

DSC2A

June 2010

DAM SAFETY MANAGEMENT SYSTEM (SMS)

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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 DSC considers that a vital part of dam safety management programs is an effective *safety management system (SMS)*. Accordingly, this sheet is provided for the guidance and direction of dam owners, and their consultants, in undertaking programs and actions in this area. However, dam owners, and their professional advisers, are reminded that they are responsible for the safety of their dams and will own the liabilities for the safety of their dams in the event risks are realised.

The purpose of this guidance sheet is to provide the owners of prescribed, or proposed dams with general advice on the objectives and necessary elements of an effective *safety management system* and of the reporting needed by the DSC in that regard, along with specific advice on the owner's responsibilities and the requirements of the DSC in this area.

The DSC Safety Management Goals and Key Requirements (Section 2) at the start of the sheet are a summary - the whole sheet is to be read for a proper understanding of DSC requirements for a dam *safety management system*.

2. DSC SAFETY MANAGEMENT GOALS AND KEY REQUIREMENTS

2.1. DSC Safety Management Goals

The DSC's primary goal, relevant to this guidance sheet, is that risks to community interests from the potential for dam failure are tolerable. This requires that the risks are.

- detected, identified and assessed;
- reduced, when necessary, as soon as reasonably practicable and in a way that best serves community interests; and
- kept under review throughout the life cycle of the dam(s).

To keep a continuous watch on risks there needs to be an effective *safety management system (SMS)* in place for each prescribed dam. That is the secondary goal of this guidance sheet. This sheet defines the DSC requirements for an acceptable *normal SMS*. The DSC will consider an alternative SMS provided the owner can demonstrate that it would reliably achieve the goals of this sub-section.

Another goal is a risk management approach that facilitates a whole of Government approach to public safety.

The following sections of this sheet aim to provide direction and guidance to assist the owner in achieving these DSC goals.

2.2. DSC Key Requirements

This section is a summary of the key DSC requirements outlined in this sheet.

Dam Safety Management System

1. The DSC requirement is that an owner will manage the risks of dam failure throughout the life of each dam by implementing an effective *dam safety management system (SMS)* (Sub-section 4.1).
2. The *normal* SMS is based on the *ANCOLD Guidelines on Dam Safety Management*, August 2003, subject to any variation set out in this and other DSC guidance sheets (Sub-section 4.1).
3. An owner may propose an alternative SMS but would need to demonstrate to the satisfaction of the DSC that the system will achieve *tolerable risks* and maintain them over the life of the dam (Sub-section 4.1).

Dam Safety Management Flow Chart

1. The DSC normally expects that a safety management system will include the high level activities set out in Figure 1. These activities are to ensure that any necessary improvements are made to achieve *tolerable risks* and that the risks from a dam are kept under review and properly managed over the whole dam life cycle (Sub-section 4.2).

Reporting to DSC on the Status of the Safety Management System

1. An owner is to report on the status of the *dam safety management system* for a dam by completing the form at Appendix A (DSC Form D12) and including it within the *surveillance report* (see DSC2C (Section 5)).
2. For dams requiring a Type III report only certain items need be completed as indicated by the underlined parts in Section 5 and in Form D12 (Section 5).
3. The form does not need to be completed for *intermediate reports* (see DSC2C – Section 5).
4. Section 5 guides owners on DSC expectations for the *normal safety management system* based on ANCOLD (2003). The answers in Form D12 enable the DSC to judge the adequacy of the *safety management system*.
5. Where an owner proposes an alternative SMS, which is accepted by the DSC, the owner is to submit an appropriate reporting form for consideration by the DSC (Section 5).

Safety Management Systems which do not Satisfy the DSC Normal Requirements

1. If there are elements of the *safety management system* which do not satisfy the DSC *normal* requirements, the normal expectation is that the owner would provide a program for actions that will achieve compliance. The alternatives are to apply to the DSC for a relaxation of particular requirements or to propose an alternative *safety management system* (Section 6).

