VESI- JA YMPÄRISTÖHALLINNON JULKAISUJA - sarja B

9E Dam Safety Code of Practice

NATIONAL BOARD OF WATERS AND THE ENVIRONMENT
Helsinki 1994

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Abstract
The Dam Safety Code of Practice should be observed in the enforcement and supervision of the Dam Safety Act (413/84) and the Dam Safety Decree (574/84). This code will replace the Dam Safety Code of Practice issued by the National Board of Waters (323/1985) and the supplementary Waste Dam Safety Code of Practice (429/1986).

The code classifies dams into categories on the basis of the risk they involve in the event of an accident (P, N and O dams) or their temporary nature (cofferdams). The code also deals with the planning and construction of dams. The owner or holder of any dam subject to the dam safety legislation (in the case of cofferdams only those that can be correlated with P dams in risk) must devise a safety monitoring programme, which, depending on the dam class, will be approved by either the National Board of Waters and the Environment (P dams) or the Water and Environment District (other dams). The programme may contain regulations concerning the monitoring proper and regular inspections (annual and regular inspections). The qualification of a dam is verified at the commissioning inspection, in addition to which at least one field inspection is held before starting to raise the water or any other material to be impounded. The dam owner or holder shall keep the material pertinent to the safety of the dam in a special safety file.

To assess the hazard risk of a dam the National Board of Waters and the Environment may order the party which has the dam constructed, or the dam owner or holder to draft a hazard risk assessment. The drafting of this assessment is dealt with in the Dam Safety Code of Practice. For dams with a very high risk (P dams) a site plan taking different potential accidents into account should be drawn up jointly by the dam owner or holder and the rescue authorities.

Keywords
Dams, waste dams, safety, code of practice, monitoring programmes, safety files, commissioning inspection, hazard risk assessment, accidents

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Tiivistelmä

Patoturvallisuusohjeet on tarkoitettu patoturvallisuuslain (413/84) ja -asetuksen (574/84) täytäntöönpanoa ja valvontaa varten. Nämä ohjeet korvaavat vesihallituksen antamat patoturvallisuusohjeet (monistesarja 323/1985) ja niitä täydentävät jätepatojen turvallisuusohjeet (monistesarja 429/1986).

Ohjeissa käsitellään patojen luokittelua padosta onnettomuuden sattuessa aiheutuvan vaaran laadun (P-, N- ja O-padot) tai padon tilapäisyyden perusteella (työpadot), patojen suunnittelua ja rakentamista. Jokaiselle lain piiriin kuuluvalle padolle (työpadoista vain P-patoon rinnastettavalla tavalla vaaralliselle) on padon omistajan tai haltijan laadittava turvallisuustarkkailuohjelma, jonka hyväksyy padon luokasta riippuen vesi- ja ympäristöhallitus (P-padot) tai vesi- ja ympäristöpiiri (muut padot). Ohjelma voi sisältää sekä varsinaista tarkkailua että määräajoin tapahtuvia tarkastuksia koskevia määräyksiä (vuosi- ja määräaikaistarkastukset). Padon kelpoisuus selvitetään käyttöönottotarkastuksessa ja ainakin yksi maastotarkastus järjestetään ennen veden tai muun padotettavan aineen noston aloittamista. Padon omistajan tai haltijan on säilytettävä patoturvallisuuden kannalta merkityksellinen aineisto erityisessä turvallisuuskansiossa.

Padosta aiheutuvan vahingonvaaran selvittämiseksi vesi- ja ympäristöhallitus voi määrätä padon rakennuttajan, omistajan tai haltijan laatimaan vahingonvaaraselvityksen, jonka laatimista ohjeissa myös käsitellään. Erityisen vaaralliselle padolle (P-padolle) on onnettomuustilanteiden varalta laadittava kohdesuunnitelma padon omistajan tai haltijan ja paloviranomaisen yhteistyönä.

Avainsanat
Padot, jätepadot, turvallisuus, ohjeet, tarkkailuohjelmat, turvallisuuskansiot, käyttöönottotarkastus, vahingonvaaraselvitys, onnettomuudet

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Anvisningarna för dammsäkerhet är avsedda för verkställighet och övervakning av dammsäkerhetslagen (413/84) och -förordningen (574/84). Dessa anvisningar ersätter de av vattenstyrelsen avgivna direktiven för dammsäkerhet (duplikatserien 323/1985) och de kompletterande säkerhetsdirektiv för avfallsdammar (duplikatserien 429/1986).

I anvisningarna behandlas klassificeringen av dammar på basen av den risk som en dammolycka förorsakar (P-, N- och O-dammar) eller dammens tillfälliga karaktär (arbetsdammar), dammarnas planering och byggande. För varje damm som omfattas av dammsäkerhetslagen (av arbetsdammarna endast de som har liknande risker som P-dammarna) bör dammens ägare eller innehavare göra upp ett säkerhetskontrollprogram, som skall godkännas av antingen vatten- och miljöstyrelsen (P-dammar) eller vatten- och miljödistriktet (övriga dammar). Programmet kan innehålla bestämmelser om både ordinarie kontroll och tidsbestämda granskningar (årsgranskningar och tidsbestämda granskningar). Dammens duglighet utreds vid ibruktagningskontrollen och åtminstone en fältgranskning ordnas innan man börjar höja vattnet eller annat uppdämbart ämne. Ägaren till eller innehavaren av en damm skall förvara med tanke på dammsäkerheten betydelsefullt material i en särskild säkerhetsmapp.

För att utreda skaderiskerna som en damm kan orsaka kan vatten- och miljöstyrelsen bestämma att den som låter bygga, äger eller innehar en damm uppgör en riskutredning. I anvisningarna behandlas också uppgörandet av utredningen. För speciellt farliga dammar (P-dammar) bör man för eventuella olycksfall uppgöra en objektplan i samarbete med dammägaren eller innehavaren och brandmyndigheterna.

Sakord (nyckelord)
Dammar, avfallsdammar, säkerhet, anvisningar, kontrollprogram, säkerhetsmappar, ibruktagningskontroll, skaderisker, olyckor

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PREFACE

In Finland, dams have been and will be constructed mainly for flood control, hydroelectric power production, water supply and fish culture and for storing waste detrimental to health or the environment. Most of Finland's dams have been built since the Second World War. Regular monitoring of safety of dams owned by State power companies was started in 1962 and that of dams owned by the water and environment administration in 1972.

The Act and Decree on Dam Safety were enacted in 1984 to improve the safety of all dams, waste dams included. For the execution of the dam safety legislation, a Dam Safety Code of Practice applying the statutory regulations as practical guidelines was issued in 1985. At the same time the dam safety regulations were extended to cover all old dams. When the revised directives, now published in English, were issued in 1991, all dams had been submitted to a basic safety inspection, and orders had been given to carry out any measures arising from the inspection. The revised Dam Safety Code of Practice thus mainly concentrates on dams under design and construction. Some alterations are foreseen in the administrative handling of the dam safety measures in 1995 as a result of the current reform of the environmental administration.

Excluding two small events in the 1950s and 1960s, no water body dam failures have occurred in Finland. Some incidents took place before and after the introduction of the legislation, but in each case a hazard was prevented with rapid countermeasures. Almost 500 of Finland's dams are covered by the legislation. Of these 80% are water body dams and 20% waste dams. It is considered that in an event of an accident, 36 of the dams would endanger human life or health or cause considerable damage to the environment or property. Most of the dams are embankment dams, and a few are massive concrete dams. Concrete structures have been used in association with regulation structures. Some dams are provided with an overflow structure for high flood.

When considering the possibility of applying the Finnish dam safety model elsewhere, it must be remembered that Finland differs markedly from other countries in topography, soil and climate but also in administrative procedures and civil engineering practices. Finland is a rather flat country characterized by glacial formations. Typical features of the climate are the long, cold winters, the freezing of soil and the spring thaw. The ground is tranquil seismically, and earthquakes presenting a threat to dams do not occur. Administration and engineering are of the same standard as in other western industrialized countries.

The emphasis of Finnish dam safety is on the prevention of dam accidents and on the effective reduction of hazards should it not be possible to prevent an accident. Careful design, construction and surveillance of dams and their appropriate maintenance play a key role in preventing dam damage. Long–term changes in conditions and the ageing of structures can be taken into account with regular safety monitoring. Rare exceptional physical conditions, human error or some other cause (e.g. internal erosion) may, nonetheless, still lead to dam failure. The objective of the Finnish dam safety system is to restrict any damage that might be caused by dam failure and to prevent loss of human life in the event of an accident. To achieve this we must have plans for the emergency repair of dams and for warning the downstream population.

Kaj Bärlund

Director General
The National Board of Waters and the Environment

Contents

APPENDIXES

1 Introduction

The authority of the National Board of Waters and the Environment (NBWE) to issue the Dam Safety Code of Practice is based on the Dam Safety Act (413/84). Under the Act on the measures concerning the rules and regulations of authorities (573/89), guidelines are general rules that are not prescriptive. The Dam Safety Code of Practice has been compiled for the enforcement and supervision of the Dam Safety Act (413/84) and Decree (574/84). These guidelines replace the Dam Safety Code of Practice issued by the National Board of Waters on 22.3.1985 (Publication series of the National Board of Waters No. 323/1985) and the supplementary Waste Dam Safety Code of Practice (Publication series No. 429/1986). These guidelines are to be applied to dams that come within the scope of the Dam Safety Act.

The Act and the provisions and regulations issued thereunder, but not those referring to the rescue services, shall be supervised by the NBWE and the district administration subordinate to it. The rescue services come under the Ministry of the Interior and its administrative authorities (provincial governments and municipal fire authorities).

For each dam subject to the Act the dam owner or holder shall draw up a safety monitoring programme, which, depending on the dam class, shall be approved by the NBWE (P dams) or the water and environment districts (N, O and T dams). As the dam class dictates the properties required of dams, the class must be established at the initial stage of planning and, if necessary, supplemented with a hazard risk assessment. Note, however, that due to changes in local conditions or for some other reason the class may change after completion of the dam, e.g. an N dam may be redesignated as a P dam. The programme may contain both monitoring proper and regular inspections. For special reasons the NBWE may exempt the body or person in question either entirely or partly from the above monitoring obligation.

The dam qualification is established in a commissioning inspection which entails at least one field inspection before starting to raise the water or other material to be impounded. The chief designer or person with the corresponding competence shall be responsible for arranging the commissioning inspection. At their discretion, representatives of the water and environment districts, and, at least for the P dams, representatives of the

NBWE and fire authority may participate in the field inspections.

The dam owner or holder shall store the documents relevant to dam safety in a special safety file.

A special site plan taking different potential accidents into account should be drawn up for a P dam by the dam owner or holder in cooperation with the fire authority.

The dam safety measures are summarized in Appendix 19.

2 Legislation

2.1 DAM SAFETY ACT AND DECREE

Dam Safety Act 1.6.1984/413

Section 1
With a view to securing and increasing safety, the provisions of this Act shall apply to the building and use of a dam.

Section 2
By a dam this Act means a dam intended for permanent use with the associated structures and facilities regardless of the construction materials or methods or the type of substance impounded in the basin.

Section 3
This Act shall be applied to a dam not less than three metres high. The Act shall, however, also be applied to a lower dam, if the volume of the substance in the basin impounded by the dam is so large or if the substance in the basin is of such a type that in the event of an accident it manifestly endangers human life or health or manifestly seriously endangers the environment or property.

This Act shall not, however, refer to dams subject to the provisions of the Mining Act (503/65) or to a canal structure as referred to in the Decree on Canal Structures (157/63).

This Act concerns cofferdams as applicable. For these dams there is no need to compile and store the safety file referred to under section 5.

Section 4
The construction of a dam shall be carried out such that in structure and strength it meets the requirements that a safety risk shall not arise from either the dam itself or its use.

The owner of a dam shall be obliged to keep the dam in a condition such that it is safe and it will not cause a hazard or have damaging or harmful effects on public or private interest.

Section 5
The dam owner or holder shall store documents relevant to dam safety in a special safety file.

The dam safety file shall be kept in a place where, if there is a threat of an accident, it is readily accessible to those concerned and can be inspected by the supervisory authorities when necessary.

More detailed provisions on compiling the safety file, on updating it to correspond to changes in circumstances, and on acquiring and compiling the supplementary data considered necessary will be issued by decree.

Section 6

To reduce the risk of damage from a dam a safety monitoring programme shall be drafted for each dam referred to in this Act.

The dam safety monitoring programme shall be drafted by the dam owner or holder. The programme shall be drafted in such a manner that all the issues relevant to dam safety shall be subjected to surveillance and inspection.

The programme may include rules concerning the actual surveillance and the inspections made at regular intervals.

Section 7

The approval of the safety monitoring programme or its amendments shall be decided by the National Board of Waters and the Environment, or as provided by decree, by the water and environment district.

The National Board of Waters and the Environment may issue further instructions about the compiling of the monitoring programme or, for a special reason, grant complete or partial exemption from the monitoring obligation laid down under section 6.

Appropriate records shall be kept of the monitoring and inspections referred to in the programme and they, as well as the monitoring programme, shall be kept in the safety file referred to under section 5.

Section 8

The provisions of section 28 of the Fire and Rescue Service Act (559/75) apply to the obligation to report and to act if a dam accident occurs or is imminent.

Section 9

To determine and assess the risk arising from a dam the National Board of Waters and the Environment may order, whenever so required, the party having the dam constructed, or the dam owner or holder to acquire or make an assessment of the risk posed by the dam to the downstream population and property in particular (hazard risk assessment) and to communicate the findings of the assessment to the National Board of Waters and the Environment, the provincial government, the regional fire commander and the municipal fire authority.

A dam referred to in this Act that in the event of an accident may manifestly endanger human life or health or manifestly seriously endanger the environment or property shall be included as a risk site in the coordination plan referred to in the Fire and Rescue Services Act. The dam owner or holder shall be obliged to assist the fire authorities in drawing up the plan, to draft the relevant assessments and necessary action plans for his part, and to acquire and maintain the facilities and materials referred to in the action plan and to take other measures to safeguard people and property against the risk posed by the dam and to participate in the implementation of the action plan.

The National Board of Waters and the Environment may issue further instructions for the drafting of the hazard risk assessment referred to in paragraph 1 and for compiling the assessments and action plans referred to in paragraph 2.

Section 10

Supervision of this Act and the rules and regulations issued by virtue of it, with the exception of the rescue service, shall be the responsibility of the National Board of Waters and the Environment and the district administration subordinate to it.

Section 11

In the event of non-compliance with the provisions of sections 4 and 5 or the regulations issued by virtue of them, measures shall be taken as applicable as stated in the Water Act (264/61) chapter 21 section 2, section 3 paragraphs 1 and 2, and section 4.

If a dam or its use, which clearly takes place in violation of this Act or the provisions of the Water Act or regulations issued by virtue of them, directly endangers public safety, the provisions of chapter 21 section 3 paragraph 3 shall be observed as applicable. However, in addition to the provincial government and police authority the National Board of Waters and the Environment or the district administration subordinate to it may take the necessary measures.

Section 12
A person who violates his duty referred to under section 4 shall be sentenced to a fine or to imprisonment for a maximum of two years for violating dam safety.

A person who neglects his duty referred to under sections 6 and 7 or fails to submit the monitoring programme referred to under section 16 paragraph 1 for approval by the set date shall be sentence to a fine or to imprisonment for a maximum of six months for neglecting the dam safety monitoring programme.

When the penalty provisions of this section are applied the provisions of the Dam Safety Act shall be valid to the extent stated for the provisions of the Water Act.

Section 13
A person who violates this Act or the provisions or regulations issued by virtue of it in cases other than those referred to under section 12 paragraphs 1 and 2 shall be sentenced to a fine or to imprisonment for a maximum of six months for violating dam safety regulations.

Section 14
More detailed provisions on the implementation and application of this Act will be issued by decree.

Section 15
This Act will come into force on August 1, 1984.

Action can be taken to implement this Act before it comes into force.

Section 16
If a dam was brought into use before August 1, 1984, the monitoring programme referred to under sections 6 and 7 shall be submitted for approval by the end of 1988. For an especially grave reason the authority who, under section 7 paragraph 1, approves the dam monitoring programme can grant an extension of the term. The assessments and action plans to be made by the dam owner or holder referred to above under section 9 shall then be compiled as soon as conditions allow. (26.6.2987/616)

In the cases referred to under paragraph 1 the National Board of Waters and the Environment shall, however, before the completion of the required hazard risk assessment, provide the provincial government with the relevant information about any dams that have been completed or are under construction in the province and for which the hazard referred to under section 9 paragraph 2 is manifest even without completion of the hazard risk assessment.

For dams other than those referred to under paragraph 2 and brought into use before the implementation of the Act the information referred to under paragraph 2 shall be communicated to the provincial government once the required hazard risk assessments have been completed.

Dam Safety Decree 27.7.1984/574

On the submission of the Minister of Agriculture and Forestry, the following is enacted under sections 5, 7 and 14 of the Dam Safety Act issued on 1.6.1984(413/84):

Section 1
The height of a dam referred to under section 3 of the Dam Safety Act (413/84) shall be the difference in height between the lowest point of the external dam structure and the highest intended surface for the impounded substance.

For a submerged dam the height shall be, contrary to paragraph 1, the difference in height between the lowest point of the external boundary of the dam and the dam crest.

Section 2
The safety file referred to under section 5 of the Dam Safety Act shall contain to the extent required by circumstances the following documents:

1) an account of the main dimensions of the dam and dammed area and the hydrological parameters used in planning;

2) a map of the area affected by the dam, the location drawing of the dam, and drawings

and documents of the dam structure in so far as they are needed to assess dam safety;

3) the safety monitoring programme with the amendments referred to under sections 6 and 7 of the Dam Safety Act;

4) the monitoring and inspection records;

5) the letters from the authorities required to be included in the file; and

6) the assessments and action plans referred to under section 9 of the Dam Safety Act as prescribed under Section 4.

Section 3

The safety monitoring programme referred to under sections 6 and 7 of the Dam Safety Act shall be drawn up in good time before completion of the dam so that it can be approved for observation before the dam is brought into use.

The safety monitoring programme of a dam referred to under section 9 paragraph 2 of the Dam Safety Act shall be approved by the National Board of Waters and the Environment. The safety monitoring programme of other dams and cofferdams shall be approved by the water and environment district.

