The UK Nuclear Industry Good Practice Guide To:

**OWNERSHIP & MANAGEMENT**

**OF**

**ALARP**



This Nuclear Industry Good Practice Guide was produced by the Safety Case Forum and published on behalf of the Nuclear Industry Safety Directors Forum (SDF)

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It is recognised that – through the experience of using this Guide – there may be  
comments, questions and suggestions regarding its contents.

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# Foreword

Demonstrating that risks have been reduced to a level that is ALARP (As Low as Reasonably Practicable) is a fundamental requirement and applies to all stages of the lifecycle of nuclear facilities. Accountability for reducing risk SFAIRP (So Far as is Reasonably Practicable) is defined by legislation through the concept of the ‘duty holder’. However, when putting this into practice during project delivery, and continued facility management, on nuclear licensed sites there remains some uncertainty over how the associated ALARP justification is shaped, developed and maintained throughout the life of a facility and how the responsibilities for ALARP are distributed throughout the range of business, technical, operational, safety and engineering specialists.

This guide does not attempt to re-define how ALARP demonstration is carried out, or answer questions such as “How do I know whether X is ALARP?” or “How far do I have to go to justify ALARP?”, rather it seeks to identify principles of ALARP demonstration which should be applied over the lifecycle of a Project, or Facility, to enable a balanced, coherent ALARP argument to be presented whenever required. This includes identifying where the ALARP “journey” starts and what the major milestones are for an ALARP demonstration within any project, or facility, lifecycle (e.g. option generation, viability, down selection, stage gate and/or periodic safety justifications). The following topic areas are covered:

* ALARP demonstration: leadership and accountability;
* Challenges and pitfalls when formulating and demonstrating an ALARP position;
* Effective managerial practices to ensure ALARP at all stages of the lifecycle of a facility;
* How the ALARP argument is framed by early hazard management strategy decisions;
* ALARP justification where many attributes and decisions affect the outcome;
* Presentation of the ALARP position.

The following key messages, arranged under the document section headings, are derived from the discussions held within a sub-group of the Safety Case Forum representing a range of safety case professionals from a number of Licensees and Authorisees.

Demonstration of ALARP at all Stages of a Facility Lifecycle.

* The early capability (Facility/Process) definition stage provides the best opportunity to ensure that inherent material hazards are ‘Eliminated’ or ‘Reduced’ via optioneering and design, and hence decisions taken are particularly important to the overall ALARP justification.
* An ALARP demonstration is not a back-end activity, it requires iteration and development over the lifecycle of a Project/Facility/Process, which should be prepared for, planned and managed, to the satisfaction of the duty holder.

Accountability/Ownership

* Site or Programme-wide strategic decisions may affect Project/Facility/Process ALARP arguments, and vice-versa.
* There is a legal responsibility on the duty holder to ensure the risk from a Project/Facility/Process is ALARP. People within the organisational structure typically have responsibilities to ensure the duty holder complies with the law.
* As progression is made through the lifecycle, the ALARP justification gets more complicated and the number of contributors increases – this needs to be recognised and effectively managed.
* An ALARP demonstration requires the balancing of different types of risk, at different levels. Contributors need to present their assessments and advice in a way which enables the duty holder to make these key decisions.
* Capturing decisions, and making visible, the key aspects of the ALARP justification is essential to enable the duty holder to ensure that an ALARP position is reached for the Programme/Project/Facility.

Hazard Management Strategy: Selection and Justification.

* Understanding and applying a preferred safety hierarchy (e.g. ERICPD) and recording the associated decision-making is the backbone of any ALARP justification. The early design stages present the greatest potential for risk reduction via the project/facility design decisions.
* In addition to the strategic considerations, selection and justification against Relevant Good Practice (RGP) and the use of sound engineering principles would normally form the basis of a solution which can be justified as reducing the risk to ALARP.
* Due to its high level of relative significance to the overall ALARP argument, significant onus (rigour, governance etc.) should be placed on ALARP justification of the option(s) selected at the early project stage-gate.
* Ensuring risks are ALARP may require overall solutions which are shaped by a number of influencing factors/constraints/specialisms. All assumptions should be rigorously underpinned.

Application of the principles in this document will assist in achieving desirable business outcomes including:

* Ease in provision of evidence of legal compliance;
* Clarity of accountability in decision making;
* Provision of an effective ALARP decision making framework for design and operation throughout all phases of a project and involving all relevant (internal and external) stakeholders;
* Consistency of approach to ALARP demonstration within the organisation;
* Provision of focused and robust ALARP justifications, generated through identifying, capturing and processing relevant data;
* Understanding the totality of risk, enabling resources to be targeted at the more significant risk reduction issues;
* The existence of an overall strategy for the provision of ALARP solutions, facilitating different disciplines to work towards a common aim;
* Hazard control strategies based on an understanding of potential options and the risk reduction and sacrifice associated with each.

The context and rationale behind these messages, along with some practical advice, is provided in this document, which is intended to complement existing regulatory and nuclear industry guidance. The following caveats apply:

* For legal guidance on ALARP in a nuclear industry context the ONR guide (Ref. 5) should be referred to in the first instance.
* There are interrelated legal duties which need to be met in addition to demonstrating health and safety risks are ALARP, e.g.: BAT requirement under environmental law.
* Some hazards are subject to specific regulations. An ALARP justification cannot be used to avoid compliance with legal requirements.

## Safety Directors Forum

In a sector where safety, security and the protection of the environment is, and must always be the number one priority, the Safety Directors’ Forum (SDF) plays a crucial role in bringing together senior level nuclear executives to:

* Promote learning;
* Agree strategy on key issues facing the industry;
* Provide a network within the industry (including with government and regulators) and external to the industry;
* Provide an industry input to new developments in the industry; and,
* To ensure that the industry stays on its path of continual improvement.

It also looks to identify key strategic challenges facing the industry in the fields of environment, health, safety, quality safeguards and security (EHSQS&S) and resolve them, often through working with the UK regulators and Government, both of whom the SDF meets twice yearly. The SDF members represent every part of the fuel cycle from fuel manufacture, through generation to reprocessing and waste treatment, including research, design, new build, decommissioning, care and maintenance and waste disposal. The Forum also has members who represent the Ministry of Defence (MoD) nuclear operations, as well as “smaller licensees” such as universities and pharmaceutical companies. With over 25 members from every site licence company in the UK, every MoD authorised site, and organisations which are planning to become site licensees, the SDF represents a vast pool of knowledge and experience which has made it a key consultee for Government and regulators on new legislation and regulation.

