

## BACKGROUND TO DSC RISK POLICY CONTEXT

### Table of Contents

Item	Page
1. Introduction.....	2
2. DSC Risk Management Policy Framework for Dam Safety .....	2
3. What is changed by this Policy Framework.....	13
Table 1 Changes to required Dam Flood Capacity under Proposed Risk Management Framework .....	14
Table 2 Progressive Improvement of Safety .....	15
Table 3 Consequence Categories.....	16
Figure 1 Proposed DSC Societal Risk Requirements: Existing Dams .....	17
Figure 2 Proposed DSC Societal Risk Requirements: New Dams & Major Augmentations .....	18
Figure 3 Worst Case Risks for Flood Starting Point Plotted on the Proposed DSC Societal Risk Requirements: Existing Dams .....	19
Figure 4 Societal Risk Requirements: Existing Dams – Comparison with Other Industries.....	20

## 1. INTRODUCTION

The *normal requirements* of the NSW Dams Safety Committee (DSC) are set out in its guidance sheets with its principal guidance sheet *DSC Background, Functions and Operations - DSC1A*, outlining the DSC's general operations and authority.

The principles that guide the DSC in its regulation of dam safety are set out in this Guidance Sheet. It provides guidance, and background information, to dam owners on the new risk management framework adopted by the DSC in its formulation of measures to ensure appropriate dam safety management arrangements in NSW.

In this sheet, Sections 2 and 3, Tables 1 and 2 (including the notes thereto), and Figures 1, 2 and 3, comprise the policy endorsed by the Government and represents the normal requirements of the DSC. The footnotes in Section 2 are clarifications of the DSC and were not in the endorsed document.

The sheet applies to all dams that are prescribed under the *Dams Safety Act 1978*.

## 2. DSC RISK MANAGEMENT POLICY FRAMEWORK FOR DAM SAFETY

This policy framework was developed by the DSC and endorsed by the NSW Government in August 2006. It comprises high level generic principles (shaded) and accompanying notes, tables and figures that amplify the principles or indicate their application.

### A - DSC Roles and Responsibilities

#### Principles

- A.1 the DSC operates under the *NSW Dams Safety Act 1978* and interprets its statutory role as being to ensure the safety of dams and their storage reservoirs in order to adequately protect the interests of the community;
- A.2 it is the responsibility of the DSC to define its requirements for the safety of dams and their storages and to ensure compliance by owners with those requirements;
- A.3 the DSC will prescribe those dams with the potential for a failure which could have a significant adverse effect on community interests;
- A.4 the DSC will not prescribe the following structures, which are not regarded as dams:
  - Levee banks;
  - Road or railway embankments, unless designed to act as dams;
  - Concrete or steel service reservoirs, which are structurally reliant on tensile hoop stress and/or reinforced cantilever action.

## **B - Dam Owner Roles and Responsibilities** (see Section 4 of the Dams Safety Act for “owner” definition)

### Principle

B.1 a dam owner is responsible for the safety of a dam and is to do whatever is needed to reliably meet the DSC’s dam safety requirements, as soon as reasonably practicable.

### Notes

Owners are expected to have effective dam safety management programs in place with procedures that meet the requirements of the Australian National Committee on Large Dams (ANCOLD) Guidelines on Dam Safety Management, 2003. The DSC requires Dam Safety Emergency Plans (DSEPs) for dams where failure would put lives at risk and requires owners to regularly assess the adequacy of their dams’ security measures. The DSC audits owners’ Dam Surveillance Reports as the initial basis for deciding on dam safety requirements.

### Principle

B.2 an owner is to submit its conclusions on safety, or proposals for safety improvements or other modifications, to the DSC for review. The DSC will review an owner’s conclusions or proposals primarily with regard to compliance with the DSC’s requirements. For all supporting and detailed data, interpretations, analyses, calculations, judgements and conclusions, the DSC will rely on the knowledge, skill and diligence of the owner’s professional advisors. This policy will not prevent the DSC challenging the owner to justify any aspect of a proposal.

### Notes

Dam owners are to employ<sup>1</sup> suitably qualified and experienced persons for dam safety tasks. The DSC may challenge an owner to show that suitable people are being used. Where specified by the DSC, conclusions or proposals are to be subjected to an independent peer review.

## **C - DSC Safety Requirements for Dams**

### Principles

C.1 the DSC’s approach is practicable goals-based regulation and it sets its safety objectives accordingly;

C.2 the DSC’s requirements for a prescribed dam define the minimum level of safety that will adequately protect community interests – the dam owner can implement a higher level of safety, subject to the need to optimize risk reduction over a portfolio of dams;

C.3 a dam is to be considered “safe”<sup>2</sup> once it complies with the DSC’s *long-term* safety requirements.

### Notes

Owners must work out how to meet the DSC’s goals-based safety objectives and send their proposals to DSC for review. Once plans are agreed, the DSC monitors compliance.

### **The DSC “Normal” Safety Requirements**

The DSC normal safety requirements define positions generally acceptable to the DSC with the starting points in assessment of long-term safety being:

- for dams, the safety level at the conservative (safer) end of any ANCOLD range for the standards-based approach (SBA) requirements, where such exist;
- for dams, where there is no SBA, compliance with the DSC public safety risk guidelines<sup>3</sup>; and

<sup>1</sup> In this context “employ” has the generic sense of “utilize the services of”, as in “engage” or “commission”.

<sup>2</sup> Throughout this document “safe” means “safe enough for the time being”. The DSC does not have any final sign-off on safety because future developments cannot be predicted.

<sup>3</sup> The DSC public safety risk guidelines are under Principle D.3.

- for mining<sup>4</sup>, recognised good practice and publications.

In situations specified by the DSC, these safety levels will then be subject to:

- a check that risk to the individual is below the ANCOLD limit of tolerability (1 in 10,000 per year for existing dams or 1 in 100,000 per year for proposed dams or major augmentations) to the extent dictated by the as low as reasonably practicable (ALARP) principle;
- a check that societal risk is below the limit of tolerability on Fig. 1 or Fig. 2, to the extent dictated by the ALARP principle;
- adequate demonstration by the owner or proponent that all other risks to community interests are tolerable; and
- consideration of the national and international safety practices at the time.

Under the SBA, the DSC classifies dams by consequence category, the principle being that the more severe the consequences of dam failure the greater the level of safety that is required. The DSC system for assigning consequence category is largely based on that of ANCOLD with *population at risk (PAR)* as an indicator of the potential for loss of life or injury in the event of dam failure. Within any consequence category, there can be a wide range in the likely loss of life from dam failure according to such factors as:

- the actual *PAR* within the category range;
- the lethality of dam failure flood waters (swift and deep or slow and shallow);
- the warning time available to the *PAR*;
- the distance of the *PAR* from the dam;
- the understanding that the *PAR* has of the severity of dam failure flooding.

