

# Guidance Note on Dam Safety Management



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We acknowledge and respect Victorian Traditional Owners as the original custodians of Victoria's land and waters, their unique ability to care for Country and deep spiritual connection to it.

We honour Elders past and present whose knowledge and wisdom has ensured the continuation of culture and traditional practices.

DEECA is committed to genuinely partnering with Victorian Traditional Owners and Victoria's Aboriginal community to progress their aspirations.



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# Revision History

Version	Date	Author	Approval	Description of Revision
1.0	2012	DSE	Executive Director, Rural Water and Governance	Initial document created and titled Guidance Note on Dam Safety Decision Principles
1.1	March 2015	DSE		Minor updates
2.0	July 2024	DEECA	Executive Director, Partnerships and Sector Performance	Title changed to Guidance Note on Dam Safety Management Updated to align with Strategic Framework for Dam Safety Regulation July 2024



# Contents

<b>Summary</b> .....	<b>3</b>
<b>1. Introduction</b> .....	<b>4</b>
1.1 Purpose .....	4
1.2 Background .....	4
1.3 Structure .....	5
<b>2. Risk Management and Dam Safety in Victoria</b> .....	<b>6</b>
2.1 Risk-informed regulation .....	6
2.2 Understanding risks .....	6
2.3 Risk management, engineering standards and standards-based approach.....	7
2.4 Considerations for very high consequence dams .....	8
<b>3. Risk Management Process and Roles</b> .....	<b>9</b>
3.1 Holistic risk management .....	9
3.2 Risk management process and role clarity .....	9
3.3 Department - Dam Operator interaction.....	11
<b>4. Risk Reduction Principles</b> .....	<b>12</b>
4.1 Affordability .....	12
4.2 Progressive improvement .....	12
4.3 Prioritising upgrades .....	13
4.4 Timing of risk reduction measures .....	14
4.5 Risk assessment uncertainty .....	15
<b>5. Risk Management, the SFAIRP Approach and Good Practice</b> .....	<b>16</b>
5.1 Tolerable risk and the SFAIRP approach .....	16
5.2 Recognised good practice .....	20
5.3 Dam Safety Management System .....	21
5.4 Cost-benefit and gross disproportionality.....	21
5.5 Societal concerns.....	22
5.6 Safety case .....	23
<b>6. Systemic Approach to Dam Safety</b> .....	<b>25</b>
<b>7. Investment Decision Making for Organisations</b> .....	<b>26</b>
<b>8. Glossary and Acronyms</b> .....	<b>28</b>
<b>9. References</b> .....	<b>32</b>
<b>Appendix 1: Dam Safety Management System</b> .....	<b>34</b>

# Summary

This guidance note aims to assist dam operators<sup>1</sup> to make key dam safety investment decisions. It provides guidance on how dam operators can prudently reduce dam safety risk so far as is reasonably practicable (SFAIRP)<sup>2</sup> through having recognised good dam safety practices and applying focussed and proportionate investment.

It provides supplementary advice to existing regulatory instruments, strategic framework and guidelines.

The safety of dams owned by Victoria's water corporations is regulated through Statement of Obligations (SoOs) issued to water corporations by the Minister for Water under the *Water Industry Act 1994*. The SoOs have regard to dam safety guidelines prepared by the Australian National Committee on Large Dams (ANCOLD).

The safety of privately owned dams and dams owned by local government authorities is regulated through licensing arrangements under section 67 of the *Water Act 1989*. Guidance to Licensing Authorities who issue licences is provided by the Minister for Water through the *Policies for Managing Works Licences*.

The Department of Energy, Environment and Climate Action (Department) is the lead agency for regulating dam safety in Victoria and provides updated guidance through the Department's *Strategic Framework for Dam Safety Regulation DEECA (2024)* which takes precedence where differences arise with ANCOLD guidelines and through this guidance note and other Department guidelines.

Decisions about ensuring tolerable dam safety, management improvements and investment about dam safety programs can be complex because of uncertainty:

- in assessing whether current or proposed risk levels satisfy the SFAIRP approach;
- about appropriate timeframes to achieve tolerable dam safety levels; and
- about whether dam safety standards and expenditure are proportionate with standards applied to other areas of public safety particularly where high and extreme consequences can occur.

This guidance note also intends to promote transparent processes for assessing adequate dam safety levels and their management and making efficient and appropriate investment in dam safety.

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<sup>1</sup> Throughout this document the individual/s and/or entity that has primary ownership and/or management and operational responsibility for a dam is referred to as the dam operator. This has the same definition as in reference DEECA 2024 (*Strategic Framework for Dam Safety Regulation*).

<sup>2</sup> So Far As Is Reasonably Practicable (SFAIRP) is required under Victorian Workplace Health and Safety, and Environmental legislation. In ANCOLD's view, the way in which ALARP is addressed in its guidelines makes it equivalent to the common understanding of the requirements to reduce risks SFAIRP. Refer DEECA 2024 for details on the relationship between ANCOLD ALARP and SFAIRP approach.

# 1. Introduction

## 1.1 Purpose

This guidance note aims to assist dam operators to:

- ensure recognised good practices are in place;
- better understand the *Strategic Framework for Dam Safety Regulation* (DEECA (2024)) including the application of ANCOLD guidelines and other relevant guidance such as ICOLD Bulletins; and
- make key dam safety investment decisions.

It focusses on better understanding of the SFAIRP approach and clarifies investment timeframes and appropriate safety levels. It assumes that the reader is familiar with the broad topics of dam safety and risk management.

This document is an update of the March 2015 *Guidance Note on Dam Safety Decision Principles* and incorporates updates from DEECA (2024) and ANCOLD's *Guidelines on Risk Assessment* (2022) and several more recent ICOLD Bulletins. It is also consistent with the Victorian *Occupational Health and Safety Act 2004* and the *Environmental Protection Act 2017* as well as Australian *Work Health and Safety Act 2011*, all of which require risks to be eliminated or reduced SFAIRP.

This guidance note supplements existing guiding documentation available to Victorian dam operators including regulatory instruments, the Department's current dam safety documents, ANCOLD Guidelines and other publications. These documents are listed in DEECA (2024).

While primarily directed toward the Victorian water corporations, this guidance note is relevant to all operators of dams (whether large or small) with an ANCOLD Consequence Category of High or greater or with a high risk of failure. Regardless, operators of all dams are encouraged to follow practices contained in this guidance note.

## 1.2 Background

Under the *Water Act 1989* dam operators are responsible for dam safety and accountable for the damage their dams may cause if they fail.

The Minister for Water is empowered by the Act to regulate the construction, operation and safety of dams in Victoria. These powers apply to dams owned or operated by public entities such as water corporations, local government, Parks Victoria and to privately owned dams. The Department supports the Minister in exercising these powers and responsibilities.

The Minister regulates the safety of dams owned by Victoria's water corporations through Statements of Obligations (SoOs) which are made under the *Water Industry Act 1994* and issued to each water corporation. The SoOs are publicly available and can be obtained from the Department's website.

The Minister for Water regulates the safety of privately owned and local government authority dams through a licensing regime set out in section 67 of the *Water Act 1989* and in the associated *Policies for Managing Works Licences* (DELWP, 2016). The Minister has delegated these licensing functions to Goulburn-Murray Water, Grampians Wimmera Mallee Water, Lower Murray Water, Melbourne Water and Southern Rural Water.

In 2010 and 2020, the Department completed independent reviews of the regulation of dam safety in Victoria as due diligence exercises to improve the dam safety regulatory framework. The reviews had recommended that the Department provide supplementary guidance to dam operators, particularly in relation to the "As Low As Reasonably Practical" (ALARP) principle, now the SFAIRP approach.

The SFAIRP approach was adopted by the Victorian Parliament in the *Occupational Health and Safety Act 2004* and in the *Environmental Protection Act 2017* and is recognised in Victoria as the governing principle for health, safety, and environmental risks. SFAIRP approach is central to determining whether risks are tolerable in the risk evaluation phase of a risk assessment and has been adopted for Victorian dam safety regulation. While ANCOLD *Guidelines on Risk Assessment 2022* (ANCOLD, 2022) uses the term ALARP, the Department has concluded that such an ALARP evaluation together with guidance from DEECA (2024) - *Strategic Framework for Dam Safety Regulation* which includes this guidance note would satisfy the

regulatory requirement that dam safety risks are eliminated or reduced to SFAIRP and therefore are considered tolerable. This conclusion is supported in references Robinson et.al (2020) and ANCOLD (2022). Refer Section 5 for more details on the SFAIRP approach.

## 1.3 Structure

The guidance note is divided into six sections covering the following topics:

- **Risk Management and Dam Safety in Victoria** ([Section 2](#)) – a discussion on risk management obligations and its application to dam safety in Victoria;
- **Risk Management Process and Roles** ([Section 3](#)) – to clarify the role of the regulator, the interaction of the regulator and dam operators, and the importance of role clarity for all participants in each part of the risk assessment process;
- **Risk Reduction Principles** ([Section 4](#)) – for uncertainty in risk assessment, staging of works, prioritisation and timing of remedial measures and continuous improvement;
- **Risk Management, SFAIRP Approach and Good Practice** ([Section 5](#)) – providing key factors and considerations in assessing risks are reduced SFAIRP and further information on the relationships of the topics covered in this document;
- **Systemic Approach to Dam Safety** ([Section 6](#)) – to encourage clear and robust systemic approaches to dam safety management; and
- **Investment Decision Making for Organisations** ([Section 7](#)) – a transparent and structured investment decision making approach that is “whole of organisation”.

## 2. Risk Management and Dam Safety in Victoria

### 2.1 Risk-informed regulation

Risk management within an effective dam safety management system (DSMS) and based on the SFAIRP approach underpins dam safety regulation in Victoria.

ANCOLD has produced a series of guidelines that are recognised by the Department as representing generally a sound industry position for dam safety management but require some adjustments as identified in DEECA (2024) and this guidance note to meet Victoria's dam safety regulatory policies and specific circumstances. Similarly, ICOLD Bulletins also assist in understanding a sound industry position.

### 2.2 Understanding risks

**Guidance:** Dam operators should develop a comprehensive understanding of consequences of dam failure and undertake risk assessments. The details of the risk assessment should be proportionate to the level (severity) of risk.

Dam operators need to develop a comprehensive understanding of dam failure consequences.

Dam operators should complete ANCOLD Consequence Category assessments (ANCOLD, 2012) to gain an understanding of the potential consequences of a dam failure including loss of life, economic losses (direct and indirect), losses such as environmental damage and public health impacts, and intangible consequences such as cultural heritage consequences and social trauma. This provides a benchmark which ANCOLD guidelines provide when recommending the degree of rigour applied to a dam safety management program (or system).

Existing consequence category assessments that are incomplete or out of date (i.e. development has taken place downstream or may need to be re-assessed in greater detail if the likelihood of dam failure increases) since the last assessment should be reviewed and updated if necessary and completed to an appropriate level of detail as a matter of urgency.

With consequence categories assigned, ANCOLD (2022) identifies different levels of risk assessment from 'Screening' to 'Very Detailed'. The first two levels (Screening and Preliminary) are intended to be used to rank risks or to get early indication of issues.

Portfolio Risk Assessment (PRA) should be undertaken by dam operators with multiple dams and reviewed periodically as part of Comprehensive Inspections and Quantitative Risk Assessments and updated as appropriate, to determine ongoing safety investigation and improvement priorities. Refer Section 7 for more details.

Detailed or very detailed risk assessments should be undertaken for dams with potential loss of life or critical infrastructure and/or essential services interdependency and extensive environment and social impacts to assess risks and support the lowering of the risk using the SFAIRP approach. This also applies to dams that meet traditional engineering standards having a High or Extreme consequence category to ensure all credible failure modes are identified and all risk control measures are in place to reduce risks SFAIRP.

There may be circumstances where a detailed quantitative risk assessment may not be required – for example, smaller, less complex dams (not large dams) with a High C consequence category, where:

- a preliminary risk assessment indicates risks are clearly below the Limit of Tolerability, and there is low uncertainty in the results; and
- failure modes and all control measures which reduce risks SFAIRP are readily identified.