The proposal for a safety monitoring programme shall be submitted to a water district bureau.

Section 4

The assessments and action plans referred to under section 9 paragraph 2 shall contain to the extent dictated by circumstances:

1) a plan of measures to be taken with regard to the water body and hydraulic structures in the event of an accident;

2) an account of the materials to be reserved in advance in the event of an accident;

3) a description of the manner in which the regional alarm will be given and communication will be maintained with the regional alarm centre;

4) information about the personnel of the dam owner or holder available in the event of an accident;

5) an account of other measures of the dam owner or holder necessary to protect people and property in the event of an accident caused by the damming; and

6) in respect of waste dams, a description of the type and quantity of the impounded substance.

Copies of the documents containing the action plans and assessments referred to under paragraph 1 shall be kept in the safety file of the dam in question.

Section 5

The assessments and action plans referred to under section 9 of the Dam Safety Act concerning dams that will be brought into use after the said Act has come into force shall be compiled so that they can be included in the coordination plan referred to under the Fire and Rescue Service Act before the dam is brought into use. If the National Board of Waters and the Environment regards a dam to be brought into use as one referred to under section 9 paragraph 2 of the Dam Safety Act it shall inform the provincial government thereof.

Likewise, the National Board of Waters and the Environment shall inform the provincial government if a dam, which was not previously considered as one referred to under section 9 paragraph 2 of the Dam Safety Act, is regarded as such due to changes in conditions or for some other reason.

Section 6

This Decree will come into force on August 1, 1984.

2.2 WATER ACT AND DECREE

At least the following parts of the Water Act and Decree apply to dam safety.

Water Act 19.5.1961/264

Chapter 2
General provisions concerning construction in a water body

Construction and the conditions for it

Section 1
Unless separate provisions have been enacted for a certain measure, the provisions in this chapter concern the constructing of a fixed or non-fixed structure or building or other structure such as a dam, embankment, bridge, cable, transport facility or jetty in a water body or across it, cleaning, pile driving or filling in the water body, excavating a new channel and other similar activities as well as the measures referred to under chapter 1 section 15. (30.4.1987/467)

Construction includes construction on land that may cause a change in the water flow or water level of the water body.

Section 3

The construction work shall be done in such a manner that the strength of the structure meets reasonable requirements.

Beginning the construction work and changing the permit terms

Section 28
Should compliance with the stipulations in the permit granted under this Act cause inconvenience due to a change in conditions, these stipulations can be amended if application is made by the party suffering the inconvenience or, if the inconvenience is against the public interest, if the application is made by the appropriate authority irrespective of the time stated in section 27 of this chapter, provided the amendment will not markedly diminish the profit to be obtained from construction. The assignee of the permit shall not be entitled to compensation from the applicant either for a loss of benefit caused by the amendment or for the expenses, should they be of a minor nature.

Should the amendment to the permit referred to in this section or the granting of new stipulations be necessary for reasons of safety, the stipulations can be amended or new stipulations can be issued irrespective of the change in conditions, otherwise observing the provisions of paragraph 1 (1.6.1984/414).

Structures made previously

Section 30
If before this Act comes into force a permit has been granted to build in a water body without at the same time stipulating what should be taken account of to safeguard public and private interest, which includes the safety of the structure, the structure shall be used in such a manner that harmful changes shall not be caused unnecessarily in the waterway and that the use of the water body for other purposes shall be hampered as little as possible. (1.6.1984/414)

The Water Court may, on the application of the owner of the structure, the party suffering from its use or the appropriate authority issue clarifying stipulations for use of the structure, ensuring, however, that the stipulations do not significantly diminish the benefit derived from the structure.

Maintenance and removal of the structure

Section 31
The owner of a structure built in a water body shall be obliged to maintain the structure so that it will not cause danger or result in damaging or harmful consequences that violate the public or private interest.

Chapter 13
Penal provisions

Section 3
A person who neglects his obligation based on this Act or a provision issued by virtue of it to maintain a dam or other structure in a water body, an embankment, channel, canal or water way constructed within or without a water body or a facility, ditch, flume or sewer asso-

ciated with hydrological conditioning or regulation of water flow in a water body shall be sentenced to a fine or, if the negligence may endanger another party or the property of another party, to imprisonment for a maximum of six months.

Chapter 21
Special provisions

Section 1
The general supervision of the observance of this Act and the rules and regulations issued by virtue of it shall be the duty of the National Board of Waters and the Environment and water and environment districts. The Ministry of the Environment and the Ministry of Agriculture and Forestry may issue the administration subordinate to these Ministries general regulations and guidelines concerning supervision. (2.4.1990/308)

The local water board shall act as the local supervisory authority, as provided in chapter 20 sections 3 and 8.

Punishable acts shall be dealt with by the police authority and the public prosecutor as part of their regular duties.

Section 2
If the supervisory authority referred to under Section 1 of this chapter finds that the provisions of this Act or regulations issued by virtue of them within his area of competence are not observed, the authority shall, if the public good so requires or if so informed by the interested party, inform the public prosecutor or take other measures to rectify what has been done illegally or neglected.

On his own initiative or at the request of the water court the supervisory authority shall be entitled to inspect facilities, buildings and other structures and to undertake the necessary investigations within his area.

The inspections and investigations referred to above under paragraph 2 shall be made, if possible, without causing inconvenience to the owner of the facility or structure or disturbing the activity of the enterprise and without betraying any business or professional secrets.

Section 3
If a person makes an attempt or undertakes a measure contrary to the provisions of this Act or regulations issued by virtue of them or the rules of the consortium referred to in this Act or neglects his obligations as stated in the Act or in the said provisions or rules or otherwise disregards the Act, the water court may, on the notification of an authority or on application by the party whose right or interest it concerns, after the party in question has been given the opportunity to provide an explanation, by imposing the threat of a fine or by threatening that what has been neglected will be done at the expense of the defaulting party, order that what has been done illegally or neglected shall be rectified. A supervisory authority or other interested party can be authorized to undertake the necessary action.

An appeal against the water court judgment in a matter referred under paragraph 1 shall be brought before the Supreme Water Court, as prescribed in chapter 17 section 1. The water court may, on special grounds and despite appeal, order the decision to be enforced. Once an appeal has been made, the Supreme Water Court may correspondingly order that the decision subject to appeal be enforced before the matter is resolved. The Supreme Water Court may also ordain the enforcement order to have expired. (5.4.1991/629)

If the above measure or default may manifestly endanger the life, health or property of the other party or the public interest, the provincial government or the police authority shall be empowered to take the necessary measures to eliminate the danger. The decision of the provincial government cannot be appealed. However, the party against which the measures have been taken may on application appeal to the water court as stated under paragraph 1.

If the maintenance obligation of a structure referred to in chapter 2 section 31 is neglected, and the owner of the structure or the party responsible for it cannot be identified without difficulty, the water court may on application entitle the supervisory authority referred to under section 1 to take the necessary steps to eliminate the inconvenience or danger at the expense of the State. The provisions concer-

ning application shall apply concerning the handling of the matter, however, for the enforcement the provisions concerning executive assistance in paragraph 2 shall apply. (5.4.1991 /629)

Separate provisions have been enacted concerning the competence of police authorities to prevent crimes and to prosecute for them. (1.6.1984/414)

Section 4
When the measure referred to under section 3 is undertaken by the authorities, the costs shall be paid beforehand out of public funds, unless otherwise ordered by the water court, and shall be collected from the refractory party following the procedure set forth for the recovery of public funds.

In the cases referred to above under section 3 paragraph 4 the water court can, on application by the supervisory authority, order the expenses borne by the State to be recovered fully or partly from the party defaulting on maintenance if he has later been identified. (1.6.1984/414)

Water Decree 6.4.1962/282

Chapter 3
Petition plans

General provisions

Section 43 (27.7.1984/573)
A plan shall be drawn up by a person of sufficient competence and experience in such a manner that it can be inspected without difficulty. It shall be clear what data, computational procedures and formulas were used to draw up the plan.

A short summary of the project and its impacts shall be appended to the application. (2.4.1990/309)

Section 45 (27.7.1984/573)
Drawings and accounts shall be made of the structures and facilities to be constructed giving the main dimensions of the structures and any information necessary for the assessment of the strength and safety of the structures and facilities and their impact on the water body or use of water.

Chapter 7
Miscellaneous provisions

Section 85
When permission has been granted to regulate the water level or water flow, the performing party shall inform the appropriate water and environment district and environmental protection board of the date on which the measure shall begin, the date on which and by whom the permit decision was issued. (19.9.1986/690)

When a permit to construct a dam referred to in the Dam Safety Act (413/84) has been issued, the authorities referred to under paragraph 1 shall be informed in good time of the date on which the dam shall be brought into use. (27.7.1984/573)

2.3 FIRE AND RESCUE SERVICES ACT AND DECREE

At least the following parts of the Fire and Rescue Service Act and Decree shall apply to dam safety.

Fire and Rescue Services Act 4.7.1975/559

Chapter 1
Fire and Rescue Services

Section 1
That which is provided and stipulated in this Act and by virtue of it shall apply to fire and rescue services.

Fire services entail fire prevention intended to prevent an outbreak of fire or to facilitate extinguishing or containing the fire, combating the danger caused by the fire, and fire-fighting and other measures called for by the fire.

Under this Act rescue services entail the measures necessary to save the victims and to prevent or contain the damage due to an accident caused by an explosion, oil hazard, landslide, traffic accident, gas or liquid leak, flood, heavy rainfall or comparable hazards or natural disasters, which can be appropriately undertaken by the fire service authorities.

Furthermore, the provisions enacted separately in the Prevention of Oil Hazards in Vessels Act (668/72) and the Prevention of Oil Hazards on Land Act (378/74) shall be observed.

Section 2
The fire and rescue services shall be planned and implemented so that the appropriate measures can be undertaken immediately and effectively under the conditions in which they are needed.

Chapter 2
Administration

Section 3
The highest command, control and supervision of the fire and rescue services rests with the Ministry of the Interior. For this purpose the Ministry has a department whose area of competence also includes other tasks handled by the Ministry.

Section 6
The country shall be divided into alarm areas to receive emergency reports and to give the alarm. The division shall be decided by the Ministry of the Interior. The alarm areas shall be defined so that all parts of the area can make contact with the regional alarm centre at any time of the day or night. The Ministry of the Interior shall define the location of the regional alarm centre. The function of the regional alarm centre is to act as general emergency report centre. (8.4.1983/355)

The local authorities in the alarm area shall see to it that the regional alarm centre is built-tand maintained. If the local authorities are not unanimous about this issue or the sharing of costs for establishing and maintaining a regional alarm centre, the issue shall be decided by the provincial government.

Section 7
The fire and rescue services within a province are controlled and supervised by the appropriate provincial government. The provinces are divided into fire and rescue service cooperation regions is such a manner that the division follows in so far as is possible the alarm area division referred to under section 6. The division shall be confirmed by the Ministry of the Interior.

The provincial government together with the local authorities shall draft plans for giving help and for other cooperation in fire and rescue services within the cooperation region (a coordination plan).

The coordination plan shall include, to the extent found necessary, orders concerning cooperation with a local authority in another cooperation region or even in another province.

The provincial government shall appoint the regional fire commander of the cooperation region from among the fire chiefs of the local authorities in the region, and one or more deputies as needed from the full-time officers of the fire brigades within the region to draft the coordination plan and command the fire and rescue services. If necessary, more detailed provisions on the duties of the regional fire commander will be issued by decree. (29.12.1989/1338)

Chapter 3
Fire brigades, cooperation between them and other cooperation

Section 19
State authorities and agencies are obliged to give executive assistance to the fire authorities in the fire and rescue services referred to in

this Act. The procedure to be followed for requesting and giving executive assistance shall be stipulated by the Council of State if necessary.

Chapter 4
Fire prevention

Section 21 (8.4.1983/355)
The Ministry of the Interior may issue regulations concerning arrangements to improve fire and personal safety at fair, exhibition, entertainment, camp-sites, camping grounds, holiday camps and other like areas and on furnishing and decorating buildings, structures, flats or spaces susceptible to fire hazards or posing a danger to personal safety.

The Ministry of the Interior, and for a single object, the municipal fire authority, may order the owner or holder of a building, structure or flat, and of storage, transport and other areas dangerous in terms of fire and personal safety to be obliged to acquire and maintain appropriate fire-fighting equipment and other contrivances that facilitate rescue to an extent considered reasonable under prevailing conditions and in regard to the fire risk and to take other necessary precautionary measures to protect people and property in the event of an accident. (29.12.1989/1338)

Chapter 5
Fire-fighting and rescue operations

Section 28
A person who sees or is informed that a fire has broken out or that another accident has happened or is liable to happen and cannot immediately extinguish the fire or prevent the danger shall be obliged immediately to inform those in danger about it, to make a fire or accident report and to undertake fire-fighting and rescue measures in so far as he is able.

Section 29
The fire-fighting and rescue operations shall be under the command of the fire authority of the municipality within which the fire broke out or other accident happened, unless provided or stipulated otherwise.

A provincial government or the Ministry of the Interior may order their appropriate official or other State authority or a municipal fire authority to command the fire-fighting andrescue operations, whenever the fire or other accident is one of those referred to under section 18, paragraph 2. A provincial government or the Ministry of the Interior may also invite experts to help direct the fire-fighting and rescue operations. (29.12.1989/1338)

Section 30
To extinguish a fire and to prevent its spread and in other accidents referred to in this Act the authority in charge of operations has the right to evacuate people, animals and properties and to order buildings, stores and other properties to be demolished, doors to be broken open, fences to be removed, earth to be dug up, gravel, sand or earth to be extracted, ditches to be filled, trees to be felled, backfires to be lit and any other appropriate measures to be taken.

To extinguish a fire everyone shall be allowed to take water from a well or source of water belonging to another.

A person who, by reason of his position or for another reason, ends up in charge of the operation can use the power of an authority in charge of fire-fighting and rescue operations to the extent dictated by the situation until the authority has assumed command.

Fire and Rescue Services Decree 31.12.1975/1089

Chapter 2
Planning and development of fire and rescue services

Section 9
The coordination plan shall determine:

1) the personnel and equipment of the fire brigades in the region;

2) the personnel and equipment, other than those referred to under subparagraph 1, of the

local authorities in the region and of the State authorities and agencies and consortiums that can be used in fire-fighting and rescue operations;

3) the availability of water for extinguishing and other fire-fighting and fire-prevention materials;

4) any privately owned equipment appropriate for fire-fighting and rescue operations and the operational personnel;

5) objects which the coordination may concern in particular and the type and amount of help then needed;

6) organization of first aid, ambulance services and other care; and

7) the procedure used in requesting, alerting and giving help.

To plan the coordination the provincial government shall appoint a management group for each cooperation region and shall appoint the regional fire commander of the cooperation region and his deputies from among the municipal fire authorities. The duty of the regional fire commander shall be to command the fire-fighting and rescue operations in the situations referred to under section 18 paragraph 2 of the Fire and Rescue Services Act. The Ministry of the Interior shall issue further instructions concerning the composition and duties of the management group.

Chapter 3
Alarm centres and alarm service

Section 12
In addition to what is provided under section 6 paragraph 1 of the Fire and Rescue Services Act, the regional alarm centre shall, if necessary, act as a communication and command centre for fire-fighting and rescue operations, rescue work and civil defence.

If necessary the regional alarm centre shall also see to warning the population about accidents or other hazardous situations.

An officer of the fire brigade in the municipality in which the regional alarm centre is located shall be appointed head of the said centre, unless the duty is otherwise prescribed in the service regulations.

Chapter 5
Fire prevention

Section 24
The fire chief may order the owner or holder of a facility or store posing a special fire, explosion, gas or other risk to be obliged to draft a report on the precautionary measuresreferred to under section 21 paragraph 2 of the Fire and Rescue Services Act necessary for saving personnel, customers and property, extinguishing the fire, alerting help and preventing danger.

What is provided in paragraph 1 refers as applicable to hospitals, nursing and welfare homes, hotels, markets, supermarkets and other like objects.

The personnel shall be informed about the plan.

2.4 OTHER ACTS AND DECREES

In addition to the Acts and Decrees dealt with in 2.1 – 2.3 reference has also been made to the following Acts and Decrees

- Administrative Procedure Act (598/82)
- Waste Management Act (673/78)
- Mining Act (503/65)
- Primary Health Care Act (66/72)
- Municipal General Hospitals Act (561/65)
- Administrative Appeals Act (154/50)
- Police Act (84/66)
- Public Health Act (469/65)
- Water and Environment Administration Act (24/86) and Decree (151/87)
- Act on Measures Concerning Official Regulations and Guidelines (573/89)
- Civil Defence Act (438/58) and Decree (237/59)

2.5. APPLICATION OF LEGISLATION

2.5.1 Definition of a dam

A dam as defined by the Dam Safety Act is a dam with the associated structures and facilities intended for permanent use irrespective of the materials of and the manner in which the dam has been constructed or of the substance to be impounded in the dam basin (Dam Safety Act section 2). Unless stated otherwise, a dam in this code is considered to include all the dam and impound structures of one dam basin.

The normative definition of a dam is as follows:

A dam is an embankment like or a wall-like structure the purpose of which is to prevent a liquid, a substance in liquid form or substances that dissolve from solids in liquids (e.g. rainwater) behind the structure to flow downstream into land or water body and/or to regulate the flow and/or the level of the impounded substance.

2.5.2 Scope of application and exceptions

The Dam Safety Act and Decree and this Code of Practice shall be applied to a dam which is at least three metres high. They shall also be applied to a lower dam if the volume of the substance in the basin impounded by the dam is so large or the basin contains a substance which, in the event of an accident, may manifestly endanger human life or health or manifestly seriously endanger the environment or property.

The height of a dam referred to in the Dam Safety Act is the difference between the lowest point of the external boundary of the dam structure and the highest design level of the impounded substance. Contrary to the above, the height of a submerged dam in a water body is the difference in height between the lowest point of the external boundary of the dam structure and the dam crest. The determination of height in different cases is dealt with in the figures of Appendix 11.

The maximum height defined in the permit decision is the highest design height of the dammed substance. If this height level is not defined in the permit, the height defined in the construction documents shall be taken as the maximum level of the impounded substance.