The Forum has a strong focus on improvement across the industry. It has in place a number of subject-specific sub-groups looking in detail at issues such as radiological protection, human performance, learning from experience and the implementation of the new regulatory framework for security. Such sub-groups have developed a number of Good Practice Guides which have been adopted by the industry.

## Sub-Group Description

This document is produced by the Safety Case Forum, which is a sub-group of the Safety Directors’ Forum. The Safety Case Forum was established in June 2012 and brings together a wide range of representatives of nuclear operators, from all the Licensees and Authorisees across the United Kingdom, including:

* Civil, commercial and defence activities;
* Design, operation and decommissioning of nuclear facilities;
* Research facilities.

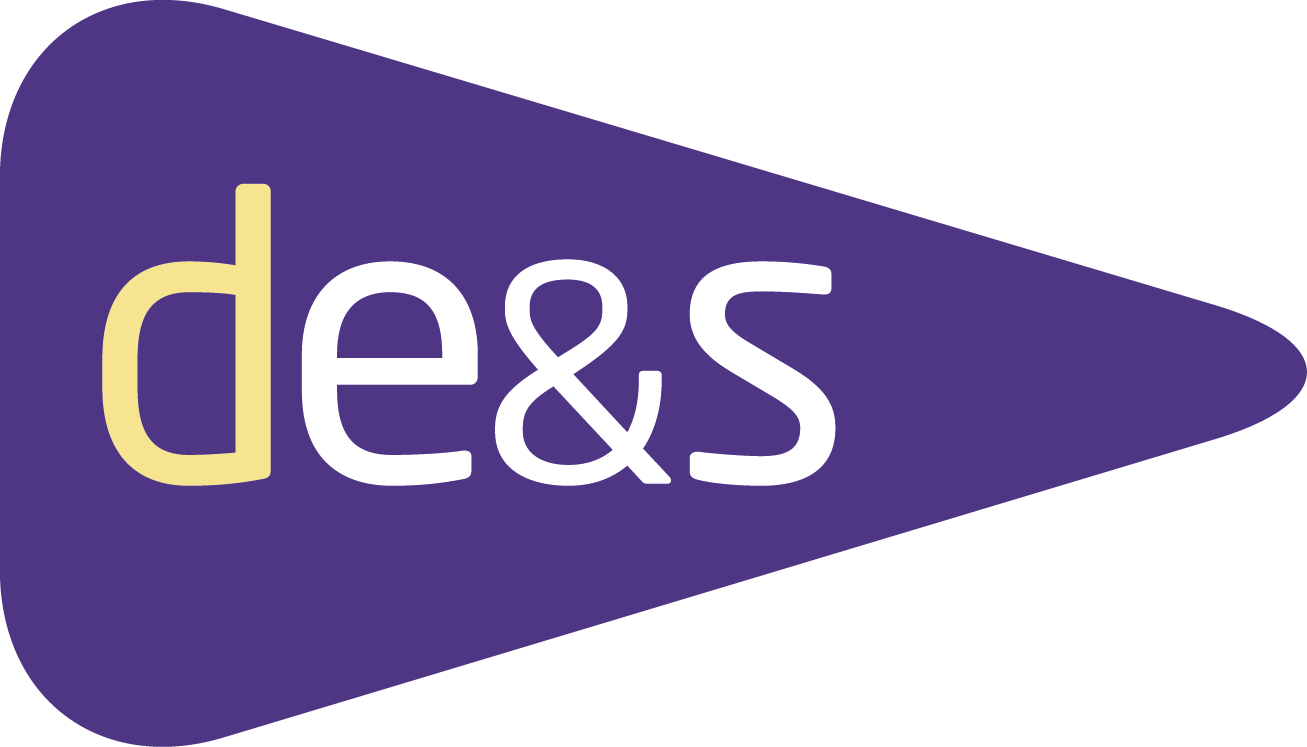
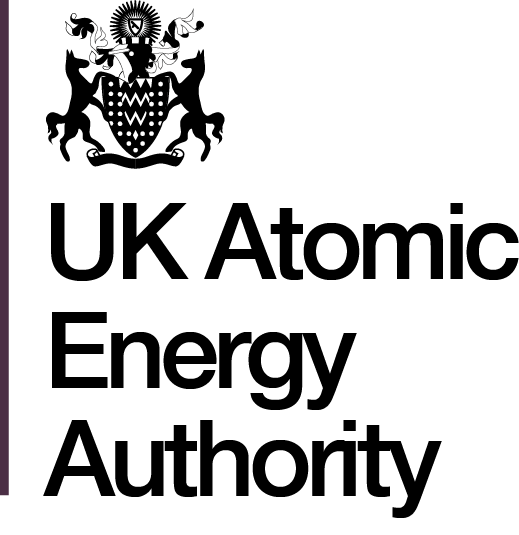
The purpose of the Safety Case Forum is to provide guidance that is useful to, and will benefit the widest possible range of UK nuclear operators.

Such guidance is not mandatory, nor does it seek to identify minimum standards. It aims to provide a tool kit of methods and processes that nuclear operators can use if appropriate to their sites and facilities.

These guides are intended to improve the standardisation of approach to the delivery of fit for purpose safety cases, while improving quality and reducing the cost of production. They are designed to cater for all stages of a facility’s lifecycle and for all processes within that lifecycle. This includes any interim, continuous and periodic safety reviews, allowing for the safe and efficient operation of nuclear facilities.

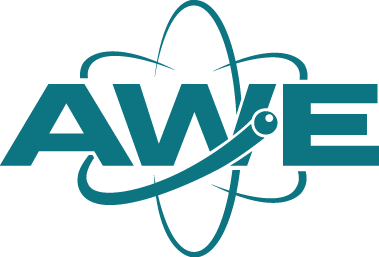
When using the information contained within these guides, the role of the Intelligent Customer shall always remain with the individual nuclear operator, which shall retain responsibility for justifying the arguments in their respective Safety Cases. The Office for Nuclear Regulation is a consultative member of the Safety Case Forum.

The following companies and organisations are participating members of the Safety Case Forum:

Safety Case Forum Guides are available on the Nuclear Institute Website:

<http://www.nuclearinst.com/SDF-safety-cases>

**Disclaimer**

This UK Nuclear Industry Guide has been prepared on behalf of the Safety Directors’ Forum by a Technical Working Group. Statements and technical information contained in this Guide are believed to be accurate at the time of writing. However, it may not be accurate, complete, up to date or applicable to the circumstances of any particular case. This Guide is not a standard, specification or regulation, nor a Code of Practice and should not be read as such. We shall not be liable for any direct, indirect, special, punitive or consequential damages or loss whether in statute, contract, negligence or otherwise, arising out of or in connection with the use of information within this UK Nuclear Industry Guide.