Reporting to DSC on Dams that do not or may not Meet DSC Safety Requirements

1. Upon becoming aware that the safety of a dam or dams does not meet DSC requirements or is uncertain, the owner is to provide a report to the DSC as soon as reasonably practicable (Section 7).
2. Thereafter reports are to be updated by 30 June each year until the DSC agrees that the safety of the dam or dams is reliably known and no safety deficiencies remain. The purpose of reporting is to enable the DSC to see that deficiencies or uncertainties are being addressed as soon as reasonably practicable and to keep the DSC apprised of changes in the program of activities (Section 7).
3. Reporting is required at:
 - the individual dam level; and may be required at
 - the portfolio level (Section 7).

Reporting to DSC of Dam Safety Incidents or Failure

1. Owners are to report safety related incidents and failures to the DSC (Section 8).
2. Incident and failure reports will be treated confidentially in those respects set out in Section 8.
3. Upon an owner becoming aware of safety incidents or failures, as described below, a report is to be provided to the DSC as soon as reasonably practicable if there are immediate or imminent implications for dam safety (see DSEP requirements in DSC2G) or otherwise in the next *surveillance report* or *intermediate report* (Section 8).
4. If, in the opinion of the owner, the incident or failure requires investigation, a list of activities and time schedule are to be provided (Section 8).

3. BACKGROUND

The principles of safety management in the developed countries have evolved in response to catastrophic accidents across all industries. Many of these accidents have resulted in large loss of life, extensive economic loss and permanent damage to ecosystems.

A consistent theme to emerge from such experiences is the need to keep risks under review by a structured ongoing system of safety management that is supported by adequate human and financial resources.

Some typical safety management principles from hazardous industry are outlined in documents which can be referenced from the DSC, including some requirements on safety management of dam safety regulators in other states.

The components of *risk* are potential failure events, the *likelihood* of each event and the adverse *consequences* should the event occur. As with other industries, the focus of dam safety management systems is the potential *consequences*, as there could be potential system vulnerabilities, which have gone unrecognized. Part of the purpose of *safety management systems* is the timely detection of such unexpected vulnerabilities. By

comparison with *likelihood*, the potential *consequences* are more readily identified. Thus if a system has potentially catastrophic *consequences* there is a stringent *safety management system* regardless of the perceived *likelihood* of those consequences being realized. On the other hand if the potential *consequences* are slight there is a much less demanding *safety management system (SMS)*.

The DSC will consider less stringent safety management at times when the potential *consequences* of system failure are reduced upon the owner making a supporting case to the DSC.

Owners need to recognize that the quality and scale of the *safety management system (SMS)* needs to reflect the potential consequences of failure rather than the size of the dam. Small dams can be very lethal. The failures of Laurel Run Dam and Kelly Barnes Dam in the United States in 1977 resulted in the deaths of forty and thirty nine people respectively. Laurel Run Dam was 12.8m high and held 555ML of water at the time of failure. Kelly Barnes Dam was 12.2m high and held 797ML at the time of failure. Small dams do not necessarily mean small consequences.

As with all of the hazardous facilities on which society relies, for a dam it is a system that needs to have its safety managed. Whilst the dam structure is the central element in that system, there are ancillary and wider sub-system elements such as:

- The operating personnel;
- The decision and command personnel and processes;
- Computers, software, monitoring and control sub-systems;
- Flood warning and emergency response personnel and processes; and
- The complete range of dam safety documentation and procedures.

These are just a few examples of sub-systems that go to make up the total dam system. The management of safety needs to address all of the system sub-systems.

4. REQUIREMENTS FOR DAM SAFETY MANAGEMENT SYSTEM (SMS)

4.1 Dam Safety Management System (SMS)

The DSC requirement is that an owner will manage the risks of dam failure throughout the life of each dam by implementing an effective dam *safety management system*.

The *normal* SMS is based on the ANCOLD *Guidelines on Dam Safety Management*, August 2003, subject to any variation set out in this and other DSC guidance sheets.

An owner may propose an alternative SMS but would need to demonstrate to the satisfaction of the DSC that the system will achieve *tolerable risks* and maintain them over the life of the dam.

The effectiveness of an SMS requires an owner to commit adequate funding, time and skilled human resources to the program and to have those responsible for the program reporting directly to top management.