Under these circumstances, there is the potential to save significant costs without compromising dam safety outcomes, particularly if implementing resulting risk reduction improvements/upgrades may cost less than undertaking a detailed risk assessment.



A general principle is that **the more risk and the more at risk**, the more prudent it is to undertake a higher level of risk assessment. Risk assessments or updates for these higher risk/consequence dams should be undertaken before other dams.

Overall, the greater the risk or consequence, the more precautionary the approach to safety assessments and improvements of dams. More specifically, the greater the risk, particularly for life safety risk, the greater of the expenditure that can be justifiable before it is considered grossly disproportionate. (Refer section 5.4 Cost benefits and gross disproportionality for more details).

A key output of the risk assessment of dams with an identified potential loss of life, is a societal F-N curve which relates F (the probability per year of causing N or more fatalities) to N (the number of potential fatalities). This is the test of societal risk tolerance.

In addition to societal risk, ANCOLD (2022) advocates compliance with individual risk tolerance. Individual risk requires assessment and evaluation, but most often societal risk will have the greater influence over life safety considerations. However, individual risk may be more significant in instances where one particular individual is (or a group of individuals are) in close proximity to a dam with the larger population further downstream.

ANCOLD (2022) provides detailed commentary on the development of societal risk curves together with individual risk analysis and their use in decision-making.

The other key output of risk assessments is determining whether risks are tolerable based on the SFAIRP approach – refer section 5 for more details.

## 2.3 Risk management, engineering standards and standards-based approach

**Guidance:** Upgrading an existing dam requires all risks are reduced SFAIRP but this may not always meet the standards of a new dam. In such instances, a risk-informed upgrade satisfying the SFAIRP approach would provide assurance that all credible risks have been addressed.

New dams should be designed and constructed to contemporary standards and recognised good practice and ensure that all risks are reduced SFAIRP.

For new and existing dams, with High and greater consequence categories, include a quantitative risk assessment.

A systemic approach should be used to deliver ongoing risk reduction.

ANCOLD (2022) states that the standards-based approach is “*The traditional approach to dams engineering, in which risks are controlled by following established rules as to design events and loads, structural capacity, safety coefficients and defensive design measures*”.

These rules (engineering standards and associated recognised good practices) are continually reviewed and improved to incorporate new science, technological advances and practices.

As part of ensuring existing dam risks are reduced SFAIRP, the dam operator needs to be able to demonstrate that existing dam(s) meet the contemporary design standards and recognised good practices of a new dam. However, for many existing dams, meeting such standards and practices can be either not feasible, impractical or unreasonable, or may not be able to adequately address all risks. In these cases, a risk-informed upgrade satisfying the SFAIRP approach provides the assurance that all credible risks have been reduced SFAIRP and at least all simple, low-cost risk reduction measures have been included.

New dams should be designed to current engineering standards and recognised good practices and ensure all risks are reduced SFAIRP.

For dams (new or existing) with at least potential loss of life with major or greater severity of damage and loss impacts (High consequence category or greater), an appropriate quantitative risk assessment should also be included to ensure all credible risks are reduced SFAIRP.

A systemic approach to ongoing risk reduction should be used - refer sections 5.2 and 5.3.

## 2.4 Considerations for very high consequence dams

**Guidance:** Dam operators should give additional attention to dams with an extreme consequence category.

In Victoria, there are approximately 26 dams with an extreme consequence category.

Operators of these dams should give particular attention to the rigour of the risk assessment methodology, including the application of the SFAIRP approach, and in particular the following:

- feasibility of satisfying the standards-based approach;
- appropriateness for higher gross disproportionality for cost benefit analysis (section 5.4)
- societal concerns (section 5.5);
- extent of risk reduction works required;
- any new risks and potential higher level of construction risks;
- ensuring the highest level of recognised good practice (section 5.2 and 5.3);
- implementation sequencing and timing;
- consideration of a safety case; and
- clarity that the benefits the dam provides to society outweighs the risks associated with dam failure.

For a full set of key factors/considerations, refer section 5.1.

The annual dam safety report submitted to the Department by large dam operators provides comprehensive and up to date information on these dams, particularly their risk profiles and mitigation programs.

## 3. Risk Management Process and Roles

### 3.1 Holistic risk management

**Guidance:** Dam operators should develop and implement appropriate plans, systems and processes that have regard to the generic processes of ISO 31000:2018 Risk Management Standard from an enterprise perspective and, for dam safety risk management, adopt ANCOLD (2022) enhanced by DEECA (2024) and this Guidance Note.

Dam operators should develop, implement and review appropriate plans, systems and processes that have regard to the generic processes of ISO 31000:2018 Risk Management Standard, to ensure that risks to their assets or services are identified, assessed, prioritised and managed. This approach provides an enterprise/organisational view of risk. For dam safety risk management, the operator should include, in conjunction with enterprise/organisational risk management, ANCOLD (2022) enhanced by DEECA (2024) and this guidance note which includes the SFAIRP approach. Both the enterprise and the enhanced ANCOLD approaches to risk assessment/management will inform dam operator decisions regarding prioritisation of risk reduction measures to tolerable levels.

### 3.2 Risk management process and role clarity

**Guidance:** Dam operators should clearly define the roles of the various participants in the dam safety risk management and investment process.

It is important to have a clear understanding of roles of the various participants involved in the risk management process. Guidance on the risk management process and the roles of identified participants is provided in ANCOLD (2022), and further enhanced including the SFAIRP approach in Figure 1 below.

The participants identified within the ANCOLD (2022) guidelines include:

- the dam owner/operator who is legally responsible for dam safety;
- the decision-maker (e.g. the Board of Directors);
- risk analysts team responsible for undertaking risk analysis (e.g. competent water corporation staff and consultants overseen by a suitably qualified professional – refer DEECA (2024) for details);
- independent reviewers (for independent advice and quality assurance) – Refer DEECA (2024) for details; and
- the dam safety regulator.

In Victoria, dam operators are responsible for managing the safety of their dams and the principle of “owner responsibility” is clearly present in the regulatory instruments.

Dam operators need to lead and commit to the management of dam safety and initiate the risk identification and assessment process for their dams portfolio, engaging all relevant internal and external expertise and clearly differentiating the decision-making role within its organisation.

Figure 1 illustrates a typical risk management process for a dam, adapted from ANCOLD (2022) and enhanced, including an overlay of the intersection between the process and the participants to provide some visibility around who is involved in each part of the process. The process should be applied to all phases of the life cycle of a dam (design, construction/commissioning, operating and decommissioning/removal).

Decision-makers are responsible for determining the appropriate level of investment in dam safety within an agreed (organisational) process. Independent reviewers (refer DEECA (2024) for more details under Independent Review definition in the Glossary) can assist dam operators in this process, however it is important not to blur the role of the independent reviewer and the decision maker/dam operator.

The Department performs a number of functions including establishing and reviewing the regulatory framework including dam safety performance, collating and assessing information, promoting good practice, industry benchmarking, and knowledge sharing.

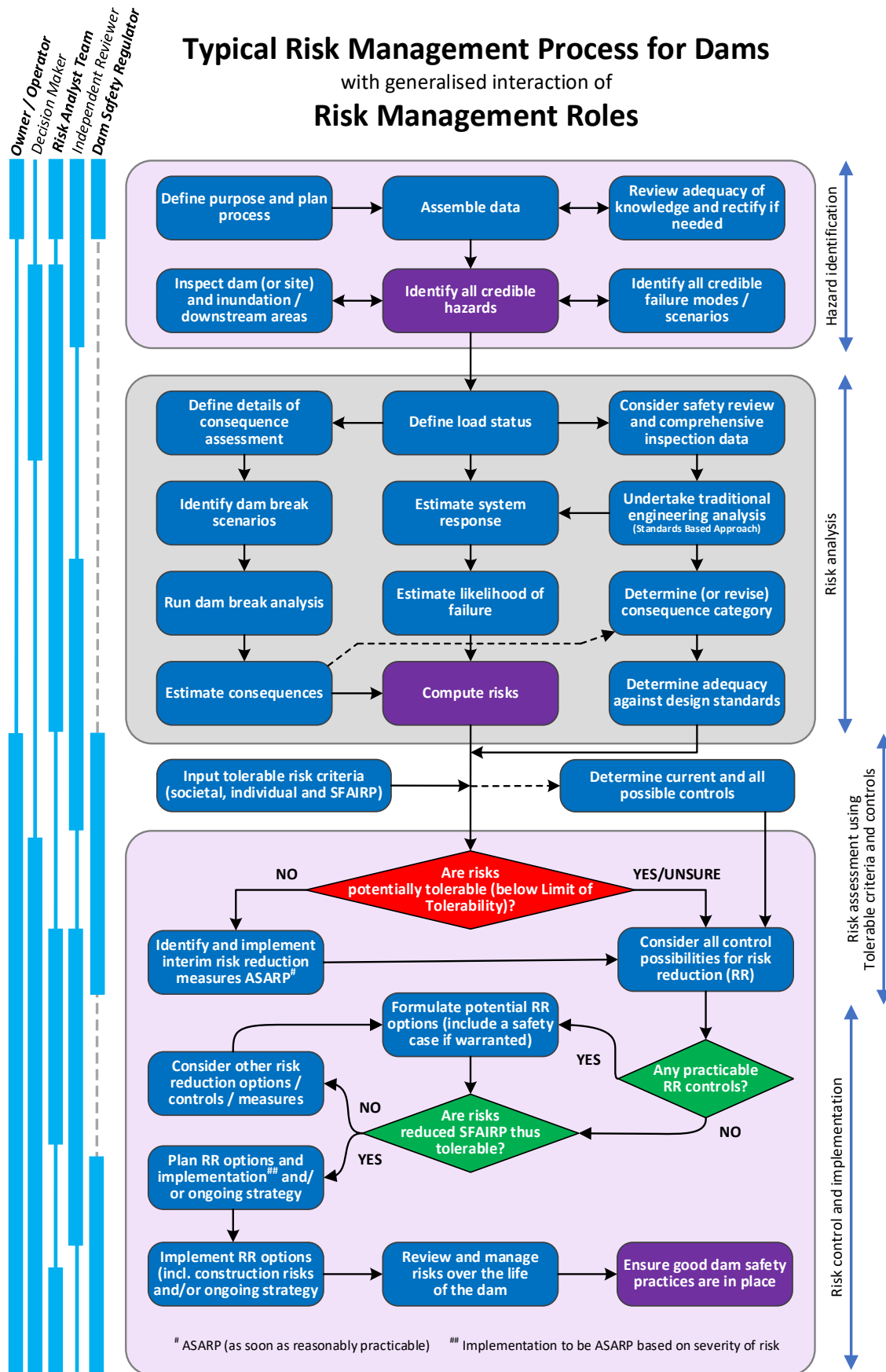


Figure 1: Risk management process, roles and interaction (adapted from ANCOLD 2022 and enhanced)

### 3.3 Department - Dam Operator interaction

**Guidance:** Dam operators should use existing forums to discuss their challenges and management approaches and continue to involve the Department in emergency exercises.

There are a number of forums relating to dam safety and emergency management matters that dam owners and operators can participate in. For example, the Victorian Dams Working Group is a key forum for water corporations, other large dam operators and the Department to discuss challenges and management approaches. It is used to discuss state-wide issues, share information and evaluate water industry dam safety performance.

The Department has formal processes with operators of large dams and emergency response agencies for managing emergency situations. Water corporations and operators of hazardous category dams should continue to involve the Department during testing and exercising their dam safety emergency plans.



## 4. Risk Reduction Principles

### 4.1 Affordability

**Guidance:** Dam operators should identify a reasonable pathway to achieve dam safety objectives and associated risk reduction whilst maintaining an acceptable pricing pathway.

Affordability of risk reduction measures is not a consideration in determining if life safety risks are reduced SFAIRP.