The likelihood of dam failure depends upon both the probability of the design events and the conditional probability of failure, given the event.

To ensure that all such factors are properly examined and weighed, the DSC has its starting point level of safety at the conservative (safer) end of the ANCOLD range and asks dam owners to fully justify any reduction in the level of safety.

The *starting point* level of safety will often be acceptable to the DSC. Basic information will be requested from the owner to enable the DSC to make an initial check on the tolerability of risks. It is mainly where there is doubt that the DSC *public safety risk* guidelines are met, that additional information would be sought from owners.

Figure 3 shows how the DSC *starting point* level of safety for flood capacity could relate to the DSC guidelines for *societal risk* (potential for loss of multiple lives) in very unfavourable<sup>6</sup> circumstances. This figure indicates how the *starting point* level of safety could often meet the DSC *public safety risk* requirements but also how the DSC may sometimes need to ask owners to provide a higher level of safety.

#### *Flood Capacity of Dams*

The DSC's requirements are detailed in Column 4 of Table 1 but it should be noted that for High A, High B, High C and Significant flood consequence category (FCC) dams, the starting point level of safety is subject to a check on the tolerability of the risks to public safety. Guidelines will be developed<sup>7</sup> to assist owners on the basic information that is required by the DSC in this regard.

<sup>4</sup> In this sheet "mining" refers to the role of the DSC in the regulation of mining that could endanger dams or their stored waters or other substances.

<sup>5</sup> The "design event" is a particular case of the general concept which might be called "loading event" or "initiating event". It means any event that can trigger the initiation of a failure mechanism. The greatest risk is not always associated with the design event. Events of a lower severity will have a higher probability of occurrence and may contribute the greatest risk.

<sup>6</sup> "Unfavourable" means that the fatality rate is 1.0 – in other words the *loss of life* is equal to the *population at risk*.

<sup>7</sup> See DSC3B *Acceptable Flood Capacity for Dams*.

However, any dam that can safely pass the probable maximum flood (PMF) will meet the DSC long-term requirement for flood capacity.

### *Dam Security*

Owners are to report on the adequacy of security measures at their dams in their Surveillance Reports. The DSC has provided guidance on its website, and its Guidance Sheet [DSC2H](#) on *Dam Security* will assist dam owners in this regard.

### *Other Hazards*

The DSC will develop<sup>8</sup> requirements for hazards other than flood although further risk reduction will not be sought for risks from:

- piping (internal erosion of embankments and/or foundations) where there are properly designed fully intercepting filters, the dam has a non-erodible rock foundation and there are measures to prevent piping into or along the rock jointing; and
- earthquake where recognized analyses show the dam is safe for the *annual exceedance probability (AEP)* 1 in 10,000 earthquake.

### Principles

C.4 the DSC accepts a dam as “safe enough” for the time being – it does not accept that a dam is safe on a once and for all time basis;

C.5 in setting dam safety requirements, the DSC will have regard to safety levels recognized in the dams engineering community and by regulators of hazardous industries.

### Notes

Recognized safety levels will be determined by the DSC, based primarily on a critical review of relevant ANCOLD guidelines, but critical consideration will also be given to:

- International Commission on Large Dams (ICOLD) publications;
- guidelines of other national dams engineering associations;
- practices of other Australian and international dam safety regulators;
- practices of leading dam owner engineering organizations;
- authoritative good practice in dams engineering, mining engineering, geotechnical engineering and other relevant disciplines;
- public safety management practices in other hazardous industries; and
- relevant Australian and international standards and codes.

The DSC will not blindly accept source documents, such as ANCOLD guidelines, in their entirety but will critically review them to ensure that their guidance will adequately serve the interests of dam safety in NSW and, as necessary, will modify or qualify the guidance contained in source documents.

### Principle

C.6 the Committee’s overriding policy is to determine its safety requirements in any particular case on the merits of the case.

### Notes

The DSC will consider submissions by owners for departure from its normal safety requirements on a case-by-case basis. Owners would need to demonstrate that risks are tolerable for the time being, or will be tolerable following proposed safety improvements. In the long-term, the DSC will expect that its public safety risk guidelines are satisfied, except for those situations where DSC does not require a check of public safety risks.

<sup>8</sup> The word “develop” here should be understood as “further develop” because the DSC already has requirements for the earthquake hazard.

## D – Assessment and Management of Dam Safety Risks

### Principle

D.1 the DSC adopts the national standard Risk Management, AS/NZS 4360:2004<sup>9</sup> as defining the framework for assessment and management of dam safety risks. Traditional dam engineering *standards* are absorbed into that framework.

### Notes

Modern safety regulation concepts developed for other hazardous industries will be adapted for dam safety purposes so far as practicable. The traditional *standards-based approach* (SBA) for dams will receive consideration for those failure modes for which standards have been established.

### Principle

D.2 a dam owner is to keep the risks of a dam under review. The safety of a dam is to be reviewed whenever the owner considers that a review is needed, but as a minimum whenever the DSC determines that a review is needed.

### Notes

The DSC's Guidance Sheet *DSC2D Demonstration of Safety for Dams* covers such matters as:

- hazards and failure modes where the traditional engineering *SBA* is to be considered;
- DSC requirements for *risk assessments*;
- guidelines for undertaking *failure modes analysis (FMA)*;
- the qualifications and experience of persons undertaking *risk assessments*;
- guidelines for demonstration of *ALARP*;
- the application of the *safety case* concept to dams; and
- application of the concepts of *prevention, control and mitigation (PCM)* to dams.

### Principle

D.3 when required to do so, a dam owner is to demonstrate that risks to public safety and other interests of the community are tolerable. To be *tolerable*, a risk must be as *low as reasonably practicable (ALARP)*. For *public safety risks*, risk boundaries – the *limit of tolerability* and the *negligible* level of risk – are relevant in applying the *ALARP* test.

### Notes

#### DSC Public Safety Risk Guidelines

##### **Risk to the Individual**

Where the adequacy of safety is judged by reference to the DSC public safety risk guidelines, the DSC requirement for the long-term is that risk to the individual be below the limit of tolerability to the extent dictated by the *ALARP* principle.

For existing dams, the DSC's limit of tolerability is 1 in 10,000 per annum, which is the same as that of ANCOLD and of Health and Safety Executive, United Kingdom (HSE). For proposed dams and major augmentations, the DSC's limit of tolerability is 1 in 100,000 per annum, which is the same as that of ANCOLD.