The Dam Safety Act does not refer to dams in mining areas, to which the provisions of the Mining Act (503/65) shall be applied, mainly those concerning safety in sections 56 and 57, which refer to the safety of the work, facilities and underground openings of a mine, open pit or excavation. However, a dam outside the mine patent or its ancillary area owned by the mine may be subject to the Dam Safety Act.

The safety requirements stated in the Mining Act correspond to those of the Dam Safety Act. The Dam Safety Code of Practice can also be applied to the safety analyses of mine dams. The supervision of dams subject to the Mining Act is undertaken by the Technical Inspection Centre of the Ministry of Trade and Industry.

The Dam Safety Act does not refer to dams of the canal service. Cofferdams are subject to the Act as applicable.

2.5.3 Supervision of the Act and special authority

Supervision of the Dam Safety Act and the provisions and regulations issued by virtue of it rests with the National Board of Waters and the Environment and the district administration (water and environment districts) subordinate to it, the rescue service excluded. The rescue service is the charge of the rescue department of the Ministry of the Interior and

the authorities subordinate to it (provincial governments, municipal fire authorities). The provisions of chapter 21 section 2 (the obligation of a supervisory authority to take measures and the right to undertake inspections and investigations) and of section 3 paragraphs 1 and 2 (executive assistance given by a water court) and of section 4 (recovery of costs for the State) of the Water Act shall be observed as applicable to rectification of non-compliance with the provisions or the regulations issued by virtue of them concerning the construction and maintenance of a dam (Dam Safety Act section 4).

If a dam or its use poses immediate danger to public safety the provincial government and a police authority (chapter 21 section 3 paragraph 3 of the Water Act) and the National Board of Waters and the Environment or the district administration subordinate to it (section 11 paragraph 2 of the Dam Safety Act) shall be empowered to take the necessary measures to eliminate the danger.

2.5.4 Obligations of the owner or holder of a dam

The owner or holder of a dam shall familiarize himself with the regulations concerning his dam and on his own initiative ensure that they are observed. The National Board of Waters and the Environment and the water and environment districts help in matters concerning interpretation of the provisions. Using their information about dams the National Board of Waters and the Environment and the water and environment districts issue guidelines and inform the owners of dams about provisions, which does not, however, lessen the obligation of the dam owner to keep himself well informed about issues pertinent to dam legislation.

3 Dam requirements

3.1 DAM CLASSIFICATION

Dams are classified by the type of hazard risk they pose in the event of an accident or because of their temporary nature. As the classification affects the properties required of the dam (Appendices 12–15), the class must be established at the planning stage. The class is checked at the commissioning inspection before the dam is brought into use (chapter 5) and also later if conditions change. The dam classification referred to in the Dam Safety Act concerns both water body and waste dams. Dam classes are as follows:

P dams

A dam is classified as a P dam if, in the event of an accident, it may manifestly endanger human life or health or manifestly seriously endanger the environment or property.

The above danger may arise from a flood wave caused by dam failure. A risk typical of a P dam may also be caused by a dam which, in the event of an accident, may manifestly endanger health or manifestly seriously endanger the environment owing to the impounded liquid, to a substance behaving like a liquid, or to the type and quantity of materials washed along with them.

A dam is classified as a P dam mainly on the basis of a hazard risk assessment, the drafting of which is dealt with in detail in chapter 7.

P dams may be less than three metres high. The provisions of section 9 paragraph 2 of the Dam Safety Act concerning the readiness to prevent accidents shall also be applied to P dams (chapter 8).

N dams

Dams are classified as N dams if they do not constitute a particular risk in the manner P dams do, but which nevertheless cannot be considered as low-risk O dams.

O dams

Dams constituting only a minor hazard risk are classified as O dams. A dam can be considered as constituting only a minor risk if, in the event of an accident, it quite manifestly cannot endanger human life or health, or, minor damage excluded, the environment or the property of another.

T dams
Cofferdams included in the Dam Safety Act are classified as T dams.

3.2 BASIS FOR DAM ASSESSMENT

The structural and operational reliability of a dam must be such that the dam does not pose a safety risk. The basic reliability of a dam is obtained through design and construction. Later reliability is affected by changes that take place over time, by repairs made, by maintenance, and by changes in operational conditions.

Dam reliability shall be assessed from data available in the dam design and construction documents and from dam monitoring and inspection data. If this information is insufficient for the assessment of dam reliability or if the monitoring and inspection data so warrant, the owner of the dam must verify the information with investigations to the extent necessary. The reliability assessment is undertaken by a person with sufficient competence and experience.

Dams must be designed and constructed in accordance with the design and construction codes in force at the time. Dams must be assessed against how well their design and condition meet the requirements set for the dam at the moment of inspection. Should a dam be considered deficient, it shall be repaired and submitted to intensified monitoring or operating restrictions, depending on the severity of the deficiencies.

3.3 GENERAL DESIGN REQUIREMENTS

The planning of a water body dam is subject to the specifications required by water rights legislation petition as referred to under sections 43 and 45 of the Water Decree (2.2). The corresponding specifications shall also be observed in designing other dams referred to in the Dam Safety Act.

The body which has the dam constructed is responsible for ensuring that the dam i designed under the direction and responsibility of a competent person (chief designer). The chief designer shall have sufficient expertise in dam design and construction.

The chief designer is responsible for the various sub-areas such as hydrological dimensioning, the design of the embankment and concrete dams, the design of the regulation and discharge structures, and for the compatibility of the designs. The design and dimensioning requirements are dealt with in Appendices 12–15. In addition to the structures proper, the plan shall contain the dam safety monitoring devices which are installed in the course of dam construction.

3.4 FUNCTIONAL ASSESSMENT

The functional assessment of a dam is made to the extent required by conditions. The aim of the assessment is to estimate the risk of dam failure under different conditions, the function of the dam and channels, and the magnitude and duration of a possible overflow. The different conditions are the usual operational conditions in summer and in winter, floods such as design floods (Appendix 12), and situations arising from operating disruptions and errors.

3.5 DAM CONSTRUCTION

The water and environment district shall be informed about the start of dam construction so that the authority has an opportunity to study the design documents beforehand.

The dam shall be constructed in accordance with good construction practice. Construction

shall proceed as required by the plan and with experienced and competent personnel. The quality control of the work shall be independent of the constructing body. The person responsible for supervising the work shall have the right to suspend work if necessary. Construction and quality control are dealt with in Appendices 13–15.

3.6 MODIFICATIONS TO THE DAM AND CHANGES IN CONDITIONS

Any effects that modifications to the dam have on dam safety shall be taken into consideration when assessing alternatives at the design and construction stages. A record is kept of gradual changes in conditions and structures by monitoring and regular inspections.

If the changes have no clear effect on dam safety a new monitoring programme need not be approved. It is sufficient if the safety documents are updated at a regular inspection.

Should the changes affect dam safety, the changes shall be reviewed as referred to in chapter 5 (commissioning inspection). If it is necessary to revise the monitoring programme, the same procedure shall be followed as when drafting a new monitoring programme.

Changes affecting dam safety may include:

- new structures in a dam such as new openings, overflow sills, and under or through passes
- renovation or renewal of and modifications to an embankment and concrete dam or a hydroelectric power plant structure acting as a dam
- changes in the use and control of the operating facilities and the structural changes thereby required
- changes in conditions affecting dimensioning such as those affecting the maximum water level and maximum discharge
- changes in conditions in the downstream area affecting the classification (e.g. an N dam becomes a P dam)
- for a waste dam, changes in the type of impounded substance which affect the classification.

4 The dam safety file

4.1 GENERAL

Under section 5 of the Dam Safety Act the dam owner or holder shall store all the documents relevant to dam safety in a special safety file. The dam safety file shall be kept in such a manner that when there is a threat of an accident it is readily available for the persons who need it and, if necessary, for inspection by the surveillance authorities. The file could be kept for instance in the office of the dam surveillance personnel.

The content of the safety file is defined under section 2 of the Dam Safety Decree (2.1) to the extent dictated by conditions. The content of the file is described in greater detail in 4.2 – 4.9. There is no need to compile and keep a file for cofferdams (T dams).

It is appropriate to include in the dam safety file the documents which a competent person considers essential for the preliminary assessment of the safety and reliability of the dam. However, the completion documents of the dam (Appendix 3) shall be collated and appropriately arranged elsewhere for the safety evaluation, and for dam repairs and maintenance.

Three copies of the safety file and a draft of the safety monitoring programme as it is at that moment are sent to the water and environment district. The missing parts are added to the file within a reasonable time in conjunction with the completion of the commissioning inspection.

4.2 COVER PAGE, CONTENTS AND LIST OF COMPLETION DOCUMENTS

The cover page shall show the name of the project and the dam, and the name and index number of the water body and water body area, permit decisions, the name of the permit holder, and the names of the owner and holder of the dam. It shall also indicate when and by whom the file was compiled. The cover page shall be made as in the model in Appendix 1.

The second leaf of the file shall give a list of contents showing the documents kept in the file, including those added later, with date of entry. The documents can be arranged in the same order as in the list in section 2 of the Dam Safety Decree.

Next, the file shall have a list of comple–

tion documents (Appendix 2). This list shall contain information about the subject of drawings, accounts and investigations, the date they were made and by whom, and the place in which they are kept.

4.3 DESIGN VALUES

4.3.1 Main dimensions of the dam and the reservoir area

The main dimensions of the dam and the data on gates and sills shall be marked in a form as in Appendix 4. Should significant variation exist the more detailed information referred to in the appendix shall be given as the need arises for the different parts of the dam or dam sections.

The main dimensions of the reservoir area are entered in a form as shown in Appendix 5. In addition, the safety file shall contain the following documents:

- discharge rating curves of the controlled and uncontrolled spillways
- discharge rating curves of the starting sills of the inflow and by-pass channels of the regulation reservoir
- volume and surface area curves of the regulation reservoir
- damming and discharge provision, regulation instruction (e.g. as a drawing).

4.3.2 Hydrological parameters

The hydrological parameters are presented in a form as in Appendix 6. The numerical values of the parameters shall be determined to the extent appropriate following the instructions in Appendix 12. Other dimensioning methods can also be accepted such as those based on meteorological-hydrological model calculation or estimation of the greatest possible flood (e.g. probable maximum flood, PMF). For extensive and regulated water bodies the model calculation is often the recommended way of assessing the advance of a design flood. However, in these cases, too, a design flood value derived from its return period corresponding to the dam class, and its calculation procedure shall always be given.

The design flood is not the same as the design value of the discharge structures, but a flood that, at this site in the water body, occurs with a given return period. The selection of the return period depends on the dam class and the conditions in the area affected by the dam (Appendix 12).

The safety file shall be provided with an account of the procedures used to reach the design values presented in Appendix 6.

4.4 MAP OF THE AREA AFFECTED BY THE DAM, A SITE MAP OF THE DAM, AND DRAWINGS AND ASSESSMENTS OF THE DAM STRUCTURE

The documents referred to in the heading, the guidelines for which are given in Appendix 7, shall be included in the safety file provided with the appropriate information about completion. The safety file shall also contain summaries of the supervision investigations of earth, concrete and foundation works during the construction.

4.5 MONITORING PROGRAMME REFERRED TO UNDER SECTIONS 6 AND 7 OF THE DAM SAFETY ACT WITH AMENDMENTS

The guideline concerning the drafting of the monitoring programme is given in chapter 6.

The model form is shown in Appendix 9. An officially approved monitoring programme is part of the safety file and shall be observed. A change in the monitoring programme requires official approval.

4.6 INSPECTION AND MONITORING DOCUMENTS

The documents of the dam commissioning inspection shall be included in the safety file to the extent appropriate. A record shall be kept of the regular and annual inspections required by the safety monitoring programme and shall be included in the safety file of the dam owner. The records of the regular inspections shall also be sent to the authorities. A record shall also be kept of the monitoring.

4.7 LETTERS FROM THE AUTHORITIES

The letters from the authorities or records of inspections undertaken by the authorities shall be included in the file if they are specifically prescribed for inclusion therein.

4.8 ASSESSMENTS AND ACTION PLANS REFERRED TO UNDER SECTION 9 OF THE DAM SAFETY ACT

The assessment of a hazard risk is dealt with in chapter 7. The hazard risk assessment and its outcome shall be included in the completion documents, but not in the safety file.

If a dam is considered as one referred to under section 9 paragraph 2 of the Dam Safety Act (P dam), its owner or holder shall, together with a fire authority, draw up a site plan containing the accounts and action plans of the owner or holder of the dam referred to under section 9 of the Dam Safety Act and section 4 of the Dam Safety Decree. The drafting of the site plan is described in chapter 8.

4.9 WASTE DAMS

Waste dams differ from dams constructed in water bodies in the type of impounded substance.

Waste dams are used to impound liquid or solids harmful or dangerous to health or the environment.

In addition to the assessments required for water body dams in this code of practice, a waste dam safety file shall contain an assessment of the health and environmental impacts of waste dam failure. The assessment of the health and environmental impacts shall be made for all waste dams subject to the Act. The impact is estimated using the form in Appendix 17, supplementing it, if necessary. Note that in the event of an accident a waste dam may endanger people and property below the dam in the same way as any other dam.

Seepage of the impounded substance shall also be assessed. To this end, data on the permeability of the dam materials and the dam foundation shall be given and the volume of the seepage water calculated. A possible collection and back-pumping system for the seepage water shall also be given. Seepage into the environment of the harmful substances in the basin is restricted and supervised under the Water Act, the Waste Management Act and the Public Health Act. The waste dam hazard risk assessment is dealt with in 7.14.

5 Commissioning inspection

The commissioning inspection of a dam shall be made in such a manner that all issues relevant to dam safety are adequately considered. The quality of the dam structures shall be assessed on the basis of the requirements given in Appendices 12 – 15. The commissioning inspection is the responsibility of the chief dam designer (3.3) or another competent person.

The commissioning inspection is based on data in the dam plans, quality control programme and, if necessary, the hazard risk assessment.

In the case of a P dam, the assessments and action plans referred to under section 9 of the Dam Safety Act shall be compiled in such a manner that they can be included in the site plan drafted under the supervision of a fire authority before the dam is brought into use (chapter 8 and Appendix 18). The dam is considered as having been brought into use when the water or other impounded substance has started to rise.

The commissioning inspection begins by notifying the water and environment district that construction shall start. At the same time the dam plans and quality control programme are communicated to the authority to the extent required. The commissioning inspection continues with the necessary field inspections, which can be reviews of structures and foundations conducted during different stages of the work. At any rate, a field inspection shall be made before starting to raise the water, once the structures are ready for this procedure. The timetable for raising the water appropriate to the state of completion of the structures is established in the course of the inspection. Representatives of the water and environment district can participate in the field inspections, as can, at least for P dams, representatives of the National Board of Waters and the Environment and the fire authorities.

The commissioning inspection is finally completed when all the structures are operationally ready, have been brought into full-scale use and have been approved to function as planned. At the closing of the commissioning inspection the records of the field inspections and the completion documents are collected, and a summary (final statement) and a proposal for dam qualification (Appendix 8) are compiled from them and included in the dam safety file.

6 Safety monitoring and inspections

6.1 THE DRAFTING AND PROCESSING OF A SAFETY MONITORING PROGRAMME

To reduce the hazard risk from a dam, a safety monitoring programme shall be drafted for each dam subject to the Dam Safety Act. The programme is drafted or acquired by the dam owner or holder. The person who drafts the programme shall have the same competence as the designer of a corresponding structure. The programme shall be so compiled that all issues related to dam safety shall be subjected to monitoring and inspection. The programme may include guidelines concerning the monitoring proper and regular inspections (section 6 of the Dam Safety Act).

The safety monitoring programme or its amendments are approved by the National Board of Waters and the Environment (P dams) or the water and environment district (N, O and T dams). The NBWE may issue further instructions on the drafting of the programme, and, for a special reason, grant total or partial exemption from the above monitoring obligation. Appropriate records shall be kept of the monitoring and inspections referred to in the programme, which, together with the monitoring programme, shall be kept in the safety file referred to in section 5 of the Dam Safety Act.

The monitoring programme shall be made well in advance of completion of the dam so that it can be approved for observation before the dam is brought into use. A draft safety monitoring programme shall be sent to the water and environment district (section 7 of the Dam Safety Act, section 3 of the Dam Safety Decree). The draft monitoring programme contains sub-programmes for both the implementation and post-implementation.

The monitoring programme of a P dam shall be sent to the water and environment district three months before the implementation and that of an N and O dam, and a T dam (cofferdam) comparable to a P dam in hazard risk, two months before the implementation unless otherwise agreed in the timetable. For other T dams it is not necessary to draw up or apply for approval of a monitoring programme proper. However, all T dams shall be monitored as appropriate taking into account the conditions.

The draft monitoring programme shall be sent to the water and environment district in

three copies. After the processing the approving authority returns one copy of the monitoring programme to the dam holder. The NBWE and the water and environment district will each retain one copy. An amendment to the monitoring programme is subject to the same procedure as the drawing up of a new monitoring programme. The draft monitoring programme can be drawn up in the form shown in Appendix 9, supplementing it if necessary.

The decision may be appealed to the NBWE (a decision by the water and environment district) or to the Supreme Administrative Court (a decision by the NBWE as stated in the Administrative Appeals Act (154/50). To correct a factual error the authority may remove his erroneous decision or review the case on the basis of the Administrative Procedures Act (598/82, section 26) with the consent of the parties involved.

6.2 MONITORING

The measures relevant to dam monitoring are set out in the form in Appendix 9. The set of measures given in the form is for guidance only, and the person who drafts the monitoring programme may change and supplement them as necessary.

Dam monitoring involves the following procedures (embankment dams in detail in Appendix 13):

- monitoring the height of water or other substance impounded in the basin
- inspection of the visible parts of the dam structures (embankment and concrete dams, regulation and discharge structures, etc.) and the dam downstream area during each inspection visit
- the observations and measurements listed in the monitoring programme and other issues relevant to the dam
- for waste dams, other special items if related to dam safety

The persons undertaking monitoring shall be instructed adequately so that they are aware of likely damage and hazards and their manifestations. They shall also be made aware of the measures they have to take if factors endangering the safety of the dam are noted. A person who undertakes measurements shall be well informed about the range of the normal values and, if the values are either higher or lower, he shall immediately inform the person responsible for the dam. A record shall be kept of the monitoring and observations.