Dam operators should identify acceptable investment and pricing pathways to achieve life safety, economic and environmental risk reduction as soon as reasonably practicable. The desired outcome is to achieve portfolio risk reduction within a reasonable timeframe (refer section 4.4 for details) and an acceptable timing and pricing pathway based on the severity of risks and having regard to practices in similar jurisdictions.

The key question is “how are we, and how will we continue, working to reduce risk at this dam?” In cases where customer impacts would be significant, the economic regulator, the Essential Services Commission (ESC), the Department and other stakeholders should be consulted to explore alternative options and broader impacts.

Investment in dam safety should be managed so that these responsibilities and goals are upheld and that protection of life, property and the environment is assured.

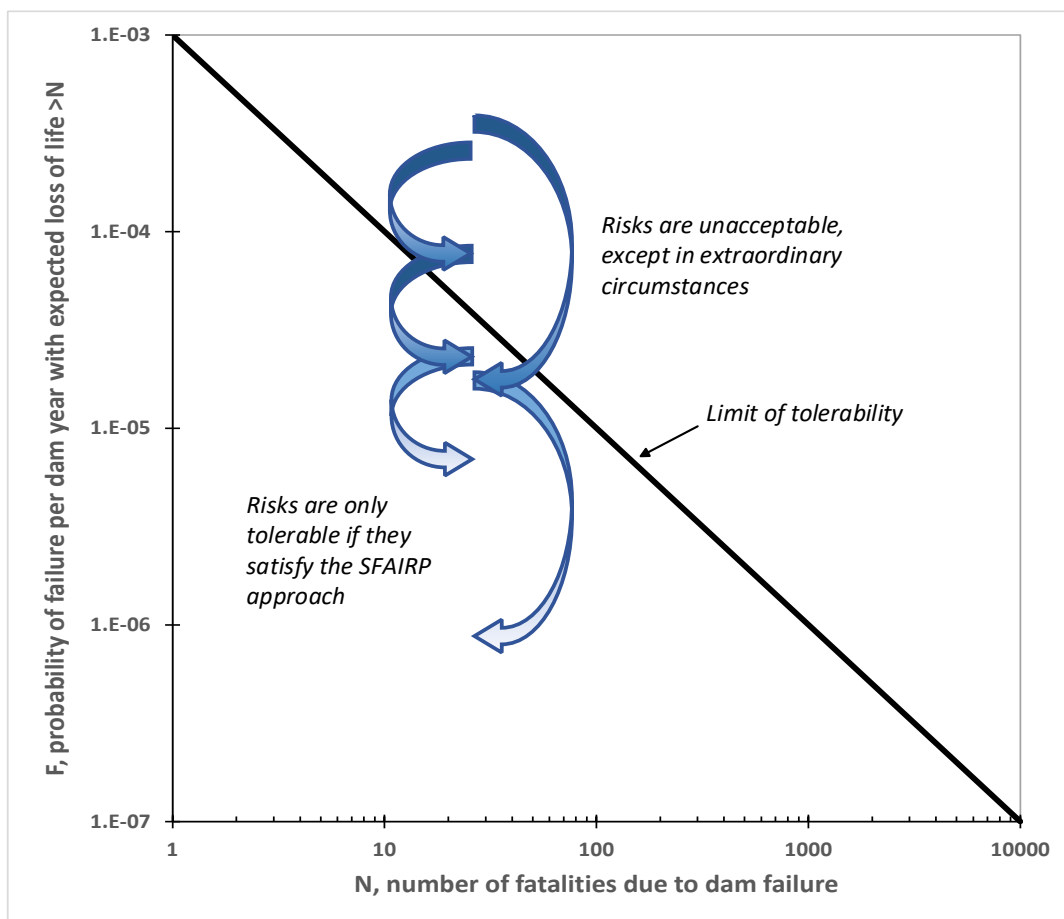
Affordability is not a consideration in taking action to reduce risks SFAIRP for dams (ANCOLD (2022)).

### 4.2 Progressive improvement

**Guidance:** Dam operators may stage risk reduction measures, (also known as Progressive Improvement), across their portfolio of dams to reduce risks first below the Limit of Tolerability, then SFAIRP.

The staging of risk reduction measures is widely practised in Victoria and the rest of Australia by dam operators with dams whose societal risk F-N curve intersects the area above the Limit of Tolerability.

The approach is to first reduce risk in rapid progression aiming for below the Limit of Tolerability and then assess further risk reduction options and implement control measures so risks are reduced SFAIRP. This staged approach is illustrated in Figure 2 which is based on Figure 7-3: ANCOLD (2022) Societal Risk Guideline: Existing Dams, adjusted for SFAIRP in DEECA (2024).



**Figure 2: F-N Curve illustrating Progressive Improvement approaches**

The first stage should, if possible, be achieved quickly by interim or intermediate measures such as lowering the normal operating level. This may be coupled with practicable ways of reducing risk by changes in operation and maintenance at the dams, heightened surveillance around the failure modes of concern and a well exercised or revised emergency management plan. Additional time and investment may be required to implement more enduring risk reduction measures.

Risk reduction may need to progress to or even beyond the requirements of traditional engineering standards in satisfying the SFAIRP approach. An important element to consider when progressively reducing risks is to take account of climate change risks.

### 4.3 Prioritising upgrades

**Guidance:** Dam operators may modify an equity-based priority list of portfolio risk reduction measures to account for efficiency and other considerations.

ICOLD (2005) describes two key and generally competing principles that should be adhered to and balanced during the evaluation of risk. These are:

- **Equity** – the right of individuals and society to be protected, and the right that the interests of all are treated fairly; and
- **Efficiency** – the need for society to distribute and use available resources for the greatest benefit.

Portfolio risk assessment provides dam operators with a view of the risk status of their dams. This approach identifies stakeholders who are most at risk for life safety as well as economic and environmental losses and can assist in balancing efficiency in undertaking risk reduction. A prioritisation approach based purely on equity would sequence risk reduction measures to reduce life safety risk ahead of economic losses for those most exposed through to those least exposed.

However, there is a third principle which influences prioritisation, namely, required risk reduction should be undertaken as soon as reasonably practicable which recognises the severity of the risks - refer section 4.4 for further details on timing of risk reduction measures.

Dam operators, in considering what is reasonably practicable may include a number of factors which modify the equity-based sequence of risk reduction measures such as:

- manifest signs of inadequacy (incident or identified failure mode emergence);
- expediency around interim improvements that can be rapidly implemented or undertaken during low risk periods (for example, prolonged low reservoir level periods);
- organisational and industry capacity;
- interdependency on essential services or critical infrastructure;
- specific community concerns;
- economic regulator planning cycle (e.g. Water Plan cycle);
- avoidance of excessive deferral duration due to other competing priorities; and
- lack of identifiable mitigation options.

Dam operators should demonstrate “momentum”, (i.e. that risk is reducing at a reasonable rate) while satisfying the economic regulator that the investment in dam safety is both necessary and does not create excessive price shocks for customers. In taking this approach, it is important to test the modified program with the original equity based order and also have regard to the timing for implementing risk reduction measures.

## 4.4 Timing of risk reduction measures

**Guidance:** Dam operators should reduce risks as soon as reasonably practicable which recognises the severity of the risks.

Short term or interim measures should be used for dams that are above the Limit of Tolerability for societal risk and for dams with deficiencies that have substantial economic/environmental consequences, until a permanent upgrade is implemented.

As a general principle, dam operators should reduce risks as soon as is reasonably practicable which recognises the severity of risks.

For dams above the Limit of Tolerability, “as soon as reasonably practicable” still applies for timing of dam safety works and measures but the dam operator should ensure highest possible priority scheduling.

In practice, the timeframe for implementing a major dam safety upgrade from identification of risk through to investigations, approvals, design, implementation and commissioning can range from a few years to up to about ten years.

Therefore, special requirements apply for dams that are above the Limit of Tolerability. For these dams, operators should investigate and implement short term or interim measures to reduce the risk to at least as close as practical to (but aiming for below) the Limit of Tolerability. Interim measures may include a combination of non-structural measures (such as drawdown or operating restrictions or increased surveillance or an early warning system within a one-year timeframe) and structural measures (for example temporary spillway crest lowering or dam crest raising within a two-year timeframe). In these cases, it is important to ensure that a revised and well exercised emergency plan is in place. In circumstances where it becomes apparent that there is an imminent likelihood of failure, immediate action is required which may require the implementation of the emergency plan.

Similar requirements should apply to dams with deficiencies that have substantial economic and or environmental consequences.

Operators need to be able to show a continuous improvement in the risk position of the portfolio of dams. For below the Limit of Tolerability to SFAIRP and standards should be as soon as reasonably practicable (ASARP) which recognises the severity of the risks.

For dam operators with a portfolio of dams a timeframe for a portfolio improvement program will be very much a case-by-case outcome, as each portfolio of dams will be different in terms of number of dams requiring improvement, the level of risk reduction required for each dam and the complexity, cost and resources of the risk reduction for each dam. However, as a useful maximum benchmark, dam operators should consider achieving their known required portfolio risk reduction program within a realistic long term planning period (say up to 20 years).

## 4.5 Risk assessment uncertainty

**Guidance:** Best estimate values with sensitivity analysis should be used in risk assessment. Uncertainty should be acknowledged, assessed and incorporated where possible so that its impacts on decisions are understood.

The best estimate values of the failure probabilities and the loss of life values should be used to estimate the societal and individual risks for comparison with the various life safety criteria.

However, it is also important to acknowledge that uncertainty exists in both the estimates of likelihood and consequences of dam failure. Dam operators should consider the level of uncertainty associated with estimated risks.

For assessment against the Limit of Tolerability, the operator should have confidence that the best estimate is clearly below the limit. The risk analyst should provide an indication of the degree of uncertainty and where it has and has not been propagated. Sensitivity analysis should be undertaken to determine which input parameters have a higher level of sensitivity in the outputs.

The level of uncertainty is likely to be a function of the type of dams, failure modes, adequacy of data and potential changes over time, including the flood and failure consequences. This uncertainty needs to be considered when determining where risks sit in relation to the Limit of Tolerability and when assessing whether risks have been reduced SFAIRP.

In the past, for risk to be considered below the Limit of Tolerability, indications have given that it would be prudent to be approximately a half an order of magnitude below.

However, the level of uncertainty can vary significantly from one dam to another.

Consequently, the application of rigorous methods of analysing the uncertainty, such as propagation of uncertainties through the analysis using the Monte Carlo simulation and/or sensitivity testing of inputs, is now considered an essential part of quantitative risk assessment.

ANCOLD (2022) & ICOLD Bulletin 191 (Preprint) August 2021 provides further information on uncertainty assessment and understanding variability.

# 5. Risk Management, the SFAIRP Approach and Good Practice

## 5.1 Tolerable risk and the SFAIRP approach

**Guidance:** Dam operators should ensure that the “So Far As Is Reasonably Practicable” (SFAIRP) approach is satisfied to meet tolerability of risk.

Dam operators are required to make judgements (as they are best placed to do so) about tolerable risk which involves ensuring all credible risks are eliminated or reduced SFAIRP.

DEECA (2024) *Strategic Framework for Dam Safety Regulation*:

- explains the basis of the Victorian approach to tolerable risk;
- considers the concept of ALARP (principle) described in ANCOLD (2022) closely mirrors the intent of the SFAIRP approach but identifies what is also important from the SFAIRP approach perspective when assessing risks are ALARP (ANCOLD, 2022), i.e., risks have been reduced SFAIRP; and
- concludes that ANCOLD (2022) use of ALARP together with guidance from DEECA (2024) would satisfy the regulatory requirement that dams are managed to a level of safety such that the risks to persons, property and the environment are eliminated or reduced SFAIRP. Therefore, risks are considered tolerable and thus achieve the same outcomes as SFAIRP as described in Work Health and Safety legislation.

The ANCOLD (2022) states that “There is no clear-cut algorithm by which owners could conclude that risks are ALARP (reduced SFAIRP). Such a conclusion requires hard thinking and careful judgement, involving consideration of multiple factors”.