For all dams and major augmentations, the DSC's negligible risk is 1 in 1,000,000 per annum, which is that of the guidelines of DOP (Department of Planning - Table 2 of Risk Criteria for Land Use Safety Planning – Hazardous Industry Planning Advisory Paper No. 4, March 2002) and the HSE broadly acceptable level of risk. In line with the HSE view, the DSC regards this negligible level of risk as so low that it is not worth searching for further reduction, though any obvious inexpensive precautions would be taken.

<sup>9</sup> The ANCOLD *Guidelines on Risk Assessment* [October 2003] have adopted the national standard as the basic framework for risk assessment.

Where the risk to the individual from dam failure is within the intolerable region (that is higher than the limit of tolerability), the DSC position is that such risks are *intolerable* in nearly all circumstances. Upon application by the owner, the DSC may be prepared to weigh such factors as the potential adverse consequences of a dam failure, the likelihood of such a failure occurring, the feasibility of risk reduction and the benefits of the dam to society, all in the context of the reliability of the estimates of the risks. Any acceptance by DSC of such risks will be by way of exception, in view of the benefits of the dam to the wider interests of society, and provided all reasonable risk reduction measures have been taken (i.e. the risks are *ALARP*).

### **Societal Risk**

Where safety is judged by reference to the DSC public safety risk guidelines, the DSC requirement for the long-term is that societal risk be below the limit of tolerability shown at Figures 1 or 2<sup>10</sup> to the extent dictated by the *ALARP* principle. For societal risk, the DSC has adopted a negligible level, which is two orders lower than (one hundredth of) the limit of tolerability on the appropriate figure. Again, the DSC regards the negligible level of risk as usually acceptably low.

Where the *societal risk* from dam failure is within the *intolerable* region of Figure 1<sup>11</sup>, the DSC position is that such risks are *intolerable* in nearly all circumstances and applications for exceptions by owners will be treated similarly as those for *intolerable risk to the individual*. Within the *intolerable* region, the higher the risk plots on the graph and the further to the right, the more difficult it would be for an owner to persuade the DSC that the benefits of the dam justify acceptance of the risks. The DSC, before making its decision, will recommend that the owner ensure *societal concerns* have been fully exposed by a process of community and other stakeholder consultation.

The DSC is aware of two key considerations:

- The potential for loss of many lives is of great concern and loss of over 1,000 lives would be seen by society as catastrophic at the international scale. In addition, the economic costs of such large tragedies are so great that it may be that the Federal Government would have to intervene; and
- It is increasingly difficult to reliably estimate probability of failure as it reduces and little confidence could be attached to estimates of probability lower than 1 in 100,000 per annum.

In judging whether the risks of an existing dam with potential for loss of more than 1,000 lives could be accepted, the DSC will weigh these facts very carefully. For such dams with risks in the *intolerable region*, it is very unlikely that the DSC would accept a continuance of the risks. Where the owner claims that the risks fall within the shaded rectangle on Figure 1, the DSC will look very critically at the reliability of the estimates of risk and will expect there has been every effort to follow a rigorous methodology.

Full compliance with any relevant *SBA* will be expected. The adequacy of *failure modes analysis (FMA)* in exposing all potential failure scenarios will be carefully examined. As a prerequisite to acceptance of risks involving such serious consequences, the owner will need to demonstrate that risks are *ALARP*. The owner will then need to demonstrate that the benefits of the dam to society warrant the continuing potential for such serious consequences. After consideration of all relevant factors, the DSC would reach a decision based on the merits of the case.

For proposed dams or major augmentations, where the potential for loss of life exceeds 1,000 persons, the DSC will make a special reference to Government<sup>12</sup> and will only agree to the project proceeding if the Government agrees that the risks are justified by the benefits that the dam would bring for society. The need for such a reference would be a rare event. In most such cases, other requirements for Government approval would also apply.

### **ALARP**

The DSC requirement is that owners or proponents demonstrate that both risk to the individual and societal risk are *ALARP*. The DSC will judge the owner's or proponent's case for *ALARP* on the basis of:

---

<sup>10</sup> Whilst not part of the policy endorsed by Government, Figure 4 of this sheet is a comparison of societal risk criteria taken from another DSC document. The criteria shown are in use by various regulators and are provided for the information of dam owners and their advisors. The information was correct in mid-2006.

<sup>11</sup> The discussion here relates essentially to the safety of existing dams. For new dams or major augmentations the DSC would not accept *intolerable risks* and the situation under discussion should not arise.

<sup>12</sup> This is a reference to the State Government.

- The disproportion between the *sacrifice* (money, time, trouble and effort) in making the safety improvement and the risk reduction that is achieved.
- the level of risk in relation to the *limit of tolerability* and the *negligible* risk level;
- the *cost-effectiveness* of safety improvement options;
- any relevant *recognized good practice*; and
- *societal concerns* as revealed by the owner's or proponent's consultation with the community and other stakeholders.

Even in cases where numerical risk criteria are already being met, there is a further principle of *avoiding avoidable risks* which needs to be followed. Guidelines on demonstration of *ALARP* for dams are to be incorporated into the Guidance Sheet DSC2D.

#### Other Risks<sup>13</sup> to Community Interests

The DSC requirement is that dam owners or proponents demonstrate that these risks are *tolerable*.

#### Principle

D.4 for a dam which would threaten lives if it failed, failure modes analysis (FMA) is to be a part of any safety review prepared for, or required by, the DSC.

#### Notes

Guidelines for undertaking *failure modes analysis (FMA)* will be included in the DSC's Information Sheet *DSC 2D Demonstration of Safety*.

#### Principle

D.5 a dam owner may use *risk assessment* as support for submissions to the DSC on dam safety, subject to the agreement of the DSC. In particular cases, the DSC may require an owner to undertake risk assessment.

#### Notes

In undertaking *risk assessment*, owners are to follow the *ANCOLD Guidelines on Risk Assessment*, October 2003 and the DSC Guidance Sheet *DSC 2D Demonstration of Dam Safety* is available.

*Portfolio Risk Assessment (PFRA)* for dams has become firmly entrenched Australia-wide in the last five years and provides a rational, holistic basis for comparing the preliminary risk status of dams, and for prioritizing remedial action strategies, or other dam safety management activities, in conjunction with the traditional *SBA*. *PFRA* also gives a basis for determining *urgency* of safety improvement. *Risk Index Schemes* can be used in ranking dams by risk and as a basis for *priority*.

The DSC encourages the use of *PFRA* or *Risk Index Schemes* by dam owners and, where satisfied with the methodology that is used, proposes to rely on the outputs as a basis for reviewing the *priority* and/or *urgency* of dam safety studies and improvements<sup>14</sup>.

