



ICOLD EUROPEAN CLUB

Working Group on Public Safety at Dams

FINAL REPORT

Coordinator: U.Norstedt (Sweden)

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Group photo from the Workshop hosted by EdF in Chambéry in January 2010

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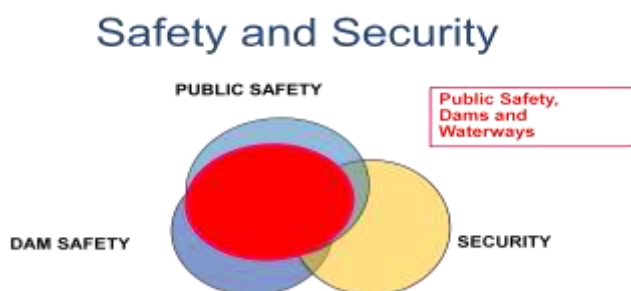
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Introduction

Safety of the public engaged in various waterways activities at dam sites and in the areas potentially affected by the operation of dams is of increasing concern in many countries. One reason for these concerns is the fact that the number of injuries and fatalities caused by these activities exceeds in many countries the similar outcomes caused by dam failures.

There are obvious links between Dam Safety and Public Safety but there are also significant differences. Safety for the public is of course one of the main reasons to keep the dam safe and to prevent dam failures but there are also other hazards to the public which are not related directly to structural dam safety. Like what is illustrated in the figure below, dam safety, security, public safety in a broader context and public safety around dams and waterways are all linked and integrated.



With this background the European Club of ICOLD decided to form a working group on the subject, EWG on Public Safety with the aim to learn from each other, to foster cooperation and experience exchange in between member countries and individuals about safety for the public being in the vicinity of our dam and waterways and to compare different legal and management concepts.

This report from the working group is focusing on those hazards and the mitigating methods associated with protecting the public and addresses questions linked to safety of the public being around dams.

Public Safety is here defined as the safety consequences on the public (excluding dam failures) from the existence and operation of dams and dykes including changes of the water regime. The areas considered include areas upstream, intakes, dams, spillways and areas downstream effected normal operation.

The WG has met in conjunction with European seminar, ICOLD annual meetings and two workshops, one in Stockholm 2008 and one in Chambéry 2010. An inventory has been made by means of a questionnaire sent to all ICOLD European Club member committees.

The WG members have been Austria, France, Germany, Norway, Portugal, Sweden (coordinator) and UK. Representatives from Greece, Italy, Spain and OPG Canada have contributed by active participating in the Chambery workshop. In a later stage Finland and Slovenia have contributed with valuable information.

Appointed representatives from the National Committees have been:

Austria:	Pius Oberhuber
France:	Alain Petitjean
Germany:	Peter Rutschmann
Norway:	Bjørn Honningsvåg
Portugal:	Eduardo Ribeiro da Silva
Sweden:	Urban Norstedt
UK:	Andy Hughes

The Working Group has been co-ordinated by the Swedish representative Urban Norstedt, who also compiled this report.

1. The Hazards & Risks

Potential risks associated with dams and hydro facilities, such as sudden opening of spillways and bottom outlets also in sunny days, are often not obvious and unexpected and therefore underestimated by the public. This calls for special information to the public.

The main public safety hazards linked to the existence and operation of dams can be described as:

Structural and operational condition:

- Sudden changes of water level due to power plant operation
- Opening of weirs, especially in cases where the downstream river section is attractive for recreation and leisure activities
- Operation of dam outlets, especially in cases where downstream river sections are utilized for activities like fishing, canoeing, ice climbing, etc.
- Intake structures for rivers/brooks, which are equipped with sand traps and a system for (automatic) flushing.
- Open channels with steep slopes and/or high velocity flow.

Hazardous activities:

- Fishing, sport activities and the risk of falling into the water upstream and in the head pond including stretch of water immediately upstream of dam spillway and generating facilities with high velocity and turbulent flow.
- Jumping or falling from dam
- Fishing, swimming and boating in the tailrace and spillway area downstream of dam and power facility, with high velocity and turbulent flow, and areas further downstream affected by water level and flow changes due to dam operation.

2. Case Histories

Stornorrfors, Ume river, Sweden



Pictures showing the area the Sornorrfors dam and the dam and spillway from downstream.

Over the years about 10 people have lost their lives in the spillway area downstream of Stornorrfors hydropower plant, a several kilometer long old riverbed. A minimum release of water, stipulated in the permit, is creating a very attractive area for recreation like swimming, fishing and sometimes canoeing. The area is well equipped with warning equipment like signs (about 200), fences and sirens.

In early 2007 it was an unexpected release of water to this old river bad due to a sudden stop in the powerstation. This is a very unusual situation in wintertime. A person living downstream was aware that a group of snowmobilers had passed over an ice road and may not be able to hear the sirens. So he placed himself on an island in the river to be able to warn the group should they return at the arrival of the water. The water arrived, broke the ice that stuck up the water then surrounding the island. He was trapped there for six hours when the rescue people were able to lift him out with helicopter. This event was investigated in co-operation with other stakeholders, resulting in the following recommendation and action plan:

- Public Safety will be an integrated part of the Hydro Power Dam Safety and Safety Management System
- Review of operating procedures.
- Investigate the real need of “patrolling”
- Communication Guides
- Installation of more:
 - Audible and visible alerts/alarms
 - Buoys
 - Fencing
 - Signs
 - TV –monitors

Although this event did not trigger the public safety efforts in Sweden it certainly emphasised the need of further actions.

In **Norway** a tragic fatal accident occurred in 1989 when two boys fell into the water close to the hydro power station intake. Some years later another fatal accident occurred with two victims from the operation personnel. All this accentuated the need of actions towards a comprehensive and systematic work on public safety in the country.

In **France** the Drac river accident downstream of the Notre-Dame-de Commiers dam, 1995, became an important driver for public safety development in EdF.



