the production of this report, which documents the best current practices.	While this document is focused on E,C&I components there may be some cross over with mechanical aspects of SSCs that incorporate both disciplines and interfaces between them. However, this document may be more applicable to ONR376 and the review of Ageing & Degradation SAPs.
C-069	IAEA	TECDOC-1188 - Volume I	Assessment and management of ageing of major nuclear power plant components important to safety: In-containment instrumentation and control cables Volume I	The objective of Part I of this report is to present the results of the Co-ordinated Research Project (CRP) on the Management of Ageing of In-containment Instrumentation and Control (I&C) Cables addressing current practices and techniques for assessing and managing ageing degradation of I&C cables in real nuclear power plant (NPP) environments. These practices and techniques have a different degree of maturity and practical application experience.	While this document is focused on E,C&I components there may be some cross over with mechanical aspects of SSCs that incorporate both disciplines and interfaces between them. However, this document may be more applicable to ONR376 and the review of Ageing & Degradation SAPs.
C-070	IAEA	TECDOC-1188 - Volume II	Assessment and management of ageing of major nuclear power plant components important to safety: In-containment instrumentation and control cables Volume II	Volume II contains annexes supporting this guidance with more detailed information and examples provided by individual CRP participants. For a quick overview, readers should see Section 8 of Part I, Volume I, which describes a systematic ageing management programme for I&C cables utilizing methods presented in the report; Section 9 of Part I, Volume I, which presents CRP conclusions and recommendations; and Part II providing the application guidance from the user's perspective.	While this document is focused on E,C&I components there may be some cross over with mechanical aspects of SSCs that incorporate both disciplines and interfaces between them. However, this document may be more applicable to ONR376 and the review of Ageing & Degradation SAPs.

ID	Source	Ref No.	RGP Title	RGP Summary	Notes
C-071	IAEA	TECDOC-1305	Safe and effective nuclear power plant life cycle management towards decommissioning	The objective of this publication is to promote and communicate the need for a longer-term perspective among senior managers and policy or strategy makers for decisions that have the potential to affect the life cycle management of a nuclear power plant including decommissioning. The following sections provide practical guidance in the subject areas that might have the potential to have such an impact. The publication should be used as an aid to help strategic planning take place in an informed way through the proper consideration of any longer-term decisions to enforce recognition of the point that decommissioning is a part of the whole life cycle of a nuclear power plant.	This is one of the few documents that look at the transition from operational life to decommissioning and also considers the impact extended operation might have.
C-072	IAEA	TECDOC-1361	Assessment and management of ageing of major nuclear power plant components important to safety: Primary Piping in PWRs	The objective of this report is to identify significant ageing mechanisms and degradation locations, and to document the current practices for the assessment and management of the ageing of PWR primary system piping. The report emphasizes safety aspects and also provides information on current inspection, monitoring and mitigation practices for managing ageing of PWR primary system piping. The underlying objective of this report series is to ensure that the information on the current assessment methods and ageing management techniques is available to all involved, directly and indirectly, in the operation of NPPs in IAEA Member States. The target audience includes NPP operators, regulators, technical support organizations, designers and manufacturers.	Document to be reviewed as part of future stages of the overall task.
C-073	IAEA	TECDOC-1402	Management of life cycle and ageing at nuclear power plants: Improved I&C maintenance	This TECDOC uses existing body of information and knowledge from the worldwide nuclear power industry to build a case for the role of I&C in plant performance improvements in terms of both plant safety and plant economy. It will then provide recommendations as to what can be done to prevent I&C ageing and obsolescence from affecting the safe and economical performance of NPPs.	While this document is focused on E,C&I components there may be some cross over with mechanical aspects of SSCs that incorporate both disciplines and interfaces between them. However, this document may be more applicable to ONR376 and the review of Ageing & Degradation SAPs.

ID	Source	Ref No.	RGP Title	RGP Summary	Notes
C-074	IAEA	TECDOC-1556	Assessment and management of ageing of major nuclear power plant components important to safety: PWR Pressure Vessels	The objective of this report is to update IAEA-TECDOC-1120 in order to provide current ageing management guidance for PWR RPVs to all involved in the operation and regulation of PWRs.	Document to be reviewed as part of future stages of the overall task.
C-075	IAEA	TECDOC-1557	Assessment and management of ageing of major nuclear power plant components important to safety: PWR Vessel Internals	The objective of this report is to update the IAEA-TECDOC-1119 in order to provide current ageing management guidance for PWR RVIs to all involved in the operation and regulation of PWRs. The IAEA is preparing a new Safety Guide on ageing management which provides key recommendations on ageing management of SSCs important to safety. This report is consistent with the new Safety Guide and supplements it by providing specific information and guidance for ageing management of PWR RVIs.	Document to be reviewed as part of future stages of the overall task.
C-076	IAEA	TECDOC-1668	Assessment and management of ageing of major nuclear power plant components important to safety: Steam Generators	The objective of this IAEA-TECDOC is to document the current practices for the assessment and management of the ageing of nuclear power plant steam generators. The IAEA-TECDOC emphasizes safety and engineering aspects and also provides information on current inspection, monitoring and maintenance practices for managing ageing of steam generators. The underlying objective of this IAEA-TECDOC series is to ensure that the information on the current assessment methods and ageing management techniques is available to all involved, directly and indirectly, in the operation of nuclear power plants in the IAEA Member States. The target audience includes nuclear power plant operators, regulators, technical support organizations, designers, and manufacturers.	Document to be reviewed as part of future stages of the overall task.