Situations where a need for *risk assessment* could arise are as follows:

- To review the risks to, or posed by, a dam;
- To better clarify the safety status of a dam, especially where the *SBA* provides no or limited guidance (e.g. piping risk);
- Where there is doubt that the DSC's *starting point* deterministic level of safety will meet the DSC *public safety risk* guidelines;
- To justify a shift from the DSC *normal* level of safety, subject to DSC agreement;
- To assist assignment of *priority* and *urgency* over the dams of an owner's portfolio or over the elements or failure modes of an individual dam; and

<sup>13</sup> "Other Risks" includes economic loss, environmental damage, public health impacts and loss of iconic structures.

<sup>14</sup> Generally the DSC would not accept *PFRA* [in the common understanding of the term] or *Risk Index Schemes* as a basis for decisions on the acceptability of dam safety risks.

- If the *FMA* reveals risks for which there are no adequate *SBA* requirements.

## E – Meeting Dams Safety Requirements

### Principle

E.1 a dam owner is to bring risks into compliance with the DSC's safety requirements as soon as reasonably practicable, is to keep the residual risks under review and is to maintain risks as low as reasonably practicable over time, having regard to future technology, scientific knowledge, and other relevant considerations of the day.

### Notes

The DSC will judge compliance with the requirement *as soon as is reasonably practicable*, having regard to relevant circumstances, particularly the level of risk.

### Principles

E.2 implementation programs for safety improvements are subject to DSC review;

E.3 safety improvements required by the DSC may be implemented progressively where that would promote more effective risk reduction for the community as regards risks from dams, but in such cases progressive implementation is subject to DSC review.

### Notes

#### *Concept of Progressive Improvement*

The DSC's objective in introducing this concept is better outcomes in risk reduction for the community from the available resources by;

- eliminating *intolerable risks* from all dams *as soon as reasonably practicable*;
- achieving the *long-term* DSC safety requirements, over all deficiencies and dams, *as soon as reasonably practicable*, having regard to relevant circumstances, in particular the existing level of risk.

A typical framework for *progressive improvement* is set out in Table 2 with three improvement phases. For particular dams there may be more or fewer improvement phases and indicative maximum times may vary, the objective in all cases being to reduce risks *as soon as reasonably practicable*.

In reviewing proposals for *progressive improvement*, the DSC will consider:

- whether the proposal will meet the objective set out above;
- the existing level of risk;
- the risk profile of dams across the relevant portfolio; and
- the costs of meeting the *medium-term* and *long-term* risk levels of Table 2.

No dam (or other infrastructure facility) can ever be risk-free. There will always be some residual risk. Under the concept of progressive improvement, there is never a final *sign-off* on dam safety. A dam's safety is reviewed regularly throughout its life and if a dam is found to be deficient in safety, the question of risk reduction pathways arises.

In considering improvements, *short-term* measures should always be implemented if practicable to reduce risks whilst plans for *medium-term* and *long-term* risk reduction are made.

For the case where a number of dams are deficient in safety, the issue is: *What is the best strategy for risk reduction over that group of dams which is deficient?* There are many possibilities, but to illustrate the implications of a policy of *progressive improvement* the following two options are considered:

1. At the outset, improve each dam of the group to the DSC *long-term* requirement as resources become available<sup>15</sup>; and
2. Improve each dam of the group over the *medium-term* to reduce risks below the *limit of tolerability*. Once *intolerable risks* are eliminated for all dams of the group, improve the dams again according to the DSC *long-term* requirement.

The second option would usually produce better risk reduction outcomes for the community. However, an owner remains responsible at all times for any residual risk and may incur liability in the event the risk is realized.

It would be necessary to ensure that economically practical improvement packages are implemented in each stage of improvement with allowance for the possibility of further improvements being required in the future.

Where an owner has access to sufficient resources, the DSC will usually have no objection to immediate reduction of risks to the *long-term* level. If immediate improvement to the *long-term* level of a given dam would slow progress on reduction of risks for other dams, the owner should discuss the matter with the DSC.

There may be cases where an ultimate level of safety can be achieved readily at low cost. And there may be cases where there is no technically feasible intermediate improvement. In such cases, the concept of *progressive improvement* does not arise.

Regardless of the hazard, the policy of *progressive improvement* could apply wherever there is a technically feasible intermediate level of improvement. The concept of *progressive improvement* could also apply to the components and failure modes of an individual dam.

#### Principle

E.4 where assignment of priority and urgency to dam safety activities is needed, the owner is to demonstrate to the DSC that the risks to the interests of the community are a key factor in the assignment system.

#### Notes

The DSC's policy is that dam owners have a systematic basis for assigning **priority** (the order in which dam safety activities or risk reduction measures are to be implemented) and **urgency** (how soon the activities or measures should be implemented) for dam safety improvements. The DSC expects that risks to the interests of the community will be a key factor in assignment of *priority* and the extent by which such risks exceed<sup>16</sup> long-term DSC requirements will be a key factor in assignment of *urgency*. The adequacy of systems for assigning *priority* and *urgency* are to be reported in Surveillance Reports.

There is a range of considerations that could influence *priority* and *urgency* including:

- the level of risk;
- the *cost-effectiveness* of risk reduction measures;
- the business interests of the owner;
- the need to limit risks during the implementation phase for safety improvements;
- the rate of development of further homes or other assets downstream of the dam;
- political sensitivities; and
- the economic and technical practicality of safety upgrade implementation packages.

In deciding on an implementation program, an owner would need to consider the technical and economic practicality of improvement packages, which could result in improvements of widely different risk levels being consolidated into the one improvement package.

---

<sup>15</sup> The meaning here is that each dam is improved to meet the long-term safety requirement before moving to the next dam.

<sup>16</sup> Since the DSC long-term requirements will often not be known in the early stages of a safety improvement investigation, the interim basis could be the extent to which the risks are higher than the *limit of tolerability* [the further above the greater the urgency] or lower than the *limit of tolerability* [the further below the lower the urgency].

## F - Dams Safety Consultation

### Principle

F.1 as part of, or in addition to, the requirements of the *Environmental Planning and Assessment Act 1979*, the DSC recommends that the dam owner consult with the community and other stakeholders as an input to decision-making on significant safety matters relating to a prescribed dam.

### Notes

Community and other stakeholder consultation is important for prescribed dams where lives could be lost in the event of failure, whenever the safety of the dam is in question, where the proposed decision is a matter of public interest or where there could be significant *societal concerns*.

As part of the risk management process, the standard AS/NZS 4360:2004 *Risk Management* requires continuous and wide consultation with the *community* (those at risk from dams and those directly affected by a dam failure) and *other stakeholders* (e.g. government agencies, insurers).