Significant improvements in public safety have been made following an accident that occurred on the Drac River, on December 4th, 1995. A sudden rise of water level downstream from the Notre-Dame-de-Commiers dam in the French Alps caused the drowning of six children and an accompanying adult during their hike along the river. The regulator and EDF realized the need to assess the risks generated by normal operations of hydro facilities and that appropriate control measures had to be taken. As a result several ministerial circulars were written to improve public safety relative to hydro facilities:

- Circulars dated November 29th, 1996 and July 13th, 1999 aim at identifying the situations and sites at risk and the actions that will improve public safety (hydropower plants operation, public information, river access limitation, etc.);
- Circular dated July 24th, 2006, requires the declaration to the control authority of significant incidents related to dam safety and public safety.

In EdF safety policy it has been made clear that hydraulic safety is an absolute priority and, if necessary, must prevail over electricity generation. The company is committed to manage the following risks: risk of catastrophic failure, risk relative to operation during floods, and risk relative to normal operations (public safety management).

Hydraulic safety is managed according to ISO 9001 standards. It is based on a strong involvement of managers and a clear organization at the Corporate and regional levels. A set of standards defines requirements regarding hydraulic safety. Safety is controlled by EDF national, regional and local management; as well EDF has established a Hydro Safety Inspector who is independent of EDF Hydro to provide oversight of the entire program. Development of the “safety culture” of employees, combined with the raising of awareness amongst water stakeholders are other major commitments included in the safety policy of the company.

During preparation of this report the committee was informed about a serious public safety accident in *Slovenia*. The accident with 13 casualties occurred in 2008 in the Sava River on the construction site of run-of-the-river HPPs in southeastern Slovenia. It happened when a group of people in two large canoes decided to run over a dam under construction near Sevnica, a town some 90 kilometers southeast of the capital of Ljubljana. At relatively low (summer) river discharge, they crossed the opened spillways, mostly without life jackets or other devices, and were trapped in the stilling basins.

3. Legal framework and responsibility

In *Austria* construction and operation of hydro power plants are regulated, among others, by the Austrian Water Law. This law stipulates that public interests and rights of third parties must not be violated by the construction and operation of the plants. Furthermore, the plants have to meet the current state of the art and if they don't, they have to be adjusted accordingly.

In *Finland* the legal concept of Everyman's right gives everyone to access to private land and enjoy outdoor activities in the nature. There are only few restrictions. The person has a right to have short time camping on private land. Everyman's right does not cover the immediate vicinity of people's homes and yards. Usually camping is not prohibited on public beaches.

The Water Act 264/1961, Chapter 1, Section 24 states "Anyone shall have a right, while not causing undue disturbance, to use a water body of passage wherever it is open. ... Anyone who uses a water body for passage shall also be permitted to use another person's water area for temporary moorage if this does not cause any major harm of disturbance to said person".

The operation of the hydropower plants including spillways and the structures with high difference in altitude produces a high hazard and a risk to person, who can enter vicinity of the hydropower plant based on Everyman's right. The paper describes only the measures of normal operation.

Originally Finnish Dams Safety Act (1.6.1984/413) and Finnish Dam Safety Decree (27.7.1984/574) came into force on August 1, 1984. The dam safety practices were described in "Dam Safety Code of Practice", Publications of the Ministry of Agriculture and Forestry 7b/1997.

Dam Safety Act (494/2009) was updated in 2009 and Ministry of Agriculture and Forestry, Finland gave Government Decree on Dam Safety (319/2010) in 2010. Many of the good dam safety practices were transferred into the dam safety legislation. Also Dam Safety Code of Practice was updated, but its status is the guideline.

Dam Safety Act and Government Decree take into account the hazard and risk to third person (public safety). The dam owner's responsibility to third person is described in following Clauses:

- "A dam shall be operated in such a way that it causes no danger to human life and health. Sufficient safety arrangements shall be in place for class 1 and 2 dams to ensure the safety of the operation of the dam. Further provisions on the safety arrangements are issued by Government Decree". Dam Safety Act (494/2009). Chapter 4 - Maintenance, operation and monitoring of a dam. Section 16 Operation of Dam.

In *France* the safety of hydropower plants is governed by decrees (« circulaires ») of July 13th, 1999 which asks the owners to identify the situations and sites at risk and to define the actions that will improve public safety (operation of hydropower plants, public information, river access limitation). The decree of July 24th, 2006 seeks the declaration of incidents which have an impact on public safety to the control authority and their quotation.

This legal framework has been completed by the decree of December 11th, 2007. This decree defines a classification of dams and dykes in four categories according to their height and volume, and new documents must be submitted to the control authority and updates every ten years (Risk assessment and Periodic Safety Review).

In *Germany*, the owners of the reservoirs / power stations etc. are responsible for all measures. There are no legislative rules besides the German standard DIN. DIN 19700 gives some general remarks on safety issues. Additionally the “German DWA Rules and Standards” specify these general standards of DIN.

In *Italy* the dam safety is regulated by means of two laws dated 1959 and 1982 (D.P.R. 1363/59 and D.M. 24 march 1982). These laws cover the sequent issues:

- Design, construction and testing (for new dams or renewal);
- Operating, monitoring and maintenance (for existing dams).

For existing dams, the main instrument used to assure dam safety is the F.C.E.M. (Foglio Condizioni Esercizio e Manutenzione - translated “Document of Conditions for Operating and Maintenance”). More recently the F.C.E.M. has been completed with issues regarding public safety (treated below). The main changes consists in adding to the document the plans of the areas downstream of the dam with the graphic indication of the sites that could be flooded in case of volunteer discharge from the outlets, with the level in the reservoir equal to the maximum for operating, and in case of collapse of the dam. There are also drawn the positions of the warning signs.

In *Norway* the public safety is touched upon in “Regulations governing the safety and supervision of watercourse structures”. This regulation is pointing out that the entity responsible for the watercourse structure has to conduct risk analyses and to establish and maintain safety measures that take into account the general public’s normal use and on and near the watercourse structures.

In **Portugal** the safety of dams is governed by the "Portuguese Regulations for Safety of Dams"(RSB), issued by the Decree-law nº 344/2007. These regulations were first published in 1990 and then reviewed in 2007.

RSB does not specifically incorporate provisions on public safety, whilst it establishes that the dam owner has to develop operating rules and emergency planning.

However, RSB also determines that a number of standards have to be published, in support of RSB application. Amongst them, a new Dam Operation Standard is presently being drafted, and this will include public safety issues.