ID	Source	Ref No.	RGP Title	RGP Summary	Notes
C-077	IAEA	TECDOC-1736	Approaches to Ageing Management for Nuclear Power Plants: International Generic Ageing Lessons Learned (IGALL) Final Report	The main deliverable of the International Generic Ageing Lessons Learned for Nuclear Power Plants (IGALL) Extra budgetary Programme (EBP), the IGALL Safety Report, provides an internationally recognized basis for an acceptable ageing management programme, as well as a knowledge base on ageing management to aid in the design of new power plants, design reviews, modifications and upgrades, and to serve as a source of information on ageing management. This publication is a summary of the national approaches taken by Member States participating in the IGALL programme. This information was collected during the first phase of the IGALL programme between 2010 and 2013, and explains different national practices in the area of ageing management and the preparation for long term operation.	Document to be reviewed as part of future stages of the overall task.
C-078	IAEA	Technical Report Series No. 338	Methodology for the Management of Ageing of Nuclear Power Plant Components Important to Safety	This technical report presents methodologies both for selecting plant components important to safety whose ageing should be assessed and for performing ageing management studies. The methodologies are based on practices at the time of production (1991 - 1992) of Member States leading in this field.	The learning from this document has been incorporated into SSG-48, (or earlier iterations) and as such may have limited value if detailed review undertaken.
C-079	IAEA	N/A	Resources for Plant Life Management in Nuclear Power Plants (October 2017)	The IAEA supports Member States in Plant Life Management, or PLiM, programmes for nuclear power plants through technical publications, coordinated research programmes, peer review missions, the PRIS database, and major conferences and technical meetings. This brochure summarises IAEA publications that address different technical and safety aspects of PLiM.	Brochure that outlines IAEA resources and services to support plant life management. Limited value in a detailed review of the document.

ID	Source	Ref No.	RGP Title	RGP Summary	Notes
C-080	IEEE	INL/CON-11-21865	Prognostics and Life Beyond 60 Years for Nuclear Power Plants	2011 IEEE International Conference on Prognostics and Health Management Safe, secure, reliable, and sustainable energy supply is vital for advanced and industrialized life styles. To meet growing energy demand there is interest in longer-term operation for the existing nuclear power plant fleet and enhancing capabilities in new build. There is increasing use of condition-based maintenance for active components and growing interest in deploying on-line monitoring instead of periodic in-service inspection for passive systems. Opportunities exist to move beyond monitoring and diagnosis based on pattern recognition and anomaly detection to prognostics with the ability to provide an estimate of remaining useful life. The adoption of digital I&C systems provides a framework within which added functionality including on-line monitoring can be deployed, and used to maintain and even potentially enhance safety, while at the same time improving planning and reducing both operations and maintenance costs.	This is a preprint of a paper intended for publication in a journal or proceedings. Since changes may be made before publication, this preprint should not be cited or reproduced without permission of the author. While this document is focused on E,C&I components there may be some cross over with mechanical aspects of SSCs that incorporate both disciplines and interfaces between them. However, this document may be more applicable to ONR376 and the review of Ageing & Degradation SAPs.
C-081	NNR (SA)	N/A	Ageing Management & Long Term Operation of NPP	National Nuclear Regulator (South Africa) presentation on Ageing Management & Long Term Operation of NPP presenting information about: • Legislation • Regulatory Framework • Licensing Basis • Requirements on licensees • Issues relating to the ageing of the plant • Regulatory programmes ensuring continued safe operation • Periodic Safety Review • Long Term Operation • IAEA Support for LTO	National Nuclear Regulator (South Africa) presentation, date unknown and not clear where it was presented. Based on a high-level review, this presentation does not appear to offer anything significantly different to SSG-48 and will not be considered further.

ID	Source	Ref No.	RGP Title	RGP Summary	Notes
C-082	NRC	N/A	International Approaches to Long Term Operation and License Renewal	NRC presentation that includes topics such as: • License Renewal and Subsequent License Renewal • IAEA Approach – Safety Reviews – Aging Management – Long Term Operation • Conclusions from IRRS Mission to US NRC • U.S. support of IAEA activities on LTO	Document identifies various LTO approaches and the relationship between the Licence & Licence renewal. Given the Licencing arrangements in the UK this report may not add value to this task; however, it may identify some useful items to be considered in a BDL submission.
C-083	NRC	NUREG-1412	Foundation for the Adequacy of the Licensing Bases – A Supplement to the Statement of Considerations for the Rule on Nuclear Power Plant License Renewal (10 CFR Part 54)	The objective of this report is to describe the regulatory processes that assures that any plant-specific licensing bases will provide reasonable assurance that the operation of nuclear power plants will not be inimical to the public health and safety to the end of the renewal period. It is on the adequacy of this process that the Commission has determined that a formal renewal licensing review against the full range of current safety requirements would not add significantly to safety and is not needed to assure that continued operation throughout the renewal term is not inimical to the public health and safety or common defence and security. This document illustrates in general terms how the regulatory process has evolved in major safety issue areas. It also provides examples illustrating why it is unnecessary to re-review an operating plants licensing basis, except for age-related degradation unique to license renewal, at the time of license renewal.	This document may provide information on BDL more from the regulatory perspective and as such may be worth a further review in a future phase.

ID	Source	Ref No.	RGP Title	RGP Summary	Notes
C-084	NRC	NUREG-1555, Supplement 1	Standard Review Plans for Environmental Reviews for Nuclear Power Plants: Environmental Standard Review Plan for Operating License Renewal	This document provides guidance to Nuclear Regulatory Commission staff in implementing provisions of 10 CFR 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions," related to reactor operating license renewals. It supplements NUREG-1555, "Standard Review Plans for Environmental Reviews for Nuclear Power Plants," which covers reviews related to reactor construction permits, initial operating licenses, early site permits, and combined licenses. Reviews conducted following this review plan lead to preparation of site-specific environmental impact statement supplements to NUREG-1437, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants."	Similar to NUREG-1412 above this document may provide information on BDL more from the regulatory perspective, with a specific focus on environmental aspects, and as such may be worth a further review in a future phase.
C-085	NRC	NUREG-1611	Aging Management of Nuclear Power Plant Containments for License Renewal	The purpose of this report is to reconcile the technical information and agreements resulting from the NUMARC IR reviews and the in-service inspection requirements of Subsections IWE and IWL as promulgated in § 50.55a for license renewal consideration. This report concludes that Subsections IWE and IWL of Section XI, Division 1, of the ASME Code as endorsed in § 50.55a are generally consistent with the technical information and agreements reached during the IR reviews. Specific exceptions are identified and additional evaluations and augmented inspection activities for renewal are recommended.	This document may provide some limited value to this task given the nature of the report. However, there is still merit in looking at it in a future phase to determine if any generic BDL aspects applicable to containments can be identified. May also provide information on Ageing & Degradation that could be used by the other task ONR376.