The normative periodicity of the inspections depends on the dam class (P, N and O dams) as stated in Appendix 10. Deviations from the normative periodicity are allowed if a system replacing the inspections is in use (e.g. remote monitoring cameras, telemetric apparatuses, and the computers and alarm systems based on them). The use and function of the replacement systems shall be described in the draft monitoring programme.

In addition, and if necessary, during floods and after exceptionally heavy rainfall and storms inspection visits shall be made to dams which are or may have been subject to extra strain.

6.3 INSPECTIONS

6.3.1 Annual inspection

The annual inspection of a dam shall be made when the soil is not frozen. In the course of the annual inspection the measurements and observations made during the year are examined, taking into account the changes, the operational state of the measuring devices is checked, and the parts of the dam and the associated facilities requiring repair are investigated in the field.

In the annual inspection special attention shall be paid to checking the function of the dam spillways and sills and power plant

discharge facilities. In flood years in particular, flood preventive measures undertaken are reviewed, so that even in abnormal flood years the operating personnel have the correct instructions for handling the situation. Likewise, on the basis of data on impacts caused by ice, their effect on discharge structures and other possible risk factors are assessed. In addition, the checking measures taken by the operating personnel during sudden heavy rainfall are gone through.

The filling and discharge channels of the basins and associated structures should be inspected in the spring after the flood. Correspondingly, the structures and facilities of waste dams, such as the inflow and outflow systems, are inspected once a year.

Records are drawn up of the annual inspection and included in the safety file of the dam owner.

6.3.2 Regular inspection

A regular inspection is made at intervals not exceeding five years. The date of the first regular inspection is counted from the date of the commissioning inspection.

A representative of the dam owner or holder and a competent person participate in the regular inspection.

The water and environment district and, for a P dam, the National Board of Waters and the Environment, the provincial government and fire authorities shall be informed about the date of the inspection so that the authorities can, at their discretion, participate in the inspection.

In the inspection

- the compiled observational data and other results and the records of the annual inspections are gone through
- structures are inspected as considered necessary
- the action plans referred to under section 9 paragraph 2 of the Dam Safety Act are inspected and the viability of the arrangements required by them is verified
- a decision is made on any follow-up measures or investigations needed
- it is established whether changes have taken place in conditions or, in the case of waste dams, in the type of impounded substance affecting the dam class (e.g. an N dam is reclassified as a P dam).

Records are kept of the regular inspection and included in the dam safety file. The records can be made more graphic with drawings, photographs, videos, etc. A copy of the records is sent to the water and environment district and, for a P dam, also to the National Board of Waters and the Environment, the provincial government and the fire authorities. Changes and supplements to the safety file are sent to the water and environment district and, for a P dam, also to the NBWE.

7 Hazard risk assessment

7.1 ASSESSMENT OF A HAZARD RISK

7.1.1 General

To assess and chart the hazard risk of a dam the National Board of Waters and the Environment may stipulate, when necessary, that the party having the dam constructed, or the dam owner or holder shall acquire or compile an assessment of the hazard risk posed by the dam, in particular to the people and property in the dam downstream area. The hazard risk assessment is necessary if the dam may be classified as a P dam, i.e. in the event of an accident the dam may manifestly endanger human life or health or manifestly seriously endanger the environment or property (section 9 of the Dam Safety Act).

The main objectives of the hazard risk assessment are:

- to provide facilities for organizing rescue operations in the event of an accident
- to create a basis for the measures needed to prevent or contain an accident or a threat of an accident
- to establish the hazard risk class at the design stage of the dam, and the standards of the dam and its monitoring which depend on this class

Subsections 7.1.2 and 7.1.3 deal mainly with the assessment of a flood due to failure of a water body dam (hazard risk for human life or property). The special features associated with the failure of a waste dam are dealt with in 7.1.4 (hazard risk for health or the environment).

7.1.2 Comparison of breach cases

The damage caused by a dam breach is usually proportional to the volume and abruptness of the discharge flow and the discharge capacity of the flood path. The impact of a dam breach is assessed for normal and flood situations. An operational examination is also made (3.4). The most dangerous discharge site in terms of the above issues shall be established for each dam section and the main discharge path. In addition to the most dangerous discharge site, a number of less dangerous breach sites are established so that in the event of an accident the extent of the

damage will be known accurately irrespective of the location of the dam breach.

Different possible dam breach cases shall be compared with each other at the discharge sites. The events resulting in breaches shall be defined by assuming that the breaches take place and develop as dictated by the structure of the dam. The assumptions shall be based on known breach cases or on the results of a computation model tested experimentally or with true cases, or on scale model tests taking into account the structure of the dam and its resistance to erosion.

The discharge shall be determined with the aid of appropriate computation methods or model tests. The method and computation procedure or test arrangement used shall be described and arguments presented for their applicability considering the properties of the basin. The initial values and assumptions shall be given.

7.1.3 Assessment of flood advance

Flood advance in the above cases can be assessed with scale model tests or computationally.

In scale model tests a discharge corresponding to the dam breach is arranged at an appropriate site in a terrain model. The flood heights and the flood advance are established, recording the data in an appropriate manner and interpreting them to correspond to the terrain.

Equations of irregularly changing flow (dynamic flow equations) shall be applied to the calculation of channel flows with the aid of an appropriate computer program. Reservoir equations may also be used for side reservoirs and basin-like channel sections. Flows over sills or through gates can be calculated using formulas of a wide sill or surface and bottom gate flows, depending on the shape of the flow path.

Estimations have to be made as to whether the dams and bridges located in the channel will resist the flood or fail.

The advance of a flood shall be traced to the extent necessary for assessing the hazard risk.

7.1.4 Hazard risk of a waste dam

The hazard risk assessment of a waste dam shall also contain estimates of the hazard risk to the population and property in the dam downstream area by applying the guidelines in 7.1.1 – 7.1.3.

In addition to the physical impacts of a dam breach and on the basis of them the risk to health and the environment caused by the substances discharging from the dam shall be assessed. Attention shall then be paid to harmful or hazardous substances the impounded materials contain, the chemical and biological properties of the dammed substance, and the surface and groundwater areas and water intake sites and their catchment areas in the path of the substance discharging from the breach. The items to be included in the hazard risk assessment are shown in the model form "Assessment of the impact of a waste dam failure on health and the environment" in Appendix 17, which is supplemented as necessary.

7.2 RESULTS OF THE HAZARD RISK ASSESSMENT

The results of the hazard risk assessment shall be communicated to the water and environment district, the National Board of Waters and the Environment, the provincial government, the regional fire commander and the municipal fire authority. The NBWE decides on the basis of the hazard risk assessment whether or not the dam shall be classified as a P dam.

The results shall contain:

1) a specification of the assessment method and guidelines for interpreting the results

2) the data used in the assessment that remain constant in different cases, such as initial discharges, coefficients and the cross-section data given as numerical data (the input and output data of the computer runs to the NBWE)

3) a summary of the comparison of different dam breach cases, which for each breach case tabulates

- the inclination of the walls of the breach opening and the final height and width of the bottom
- the time taken by the breach
- the water level in the basin at the onset of breach
- the cause of the breach (internal erosion, scouring, intentional damage or surface erosion)
- maximum discharge

4) the results of each flood, either calculated or measured from a scale model test, shall be given for the first 5 km of the flood path at least at cross-section intervals of 1 km and thereafter at least at every 5 km (Appendix 16).

5) the opinion of the person who made the assessment on the hazard risk caused by each flood case to human life and property (fixed structures and buildings). The objects affecting the classification are listed if necessary. The list shall contain information about the elevations of the objects and the height and flow rate of the water at each object

6) an assessment of the health and environmental risks caused by a waste dam breach in accordance with the model form in Appendix 17

7) the dam class proposal of the person who made the assessment.

8 Prevention of and precautions against a dam accident

8.1 PREVENTION OF A DAM ACCIDENT

Anyone who notices or is informed that a dam accident has happened or liable to happen and cannot at once prevent the danger is obliged without delay to inform those in danger, to make an accident report to the authorities, and to proceed with rescue operations in so far as he or she is able (Fire and Rescue Services Act, section 28, referred to under section 8 of the Dam Safety Act). This obligation concerns particularly the dam owner or holder and the dam management personnel in their service. They shall also take immediate action within their capability to prevent and contain the accident.

The responsibility of the different authorities for rescue operations and their obligation to give executive assistance is based on the relevant legislation. The duties are defined in the directive on the planning of public rescue services issued by the Ministry of the Interior on 1.12.1988 (Publication Series A:26 of the Rescue Department of the Ministry of the Interior, 1184/701/88). When this directive is applied to dam accidents the duties of the authorities are as follows:

- The fire authorities see to the measures called for by the dam breach and the resulting flood in so far as is appropriate for fire brigades (Fire and Rescue Services Act 559/75, section 1). The measures appropriate for fire brigades are those that have to be taken urgently, and which require a fire brigade's good operational readiness, facilities, and professional skill and expertise in rescue operations in accident situations.

Should the fire brigades be considered capable of undertaking other urgent measures called for by a dam accident (chapter 21 section 21 paragraph 3 of the Water Act 264/61), such as starting to repair the dam, they shall be instructed in advance about the measures required by each dam. The fire authorities are also responsible for directing rescue operations and for seeing that the rescue service plans are compatible with each other.

The plans to be made for emergency conditions are prescribed separately in the Civil Defence Act (438/58) and Decree (237/59). Prevention of a dam accident in a state of emergency calls for special preventive measures which are the duty of the dam owner or holder. When making plans for a

state of emergency special attention shall be paid to the new risks involved in dam accidents that occur under such conditions.

- The police authorities see to public order and safety, isolation of the danger zones, traffic control, organization of the search for missing persons, and other measures appropriate for them (sections 1, 17 and 23–26 of the Police Act 84/66 and chapter 21 section 3 paragraph 3 of the Water Act 264/61).

The main duties of police authorities in the event of a dam accident are to warn people and remove them from the danger zone. The police authorities, too, shall be instructed in advance about their duties in the event of a dam accident.

- The health authorities are responsible for organizing first aid and emergency care, ambulance services and other medical care and environmental health services (Primary Health Care Act 66/72, Public Health Act 469/65, Act on Municipal General Hospitals 561/65).

- The water and environment administration (the National Board of Waters and the Environment and the water and environment districts) is responsible for the supervision of dam safety (section 10 of the Dam Safety Act 413/84), the necessary measures to eliminate the danger caused by the dam (section 11 of the Dam Safety Act), flood protection, the prevention of damage and inconvenience caused by water and ice or freezing (sections 1 and 2 of the Water and Environment Administration Act 24/86, chapter 12 sections 17 and 19 of the Water Act).

The measures taken by the water and environment administration in the event of a dam accident mainly concern the water body and hydraulic structures, the advance planning of these measures, the expertise needed to implement them, and, as allowed by local conditions, participation in the measures. The measures are defined in greater detail in plans drawn up in advance to cover specific cases, as applies to the other authorities, too.

- The Finnish National Road Administration offers help with clearance and rescue operations, with particular responsibility in the event of a dam accident for road repairs and the maintenance of communication with the sites of action.

8.2 HOW TO TAKE A P DAM INTO ACCOUNT WHEN PLANNING THE RESCUE SERVICE

The comprehensive action plan needed by the local authorities for organizing rescue services (the municipal rescue service plan) contains a basic rescue service plan and supplementary plans for different sectors, types of accident and sites. Preparation of these plans is the duty of the municipal fire chief.

The coordination plan for a cooperation area composed of several municipalities deals with subjects such as intermunicipal assistance, cooperation with fire brigades and other authorities, and the capability of consortiums and companies to participate in the rescue service. The coordination plan covers the rescue service plans of individual communities. It is drawn up by the provincial government together with the management group of the cooperation area.

On the basis of the coordination plans of the different cooperation areas, the provincial government also draws up a coordination plan for the fire and rescue services, the provincial coordination plan, which covers the whole province. The above plans drawn up in municipalities, cooperation areas and provinces complement each other and form the basis for the rescue operations under all conceivable accident conditions. The plans and their compatibility with each other are shown in Fig. 1.

Provincial coordination plan	
Development of fire and rescue services (and other rescue administration)	Rescue service

Coordination plan for the cooperation area		
Basic plan for rescue service		
Plans for different sectors	Site plans	Plans for different types of accident

Municipal rescue service plan		
Basic plan for rescue services		
Plans for different sectors	Site plans	Plans for different types of accident

Figure 1. General rescue service plans

The risk of a P dam causing an accident shall be taken into account when planning rescue services. Whether the planning has to cover the cooperation area or even the whole province or only a municipality depends on the magnitude of the accident on which the planning is based.

The owner or holder of each P dam is obliged to help the fire authorities in drawing up this plan and, in accordance with the site plan, to take precautions against accidents.

Under section 4 of the Dam Safety Decree the following information shall be available in the event of an accident caused by a P dam to the extent required by the conditions:

1) a plan concerning the measures to be applied to a water body or to hydraulic structures in the event of an accident
2) an account of stocks of materials kept for an accident
3) an account of the alarm system and communication links to the regional alarm centre
4) an account of the personnel of the dam owner or holder available in the event of an accident
5) an account of the other measures to be taken by the dam owner or holder, necessary to protect people and property, in the event of an accident caused by damming, and
6) an account of the type and quantity of the substance impounded by waste dams.

In addition to the above, which must mainly be seen to by the owner or holder of a P dam, the other basic information needed for the planning of the rescue services is the results of the hazard risk assessments dealt with in the previous chapter and matters that are the responsibility of the fire authorities. The fire authorities are mainly responsible for organizing rescue operations, that is, for

- directing the whole operation
- communications
- medical care
- servicing
- alerting the population and
- providing information.

In practice, the planning of rescue services for a P dam starts with the drafting of a site plan. This plan and the precautions against accidents are dealt with in detail in Appendix 18. The site plan shall be checked and updated in the course of the regular inspections.

The basic plan of a municipal rescue service shall take into account the site plans drawn up for all the P dams in the municipality. The content of the basic rescue service plan, which is dealt with in the aforementioned directive on the planning of public rescue services, will not be described further in this context. Note, however, that P dams should be included in the list of special objects in the basic plan and that the arrangements and information concerning operation organization, special apparatuses, experts, intermunicipal cooperation and subtasks of the rescue service, which are required by P dams and differ from those called for by other types of accident, should also be taken into account.

The special arrangements are described in detail in the site plan for each P dam referred to in the basic plan.

An accident to a P dam affecting several municipalities shall be taken into account in the coordination plan of a cooperation area. This is done on the basis of the site plan of the dam in question. If there are P dams in the same water body within areas of different municipalities their site plans shall be coordinated if necessary so that accident prevention can be undertaken as an entity. The accident situation may affect several cooperation areas. Therefore, the rescue service planning concerning all P dams in the water body shall be coordinated at provincial level. To this end, the site plans of individual P dams are combined to form a field-of-activity plan for each water body. This calls for cooperation between the fire authorities and dam owners.

APPENDIX 1. MODEL FOR THE COVER PAGE OF A DAM SAFETY FILE

Index number and name of dammed water body

_____

_____

Location municipality and site of dam _____

_____

_____

_____ SAFETY FILE AND MONITORING PROGRAMME

(Name of dam)

Purpose of use _____

Permit (issuing body, date, name of project)

_____

_____

_____ Date of implementation _____

Owner _____

Holder _____

Address and tel. no. of holder _____

_____

Proposed dam class _____

Safety file completed on _____

Safety monitoring programme sent for inspection _____

Date and signature (of dam holder) _____

_____

Amendments and additions: _____

_____

For official use:

Dam class _____

Safety monitoring programme approved on _____

Other measures ordered to be carried out:

APPENDIX 2. LIST OF COMPLETION DOCUMENTS

Project Water and Environment District

Object Municipality

Where and by whom the documents are kept

Contents	Scale	Drawing No.	Date	Designer	Notes

APPENDIX 3. DAM COMPLETION DOCUMENTS

The completion documents of a dam may be compiled as one or several files if necessary. They include the design documents of structures with any changes made during construction marked on them, or these documents without changes but supplemented with an account and drawings concerning the changes. A summary of work supervision and records of inspections and the commissioning inspection are also needed.

The following is an example of the items the dam completion documents should contain and how they might be grouped.

Hydrological design

- observational data
- design flow and water level and basis for their assessment
- design functioning of structures under design conditions

Earth and rock structures

- results of soil and bedrock studies, laboratory data
- construction materials data
- dimensioning of structures, stability calculations and settlement assessments
- reinforcements made for soil, bedrock and slope with completion drawings and data on materials used
- longitudinal profiles showing the areas to which the type cross-sections have been applied
- type cross-sections
- work specifications with supplements
- work supervision data
- maintenance instructions

Concrete structures

- design and stability calculations, and quality requirements of materials and work
- drawings of permitted load levels
- founding of structures and their linkage to the earth and rock structures
- structural and reinforcement drawings
- specifications for the materials and works at different sites
- work supervision data
- maintenance instructions

Steel structures (in regard to regulation and lock installations)

- design calculations, materials and work specifications
- linkage to other structures and machineries
- structural drawings with data on materials
- certificates of materials
- surface treatment
- instructions for use and maintenance

Machinery (in regard to regulation and lock installations)

- design
- specifications and drawings of the machinery and data on materials given by the manufacturer
- installation drawings
- reports on test runs
- surface treatment
- certificates of materials
- instructions for operation and maintenance
- list of spare parts

Electrical facilities (regulation and lock installations)

- design of electrical installations
- final drawings
- instructions for operation and maintenance
- records of an inspection in which the electrical installations were approved

Monitoring and control facilities (regulation, lock, alarm and maintenance facilities)

- system plans and diagrams
- reports on facilities
- description of failure and malfunction alarm system
- drawings for connections and installations; permits for telephone and other extensions
- operation, test and maintenance instructions

Permit decisions, contracts and compensations (regulation, emergency and materials reserves)

- permit decisions
- contracts for use and maintenance of structures
- other legal issues relevant to dam safety and its upkeep

Records of inspections and of significant repairs and modifications shall be added to the existing completion documents, ensuring that the documents of the entities grouped as above are kept in the same place. The completion documents shall be well protected.