This guide is produced by the Nuclear Industry. It is not prescriptive but offers guidance and in some cases a toolbox of methods and techniques that can be used to demonstrate compliance with regulatory requirements and approaches.

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# 1 Introduction

Demonstrating that risks have been reduced to a level that is ALARP (As Low As Reasonably Practicable) is a fundamental requirement and applies to all stages of the facility lifecycle. Accountability for reducing risk SFAIRP (So Far as is Reasonably Practicable is defined by legislation through the concept of the ‘duty holder’. This requires that duty holders should be mindful of the “ALARP principle” and what practical arrangements are required through the project/facility lifecycle, in order to support periodic staged presentations of the “ALARP argument” that are carefully and comprehensively cross-referenced in order to provide a structured narrative. Processes applied by duty holders should therefore be driven to meet the proportionate demands of justifying ALARP at any given lifecycle stage of the project or facility.

This guide does not attempt to re-define how the demonstration of ALARP is carried out within other processes, rather, it seeks to identify principles for the demonstration of ALARP which should be applied over the lifecycle of a project, or facility, to enable a balanced, coherent ALARP argument to be presented whenever required. This includes identifying where the ALARP demonstration “journey” starts and the major milestones for ALARP demonstration within any project, or facility lifecycle (e.g. option generation, viability, down selection, stage-gate or periodic safety justifications).

Whilst the record of an ALARP justification may be co-ordinated by safety case professionals; the contributions to this justification will come from across all areas of a duty holder’s organisation, which could also include the supply chain.

Much of the guidance is framed in terms of the duty holder, who holds the legal responsibility, however this guidance is aimed at senior managers supporting the duty holder, for example in the roles identified below, as they establish the framework within which the safety and ALARP demonstration is delivered within an organisation:

* Business leaders;
* Operations/facility managers;
* Project clients/sponsors;
* Project and engineering managers.

If managed correctly an ALARP demonstration provides a narrative which is updated at each project stage-gate, or facility periodic review of safety, to describe the chosen option and the reasons behind the choice.

Appropriate ownership and management of ALARP will drive a demonstration which provides the reasoning and justification for why a given approach has been taken, rather than solely as a means of justifying why something has not been done.

It is important that ownership and governance of ALARP is clear within an organisation, at all levels, and that decision making & challenge around the ALARP principle is understood.

If the duty holder is presented with focused, accurate, proportionate and clear information at the right time, well informed decisions can be made, so avoiding subsequent compromises in the design and the overall ALARP position.

This Good Practice Guide builds on previous guidance as follows:

|  |  |  |
| --- | --- | --- |
| **Guide** | **Focus Area** | **Forum** |
| Application of ALARP to Radiological Risk” (Ref. 1) | ALARP in the context of radiological exposure | SDF Industry Radiological Protection Coordination Group (IRPCG) GPG |
| Guidance on the Demonstration of ALARP within a Nuclear Holistic Safety Case (Ref. 2) | ALARP justification in circumstances which require a balance of risks | NDA Safety Case Forum: Holistic Safety Cases Subgroup |
| The Periodic Review of Leadership and Management for Safety (Ref. 3) | Safety leadership and accountability within corporate structures | SDF Safety Case Forum |

Table 1: Relevant Previous Guidance

This guide considers the perspective of the duty holder balancing risks during various lifecycle stages and from a range of sources and aims to provide further guidance on:

* ALARP demonstration: leadership and accountability;
* Challenges and pitfalls when formulating and demonstrating an ALARP position;
* Effective managerial practices to ensure ALARP at all stages of the facility lifecycle;
* How the ALARP argument is framed by early hazard management strategy decisions;
* ALARP justification where many attributes and decisions affect the outcome;
* Presentation of the ALARP position.

## 1.1 Background to ALARP

The term ALARP arises from UK legislation, which requires that:

*“It shall be the duty of every employer to ensure, so far as is reasonably practicable, the health, safety and welfare at work of all his employees.”*

and

*“It shall be the duty of every employer to conduct his undertaking in such a way as to ensure, so far as is reasonably practicable, that persons not in his employment who may be affected thereby are not thereby exposed to risks to their health or safety.”*

The phrase ‘So Far As is Reasonably Practicable’ (SFAIRP) in this and similar clauses, is interpreted as leading to a legal requirement that any risk must be reduced to a level that is As Low As is Reasonably Practicable (ALARP).

Although not discussed within this guide, similar principles and practices to those described for ALARP demonstration also apply to the application of Best Available Techniques (BAT) as part of compliance with Environmental Law.[[1]](#footnote-1)

The legal framework in the UK is goal setting, except for a limited number of legal duties and regulatory requirements. It places the duty on the organisation (duty holder[[2]](#footnote-2)) introducing risk to ensure that risk is reduced where reasonably practicable to do so. Duty holders therefore apply their knowledge and judgement of their activities to meet these requirements, rather than comply with a set of prescriptive and predetermined standards. The UK has judged that this approach results in an ongoing drive to reduce risk giving an overall benefit to society.

Risks must be averted unless there is a gross disproportion between the costs and benefits of doing so. The key consideration in determining whether a risk is ALARP relates to the definition of ‘reasonably practicable’ i.e. the relationship between the risk and the sacrifice (in terms of time, trouble and cost) required to avert it. Including gross disproportion, means that an ALARP judgement in the UK is not a simple cost benefit analysis, but is weighted to favour carrying out the safety improvement.

## 1.2 Challenges and Pitfalls

This section introduces some of the potential challenges and pitfalls during lifecycle ALARP demonstration. Guidance on addressing these is provided in the ALARP Journey[[3]](#footnote-3) Section 2.

The principle of ALARP is relatively simple; action shall be taken to reduce a risk unless the sacrifice from doing so is grossly disproportionate to the reduction in risk. However, the application poses significant difficulties. Obtaining a true reflection of both risk and sacrifice can be challenging for a single hazard; consideration of the balance of the totality of hazards across a facility, programme or site, is a complex task with a number of challenges, as outlined below.