In **Sweden** like in Finland the legal concept of Everyman's right is important. The Environmental Code and the Prevention of Accidents Act provide the legal framework for a dam owner's legal social responsibility towards the general public. Some permits have been issued containing specific requirements intended to protect the general public, such as warning signs and the need to issue audible or visual signals when discharges occur.

In the **UK** reservoir safety is 'regulated' currently by the Reservoirs Act 1975. This Act is being amended to 'strengthen' its requirements, and these amendments are currently in the House of Lords for consideration. This Act has no provisions within it associated with Public Safety although it is clear that, under common law, owners have some responsibilities to protect the public.

In general the approach to public safety responsibility differs between the countries. In all countries the dam safety regulations stipulate that the dam owner/operators are fully responsible for consequences in case of a dam failure. Some countries have the same approach to public safety accidents, while others are considering this responsibility as shared between owner/operator and people visiting the area. Owners are responsible for risk management and risk mitigation by appropriate structural and operational adjustment, information, warning and appropriate barriers. People in the public are responsible to take warnings and respect barriers.

4. Current Practice

Current practices around Europe vary significantly. While France and Norway have taken a lead in the development, others are under development and while others have just been aware of the need of a risk based and systematic approach.

While public safety has always been a part of a dam owners program, it has generally been dealt with on an ad hoc basis with each dam site and hydropower facility addressed separately. More recently, an integrated approach has been developed by various organizations that bases a safety program on assessing the site specific risks against a common set of criteria from which control measures can be consistently established. This change in approach has been brought about due to an increase in tourist activities, a higher expectation by society for organizations and regulators to protect their safety, as well as in response to a number of very serious safety accidents which have resulted in fatalities associated with dams and hydropower installations.

Incidents and most importantly accidents seem to have been the main trigger and driver for regulations and more systematic analyses and practices. An inventory was made with a questionnaire sent to the European Club members. Seven countries responded. The answers are summarized in attachment 1. The result of this inventory indicates on a general level:

- All have identified Public Safety as an important issue for the future
- Most countries have law or governing legislation and guidelines supporting the owners.
- Some are requiring internal control. The responsibility is often, but not always, clearly defined. Legal requirements about information to the public and incident reporting are unusual.
- The dam owners working procedures mostly have clear defined responsibility delegations, while quality system, interaction with external group, feedback and incident reporting is under development.
- The risk assessment includes upstream as well as downstream consequences. Introduction of Public Safety in general safety management system, systematic identification of hazards potential and establishing prioritization criteria's is under development. Formal processes for decision-making are unusual.
- Answers regarding mitigation measures indicates that warning signs at potential risk areas, and also physical barriers are commonplace, while access to the dams as such are not restricted by such barriers. The communication to the public differs a lot.

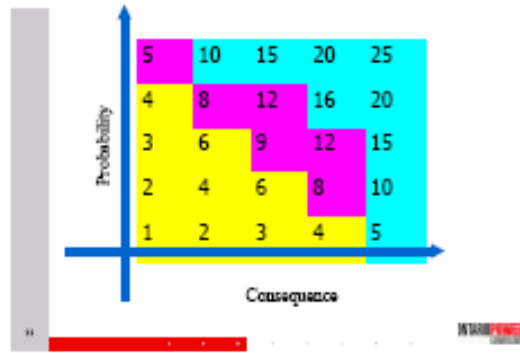
5. Risk Assessment Methods

The working group has been informed about risk assessments methodologies implemented in France and Canada (OPG was invited to participate in the workshops)

The risk assessment method developed by EDF takes into account several parameters depending on the site (downstream, upstream, channel): river morphology, gradient of water elevation, occurrence of water discharge and its detectability, stakeholder's characteristics and water uses. The result consists of a mark for the site ranging from 1 (very low risk) to 5 (very high risk). They have established a **"GOOD"** methodology taking the **G**ravity (seriousness of consequences), **O**ccurrence of water discharge, **O**ccurrence of public attendance and **D**electability into account.

EdF has been very successful in their public safety risk reduction.

OPG | Canada has developed a similar methodology for public safety risk management. Below is shown a criticality and priority matrix.



All organization has one way or another for analyzing, assessing and managing their public safety risks and some are developing more systematic methodologies. Vattenfall in Sweden is basing its development on the experiences from France and Canada.

6. Mitigation Measures

Mitigation measures comprise relevant structural and operational adjustments, access barriers and warning systems as well as education of operational personnel and information to the public for better understanding the hazards involved and avoiding dangerous behavior.

Warning systems.

Signage

Different kinds of signage are used in different European countries.



Examples of signage types from UK, Norway Sweden and France

Sirens

Sirens are used to alert people before spillway operation.

Acciona Energia in Spain is sharing the following ideas about different types of sirens.

Both types (pneumatic and electronic) have substantial advantages and disadvantages.

- Pneumatic siren are easy to maintain and cheaper but it needs an air compressor.
- Electronic siren makes it possible to make silence tests and the signal can be changed. As it doesn't need the air compressor the space required is small. On the other hand, this siren is more expensive.

Barriers

Different kinds of barriers are used to restrict the access to dangerous areas.

Fences

Fences of different kind are used. Two examples from Norway are shown below.



Examples of fences in Norway

Booms

Different kinds of booms are used to restrict access to dangerous areas from the water. They are often equipped with warning texts and can also serve as rescue equipment for people falling into the water. In that case it could be advantageous to place the boom diagonally over a canal to help people to reach the firm ground. Below some examples from Canadian booms are shown.



Canadian examples of access barriers by booms.

Communication/Education/Information Systems.

The general public has a tendency to underestimate the hazard and risks linked to activities around dams and waterways. They are for instance often not taking into account possible

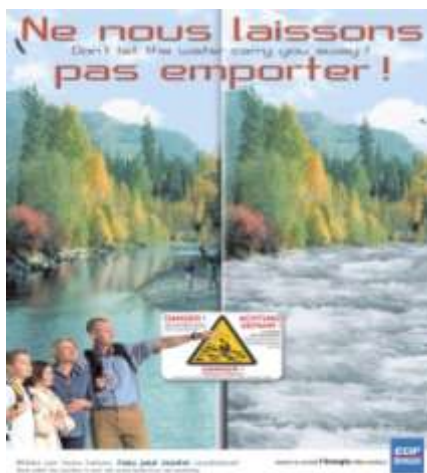
sudden changes in water flow and rising of water level. Some are notorious risk takers, while most people would take precaution if informed and warned about the risks not taking. Below are shown two examples of situations, one from Sweden and one from France, where the people swimming and fishing may not be fully aware of possible release of water from upstream.