ID	Source	Ref No.	RGP Title	RGP Summary	Notes
C-086	NRC	NUREG-1801 (Rev 2)	Generic Aging Lessons Learned (GALL) Report	NUREG-1801, "The Generic Aging Lessons Learned (GALL) Report" (GALL Report), contains the staff's generic evaluation of the existing plant programs and documents the technical basis for determining where existing programs are adequate without modification and where existing programs should be augmented for the period of extended operation. The evaluation results documented in the GALL Report indicate that many of the existing programs are adequate to manage the aging effects for structures or components for license renewal without change. The GALL Report also contains recommendations on specific areas for which existing programs should be augmented for license renewal.	Document to be reviewed as part of future stages of the overall task. IAEA equivalent document will be reviewed initially so this document will be reviewed primarily looking at any differences.
C-087	NRC	NUREG-2214	Managing Aging Processes In Storage (MAPS) Report	This Managing Aging Processes in Storage (MAPS) Report provides guidance for the U.S. Nuclear Regulatory Commission (NRC) technical reviewer. It establishes a technical basis for the safety review of renewal applications for specific licenses of independent spent fuel storage installations and Certificates of Compliance for dry storage systems, as codified in Title 10 of the Code of Federal Regulations Part 72, "Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor-Related Greater Than Class C Waste."	It is recognised that the BDL guidance will not only be centred around civil nuclear facility, but the full range of nuclear facilities (now and in the future). As such this document, which focuses on storage facilities, may provide a different perspective to BDL expectations. This may also have some value to the ageing & degradation task ONR376.

ID	Source	Ref No.	RGP Title	RGP Summary	Notes
C-088	OECD - NEA	NEA/CNRA/R(99)1	Regulatory Aspects of Ageing Reactors - 1998 CNRA Special Issue Meeting	Each year the CNRA selects a topic of special interest to members for discussion. The topic chosen for 1998 was Regulatory Aspects of Ageing Reactors. The report predominantly looks at answers provided by the Member countries and the analysis performed by a task group established by the Organising Committee group. Additionally, insights from the CNRA discussions are provided in appropriate sections. This report integrates the work performed by the Organising Committee for the 1998 CNRA Special Issues meeting and the resulting discussions which took place during the meeting.	Document to be reviewed as part of future stages of the overall task.
C-089	OECD - NEA	NEA/CNRA/R(2001)1	Regulatory aspects of life extension and upgrading of NPPs - CNRA Special Issue's Meeting 2000	At its annual meeting in June 1999, the Committee on Nuclear Regulatory Activities (CNRA) agreed to hold a Special Issue Meeting in June 2000 on the topic of "Life Extension and Upgrading". This report includes the synthesis of the responses received from Member countries and the results and conclusions of the CNRA discussions.	This document may provide information on BDL more from the regulatory perspective and as such may be worth a further review in a future phase.
C-090	OECD - NEA	NEA/CSNI/R(2002)26	Technical Aspects of Ageing for Long-Term Operation	Besides national activities there are a number of international activities in particular under the umbrella of the IAEA, the OECD and the EU. For example, ageing research plays an important role in the 4th and 5th Framework Programme of the European Commission. A bibliography on major ageing related EU research activities under the 4th and 5th Framework Programme is given. International working groups and networks dealing with ageing related issues are summarised. Relevant guidance documents on plant ageing management, which could be used for orientation, are listed. This document restricts itself to the technical aspects of the basis for long-term operation. Its objective is the characterisation of technical key items. Regulatory aspects are being discussed within CNRA.	The report notes that to provide a technical basis for long-term operation of nuclear power plants it is necessary to: - invest in research methods and strategies related to plant life management - promote computer-aided modelling to predict degradation at a quantitative level - update the individual plant documentation to avoid gaps in knowledge caused by the reorientation of industry and by the retirement of experienced people - initiate, develop and promote clubs of users of similar technology internationally - establish a system of information retrieval to bridge gaps between today's and previous design and manufacturing standards - increase the flexibility of the quality assurance system to qualify products manufactured to other standards for plant specific use.

ID	Source	Ref No.	RGP Title	RGP Summary	Notes
C-091	OECD - NEA	NEA/SEN/NDC(2000)6	Status Report on Nuclear Power Plant Life Management	The main objective of this report is to provide a summary of the current status of industry programmes and government policies for nuclear power plant life management in OECD Member countries. Such data will facilitate discussion on maintaining nuclear power viability in the immediate future through improved plant life management.	Document identifies various LTO approaches and the relationship between the Licence & Licence renewal. Given the Licencing arrangements in the UK this report may not add value to this task.
C-092	OECD - NEA	Nuclear Development ISBN 92-64-05842-7	Glossary of Nuclear Power Plant Ageing	As the service life of operating nuclear power plants increases, potential misunderstanding of terms related to ageing degradation of Systems, Structures, or Components (SSCs) is receiving more attention. Common ageing terminology has been developed to improve the understanding of ageing phenomena, facilitate the reporting of relevant plant failure data, and promote uniform interpretations of standards and regulations that address ageing. The Nuclear Energy Agency (NEA) has published this glossary, in co-operation with the Commission of the European Communities (CEC) and the International Atomic Energy Agency (IAEA), as a handy reference to facilitate and encourage widespread use of common ageing terminology. The goal is to provide plant personnel (and others who address ageing) with a common set of terms that have uniform, industry-wide meanings, and to facilitate discussion between experts from different countries.	Document was written in 1999 and was one of the earliest documents to provide a description of the common terms used in the area of Ageing Management and Long-Term Operations. While some of the terminology has moved on since this was produced, it still has some value to ensure a shared understanding of the terminology used.