1.2.1 Accountability for ALARP

* Where within complex organisational, facility and project personnel structures, does accountability for ALARP actually lie?
* How does accountability vary where there are multiple components of risk? For example, there may be potentially conflicting requirements between facilities, programmes and sites. One, or more, may need to accept a higher risk for their area of responsibility to reach an overall ALARP position.
* How does accountability change dependent on the stage within the facility lifecycle?

1.2.2 Considerations when Judging ‘Reasonably Practicable’

* The role of Relevant Good Practice;
* Availability of data on risks, risk reduction and sacrifices;
* The potential effects of uncertainty in data;
* Risk tolerability.

1.2.3 How do we Communicate, to ensure:

* Decisions are made at the right level, with the right level of information being available to support the process;
* Solutions are determined taking into account all relevant risks such that the overall risk will be ALARP;
* Resources are targeted at areas of higher risk.

1.2.4 Clarity of Picture

There are significant challenges in estimating components of both risk and sacrifice. Safety, engineering and technical assessments can be conservative to varying levels and where there are uncertainties, margins are included to allow for this.

The degree of conservatism and uncertainty in a given risk is often not clearly captured, or communicated, making it difficult to compare different risks with confidence (e.g. do we know if we are weighing 7 against 10 or actually weighing 8 +/-1 against something which is probably 1 but could at worst case be 10).

In most cases it comes down to subjective judgement rather than a quantitative analysis (which itself has the potential to provide a misleading result due to the inherent uncertainty).

The sacrifice is also difficult to estimate and assumptions may be unclear. Over-design of a solution in order to meet prescriptive substantiation processes may result in rejection of an option which is presumed to be too costly in terms of time, cost and trouble when a simpler solution (e.g. commercial, ‘off the shelf’) would satisfy the requirements of ‘reasonably practicable’. This is illustrated in Figure 1 by the following analogy.

Figure 1: Building up a Picture from a number of narrow perspectives



1.2.5 Proportionality of Assessment

It is relatively easy to ask ‘what more could be done?’, but difficult to judge what is reasonable and proportionate in addressing this question. The degree or level of justification should be in proportion to the level of risk presented by the facility, process, or operation.

1.2.6 Communication and Information Flow

The scope of nuclear facilities and their operations is such that one individual cannot comprehensively consider the overall strategy and approach whilst also considering the detail of every decision which impacts on the ALARP demonstration.

Lower level technical decisions will be made by engineers and safety specialists in consultation with operators. Setting the context for these decisions is a challenge; inappropriate decisions can be made from a “coal-face” perspective where ‘reasonably practicable’ is judged in isolation from the overall ALARP position.

Conversely, it is necessary for specialists to be able to communicate to the duty holder the significance of departures from standards, criteria and RGP, so that the duty holder has a balanced view. A pitfall could be, that constraints set-out from an overall ALARP strategy may be seen as immovable, so that the strategy is implemented even when new information is revealed which renders the original strategy no longer ALARP.

Adequate capture and communication of these issues, at the appropriate level is required.

1.2.7 Stakeholder Awareness

Insufficient awareness from any stakeholders (be they regulatory or internal) can drive inappropriate results. An insular view, with focus on a specific aspect, may drive a solution which may seem ‘practicable’ but when viewed in the overall context is not reasonable. For example, reducing the risk from a dropped-load nuclear hazard when constructing near an operational facility, by avoiding the use of a crane, could result in an inappropriate increase in conventional safety risks, or, if a process or operation gives rise to the potential for an explosion, the radiological consequences may be relatively minor but there would be significant risk of physical injury, or death.

# 2 ALARP Journey

## 2.1 Introduction

The concept of the ALARP “journey” and “destination” provides a framework within which to manage the ALARP decision making process throughout the lifecycle of a facility. The journey comprises a series of safety decisions and justifications which have to be made according to a hierarchy of controls. An example of such a hierarchy when designing for safety in normal operations is ERICPD (Eliminate, Reduce, Isolate, Control, Protect and Discipline). A similar preferential hierarchy is used when analysing the operation and selecting safety measures against fault conditions.

For new build, each stage of the ALARP justification will interface with the previous and subsequent stage(s) and will involve a number of inter-related justifications.

In outline, for new facility design, there are three stages to the ALARP journey, they are:

1. **Stage 1 (Programme/Business):** The Strategy, the Capability; the “Business Need” including Strategic ALARP factors such as doing ‘the right thing at the right time’. The justified option will constitute the baseline for the facility/process design in Stage 2.

The early capability (facility/process) definition stage provides the best opportunity to ensure that inherent material hazards are ‘Eliminated’ or ‘Reduced’ via optioneering and design and hence decisions taken are particularly important to the overall ALARP justification.

1. **Stage 2 (Project):** Facility/Process/Equipment. Focus on opportunities to Eliminate, Reduce, Isolate and Control the inherent material hazards by virtue of the normal process design.  This stage may also introduce hazards which themselves need to be managed (e.g. conventional hazard of lifting shielded flasks).
2. **Stage 3 (Facility):** Selection of Safety Measures. Focus on the provision of safety measures to manage the residual hazards which cannot be Eliminated, Reduced or Isolated any further.

Figure 2: ALARP Journey for a New Facility Design



## 2.2 Demonstration of ALARP at all Stages of a Facility’s Lifecycle

The ALARP journey continues beyond facility design into subsequent lifecycle phases. The lifecycle of a facility can be described as follows.

* **Design Stage 1** – Front End Development/Studies/Informing a capability business case and including a justification that it is the right project at the right time.
* **Design Stage 2** – Identifying options for further investigation and down-selection (Concept).
* **Design Stage 3** – Development of a single technical option and determining the requirements and defining the solution (Preliminary/Detailed Design).
* **Construction/Commissioning** – Delivering the solution and implementing the equipment and infrastructure.
* **Operations** – Operate the facility, support and maintain the equipment.
* **Decommissioning** – Withdrawal from service and disposal of equipment.

This may be mapped onto the staged safety case submissions where the ALARP journey is applied (see Figure 3).

The requirement to demonstrate that risks have been reduced to a level that is ALARP applies to all stages of the lifecycle of any facility. The means of doing so should be proportionate to the level of risk presented. To demonstrate an ALARP position a number of steps may be required. For example, determining options for risk reduction at a facility level, process level, or safety controls level, consideration of good practice and its relevance to the situation, judging whether these options are ‘reasonably practicable’ and then following-through on the implementation of the chosen options.

In addition, the ALARP demonstration is not static but should consider changes as projects and facilities evolve, risks are assessed and technology changes. All project, design and operational decisions affecting safety throughout a project, or facility, therefore have to be underpinned by a consideration of risk reduction to deliver an overall solution which reduces the risk to ALARP.

