



# Guide to Best Practice in the Operation, Maintenance and Safety of Dams

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# Foreword

Water is a scarce resource, which makes its management one of the greatest challenges facing us globally. In South Africa, water is a basic human right - but that right only applies to basic human needs and the maintenance of environmental sustainability.

South Africa's development vision will only be realised if water resources are managed in a way that is sensitive and supportive of the many demands which we place upon those resources. The operations and maintenance of dams is a very essential component of sound and sustainable water resource management. South Africa has more than 500 large dams, which are used mainly for irrigation purposes and to supply urban areas with water.

Although this guide was prepared for DBSA project teams involved in dam projects, it can be a useful resource for dam owners and other people responsible for the operation and maintenance of dams. The guide introduces the reader to measures aimed at improving the safety of new and existing dams so as to reduce the potential for harm to people, damage to property or resource quality.

We welcome your contributions to this guide, which will be updated in the future based on new developments in the field.

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# Introduction

The DBSA has financed the implementation of fifteen large dams. In November 2000 the international debate about the development effects of large dams culminated in the publication of the report of the World Commission on Dams (WCD). The WCD's *"examination of examples from Laos to Malawi to Canada"* demonstrated that effectively managing the operation of existing projects is a cost-effective approach towards meeting the economic, social and environmental needs of present and future generations.

Dams potentially provide social and economic benefits but at the same time pose a threat to lives and livelihoods and the environment. Dam owners have a legal obligation, in most jurisdictions, to ensure that dams are operated in a way that optimises economic and social outputs while not compromising safety. This is a dynamic process that requires regular monitoring and review. The WCD, for example, advocates a comprehensive review of all existing dams to ensure that they are optimally delivering benefits in an effective, efficient and equitable manner.

Dam failure usually implies a breach of the wall and a catastrophic release of the stored water. It may also be in a more economic sense as the reservoir fills up with sediment and the dam is no longer able to fulfil its storage function.

The purpose of this guide is to outline some of the principal considerations that should guide DBSA project teams during surveillance, monitoring and evaluation operations so that the purpose of the dam continues to be optimally achieved. It does not attempt to address the questions surrounding the broader development objective or project that the provision of water will enable. The guide is written from the perspective of a development finance institution and thus does not attempt to deal with the many complex technical issues inherent to the topic. The groundwork for most of the actions described here is laid during the planning and design stages so that the guide inevitably refers to but does not exhaustively treat these phases in the project cycle.

The DBSA would normally regard the setting up of the operation, maintenance and safety systems as a part of project cost to be financed from the loan. It will be apparent from this guide that there are considerable on-going costs that will have to be financed by the owner from other sources.

The DBSA's practical experience in the field is limited so that most of the material is drawn from the WCD report, literature of the US Bureau of Reclamation and the International Commission on Large Dams (ICOLD) and from other sources. This guide should be used in conjunction with the "Guide to Best Practice in Water Resources Development", the second revision of which was approved in February 2003.

- <sup>1</sup> *The International Congress on Large Dams defines a large dam as having a height of 15 metre or if 5 to 15 metre in height having a capacity of greater than 3 million cubic metre.*
- <sup>2</sup> *World Commission on Dams, Dams and Development - A new framework for decision making, Earthscan Publications, November 2000.*

# Management Plan

Like all substantial assets a large dam has to be effectively managed in a process sometimes referred to as infrastructure asset management. This includes a formal management, business or strategic plan that provides an overview of the various components that this guide deals with below in more detail. The management plan outlines the year-to-year programme of actions and assigns responsibility for their initiation. So, for example, the plan might set the interval for dam safety inspections, name the official responsible for initiating the work, determine whether a procurement process is needed for the inspector and many other general items. The plan will vary greatly with the type and size of the dam. An outline of such a plan could be:

- Operations
- Maintenance
- Dam safety
- Staffing
- Authority and responsibility
- Record keeping and document registers
- Asset register
- Procurement procedures
- Occupational health and safety
- Quality management programme
- Reporting
- Training
- General annual programme
- Budget and financial controls

Each year the responsible person should report against the plan and on the basis of this report the plan should be updated, the ensuing budgetary provisions determined and the staff with the necessary skills recruited.