Accordingly, the SFAIRP approach requires assessing all practicable risk reduction controls/measures (including control systems) associated with each failure mode of a dam against influencing key factors and considerations to determine what is reasonable and documenting such decisions.

These key factors and key considerations are grouped into two sets as follows:

- Key factors set out in ANCOLD (2022) C11-7-5 are as follows (in italics) plus associated specific aspects [in brackets] considered important from a SFAIRP approach perspective:
  - *Compliance with any recognised good practice which is a primary consideration* [refer section 5.2, and including an effective dam safety management system remains in place - refer section 5.3];
  - *Demonstration of gross disproportion for risks to public health and safety* through use of the Cost-to-Save-a-Statistical-Life metric which introduces gross disproportionality in a Cost-Benefit Analysis [refer section 5.4];
  - *The level of existing risk* [including the consequence category, the level of existing risk:
    - > influences the understanding of tolerability, particularly if above the limit for societal risk;
    - > is required as a base for cost benefit analysis (including cost to save a statistical life) and for understanding the adequacy of existing risk controls measures;
    - > assists with prioritising and the level of rigour of the SFAIRP assessment required; and
    - > identifies the extent of risk reductions/precautions required];
  - *Societal concerns* [refer section 5.5];
  - *Affordability* [refer section 4.1];
  - *Duration of the risk*



[ANCOLD (2022) suggests that short duration risks that occur during dam construction or dam upgrade projects should not exceed specified levels. Duration of risks are also impacted by priorities (refer section 4.3) and timing (refer section 4.4) and staging (refer section 4.2) of risk reduction measures]; and

– *Any creation of new risks by the risk reduction measures*

[including any new areas affected such as upstream from raising the dam wall height, how risks change such as from installation of fuse plugs or for other dams on the same waterway (cascade effect, particularly those downstream) and construction risks. Risk reduction can itself be risky. In some cases, reducing dam safety risks cannot be done without creating new and poorly understood or possible greater risks. In such situations, evaluation of SFAIRP may conclude that it is better to leave things as they are].

• Key considerations viewed important from a SFAIRP approach perspective are:

- *Steps required to assess SFAIRP (ALARP)* – as summarised in section C11-7-4 ANCOLD (2022) and enhanced by DEECA (2024) section 4.1.2.1 and this section of this guidance note;
- *Engineering and management risks* – risk assessments need to focus on both engineering and management risks (refer ANCOLD (2022) section C16-2);
- *Adequacy of the failure modes analysis* – the determination of SFAIRP should be based on no less than a contemporary, thorough and expert assessment of potential failure modes. Operators will need to remain informed of any changes to the body of knowledge regarding potential failure modes, which may result in new failure modes being considered or modifications to event trees associated with existing failure modes;
- *Disaggregation approach* – ANCOLD (2022) section C11-7-3 advises that this is the fundamental approach for applying ALARP (SFAIRP) and arguably the approach required by the Australian Work Health and Safety Acts.

ANCOLD (2022) identifies two forms of the disaggregated approach:

- > the “event/fault tree/component concept” where failure modes are carefully developed to ensure all reasonably practicable measures have been taken at each step of the potential failure mechanism. System components have the ALARP (SFAIRP) test applied to ensure all reasonably practicable measures have been taken (or are proposed).

Dam operators have tended to concentrate on using this concept as it is required to determine a dam’s quantified risk levels against societal and individual risk criteria, risk reduction achieved and residual risk remaining; and

- > the “bow tie concept” (also known as Prevention, Control and Management - PCM concept) where for a specific risk (potential failure mode) to be ALARP (SFAIRP), it is necessary to demonstrate all reasonably practicable measures have been taken under prevention, control and mitigation, to ensure no hazard/risk or reasonably practicable control measure has been overlooked.

Questions which are asked in the approach are: what are the risks, what can be done to eliminate or reduce the risks and what is the maximum risk reduction (control measures) that would be reasonably practicable to implement.

This concept is a controls based approach, and in effect the main part of the SFAIRP approach.

A key aspect of this concept is to be able to show clearly the relationships and controls (involving engineering / technical controls including works design, construction and safety (risk and reviews) assessments) and management including surveillance, operations and maintenance, emergency and administrative such as resourcing, training, knowledge, plans and other quality assurance activities), that are:

- pro-active precaution - eliminate / prevent / reduce the risk of every credible hazard (potential failure mode) from progressing to a defined “undesirable” event (e.g. the uncontrolled release of water from a dam). If a safety case is warranted, consider the value of including all hazards and potential failure modes); and
- re-active resilience - mitigate (and recovery of) the consequences following the “undesirable” event (incident).

An often-used model is the “bow tie” diagram as it provides a clear visual picture of the controls and their relationships. Refer Figure 3 Typical Bow Tie Risk Management Control Diagram (adapted from ICOLD (2017) & ICOLD 191 (Preprint Aug 2021)).

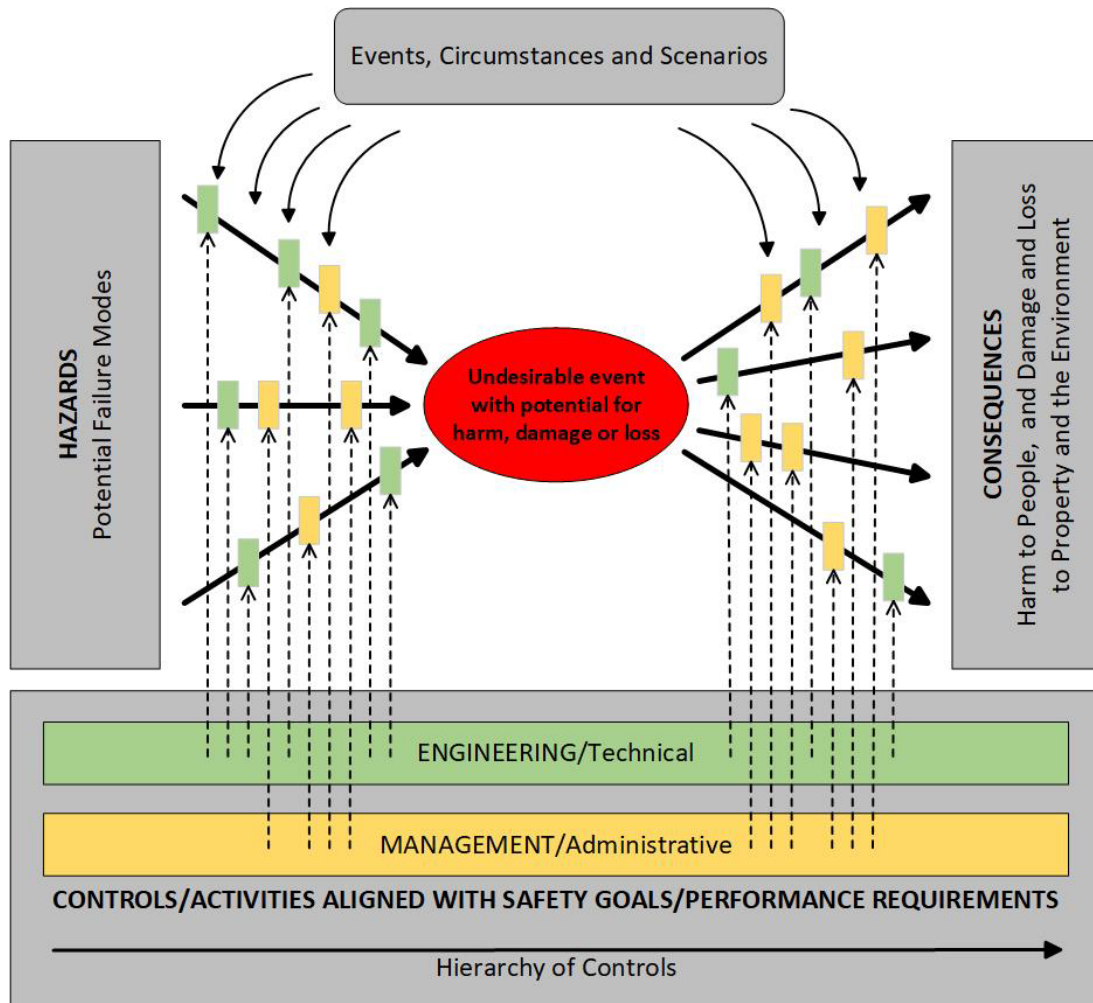


Figure 3: Typical Bow Tie Risk Management Control Diagram (adapted from ICOLD (2017))

The “bow tie” diagram effectively:

- illustrates all known controls;
- assists with the identification of other controls a reasonable person ought to have known or could reasonably foresee (i.e. identification of all possible controls);
- identifies all controls requiring assessment for adequacy (refer adequacy of control measures below); and
- provides a key input into determining if risks have been reduced SFAIRP.

Both forms of the disaggregation approach cover the same basic risk and control measures assessments but with different emphases. Using a combination of both forms:

- > maximises assurance that no risk or reasonably practicable control measure has been overlooked; and
- > facilitates improved understanding within all levels of an organisation of the critical controls (engineering and management) required for dam safety over the life of the dam.

One aspect of both forms of the disaggregation approach is the identification of what risk reductions are practicable. A general concept of what is practicable is:

- > under the specific circumstances, the control measure is feasible to construct or implement;

- > the control measure is effective in reducing the risk (likelihood and/or consequence); and
- > overall, the control measure does not increase existing risk either through creating greater existing risks or introducing new risks.
- *Adequacy of control measures* – consideration of how effective the risk control measures are, that is, consideration be given to how adequately do the control measures cover the following:
  - > the hierarchy of control (prevention/elimination, control/reduction and mitigation);
  - > a distribution of different types of controls (engineering and management);
  - > layers of protection (levels of defence such as more than one control of the same type);
  - > common cause of failure avoidance; and
  - > performance of individual and system controls against:
    - safety goals / performance requirements;
    - contemporary standards / codes and recognised good practices guidance;
    - emerging technology and practices, better scientific understanding of controls performance and events which have implications for existing controls (e.g. climate change); and
    - quality assurance that the performance required is being achieved and will remain in place including implications for the dam safety management system.
- *Consideration of standards-based approaches* – satisfaction of contemporary engineering standards may assist with justifying a SFAIRP determination (refer section 2.3 above);
- *Availability of risk reduction options* – in some situations, for some failure modes, it may not be possible to identify additional practicable or viable risk reduction options, thus justifying a SFAIRP determination. Operators will need to be mindful of technological and other developments and review this assessment periodically;
- *Uncertainty of risk assessments* – refer section 4.5;
- *Benchmarking* – the Department’s annual state-wide dam safety report and information portal provide information to benchmark dam safety risks, and this information is improving annually as dam operator reporting matures.  
Such benchmarking may provide helpful information about extent and rate of risk reduction and associated investment, particularly as risk diminishes over time with increasing investment. This feedback information could also help inform owner investment decisions.  
In addition, dam safety management systems, processes and procedures could also be benchmarked against established / recognised good practice.
- *Safety Case* – where considered warranted – refer section 5.6 and DEECA (2024).

## 5.2 Recognised good practice

**Guidance:** Dam operators should apply good practice, beyond “engineering good practice”, to enhance dam safety management.

ANCOLD (2022) states that *“Relevant good practice for an existing dam is first established by using the standards and design guidelines that would be applied to the design of a new dam as a benchmark. The design features of the existing dam should then be compared to these standards, and any shortfalls are subjected to the test of reasonable practicability (SFAIRP). These departures or deficiencies are often identified as part of the dam safety review.”*

ANCOLD (2022) also states *“However these guidelines are focussed on the analysis of dam safety engineering risks and not on broader dam safety management risks. Dam Safety Management risks are dealt within ANCOLD Guidelines on Dam Safety Management (2003). Dam owners should ensure that risks are reduced to ALARP (SFAIRP) in accordance with these guidelines and that it has a dam safety management program (or system) established in accordance with the Guidelines on Dam Safety Management.”*

In the context of the *Strategic Framework for Dam Safety Regulation (DEECA 2024)* and a SFAIRP approach determination, the above statements also require for each deficiency or departure the key factors and considerations (refer section 5.1) for a SFAIRP approach to be applied to decide on the risk reduction options to be implemented.