ID	Source	Ref No.	RGP Title	RGP Summary	Notes
C-093	OECD - NEA	Nuclear Development ISBN 978-92-64-99205-4	The Economics of Long-term Operation of Nuclear Power Plants	The aim of this study was to collect and analyse technical and economic data on the upgrade and lifetime extension experience in OECD countries. An OECD/NEA Ad Hoc Expert Group on the Economics of Long-term Operation of Nuclear Power Plants was established for this purpose with representatives from eight countries (list of members can be found in Appendix 2). This study applies a multi-criteria approach for assessing the range of issues important in any decisions related to LTO, based on the current and future financial conditions of operation, political and regulatory risks, the state of the plants' equipment and the general role of nuclear power in the country's energy policy.	Document was written in 2012 and focusses on the economic factors for LTO, some aspects of the documents may still be valid. Economic factors will contribute to the decision to move to extended operation and as part of the ALARP arguments to substantiate BDL operation for individual SSCs. As a result, it is not clear what value this document may add to the task; however, it is not clear it can be excluded at this stage either.
C-094	OECD - NEA	Nuclear Regulation - NEA/CNRA/R(2012)5 ISBN 978-92-64-99187-3	Challenges in Long-term Operation of Nuclear Power Plants - Implications for Regulatory Bodies	Following discussions at the CNRA meeting held on 7-8 June 2010, the Senior Task Group on Long-term Operation was established to prepare a document on regulatory challenges for long-term operation of nuclear power plants. The group was to review the principles and criteria that should be considered in making a regulatory decision to approve an operator's application for operation of a nuclear power plant beyond the operation period considered in the plant's design. During the preparation of this document, the 2011 Fukushima Daiichi nuclear power plant accident occurred. As a consequence, the CNRA requested that aspects of the event related to long-term operation should also be addressed in the review. This report has been prepared by the Senior Task Group on Long-term Operation, in collaboration with the International Atomic Energy Agency (IAEA), on the basis of discussions and input by members of the group and consideration of information from a wide array of documents produced by the NEA, its member countries and other international organisations.	Document to be reviewed as part of future stages of the overall task.

ID	Source	Ref No.	RGP Title	RGP Summary	Notes
C-095	ONR	Licence Condition Handbook February 2017	Licence condition handbook - The standard licence conditions attached to nuclear site licences	This booklet has been produced as an aide-memoire for nuclear inspectors. It reproduces the licence conditions from Schedule 2 of the standard nuclear site licence and highlights the regulatory powers within the conditions.	Document reviewed as part of the review of TAGs / TIGs and may need to reviewed / referenced in future stages of the overall task. It should be noted that the individual TAGs & TIGs reviewed are not listed in this table as they are included in an Appendix specifically related to the TAGs & TIGs.
C-096	ONR	2014 Edition Revision 0	Safety Assessment Principles for Nuclear Facilities	The Office for Nuclear Regulation (ONR) is the independent regulator of nuclear safety and security across the UK. ONR's inspectors use these Safety Assessment Principles (SAPs), together with supporting Technical Assessment Guides (TAGs), to guide their regulatory judgements and recommendations when undertaking technical assessments of nuclear site licensees' safety submissions. Underpinning these is the legal duty on licensees to reduce risks so far as is reasonably practicable, and this informs the use of these SAPs. In addition, the SAPs are used to guide our assessments of proposed new nuclear facilities designs that may come forward for eventual construction at sites in the UK.	Document reviewed as part of the review of SAPs and may need to reviewed / referenced in future stages of the overall task.
C-097	ONR		ENSREG Topical Peer Review on Ageing Management United Kingdom National Assessment Report – December 2017	The European Union's Nuclear Safety Directive requires the member states to organise a topical peer review (TPR) every six years with the first one starting in 2017. ENSREG has selected ageing management at nuclear power plants and research reactors as the topic for the first review. The first stage of the peer review is for each member state to produce a national assessment report. This is the UK National Assessment Report, which will be used in the later stages of the peer review.	Other national reports may also be of use and require review in future stages of the overall task.

ID	Source	Ref No.	RGP Title	RGP Summary	Notes
C-098	Other	N/A	A general LTO assessment project approach using IAEA guidelines applied to Borssele (The Netherlands) and Ringhals (Sweden)NPPs	This article describes the LTO assessment project of Borssele NPP in the Netherlands and the set-up of the LTO assessment project at Ringhals NPPs in Sweden. The Borssele project was carried out by three parties: EPZ (utility), AREVA (design and constructor) and NRG (independent consultant). The experience NRG gained during this project is used to support Ringhals in their LTO project.	Paper by F. J. Blom & M. Schopman Article to be reviewed as part of future stages of the overall task.
C-099	Other	N/A	Ageing Management and LTO of NPPs – Swedish perspective	Presentation by Michael Knochenhauer, Director, Nuclear Power Plant Safety, Swedish Radiation Safety Authority Presented at IAEA / Senior Regulator's Meeting 16-17 September 2015	Presentation to be reviewed as part of future stages of the overall task.
C-100	Other	N/A	Slovenian Regulatory Approach to Design Lifetime Extension	Nowadays many NPPs plan to operate longer than foreseen by their original design. In Slovenia there is a single NPP, Krško NPP, that has been designed for 40 years of operation, which expires in 2023. The operator has already expressed the intention to operate for at least 60 years. Slovenian Nuclear Safety Administration (SNSA) had to form relevant regulatory requirements and its approach to approval of a prolonged operation. The requirements and the approach here presented have been formed conservatively, based on best international practices and specific Slovenian circumstances.	Paper taken from the proceedings of the International Conference Nuclear Energy for New Europe, Portorož, Slovenia, Sept. 6-9, 2010 This document may provide information on BDL more from the regulatory perspective and as such may be worth a further review in a future phase.