Pictures of people on picnic and fishing downstream dams in Sweden and France

With this background it is very important for the dam owners and operators to take initiatives to inform and warn the public, thus raising the general awareness of the hazards associated with dams and dam operation and informing about the location of unique hazards associated with specific individual sites. That should be done targeting the subject in general and also with specific site-specific information to local actors and visitors.

Information activities are taking place in some countries. In France for instance a lot has been done in this field. EdF have engaged 160 “hydroguides” in summers distributing some 200.000 leaflets. They also arrange some 500 conferences in local schools.



Public education materials illustrate how river conditions can change dramatically as a result of dam and hydropower operations.

Also in Norway and Sweden pamphlets for general information and education on public safety around dams are published. A Norwegian pamphlet which also includes comprehensive description on regulation and practical guidance supporting the dam owners is shown below.



A Norwegian pamphlet explaining hazards and safety measures.

7. Conclusions

There are obvious links between Dam Safety and Public Safety but there are also significant differences. Safety for the public is of course one of the main reasons to keep the dam safe and to prevent dam failures but there are also other hazards to the public which are not related directly to structural dam safety.

As indicated in the Introduction chapter, safety of the public around dams and water ways is of increasing concern in many countries. France and Norway are in the forefront when it comes to creating a more systematic work in this field. Some countries are not too far behind while others have just realized the need of such approach. This issue needs further attention in Europe.

The working group's general findings could be summarised as:

- Growing interest in Europe
 - 9 countries in Chambery
- Different legal and regulatory systems
 - Mostly a dam owner responsibility, but often regarded as shared with visitor.
- Links and differences in between Public Safety/Dam Safety/Security/Workers Safety
- Different development in Europe
 - France and Norway have leading positions in a systematic approach and progress
 - Other countries in different stage in the development process
 - Some are just about to start the process
- Incident and accident driven development.
- Systematic Risk Management important
 - Public Safety Management can be an integrated part in a company's general Safety Management System
 - Analyze the risks and prioritize action
 - Event investigations and statistics are important
 - Education and communication is very important
- How safe is safe enough depends and is so far impossible to answer

One of the outcomes of the Working Group has resulted in ICOLD creating a new Technical Committee to address this important subject of Public Safety around Dams. European countries are well represented in that committee and they are supposed to take a lead in further European development. All European National Committees are recommended to follow the work of this new committee.

Appendix 1-Questionnaire Public Safety in Europe

This questionnaire was sent to ICOLD European national committees and responds was received from 7 countries.

	Yes	No
General		
1. IIs Public Safety around Dams and Waterways so far at all handled as a special issue in your country/company?	6	1
2. Has this been identified as an important issue for the future?	7	

Comments:

Austria *Public safety is governed by general law, but is not a special issue.*

France *Many of the French hydropower plants and dams are operated on rivers also used for fishing, canoeing, and other recreational activities. That is why public safety is a big stake for public authorities and hydro operators.*

Strong improvements of public safety have been made after the accident that occurred on the Drac river, on December 4th, 1995. A sudden rise of water level caused the rowning of six children and an accompanying adult during their stroll along the river.

Germany *In Germany, the owners of the reservoirs / power stations etc. are responsible for all measures. To my knowledge, there are no legislative rules besides the German standard DIN.*

DIN 19700 gives some general remarks on safety issues. Additionally the "German DWA Rules and Standards" specify these general standards of DIN.

	Yes	No
Legal Framework		
1. Are the laws or legislation that governs the public safety identified and clear?	6	1
2. Are there guidelines that interpret the law in place to support the dam owners?	5	2
3. Is there a requirement of internal control?	5	2

4. Is there in any way a shared responsibility between the lawmakers and the dam owner?	1	5
5. Does the “law” require information or communication to public?	2	5
6. Does the law require declaration and description of incidents?	3	4
7. Is it mandatory?	2	3
8. Does the legal framework have any requirement of a post-incident reporting?	1	6

Comments:

Austria

2. No written guidelines, but common practice

4. In general, safe operation of a plant is the responsibility of the owner. The operation plan is, however, approved by the water authority.

5. Communication to the public is required for e.g. EAPs, but formally not for all possible adverse scenarios due to normal operation. However the operator maintains informal contact with the public.

6 and 7. They require the declaration of possible incidents due to malfunction of the plant (“Störfälle”)

France

The safety of French hydropower plants is governed by decrees (« circulaires ») of July 13th, 1999 which asks the owners to identify the situations and sites at risk and to define the actions that will improve public safety (operation of hydropower plants, public information, river access limitation).

The decree of July 24th, 2006 seeks the declaration of incidents which have an impact on public safety to the control authority and their quotation.

This legal framework has been completed by the decree of December 11th, 2007. This decree defines a classification of dams and dykes in four categories according to their height and volume, and new documents must be submitted to the control authority and updated every ten years (Risk assessment and Periodic Safety Review).

Portugal

The owner must report to the Authority any incidents or accidents due to unforeseen events or malfunction of the dam.

UK 5. *Not at moment*

7. *But will be*

Germany *See the former remarks.*

Mainly DWA Rules and Standards, but not in a very precise way.

There are not really “lawmakers” in this field, but, of course, the DWA Rules and Standards are discussed and interpreted by both sides: administration and owner.

	Yes	No
Working procedure		
1. Are the accountability and delegation of responsibility clearly specified and documented?	5	2
2. Does quality system for dam safety incorporate Public Safety Program?	3	4
3. Does your program incorporate interaction with external interest groups?	4	3
4. Have such program, or similar, been implemented to handle Public Safety Issues?	4	3
5. Do your working procedures encounter experience feed back?	3	4
6. Is there a formal incident reporting system for Public Safety in your country/company?	3	4
7. Have your management process been reviewed?	2	5

Comments:

Austria 3, 4 and 5. *Not on formal basis*

6. *Some companies have formal incident reporting, some handle it informally.*

7. *Not with respect to public safety*

France *At Electricité de France, public safety is an absolute priority and, if necessary, must prevail over electricity generation. Development of a safety culture is one of the major commitments included in the safety policy of the company. Organization and responsibilities of managers at each level of the company are defined. Furthermore, periodic control and audits are made by an “hydraulic safety inspector” directly managed by the board.*

An incident reporting system is managed by the ministry of industry. Safety events are classified as incidents (yellow color), serious incidents (orange color) or accidents (red color) according to their consequence on properties or on persons. At several Hydroelectric companies (EDF, CNR, ..) a more detailed incident reporting system do exist for more than ten years and is intensively used for each incident analysis and global feedback.