The DSC recommends that owners of prescribed dams, where lives could be lost in the event of failure, ensure the community is adequately informed and consulted as part of decision-making whenever the safety of the dam is in question, where a proposed decision is a matter of public interest or where there may be significant *societal concerns*. Dam owners should inform and consult with the community generally, and specifically with those at risk, on the risks and potential consequences of dam failure, including outcomes of *risk assessments*, and risk reduction options and proposals. Such consultation would reveal *societal concerns* that need to be considered in deciding on the tolerability of risk. The DSC also expects that there will be consultation even where the owner concludes a dam is adequately safe though there has been a question over its safety. Since the decision is to do nothing, such a case does not require consultation under the NSW *Environmental Planning and Assessment Act*,

If an owner fails to consult, the DSC may make public relevant information that it holds regarding the safety risks of the dam.

Consultation on safety improvements should occur throughout all the planning stages and should be started as early as the practicalities of establishing effective communication and understanding will allow. To assist dam owners and mining companies, the DSC is developing guidelines for community and other stakeholder consultation in Guidance Sheet DSC2I *Community Consultation and Communication (CC&C)*.

### Principles

F.2 where mining could create significant risks for dams or their stored waters, the DSC will consult with the dam owner, and if needed with the community and other stakeholders, to ensure that all relevant considerations are taken into account in making recommendations to the Minister administering the *Mining Act 1992* or in taking action under the *Dams Safety Act 1978*;

F.3 as part of, or in addition to, the requirements of the *Environmental Planning and Assessment Act 1979*, the DSC recommends that mining companies consult with the dam owner, and if necessary with the community and other stakeholders, as an input to their decision-making on matters which could give rise to significant risks to dams or their stored waters.

## G - Mining Activities and Dam Safety

### Principle

G.1 the DSC will oversight and will make recommendations to the Minister administering the *Mining Act 1992* on any mining activity which poses significant risks to prescribed dams or their storage reservoirs in order to adequately protect the interests of the community.

### Notes

The DSC will define<sup>17</sup> *Notification Areas* around certain prescribed dams, and some storage reservoirs, to define the areas where mining will be subject to the DSC's recommendations.

### Principles

- G.2 To protect the safety of prescribed dams or their storage reservoirs, certain mining activities may be regulated under the Dams Safety Act 1978;
- G.3 for mining that could affect prescribed dams or their storages, a mining company is to assess the risks to a dam or its storage reservoir as the result of mining and is to demonstrate to the DSC that the risks will be tolerable as defined by the DSC;
- G.4 a mining company is to submit its proposals for mining, which could affect prescribed dams or their storages, to the DSC for review. The DSC will review the company's proposals primarily with regard to compliance with the DSC's safety requirements. For all supporting and detailed data, interpretations, analyses, calculations, judgements and conclusions, the DSC will rely on the knowledge, skill and diligence of the company's professional advisors. This policy will not prevent the DSC challenging the company to justify any aspect of a proposal;
- G.5 the DSC will oversight and make recommendations on mining activities in such a way as to not restrict mineral recovery, within the constraint that risks to the safety of prescribed dams and/or their storage reservoirs are *tolerable* to the DSC.

## **H - DSC Policy Formulation and Implementation**

### Principle

- H.1 in formulating its safety policies, the DSC will observe the following principles:
- Proposed policy changes, with significant implications for owners, stakeholders, affected communities or the state, will be submitted to the Minister administering the *Dams Safety Act 1978*;
  - Proposed new policies, other than minor changes, will be posted on the DSC's web site for a period to enable submission of comment by dam owners, consultants and other interested parties. The DSC will write to the owners of prescribed dams, or to mining companies, as the case may be, inviting them to comment;
  - Policies will preferably be *goals-based* rather than *prescriptive*, to the extent that is practicable;
  - Policies will be formulated in such a way that adverse side effects will be minimised;
  - Policies will be consistent with relevant legislation and regulations, and with relevant Government requirements;
  - For significant new policies, or significant changes to existing policies, policy impact statements will be prepared;
  - Policies will provide a balance between risks and costs in accordance with recognized safety management principles;
  - Alternatives to proposed policies will be considered;
  - Major policy proposals will be externally reviewed by appropriate specialists, and persons qualified to articulate stakeholder interests, and their comments will be considered by the DSC; and
  - The reasoning in support of policies will be documented.

---

<sup>17</sup> The word "define" is to be understood as "continue to define". The DSC has defined Notification Areas for many years now.

## Notes

The principles for policy formulation recognize the modern principles of good regulation in policy formulation. Those affected by proposed policies will have an opportunity to contribute to formulation of the policies with the principles of equity, fairness and transparency observed. Within this policy framework, detailed DSC requirements will be progressively incorporated into its Guidance Sheets and displayed on the DSC website.

### **3. WHAT IS CHANGED BY THIS POLICY FRAMEWORK?**

The DSC's dealings with dam owners are shifted from a *partly-prescriptive* to a *goals-based* approach to regulation of dam safety, to the extent that is practicable. The immediate changes are:

- Failure modes analysis (FMA) is required as part of all safety reviews for dams with lives at risk;
- New safety requirements are introduced for the flood capacity of dams. Table 1 summarises the key changes;
- Security provisions for dams are enhanced by the incorporation of risk management systems; and
- *Risk assessment* is accepted as a tool to assist dam safety management.

Table 1 gives broad requirements only, because the detailed requirements for flood capacity of dams are yet to be developed in a revised Guidance Sheet DSC3B. To assist understanding of the classes of dams that are affected by the changes, Table 3 summarises the basis for consequence categories, as set out in the DSC's Guidance Sheet DSC3A.

The DSC's minimum requirements for earthquake capacity (DSC3C) will change to reflect this policy framework and changes will be made to guide owners with regard to other hazards, such as internal erosion (piping) and human factor hazards.