4.2 Dam Safety Management Flow Chart

The DSC normally expects that a *safety management system* will include the high level activities set out in Figure 1. These activities are to ensure that any necessary improvements are made to achieve *tolerable risks* and that the risks from a dam are kept under review and properly managed over the whole dam life cycle.

5. REPORTING TO DSC ON THE SAFETY MANAGEMENT SYSTEM (SMS)

An owner is to report on the status of the dam *safety management system* for a dam by completing the form at Appendix A (DSC Form D12) and including it within the *surveillance report* (see DSC2C). For dams requiring a Type III report, only certain items need be completed as indicated by the underlined parts in Section 5 and in Form D12. The form does not need to be completed for *intermediate reports* (see DSC2C).

This section guides owners on DSC expectations for the *normal safety management system* based on ANCOLD (2003). The answers in Form D12 enable the DSC to judge the adequacy of the *safety management system*.

Where an owner proposes an alternative SMS, which is accepted by the DSC, the owner is to submit an appropriate reporting form for consideration by the DSC.

5.1 Inspections

Does the owner's inspection program meet the following requirements? A "no" to any question means a "no" on Form D12. For Type III *surveillance reports* only the underlined questions need be addressed.

- Does the program provide for all four levels of inspection and personnel as in Table 5.1 of ANCOLD (2003 – Reference 1)?
- Is the frequency of inspection at least that given in Table 5.2 of ANCOLD (2003)?
- Has at least one of the owner's inspection personnel received appropriate dam safety training within the past five years?
- Do routine inspection reports follow a checklist and are they signed and retained permanently?
- Are other level inspection reports signed and retained permanently?