# General Context

## Compliance

The DBSA requires that all its projects be in compliance with all legal provisions. As far as the topics of this guide are concerned, dam safety has attracted the attention of regulators in some SADC countries. However, there are many other aspects of dam work that are regulated through other sectors, notably environmental management and occupational health and safety.

## Training

This guide addresses various processes, the value of which can only be realised if the operators are thoroughly trained in their use. Obtaining the maximum benefits from a large dam or being prepared for every eventuality during emergency operation, requires ongoing training and management.

## The Relationship between Operation, Maintenance and Safety

It is perhaps trite to point out that these three functions are closely inter-related. A poorly maintained dam cannot be operated safely. There are, however, some digressing objectives. So, for example, a dam safety inspection may not concern itself with whether stored water is being efficiently used or that ancillary infrastructure is being poorly maintained or that the fish ladder is dry. A public participation programme is essential on questions of operation but is probably much less important for maintenance. This guide separates the three processes for descriptive convenience but the key to their integration lies in the management processes in the institution of the dam owner.

## Management Issues and Finance

The guide is not intended to address the general management and finance issues that surround operation, maintenance and safety. Clearly the assignment of responsibility and accountability and the provision of sufficient budget for all the processes outlined here, is axiomatic. Dam safety issues should not be compromised by financial expediency.

## Documentation

These guidelines refer to a large volume of documents that form the basis for establishing good practice. At every dam or within the immediate vicinity, a facility must be provided where the documents can be readily available. This needs to be built with storage units able to protect the documents for long periods. The documents should be duplicated at the head office of the owner.

## Record Keeping

Record keeping and the associated reporting are critical in the efficient operation, effective maintenance and safety of dams. Each of the practices referred to in this guide generate records that should be stored in the document facility referred to above either in electronic or original format according to standing instructions. Records should be duplicated in the head office of the owner.

## Participation

A large dam has many stakeholders. While the interaction with most stakeholders declines on completion of the dam, many of the stakeholders who retain an interest remain. This is particularly important if the dam should have unexpected consequences. The interaction with stakeholders should be guided by a participation plan.

# Operation

A distinction is usually drawn between the operation of the dam for its normal function of water supply (or hydropower generation) and that during flood or emergency circumstances.

## Dam Operating Procedures

Dam operating procedures (also known as "operating rules") refer to the circumstances in which controlled releases are made to maintain the river environment and to supply users. The long-term yield of a dam is estimated using flow records and sophisticated modelling techniques. The demand model usually takes into account monthly fluctuations. However, in real-time, demand for the next period depends on many factors such as antecedent rainfall, temperature and crop cycle. Under normal circumstances a weekly cycle of release planning is followed. It is good practice to draw up a set of procedures that guide the short-term releases from the dam. For example, when the dam content falls below a certain level at a particular time of the year, certain users are rationed. The operating rules may be linked to other dams in a river basin context. In critical drought periods it may be necessary to re-run or re-calibrate the hydrological and demand models.

The operating procedures should be determined through an inclusive consultative process, be unequivocal and well publicised.

## Floods

On some dams, such as Maguga Dam on the Komati River in Swaziland, the operator has no control over the flow that goes over the spillway during floods ("uncontrolled spillways"). Other dams, such as Vaal Dam on the Vaal River in South Africa, are equipped with large floodgates so that the operator can regulate the flow over the spillway ("controlled spillways"). There is a danger that with incorrect operation the maximum flood released can actually be larger than the flow into the dam. The objective of flood routing is to minimise downstream damage without compromising the safety of the dam. During large floods in river systems such as the Vaal River where several dams are involved, the floods are routed from a control centre using real-time computer simulations. In times of such floods however the accompanying adverse weather often renders communications less effective and the on-site operator has to be equipped with the manuals and training that will enable him to independently take the correct measures when necessary.