APPENDIX 4. MAIN DIMENSIONS OF THE DAM

The main dimensions of the _____ dam (including all dams within the same reservoir system)

DAMS AND DAMMED SECTIONS (including dam–like embankments)

Dam section, its materials and type (e.g. a homogenous earthfill dam, zoned earthfill dam, concrete dam)	Stationing or lenght of section (m)	Width of dam crest (m)	Maximum height (m)	Lowest elevation of crest	Lowest level of core	Smallest free–board (m)	Slope inclinations		Notes
							wet	dry	

GATES AND SILLS (within the above dammed sections or separate)

Structure and functional type (e.g. turbine gate, flood spillway, bottom outlet, sill, log chute)	Location within dam	Length of sill (m)	Maximum discharge at HW (m^3/s)	Elevation of sill and the upper edge of bottom outlet	Type of closing installations	source of power	control	de–icing

APPENDIX 5. MAIN DIMENSIONS OF THE RESERVOIR AREA

MAIN DIMENSIONS OF THE _____
RESERVOIR AREA (name of dam)

PERMITTED WATER LEVEL		ELEVATION	AREA	VOLUME
Technical	NW	_____ m	_____ km^2	_____ million m^3
	NW	_____ m	_____ km^2	_____ million m^3
	HW	_____ m	_____ km^2	_____ million m^3
Emergency	HW	_____ m	_____ km^2	_____ million m^3

Elevation system applied: _____

Technical NW = elevation of lowest sill

NW = the lowest permitted upstream water level or, if not determined, the lowest design water level when the dam is in use

HW = the highest permitted upstream water level or, if not determined, the highest design water level when the dam is in use

Emergency HW = the lowest elevation of the top of the dam core, excluding the sills

Reservoir storage capacity (HW – NW): _____ million m^3

Emergency storage capacity (emergency HW – HW): _____ million m^3

APPENDIX 6. HYDROLOGICAL PARAMETERS

1. THE TOTAL CATCHMENT AREA ABOVE THE DAM (*):

catchment area	_____	km^2
lake percentage	_____	%
the mean of annual maximum discharges	_____	m^3/s

2. CATCHMENT AREA OF THE DAM BASIN (**):

catchment area	_____	km^2
lake percentage	_____	%
the mean of annual maximum discharges	_____	m^3/s

3. DESIGN FLOOD AT DAM:

A. From the whole catchment area

return period	_____	y
maximum discharge (inflow)	_____	m^3/s
maximum water level	_____	m (elevation system: _____)
maximum discharge (outflow)	_____	m^3/s

B. With any by–pass discharges subtracted (see item 4)

return period	_____	y
maximum discharge (inflow)	_____	m^3/s
maximum water level	_____	m (elevation system: _____)
maximum discharge (outflow)	_____	m^3/s

4. IF WATERS FROM A PART OF THE UPSTREAM CATCHMENT AREA CAN BE CHANNELLED TO BY–PASS THE DAM, THE FOLLOWING INFORMATION SHALL BE GIVEN ABOUT EACH BRANCHING SITE (in a separate appendix if necessary)

location of branch _____

_____

catchment area	_____	km^2
lake percentage	_____	%
return period of design flood	_____	y
rate of design flood	_____	m^3/s
maximum water level	_____	m (el. syst. _____)
water can be channelled past the dam at	_____	m^3/s

(*) Includes the catchment area of the dam basin itself.
(**) If the dam basin is situated separately from the main river basin.

5. DISCHARGE AT THE DAM:

Maximum permitted discharge _____ m^3/s

Other regulations included in the permit (if necessary):

_____

_____

_____

_____

Discharge capacity of dam sills and flood gates (without flows through power plant facilities):

at design high water level _____ m^3/s
at emergency high water level _____ m^3/s

The shortest time for lowering the water level of the reservoir from the HW level to the technical NW level when the inflow equals the mean of annual maximum discharges _____ days

---

Instructions given in Appendix 12 are applied when determining the design values. The data on which the calculation was based and the time curves of the design flood, outflow and water level shall be given in an appendix if necessary (i.e. if the damping effect due to the reservoir is taken into consideration in the design)

APPENDIX 7. MAPS AND DRAWINGS IN THE SAFETY FILE

	Maps, scale	**Sections** longitudinal sections	cross–sections	**Content** (minimum)
Area affected by the dam	1:10 000 ...1:100 000			Location, name, names of construction objects, roads and road maintenance units
Embankment dams	1:500 ...1:5 000	1:100/1:1 000 ... 1:500/1:5 000 A continuous longitudinal section shall be given for each damming section	1:50...1:500	Shape and size of structure, elevation system, bench marks, dam line with pile numbers, boundaries between dam types, monitoring and other facilities, levels of dam crest and core, types of foundation with reinforcement, regulation limits, drainage system with discharge gates, material requirements
Concrete dams	1:500 ... 1:5 000	1:100/1:1 000 ...1:500/1:5 000	1:50...1:500	Location, type cross–sections with foundation reinforcements, drains, monitoring facilities, information of the above entry as applicable
Power plant structures	1:500 ...1:5 000	1:100/1:1 000 ...1:500/1:5 000	1:50...1:500	Location, type cross–sections with foundation reinforcements, drains, closing installations, monitoring facilities
Regulation structures	1:500 ... 1:5 000	1:100/1:1 000 ...1:500/1:5 000	1:50...1:500	Location, type cross–sections with foundation reinforcements, closing installations, damping structures, monitoring facilities
Log chute structures	1:500 ... 1:5 000	1:100/1:1 000 ...1:500/1:5 000	1:50...1:500	Location,type cross–sections with foundation reinforcements, drains, closing installations, monitoring facilities
Canals	1:500 ...1:10 000	(1:100/1:1 000 ...1:500/1:5 000)	1:50...1:500	Location, type cross–sections with foundation reinforcements and facing, monitoring facilities
Others	1:500	(1:100/1:1 000)	1:50...1:500	The information of the above entry as applicable

APPENDIX 8. PROPOSAL FOR DAM QUALIFICATION

PROPOSAL FOR QUALIFICATION OF THE _____
DAM

On the basis of the hazard risk constituted by the dam in the event of an accident, it is proposed that the dam be classified as a P/N/O/T dam referred to in the Dam Safety Code of Practice on the following grounds: _____

_____

_____

The proposed qualification is based on

☐ a commissioning inspection

☐ the following other investigations and inspections: _____

_____

_____

_____

The following properties affecting the dam qualification have been investigated:

PROPERTY	CONCLUSION

APPENDIX 8/2

The other factors affecting the dam qualification have been taken into account as follows:

Summary concerning dam qualification:

Date Signature

Officially approved:

Water and Environment District

Date Signature

National Board of Waters and the Environment

Date Signature

APPENDIX 9. DAM SAFETY MONITORING PROGRAMME

THE SAFETY MONITORING PROGRAMME FOR THE _____ DAM

The state of the structures and facilities and changes in them that affect dam safety shall be verified by regular inspections (to be held at intervals not exceeding five years) with measurements, analyses of observational data, test runs of the equipment, and other investigations considered necessary.

The annual inspection shall establish the state of the structures and changes in them visually and by means of equipment test runs. The structures shall be inspected in spring or early summer after the flood and thaw.

The regular and annual inspections shall check each structure for the following (in a separate appendix if necessary):

OBJECT	INSPECTION

APPENDIX 9/2

The dam shall be monitored as follows (periodicity):

_____

_____

_____

_____

In addition, monitoring shall be made when the structures are subjected or may have been subjected to special stress during the breakup of the ice or a flood or as a result of heavy rainfall or a storm.

The following monitoring measures shall be taken:

MEASURES	PERIODS
1. inspection of visible parts of dam structures	every time
2. checking of internal inspection galleries and wells	_____
3. visual inspection of collection wells and discharge points of dam filter system (performance of drains and colour of seepage water)	_____
4. reading the stand pipes, measuring weirs and other gauges	_____
5. inspection of drains in the downstream area	_____
6. _____	_____

The monitoring includes the following measures for individual structures (in separate appendix if necessary):

OBJECT	MEASURES

The above should be observed

☐ until _____

☐ until further notice

_____ _____

Date Signature

Officially approved:

Water and Environment District _____

_____

_____

_____ _____

Date Signature

National Board of Waters and the Environment _____

_____

_____

_____ _____

Date Signature

APPENDIX 10. PERIODICITY OF DAM INSPECTIONS UNDER NORMAL CONDITIONS

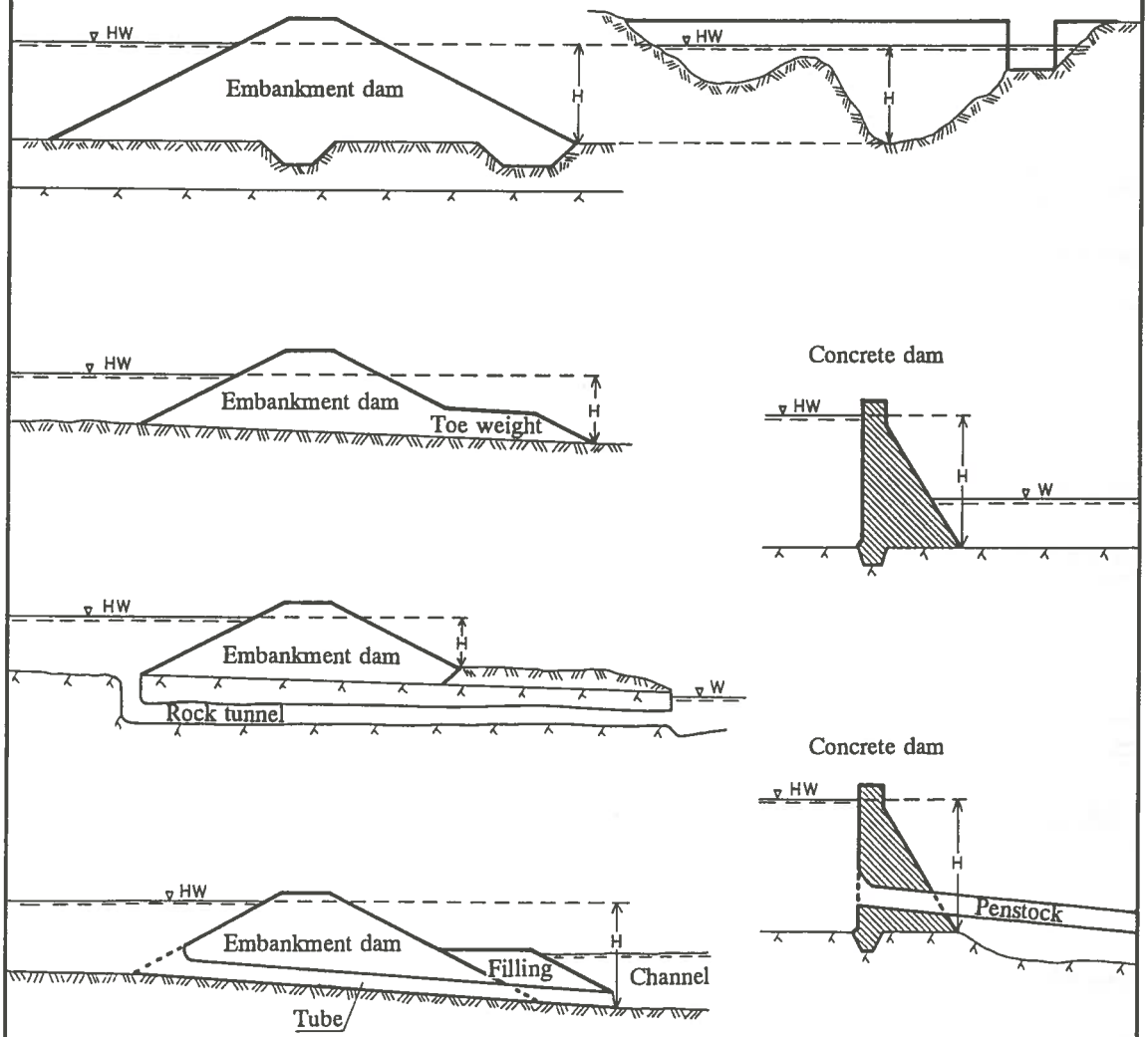
PERIODICITY OF INSPECTIONS UNDER NORMAL CONDITIONS (MINIMUM) EMBANKMENT DAM

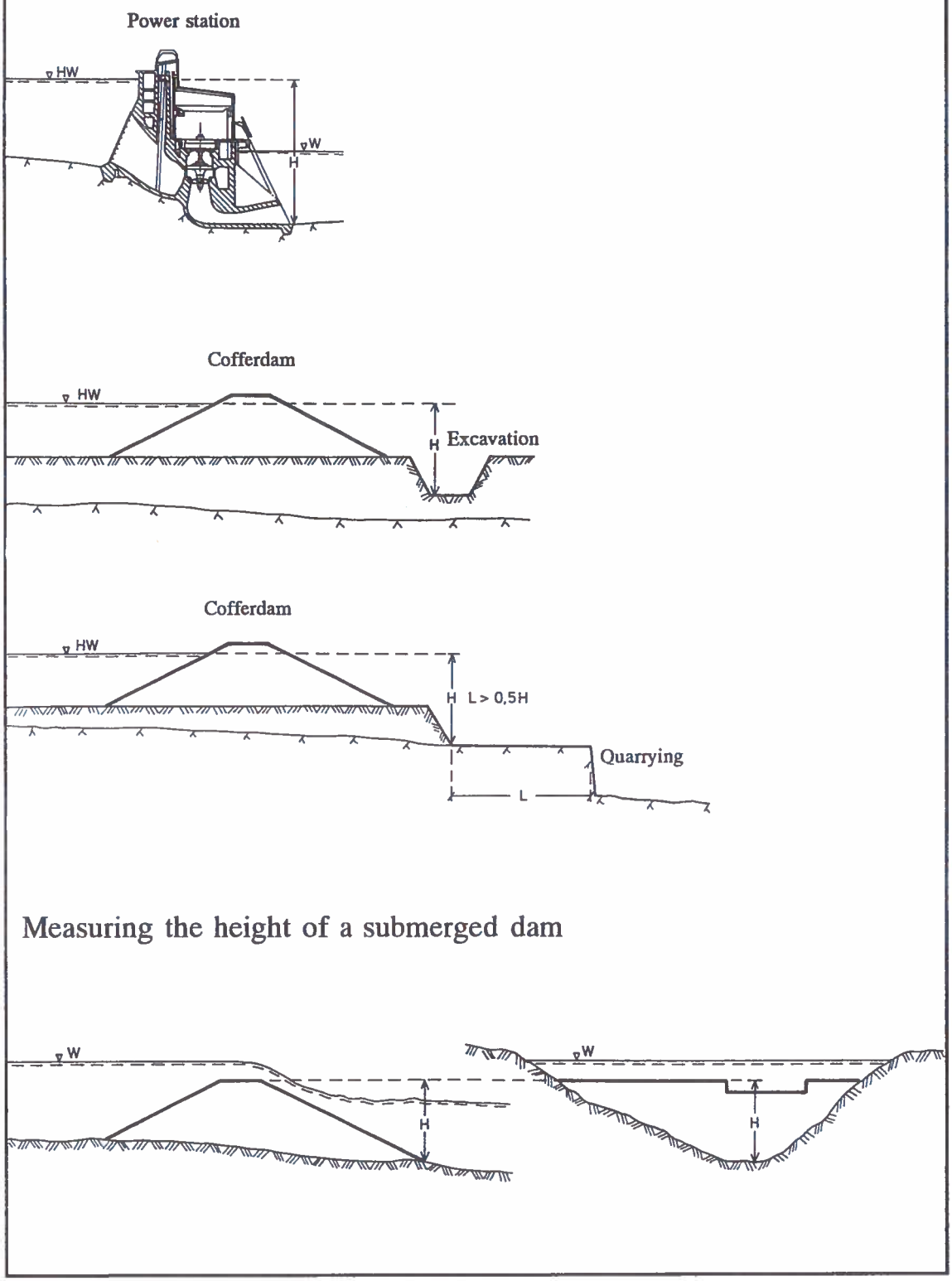
AGE OF DAM	DAM CLASS		
	P dam	N dam	O dam
First filling	Once a day – several times a day (depending on degree of fullness and water level	Once a week – several times a day (depending on degree of fullness and water level)	
Five first years after the first filling	April: two times a month May–June: once a week July–March: once a month	April–June: two times a month July–March: once a month	April–June: once after the flood July–March: once
Over five years after the first filling	Frequency of inspection is determined on the basis of monitoring data. If less frequent monitoring is justified, an amendment of the monitoring programme shall be approved by the authorities.		

APPENDIX 11. EXAMPLES OF HOW TO MEASURE THE HEIGHT OF A DAM

H = height

See 2.52 and section 3 of the Dam Safety Act and section 1 of the Dam Safety Decree.





Measuring the height of a submerged dam

APPENDIX 12. HYDROLOGICAL DESIGN PARAMETERS

1 HYDROLOGICAL DESIGN CONSTRAINTS TO BE MET BY DAMS

The design flood values given in Table 1/12 based on the hazard risk class of the dam are applied when designing the spillways. In designing the basins and dams off the channel proper the value of the design flood can be deduced from the catchment of the basin, provided that the inflow channels of the basin can be shut if necessary. It is imperative to ascertain whether the inflow channels can also be shut under abnormal flood conditions. Determinations of the discharge capacity of the dam spillways shall take into account the size of the reservoir and the discharge capacity of any channel between the basin and dam. At the initial stage of dam planning it is important to ensure that the class and dimensioning of the dam are compatible with existing dams in the water body. Data on them are available from the owners of these dams and from water and environment districts.

At discretion, lower design values can be used in designing cofferdams, but in certain cases, e.g. when determining freeboard, special attention shall be paid to the effect of ice, e.g. of frazil ice, in winter. There are no strict design rules for cofferdams because the needs and requirements of these dams vary greatly depending on local conditions.

Table 1/12. Return periods of design flood by dam class

Class	Return period in years
P	5 000 – 10 000
N	500 – 1 000
O	100 – 500

2 DETERMINATION OF DESIGN FLOOD

The selection of the method to determine the design flood depends primarily on the hydrological data available. The selection is also influenced by the properties of the basin, the type of regulation, the regulations implemented in the upstream area, and other changes in the catchment.