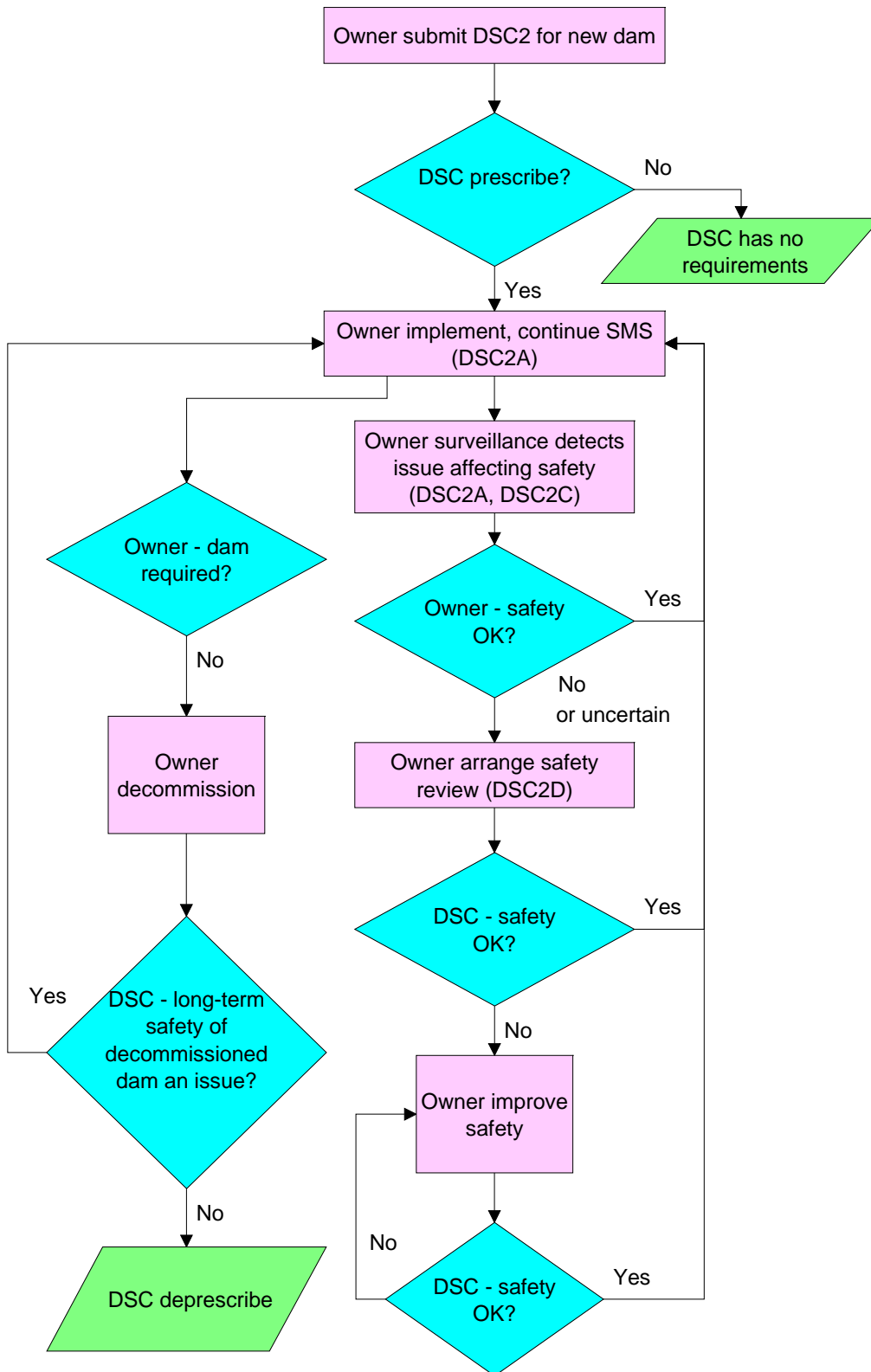


Figure 1 Application of Safety Management System over Dam Life Cycle

5.2. Monitoring

Does the owner's monitoring program meet the following requirements? A "no" to any question means a "no" on Form D12. For Type III *surveillance reports* this question does not need to be addressed.

- Does monitoring frequency comply with Table 5.3 of ANCOLD (2003)?
- Are monitoring records permanently retained?

5.3 Instrumentation

Does the owner's care of instrumentation meet the following requirement? A "no" means a "no" on Form D12. For Type III *surveillance reports* this question does not need to be addressed.

- Have instruments been calibrated at the frequency recommended by the manufacturer or supplier?

5.4 Surveillance evaluation

Does the owner's evaluation of surveillance records meet the following requirement? A "no" means a "no" on Form D12. For Type III *surveillance reports* this question does not need to be addressed.

- Does a suitably trained technician review inspection and monitoring records at least monthly for Extreme and High A category dams, at least every three months for High B dams and at least annually for other dams, having regard to Appendix B.3 of ANCOLD (2003)?
- Does a dam engineer review inspection and monitoring records at least annually for Extreme and High consequence category dams and at least every two years for other dams, having regard to Appendix B.3 of ANCOLD (2003)?

Note that these frequencies are only acceptable upon the condition that any unusual results are promptly referred to a suitably qualified person for evaluation.

5.5 Surveillance Report

Whilst surveillance reports are the key element of a dam safety management system, they are not part of the SMS status reporting form because the DSC will oversight submission of surveillance reports directly. DSC requirements are in its guidance sheet on Surveillance Reports for Dams (DSC2C). Note that more frequent intermediate reports are required for tailings and ash dams.

5.6 Safety Reviews

Whilst *safety reviews* are an important element of a dam *safety management system*, they are not part of the SMS reporting form because the DSC would oversight completion of *safety reviews* directly, usually by monitoring the execution of the recommendations of *surveillance reports*. DSC requirements for *safety reviews* are in its guidance sheet on *Demonstration of Safety for Dams* (DSC2D).

5.7 Safety Improvements

Whilst *safety improvements* are an important element of a dam *safety management system*, they are not part of the SMS reporting form because the need for them is owner or dam specific and DSC would oversight implementation directly. DSC requirements are specific to each case and would be directly advised to the owner.

5.8 Security

Does the owner's protection against unauthorized interference with the dam meet the following requirement? A "no" means a "no" on Form D12. For Type III *surveillance reports* this question does not need to be addressed.