An ALARP demonstration is not a back-end activity, it requires iteration and development over the lifecycle of a project, facility or process, which should be prepared for, planned and managed, to the satisfaction of the duty holder.

The following section discusses some of the aspects of the ALARP journey that are pertinent at each of the lifecycle stages, where ‘ERICPD’ refers to the hierarchy of controls (see Figure 5 under ‘Hierarchy of Controls’).

# 3 Key Themes

There are a number of key themes that relate to management of the ALARP demonstration. At each stage of the lifecycle, there are different aspects of these themes that come into play, these are outlined in the following sections.

## 3.1 Accountability/Ownership

Throughout the ALARP journey, there will be interdependencies between the business, technical and safety requirements, and thus all these stakeholders need to be involved in the decision-making right from the start.

The key drivers for decision making, and the associated ALARP justification, will shift as the ALARP journey through a new facility design progresses, as illustrated in Figure 4. For example, the key decisions relating to ALARP will change from those taken at a strategic/business level, to those taken by technical and safety teams, as the facility design develops.

Site or programme-wide strategic decisions may affect Project/Facility/Process ALARP arguments, and vice-versa.

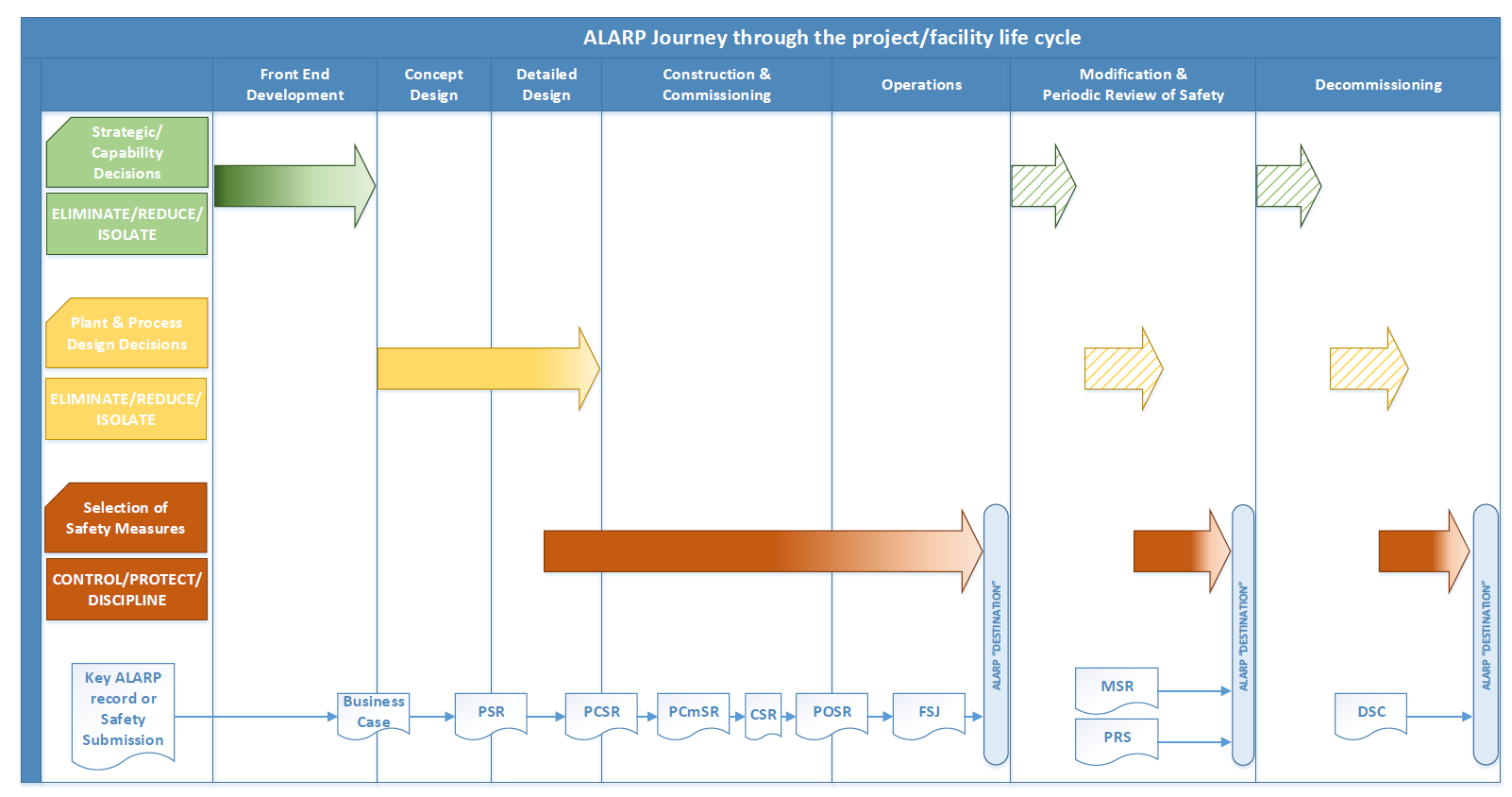
Figure 3: Indicative ALARP Journey through the Project / Facility Lifecycle[[4]](#footnote-4)[[5]](#footnote-5)

Figure 4: ALARP Key Drivers that Vary during the ALARP Journey



## 3.2 Personnel

The legal responsibility to ensure risk is ALARP is held by the duty holder; however, an ALARP justification requires input, and expertise, from many levels within the organisation, facility or project. Establishing who, and which specialism, within a facility or project team is accountable for the information which enables an ALARP position to be established, is important in ensuring that the case hangs together, and is not skewed unduly toward one aspect, or hazard.

The following considerations are important to the ability to effectively develop an ALARP position:

* Universal recognition and understanding of accountability for ALARP demonstration (self and interfacing roles);
* Directors and programme boards should recognise the impact of self-imposed targets and constraints on the ability to demonstrate that risks are ALARP;
* Engineers, safety assessors and other specialists need to provide definitive conclusions which enable a decision to be taken by the duty holder.

In the case of a new facility under design, support to the duty holder would be provided by people in key roles such as the Client, Project Sponsor (for the project, programme, or site) making the business case.

During the operational stage the key duty holder support role is carried out by the person with overall accountability for safety on the facility (e.g. Safety Case Owner).

There is a legal responsibility on the duty holder to ensure the risk from a project/facility/process is ALARP. People within the organisational structure typically have responsibilities to ensure the duty holder complies with the law.