Dam operators should adopt a broad view of good practice based on the consequences/risk and complexity of the dam covering both engineering and management good practice. Examples of good practice include:

- a comprehensive and robust operations and maintenance procedures including surveillance and monitoring regime and associated instrumentation and notification protocols;
- well-developed and exercised dam safety emergency plans;
- effective safety assessments, including risk assessments and safety reviews and where warranted safety cases;
- practices relating to building organisational dam safety management capability, competency and capacity through training and cross functional resource sharing and benchmarking practices;
- leadership development and organisational resilience practices;
- adopting a “defence in depth” approach to critical operating systems, i.e. leveraging multiple defences or barriers to protect the asset;
- application to dam safety of sound organisational governance, enterprise asset and risk management and associated quality management/assurance; and
- implementation of an effective DSMS (refer section 5.3) where its elements are risk informed and influenced by risk management outcomes and supported by quality assurance, such as:
  - identifying works requiring improvement and assisting with potential solutions and determining their impact on risk reduction; and
  - identifying operations, maintenance, surveillance and emergency procedural changes required or triggering actions such as special inspections or informing risk assessments and safety reviews from incidents.

As part of quality management, dam operators should undertake sound knowledge management including records of processes and all options considered in their decision-making processes. They should also record why certain options were adopted and others were not, in terms of their reasonableness and practicability. This would be an integral part of due diligence obligations.

## 5.3 Dam Safety Management System

**Guidance:** Dam Operators should include an effective dam safety management system (DSMS) as a key part of ensuring good practice.

An effective dam safety management system (DSMS) provides confidence that known and foreseeable credible risks are/remain tolerable and good practices are in place. It is viewed as the primary means for dam operators for ensuring risks are reduced SFAIRP and persons, environment and property are safe SFAIRP from dam failure, over its life. Consequently, it is important that dam operator's organisational objectives, wider strategic plans, dam safety goals and the DSMS are aligned and integrated.

A typical DSMS diagram has been developed for the *Strategic Framework for Dam Safety Regulation* (Victoria). This is reproduced in Appendix 1: Dam Safety Management System, with further explanation of the DSMS elements set out in the accompanying table.

## 5.4 Cost-benefit and gross disproportionality

**Guidance:** Dam operators should consider the cost-benefit and associated gross disproportionality of remedial measures when assessing SFAIRP.

The Cost-to-Save-a-Statistical Life (CSSL) is a metric that can introduce gross disproportionality into cost-benefit analysis, to then be used as an important factor in a range of considerations when assessing whether risks are reduced SFAIRP.

ANCOLD (2022) provides formulae for calculating the “adjusted” CSSL, abbreviated as CSSL(A). The adjusted form takes account of the extent to which the cost of risk reduction measures is offset by the expected value of the reduction in monetary loss risks and any reduction in annual operating costs, and should be used for assessing SFAIRP.

All practical risk reduction options identified should be analysed for CSSL(A) to provide the best information for assessing and providing assurance all risks are reduced SFAIRP.

Consistent with the progressive improvement approach, the CSSL(A) should be calculated for each stage of a dam safety upgrade.

There is no value of CSSL(A) at which it can categorically be said that SFAIRP is justified. Rather, the case in favour of satisfying the SFAIRP test strengthens progressively as the CSSL(A) value decreases.

ANCOLD (2022) includes Table 8.7 Demonstration of Gross Disproportion which provides guidance for SFAIRP justification based on the CSSL(A). The thresholds in the table are a function of the Value of Preventing a Fatality (VPF) and the disproportionality factor.

The VPF is cited in ANCOLD (2022) as \$AU7.7 million (30 September 2021). This is derived from the value published by the Office of Best Practice Regulation (Australia) adjusted to take into account involuntary risks and the distribution of benefits from dams.

A disproportionality factor is used to test whether an investment in dam safety is grossly disproportionate to the benefits associated with an avoided fatality.

ANCOLD (2022) indicates a disproportionality factor of 10 for risks just below the Limit of Tolerability, dropping to approximately 2 for risks two orders of magnitude below the Limit of Tolerability. For potential life loss less than 10 the disproportionality factor is progressively reduced to 1. The concept of disproportionality has been adapted from HSE (2001) which is widely used and generally considered appropriate.

Once a dam operator has achieved risk reduction below the Limit of Tolerability, it is unlikely that CSSL(A) will provide justification for additional risk reduction. Dam Operators however must still assess all the other key factors and considerations set out in section 5.1 (along with checking CSSL(A)) to determine if risks have been reduced SFAIRP).

It should be noted that the base condition for estimating CSSL(A) is the dam in its configuration prior to a planned upgrade program, whether staged or not.



A similar logic can be applied to economic losses - the greater the risk of economic loss, the less weight should be given to the factor of cost of risk reduction measures. There are no accepted industry wide criteria for “economic risk criteria” equivalent to the Limit of Tolerability adopted for societal risk, although cost benefit analysis (CBA) generally uses a disproportionality factor of 1 provided all tangible impacts of dam failure are costed. However, regulators are likely to take special interest in dams with significant economic costs, particularly where those costs would be borne beyond the organisation by downstream communities and wider society and where there are substantial intangible environmental or social impacts.

## 5.5 Societal concerns

**Guidance:** Dam operators need to communicate risk-informed safety upgrade decisions to affected communities.

Dam operators should communicate with stakeholders who are potentially affected by a dam incident. Dam operators also have an obligation to communicate risk-informed dam safety upgrade decisions to affected communities. DEECA has produced a guideline for dam operators on *Engaging communities on dam safety - A guide for dam owners* (DELWP, 2015a).

Dam operators should engage affected communities and consider their views, as appropriate. However, key decisions concerning dam safety risks and SFAIRP should be made by the dam operator.

There has been little attention paid to understanding community perceptions of dam risks in Australia. Research uncovered was undertaken by CSIRO some three decades ago (CSIRO, 1992) showed that when compared to 19 other risks such as traffic accidents, medical error and bushfires, dam failure was the lowest short and long-term concern.

It is recognised that societal concern could increase if there was a significant dam safety incident in Australia or overseas.

Societal concerns are likely to be similar for the majority of dams across Australia, however further research is warranted on the community’s perception of dam safety risk.

There is a lack of guidance and precedent for incorporating societal concerns for dam failure risks in Australia.

The HSE (2001) includes societal concerns in assessing ALARP (SFAIRP). Societal concerns are defined as the:

*“...risks or threats from hazards which impact on society and which, if realised, could have adverse repercussions for the institutions responsible for putting in place the provisions and arrangements for protecting people, e.g. Parliament or the Government of the day. This type of concern is often associated with hazards that give rise to risks which, were they to materialise, could provoke a socio-political response, e.g. risk of events causing widespread or large scale detriment or the occurrence of multiple fatalities in a single event”.*

HSE (2001) further notes that hazards giving rise to societal concerns generally share a number of common features:

- they give rise to risks which could cause multiple fatalities;
- it is difficult for people to estimate intuitively the actual threat; and
- exposure involves vulnerable groups, e.g. children, where the risks and benefits tend to be unevenly distributed.

Societal concerns which should be factored into the assessment of SFAIRP include:

- dams with very high consequences (for example an identified failure mode leading to a potential loss of life of more than 100 or a catastrophic environmental impact);
- a highly vulnerable population at risk (such as a school immediately downstream of a dam);
- known and strong interdependence of a dam with critical infrastructure and the provision of essential services; and

- situations where there is a lack of trust from the community that the risk is being adequately managed, perhaps resulting from an earlier dam safety incident.

Also refer ANCOLD (2022).

Strategies to engage with the community on dam safety will require input from communication specialists and in some cases liaison with organisations such as local government authorities and emergency management agencies.

## 5.6 Safety case

**Guidance:** Dam operators, in fulfilling their dam safety duty of care (due diligence), may consider if a safety case is warranted; but in any case, need to ensure that a safety case is deemed to be satisfied.

Section 4.1.3.2 in DEECA 2024 sets what is currently deemed to satisfy a safety case until a dam industry safety case format and process has been agreed upon. It identifies when a dam operator may consider a safety case is warranted and references which may assist.

The following is provided to assist dam operators understand the value of a safety case in further demonstrating / reinforcing safety quality assurance and due diligence of a dam, particularly for dams where consequences and risks are very high or unacceptable for reducing uncertainties in quantitative risk assessments and safety reviews or where further enhancement of SFAIRP approach (Refer DEECA (2024)) may be considered warranted.

The UK Ministry of Defence (2004) defines a 'Safety Case' as *"A structured argument, supported by a body of evidence that provides a compelling, comprehensible and valid case that a system is safe for a given application in a given environment."*

A similar definition by Kelly (2004) is *"A safety case should communicate a clear, comprehensive and defensible argument that a system is acceptably safe to operate in a particular environment."*

Considering the above definitions, from a Victorian dam safety perspective, a safety case is a structured argument supported by a sound body of evidence which demonstrates the dam is safe SFAIRP. It should clearly show that all credible risks are reduced SFAIRP and thus considered tolerable by bringing together in a systematic manner with all supporting safety information into a single document.

The document should clearly:

- set out a well-reasoned, structured argument that:
  - demonstrates all reasonably practicable dam safety risk controls (both engineering and management) are in place and are adequate for eliminating or reducing all credible risks SFAIRP and thus residual / continuing risks are considered tolerable;
  - shows all key factors / considerations have been adequately assessed – refer section 5.1;
  - provides sound and compelling justification why benefits sufficiently outweigh the risks if risks remain high or unacceptable due to no reasonably practicable risk reducing measures available or due to exceptional circumstances,

so that the safety of people, property and the environment is and remains safe from dam failure and inadequate operations / management, SFAIRP.
- show there is an effective DSMS in place which quality assures (supports the argument) that the control measures in place eliminate or reduce SFAIRP all credible risks and will continue to do so over the life of the dam.

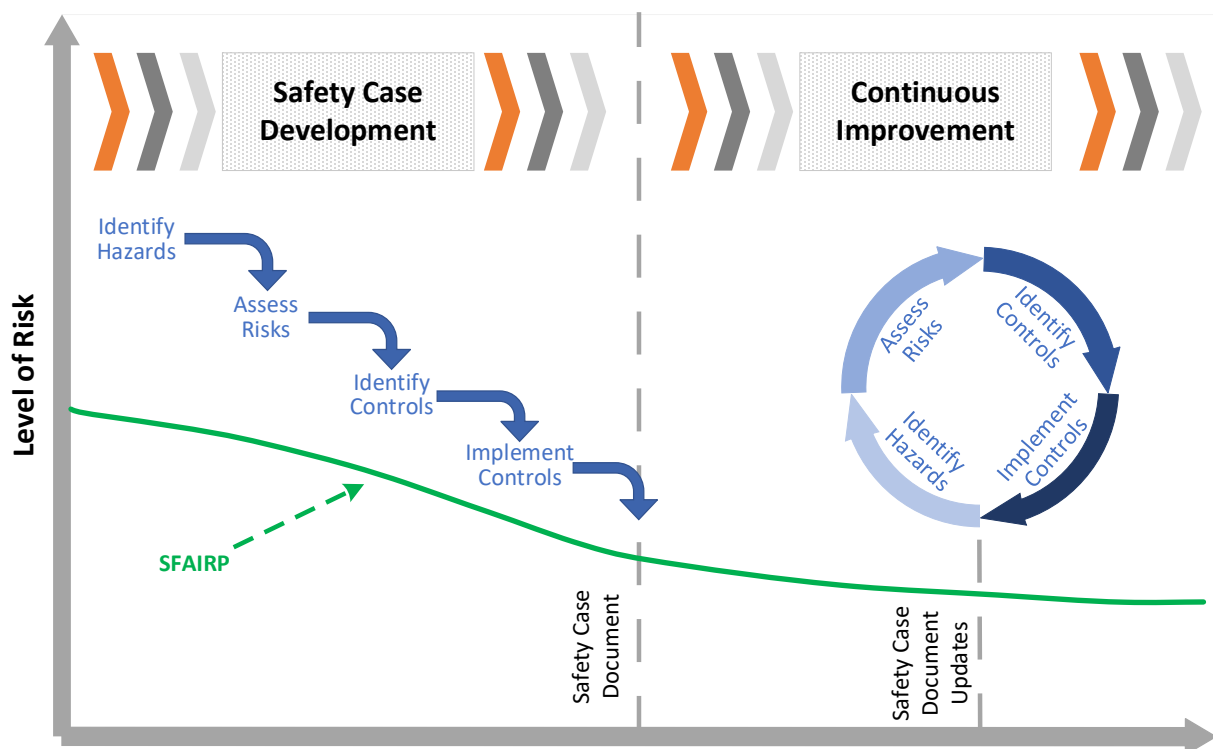
Effectively the safety case is a summary document with appendices which comprehensibly sets out the SFAIRP approach (refer DEECA (2024) sections 4.1.3.1 and 4.1.3.2 and this guidance note section 5.1) in the form of a structured argument.