- Has security been reviewed in the past five years by a suitably qualified person (see the note *Dam Security* at www.damsafety.nsw.gov.au/Dams/Requirements/dam_security.shtml)?

5.9 Quality Assurance

Does the owner's quality assurance system meet the following requirements? A "no" to any of the questions means a "no" on Form D12. For Type III *surveillance reports* only the underlined question needs to be addressed.

- Is the responsibility for dam safety within the dam owner organization documented as to what positions are responsible for what functions?
- Has an audit at the *Function* level been conducted within the past ten years (see Table 2.3 of ANCOLD 2003)?
- Have audits at the Process and Validation levels been conducted within the past five years (see Table 2.3 of ANCOLD 2003)?

5.10 Data File

Does the owner's record system meet the following requirement? A "no" means a "no" on Form D12.

- Is a data file maintained for the dam in accordance with Sub-section 5.4 of ANCOLD (2003)?

5.11 Operations and Maintenance (O&M) Manual

Does the owner's operations and maintenance system meet the following requirements? A "no" to any question means a "no" on Form D12. For Type III *surveillance reports* this question does not need to be addressed. This sub-section applies to Significant and higher *consequence category* dams only.

- Is there an O&M manual, broadly complying with Appendix A of ANCOLD (2003), for the dam?
- Has the O&M manual been reviewed and updated, as necessary, within the past five years?

- Is the O&M manual a *controlled* document (see Sub-section 4.4.3 of ANCOLD 2003)?
- Is an Operations and Maintenance Log maintained for the dam?

5.12. Dam Safety Emergency Plan (DSEP)

Does the owner's emergency planning for the dam meet the following requirements? A "no" to any question means a "no" on Form D12. For Type III *surveillance reports* this question does not need to be addressed.

- Is there a DSEP, complying with DSC2G, for the dam?
- Is the DSEP a *controlled* document?
- Has the DSEP been reviewed and updated in the past year?
- Has the DSEP been tested and re-issued in the past five years?

5.13 Documentation (post 1979 dams only)

Do the owner's records for the dam include the following documents? A "no" to any question means a "no" on Form D12. For Type III *surveillance reports* this question does not need to be addressed.

- Is there a *design report(s)* for the dam and is it readily accessible? If not, a *safety review* is acceptable in its place.
- Is there a *construction report(s)* for the dam and is it readily accessible?
- Are *work as executed* (WAE) drawings available for the dam and is a hardcopy set readily accessible to those personnel responsible for the various aspects of the *safety management system*?

For the purpose of this guidance sheet the DSC only wants to know that the documents exist – it does not need to have the documents.

5.14 Education and Training

Do the owner's personnel responsible for day to day care of the dam meet the following requirement? A "no" means a "no" on Form D12. For Type III *surveillance reports* this question does not need to be addressed.

- Have the owner's personnel received training in the relevant aspects of Table 2.2 (ANCOLD 2003) in the past five years?

6. SAFETY MANAGEMENT SYSTEMS (SMS) WHICH DO NOT SATISFY THE DSC NORMAL REQUIREMENTS

If there are elements of the *safety management system* which do not satisfy the DSC *normal* requirements the expectation is that the owner would provide a program for actions that will achieve compliance. The alternatives are to apply to the DSC for a relaxation of particular requirements or to propose an alternative *safety management system*.

In considering relaxation of requirements the DSC would consider such factors as:

1. the potential consequences of a dam failure;
2. the likelihood of a dam failure;
3. whether it is reasonable to insist on the DSC *normal* requirement in all the circumstances;
4. the technical resources that are reasonably available to the owner;
5. any impediments to meeting the DSC *normal* requirement that are beyond the reasonable control of the owner; and
6. the impact of not meeting the *normal* requirements on the risks of dam failure.

The onus is on the dam owner to demonstrate that any alternative SMS would result in tolerable risks.

7. REPORTING FOR A PORTFOLIO OF DAMS, SOME OF WHICH DO NOT SATISFY DSC REQUIREMENTS OR ARE OF UNCERTAIN SAFETY

Upon becoming aware that the safety of a dam or dams does not meet DSC requirements or is uncertain, the owner is to provide a report to the DSC as soon as reasonably practicable.