Depending on the data available the determinations are made as follows:

1) If more than 20 years of maximum discharge data are available on the dam site a frequency analysis is made using the Gumbel distribution of extreme values.

2) If a record of maximum discharge data covering 5–20 years is available on the site the data are submitted to frequency analysis. It is recommended that a similar analysis be made on a long sequence of maximum discharge data from an adjacent water body using the same years as for the target water body.

3) If a set of data covering more than five years is available from the same water body close to the dam site (less than 20% change in catchment size, no major lakes in between), its maximum discharge data can be converted into those of the dam site directly in proportion to the catchment areas, thereafter proceeding as described in 1 or 2, depending on the length of the observation sequence.

4) If a set of data covering more than five years is available from the same water body (but not from unreasonably far off), but which, however, does not meet the criteria of 3 above, its maximum discharge data are

converted into those of the dam site using nomograms, other sets of data and general hydrological knowledge, thereafter proceeding as in 1 or 2, depending on the length of the observation sequence.

5) Otherwise, frequency analyses made using the Gumbel distribution on data sets of over 20 years from the two most appropriate reference water bodies are used. The results are corrected by taking into account the difference in hydrology between the reference and target water bodies. Even a short data set from the target water body, preferably from the dam site, is then of particular importance.

6) If there are no appropriate reference water bodies, the assessment has to be based on nomograms, the hydrological properties of the catchment and discharge data collected at the dam site during the design period.

7) Coefficients listed in Table 3/12 can be used to determine a design flood flow corresponding to a return period of over 100 years.

The influence of other factors is taken into account as follows:

A. If the volume of a basin is so large that the design flood can be assumed to be damped out, the entire design flood shall be determined (Fig. 1/12):
1. Maximum discharges of different durations (e.g. 1, 3, 5, 10 and 20 days) and their occurrence in relation to the flood peak are calculated from the annual maximum discharge peaks.
2. An analysis of return periods is made on maximum discharges of different durations using the Gumbel distribution of extreme values.
3. A hydrograph is compiled in which the maximum discharges of different durations are those referred to in A.2, and their relative occurrence corresponds to the average occurrence in A.1.

If it is manifest from A.1 that the temporal distribution of major floods differs from that of minor floods, this fact can be taken into account when dating maximum discharges of different durations.

It is not necessary to compile a hydrograph if the dimensions of the dam allow undamped floods.

B. Analysis of return periods of rare flood cases cannot usually be based on a set of data on regulated flows. In that case, the inflow from the upstream area of the regulation structure, the bulk of which at least comes from the unregulated region, shall be taken as the basis.

C. If major regulation works have been made in the upper catchment, calculation of the design flood should start with the uppermost regulation. The effect of each regulation on the magnitude of the design flood is then assessed by moving downstream (taking into account the impact of a dam breach, if necessary). In practice this usually requires data on dams in the water body and the effect of the dams on the advance of the flood to be obtained from the dam owners and water authorities.

D. Any extensive draining and other measures affecting runoff made in the upper catchment must be taken into account when determining the design flood. Before the analysis of return periods is conducted the maximum discharges predating the project are corrected to present-day conditions with a coefficient based on the estimated impact of the project. If the changes in the catchment continue and their final magnitude can be estimated, this can be taken into account when determining the value of the coefficient.

E. If a dam (and the associated basin) is located off the main channel or if, in the upper course of the water body, the flow has been directed from one part of the water body to the other using canals or other structures, the distribution of the flow between the channels in the event of rare floods should be assessed for each branching point. The distribution should be based on the prevailing conditions, because the value used in design is rarely compatible with reality. If one of the channels at a branch can be completely closed, this can be taken into account when determining the design flood. However, it is imperative to know that the channel can be closed if necessary. During rare floods water may be directed into abnormal paths in some watercourses even if there are no structures such as those mentioned above.

3 DETERMINATION OF DESIGN HIGH WATER LEVEL AND DESIGN OUTFLOW

Design high water level and design outflow are determined from the design flood, the water level at the onset of the flood and the surface area curve of the reservoir. For existing dams the design high water level depends unambiguously on the design flood and the initial water level. The best combination of design high water level and design outflow is sought for the dams under design. In both cases allowance must be made for wind, flow changes and impact due to ice and added to the calculated design high water level if considered necessary. Determinations of the discharge capacity of the dam omit the flow through the power station machinery.

If the volume of the reservoir is small, the design outflow equals the design flood. In that case the initial water level does not play a significant role and the design high water level is controlled by the design flood, the channel and the discharge capacity of the dam.

For larger reservoir volumes the design high water level and the design outflow are calculated with either a simple water balance method or a method that takes into account the inclination of the water level in the reservoir. The latter shall be applied to long, narrow reservoirs. The length of the time step used in the calculation depends on the surface area of the reservoir and the magnitude of the inflow. The results can be presented graphically as shown in Figure 1/12. For summer and winter floods and for reservoirs with minor water resources it is recommended that the highest permitted water level of the reservoir be taken as the initial water level of the reservoir and, for the spring flood, the water level that existed before the flood, determined from the operational data.

An ice jam or frazil ice in a river may cause a high water level with a return period significantly longer than that of the maximum discharge occurring during the existence of the

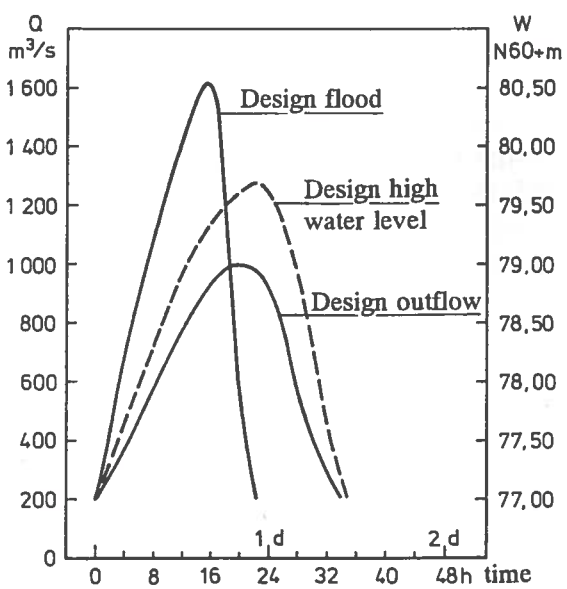


Figure 1/12. An example of reservoir routing

ice jam or frazil ice. The high water level in the reservoir may be markedly affected by the volume of ice gathered in the reservoir or by the impact of ice on the discharge structures.

The return period of the inflow chosen for use in dimensioning the spillways depends not only on the safety factor against the dam breach but also on dam construction costs. The return period is a statistical parameter and the probability that the design flood will be exceeded increases along with the operational age of the dam. If it is assumed that the operational life of a dam, for instance, is 100 years, then there is a 63% probability that a flood with a frequency of less than once in 100 years will occur during this time and an 18% probability that a flood with a frequency of less than once in 500 years will occur (Table 2/12). As dams, excluding temporary ones, are designed to last for a long time, there is no sense in dimensioning them on the basis of short return periods. Dam design is facilitated by the fact that the change in the design flood decreases in relation to the increase in the return period. If a flood with a frequency of once in 1000 years is taken as the design flood the design discharge is only 30% greater than if a flood with a frequency of once in 100 years had been selected as the design flood (Table 3/12). Therefore, the dam construction costs do not usually increase much when the return period of the design flood is lengthened.

Table 2/12. Probability (%) of the design flood being exceeded during the return period as a function of the design operational life of the structure

Flood return period (yr)	Design life of dam (yr)					
	10	50	100	200	500	1 000
10	65	99	100	100	100	100
50	18	64	87	98	100	100
100	10	40	63	87	99	100
200	5	22	39	63	92	99
500	2	10	18	33	63	86
1 000	1	5	10	18	39	63

Table 3/12. Ratios of maximum discharges at some observation sites determined using the Gumbel distribution of extreme values

Observation site		HQ1000 / HQ100	HQ5000 / HQ100	10000 / HQ100
4:6	Lieksanjoki, Ruunaa	1.28	1.47	1.55
4:24a	Koitajoki, Lylykoski	1.27	1.46	1.54
4:8087	Kallavesi, Konnus+Karvio	1.28	1.48	1.57
14:9	Vuosjärvi, Huopanankoski	1.27	1.46	1.54
14:29	Nilakka, Äyskoski	1.28	1.48	1.56
14:40	Petäjävesi, outlet	1.30	1.51	1.60
16:1a	Koskenkylänjoki,Pyhäjärvi	1.35	1.59	1.70
28:3	Aurajoki, Hypöistenkoski	1.32	1.55	1.65
35:94	Loimijoki, Maurialankoski	1.30	1.50	1.59
42:10	Kyrönjoki, Lansorsund	1.26	1.44	1.51
44:5	Lapuanjoki, Pappilankari	1.29	1.49	1.57
51:2	Lestijoki, Lestijärvi	1.28	1.47	1.56
54:4	Pyhäjoki, Pyhäkoski	1.29	1.49	1.58
57:7	Siikajoki, Länkelä	1.30	1.51	1.60
59:19	Lammasjärvi, outlet	1.29	1.49	1.58
60:4	Kiiminginjoki, Haukipudas	1.30	1.50	1.59
61:19	Iijoki, Merikoski	1.26	1.45	1.52
65:17	Kemihaara, Kummaniva	1.26	1.43	1.51
65:36	Ounasjoki, Marraskoski	1.31	1.48	1.56
67:8	Muonionjoki, Muonio	1.25	1.43	1.51
67:22	Tornionjoki, Karunki	1.25	1.42	1.49
71:8	Juutuanjoki, Saukkoniva	1.28	1.48	1.56

APPENDIX 13. REQUIREMENTS OF EMBANKMENT DAMS

1 PLANNING

1.1 Competence of designer

A designer of P and N dams and of the T dams comparable to them shall have a knowledge of foundation engineering and soil mechanics corresponding to the main subject level of a graduate construction engineer and at least five years previous experience in geotechnical planning. A designer of P dams shall also be experienced in the design of embankment dams.

1.2 Loads and calculations

The different parts of the dam are dimensioned taking into account the weight of the materials in the structure, the loads due to seepage (pore water pressures), the forces caused by waves and frost, and the traffic load on the dam crest. Vibrations due to blasting may also create loads during construction. Depending on the case, other external loads shall also be taken into account in calculations.

The stability of a dam is calculated at least for the construction period (the risk is usually highest at the end of the work), normal operational conditions and after a rapid fall in water level (the risk is usually highest when the water level drops from HW to the technical NW). Other loading cases should be considered individually. The stability calculation includes the stabilities of the dam and foundation.

Dam and foundation settlements are dealt with in accordance with conventional calculation procedures.

1.3 Calculation of seepage flow

Seepage flows through, under or around the embankment dams are assessed for different cross-sections. The calculations are performed with reliable software. The sites of the structures associated with the dam or running through the dam shall be treated separately, unless the flow there is not made smaller than in the enveloping dam.

The seepage flow rate and flow concentrations (maximum flow rate and maximum gradients) are calculated.

1.4 Stability calculations

Stabilities are calculated for different cross-sections at least for the loads referred to in 1.2. The calculation can be made either with the total safety method or using partial safety coefficients. Total safety is the ratio of shear strength to the shear stress prevailing in the assumed fracture plane. The Guidelines for Foundation Construction (RIL 121-1988) are applied when the method of partial safety coefficients is used at the rupture limit.

The rupture limit analyses should be supplemented with calculations on strain under the conditions prevailing when the dam is in use, at least if the dam is made of materials whose maximum strength is mobilized at very different strain values (an extreme case: clay core/blasted rock shoulder). In the above cases calculations of the total safety or the limit state of failure may give too favourable a picture of dam stability.

1.5 Minimum requirements for dams

1.5.1 Stability

The total stability of dams in a state of constant seepage flow should be at least 1.5. At the final stage of construction and on a sudden fall in water level (HW–NW) total stability should not be less than 1.3.

1.5.2 Freeboard of dam

The freeboard of N and P dams (difference between the dam crest and the HW level) is deduced from the maximum wave height at HW. The freeboard should be at least twice the height of the maximum wave. A preliminary calculation of wave height can be made from the length of the open water area. More detailed dimensioning takes account of the direction, duration and velocity of the prevailing winds.

The freeboard shall, however, always equal the depth of frost penetration that occurs at least once in ten years (in general the dominant factor of the freeboard).

For O dams the freeboard is determined by the maximum wave height or depth of frost penetration occurring once in five years.

1.5.3 Safety margin of dam

The safety margin of P and N dams (difference between the top of the core and the HW level) should be no less than 0.4 m, and for O dams 0.3 m. Allowance must also be made for settlement of the structure and foundation.

1.5.4 Wet slope facing

The size of boulders in wet slope facing and the thickness of the facing are determined from the maximum wave height. The range of the variation in high water dictates the extent of the facing. The design wave height should not be less than 1.5 m if the damaging effect of ice loads on the facing is to be prevented. If smaller boulders are used, structures may need to be repaired now and then.

1.5.5 Dam crest

The crest width of P and N dams should be at least 4 m. The width must be increased by 0.5 m if the height of the dam exceeds 10 m, and by a further 0.5 m for each successive 10 m. For special reasons the crest width of N dams less than 4 m high can be 3.5 m. The crest of O dams should be no less than 3 m wide.

The crest should be passable over its entire length.

1.5.6 Filtering structures and drainage system of a dam

The filtering structures and the drainage system should be so dimensioned that they are capable, in all circumstances, of protecting the core against erosion and of discharging the waters seeping through, under or around the dam and to smooth any peaks in flow gradients. The filtering structures must meet the grain size criteria, and their permeability must be higher than that of the protected structure by a factor of 100. The drainage system must be able to put through a volume which is ten times that of the calculated total seepage water.

1.5.7 Vegetation

No trees are allowed on the dam crest or wet slope, but trees not exceeding 50 mm in diameter at the butt end are permitted to grow on the dry slope. Exceptions to this rule can be made only after an investigation of each dam in question.

1.6 Filing the design documents

Calculations and data on materials and other design documents are filed so as to be available for later repairs should the need arise. The main design information is filed together with the completion documents as required by this Code of Practice.

2 CONSTRUCTION

2.1 Management and supervisory personnel

The management and supervisory personnel shall have sufficient experience of carrying out demanding earthworks, and the persons responsible for these works shall have experience of previous works on embankment dams.

The supervisory personnel and management shall not be dependent on each other, and the supervisor shall have the right to halt construction should the conditions, materials used or work methods differ from those specified in the design documents.

The designer shall participate in supervision by overseeing the most demanding work stages and inspecting the site records.

2.2 Quality control of work and materials

Work is controlled by continually monitoring its progress. The quality of work and materials is controlled at least as stated in the control programme compiled in association with the design documents. The programme must give the minimum standards for investigations of materials and control tests of the structure.

Records are kept of the control tests. They shall record the date and results of the tests, any deviations and the corrections made, etc. in such a manner that the sites of the tests can be unambiguously located afterwards.

2.3 Filing of work documents

All results of quality control tests and control reports are collated and filed. A summary is made of them and added to the dam completion documents.

Record drawings showing all the structures made including the foundation works and any changes in plans implemented during the work are made on the basis of measurements undertaken during the work.

3 MONITORING

3.1 Monitoring personnel

The personnel participating in the commissioning and regular inspections are referred to in chapters 5 and 6. It is recommended that the dam designer or a person with the corresponding expertise should participate in the annual inspections (at least for P dams).

Personnel undertaking the monitoring proper shall be trained at the dam, appropriate attention being paid to the special features of each dam.

3.2 Monitoring of seepage waters

Seepage waters can be monitored with pore water pressure gauges, groundwater wells, drain structures or drainage ditches. Special emphasis should be placed on changes in pore water pressure, water level or rate of water flow, and on water quality (colour, turbidity,

etc.). After completion of the dam (by the firstregular inspection at the latest) alarm limits should be set for pore water pressure, the water level in groundwater tubes and/or the measured water volumes, which, if over- or undershot, would call for inspection by an expert at least.

Objects subject to special surveillance are springs, wet areas in the downstream area, changes in vegetation (e.g. proliferation of willow) and areas that remain ice-free in winter or become snow-free early in spring.

In areas where the tail water extends to the dry slope of the dam it is not usually possible to measure seepage water flow. To determine the quality of seepage waters the inspections should be made when there is no flow in the downstream channel.

The concentrations of seepage flows can be studied with ground-penetrating radar. It is recommended that the radar be used at regular intervals at all embankment dams. With the aid of the radar results it is also possible to place monitoring instruments (pore water pressure gauges, groundwater wells etc.) at the site of the detected concentrations and thus to improve the surveillance.

3.3 Monitoring the structure

The structure can be monitored with measurements (levelling, settlement observations, etc.) and visually. The visual monitoring should concentrate above all on the changes that are taking place (settlements/cracks in the crest or slopes, state of facing, unusual frost heaves, etc.). The wheel track grooves on the dam crest may not exceed 50 mm in depth.

The embankment dams shall be kept free from vegetation so that any deformations are readily visible. The drainage ditches in particular shall be kept clean.

Frost action on the dam crest and slopess- hould be monitored regularly making use of measurements of frost heaving, the depth offrost penetration and the temperature of the structure.

3.4 Filing the monitoring data

Monitoring data are filed and summaries are made for the annual and regular inspections.

4 COFFERDAMS

4.1 Design

The same requirements apply to cofferdams as to permanent dams. However, stability during the life-time of the dam need not be more than ≥ 1.3 (total safety). Stability must then be calculated applying the maximum water level that occurs during the period the dam is in use and the traffic loads during the construction of the dam.

4.2 Construction

The supervisory instructions for embankment dams proper are applied, as appropriate, to the construction of cofferdams, construction and quality control.

4.3 Monitoring

The cofferdams are monitored mainly by the site personnel. A monitoring programme must always be drafted for a dangerous cofferdam comparable to a P dam. For other cofferdams a monitoring programme is drafted at the discretion of the designer.

APPENDIX 14. REQUIREMENTS OF CONCRETE DAMS

1 DESIGN

1.1 Competence of the designer

The designer of a concrete dam shall have sufficient qualifications as required by the dam class and structure, and appropriate experience in designing concrete structures.