The identification of failure modes and results from a safety review and risk assessment will provide key information for a safety case. Dam operators considering a safety case should ensure that these aspects are

prepared so that the results can be readily incorporated into the safety case development (ANCOLD, 2022 G16-2). If the safety case is to be undertaken in conjunction with a risk assessment/safety review, then from an efficiency and quality assurance perspective, consideration should be given to incorporating the safety case steps into the risk assessment/safety review steps and in particular the steps required to assess SFAIRP (refer section 5.1 above).

A safety case has other benefits such as:

- increasing awareness and understanding of the relationships between hazards, risks, control measures, SFAIRP approach and dam safety management;
- providing further quality assurance of compliance with the dam safety regulatory requirements; and
- contributing to continuous improvement identified by The National Offshore Petroleum Safety and Environment Management Authority in a SFAIRP guidance note to industry issued in 2014 (NOPSEMA, 2014). Figure 4 below is reproduced and adapted from (NOPSEMA, 2014).



**Figure 4: Continuous Improvement in Safety through Implementation of the Safety Case (adapted from NOPSEMA, 2014)**

Figure 4 illustrates the journey of risk reduction from unacceptable risk through a SFAIRP determination, to documenting a safety case, then to ongoing monitoring / assessment of SFAIRP and continuous improvement.

This approach reinforces the concept that in the assessment of risks reduced SFAIRP, ***the journey is the destination.***

Many dam operators in Victoria and around Australia are approaching the equivalent “Safety Case Document” point for the majority of their portfolios.

## 6. Systemic Approach to Dam Safety

**Guidance:** Dam operators should develop a dam safety policy statement and make it publicly available.

Dam operators should clearly articulate how dam safety is to be managed and how it aligns with the dam operator's risk appetite. For water corporations and other organisations, this would comprise a publicly available Board policy statement.

The policy statement should focus the organisation on the risks inherent in management and operation of dams, and the procedures in place to mitigate these risks. The policy statement should have regard to DEECA (2024) Strategic Framework for Dam Safety Regulation, this guidance note and as referenced in ANCOLD guidelines ANCOLD (2003) and ANCOLD (2022) and ICOLD Bulletin 191 Preprint (August 2021).

Dam operators should review their dam safety management system (refer section 5.3) and associated activities to ensure they are effectively delivered across the organisation. Where possible, dam safety activities should be integrated into business systems and workflow procedures, so they are performed routinely, and subject to organisational internal and external reviews and audits.

Dam operators should perform periodic and repeatable assessments of their dam safety management performance against the requirements arising out of DEECA (2024), ANCOLD (2003) and ANCOLD (2022), where applicable, the Statement of Obligations, licence requirements and the policy statement.

A dam safety management performance report provides a clear assessment of performance over time and may assist with prioritisation of interventions to address identified improvement areas.

As an example, the annual dam safety report submitted to the Department by large dam operators addresses performance requirements considered important from a regulatory assurance perspective.

A key challenge for dam operators is to retain sufficient internal expertise so to ensure they are able to fulfil owner responsibilities, including decision making, relating to dam safety management and investment decisions.

Dam operators should maintain and enhance organisational capability in dam safety management.

Dam operators recognise the challenges around securing, retaining and developing competent personnel to undertake dam safety management functions. Many have staff capability development programs in place that include organisational responses to capacity building such as cross functional teaming, training, succession planning and the use of expert panels to support internal decision making.

Dam operators have consistently engaged in learning forums such as the Victoria Water Industry Dams Working Group.

## 7. Investment Decision Making for Organisations

**Guidance:** A structured investment decision making approach will help organisations navigate major capital project selection and build portfolio investment alignment with internal and external stakeholders.

Managers in organisations, public and private, face the ongoing task of allocating resources wisely (in particular equitably and efficiently) to achieve their strategic goals. The task of investment decision making is difficult due to its complexity. Costs, benefits and risks must be balanced across multiple criteria, and stakeholders need to be engaged to differing degrees in investment decisions that inevitably involve trade-offs due to the limited availability of resources (Phillips and Bana e Costa, 2007). There may also be timing restrictions or limitations on certain projects or groups of projects. Although organisations create functional groups to achieve specific objectives, these same groups may interpret organisational priorities differently and pursue achievement of the objectives of their part of the organisation ahead of or even behind the whole.

Independent economic regulation in the water sector and adoption of asset management standard systems have prompted water corporations to review their investment decision making approaches so that they are more integrated and linked to the sustainable provision of services at agreed levels and achieving tolerable risks at appropriate or acceptable costs.

**Guidance:** Organisations need to balance resource allocation across the drivers of value creation (what an organisation wants to do), compliance (what must be done) and risk mitigation (what should be done).

Organisations that manage dams do not exist for that purpose, rather, they exist to pursue greater strategic objectives and a wider organisational purpose of adding value and providing services to communities and stakeholders. The pursuit of adding value represents the starting point for identification of capital projects. Thus, dams in Victoria have been constructed in response to owner organisations, past and present, meeting goals around provision of, for example, sustainable water supply and irrigation protection for communities. Safe management of these dams, SFAIRP, is then an inherent obligation that operators must comply with, taking account of the risks associated with their dams. Consideration of compliance and risk also prompt the identification of capital projects. Resource allocation must then be balanced across these drivers of value creation (what an organisation wants to do), compliance (what an organisation must do) and risk mitigation (what an organisation should do). Projects identified from these drivers should link directly to one or more strategic objectives.

For many dam operators, the Portfolio Risk Assessment (PRA) process represents their risk informed renewal prioritisation methodology.

The PRA should be updated as and when more detailed quantitative risk assessments are completed for the dams. Furthermore, it is recommended that the prioritisation from the PRA is updated at least on a 5-10 yearly basis.

The PRA and updates are used in order to:

- allow dam operators to prioritise the improvement needs of their dams including associated dam safety management;
- identify those future projects that will secure ongoing dam operations and protection of community interests; and
- create a capital improvement program.

For example, dam improvements addressing reduction of societal risk from above to below the Limit of Tolerability must be given the highest and most urgent priority. However, for dam safety improvements associated with reducing risks SFAIRP, while should be done as soon as reasonably practical based on the



severity of risk, the need to integrate the outcomes of the PRA with other organisational capital investment programs can make it challenging. Hence, an overarching investment framework will generally be required.

The benefits of a structured approach to prioritising projects include a more defensible, efficient and repeatable decision-making process along with an overall better selection of projects to be funded based on their contribution to strategic objectives. Other benefits may include increased compliance with legislative requirements, establishment of a performance baseline for future planning efforts and improved communication of strategic objectives across the organisation and with relevant stakeholders. The process itself may be helpful in connecting and aligning the dam safety management part of an organisation with the wider organisation, in collective pursuit of a common purpose and vision.

## 8. Glossary and Acronyms

The following glossary of terms is taken from various documents including the Guidelines on Risk Assessment (ANCOLD, 2022) and Guidelines on Dam Safety Management (ANCOLD, 2003).

TERM	DEFINITION
<b>ALARP</b>	As Low As Reasonably Practicable Principle. That principle which states that risks, lower than the 'limit of tolerability', are tolerable only if risk reduction is impracticable or if its cost is grossly disproportionate (depending on the level of risk) to the improvement gained (ANCOLD, 2022).
<b>ANCOLD</b>	Australian National Committee on Large Dams. <a href="https://ancold.org.au/">https://ancold.org.au/</a>
<b>Bow tie diagram</b>	A visual method for showing the relationship between hazards, a defined undesirable event, the consequences arising from the event and the controls that prevent the hazard from causing the event or that arrest the event to prevent failure or that mitigate the consequences, given failure.
<b>Consequence</b>	In relation to risk analysis, the outcome or result of a risk being realised. Includes flood impacts in the downstream as well as upstream areas of the dam resulting from failure of the dam or its appurtenances, as well as indirect impacts over an indefinitely large area.
<b>Consequence Category</b>	A classification of adverse consequences resulting from a dam failure (ANCOLD, 2012b).
<b>Dam Operator</b>	The individual/s and/or entity that has primary ownership and/or management responsibility for a dam. Dam operators of public dams in Victoria include the following State entities/agencies - Water Corporations, Local Government, Parks Victoria and the Department of Energy, Environment and Climate Action. For private dams included in a works licence, the dam operator is the holder of the licence. For other private dams, the dam operator is the dam owner.
<b>DEECA</b>	Department of Energy, Environment and Climate Action (formerly known as DELWP, DEPI and DSE). <a href="https://www.deeca.vic.gov.au/">https://www.deeca.vic.gov.au/</a>
<b>DELWP</b>	Department of Environment, Land, Water and Planning, Victoria (now DEECA).
<b>DEPI</b>	Department of Environment and Primary Industries, Victoria (now DEECA).
<b>DSC</b>	Dams Safety Committee. Former New South Wales dam safety regulator. <a href="https://www.damsafety.nsw.gov.au/">https://www.damsafety.nsw.gov.au/</a>
<b>DSE</b>	Department of Sustainability and Environment, Victoria (now DEECA).
<b>DSEP</b>	Dam Safety Emergency Plan. A continually updated set of instructions and maps that deal with possible emergency situations or unusual occurrences at or related to a dam or reservoir.
<b>Emergency management</b>	The organisation and management of resources for dealing with all aspects of emergencies. Emergency management involves the plans, structures and arrangements which are established to bring together the normal endeavours of government, voluntary and private agencies in a comprehensive and co-ordinated way to deal with the whole spectrum of emergency needs including planning, prevention, response and recovery.

TERM	DEFINITION
<b>EMV</b>	Emergency Management Victoria leads emergency management in Victoria by maximising the ability of the emergency management sector to work together and to strengthen the capacity of communities to plan for, withstand, respond to and recover from emergencies. EMV supports the Emergency Management Commissioner to lead and coordinate emergency preparedness, response and recovery across Victoria's emergency management sector in conjunction with communities, government, agencies and business. EMV is an integral part of the broader emergency management sector and shares responsibility with a range of agencies, organisations and departments for ensuring the system of emergency management in Victoria is sustainable, effective and community focussed <a href="https://www.emv.vic.gov.au/about-us">https://www.emv.vic.gov.au/about-us</a> .
<b>ESC</b>	Essential Services Commission. Victoria's independent economic regulator of essential services supplied by water and sewerage, electricity, gas, ports and rail freight industries. <a href="https://www.esc.vic.gov.au/">https://www.esc.vic.gov.au/</a>
<b>Dam failure</b>	In the general case, the inability of a dam system, or part thereof, to function as intended. Thus, in terms of performance to fulfil its intended function, the inability of a dam to perform functions such as water supply, prevention of excessive seepage or containment of hazardous substances. In the context of dam safety, failure is generally confined to issues of structural integrity, and in some contexts to the special case of uncontrolled release of the contents of a reservoir through collapse of the dam or some part of it.
<b>Hazard</b>	Threat or condition, which may result from either an external cause (e.g. earthquake, flood, or human agency) or an internal vulnerability, with the potential to initiate a failure mode. A source of potential harm or a situation with a potential to cause loss.
<b>Hazardous category dam</b>	A dam on a waterway or a dam not on a waterway as described in section 67(1A) of the Water Act, that is classified as Significant, High (C, B or A) or Extreme Consequence Category based on the current <i>ANCOLD Guidelines on Consequence Categories for Dams</i> .
<b>HSE</b>	Health and Safety Executive. The national independent watchdog for work-related health, safety and illness in the United Kingdom. It is an independent regulator and acts in the public interest to reduce work-related death and serious injury across Great Britain's workplaces. <a href="https://www.hse.gov.uk/">https://www.hse.gov.uk/</a>
<b>ICOLD</b>	International Committee on Large Dams. This is a non-governmental international organization which provides a forum for the exchange of knowledge and experience in dam engineering. ICOLD has National Committees from over 100 countries with approximately 10,000 individual members. <a href="https://www.icold-cigb.org/">https://www.icold-cigb.org/</a>
<b>Incident</b>	An event which could deteriorate to a very serious situation or endanger the dam.
<b>Individual risk</b>	The increment of risk imposed on a particular individual by the existence of a hazardous facility. This increment of risk is an addition to the background risk to life, which the person would live with on a daily basis if the facility did not exist.