Thereafter reports are to be updated by 30 June each year until the DSC agrees that the safety of the dam or dams is reliably known and or until the dam meets DSC safety requirements. The purpose of reporting is to enable the DSC to see inadequate safety or uncertainties as to safety status are being addressed as soon as reasonably practicable and to keep the DSC apprised of changes in the program of activities.

Reporting is required at:

- the individual dam level; and may be required at
- the portfolio level.

7.1 Reporting for an Individual Dam with Inadequate or Uncertain Safety

For owners of individual dams, where a need for further investigation or improvement of safety has been identified, the minimum reporting requirement is:

- The owner is to provide the DSC with the current best estimate of the safety status of the dam within three months of the need for investigation or improvement being identified (see DSC2D);

- The owner is to provide the DSC with a program for improvement or investigation activities as soon as reasonably practicable, but at least within six months, after the need for them has been identified (the normal expectation of the DSC is that the program would accompany the *surveillance report* or *safety review* that first identifies the need for investigation or improvement);
- By 30 June each year the owner is to provide a progress report and any updated program; and
- Any deviation from these reporting requirements is to be agreed with the DSC.

Despite these minimum requirements, the DSC expects that an owner will inform the DSC of significant developments affecting the program as soon as the owner is aware of the changed circumstances.

7.2 Reporting for a Portfolio of Dams, some of which do not Satisfy DSC Requirements or are of Uncertain Safety

For those owners of multiple dams, where two or more prescribed dams are known to not meet DSC requirements or need further investigation of safety, the minimum reporting requirement is:

- The owner is to provide to the DSC an initial best estimation of the risk profile of the dams in question together with a statement of safety improvements and/or investigations that will be required. Where the owner has five or more dams either known to not meet DSC requirements or requiring further investigation, the DSC would normally expect to be provided with a portfolio risk assessment (PRA), giving the estimated risks for each dam, as the basis for the schedules of activities for investigation or safety improvement. The information is to be provided by a date agreed with the DSC;
- If any of the dams is known to have *intolerable risks*, the owner is to provide a schedule of activities and key dates (labeled Improvement Schedule 1) designed to eliminate the intolerable risks *as soon as reasonably practicable*. The initial version of this schedule is to accompany the initial information required under the preceding point;
- Once all intolerable risks are believed to be eliminated, the owner is to provide a schedule of activities and key dates (labelled Improvement Schedule 2) for improvements to achieve the long-term level of safety, required by the DSC, on all of the dams. The initial version of this schedule is to be provided by a date agreed with the DSC.
- By 30 June each year the owner is to provide a progress report and updated Schedules 1 and/or 2;
- Any deviation from these reporting requirements is to be agreed with the DSC.

Despite these minimum requirements, the DSC expects that an owner will inform the DSC of significant developments affecting the program as soon as the owner is aware of the changed circumstances.

8. REPORTING TO DSC OF DAM SAFETY INCIDENTS OR FAILURES

Owners are to report safety related incidents and failures to the DSC.

The purposes of incident or failure reporting are:

1. To alert the DSC to a potentially dangerous situation so that assistance can be given to the owner in remedying the situation;
2. If necessary, to provide for the earliest practicable activation of the *dam safety emergency plan (DSEP)*;
3. To enable the DSC to better understand the safety status of the dam;
4. To provide learning, through publication of details on the DSC web site, that will assist other owners and their consultants to avoid similar occurrences at their dams.

Incident and failure reports will be treated confidentially in those respects set out in this section. In any material published by the DSC, the dams and owners will not be identified. It would be necessary to identify the type of dam, which could sometimes be sufficient to identify the dam. The DSC would be sensitive to such possibilities and in such cases would consult with the owner before the information is published.