Germany *As mentioned before, the owners (energy companies ...) are responsible.*

Some questions are not concerning us, because we are not a manager of a reservoir.

	Yes	No
Risk assessment		
1. Is Public Safety included in your Country/company safety Management System?	4	3
2. Are there any formal procedures to identify hazards to public safety?	3	4
3. Do you identify the upstream consequences* of standard operations? * <i>rate of water level rise, rate of flow variation, flow velocity</i>	6	1
4. Do you identify the downstream consequences of standard operations?	7	
5. Do you analyze the consequences of gates malfunction?	4	2
6. Is the public interaction around waterways clarified and documented?	4	2
7. Does your analyze process incorporate the likelihood of undesired consequences?	3	3
8. Are there criteria's established for evaluation and prioritization of mitigation activities?	3	3
9. Is there a formal process for decision-making?	2	4

Comments:

Austria

1. *Some companies include it more or less*
- 3 and 4. *During establishing of the operational rules*
5. *Not systematically*
6. *Not formally*

France

Site criticality is assessed with a method taking into account the river morphology, the type of spill of water and the site attendance. Since 1996, site criticality has been greatly reduced.

UK

2. Coming
5. Owners do

Mitigation measures

Five countries has responded to the following questions

Five responds on the following questions	Yes	No
1. Are there any “national standards” that ensure a uniform level of safety measures related to large dams/public safety?	3	2
2. Are signs and other information materials standardized to ensure recognition throughout the country?	2	3
3. Are potential high risk areas such as intakes, spillways and downstream areas, marked by signs or other warning devices?	5	
4. Are structural measures applied? (fences, locked gates, floates, cables etc)	5	

5. Are safety measures adapted to seasonal changes? (e.g different measures applied according to season?)	4	
6. In what way are the potential dangers related to public safety communicated to the public?		
i. <i>Internet</i>	1	4
ii. <i>Paper</i>	3	2
iii. <i>Radio/television/news</i>	2	3
iv. <i>Map(marked on maps)</i>	2	3
v. <i>Commercials</i>		4
7. Are safety measures in place both upstream and downstream of dams?	3	2
8. Is access to intake structures restricted by physical barriers?	3	2
9. Is access to dams restricted by physical barriers?		5
10. Are intakes, dams and rivers monitored to detect public activity in potential high risk areas?	3	2
11. Are protective devices such as life rings available on site to allow for quick response to accidents?	3	2

Comments:

Austria 1 No standard, but common practice
Portugal 3 and 4. In some reservoirs

Two other countries have responded on two more general questions

1. What type of measures of precautions are taken to prevent accidents to occur?
2. What types of measures are taken for consequence reduction?

France

Three main categories of measures are used for prevent accident to occur:

- *operational constraints on hydroelectric process and gates operation,*
- *Access to the river is restricted in some cases where public safety is at stake*
- *But most of the efforts are dedicated to the information and communication with the public. Several thousand of warning signs have been installed along the rivers, advertisements are published in newspapers. They are completed by direct information provided by students patrolling on the sites (“hydroguides”).*

More information are available through a publication in Hydropower and dams or presentations made during ICOLD congress or workshops :

- *A new approach to hydraulic safety : F. Collombat and M. Poupart, Hydropower and dams, 2003 issue 3*
- *Assessing public safety around waterways : C. Perret and M. Poupart, Seoul 2004*
- *Impact of hydropower facilities on public safety ; regulations enforced by the French public authorities, actions undertaken by Electricité de France to lower these risks : P. Le Delliou and M. Poupart, ICOLD 22 th congress Barcelona, Q85*

UK

- *Signs*
- *Education Leaflets*

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Appendix 2

Details from individual countries

Austria

Construction and operation of hydro power plants are regulated, among others, by the Austrian Water Law. This law stipulates that public interests and rights of third parties must not be violated by the construction and operation of the plants. Furthermore, the plants have to meet the current state of the art and if they don't, they have to be adjusted accordingly.

Particular requirements are specified for dams higher than 15 m above foundation level or impounding reservoirs of more than 500,000 m³. A project for the construction of a new dam of this category has to be checked by the Austrian Commission of Dams. Further requirements concerning the operation of such a dam are:

- The owner has to appoint a Dam Safety Engineer (DSE) and a sufficient number of deputies to ensure permanent on-call service.
- Yearly inspection by the DSE and the Dam Safety Officer of the respective province.
- Yearly Dam Safety report signed by the DSE has to be submitted to the Federal Dam Supervisory Section.
- Five-year inspection by the Federal Dam Supervisory Section.
- An Emergency Action Plan (EAP) is mandatory.

A further law concerns the obligation of the owner to keep the public informed about potential risks and their consequences associated with the power plant.

The specific measures for ensuring public safety for a particular dam are stated in the Operating Instructions. These instructions are an essential part of the Notice of Final Acceptance released by the respective water authority after completion of the plant.

VERBUND – Austrian Hydro Power operates 67 run-of-river power plants and 22 storage power plants. Matters where public safety has to be taken into consideration are e.g.:

- Intake structures for river (brook) diversion are equipped with a sand trap and flushing of it is carried out automatically leading to a surge wave in the river bed.
- Some reservoirs are also utilized for water sports. Potential risks thereby are: change of water level, access to spillways, vortexes near intake structures, etc.
- Reservoirs with steep slopes and e.g. asphalt concrete facing: Escape from the reservoir without help is hardly possible.
- Open channels with high velocity flow: Again, escape without help is almost impossible.
- In some cases the regions downstream of weirs would be attractive for recreation and leisure activities, but weir opening could be necessary also on a sunny days.
- The region downstream of dams is sometimes used for activities like fishing, canoeing, ice climbing, etc. Operation of bottom outlets could, however, be necessary at any time.