ID	Source	Ref No.	RGP Title	RGP Summary	Notes
C-101	Other	N/A	Sensitivity study of a new model for assessing time-dependent risk in ageing NPP	The nuclear power plants risk reduction by application of the probabilistic safety assessment is one of the main focuses of the nuclear safety today. The goal is the reduction of the unavailability of the nuclear power plants safety systems. On the other hand, the world NPP fleet is ageing fast. Equipment ageing has gradually become a major concern in the nuclear industry since the number of safety systems components, that are approaching their wear-out stage, is rising fast. This paper is aimed towards performing sensitivity analysis on a previously developed model for assessing time-dependent unavailability of ageing safety equipment, which is briefly presented and discussed.	Paper taken from the proceedings of the International Conference Nuclear Energy for New Europe, Bled, Slovenia, Sept. 9-12, 2013 This document may provide information on a methodology that as part of various analyses will support BDL submissions. As such may be worth a further review in a future phase.
C-102	Other	N/A	Ageing management in NPP. Effectiveness of the methods for control, examination and monitoring in relation to mechanisms of degradation of mechanical properties	This paper describes ageing management activities for Long Term Operation (LTO) of components of Kozloduy NPP EAD. The stages of LTO Project are: Stage 1 - implementing a comprehensive assessment of the actual condition of the equipment; Stage 2 - providing of a Complex Analysis; Stage 3 – licensing of Plant Life Extension (PLEX) for long-term operation (LTO). The main activities are assessment of actual condition of the equipment and building; review of methods for control (non-destructive), examination and monitoring; assessment of effectiveness of methods; necessity of additional control/ examination/ service. The paper describes some mechanisms of degradation of mechanical properties, methods for control and criterions for their effectiveness.	Paper identified in MATEC Web of Conferences 145, 05015 (2018), NCTAM 2017 Paper to be reviewed as part of future stages of the overall task.

ID	Source	Ref No.	RGP Title	RGP Summary	Notes
C-103	Other	N/A	Ageing related events at nuclear power plants	This paper presents main results of a comprehensive study performed by the European Clearinghouse on Operating Experience Feedback of NPP with the support of IRSN (Institute de Sûreté Nucléaire et de Radioprotection) and GRS (Gesellschaft für Anlagen und Reaktorsi-cherheit mbH). Physical ageing mechanisms of structure, systems and components that eventually lead to ageing related systems and components failures at nuclear power plants were the main focus of this study. The analysis of ageing related events involved operating experience reported by NPP operators in France, Germany, USA and to the IAEA/NEA International Reporting system, on operating experience for the past 20 years (i.e. 1990-2009). A list of ageing related events was populated. Each ageing related event contained in the list was analysed and results of analysis were summarized for each commodity group for which the ageing degradation appeared to be a dominant contributor or direct cause. The most common degradation mechanisms/ageing effects for each specific component/commodity group, their risk significance and consequences to the plant performance are described. This paper provides insights into ageing related operating experience as well as recommendations to deal with the physical ageing of nuclear power plant SSC important to safety.	Paper identified in Natural Science Vol.5, No.1, 31-37 (2013) By Alexander Duchac, Nuclear Reactor Safety Assessment Unit, European Commission Joint Research Centre, Institute for Energy and Transport, Petten, The Netherlands Paper to be reviewed as part of future stages of the overall task.

ID	Source	Ref No.	RGP Title	RGP Summary	Notes
C-104	Other	N/A	Long-Term Operation of VVER Power Plants	In this chapter – after an overview of basic technical features of VVER plants – the development and implementation of PLiM programmes for VVER plants will be presented. The methods for ensuring long-term operation are focused on the type and lifetime limiting ageing/degradation mechanisms of the most important systems structures and components. The integration of the plant activities/programmes into coherent PLiM programme will be demonstrated taking into account the frame of regulatory requirements regarding long-term operation. The role of the international research and co-operation environment affecting the lifetime management of VVER plants will also be presented. The presentation of the PLiM and long-term operation will focus on the older VVER-440/213 and VVER-1000 type plants. Especially the long-term operation of the VVER-440/213 plants requires specific engineering effort.	Paper by Tamás János Katona, Nuclear Power Plant Paks Ltd. Hungary Paper to be reviewed as part of future stages of the overall task.
C-105	Other	N/A	NuPEER Dijon 2005 Symposium. Ageing issues in nuclear power plants	The French Nuclear Safety Authority (ASN) organized an international symposium on regulatory aspects of ageing issues for nuclear pressure equipment. The ageing of nuclear pressure equipment is an issue of growing importance for nuclear regulators and material experts worldwide as age-related degradation of major pressure-retaining components challenges the remaining operating life of nuclear power plants. This symposium aimed at providing a forum for technical exchange among the staffs responsible for nuclear pressure equipment within the safety authorities and the associated expertise organisations.	This nearly 500 page document contains a lot of presentations from various organisations associated with this topic. While a detailed review may add little value to this task, keyword searches covering some of the areas related to BDL may identify some insight that does add to the overall task.