The designer of a concrete dam is either the chief designer or acts under the supervision of the chief designer. The chief designer is responsible for coordinating the plans of different parties.

The concrete structures of P and N dams shall be designed in structural class 1. In this class the competence of the designer is ascertained by a panel of experts appointed by organizations in the building and concrete sector.

1.2 Loads and their calculation

The loads are calculated as stated in the Guidelines for Structural Loads (RIL 144–1990).

The design discharges and corresponding water levels can be calculated from the statistical data as shown in Appendix 12. The uplift affecting the bottom of the dam can be calculated from the seepage flow analysis, provided experimental permeability values are available for the basement rock/soil. The calculation can be made in two or three dimensions. The computer software must be well–tested and approved for these applications. If necessary, the results should be checked with measurements.

1.3 Combining the loads

The loads are combined by applying the Guidelines for Structural Loads, taking into account the magnitude of the concomitantly effective loads with special emphasis on the simultaneous occurrence of different water levels and ice loads.

1.4 Stability calculation

The structure must have sufficient safety against overturning and sliding. The safety is determined with either the total safety method or a limit state procedure.

Safety against overturning determined with the total safety method is considered sufficient if it is >1.5 under normal conditions and >1.3 during maintenance, when the structure is empty and without machinery and facilities. Under normal operational conditions, safety against sliding must be >2.0 and during maintenance >1.8. The safety values are calculated using the nominal loads.

If the limit state procedure is used, safety against overturning and sliding can be assessed by applying the Norwegian instructions for dam design (Forskrifter for dammer, Norges vassdrags– og elektrisitetsvesen 1982).

Safety against overturning and sliding can also be estimated with the appropriate FEM models.

1.5 Measures to improve stability

Dam stability can be improved with prestressed anchorage devices. These may be either strand or bar anchors. Only double–protected anchors are applicable. Should the anchors be used to improve stability under normal operational conditions it is imperative that their stress can be tested during use.

Conventional grouted deformed steel rock bolts, whether prestressed or not, are not taken into account as a stabilising factor in the stability assessment of the structure unless

their long-term strength and deformability andthe displacement ability of the structure have been established.

It is important that the functioning of the anchorage can be checked during use. Conventional drains, whose functioning cannot be checked during use of the dam, are not taken into account as a factor reducing pore water pressure. The magnitude of uplift can be monitored with pore water pressure gauges installed under the structure.

1.6 Properties of materials

In the design of dam structures the requirements set by watertightness and frost resistance must be taken into account when determining the environmental class. As a rule, structures belong to environmental class 1.

In the design of massive structural parts it is essential that the changes in volume caused by hydration heat do not have an adverse effect on the structure. As a rule, low-heat cements are preferred. Normally there is no need to take protective measures if the temperature difference between the surface and the internal parts of the structure is < 20°C.

If necessary, the dissolving effect of the aggressive substances transported by air and rainwater on calcium compounds should be taken into account.

1.7 Mode of function of the structure

The dam structure shall be divided into parts with movement joints, taking into account factors such as the type of foundation. As a rule, the machinery units should be divided into blocks of their own. The linking of the concrete dam to embankment dams or peripheral fills should be designed in cooperation with the geotechnical designer.

Changes in volume due to hydration heat during construction are taken into account by dividing the structure into casting blocks and making the casting sequence as appropriate as possible.

1.8 Design documents

The design materials are documented as stated in the instructions for structural calculation, and information about the place where they are filed is entered in the list of completion documents.

2 SUPERVISION DURING CONSTRUCTION

2.1 Competence of management

The foreman responsible for concrete works shall have the competence required by the structural class and, in general, the competence of a foreman supervising demanding works.

2.2 Supervision of work quality

The quality control of the concrete structures is made in accordance with the concrete standards. Matters essential for dam safety should be checked as construction proceeds. A record should be kept of inspections to an extent considered appropriate. Matters to be supervised and recorded include the type and permeability of the basement rock/soil, the stress of the prestressed anchorage, temperature changes in cast structures, etc.

2.3 Recording the work information

The results of the quality control tests and inspections made during the construction stage are summarized and added to the commis-

sioning inspection documents. The quality control reports are filed with the completion documents.

3 MONITORING DURING USE

Monitoring objects important for dam safety during use include the functioning of drains and anchorage, the amount and type of leaks, and changes in them.

Water bodies and submerged structures are inspected when possible during maintenance while the structures are visible. A record is kept of the inspections and added to the documents of regular inspections. A diver is employed if necessary.

APPENDIX 15. REQUIREMENTS OF GATES

1 STEEL STRUCTURES

The steel structures of gates shall be designed in accordance with the Guidelines for the Design of Steel Structures SFS 3200, taking into account the strength specifications required by conditions during use.

The loads shall be considered as stated in the Guidelines for Structural Loads (RIL 144–1990).

2 MACHINERY

Devices to prevent overloading:
If the structure is such that the machinery or gate can get damaged at overload, the machinery shall include a safety device provided with an appropriate alarm system.

To prevent slanting:
The slanting of gates shall be prevented either mechanically or electrically. The machinery shall have a detector to record any slanting that interferes with operations, and a system for straightening the gate.

Functioning of chains:
If the force acting on the gate is transmitted by chains, it must be ascertained that the chains and winding drum work in winter, too.

Greasers:
It is important that the gate can be readily and safely greased, and that the person responsible for the functioning of the gate sees to the necessary greasing in accordance with the maintenance programme.

Test run:
If necessary, functioning of the machinery shall be ascertained with a test run.

3 ELECTRICAL DEVICES

The design and use of the electrical devices shall comply with the regulations for electrical safety.

Limit switches:
The machinery shall be fitted with reliable limit switches, which stop the movement at the extreme gate positions and in certain special circumstances.

Heating:
If it is necessary to use the gate also at sub–zero temperatures, the gate and its reveal shall be provided with a heating system. If the machinery and electrical devices require a warm room or operation centre these must be provided with effective heating facilities.

Information about the attitude of the gate:
The user of the gate must be reliably informed about the attitude of the gate.

Warning devices:
If unexpected opening of the gate endangers human life, people shall be warned about the opening with a siren or the like.

4 USE AND MAINTENANCE INSTRUCTIONS

Use and maintenance instructions shall be drawn up for the gate and stored in an appropriate manner.

5 EMERGENCY HOISTING SYSTEM

P and N dams:
In addition to the hoisting system proper, the

gate must have an emergency hoisting system with a hoisting time sufficiently short in relation to the time margin allowed by the dam. The time margin is the period during which malfunction or damage may result in a dangerous situation. For example, it may be the time during which water rises from HW to emergency HW. The emergency hoisting system shall be such that the gate can be opened even during a power failure.

APPENDIX 16. PRESENTATION OF THE FLOOD RESULTS OF A HAZARD RISK ASSESSMENT

The results of each flood case assessment, derived from either calculations or scale model tests, shall be presented on a map (1:20 000) and in tables listing water level and flow data at different stages of flood by cross–section.

Flood map

The map shall show:

- the path of the flood peak as a maximum water level contour
- the boundaries of the flooded area half an hour and one hour after the failure
- the locations and code numbers of the computed cross–sections
- the point of time of the maximum water level at each cross–section in hours from the failure.

A flood map can be compiled as an over–lay on a basic map using its contour element as a map base drawn on a transparent sheet. The overlay must be provided with register and position marks.

Tabulated flood data

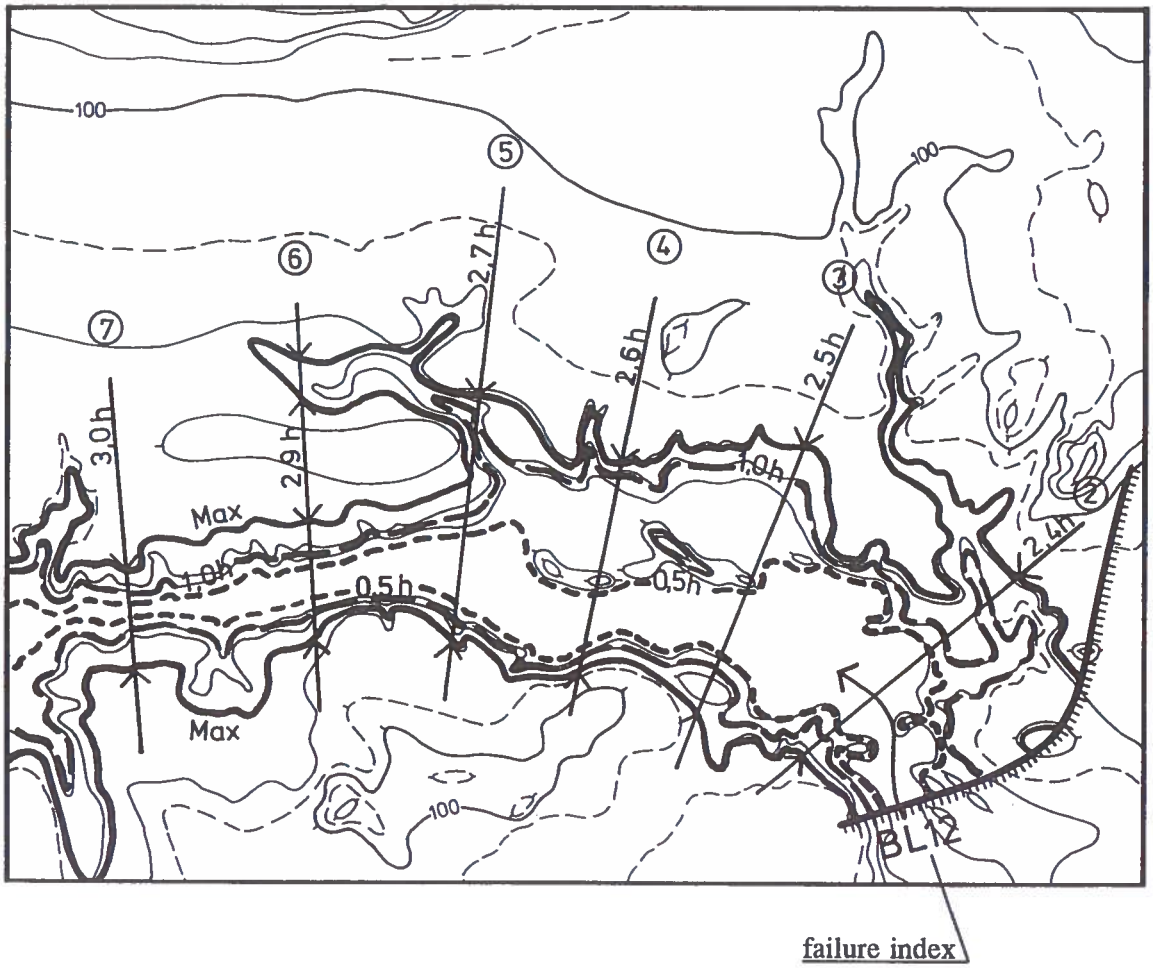
The flood data on the calculated cross–sections should be presented in tables as follows:

- water level (W), discharge (Q) and flow velocity (v) at each cross–section at differ–ent moments during the flood

- a summary table giving for each cross–section:
  - the initial discharge (m^3/s) before the onset of the flood
  - maximum discharge (m^3/s)
  - the moment at which the maximum discharge occurred in hours from the failure
  - the initial water level (+m) before the flood
  - maximum water level (+m)
  - the moment at which the maximum water level was reached in hours from the failure
  - the difference between the maximum water level and the initial water level
  - maximum flow velocities (m/s).

The flood data tabulated as above should be appended to the flood map so that the flood data on each cross–section are easily readable. If space allows, the flood data can be made more graphic by transferring some of them to the overlay.

Figure 1/16 gives an example of a flood–map overlay.



④ — code number of cross-section

2.6h — the moment at which the water reaches the maximum level in the cross-section in hours from the failure

Max / 1.0h — the highest water level contour due to the failure

0.5h, 0.5h, 1.0h — water level contours half an hour and one hour after the failure

Figure 1/16. A flood map of a hazard risk assessment.

APPENDIX 17. ASSESSMENT OF THE IMPACT OF A WASTE DAM FAILURE ON HEALTH AND THE ENVIRONMENT *)

1 GENERAL

Year in which basin filling started _____

Year in which filling was completed (if known) _____

Estimated maximum amount of waste in basin (m^3) _____

Mean increase in amount of liquid waste per year (m^3) _____

Recycling of process water (%) _____

Volume of basin (m^3) _____

Liquid waste as a proportion of waste basin volume (%) _____

Is the basin monitored for effluents _____

Substances (concentrations and quantities) in the water discharged from the basin (e.g. according to the latest annual report of the obligatory monitoring of effluents or seepage waters):

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

*) details in separate appendices if necessary

APPENDIX 17/2

2 WASTES IN THE BASIN

2.1 The impounded material contains the following substances harmful or dangerous to health and the environment:

Harmful or dangerous substances	Mode of formation e.g. process	Amount/ concentrations	Date of disposal/ mode of disposal	Substances as proportion (%) of total to be washed into the environment in a dam failure

The impounded substances endanger health and the environment because:

2.2 Any other substances in the waste basin:

2.3 Chemical and biological determinations on the impounded waste (to be made as the need arises if the health and environmental risks of the waste dam cannot be assessed otherwise)

1) pH value _____

2) electrical conductivity _____

3) total nitrogen content _____

4) total phosphorus content _____

5) chemical oxygen consumption (COD_{Cr}) _____

6) heavy metals _____

7) harmful organic substances or groups of substances _____

8) acute toxicity to water flea Daphnia magna EC50 (24 or 48 h) _____

3 AN ASSESSMENT OF THE DANGER CAUSED BY DAM FAILURE (if calculations or scale model tests have been made of the flood wave caused by failure of the waste dam, the results must be used in points 3 and 4)

3.1 A drawing on a basic map showing the area over which waste would spread in the event of a failure and the objects at risk in this area

3.2 The danger to human life, health, the environment or property caused by dam failure (if there are several possible failure paths, each of them should be treated separately)

_____

_____

_____

_____

_____

_____

_____

_____

3.3 Surface water areas, their catchments, groundwater areas, their areas of formation, surface water intake plants, groundwater intake plants, household wells or other objects at risk on the failure path (if there are several failure paths, each should be treated separately)

3.4 The impact of waste on the water body and environment in a dam failure (e.g. unpleasant smell, nonaesthetic forms, oxygen deficiency, fish deaths; if there are several failure paths, each should be treated separately)

4 PRELIMINARY ACTIONS AND PREVENTIVE MEASURES TO PROTECT OBJECTS AT RISK IN THE EVENT OF A FAILURE (the assessment may include 1) information about ditches, depressions in the terrain, etc., in which the waste can be stopped from spreading and collecting, 2) plans and materials for building temporary dams at suitable sites, or the closing of ditches with a dam to prevent the spread of waste, and 3) a protective embankment around the objects at risk)

5 OTHER ITEMS TO BE CONSIDERED

APPENDIX 18. A SITE PLAN FOR A P DAM AND PRECAUTIONS AGAINST ACCIDENTS

1 OUTLINE AND DRAFTING OF A SITE PLAN

A site plan is drawn up jointly by a fire authority and the dam owner or holder. Its general outline is as follows.

Components of the site plan (DO = dam owner or holder, FA = fire authority)

1) Description of hazard risk (DO)
- general description of dam and water body
- examination of hazard risk assessment

2) Information about the accident (DO and FA)

3) Measures applied to hydraulic structures and water body, and the repair of dam damages (DO)

4) Provision of personnel and equipment in the event of an accident
- those of the dam owner (DO)
- others (FA)

5) Materials needed in the event of an accident (DO)

6) Other precautionary countermeasures taken (DO and FA)

7) Account of the type and amount of the substance impounded by a waste dam and the hazard risk due to it (DO)

8) Rescue operations in the event of an accident (FA)

The following are appended to the site plan:

- a diagram showing the alarm connections (FA)
  - alert of authorities
  - alert of population
- personnel of the dam owner (DO)
- equipment resources (DO and FA)
- a map (1:20 000) of the dammed area and roads and of sites from which repair materials can be extracted (DO).

A site plan like this would contain the accounts and action plans referred to under section 4 of the Dam Safety Decree. The original is held by the fire authority and a copy is kept in the dam safety file. The fire authority is also provided with an operative map of the results of the hazard risk assessment (cf. chapter 7).

The procedures defined in the site plan may be carried out as illustrated in Fig. 1/18. The contents of the site plan are described in detail in the following.

2 DESCRIPTION OF THE HAZARD RISK

The dam owner or holder draws up a brief general description of the dam and the associated water body at the beginning of the site plan. The description should be restricted to those items that must be known in the event of an accident.

This part includes the dam owner`s general description of the significant results of the hazard risk assessment.