In general, potential risks associated with hydro facilities are often not obvious and therefore underestimated by the public.

The main precautions to reduce risks and to ensure public safety are:

- Installation of appropriate barriers at the accesses to dangerous points of the hydro power arrangements
- Installation of fences
- Provision of rescue equipment
- Installation of warning signs
- Inspection of the downstream river bed before bottom outlet opening and moderate increase of discharge
- Information of and communication with the public

Verbund – AHP releases a general safety report once a year – beside the numerous particular reports as e.g. annual dam safety reports. This report contains all relevant aspects concerning e.g. safety of employees, safety of the facilities including dam safety, fire security and also public safety. All accidents and incidents are recorded and evaluated to improve the safety of persons and facilities.

Finland

In Finland the legal concept of Everyman's right in Finland gives everyone to access to private land and enjoy outdoor activities in the nature. There are only few restrictions. The person has a right to have short time camping on private land. Everyman's right does not cover the immediate vicinity of people's homes and yards. Usually camping is not prohibited on public beaches.

The Water Act 264/1961, Chapter 1, Section 24 states "Anyone shall have a right, while not causing undue disturbance, to use a water body of passage wherever it is open. ... Anyone who uses a water body for passage shall also be permitted to use another person's water area for temporary moorage if this does not cause any major harm of disturbance to said person".

The Water Traffic Act 463/1996, Chapter 2, Section 5 states "Anyone who uses a waterborne vehicle for passage through a water area shall take the care and precautions required by the conditions ...".

The Waste Act 1072/1993 Section 19 "Prohibition of Litter" states that everyone is responsible for cleaning up after themselves.

The operation of the hydropower plants including spillways and the structures with high difference in altitude produces a high hazard and a risk to person, who can enter vicinity of the hydropower plant based on Everyman's right. The paper describes only the measures of normal operation.

Legal framework and responsibility

Originally Finnish Dams Safety Act (1.6.1984/413) and Finnish Dam Safety Decree (27.7.1984/574) came into force on August 1, 1984. The dam safety practices were described in "Dam Safety Code of Practice", Publications of the Ministry of Agriculture and Forestry 7b/1997.

Dam Safety Act (494/2009) was updated in 2009 and Ministry of Agriculture and Forestry, Finland gave Government Decree on Dam Safety (319/2010) in 2010. Many of the good dam safety practices were transferred into the dam safety legislation. Also Dam Safety Code of Practice was updated, but its status is the guideline.

Dam Safety Act and Government Decree take into account the hazard and risk to third person (public safety). The dam owner's responsibility to third person is described in following Clauses:

- "A dam shall be operated in such a way that it causes no danger to human life and health. Sufficient safety arrangements shall be in place for class 1 and 2 dams to ensure the safety of the operation of the dam. Further provisions on the safety arrangements are issued by Government Decree". Dam Safety Act (494/2009). Chapter 4 - Maintenance, operation and monitoring of a dam. Section 16 Operation of Dam.
- "The safety of a class 1 and 2 dam shall be ensured by means of:
 - 1) arrangements to ensure the operation of the dam in case of disturbance;
 - 2) warning and other arrangements concerning the discharge of a watercourse dam to prevent danger to those above or below the dam;
 - 3) where necessary , arrangements to prevent damage caused by sabotage and vandalism.

The dam owner must prepare and keep up to date a description of safety arrangements and provide this to the dam safety authority if this is not shown in the other documents provided to the dam safety authority". Government Decree on Dam Safety (319/2010). Section 9 - Dam safety arrangements.

CURRENT PRACTICE

General

The safety of third person has been considered during the design of the hydropower plants and some measures are provided at the Finnish dams (fences, signs and sirens). New Finnish dam

safety legislation requires thorough review of the existing safety measures and the risks are studied more in detail.

Government Decree on Dam Safety (319/2010) determines quite absolutely that the safety of a class 1 and 2 dam *shall be ensured*. This contradicts with the practice - any system or measure has a probability of hazard for third person. The acceptable risk levels are not given in the legislation or in the guidelines.

Everyman's right in Finland makes the studies complicated. What is the responsibility of third person - the coverage of signs and rejecting the information, etc.?

The operation safety of the spillway gates is raised in the first list item of Section 9 in Government Decree on Dam Safety. The description of the gate and its lifting and heating arrangements has been included in the dam safety documentation based on the Dam Safety Act from 1984. New requirement is to study the time for filling of the reservoir to the emergency level and compare it with the accessibility of the operation personnel to the dam side (so called "playtime"- study).

The study of the safety arrangements are done in two phases (Fortum practice). The existing safety arrangements and its condition are mapped in the first phase. The risks are evaluated and the improvement proposals are presented. The additional safety measures are implemented and documented in the second phase. The documentation is submitted to the dam safety authority. The condition of the safety measures is reviewed during the annual inspections (instruction).

Risk Assessment

Everyman's right gives a person right to walk, ski, cycle or boat in the vicinity of the hydropower plant. It has been experienced that the fisherman are entering close to the power house even it is illegal.

Possible risks, which may cause hazard to third person, have been considered

- sudden opening of the gates (and turbines) causing abrupt change in the water levels (upstream and downstream) and in the discharge,
- opening of the spillway gates, where the water is entering to a dry river bed,
- unprotected and non warned high altitudes e.g. unexpected falling down to tailrace channel,
- operation of the hydropower plant causing weak ice and
- drop down of accumulated ice in the powerhouse structures.

Mitigation measures

Presently following safety measures are at the power plants:

- The opening of the spillway gates are alarmed with sirens (River Oulujoki and River Ämmä).
- The booms and safety wires are across the river upstream of the power plant.
- The signs "Warning. The gates are opening with remote control" are warning people entering to the dry river bed and downstream of the spillway.
- The entering to the hydropower plant area is prohibited.
- The area is usually partly fenced.
- The gate spill performances to old riverbed are arranged at Imatrankoski HPP. The performance is popular. Therefore the signs are written in four languages (Finnish, Swedish, English and Russian)



The signs at Imatrankoski.

The work on the safety measures has started. First phase reviews have been done for some river cascades. The mapping of present mitigation measures shows that there is a need to improve the safety measures. The proposals of the first phase have been prepared.