**Table 1 - Changes to Required Dam Flood Capacity under Proposed<sup>18</sup> Risk Management Framework<sup>(7)</sup>**

(1)	(2)	(3)	(4)	(5)	(6)
Flood Consequence Category under Proposed Policies	Minimum Flood Capacity – Existing Policies	Minimum Medium-term Flood Capacity – Proposed Policies	Starting Point Long-term Flood Capacity – Proposed Policies <sup>(6)</sup>	Change	Comment
Extreme FCC – was High IFHC <sup>(1)</sup>	PMF <sup>(2)</sup>	Flood capacity that has risks to life lower than the <i>limit of tolerability</i>	PMF	Possibly a reduced requirement in the <i>medium-term</i> . No change in the <i>long-term</i>	Typically irrigation dams and water supply dams for large cities upstream of urban areas
High A FCC – was High IFHC	PMF <sup>(2)</sup>	Flood capacity that has risks to life lower than the <i>limit of tolerability</i>	Flood capacity as for PMPDF except that initial reservoir level is to be FSL <sup>(4)</sup>	Possibly a reduced requirement in the <i>medium-term</i> . Small reduction in the <i>long-term</i>	Medium or large dams upstream of rural settled valleys
High B FCC – was High IFHC	PMF <sup>(2)</sup>	Flood capacity that has risks to life lower than the <i>limit of tolerability</i>	Flood capacity of PMPDF or AEP 1:1,000,000, whichever is less	Reduced requirement in both the <i>medium-term</i> and <i>long-term</i>	Many dams owned by Councils for town water supply, as well as some other dams
High C FCC – was High IFHC	PMF <sup>(2)</sup>	Flood capacity that has risks to life lower than the <i>limit of tolerability</i>	Flood of PMPDF or AEP 1:100,000, whichever is less	Reduced requirement in both the <i>medium-term</i> and <i>long-term</i>	Many dams owned by Councils for town water supply, as well as some other dams
Significant FCC – was Significant IFHC	Flood of AEP 1:1,000 to 1:10,000 but not less than half PMF <sup>(3)</sup>	To be determined case by case	Flood of AEP 1:10,000 <sup>(5)</sup>	Similar or reduced requirement in the <i>long-term</i>	Most significant class of dams affected is mine tailings dams storing toxic wastes
Low FCC – was Low IFHC	No requirement	To be determined case by case	Flood of AEP 1:100 to 1:1,000 according to scale of consequences within the category	Increased requirement in the <i>long-term</i>	Now regulates medium level damage to property
Very Low FCC – was Low IFHC	No requirement	No requirement	No requirement	No change	

Notes to Table 1:

1. *IFHC* is *Incremental Flood Hazard Category* (now replaced by *Flood Consequence Category – FCC*);
2. If loss of life would be expected in the event of dam failure;
3. If there is potential for loss of life in the event of dam failure but it is not expected;
4. *PMPDF* is the *Probable Maximum Precipitation Design Flood* – see *ANCOLD Guidelines on Selection of Acceptable Flood Capacity for Dams*, March 2000 – FSL is *full supply level*;
5. Cannot have this consequence category if loss of non-itinerant lives is reasonably likely – must be at least High C. Non-itinerant persons are regular occupants of dwellings, schools, hospitals, nursing homes, commercial and industrial premises and other permanent places of occupation;
6. Subject to consideration of national and international practice at the time and the need for risks to be *ALARP*;
7. This table reflects the *ANCOLD* fall-back table (Table 8.1 of *ANCOLD Guidelines on Selection of Acceptable Flood Capacity for Dams*, March 2000) and thus makes no distinction between existing and new dams, though the *DSC public safety risk* guidelines do make such a distinction.

<sup>18</sup> The word “proposed” applied at the time that the policy document went forward for consideration by Government. “Proposed” is no longer applicable. This comment applies also to Figures 1 and 2.

**Table 2 - Progressive Improvement of Safety**

Stage	Aims	Indicative Timeframe for Completion of Safety Improvements <sup>(1)</sup>
<i>Short-term or Interim</i>	<ul style="list-style-type: none"> <li>To maximize safety, in a cost-effective manner, whilst planning proceeds for the later stages of improvement.</li> </ul>	<ul style="list-style-type: none"> <li>For a structural fix - <i>as soon as reasonably practicable</i>, but generally not longer than 2 years. Program to be agreed with DSC;</li> <li>For a non-structural fix, such as operating restrictions, warning and evacuation plans - <i>as soon as reasonably practicable</i>, but generally not longer than 1 year. Program to be agreed with DSC.</li> </ul>
<i>Medium-term</i>	<ul style="list-style-type: none"> <li>To reach a low but not ultimate level of risk.<sup>(2)</sup></li> <li>To reach risk levels below the <i>limit of tolerability</i>.<sup>(3)</sup></li> </ul>	<ul style="list-style-type: none"> <li><i>As soon as reasonably practicable</i>, but generally not longer than 10 years. Program to be agreed with DSC.</li> </ul>
<i>Long-term</i>	<ul style="list-style-type: none"> <li>To satisfy the DSC <i>starting point</i> deterministic safety level.<sup>(4)</sup></li> <li>To have risks below the <i>limit of tolerability</i> to the extent required by the <i>ALARP</i> principle.<sup>(5)</sup></li> <li>To satisfy national and international practice, if appropriate.<sup>(6)</sup></li> </ul>	<ul style="list-style-type: none"> <li><i>As soon as reasonably practicable</i>, but generally not longer than 20 years. Program to be agreed with DSC.</li> </ul>

Notes:

1. Time runs from the date of the DSC's conclusion there is a safety deficiency. The actual time frame would vary from dam to dam and from owner to owner, depending on such factors as the level of risk, the risk profile of the owner's portfolio of dams and the complexity of needed planning. In all cases, safety improvements should be implemented *as soon as reasonably practicable*, having regard to relevant circumstances, particularly the level of risk;
2. The risk level reached would depend on the circumstances of each case. For example, the DSC might expect an owner with just one dam with only a moderate deficiency in flood capacity to bring it into line with the DSC *normal* requirement in the *medium-term*. But, an owner with several dams, all seriously deficient in flood capacity, might be permitted to defer upgrading to the DSC *normal* level of safety to the *long-term*, and to just achieve risks below the *limit of tolerability* in the *medium-term*. There may be more or fewer than three phases of improvement;
3. For *risk to the individual*, this is the ANCOLD *limit of tolerability* of 1 in 10,000 per annum. For *societal risk*, it is the limit given in Figure 1 or Figure 2, as appropriate;
4. If not already satisfied in the *medium-term*;
5. If the DSC *starting point* level of safety cannot be demonstrated as *ALARP*;
6. Depending on the national and international thinking of the day – what level of consensus there is, how soundly based international practice is and so on.

**Table 3 - Consequence Categories**

Adapted from ANCOLD *Guidelines on Assessment of the Consequences of Dam Failure*, Table 3.

Notes 1, 2, 3 and 6 are essentially the same as in the ANCOLD guidelines. Notes 4 and 5 have been modified. Note 7 is new. There are minor changes to the table.

Population at Risk (PAR) (Note 7)	Severity of Damage and Loss			
	Negligible	Minor	Medium	Major
<1	Very Low	Very Low	Low	Significant
1 to 10	Low (Notes 1, 4&5)	Low (Notes 4 & 5)	Significant (Note 5)	High C (Note 6)
10 to 100	(Note 1)	Significant (Notes 2 & 5)	High C (Note 6)	High B (Note 6)
100 to 1000		(Note 2)	High A (Note 6)	High A (Note 6)
>1000			(Note 3)	Extreme

Note 1: With a PAR of 5 or more people, it is unlikely that the severity of damage and loss will be “Negligible”.

Note 2: “Minor” damage and loss unlikely when the PAR exceeds 10.

Note 3: “Medium” damage and loss unlikely when the PAR exceeds 1000.