ID	Source	Ref No.	RGP Title	RGP Summary	Notes
C-106	Other	ISBN 978-1-84569-511-8	Understanding and Mitigating Ageing in Nuclear Power Plants - Materials and Operational Aspects of Plant Life Management (PLiM)	This book reviews the ageing-degradation mechanisms of materials used in nuclear power plant structures, systems and components, their relevant analysis and mitigation paths, and reactor-type specific plant life management (PLiM) practices. Obsolescence and other less obvious ageing-related aspects in nuclear power plant operation are also examined in depth. Part One introduces the role of nuclear power in the global energy mix, and the importance and relevance of PLiM for the safety regulation and economics of nuclear power plants. Key ageing degradation mechanisms and their effects in nuclear power plant systems, structures and components are reviewed in Part Two, along with routes taken to analyse the ageing of materials and to mitigate or eliminate ageing degradation effects. Part Three reviews analysis, monitoring and modelling techniques applicable to the study of nuclear power plant materials. Part Four reviews the particular ageing degradation issues, plant designs, and application of PLiM practices in a range of commercial nuclear reactor types. This book is a standard reference for all nuclear plant designers, operators, and nuclear safety and materials professionals and researchers.	Tipping, Philip G.. (2010). Understanding and Mitigating Ageing in Nuclear Power Plants - Materials and Operational Aspects of Plant Life Management (PLiM). Woodhead Publishing. ISBN 978-1-84569-511-8 Book to be reviewed as part of future stages of the overall task.

ID	Source	Ref No.	RGP Title	RGP Summary	Notes
C-107	Other	Powder Technology 321 (2017) 390–408	Ageing management and life extension of concrete in nuclear power plants	This review investigates the physical and chemical attack of reinforced concrete structures in nuclear power plants (NPPs) throughout their service life. It also examines precautions that can be taken against the deterioration caused by these types of attacks. The data from the studies reviewed indicate that mineral additions to the cement, such as silica fume, ground granulated blast furnace slag, fly ash, and metakaolin, can increase the performance of concrete for use in NPP components due to filler effects, nucleation effects, and pozzolanic activity. Based on the data available, it can be inferred that barite aggregate can be used to improve performance in NPP components that may be exposed to radiation, fly ash can be added to decrease hydration temperatures, and low C3A content cement and low water-to-cement ratios can be used to increase resistance to sulphate attack.	While this document is focused on containment and concrete structures there may be some cross over with mechanical aspects of the structures and the interfaces between them. However, this document may be more applicable to ONR376 and the review of Ageing & Degradation SAPs.

ID	Source	Ref No.	RGP Title	RGP Summary	Notes
C-108	Other	ENERGIFORSK REPORT 2016:265	ACCEPPT – Ageing of Concrete and Civil Structures in Nuclear Power Plants Project summary	The nuclear power plant containments are designed to protect the outside environment in case of accidents. Regardless the age and the stage of the production of the NPPs, the owners of the NPPs have to guarantee their safety and serviceability. The owners have to show that their structures meet all requirements made by the authorities and other legislators. The owners have to assess the condition of the structures and provide reliable information about the current and future condition of the structures In the project ACCEPPT (Ageing of Concrete and Civil structures in nuclEar Power PlanTs) several European nuclear power producing companies co-operated in developing the knowledge regarding the aging of pre-stressed containments with an internal steel liner. ACCEPPT regarded the ageing of prestressed nuclear reactor containments with an internal steel liner and was divided into two major parts. The project had two focus areas; whether or not the pre-stressed structure and its constituents fulfil as designed/according to new requirements and the liner's ability to fulfil the required tightness.	While this document is focused on containment and concrete structures there may be some cross over with mechanical aspects of the structures and the interfaces between them. However, this document may be more applicable to ONR376 and the review of Ageing & Degradation SAPs.
C-109	Other	E-Journal of Advanced Maintenance Vol.5-1 (2013) 70-76 Japan Society of Maintenology	LWR Sustainability: Assessment of Aging of Nuclear Power Plant Safety Related Concrete Structures	Current regulatory testing and inspection requirements are reviewed and a summary of degradation experience is presented. Techniques commonly used to inspect NPP concrete structures to assess and quantify age-related degradation are summarized. An approach for conduct of condition assessments of structures in NPPs is presented. Criteria, based primarily on visual indications, are provided for use in classification and assessment of concrete degradation. Materials and techniques for repair of degraded structures are generally discussed.	While this document is focused on containment and concrete structures there may be some cross over with mechanical aspects of the structures and the interfaces between them. However, this document may be more applicable to ONR376 and the review of Ageing & Degradation SAPs.

ID	Source	Ref No.	RGP Title	RGP Summary	Notes
C-110	Other	The European Physical Journal Conferences · July 2013 DOI: 10.1051/epjconf/20135603001	Developing a Computerized Aging Management System for Concrete Structures in Finnish Nuclear Power Plants	This paper is about the development of a computerized ageing management system for the nuclear power plants concrete structures. The computerized ageing management system is a part of the research project "Aging Management of Concrete Structures in Nuclear Power Plants (MANAGE)". This research project is funded by SAFIR 2014 (The Finnish Research Programme on Nuclear. Power Plant Safety 2011 – 2014). The goal is to create software platform that allows individual examination, analyses, planning and visualization of concrete structural parts of the nuclear power plant units. The computerized ageing management system is built upon central database and implementation applications. It will assist the personnel of power companies to implement the aging management activities at different phases of the lifetime of a power plant. It will provide systematic methods for planning, surveillance, inspection, monitoring, condition assessment, maintenance and repair of structures.	While this document is focused on containment and concrete structures there may be some cross over with mechanical aspects of the structures and the interfaces between them. However, this document may be more applicable to ONR376 and the review of Ageing & Degradation SAPs.
C-111	PSA Norway	CGI Report 06:21	Performance Monitoring of Systems and Active Components	This briefing report on the performance monitoring of systems and active components was prepared by the Chockie Group International as part of the project for The Petroleum Safety Authority Norway entitled, Design Life Extension Regulations (PSA Project Reference Number: NO 99B16). The objective of this report is to provide an overview of the nature of performance monitoring regulations within the United States nuclear power industry.	Given this document looks at Nuclear (mainly US) Experience the review of the document should focus on the conclusions and how the nuclear experience could be adapted to oil & gas. If this is not done and it is simply a summary of nuclear experience then this may have limited value.