TERM	DEFINITION
<b>Large Dam</b> (based on ANCOLD) – refer <a href="http://www.ancold.org.au">www.ancold.org.au</a>	<p>A large dam (<a href="http://www.ancold.org.au">www.ancold.org.au</a>) is defined as one which is:</p> <ul style="list-style-type: none"> <li>(a) more than 15 metres in height measured from the lowest point of the general foundations to the 'crest' of the dam,</li> <li>(b) more than 10 metres in height measured as in (a) provided they comply with at least one of the following conditions: <ul style="list-style-type: none"> <li>(i) the crest is not less than 500 metres in length;</li> <li>(ii) the capacity of the reservoir formed by the dam is not less than 1 million cubic metres;</li> <li>(iii) the maximum flood discharge dealt with by the dam is not less than 2,000 cubic metres per second;</li> <li>(iv) the dam is of unusual design.</li> </ul> </li> </ul> <p>No dam less than 10 metres in height is included.</p>
<b>Likelihood</b>	A qualitative description of probability and frequency.
<b>PAR</b>	Population at Risk. All those persons who would be directly exposed to floodwaters assuming they took no action to evacuate.
<b>PLL</b>	Potential Loss of Life. The part of the population at risk that could lose their lives in the event of a dam failure.
<b>Risk</b>	Measure of the probability and severity of an adverse effect to life, health, property, or the environment. In the general case, risk is estimated by the combined impact of all triplets of scenario, probability of occurrence and the associated consequence. As a special case, average (annualised) risk can be estimated by the mathematical expectation of the consequences of an adverse event occurring (that is, the product of the probability of occurrence and the consequence, combined over all scenarios).
<b>Risk analysis</b>	The use of available information to estimate the risk to individuals or populations, or property or the environment, from hazards (qv). Risk analyses generally contain the following steps: scope definition, hazard identification, and risk estimation.
<b>Risk assessment</b>	<p>The process of reaching a decision recommendation on whether existing risks are tolerable and present risk control measures are adequate, and if not, whether alternative risk control measures are justified or will be implemented. Risk assessment incorporates, as inputs, the outputs from the risk analysis and risk evaluation phases.</p> <p>Consistent with the common dictionary definition of assessment, viz. "To analyse critically and judge definitively the nature, significance, status or merit of [risk]", risk assessment is a decision-making process, often sub-optimal between competing interests, that results in a statement that the risks are, or are not, being adequately controlled. Risk assessment involves the analysis, evaluation and decision about the management of risk and all parties must recognize that the adverse consequences might materialise and owners will be required to deal effectively with consequences of the failure event.</p>
<b>Risk-based</b>	Primarily uses the outcomes of the risk assessment.
<b>Risk control</b>	The implementation and enforcement of actions to control risk, and the periodic re-evaluation of the effectiveness of these actions.
<b>Risk-informed</b>	Risk outcomes are used to inform decisions, taking account of uncertainties and adopting professionally prudent and pragmatic considerations.
<b>Risk management</b>	The systematic application of management policies, procedures and practices to the tasks of identifying, analysing, assessing, controlling and monitoring risk.

TERM	DEFINITION
<b>SFAIRP</b>	So Far As Is Reasonably Practicable. A legal term enshrined in Australian law, especially the model Work Health and Safety legislation.
<b>Societal risk</b>	The risk of widespread or large-scale detriment from the realisation of a defined hazard, the implication being that the consequence would be on such a scale as to provoke a socio/political response, and/or that the risk provokes public discussion and is effectively regulated by society as a whole through its political processes and regulatory mechanisms. Such large risks are typically unevenly distributed, as are their attendant benefits. Thus, the construction of a dam represents a risk to those close by and a benefit to those further off, or a process may harm some future generation more than the present one. The distribution and balancing of such major costs and benefits is a classic function of government, subject to public discussion and debate.
<b>SoO</b>	The Statements of Obligations (SoO) are regulatory instruments issued by the Minister for Water to water corporations and licensees. The SoOs impose obligations on the water corporations and licensees in relation to performance of their functions and the exercise of their duties.
<b>Standards Based Approach</b>	The traditional approach to dams engineering, in which risks are controlled by following established rules as to design events and loads, structural capacity, safety coefficients and defensive design measures.
<b>Tolerable risk</b>	<p>A risk within a range that society can live with so as to secure certain net benefits. It is a range of risk that we do not regard as negligible or as something we might ignore, but rather as something we need to keep under review and reduce it still further if and as we can. In the context of these guidelines, tolerable risk means that risks are reduced to such levels that ALARP conditions are continually met (ANCOLD (2022)).</p> <p>Refer section 4.1.2.1 of DEECA (2024), <i>Strategic Framework for Dam Safety Regulation</i> for further clarification of the definition of “tolerable risk” from the Victorian Regulatory perspective including the use of SFAIRP instead of ALARP.</p>

## 9. References

**NOTE: References include here are the latest at the time of publication of this framework. However, readers should refer to the latest version or as amended references.**

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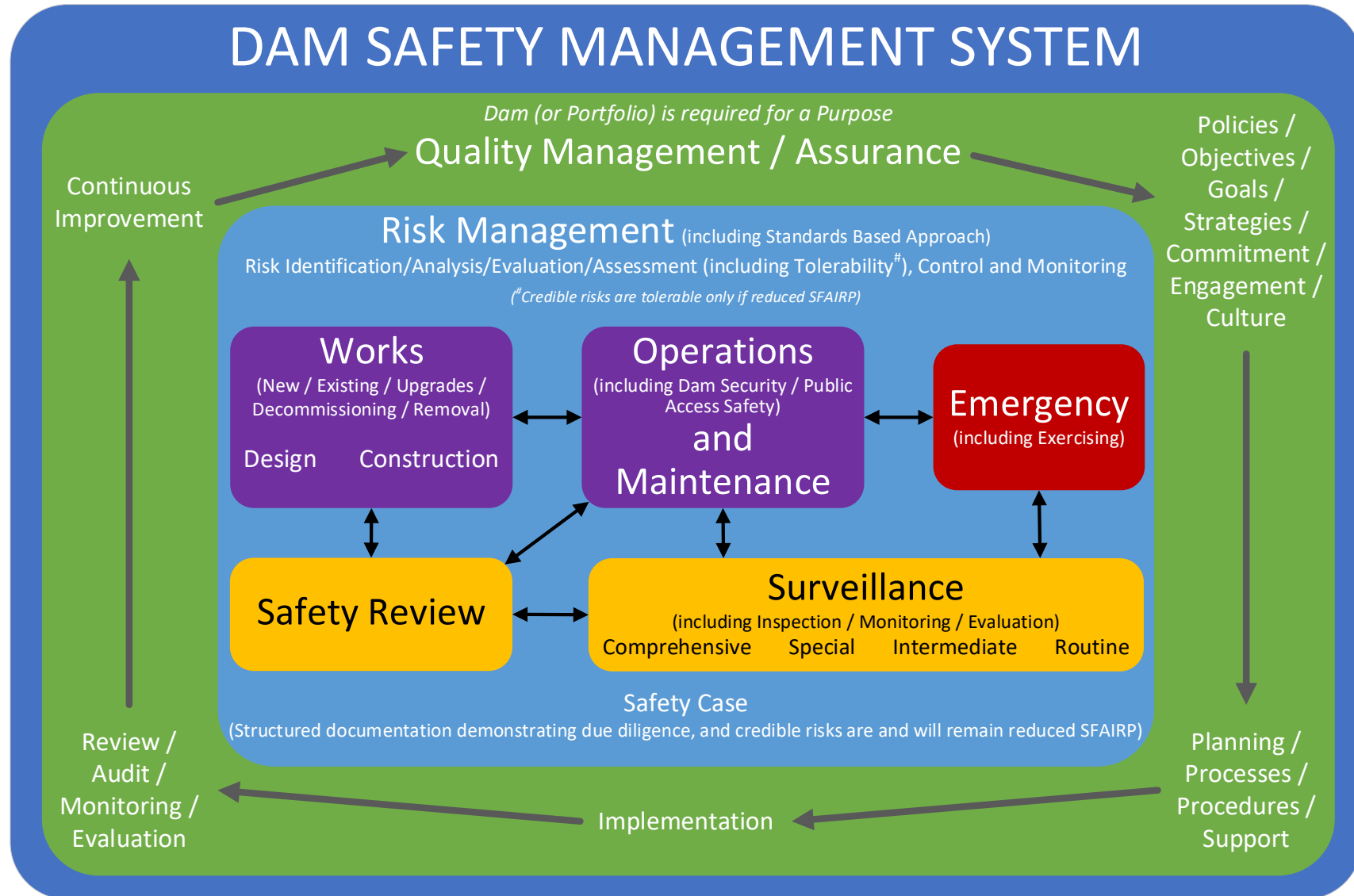
*Water Act 1989* (Victoria).

*Water Industry Act 1994* (Victoria).

*Work Health and Safety Act 2011* (Australia).