Upon an owner becoming aware of safety incidents or failures, as described below, a report is to be provided to the DSC immediately if there are implications of an imminent threat to dam safety (see also DSEP requirements in DSC2G). For such a situation, reporting is to be in two stages, the immediate report of date, time and immediately observable facts and a subsequent more detailed and more considered report that identifies the cause and incident mechanism so far as practicable. Such reports are held by DSC for reference and for wider dam owner education uses, with appropriate protection of confidentiality (see Reference 2 - UK Environment Agency 2007 for practice in the UK). If, in the opinion of the owner, the incident or failure requires investigation, a list of activities and time schedule are to be provided.

Other incidents or failures are to be reported in *surveillance reports* or *intermediate reports* (see DSC2C).

Safety incidents or failures are to be reported in the following categories:

- Any change observed in the dam or its surrounds which could indicate an increased vulnerability to failure (for example, a sudden increase in seepage flow not related to rainfall, appearance of turbidity in seepage flow, appearance of new seeps, appearance of cracking in the dam);
- Incidents which could interfere with correct functioning of the dam (for example, a landslide into a spillway chute, malfunction of emergency dewatering valves, malfunction of spillway gate operating equipment);
- Damage to the dam or ancillary structures (such as from flood, earthquake or fire);
- Breaches of security with implications for dam safety;
- Failures in the dam or ancillary structures without loss of dam storage;
- Failures in the dam or ancillary structures with loss of dam storage but without a catastrophic breach; or
- Failures in the dam or ancillary structures with loss of dam storage due to a catastrophic breach.

9. REFERENCES

1. ANCOLD (Australian National Committee on Large Dams), 2003, *Guidelines on Dam Safety Management*, August.
2. UK Environment Agency, 2007, *Learning from Experience. Post-incident Reporting for UK Dams*, April.

APPENDIX A

STATUS OF SAFETY MANAGEMENT SYSTEM REPORTING FORM

Status of Dam Safety Management System

DSC Form D12

1. Purpose

To inform the DSC of the status of the dam *safety management system* in place for the named dam at the date of reporting in terms of the *normal* DSC requirements. Include the completed form in the *surveillance report* for the dam.

For Type III surveillance reports only the underlined items require completion.

2. Dam

Name:

Flood Consequence Category:

Sunny Day Consequence Category:

3. Status of the Safety Management System [see Section 5 of DSC2A]

Key program elements	Meets the <i>normal</i> requirements of DSC2A?	Details of departures from <i>normal</i> SMS ¹
<u>Inspections</u> (levels, frequency, trained staff, checklists, sign-off, retention)	<input type="checkbox"/> Yes <input type="checkbox"/> No	
Monitoring (ANCOLD 2003-Table 5.3)	<input type="checkbox"/> Yes <input type="checkbox"/> No	
Instrumentation	<input type="checkbox"/> Yes <input type="checkbox"/> No	
Surveillance evaluation	<input type="checkbox"/> Yes <input type="checkbox"/> No	
Security	<input type="checkbox"/> Yes <input type="checkbox"/> No	
<u>Quality assurance</u>	<input type="checkbox"/> Yes <input type="checkbox"/> No	
<u>Data file</u>	<input type="checkbox"/> Yes <input type="checkbox"/> No	

Key program elements	Meets the <i>normal</i> requirements of DSC2A?	Details of departures from <i>normal</i> SMS ¹
O&M manual	<input type="checkbox"/> Yes <input type="checkbox"/> No	
DSEP	<input type="checkbox"/> Yes <input type="checkbox"/> No	
Documentation	<input type="checkbox"/> Yes <input type="checkbox"/> No	
Education and training	<input type="checkbox"/> Yes <input type="checkbox"/> No	

(Note 1: Attach list if space is insufficient)

4. Deviations Agreed by DSC

List deviations from the *normal* DSC requirements which have been agreed with the DSC (cite DSC advice date - attach list if space is insufficient)

5. Application for Deviations

If a deviation from the *normal* DSC requirements is sought in respect of any item, a submission setting out the reasons which are thought to justify the deviation is required. The DSC will either seek additional information or advise its decision as soon as reasonably practicable.

6. Improvement of Safety Management System

List the activities and completion dates for achieving the *normal* DSC requirements or with other requirements agreed with the DSC. (Attach list if space is insufficient)

7. Submitted for the Owner

Signed:

Name:

Position:

Date:

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



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