## 3.3 Trust and Collaboration

The key to arriving at an ALARP position at any given stage, is to establish trust and respect at all levels throughout the team. This ensures that each individual’s contribution to the ALARP conclusion is respected and gets a fair hearing. At the same time the representatives from the individual specialisms must respect the ability of the duty holder, to choose not to fully implement their advice, if it detracts from an optimised ALARP solution. Trust and collaboration can be improved through:

* Maintaining long-term team continuity;
* Enabling a problem-solving environment during early project phases before entering ‘project delivery mode’;
* Regular communication forums and team-building exercises;
* Provision of clear and concise technical arguments so that the duty holder can readily assimilate information from a number of specialisms, or business areas.

As progress is made through the lifecycle, the ALARP justification gets more complicated and the number of contributors increases – this needs to be recognised and effectively managed.

## 3.4 Decision Making and Challenge

Decision makers need to be aware, of how ensuring that risks remain ALARP may impact on other business performance indicators, or commercial drivers. It should be recognised that any business decision carries uncertainty until after an iterative ALARP justification has been undertaken. In addition, more than one option may need to be taken forward in development to the next stage, if more information and analysis is required on which to base a final decision.

The definition of which body, and process, will exercise governance over the decisions arising from the ALARP assessment, needs early consideration. The decision-making and governance processes need to be suitable to enable an integrated approach between competing solutions, individually tailored for nuclear safety, environmental, conventional safety, etc. See also ‘Hazard Management Strategy’ below.

An ALARP demonstration requires the balancing of different types of risk, at different levels. Contributors need to present their assessments, and advice, in a way which enables the duty holder to make these key decisions.

In addition to the owners and decision makers, communications with the wider stakeholder group as to the outcomes of the ALARP demonstration will be required at each stage. Stakeholders may vary with each stage of the ALARP journey, for example, as greater design detail emerges there may be a need to engage with a wider range of technical and regulatory specialists. Following implementation and into operations, the audience will be narrower, reflecting the reduction in the scope of stakeholders able to influence the ALARP position.

## 3.5 Records, Documentation, Justification and Knowledge Transfer

The retention of records and information which serve to underpin the ALARP justification is important at all stages of the lifecycle. During early design the emphasis is on recording decisions that affect the hazard management strategy. Decision-makers should record (and make available) the basis for their decisions. It is important to provide a record of options not taken forward, as well as those that are.

Using tools and techniques to monitor ongoing risks and recording these correctly is important to enable ALARP demonstration during an operational phase (e.g. managing the risk of operational conflicts during maintenance activities).

Capturing decisions and making visible key aspects of the ALARP justification is essential to enable the duty holder to ensure that an ALARP position is reached for the programme, project, or facility.

# 4 Hazard Management Strategy: Selection and Justification

The ALARP argument should be comprehensive, inclusive of all hazard types, and based on a Hazard Management Strategy (HMS) that provides an optimum balance between nuclear, non-nuclear and environmental hazards. There should be an understanding of the type and level of risk, so that effort can be focused on the key risks (not all risks will need the same attention at the same level).

As the maturity of the option and the design develops, there will be fewer opportunities presented to eliminate, or reduce, the inherent material hazards of the process.

## 4.1 Hierarchy of Controls

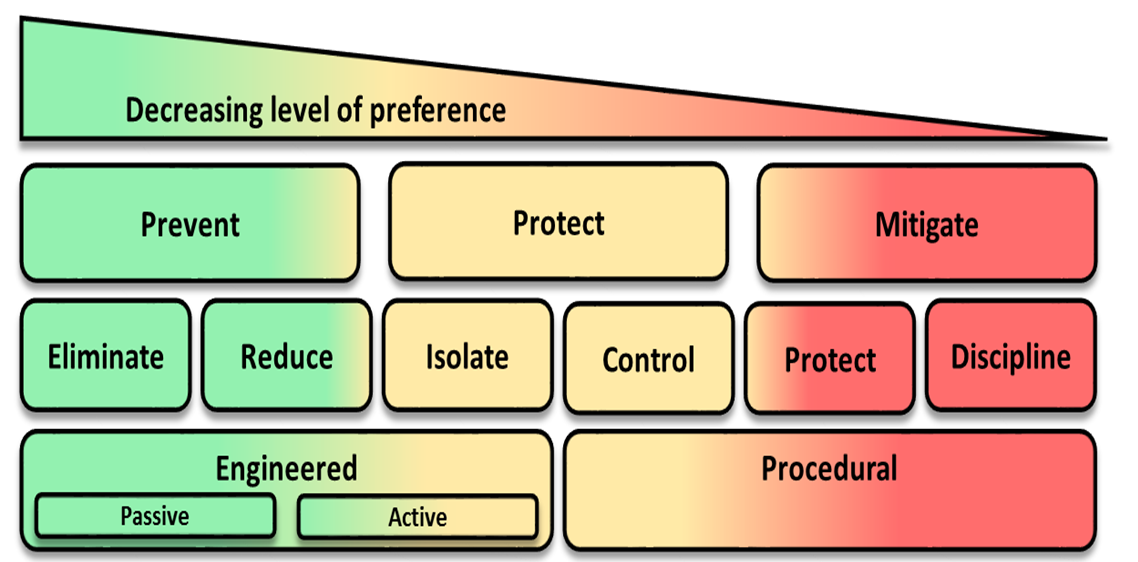
During the design and hazard management strategy development there is a preferential hierarchy.

Where the unprotected hazard consequence is high, and there is a significant divergence from RGP, a detailed justification is required.

Understanding and applying a preferred safety hierarchy (e.g. ERICPD) and recording the associated decision-making, is the backbone of any ALARP justification. The early design stages present the greatest potential for risk reduction via project, or facility design decisions.

Sequential and chronological application of a preferred safety hierarchy such as the ERICPD concept of Eliminate, Reduce, Isolate (e.g. segregation of personnel), Control, Protect (with PPE, etc.) and application of Discipline (operational controls) to manage hazards, is fundamental to the way in which risks are assessed and control measures identified, and implemented, in order to achieve an outcome that can be justified as ALARP.

Figure 5: Examples of Preferential Safety Hierarchies



## 4.2 Relevant Good Practice

Selection and justification against ‘Relevant Good Practice’ goes a significant way toward demonstrating risks are ALARP.

In addition to the strategic considerations, selection and justification against Relevant Good Practice (RGP) and the use of sound engineering principles would normally form the basis of a solution which can be justified as reducing the risk to ALARP.