ID	Source	Ref No.	RGP Title	RGP Summary	Notes
C-112	PSA Norway	CGI Report 06:22	Condition Monitoring of Passive Systems, Structures, and Components	This briefing report on the condition monitoring of passive systems and components was prepared by the Chockie Group International as part of the project for the Petroleum Safety Authority (PSA) Norway entitled, Design Life Extension Regulations (PSA Project Reference Number: NO 99B16). The objective of the report is to provide an overview of the life extension regulations within the United States nuclear power industry – in particular the regulations affecting the aging management of passive systems, structures and components. This report is a companion to a previous briefing report that the Chockie Group International prepared for the PSA entitled, Performance Monitoring of Systems and Active Components (CGI Report 06.21).	Given this document looks at Nuclear (mainly US) Experience the review of the document should focus on the conclusions and how the nuclear experience could be adapted to oil & gas. If this is not done and it is simply a summary of nuclear experience then this may have limited value.
C-113	PSA Norway	CGI Report 06:23	Aging Management and Life Extension in the US Nuclear Power Industry	This report on aging management and life extension actions within the United States (US) nuclear power industry was prepared by the Chockie Group International as part of the project for the Petroleum Safety Authority (PSA) Norway entitled, Design Life Extension Regulations (PSA Project Reference Number: NO 99B16). The objective of the report is to provide an overview of the development and application of aging management and life extension programs and regulations within the US commercial nuclear power industry.	Given this document looks at Nuclear (mainly US) Experience the review of the document should focus on the conclusions and how the nuclear experience could be adapted to oil & gas. If this is not done and it is simply a summary of nuclear experience then this may have limited value.

ID	Source	Ref No.	RGP Title	RGP Summary	Notes
C-114	PSA Norway	OSL-804-R04	Ageing of Offshore Concrete Structures	In total 27 fixed concrete platforms have been built for the North Sea of which 15 were for the Norwegian sector, 10 for the UK sector and 1 each in the Danish and Dutch sectors. Of these platforms, 1 was destroyed during the final stages of construction (Sleipner A) and 4 associated with the Frigg field have been decommissioned. In addition, there have been 2 platforms removed from the German Baltic Sea. There are also various templates and floating concrete structures in the North Sea. A listing of the oil industry's offshore platforms is contained at the back of this report. The first concrete structure to be installed in the Norwegian sector was the Ekofisk tank in 1973; the first to be installed on the UKCS was Beryl Alpha in 1975. Both of these are now over 30 years old. Life extension should therefore already be in place or under consideration for many of the structures to ensure they have capacity to continue operations and to act as bases for nearby subsea completions. Ageing is therefore a consideration for the continued long term integrity of these structures.	There is value in reviewing this document in more detail to see if there is learning from other high-hazard industries that can be applied to this task or ONR376.
C-115	PSA Norway	OSL-821-R02	Structural Integrity Barrier Management Capability Maturity Model	This document presents a tool for assessing the competence of an organisation in Structural Integrity Management required to ensure the safety of an offshore installation. The tool is intended to be used either by the regulator or an external auditor, but can equally well be used for self-assessment; it can be used in its entirety or elements of it can be used to assess particular departments or functions. The requirement for structural integrity is a regulatory requirement in its own right, but is also required to ensure the integrity of certain safety barriers required to prevent accidental events. As such the model described in this document can be used as part of the barrier integrity assessment of a barrier management audit.	There is value in reviewing this document in more detail to see if there is learning from other high-hazard industries that can be applied to this task or ONR376.

ID	Source	Ref No.	RGP Title	RGP Summary	Notes
C-116	PSA Norway	N/A	Ageing and Life Extension of offshore installations Conference September 2008	Various presentations to support a conference on Ageing & Life Extension in September 2008. Various presentations have been identified including sessions on: - Overview of work on ALE - Proposed Methodology - Safety Systems - Concrete Structures - UK HSE Experience & ALE Work	There is value in reviewing this document in more detail to see if there is learning from other high-hazard industries that can be applied to this task or ONR376.
C-117	PSA Norway	N/A	Safety and Inspection Planning of Older Installations	The document describes - State-of-the art for risk-based inspection methods - Development of new inspection planning methods for older installations The basic principles in reliability and risk based inspection planning are described. The basic assumption made in risk / reliability based inspection planning is that a Bayesian approach can be used. This implies that probabilities of failure can be updated in a consistent way when new information (from inspections and repairs) becomes available. Further the RBI approach for inspection planning is based on the assumption that in all future inspections no cracks are detected. If a crack is detected then a new inspection plan should be developed. The Bayesian approach and the no-crack detection assumption implies that the inspection time intervals usually become longer and longer.	There is value in reviewing this document in more detail to see if there is learning from other high-hazard industries that can be applied to this task or ONR376.