Note 4: Change to Significant where the loss of itinerant lives is reasonably likely, given dam failure. As a guide, loss of lives can be seen as reasonably likely where the product of annual probability and number of lives lost exceeds 0.001.

Note 5: Change to at least High C where the loss of non-itinerant lives is reasonably likely, given dam failure.

Note 6: Refer Section 2.7 and 1.6 of the ANCOLD *Guidelines on Assessment of the Consequences of Dam Failure* for explanation of the range of High Consequence Categories.

Note 7: The contribution to PAR of non-itinerants (ie regular occupants of dwellings, schools, hospitals, nursing homes, commercial and industrial premises and other permanent places of occupation) shall be the largest total population that is exposed at the one time on a regular basis. To allow for the variable exposure of itinerants, the contribution to PAR of such populations shall be computed on the basis of exposure factors. Where low exposure factors are applied to few itinerants, it is possible to have a notional PAR which is less than 1.0.

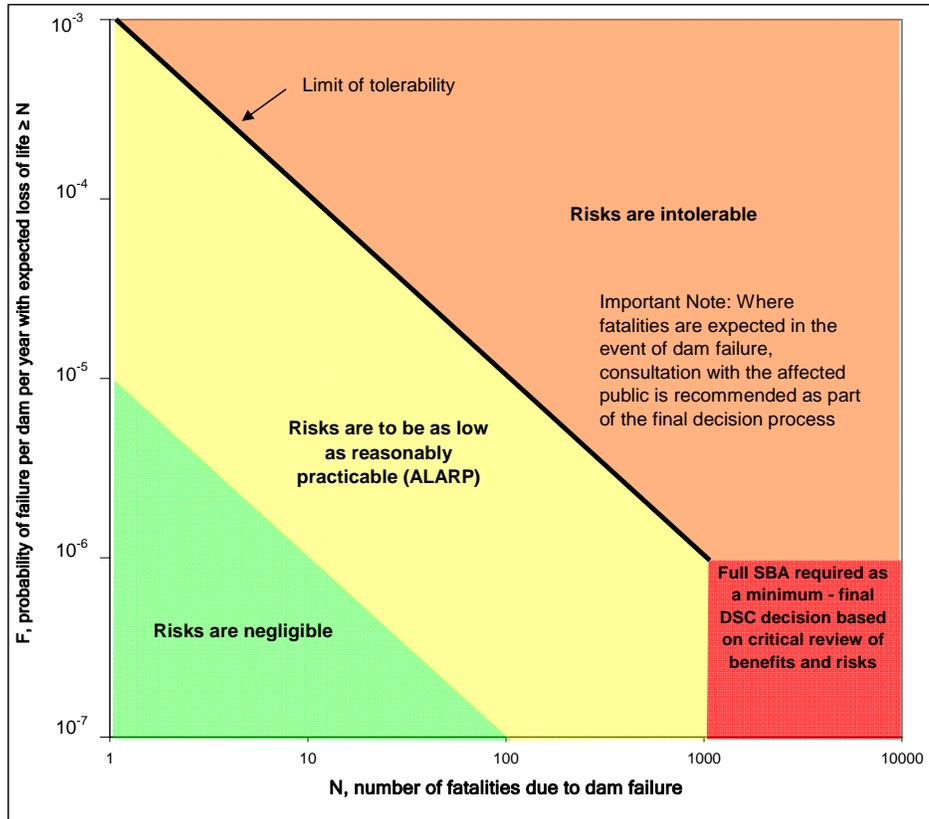
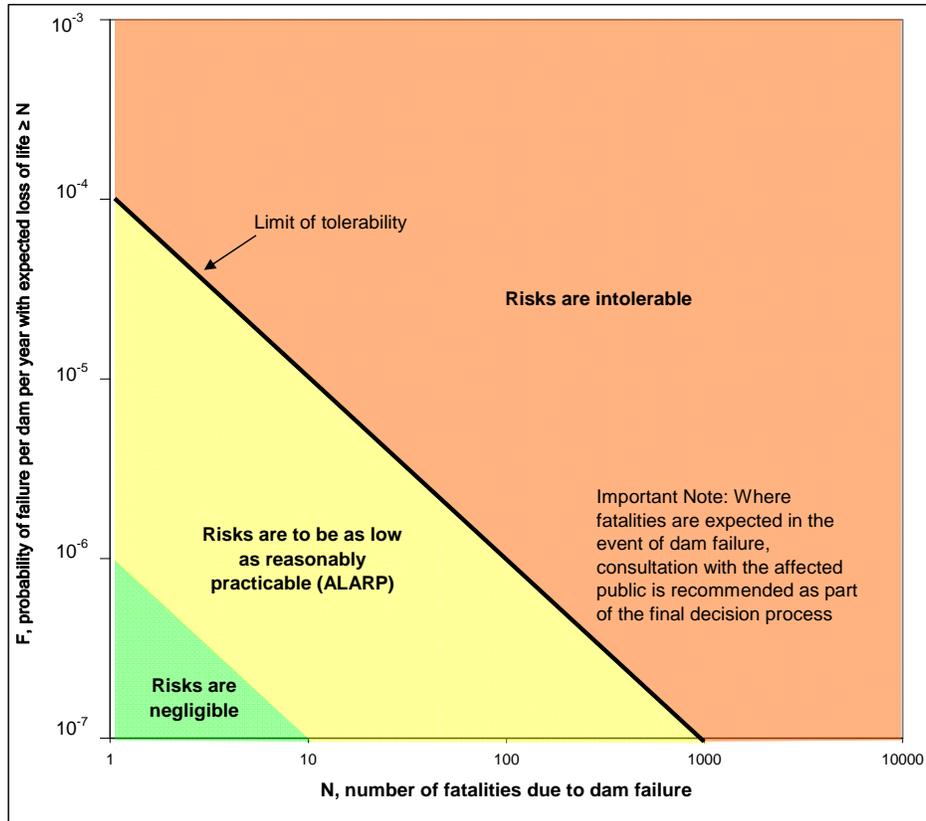