RGP compliance is likely to be sufficient to meet the minimum standard set in law. The challenge is generally in justifying whether the technology, or technique, is relevant to the particular application.

RGP for non-nuclear safety is generally easier to ascertain than for nuclear safety because there is more likely to be a directly (and obviously) relevant standard available. Hence the ‘relevancy’ aspect is easier to justify with confidence.

For the nuclear industry, hazard scenarios are often unique, requiring bespoke design solutions, so that there are not always specific industry-wide standards which are directly relevant. Examples can however be found, in some design areas such as ventilation systems, gloveboxes and transport packages, but even these may not address the entirety of the design solution and hazard management requirements.

RGP may also relate to the assessment tools, standards and criteria adopted.

An ALARP demonstration will always be context-specific, e.g. what is acceptable today, may, because of advancing technology and changing expectation, not be acceptable at some point in the future.

The stage of the project, or facility lifecycle, the point at which you find yourself in the ALARP journey, plays a significant part in deciding the level of justification required for the selected design solution. In general, the level of justification for the solution should be greater at the beginning of the ALARP journey, as these early ALARP decisions are more fundamentally significant and form the foundations upon which all subsequent decisions are built.

Due to its high level of relative significance to the overall ALARP argument, significant onus (rigour, governance etc.) should be placed on ALARP justification of the option(s) selected at the early project stage-gate.

Similar differences between the levels of the required justification may exist depending on the available options for addressing shortfalls found during the operational phase of a facility, or process.

## 4.3 Risk

Risk assessment in its broadest sense is a fundamental part of any facility, or process modification design process. Designs should seek to reduce risks SFAIRP firstly by reducing the consequences and secondly by reducing the likelihood.

Challenges arise with trying to understanding the overall ALARP picture and achieving a balance across a number of influencing factors, and specialisms, which determine the optimum solution. Nuclear design and engineering projects often require specialist assessment to quantify risk (e.g. environment, multiple safety disciplines, etc.).

[Ref. 2] provides specific guidance relating to the balancing of risks from different hazards, along with a number of case studies.

Ensuring risks are ALARP may require overall solutions which are shaped by a number of influencing factors, constraints or specialisms. All assumptions should be rigorously underpinned and recorded.

Some hazards are subject to specific regulations, compliance against which may influence the optimum engineered solution. An ALARP justification cannot be used to avoid compliance with legal requirements.

The level of effort expended in undertaking an ALARP assessment, and the level of detail presented in the justification should itself be suitable and sufficient to the circumstances being considered and balanced against the level of risk (see HSE framework for the tolerability of risk and the associated guidance on the proportionate justification of reducing risk to ALARP – Reference 6).

At a low level of significance a statement of the applicability of relevant good practice may suffice, but for highly nuclear safety significant, high risk, or complex issues, a detailed, rigorous and comprehensive ALARP justification is likely to be required.

# 5 Communication – Clarity of Argument

The level of ALARP demonstration detail can be tailored for different audiences, this may result in different layers of documentation. Clarity of the presentation of the ALARP argument can be improved through the use of a ‘Claims, Arguments, and Evidence’ format – see Appendix 1 “ALARP Justification Documentation” for guidance on how to present the argument.

# 6 Glossary

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| **Term** | **Definition** |
| ACOP | Approved Code of Practice. |
| ALARP | As Low As Reasonably Practicable.  *It is recognised that using “ALARP” as a way of describing safety case processes (e.g. ALARP justification, ALARP argument etc.) is not legally precise terminology. However, this terminology has been adopted in this guide as short hand when discussing arrangements for ensuring* ***risk*** *is ALARP, as this has become custom and practice within the nuclear industry.* |
| BAT | Best Available Techniques. |
| BEIS | (Department of) Business, Energy and Industrial Strategy. |
| CAE | Claims, Arguments, Evidence. |
| DECC | Department for Energy and Climate Change (Now BEIS). |
| Duty Holder: | The legal entity which holds the duty under H&SWA. |
| ERICPD | Eliminate, Reduce, Isolate, Control, Protect (with PPE, etc.) and apply Discipline. |
| GPG | Good Practice Guide (Nuclear Industry Safety Directors Group). |
| Hierarchy of Controls: | Preference for differing potential controls to manage hazards / risks. Typically, these will express a preference for passive, engineered controls over active operational controls and controls which prevent rather than mitigate a fault condition. |
| HMS | Hazard Management Strategy. |
| IRPCG | Industry Radiological Protection Coordination Group (NI SDF Sub-Group). |
| P-SHAPED | Preparation, Succinct, Home-grown, Accessible, Proportionate, Easy to understand and Document-lite. |
| RGP | Good practice as judged by the duty holder through an understanding of the industry, legal precedents and regulations / regulatory engagement which, when applied to engineering or operations can be shown to be relevant to the situation being considered. |
| SCF | Safety Case Forum. |
| SDF | Safety Directors Forum. |
| SFAIRP | So Far As Is Reasonably Practicable. |
| YNPF | Young Nuclear Professionals Forum. |

# 7 References

|  |  |
| --- | --- |
|  | **Title** |
|  | “Application of ALARP to Radiological Risk”, Issue 1, December 2012, Nuclear Industry Safety Directors Forum Sub-Group: Industry Radiological Protection Co-ordination Group (IPRCG). |
|  | “Guidance on the Demonstration of ALARP within a Nuclear Holistic Safety Case”. A B Buchan and I A Sadler. 05/02/10. |
|  | “The Periodic Review of Leadership and Management for Safety” Good Practice Guide, Issue 2, March 2020, Nuclear Institute Safety Directors Forum Sub-Group: Safety Case Forum (SCF). |
|  | “Best Available Techniques for the Management of the Generation and Disposal of Radioactive Wastes”, Issue 1, 2010. Nuclear Industry Safety Directors Forum Sub-Group: Environment Agencies Requirements Working Group (EARWG). |
|  | “Risk informed regulatory decision making” ONR, 2017. |
|  | “Reducing Risks, Protecting People” HSE, 2001. |
|  | “Right First Time Safety Cases: How to Write a Useable Safety Case”, Issue 2, March 2020, Nuclear Industry Safety Directors Forum Sub-Group: Safety Case Forum (SCF). |

# APPENDIX A: ALARP Justification Documentation

This section provides guidance on the format of the ALARP justification document including general topics to cover factors which need to be considered and other areas that should be addressed.

A1 Proportionate Documentation.