ID	Source	Ref No.	RGP Title	RGP Summary	Notes
C-118	PSA Norway	SINTEF A15322 ISBN: 978-82-14-04874-2	Ageing and Life extension for offshore facilities in general and specific systems	A large number of facilities and parts of the infrastructure on the Norwegian Continental Shelf (NCS) are approaching or have exceeded their original design life. Many fields, however, have remaining recoverable oil and gas reserves which may be profitable if the field's life time is extended. From a safety point of view, the condition of systems, structure and components (SSC) may not be acceptable for extended operation. The main objectives of this report are: • To give an overview of and discuss various aspects of ageing related to offshore facilities, the risk they represent to the integrity of a facility and how to deal with them in an LE process, i.e. the basis for deciding on LE. How to document the safety of an ageing facility, in particular, and how to uphold the safety level by means of a maintenance programme balancing the ageing mechanisms. • To identify possible knowledge gaps and suggest recommendations for those facing LE of offshore facilities.	There is value in reviewing this document in more detail to see if there is learning from other high-hazard industries that can be applied to this task or ONR376.
C-119	SMiRT	SMiRT 19, Toronto, August 2007 Paper # D01/2	Nuclear Power Plant Mechanical Components Ageing Management Programs in Slovakia	Safe and reliable operation should be kept during the whole nuclear power plant (NPP) operation. Some of most important means are provided us for this purpose by so called "ageing management programmes" (AMP). Ageing could be considered broadly in principle as time change of service–related characteristics and properties of equipment (mechanical components, structures, electrical and I&C systems), the computer systems (hardware and software), plant specifications and documentation, staff abilities and knowledge and information level. In our paper we will concentrate on problems of NPP mechanical components ageing only. We shall try to describe basic features of research project which have been carried out in Slovakia recently with the aim to develop AMPs for main mechanical components of WWER 440 NPP primary and secondary circuit.	Paper to be reviewed as part of future stages of the overall task.

ID	Source	Ref No.	RGP Title	RGP Summary	Notes
C-120	SMiRT	SMiRT-22 August 18-23 2013 (Div VI)	Nuclear Power Plant Concrete Structures	The paper aims at providing an account of evolution of NPP concrete structures in last two decades by summarizing the development in the areas of concrete technology and construction techniques, design methodology, maintenance and ageing management of concrete structures.	While this paper is focused on concrete structures there may be some cross over with mechanical aspects of the structures and the interfaces between them. However, this document may be more applicable to ONR376 and the review of Ageing & Degradation SAPs.
C-121	SMiRT	SMiRT-23 Manchester, United Kingdom August 10-14, 2015 Division VIII, Paper ID 548	Ageing Management of Concrete Structures in Nuclear Power Plants	Operating experience (OPEX) has shown that effective control of the ageing degradation of the major Nuclear Power Plant (NPP) components is important to plant safety and plant life; it is also important from economic point of view. Thus, ageing in NPPs must be effectively managed to ensure availability of design functions throughout plant life cycle. The paper describes main updates included in the new IAEA document (NP-T-3.5) and discusses good industry practices to ensure integrity of concrete structures during different NPP lifecycle phases; i.e. design, fabrication, construction, commissioning, operation (including long-term operation and extended shutdown), and decommissioning.	While this paper is focused on concrete structures there may be some cross over with mechanical aspects of the structures and the interfaces between them. However, this document may be more applicable to ONR376 and the review of Ageing & Degradation SAPs.
C-122	STUK	GUIDE YVL A.8	Ageing Management of a Nuclear Facility	The present Guide sets forth the requirements pertaining to the design, operation and maintenance activities conducted by the licensee (licence applicant prior to the granting of the construction licence) with regard to the ageing management of the systems, structures and components (SSC) of a nuclear facility, and describes the regulatory oversight by means of which STUK controls compliance with said requirements.	Issued 20 May 2014 Document to be reviewed as part of future stages of the overall task.

ID	Source	Ref No.	RGP Title	RGP Summary	Notes
C-123	WENRA	March 2011	Pilot study on Long term operation (LTO) of nuclear power plants	Many operators in Europe have recently expressed their intention to operate their nuclear power plants longer than foreseen by their original design (this is referred to in this document as “long term operation” or LTO). This happens in a context where new plants are under construction in Europe and where these new plants are designed to meet higher safety levels than the existing ones. Regulators will have to take position on the safety aspects of continued operation of nuclear power plants. To achieve better consistency between these positions, WENRA asked the Reactor harmonization working group (RHWG) to consider the issue of continued operation of existing nuclear power plants.	Learning from this task will have be incorporated into LTO programmes across the EU and the work will have been superseded by the ENSREG documents. Therefore, this will not be reviewed further.
C-124	WENRA		Topical Peer Review 2017 Ageing Management Technical Specification for the National Assessment Reports	The European Union’s Nuclear Safety Directive 2014/87/EURATOM (NSD) requires the member states to undertake topical peer reviews (TPR) every 6 years with the first starting in 2017. The member states, acting through the European Nuclear Safety Regulators Group (ENSREG), have decided that the topic for the first topical peer review is ageing management. The first stage of the peer review process is the production of a national assessment report for each country participating in the topical peer review, as required under item (a) above. This technical specification defines the structure and contents of the national assessment reports to facilitate an effective peer review. The other stages of the TPR are specified else-where (i.e. the Terms of Reference for TPR process).	ToR for Peer Reviews are presented in HLG_p(2016-33)_348 and like the ToR this document is considered not relevant to this task. The individual reports from member countries may provide some insight, but as they focus on Ageing Management significant effort may be needed to go through all of them to identify BDL information.

ID	Source	Ref No.	RGP Title	RGP Summary	Notes
C-125	WENRA		WENRA Safety Reference Levels for Existing Reactors - Update in Relation to Lessons Learned from TEPCO Fukushima Daiichi Accident	A principal aim of the Western European Nuclear Regulators' Association (WENRA) is to develop a harmonized approach to nuclear safety within the member countries. One of the first major achievements to this end was the publication in 2006 of a set of safety reference levels (RLs) for operating nuclear power plants (NPPs). WENRA is committed to continuous improvement of nuclear safety. To this end WENRA is committed to regularly revising the RLs when new knowledge and experience are available. In line with this policy the initial RLs were updated in 2007 and 2008. After the TEPCO Fukushima Dai-ichi nuclear accident, they have been further updated to take into account the lessons learned, including the insight from the EU stress tests. As a result, a new issue on natural hazards was developed and significant changes made to several existing issues.	Document to be reviewed as part of future stages of the overall task.