## Emergency Procedures

The emergency preparedness plan (EPP), describes the circumstances under which emergency procedures are invoked and what is to be done by various persons. Emergencies may arise during extreme floods, on the observation of excessive seepage or other causes depending on the design of the dam. The personnel at the dam would rarely have the skills to deal with emergencies on their own so that the emergency plan is characterised by describing the circumstances under which various individuals or disaster management authorities are notified. At the core of this approach is the need to maintain current contact details and to place this contact list in a prominent place. Disaster management authorities would similarly have an emergency action and evacuation plan (EAP).

Experience indicates that the implementation of an emergency preparedness plan requires extensive and on-going interaction with and training of all role-players.

## Equipment

A dam is equipped with mechanical and electrical equipment. This may vary from small electronic instruments to large floodgates. The operator must have access to the manufacturer's instructions for every piece of equipment on the dam.

## Warning Systems

During flood operation or an emergency there must be a plan for alerting or evacuating people from the danger areas. This is usually the responsibility of the civilian authorities in the area. The emergency preparedness plan at the dam must be meticulously kept up to date and include all the contact details of the responsible disaster management authorities. All parties concerned must understand the circumstances under which a notification is given so that the plan is usually the product of negotiation. The warning system must be complete before the dam is filled for the first time.

## First Filling

The first filling of a dam is a critical period during which special procedures are adopted to ensure dam safety. A survey by ICOLD<sup>3</sup> reported that of 167 dam failures investigated, 35 occurred during first filling. One example of such a special procedure is that, it is desirable to fill the dam slowly. These procedures cannot be compromised by the need to bring the dam into effective operation as rapidly as possible for financial reasons. It is good practice (and required by SA dam safety regulations) for the operating procedures manual to have been completed before first filling commences. These are supplemented by special arrangements during first filling. During the initial phases of filling the emergency plans are usually invoked to the status of an alert.

## Environmental Management Plan (EMP)

The EMP derives from the environmental impact assessment undertaken during the planning phase and leads on from the EMP followed during the construction phase. It must deal with the dam wall, the lake, the river downstream and other areas such as access roads. The plan will deal with a large range of topics from the protection or conservation of sensitive areas to the control of weeds and disease vectors that may be encouraged by the lake. Most jurisdictions have regulatory provisions dealing with environmental management. The DBSA has a separate guideline for the Development and Implementation of Project Specific Environmental Management Plans<sup>4</sup>.

## Sustainable Utilisation Plan

The dam and the lakeshore often represent an economic asset. Frequently a considerable area that can be exploited for recreation and other purposes lies between the full supply level of a dam and the higher flood levels. At least a zoning plan for the lakeshore should be included or produced separately. Best practice now requires the preparation of a plan referred to as a sustainable utilisation plan. If this is produced during the time when mitigation measures are designed, the allocation of the benefits can form part of the mitigation measures.

<sup>3</sup> ICOLD, *Dam failures - Statistical analysis, ICOLD Bulletin No 99*

<sup>4</sup> DBSA, *Guideline for the Development and Implementation of Project Specific Environmental Management Plans, 2001.*

## Records

The operating procedures detail the records that are to be kept, how they are processed, to whom they are referred for review and how they are achieved.

## Occupational Safety

The operation of some of the equipment on large dams may entail entering hazardous locations. Warning signs must be erected at all such locations and the operators must have readily available the tools and protective equipment needed to safely operate the equipment while being protected against any hazards. Similarly there should be plans for treating or evacuating injured workers.

# Maintenance

## The Nature of Maintenance Management

Maintenance is undertaken to ensure that the dam is safe, that all elements of the dam will perform optimally and that the value of the asset is preserved. The approach should follow general maintenance practice, with adaptations to the special nature of dams and particularly to the dam safety aspects.