France

Origin and regulatory framework

Many French hydropower plants and dams are operated on rivers that are used for fishing, canoeing, and other recreational activities. For this reason, public safety is a major stake for public authorities and hydro operators.



Illustration of the Extensive Public Usage of EDF Controlled Waterways

Significant improvements in public safety have been made following an accident that occurred on the Drac river, on December 4th, 1995. A sudden rise of water level downstream from the Notre-Dame-de-Commiers dam in the French Alps caused the drowning of six children and an accompanying adult during their hike along the river. The regulator and EDF realized the need to assess the risks generated by normal operations of hydro facilities and that appropriate control measures had to be taken. As a result several ministerial circulars were written to improve public safety relative to hydro facilities:

Circulars dated November 29th, 1996 and July 13th, 1999 aim at identifying the situations and sites at risk and the actions that will improve public safety (hydropower plants operation, public information, river access limitation, etc.);

Circular dated July 24th, 2006, requires the declaration to the control authority of significant incidents related to dam safety and public safety.

Safety policy and management at EDF

At EDF, hydraulic safety is an absolute priority and, if necessary, must prevail over electricity generation. The company is committed to manage the following risks: risk of catastrophic failure, risk relative to operation during floods, and risk relative to normal operations (public safety management).

Hydraulic safety is managed according to ISO 9001 standards. It is based on a strong involvement of managers and a clear organization at the Corporate and regional levels. A set of standards defines requirements regarding hydraulic safety. Safety is controlled by EDF national, regional and local management; as well EDF has established a Hydro Safety Inspector who is independent of EDF Hydro to provide oversight of the entire program. Development of the “safety culture” of employees, combined with the raising of awareness amongst water stakeholders are other major commitments included in the safety policy of the company.

Public Safety risk assessment

Risks relative to normal operations of hydro facilities cover potential effects to people of:

- variations of water level or water flow rate (exclusive of catastrophic failures of structures and materials, and of variations during natural floods) and also
- the physical presence of facilities.

The risk assessment method developed by EDF takes into account several parameters depending on the site (downstream, upstream, channel): river morphology, gradient of water elevation, occurrence of water discharge and its delectability, stakeholder’s characteristics and water uses. The result consists of a mark for the site ranging from 1 (very low risk) to 5 (very high risk).

Following the assessment, if necessary, risk may be reduced by operational procedures adaptation (modification of warning water release, progressive start of turbines, coordination with upstream and downstream dams and plants, etc). Access to the river is restricted in some cases where public safety is at stake. Most of the efforts are dedicated to the information and communication with the public. This effort comprises several thousands of warning signs installed along the rivers, advertisements published in newspapers, regular meetings with the stakeholders (fishermen, whitewater sports clubs, local residents, etc). EDF also invests heavily in a summer awareness campaign provided by students employed as “Hydro Guides” around the sites at risk.



Illustrating the Educational Materials Distributed by EDF Hydro Guides to Members of the Public

In total, risk assessments have been conducted for more than 1 500 sites. The number of high and very high hazardous downstream sites has been greatly reduced: from 184 in 1996 to 24 in 2010. The remaining sites are the most difficult to improve and will require innovative solutions developed in cooperation of EDF operators Engineering Units and water stakeholders.

Experience feedback

Operational events related to water that are liable to have an effect on the public are called Hydraulic Safety Significant Event (*ESSH*). They are classified from level 1 to 6 according to the seriousness of the effects they have. A “0” severity level was added for near-misses. The classification also distinguishes different types of effects: effects on human beings, property damages, uncontrolled water levels, uncontrolled water discharges and unsafe situations.

Hydro safety events linked to normal operations of facilities represent approximately 90% of the total number of *ESSH*. Their analysis provides a great deal of information and help to avoid accidents which could be serious.

Conclusion

EDF Hydro has been deeply involved in public safety for 15 years with a policy based on commitment of managers at every level, however in spite of the significant results that have been obtained, permanent vigilance is required because incidents may happen, water stakeholders can change their habits, and hazards can be displaced from one site to another.

Working with the public, skills and creativity, and sometimes investments are the keys for further improvements.

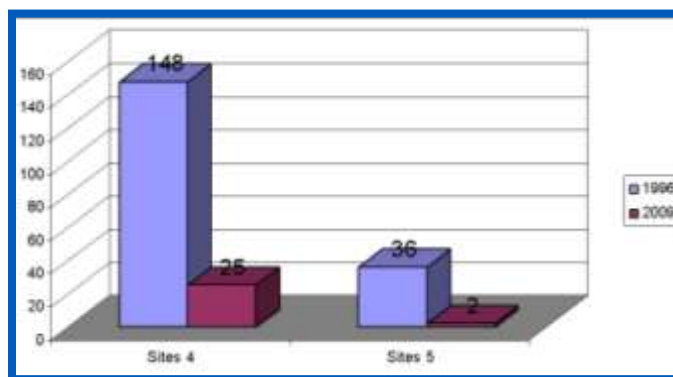


Figure: Reduction of hazardous downstream sites between 1996 and 2009

Italy

Presentation in Chamberly Workshop 2010 from Edipower (Italy)

Introduction

Dams in Italy are treated differently depending on their geometrical features. The term large dam is referred only to the dams whose height is more than 15 meters or the storage capacity is more than 1.000.000 m³. Law regulations are different for large dams and small dams.

Large dams

The topics regarding the safety of the dam and downstream areas are divided in two fields:

- Dam safety (from a structural and geological point of view for the dam itself and the shores of the reservoir);
- Public safety.

Dam safety

Dam safety is regulated by means of two laws dated 1959 and 1982 (D.P.R. 1363/59 and D.M. 24 march 1982). These laws cover the sequent issues:

- Design, construction and testing (for new dams or renewal);
- Operating, monitoring and maintenance (for existing dams).

For existing dams, the main instrument used to assure dam safety is the F.C.E.M. (Foglio Condizioni Esercizio e Manutenzione - translated "Document of Conditions for Operating and Maintenance").

It consists of a complete document which describes the features of the dam and its reservoir in terms of all geometrical and physical dimensions (heights, widths, volumes, etc. completed by drawing of plan and profile). An important chapter is dedicated to the positions and amount of discharges of spillways and outlets.