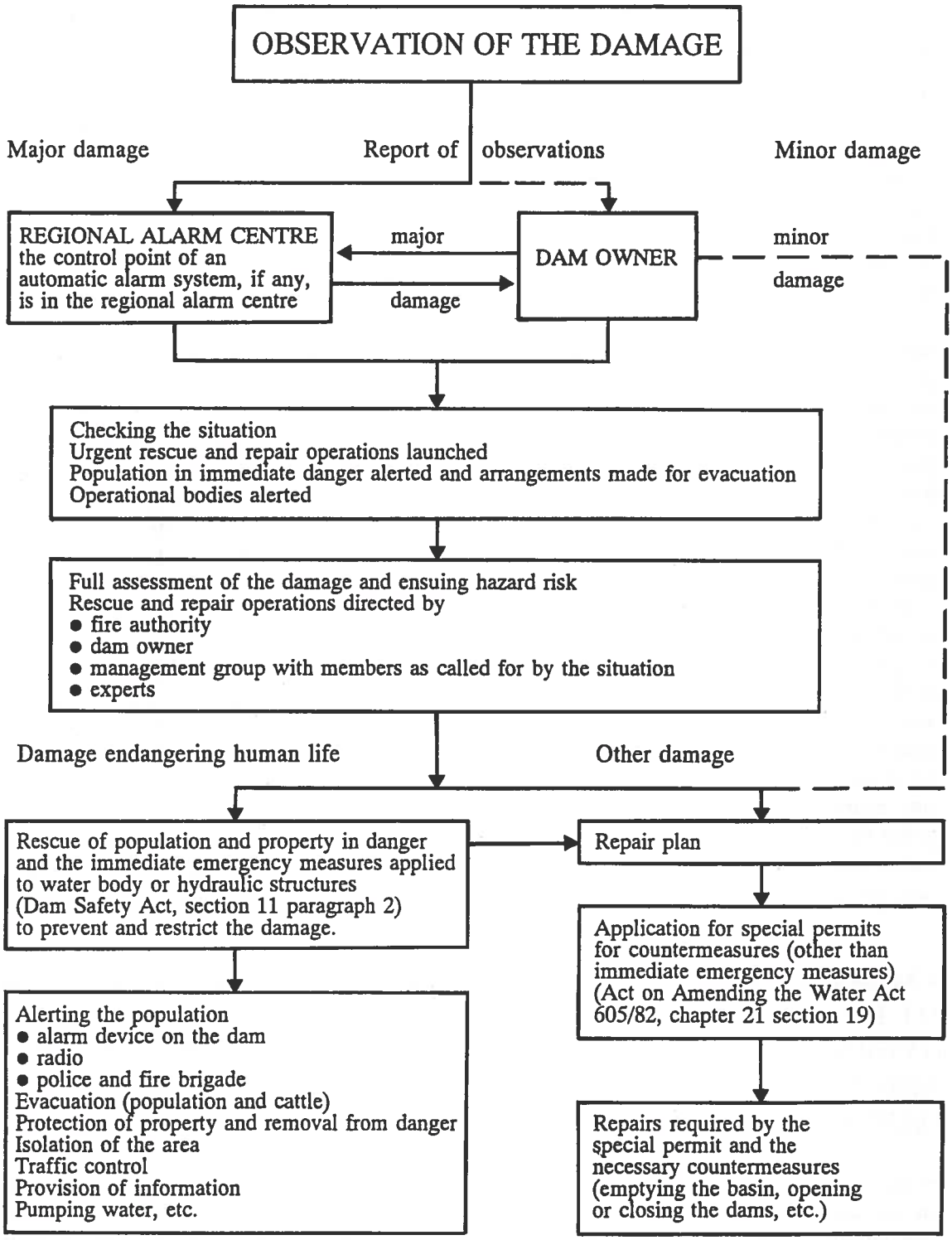


Figure 1/18. Action required by the site plan

3 HOW TO OBTAIN AND CHECK INFORMATION ABOUT THE ACCIDENT

Together with the fire authority the dam owner or holder shall ascertain how information about damage to a dam, an imminent risk of an accident or an accident can be expressed and how it will be conveyed to the fire authorities (regional alarm centre and fire brigades), to those responsible for water regulation (regional control centres and dam supervisors), the dam holder (responsible persons), water and environmental authorities (water and environment district and experts), the major users of the water and water body (downstream water intake plants and dams), and the road and traffic control authorities (endangered bridges, the Finnish National Road Administration and the police).

In this context an explanation is given of the information that should be solicited from the people reporting the event and how it should be checked. The information should be presented in an alarm diagram, which may be appended to the site plan (to facilitate updating of the data). The personnel responsible for dam maintenance shall be instructed about giving the alarm. In this respect the regional control centres, which are on round-the-clock duty, are in a key position.

4 MEASURES TO BE APPLIED TO THE WATER BODY AND HYDRAULIC STRUCTURES, AND THE REPAIR OF DAM DAMAGE

In the site plan the dam owner or holder shall set out the measures that, in the event of a dam failure or likely occurrence of one, can be taken forthwith to prevent or limit the damage that would otherwise result from the accident. Depending on the conditions, these measures include repair of the damaged dam or repair to prevent or slow down the spread of the damage, and adjustment of filling and discharge flow.

The site plan shall show whether water can be channelled elsewhere with emergency measures. Measures that change structures and the need for and consequences of them shall be listed. It must also be shown where and how emergency measures such as opening the dam, and closing or diverting a channel can be done, and who is authorized to undertake these measures (Dam Safety Act, section 11). The equipment and materials required by the emergency measures and the expertise to use them and the training of rescue personnel in advance must also be made clear.

It is imperative that the filling and discharge flow can be adjusted immediately the alarm is given. To this end, measures must be taken to ensure that those responsible for adjustments, such as a power plant, remote control centre (e.g. regional control centre) or the dam manager, can immediately be informed about the event by the regional alarm centre. The dam owner explains in advance how adjustments are made, and in his plan lists the adjustments to be made and the consequences to the water body of using different adjustments from those in the permit. It shall also be shown which of the downstream water body regulating bodies shall be informed simultaneously about the accident and the adjustment measures they should take.

The dam owner shall also give preliminary instructions in the site plan about repairs to the dam. Dam damage can be temporarily repaired by:

- closing the breach part with blasted rock, sandbags or other heavy objects and materials transported to the site, or with materials taken from the dam crest close to

the breach protecting the breach part withgeotextiles or other fabrics preventing displacement of the materials piled up on top of it
- sealing the breach part by spreading tarpaulins and plastic sheeting over the wet slope of the dam
- closing the gates with stoplogs, needles, plates, etc., and
- reinforcing concrete or earth structures with toe weights and shoulders.

The initial repairs applied to a damaged dam may be urgent. In some cases the necessary speed can be achieved only with the aid of the fire authorities and their equipment. Therefore, the availability of appropriate equipment shall be taken into account in the site plan, and the fire brigade should be sufficiently instructed in emergency dam repair measures.

5 PERSONNEL AND EQUIPMENT NEEDED IN THE EVENT OF AN ACCIDENT

The dam owner or holder shall provide information about the personnel he has available, such as their number, their occupations and their work sites. The data on those responsible for the dam shall include their name, field of expertise, home address and alarm connections. To facilitate updating of the plan particulars likely to change should be given in appendices.

The dam owner or holder shall also ascertain what machinery, e.g. excavators, bulldozers, wheel loaders, chassis, dump lorries, mobile cranes, and grouting equipment and materials, are required by the repairs in the preliminary instructions and what machinery he himself has. A records of the above machinery owned by outsiders is kept and updated by the fire authority with the assistance of the dam owner. To ease the updating, changing data should be given in an appendix.

6 MATERIALS NEEDED IN THE EVENT OF AN ACCIDENT

The dam owner of holder shall see to it that blasted rock or natural boulders to be used in repair are stored or otherwise available near the dam. The blasted rock storage or the boulder extraction site shall be so located that repairs can be started at any place on the dam crest within an hour from the beginning of loading.

The total volume of the blasted rock or boulders shall be $\geq 3\ H^3$ (m^3), where H stands for the maximum height of the dam in metres. However, no more than 2 000 bulk m^3 need be reserved for the dams of one basin. The average size of the blasted rock shall be at least 0.1 m^3 and that of the natural boulders at least 0.2 m^3, with the maximum sizes of both not exceeding 1 m^3, which is the size of a boulder that can be handled by a 10–t wheel loader.

If materials suitable for sealing (e.g. glacial till) are not available within the above transport distance from the dam, they, too, shall be stored in amounts corresponding to those of blasted rock. Information about the availability of gravel and sand shall be included in the site plan.

The site plan shall include a map of materials intended for accident prevention showing the extraction sites for blasted rock and glacial till. The map shall also show the roads and ascents along which the materials can be transported to the dam. In addition, the availability of other materials needed for repairs, such as geotextiles must also be established.

7 OTHER COUNTERMEASURES IN THE EVENT OF A DAM BREACH

If there are people living so close to the dam in a potential downstream hazard area that the alarm given by the fire and rescue services could not possibly reach them in time, the area at particularly high risk shall be provided with a system capable of sounding the alarm in time. The normative time limit for an area at particularly high risk is two hours from dam failure. The need for such a system shall be ascertained by the fire authority, and the conclusion given in the site plan. Under the Fire and Rescue Services Act, the fire authority can order the necessary equipment to be acquired.

If for some other reason it is unnecessary to establish an alarm system in the area in question (see the Ministry of the Interior directive of 30.4.1979 on local alarm systems, Publication of the Rescue Department, MI 5/1979), the dam owner must set up an alarm system. The alarm devices of the system must be such that, if necessary, they can be activated from the dam, an appropriate remote control centre and the regional alarm reception centre. Use can be made of the above Ministry of the Interior directive on local alarm systems when planning the alarm system. The function of the special alarm system shall be set out in the site plan.

8 AN ACCOUNT OF THE TYPE AND QUANTITY OF SUBSTANCE IMPOUNDED BY A WASTE DAM AND THE HAZARD RISK IT PRESENTS

The dam owner or holder shall assess the health and environmental effects of a waste dam failure and the measures needed to combat the danger. The items to be dealt with areshown in the model form in Appendix 17, which, when completed, can be used as the required assessment (cf. 7.14)

9 RESCUE OPERATIONS IN AN ACCIDENT

The fire authority draws up for the site plan his account of the rescue operations to be undertaken in an accident caused by a P dam. The account deals with the supplementary and special arrangements which the rescue operations may entail in a dam accident.

The special arrangements, to which reference shall be made in the basic plan of the rescue service at local authority level and, if necessary, also at cooperation area level, may be needed for:

- defining the duties of the authorities and bodies participating in the rescue service
- intermunicipal cooperation and assistance
- command in the event of an accident
- communications
- nursing and environmental health care
- service activities (meals, temporary accommodation, materials service, acquisition of service materials)
- alerting the population (warning, directing the move from the danger area and evacuation)
- providing information in an accident.

The above plans are drawn up in accordance with instructions from the Ministry of the Interior. The planning is based on the hazard risk assessments of a P dam or several successive P dams, which define the worst possible accident situation.

APPENDIX 19. SUMMARY OF DAM SAFETY MEASURES

DESIGN
- under the direction and responsibility of the chief designer
- determination of dam class
- hydrological specifications
- hazard risk assessment if necessary
- structural design

CONSTRUCTION
- the water and environment district is informed about the date construction began
- good construction practice and quality control

COMMISSIONING INSPECTION
- starts with notification to the water and environment district that construction has begun
- all items affecting dam safety are assessed
- at least one field inspection before starting to raise the water or other impounded materials
- final statement and proposal for dam qualification

SAFETY MONITORING PROGRAMME
- proposal in three copies to the water and environment district, for a P dam 3 months and for other dams 2 months before the dam is taken into use
- monitoring proper
- annual and regular inspections
- the National Board of Waters and the Environment approves the programme for P dams, and the water and environment district those for N, O and T dams

DAM SAFETY FILE
- three copies of it are sent together with the monitoring programme to the water and environment district
- missing items are added at completion of the commissioning inspection
- the file is kept up–to–date by supplementing it at regular inspections and in special cases

PREVENTION OF AND PRECAUTIONS AGAINST A DAM ACCIDENT

A P dam (before starting to raise the water or other impounded substance):
- hazard risk assessment (dam owner or holder)
- other accounts and action plans as stated in the Dam Safety Act, section 9 and the Dam Safety Decree, section 4 (dam owner or holder)
- site plan (the fire authority and dam owner or holder)

APPENDIX 20. TERMS WITH EXPLANATIONS

DOCUMENTS

Completion documents	Needed in dam maintenance and for assessing the dam qualification, the completion documents of a dam listed in Appendix 3 are the key design and construction documents.
Safety file Dam Safety Act (DSA) section 5 and Dam Safety Decree (DSD) section 2	The dam safety file is a collection of documents which should contain all the material significant for dam safety defined in section 2 of the DSD.
Safety monitoring programme, DSA sections 6–7	The dam safety monitoring programme states how all issues pertinent to dam safety should be monitored and regularly inspected. The National Board of Waters and the Environment (NBWE) may give more detailed instructions about compiling the monitoring programme.
Hazard risk assessment DSA, section 9 paragraphs 1 and 3	The hazard risk assessment is an estimate of the hazard risk that the dam may pose in an accident, particularly to the people and property in the downstream area. The NBWE may, if the need arises, order the body who has had the dam constructed or the dam owner or holder to acquire or draw up a hazard risk assessment. Further instructions concerning the assessment may be issued by the NBWE, if necessary.
Results of the hazard risk assessment, DSA section 9 paragraph 1	The results of the hazard risk assessment, which summarize the damage, its extent and timetable, are the basis for the site plan drawn up by the fire authority. The results shall be sent by the body which has had the dam constructed or the dam owner or holder, who has acquired the assessment, to the NBWE and the water and environment district, provincial government, regional fire commander and the municipal fire authority.
The dam owner`s accounts and action plans in the event of an accident, DSA section 9 paragraph 2 and DSD section 4	The accounts and plans of the dam owner as listed under section 4 of the DSA form the basis of the fire authority's site plan

Coordination plan (of the fire and rescue service), Fire and Rescue Service Act section 7, Fire and Rescue Service Decree section 6 and DSA section 9 paragraph 2	In a municipality the fire chief shall draw up a comprehensive operational plan which includes the general principles for operations in different accidents and basic information about the objects at special risk. The provincial government, in cooperation with the municipal authorities, shall draft a plan for assistance and other cooperation within the cooperation area including the capability of other authorities, bodies and private citizens to participate in the fire-fighting and rescue operations. The dams referred to in the DSA section 9 paragraph 2 are taken into account as hazard objects in the coordination plans of the local authorities and cooperation areas.
Site plan, Fire and Rescue Service Decree section 6 and DSA section 9 paragraph 2	A site plan is drawn up as part of th coordination plan under the direction of the fire authority for the dam hazard referred to under section 9 paragraph 2 of the DSA, on the basis of the accounts and plans of the dam owner stated under section 9 of the DSA and section 4 of the DSD.

HYDROLOGICAL TERMS

High water level, HW	High water level is the maximum water level during a certain period. As a rule, it is the HW during 24 h (either the daily average or that recorded once a day). In addition to the water level data, the period should also be given during which the data were collected and on which the water level value is based, e.g. 87.50 m (1960–1980).
Low water level, NW	Low water level is the minimum water level during a certain period. In general it refers to the NW recorded during 24 h. In addition to the water level data, the period should also be given during which the date were collected and on which the water level value is based, e.g. 86.50 m (1960–1980).
Emergency high water level, emergency HW	Emergency high water level is the water level which, when exceeded, may cause changes in dam structures.
Technical low water level, tech. NW	Technical low water level is the lowest possible water level structurally allowed by spillways, syphons or natural sills.

Maximum discharge, HQ

Maximum discharge is the highest discharge during a given period. As a rule, it refers to the discharge during 24 h, but e.g. HQ (5 d) is the highest value of the mean discharge of five consecutive days. In addition to the discharge data the period should also be given during which the data were collected and on which the maximum discharge value is based, e.g. 150 m^3/s (1960–1980). If the part of the water body under consideration is a lake or other basin smoothing the flow peaks, the terms HQ (inflow) and HQ (outflow) are used with reference to the maximum discharge entering or leaving the basin, respectively.

Hydrograph

The hydrograph is a time curve of the discharge or the water level, i.e. a curve that illustrates the discharge or the water level on consecutive days, usually during flood peaks.

Return period, frequency, 1/Tr

Return period is a statistical term and means the period during which a given HQ value is exceeded once on average. For example "HQ (1/1000) is 200 m^3/s" means that a maximum discharge with a rate of at least 200 m^3/s will occur on an average once in 1000 years.

Design flood

Design flood is an inflow hydrograph corresponding to the return period chosen on the basis of the dam properties and safety classification, i.e. the time curve of the inflow.

Design high water level

Design high water level is the maximum water level that occurs during the design flood, when the total discharge capacity of the dam is in use, excluding the flow through the power plant machinery.

Design outflow

Design outflow is the hydrograph of the dam outflow calculated from the design flood, the storage volume of the basin and the discharge capacity of spillways, with the initial water level value determined by the mode of use of the dam.

STRUCTURAL TERMS

Height of dam, DSD Section 1

The height of a dam is the difference in height between the lowest point on the external dam boundary and the

highest design level of the impounded substance. The height of a submerged dam is calculated as the difference in height between the lowest point on the external boundary and the dam crest.

Submerged dam — A submerged dam is a dam with water flowing over its crest.

Waste dam — A waste dam is a dam impounding wastes.

Freeboard — Freeboard is the height difference between the highest design level of the impounded substance and the dam crest.

Safety margin — The safety margin of a dam is the height difference between the top of the core and the HW level.

DAM CLASSIFICATION TERMS

P dam — Dams that may manifestly endanger human life or health or manifestly seriously endanger the environment or property are classified as P dams. They may be less than three metres high.

N dam — Dams that are not particularly dangerous as P dams and which cannot be considered as only marginally dangerous as O dams are classified as N dams.

O dam — Dams that pose only a minor hazard risk are classified as O dams. A dam is considered as marginally dangerous if, in the event of damage, it cannot manifestly endanger human life or health or, minor damage excluded, the environment or the property of another party.

T dam — Cofferdams subject to the provisions of the DSA are classified as T dams.

SAFETY MONITORING TERMS

Commissioning inspection — The commissioning inspection examines the qualification of a dam in terms of dam safety. The inspection may be undertaken in several steps.

Regular inspection

Regular inspections are made of the P, N and O dams subject to the provisions of the DSA at least once every five years. Changes in the state of the dam, and changes in conditions affecting the stability of the dam are then examined on the basis of monitoring, field inspections and completion data. Regular inspections also assess the functionality of the action plans of the dam owner (DSA section 9 paragraph 2).

Annual inspection

Annual inspections are made of dams subject to the provisions of the DSA once a year. It is then checked that there have been no changes to the state or functioning of the structures and facilities.

Monitoring

Monitoring is the continuous surveillance of the dam at regular intervals.

Approval of the dam safety monitoring programme, DSA section 7 and DSD section 3

The National Board of Waters and the Environment approves the monitoring programme of P dams, and the water and environment district that of N, O and T dams. The monitoring programme is sent to the water and environment district not later than two months before the dam is taken into use. The monitoring programme of P dams, however, is sent not later than 3 months.

MISCELLANEOUS

Dam accident, DSA section 3 paragraph 1, DSA section 9 paragraph 2

A dam accident is an event in which the dam or auxiliary facilities are damaged or subject to failure to such an extent that the impounded substance is discharged or liable to be immediately discharged.

Dam terms and definitions are dealt with in greater detail in the Glossary of Technical Dam Terms published by Suurpadot – Suomen osasto ry (Helsinki 1983) and in the relevant literature.

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