The potential range of maintenance activities for dams varies greatly from project to project so that an exhaustive treatment here is not possible. Some of the general categories are:

- Mechanical equipment e.g. oiling, greasing, painting;
- Electrical equipment e.g. cleaning, safety checks;
- Electronic equipment e.g. telecommunications, instrumentation;
- Occupational safety e.g. functionality of safety equipment such as handrails;
- Vegetation e.g. prevention of trees on embankment dams;
- Public amenities and safety e.g. signage, fencing, roads, pathways, security;
- Buildings e.g. pump stations;
- Miscellaneous items e.g. cleaning the trash racks, keeping drainage paths clear; and
- Animals, vermin and birds. Animals can burrow through earth embankments, vermin can chew through electrical circuits and birds can soil installations.

As with operations a comprehensive maintenance manual is required that details and schedules all maintenance actions. The manufacturer's manuals for specialised equipment must be included or be readily available.

## Maintenance Management Systems

The maintenance management system consists of a number of sub systems:

- A design phase that should commence at the earliest possible time and must be complete before the dam is taken into operation;
- The manuals that document the what, how, who and when issues;
- The routine inspection system that determines whether the programme is being implemented and that it is having the intended effect;
- The dam safety inspection system that determines whether there are any threats to the dam's safety and consequently any maintenance or upgrade requirements;
- A review and upgrade system that strives for continual improvement;
- The record-keeping system; and
- The institutional structure that defines policy and assigns responsibility and accountability.

## Route Testing

Included in the maintenance plan should be the schedules for the periodic testing of EVERY piece of equipment on the project. This should be under the full range of design operating conditions. So for example, a floodgate should be test operated under both dry and reservoir full conditions even if the latter test is of short duration or not necessarily over its full operating range.

## Staffing

It would be unusual for the staff with the full range of skills necessary for all the tasks to be stationed on site. In fact, smaller dams may have no on-site staff. Hence it is necessary to keep a register of specialised skills and to contract these as required or to engage on a contingency basis. Continuity, regularity specific knowledge of the project should be the guiding concepts.

## To Deficiencies

Where routine inspections reveal deficiencies, the maintenance plan should set out the procedures to have them repaired timeously. The authority to order repairs must be clear at all times. Where a deficiency threatens the safety of the dam the decision-maker should be able to over-ride budgetary and other bureaucratic processes that might leave the dam's safety under threat for extended periods.

## Spares and Standby

The maintenance programme needs to include a policy on the holding of spares and standby equipment that takes into account the availability and proximity of spares, any potential disruptions to transport routes during emergencies such as flood events, the criticalness of the equipment in emergency conditions and the general questions of cost tradeoffs.

# Dam Safety

## General

There has been a relatively low incidence of the catastrophic failure of large dams in South Africa. On the other hand there have been many failures of small "farm dams" where standards of engineering have not been followed or have been inadequate. The DBSA funded the 38 metre high Zoeknog Dam for the then government of Lebowa, which failed on January 23 1993, during its first filling; fortunately without loss of life<sup>5</sup>. Internationally, there have been at least three dam failures that caused the death of more than 2000 people. The most notorious and unusual failure is usually cited as the Vaiont Dam, a high arch structure in Italy.

<sup>5</sup> *Lebowa Government, Department of Agriculture and Environmental Conservation, Branch: Water Affairs, Investigation concerning the failure of Zoeknog Dam: Pertinent Information, Report No. 1455/6057, March 1994.*

A mountainside slipped into the reservoir along a geological weakness that had been further aggravated by seepage water from the reservoir. The material caused a wave 100m high to pass over the dam wall, resulting in extensive destruction of downstream homes and the loss of 2600 lives. Ironically, the structure never failed and Vaiont Dam still stands, but remains full of earth and unused.