# Appendix 1: Dam Safety Management System

Figure 5: Typical Dam Safety Management System



**Table 1: Dam Safety Management System Elements, References and Relationships**

<b>System Element – Sub Elements</b>	<b>Key Aspects</b>	<b>References the operator must have regard to (*)</b>	<b>Relationships to Other Elements</b>
<b>Works</b> (Incl. appurtenances)	<ul style="list-style-type: none"> <li>• New &amp; Existing</li> <li>• Alterations - Remedial Actions &amp; Upgrades</li> <li>• Decommissioning / Removal</li> </ul>	<ul style="list-style-type: none"> <li>• DEECA (2024)</li> <li>• ANCOLD (2003)</li> <li>• ANCOLD (2022)</li> <li>• DELWP (2016a)</li> <li>• AS ISO 55000 Series (Asset Management)</li> <li>• ICOLD Bulletins 154 (2017), 175 (2021) &amp; 191 (Preprint Aug 2021)</li> </ul>	<ul style="list-style-type: none"> <li>• Underpinned (informed) by Risk Management (incl. failure modes and construction risks)</li> <li>• Undertaken in a quality managed / assured manner</li> </ul>
– Design (incl. Concept, Investigations, Analysis / Assessments)	<ul style="list-style-type: none"> <li>• Contemporary Principles (e.g. design for safety), Criteria / &amp; Data (Standards, Practices, Risk Precautions) for New Dams &amp; Alterations</li> <li>• Actual Design Data for Existing Dams</li> </ul>	<ul style="list-style-type: none"> <li>• Related ANCOLD guidelines</li> <li>• Other appropriate dam design guidance</li> </ul>	<ul style="list-style-type: none"> <li>• Inform and informed by Safety Reviews and Operations &amp; Maintenance</li> </ul>
– Construction (incl. Supervision & Commissioning)	<ul style="list-style-type: none"> <li>• Contemporary Principles (e.g. design for safety), Criteria &amp; Data (Standards, Practices, Risk Precautions) for New Dams &amp; Alterations</li> <li>• Actual Design Data for Existing Dams</li> </ul>	<ul style="list-style-type: none"> <li>• Related ANCOLD guidelines</li> <li>• Other appropriate dam construction guidance</li> </ul>	
<b>Operations &amp; Maintenance</b>	<ul style="list-style-type: none"> <li>• Works (incl. Appurtenances but excluding Decommissioning unless retaining ownership &amp; Removal)</li> <li>• Contemporary Good Practices established for New Dams &amp; Alterations</li> <li>• Progressive Updated Good Practices for Existing Dams</li> </ul>	<ul style="list-style-type: none"> <li>• DEECA (2024)</li> <li>• AS ISO 55000 Series (Asset Management)</li> <li>• ICOLD Bulletins 154 (2017) &amp; 191 (Preprint Aug 2021)</li> </ul>	<ul style="list-style-type: none"> <li>• Underpinned by (inform and informed by) Risk Management (incl. addressing / responding to failure modes)</li> <li>• Undertaken in a quality managed / assured manner</li> </ul>
– Operations	<ul style="list-style-type: none"> <li>• Operating</li> <li>• Dam Security</li> <li>• Cyber security</li> <li>• Public Access Safety</li> </ul>	<ul style="list-style-type: none"> <li>• ANCOLD (2003)</li> <li>• Other appropriate dam operations &amp; maintenance guidance</li> </ul>	<ul style="list-style-type: none"> <li>• Inform and informed by Surveillance and Works (incl. appurtenances)</li> <li>• Conditions may trigger Emergency management</li> </ul>
– Maintenance	<ul style="list-style-type: none"> <li>• Periodic (incl. Functional Testing)</li> <li>• Conditional</li> <li>• Preventative</li> <li>• Corrective</li> </ul>		<ul style="list-style-type: none"> <li>• Inform and informed by Surveillance and Works (incl. appurtenances)</li> </ul>

System Element – Sub Elements	Key Aspects	References the operator must have regard to (*)	Relationships to Other Elements
<b>Surveillance</b>	<ul style="list-style-type: none"> <li>Monitoring</li> <li>Inspections</li> <li>Operational and Alarm Testing</li> <li>Safety Evaluation</li> </ul>	<ul style="list-style-type: none"> <li>DEECA (2024)</li> <li>ANCOLD (2003)</li> <li>ICOLD Bulletins 154 (2017) &amp; 191 (Preprint Aug 2021)</li> </ul>	<ul style="list-style-type: none"> <li>Underpinned by (inform and informed by) Risk Management (incl. addressing / responding to failure modes)</li> <li>Established and updated as part of Operations</li> <li>Monitoring and Inspections may trigger Emergency management</li> </ul>
– Routine Inspections	<ul style="list-style-type: none"> <li>Operations personnel visual observation</li> </ul>		<ul style="list-style-type: none"> <li>Conditions may trigger Maintenance or inform a Special Inspection</li> </ul>
– Intermediate Inspections	<ul style="list-style-type: none"> <li>Dams engineer visual examination / evaluation of data &amp; any corrective action</li> </ul>		
– Special / Emergency Inspections	<ul style="list-style-type: none"> <li>Specific feature or condition examination / evaluation of pre-emptive or corrective action</li> </ul>		<ul style="list-style-type: none"> <li>Outcome may trigger Maintenance or Emergency actions / Works or</li> <li>Safety Review / Risk Assessment</li> </ul>
– Comprehensive Inspections	<ul style="list-style-type: none"> <li>Full inspection and assessment of safety status</li> </ul>	<ul style="list-style-type: none"> <li>DEECA (2024)</li> <li>ANCOLD (2003)</li> <li>ANCOLD (2022)</li> </ul>	<ul style="list-style-type: none"> <li>Outcome may trigger Maintenance or Emergency actions / Works, trigger and should be part of Safety Review and should include review of Risk Management and DSMS</li> </ul>
<b>Emergency</b>	<ul style="list-style-type: none"> <li>Tested and exercised plans</li> <li>Notification</li> <li>Response</li> <li>Recovery</li> </ul>	<ul style="list-style-type: none"> <li>DEECA (2024)</li> <li>DELWP (2021)</li> <li>ANCOLD (2003)</li> <li>ICOLD Bulletins 154 (2017) &amp; 191 (Preprint Aug 2021)</li> </ul>	<ul style="list-style-type: none"> <li>Underpinned by (inform and informed by) Risk Management (incl. addressing / responding to failure modes)</li> <li>Undertaken in a quality managed / assured manner</li> <li>May be triggered by Surveillance Inspections or Operations conditions and subsequently influence Operations, Maintenance, Surveillance, Safety Review and Works</li> </ul>

System Element – Sub Elements	Key Aspects	References the operator must have regard to (*)	Relationships to Other Elements
<b>Safety Review</b>	<ul style="list-style-type: none"> <li>• Safety Goals and Status</li> <li>• Safety Criteria &amp; Data Changes</li> <li>• Resulting Deficiencies &amp; Improvements required</li> </ul>	<ul style="list-style-type: none"> <li>• DEECA (2024)</li> <li>• ANCOLD (2003)</li> <li>• ICOLD Bulletins 154 (2017) &amp; 191 (Preprint Aug 2021)</li> </ul>	<ul style="list-style-type: none"> <li>• Underpinned by (inform and informed by) Risk Management (in particular failure modes and reducing risks SFAIRP)</li> <li>• Undertaken in a quality managed / assured manner</li> <li>• Requires information from, and informs, Works Design and Construction, Operations &amp; Maintenance and Comprehensive Inspections</li> </ul>
<b>Risk Management</b>	<ul style="list-style-type: none"> <li>• <u>Risk Identification</u> (incl. Hazards / Failure Modes / loading states)</li> <li>• <u>Risk Analysis / Evaluation / Assessment</u> (incl. Consequences &amp; Category / Traditional (Standards-Based Approach) / Event (Fault) Tree Approach / Controls Adequacy (Bow Tie) &amp; Adequacy Approach / Variability &amp; Uncertainty / Existing &amp; Proposed Societal, Individual &amp; Other Risks / <u>Tolerability</u> # / Deficiency Identification / Risk Reduction Decision Making &amp; Program &amp; Plans Implications),</li> <li>• <u>Risk Control</u> (incl. Risk Reduction Programs, Plans &amp; Implementation Risks)</li> <li>• <u>Risk Monitoring</u> (incl. Tracking Reoccurring and Emerging Risks)</li> <li>• (# risks are tolerable only if reduced SFAIRP - that is the SFAIRP Approach has been applied resulting in all reasonably practicable risk control measures and recognised good practices are and will remain in place over life of dam)</li> </ul>	<ul style="list-style-type: none"> <li>• DEECA (2024)</li> <li>• ANCOLD (2022)</li> <li>• AS ISO 31000 (2018) – based on generic processes</li> </ul>	<ul style="list-style-type: none"> <li>• Underpins (informs and informed by) all above DSMS elements</li> <li>• Undertaken in a quality managed / assured manner</li> </ul>

System Element – Sub Elements	Key Aspects	References the operator must have regard to (*)	Relationships to Other Elements
<ul style="list-style-type: none"> <li>– Safety Case (where considered warranted)</li> </ul>	<ul style="list-style-type: none"> <li>• Structured documentation demonstrating credible risks are and will remain reduced SFAIRP and due diligence</li> <li>• (Structured argument supported by a sound body of evidence the risks are reduced SFAIRP)</li> </ul>	<ul style="list-style-type: none"> <li>• DEECA (2024)</li> <li>• McGrath et al (2020)</li> <li>• Engineers Australia/Royal Engineering Society (2014)</li> <li>• ANCOLD (2022)</li> </ul>	<ul style="list-style-type: none"> <li>• Strengthens the demonstration of Tolerable Risk (Risks reduced SFAIRP) / Safety Reviews outcomes and Recognised Good Practices</li> <li>• Strengthens continuous improvement (incl. justification for risk reduction measures covering Works, Operations &amp; Maintenance and Surveillance).</li> <li>• Strengthens duty of care /due diligence</li> </ul>
<p><b>Quality Management / Quality Assurance</b> (# equivalent AS ISO 55001, 2014 element description)</p>	<ul style="list-style-type: none"> <li>• Dam (or Portfolio) is required for a Purpose (Including System Management, Competency, Information, Documentation &amp; Reporting)</li> </ul>	<ul style="list-style-type: none"> <li>• AS/NZS ISO 9001 (2016)</li> <li>• AS ISO 55001 (2014)</li> <li>• ICOLD Bulletin 154 (2017), 191 (Preprint Aug 2021) &amp; 192 (2021 Preprint)</li> <li>• DEECA (2024)</li> <li>• DELWP (2015a)</li> </ul>	<ul style="list-style-type: none"> <li>• Applied to all elements including the DSMS itself</li> </ul>
<ul style="list-style-type: none"> <li>– Policies / Governance /Objectives / Goals</li> <li>– Strategies / Commitment / Engagement</li> <li>– Safety Culture (Context of Organisation &amp; Leadership) #</li> </ul>	<ul style="list-style-type: none"> <li>• Governance / Business &amp; Asset Management Integration</li> <li>• Change Management</li> <li>• Focused Organisational Roles, Responsibilities and Accountabilities</li> <li>• Staff, Stakeholder &amp; Regulator engagement</li> <li>• Safety Policy Goals, Culture &amp; Capacity Building</li> </ul>		



System Element – Sub Elements	Key Aspects	References the operator must have regard to (*)	Relationships to Other Elements
– Planning / Processes / Procedures / Support ( <i>Planning &amp; Support</i> ) #	<ul style="list-style-type: none"> <li>• Regulator Permissions &amp; Performance Requirements &amp; Internal Measures</li> <li>• Adequate Resourcing – Budgets, Capability, Equipment, Competency, Education &amp; Training &amp; OHS Implications</li> <li>• Activities Frequency &amp; Relationships</li> <li>• Plans</li> <li>• Knowledge Management incl. Record Maintenance</li> <li>• Aligned Roles, Responsibilities &amp; Accountabilities</li> <li>• Staff &amp; Stakeholder Awareness &amp; Communication</li> </ul>		
– Implementation ( <i>Operation</i> ) #	<ul style="list-style-type: none"> <li>• Programming &amp; Scheduling</li> <li>• Activity, Project, Outsourcing &amp; Change Management</li> <li>• Completion Reports &amp; Drawings Certification</li> </ul>		
– Evaluation / Monitoring & Review / Audit (internal & external) ( <i>Performance Evaluation</i> ) #	<ul style="list-style-type: none"> <li>• Coverage, Timing, Independence &amp; Skill Range Required</li> <li>• Appropriateness, Effectiveness &amp; Efficiency Assessment</li> <li>• Performance Reporting on All System Elements incl Benchmarking Goals &amp; Measures</li> <li>• Annual Safety Statement</li> </ul>		
– Continuous Improvement ( <i>Improvement</i> ) #	<ul style="list-style-type: none"> <li>• Commitment to System Improvement &amp; Updates</li> <li>• Managing All Incidents Deficiencies &amp; Changes</li> <li>• Taking Corrective Action to Prevent Reoccurrence</li> </ul>		
<b>Dam Safety Management System</b> (DSMS itself)	<ul style="list-style-type: none"> <li>• Recognised Good Practice for Dam Safety Management</li> <li>• DSMS should be scalable based on consequences / risk / complexity associated with the dam</li> <li>• DSMS should be quality assured</li> </ul>	<ul style="list-style-type: none"> <li>• DEECA (2024)</li> <li>• ANCOLD (2003)</li> <li>• ICOLD Bulletin 154 (2017)</li> <li>• AS ISO 55001</li> <li>• Supporting Other Jurisdictions DSMS guidelines</li> </ul>	<ul style="list-style-type: none"> <li>• Identifies all system elements required to manage dam safety and their interrelationships within the dam operator's asset management</li> </ul>

\* This Guidance Note along with other Departmental guidelines supports DEECA (2024).