Figure 1 – Proposed DSC Societal Risk Requirements: Existing Dams

**Explanation of Notation on the Figure**

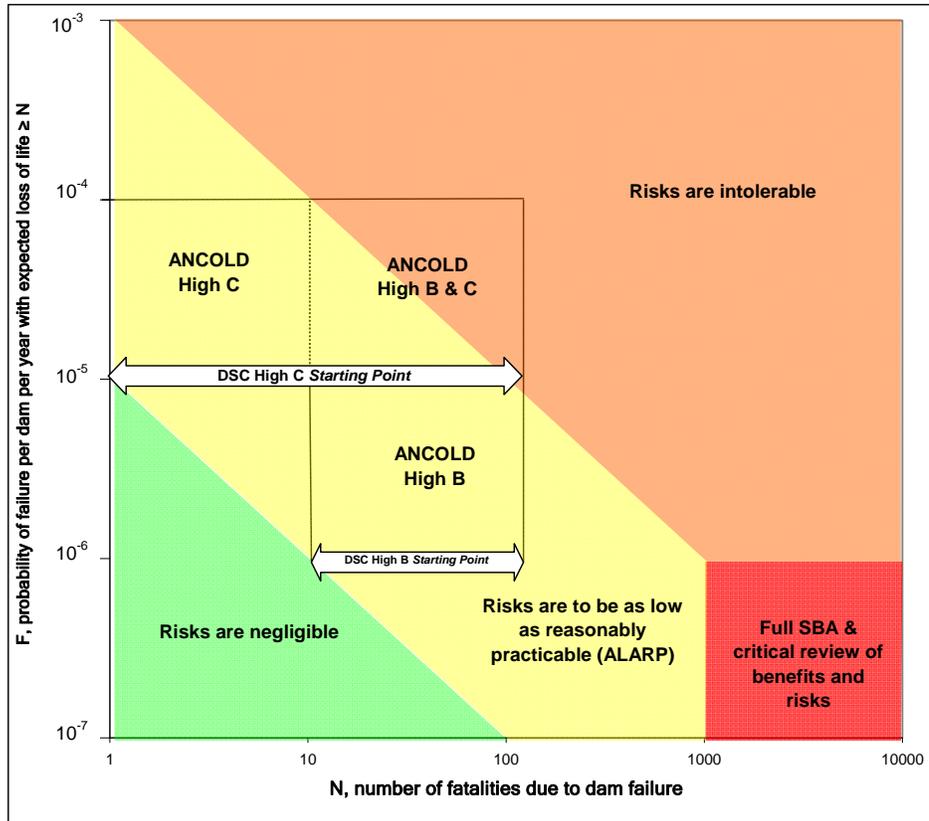
Notation on the Figure	Everyday Meaning
$10^{-3}$	1 in 1,000
$10^{-4}$	1 in 10,000
$10^{-5}$	1 in 100,000
$10^{-6}$	1 in 1,000,000
$10^{-7}$	1 in 10,000,000



**Figure 2 – Proposed DSC Societal Risk Requirements:  
New Dams & Major Augmentations**

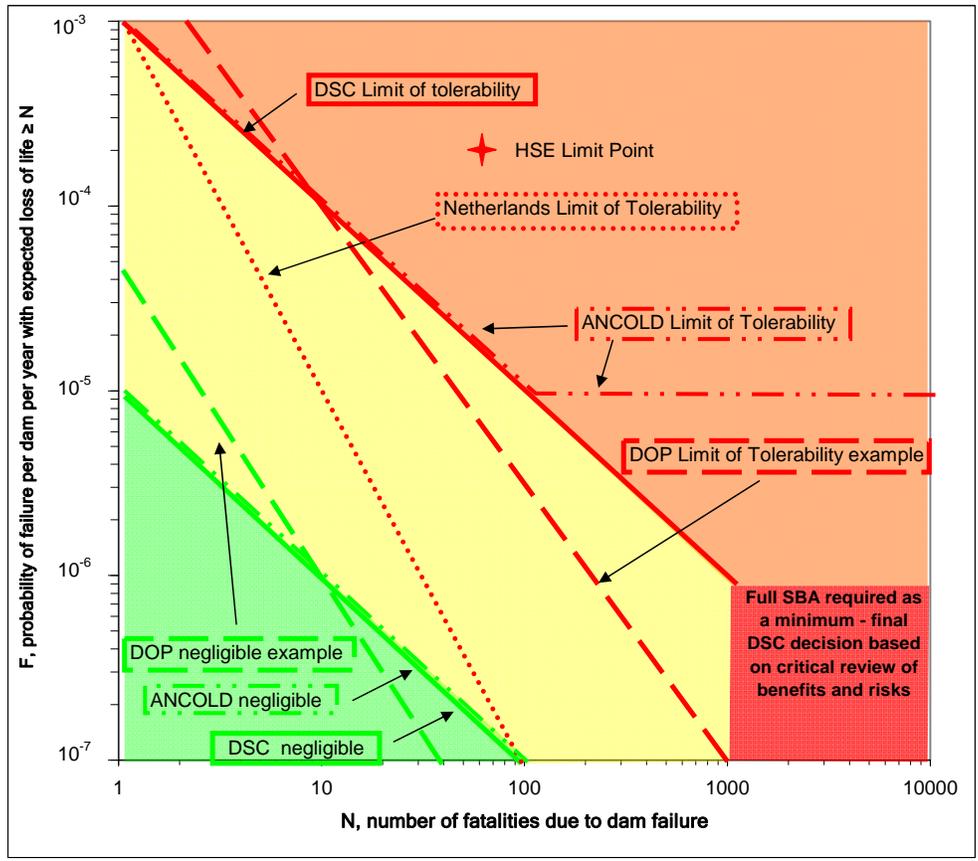
**Explanation of Notation on the Figure**

<b>Notation on the Figure</b>	<b>Everyday Meaning</b>
$10^{-3}$	1 in 1,000
$10^{-4}$	1 in 10,000
$10^{-5}$	1 in 100,000
$10^{-6}$	1 in 1,000,000
$10^{-7}$	1 in 10,000,000



**Figure 3 – Worst Case Risks for Flood Starting Point Plotted on the Proposed DSC Societal Risk Requirements: Existing Dams**

(Note: ANCOLD indicates flood capacity should be selected, within the nominated range, according to consequences. However, since no procedure is specified for such selection the full ANCOLD flood capacity range for each consequence category is plotted on Figure 3. To define a “worst case”, the plot is based on loss of life being equal to the population at risk and the conditional probability of dam failure, given the design event, being 1.0).



**Figure 4 - Societal Risk Requirements: Existing Dams - Comparison with Other Industries**

This Guidance Sheet is one of a series available from our Website at:

<http://www.damsafety.nsw.gov.au>

In order to read this file you need a Portable Document Format (PDF) reader. A free PDF reader is available from <http://www.adobe.com/>

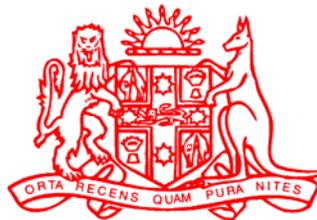
For any further information please contact:

**NSW Dams Safety Committee**  
Level 3, Macquarie Tower  
10 Valentine Avenue, Parramatta NSW 2150

 PO Box 3720, Parramatta NSW 2124

 (02) 9842 8073  (02) 9842 8071

 [dsc@damsafety.nsw.gov.au](mailto:dsc@damsafety.nsw.gov.au)



ISSN 1039-821X