The depth of the ALARP arguments, and therefore the way in which these arguments are presented, should be proportional to the hazards, risks, and complexity of the Facility, systems, processes or equipment under consideration.

The depth of the argument will also be dependent on the lifecycle stage, e.g. risks may be less well understood at the early stages of a new-build project; risk will change throughout a decommissioning project. The following guidance should therefore be applied proportionately bearing in-mind the additional guidance in the SCF P-SHAPED safety case presentation guide [Ref. 7].

In many cases, the safety case is the ALARP justification document.

A2 Justification Documentation.

The scope of the ALARP justification document should cover the entirety of the activities, or projects, to be justified by the overall safety case, or modification, being careful to specifically identify the physical, and time related boundaries for the justification.

The key decisions and their justifications shall be recorded with suitable and sufficient information in order to clearly demonstrate that risks are ALARP and (where appropriate) “BAT” has been utilised and implemented.

The ALARP justification document should explain, in simple terms, the claims being made, the arguments that support these claims, and it should make reference to the evidence in subsidiary documents that supports the validity of the arguments.

The ALARP argument should summarise the risk reduction measures that have been applied throughout the safety assessment process in order to demonstrate that the risks are tolerable and “ALARP” and that (where appropriate) “BAT” has been applied. Depending on the lifecycle phase (and hence the ALARP justification focus) this should summarise how the design has been informed by the safety assessment process and developed to eliminate, or where this is not practicable, to reduce risks so far as is reasonably practicable.

Confirmation should be provided that the safest reasonably practicable option has been selected for each activity and associated facility/equipment, which is not grossly disproportionate in terms of cost, time and trouble. A balanced view of the positive and negative aspects of the ALARP solutions should be provided, along with the challenges and the solutions.

Adherence to relevant good practice, and the use of sound engineering judgement, will form the basis of a robust ALARP justification. Where necessary this can be supported by a number of tools and techniques such as Cost Benefit Analysis, Multi Attribute Decision Analysis, Probabilistic Safety Assessment, and Design Basis Accident Analysis.

The discussion of ALARP within the safety justification should be sufficiently thorough to demonstrate that a logical, systematic and comprehensive approach has been adopted; to ensure that the judgements made, and the conclusions reached, are explicit and visible.

The detail of the ALARP arguments may be provided in lower tier documentation, which may focus on one, or more, aspects of the facility, or operation (e.g. containment system, ventilation system, glovebox). The lower tier documentation should provide the detailed arguments behind the information presented in the main document, and shall provide extensive references to the evidence in support of the detailed arguments.

When considering the principle of ALARP, the assessment required and the argument to be presented, then the extent of the documentation should be proportionate to the requirement, just as the effort expended on demonstrating ALARP should be consistent with the risk being addressed.

The general topics for inclusion include:

* Scope and boundaries of the project, or facility and the issues being addressed;
* Lifecycle stage (and updates since the previous stage);
* Identify and be clear on the hazards and levels of risk being considered;
* Identification of the Assumptions and Constraints applied to the project;
* Description of the methodologies used in the optioneering and decision-making processes, and the factors considered in assessing the options;
* Justification of the selection and ranking of attributes in a multi-attribute analysis;
* Evidence that a thorough and comprehensive options identification process has been conducted (supported by evidence in lower tier documentation);
* Evidence that all relevant stakeholders have had an appropriate input into the process;
* Focus on management of the more significant hazards and risks;
* Summarise the ALARP justification decisions from the previous stages of the ALARP journey that underpin the validity of the residual hazard to be managed at this stage.

The factors that should be considered for inclusion in the ALARP argument are:

* Inclusion of hazards from both normal and fault conditions;
* Identification of Relevant Good Practice and confirmation that it is directly relevant;
* The engineered features and key operational controls that are required;
* Describe how the hierarchy of controls has been appropriately considered and highlight any significant deviations from the principles (e.g. reliance on discipline rather than engineered protection);
* Discuss the assessment against modern standards, highlight any significant deficiencies;
* A summary discussion of the options considered to address any weaknesses in the arguments;
* The results of any quantitative analysis (e.g. multi-attribute analysis) and the reasoning for the decisions that have been made (supported by evidence in lower tier documentation);
* Reasons for the selection of the final option(s), including appropriate substantiation for the decisions made;
* Justification for rejecting options as not viable, or not reasonably practicable;
* Qualitative justification for the selection of the option, comparing benefits against sacrifice (including gross disproportion) with input from Cost Benefit, if appropriate;
* Justifying any divergence from the optimum attributes;
* Explain why more improvements cannot be made and explain any associated cost implications and considerations;
* Discuss any residual levels of risk that cannot be reduced further;
* If the Basic Safety Objective (BSO) or other relevant acceptability criteria cannot be achieved, explain why;
* Any significant margins or uncertainties should be highlighted.

In bringing the justification together, the following will need to be addressed:

* Recommendations (programme of improvements with justified timeframes and priorities);
* Balance of risk from different hazard types (e.g. safety, environment, security);
* Balance of risks to different exposure groups;
* Balance of risk between normal and accident conditions;
* Interim justification (including any interim arrangements);
* State the overall conclusion as to whether risk is “ALARP, based on the evidence provided” or “ALARP subject to the implementation of the improvements identified”;
* Consideration of all future stages including POCO, decommissioning and waste management.

1. See Reference 4 for further information about BAT and requirements under environmental law. [↑](#footnote-ref-1)
2. Reference 5 sets out ONR’s risk informed framework and its role in their regulatory decision making, it includes the context of the framework in relation to different elements of the life-cycle of a nuclear facility. It also describes factors that are considered in reaching a regulatory decision that may be broader than those duty holders are expected to take into account in complying with the law. [↑](#footnote-ref-2)
3. The “ALARP Journey” has been used to describe the application of ALARP through the lifecycle of a facility or operation. It covers all stages in the lifecycle from concept through to decommissioning. [↑](#footnote-ref-3)
4. “Strategic/Capability decisions at the front end, include ensuring that the right job is being proposed, at the right time.” [↑](#footnote-ref-4)
5. Safety Case Submissions relate to a commonly recognised process and have been abbreviated in the diagram above. These can be expanded as follows, where ‘SR’ is ‘Safety Report’, ‘Preliminary SR, Pre-Construction SR, Pre-Commissioning SR, Commissioning SR, Pre-Operations SR, Final Safety Justification, Modification SR, Periodic Review of Safety, Decommissioning Safety Case [↑](#footnote-ref-5)