Studies commissioned by ICOLD<sup>6</sup> have revealed that the failure rate of large dams has been falling over the last four decades. Thus, 2,20% of dams built before 1950 failed, while the failure rate of dams built since 1951 is less than 0,5%. The proportion of dams failing in any height category varies little with the category. Most failures involve newly built dams. Some 70% of failures occur in the first ten years of life of the dam, and more especially in the first year after commissioning. The highest failure rate is found in dams built in the ten years 1910-1920.

Foundation problems are the most common cause of failure in concrete dams, with internal erosion and insufficient shear strength of the foundation, each accounting for 21% of failures. The most common cause of failure of earth and rockfill dams is overtopping (31% as primary cause and 18% as secondary cause). This is followed by internal erosion in the body of the dam (15% as primary cause and 13% as secondary cause) and in the foundation (12% as primary cause and 5% as secondary cause). With masonry dams, the most common cause is overtopping (43%) followed by internal erosion in the foundation (29%).

Where the appurtenant works were the seat of the failure, the most common cause was inadequate spillway capacity (22% as primary cause and 30% as secondary cause). The post-failure action most frequently reported was scheme abandoned (36%), construction of a newly designed dam (19%) and overall reconstruction with the same design (16%).

## Key Elements of a Dam Safety Programme

### Project Management

The actions in a dam safety programme commence during the first phases of site investigation and continue throughout the life of the dam. A project management approach to dam safety should be established at the earliest phase and continue at least until the commencement of routine operations.

<sup>6</sup> ICOLD, *Dam failures - Statistical analysis, ICOLD Bulletin No 99*

A special management structure is necessary because, for example, the dam safety project and the design project can diverge in their focus. One example being that the designer, once having examined the cores from the drilling of the foundation and decided on the design may then have less interest in the physical cores and their documentation than the dam safety project manager as the latter must ensure their preservation for future reference, perhaps many years into the operation of the dam.

A project management approach is also needed for the two major transitions in the dam implementation process. These are the change from design to construction and from construction to operations. At each of these transitions the individuals driving the project change as do their approaches and objectives. The transition needs to be managed and is characterised by the preparation of project documents, apart from the plans and specifications that ensure that vital information for the dam's safety remains available. The reports may take various forms but typically might consist of:

- Design report(s) that set(s) out the assumptions and criteria used by the designer;
- Foundations investigation report that allows comparison with what is actually encountered when construction commences;
- Constructability report;
- Construction management plan;
- Dam first filling report

## Competent Design

The design of large dams is a very specialised task that involves the integration of the skills of many highly specialised fields of science and engineering. In most jurisdictions the authority responsible for dam safety requires some form of special registration for designers considered competent to design dams. The particular provisions of the South African regulatory system are described in detail later on in this guide.

Organisations would seldom be in the position where they could practically appoint their own advisors to go into the intricacies of the design to confirm the optimality or safety of the proposals. The project team should therefore ensure that:

- The designers have adequate experience and range of skills for the project;
- A review designer or panel is appointed if the project is large or complex;
- The design brief calls for a comprehensive design report to be delivered before the construction tender is called which includes a constructability review, particularly of the instrumentation; and
- The client (borrower) has sufficient capacity to manage the technical design process.

## Floods

The hydrological safety of large dams is one of the more complex issues in design. The designer must create a flood passage design that caters for "small" events as well as for large, potentially damaging events. For example, a 1 in 100 year event might be selected, as a "no damage" event i.e. the flood must pass through the structure under normal operating conditions. On the other hand the probable maximum flood concept may be used as the flood that the structure must pass, perhaps with damage or the loss of a sacrificial element, but without catastrophic failure and sudden release of the lake.

The team should satisfy itself that the designers have selected correct flood designs and that they have complied with any prescriptions of the regulatory authority or in the absence of any prescriptions to the recommendations of professional organisations such as SANCOLD or ICOLD.

## Construction Observation

On large dam construction a team of professional engineers carries out supervision in accordance with well-established industry norms. The ultimate responsibility in most contract arrangements rests with an individual designated as the "engineer". The relevant functions include:

- Setting out the works;
- Adapting the design to unforeseen conditions;
- Approving construction methods;
- Testing materials for use and once placed against specifications;
- Confirming the construction is within specification; and
- Limiting environmental impacts.

The project team must ensure that all the systems are in place for the engineers to effectively carry out these functions.

## Instrumentation

All large dams should be equipped with a range of instruments for measuring aspects of the dam's performance. Unfortunately, this has not always been the case, particularly on minimally engineered farm dams. Instruments are built into the structure during construction but may also be retro fitted to old structures. Many older dams only have a system of embedded survey beacons with remote control stations that can be used to detect any macro-scale movements. Most embankment dams should have a system for collecting and continuously measuring the seepage flows through the dam. More sophisticated examples of instrumentation for dams are those that measure seismic movement, pressures, inclinations and strain.

The instrumentation design is specific to each structure and the circumstances of the location. It should include a specification of the frequency and nature of observation. The verification that the instruments are accurately measuring what was intended and the interpretation of the readings are highly specialised and meticulous tasks for an expert.

## Records

The systematic recording and archiving of all data and information relative to the dam's performance during construction and subsequently is essential if the safety of the dam is to be effectively managed.

## Emergency Procedures

Emergencies may arise during floods or may be indicated by unusual observations or readings from the instruments. The operators on site must have immediate access to the emergency preparedness plan that sets out how they should respond to any given set of circumstances. The plan must be prepared prior to the initial filling of the dam. The emergency preparedness plan manual caters inter alia for the notification procedures for the disaster management authorities, downstream users, riparian dwellers (formal and informal) that may need to evacuate any areas threatened by a potential failure. Lists of names, addresses, contact numbers and alternatives are usually included. Clearly such a plan would need everyone to be fully informed and trained in the procedures.

## Safety Inspections

A dam safety programme should set out the nature and frequency of dam safety inspections. Aspects of dam safety should be inspected on a daily, weekly, monthly, annual or five-yearly basis depending on the circumstances. The nature of inspections varies from simple observation of seepage flows (daily) to complex stress measurements (annual or five-yearly). Clearly, the on-site operators need to be trained in some of the more frequent routine observations of the features of the dam that will indicate its performance and provide early warning of any serious problems. Most regulatory systems call for an at least five-yearly intensive safety inspection of the dam by a specialised dam engineer. More frequent inspections than required by regulation make business sense from a risk mitigation perspective and extensive annual inspections are recommended for most dams.

# Dam Safety Regulations in South Africa

## General

Sections 117 to 123 of Chapter 12: "Safety of Dams" of the National Water Act, 1998 (NWA), with the regulations made in Government Notice R.1560 of 25 July 1986, regulate dam safety in South Africa. Although promulgated under the old Water Act of 1956 the regulations are still in effect by virtue of the continuance section 163(4) in the NWA. At the time of writing, the regulations are in the process of being revised but the proposals are of such a nature that they should not materially affect this guide.

The NWA and regulations set up a generalised classification system. It combines the height of the dam and the hazard potential to place all dams with a safety risk into one of three categories (Categories I, II and III). The safety requirements increase with the category classification. The classification is not rigid and the Director-General (DG) may, where he considers that circumstances justify it, assign to a dam another category.

## Important Provisions

The regulation is enforced through a registration and licensing system ("permit" in the old nomenclature of the regulations). An owner may not commence any physical work on constructing, enlarging or altering a dam without a licence. The regulation sets out the information that must be included in the licence application and requires material variations to be notified. Note that this licence for dam safety is in addition to the licence required in terms of section 22 for the "water use" defined in section 22(b) as "storing water".

For Category II dams an approved professional person (APP) ("engineer" in the old nomenclature) must be appointed and for Category III dams a professional team must assist him. The Director General may also call for independent review or checking of the proposals.

The approved professional person is required to keep records of the construction of the dam, to prepare "as-built" drawings and a construction completion report and to issue a completion certificate. For Category III dams reports on geological conditions and on quality control during construction are required.

For Category II and III dams the approved professional person must draw up an operating and maintenance manual (which includes an emergency preparedness plan). The regulation sets minimum requirements in relation to safety.

The owner may not commence impoundment of a Category II or Category III dam before the DG has issued the Owner with a licence to impound. The regulations set out the requirements for applying for a licence to impound. A licence to impound may not be issued without the operation and maintenance manual, referred to above, having been completed.

The Director General is given wide powers to inspect dams with a safety risk and to direct the owners to undertake any maintenance or remedial work that may be necessary for the continued safety of the dam.

The owner is required amongst others to:

- Regularly inspect the dam's condition and to have a comprehensive dam safety inspection undertaken every five years or lesser period if so directed by the Director General;
- Maintain copies of the records of the dam including the operation and maintenance manual, at an accessible place near the dam; and
- Immediately advise the Director General and authorities responsible for any evacuation of threatened areas if any potential emergency situation arises at the dam.

The regulations also deal with the decommissioning of dams and administrative actions.

## Surveillance, Monitoring and Evaluation Strategies

The DBSA has general guidelines for these project team tasks. Where the DBSA has only funded elements of a project that involves a dam such as the advanced infrastructure for the Lesotho Highlands Water Project (LHWP), the scope of these tasks on the dam proper is at the discretion of the DBSA operations manager.

As far as large dams are concerned the DBSA interests are principally that:

- The value of the asset is being maintained;
- Operations are creating maximum development benefits and revenue; and
- The asset is safe and there is emergency preparedness.

The DBSA project team will not need to deal with the intricate technical detail directly but must verify that regulatory requirements are met and that best practices are followed i.e. a focus on process. In order to do this the DBSA team will largely rely on the documents described above and perform field verification checks. Where the DBSA project team is uncertain of any aspect, it should not hesitate to procure the advice of an expert.

### Documentation Inspection

The team needs to confirm that a dam safety inspection has taken place, check that the inspector was competent to do the work, peruse the report and determine whether effect has been given to the recommendations. In South Africa it will also rely on any certificate of compliance that is issued by the Dams Safety Office in the Department of Water Affairs and Forestry.

## Site Inspection

The purpose of a site inspection is to form a general impression of the quality of management of the dam and to verify selected items from the documents. So, for example, the team could call for a demonstration that all the instruments are functioning without needing to fully understand their functioning, inspect the on-site records and reports to see that they were regularly prepared or check that the emergency numbers were those of the intended authorities.

## Interviews

The team should interview key persons in the head office staff to determine whether the dam is being effectively managed.

## Unusual Events

Following any unusual event such as large floods or seismic activity the DBSA should liaise with the owner to determine the condition of the dam and whether special inspections or remedial work is needed.

## Conclusion

Large dams require careful management to ensure that the intended benefits are delivered, the value of the asset is preserved and the dam itself and the public are safe.

On dams that it finances, the DBSA has to make a constant trade-off between looking after its investment and getting too involved in the highly technical day-to-day operation, maintenance and safety of the dams. This guide provides essential information for DBSA project teams and other organisations involved in the financing of dams.

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# Vision

The vision of the Development Bank is to be a leading change agent for socio-economic development in Southern Africa.

# Mission

The Development Bank contributes to development by mobilising and providing finance and expertise and by establishing partnerships to develop infrastructure, in order to improve the quality of life of the people of Southern Africa.

# Strategic thrusts

- Accelerating the delivery of financial and non-financial services in an efficient and integrated manner
- Providing financial resources and expertise for excellence in delivery
- The asset is safe and there is emergency preparedness.
- Increasing the Bank's involvement in the poorest areas
- Becoming a knowledge-based institution
- Promoting business growth through innovation and responsible risk-taking
- Building and maintaining strong strategic partnerships to maximise development impact
- Recognising and rewarding performance in relation to specific deliverables
- Continuing the Bank's transformation by building on the past and aligning for the future



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