The other articles treat about the established control measures (number, type, positions) that are to be performed on that specific dam and their frequencies (daily, monthly, etc.), tests on discharge of spillways and other outlets, and procedures of data transmission to public authorities.

In case an earthquake occurs there is a procedure to follow proportioned to the degree of magnitude and the distance dam-epicenter. Common precautions are a visual inspection and a repetition of main measurements.

More recently the F.C.E.M. has been completed with issues regarding public safety (treated below). The main changes consists in adding to the document the plans of the areas downstream of the dam with the graphic indication of the sites that could be flooded in case of volunteer discharge from the outlets, with the level in the reservoir equal to the maximum for operating, and in case of collapse of the dam. There are also drawn the positions of the warning signs.

Moreover it has been added the procedures for acoustic signals (siren) in case of volunteer water discharge.

Finally, according to Italian law large dams must be watched 24 hours a day. Commonly the house is adjacent to the dam. Usually, in this house the watchmen work 8 hours a day and remain there, or nearby, on disposal for the rest of the day.

Public safety

For each dam there is a document that establishes instructions in case of predicted or actual floods. It indicates, in such cases and for growing risk, the procedures that surveillance personnel has to follow when the dam reaches level higher than the maximum operating level.

In addition, for normal exercise and both for large and small dams, sometimes there are internal procedures to manage the water discharges in the river downstream of the dams, meaning that they are done and respected by the company itself. These procedures derive for example from previous habits or agreements between the company and other stakeholders of the river and/or public authorities or institutions (for example fishing associations).

Small dams

After an accident occurred in the country to a private small dam in 1985 it become evident that it wasn't strictly necessary to have large dimensions to have possible consequences for public safety. While large dams are of state pertinence, the single regions have to take care of the small dams located in their territory. Therefore every region should have drafted proper instructions for safety and maintenance. Up to now only some regions have done this, with documents resulting rather similar, but simplified, to the same applied in the national field.

Portugal

Dam safety is governed by the "Portuguese Regulations for Safety of Dams"(RSB), issued by the Decree-law nº 344/2007. These regulations were first published in 1990 and then reviewed in 2007. Since 1990 some standards concerning the different stages of the life of dams have also

been published, to complete and to help the application of the law. A new standard on “Dam Operation” is presently being drafted, that will include public safety issues.

In Portugal the largest dams are mainly for hydropower, for irrigation and for water supply purposes. There are about 200 dams with height greater than 15m, and also a very significant number of smaller dams.

Several hydropower dams have warning and alert systems with sirens that are used before discharges, to warn people downstream. Some specific large dams for irrigation and water supply also have adopted warning cautions, namely concerning bottom outlet or spillway discharges. Mainly in the larger dams, warning signs and physical barriers for particular structures and zones are relatively commonplace.



Two photographs with fences from a specific dam, Alvito dam, but this is only an example

According to the Water Law, in recent years the Water Institute has launched tenders on the elaboration of spatial plans concerning the occupation of margins in large reservoirs, meant to discipline the associated different uses (e.g. protection, recreation, tourism, fishing, etc) in a compatible and sustainable way, namely taking in due account water protection. These also include public safety concerns, by imposing warning signs in areas near the dams, especially close to gates, valves and spillways to prevent people from being there.

Slovenia

Short contribution from Lower Sava River Powerplants (HESS)

Based on the up-to-present experience, operators of the Lower sava River HPPs (HESS) agree completely with the statements given in the introductory part of the ICOLD EU Working Group report. At HESS company, dangers and risks arising from reservoirs (including dams) are accounted for in risk assesments which are prepared for each separate reservoir/dam, in accordance with existing legislation. This document (Risk Assessment) represents a source of information for Operation Manuals and also for Maintenance Manuals, which assures the highest possible Safety Management level for the structure as a whole.

In cases of flood-level natural discharges, dam operation is adapted to actual conditions. In cases of possible negative flood influences in a wider influential area as well as on population, alarming is applied through regional (emergency) information center.

In everyday practice, it is regularly observed that public (i.e. individuals) is not aware of potential dangers imposed by HPPs and is thus unnecessarily exposed by, e.g.:

- fishing directly downstream from the HPP («convenient spot«)
- cruising with various vessels in the vicinity of dams
- tobogganing along the spillway piers
- searching of lost items (balls, tires) among floating debris
- performing of various »agreed challenges« along the (Sava) river, i.e. »kayaking towards the Black Sea«
- approaching of the riverbanks during flood events
- etc

According to the above mentioned practices, the HPP operator feels responsibility to educate the population, especially those living closer to the reservoirs. This is realised through:

- warning signs
- presentations to various (interest) groups
- HPP visits
- Notification and description of HPP operation modes on internet
- Education of intervention personnel (firemen, civil protection forces, ...)
- »open door days« on HPPs



Examples of warning signs

Education of population is also the responsibility of local communities. They however very often only see the possibilities recreational activities enabled by formation of the reservoirs, but are on the other hand only weakly aware of possible risks imposed by such activities.

In cases of risks (or accidents), every case is analysed individually, corresponding measures are taken and thereby the safety state is refreshed regularly. Special attention is paid to structures

under construction, where additional risks due to construction activities appear and which require specific handling.

(Prepared by Damijan Požun (HESS), Translation by Andrej Širca (SLOCOLD))

Sweden

Over the years accidents around dams and adjacent waterways in Sweden have caused approximately 10 fatalities. Some plants have been more vulnerable to public safety incidents than others due to long spillway river beds, the ever increasing outdoor adventure activities upstream and downstream, including the use of personal watercraft. At the same time safety expectations by society as a whole have increased. The picture below illustrates people unaware of risks.



Attractive but dangerous location downstream in a spillway canal

Like Finland Sweden has a type of legal concept of Everyman's right giving everyone access to private land and the right to enjoy outdoor activities in the nature. This forms special ground for public safety requirements. The Swedish Environmental Code and the Prevention of Accidents Act provide the legal framework for a dam owner's social responsibility towards the general public. In some installations permits have been issued containing specific requirements intended to protect the general public, such as warning signs and the need to issue audible or visual signals when discharges occur.

Vattenfall was the first Swedish hydropower utility to formulate a Public Safety Guideline (2007). Following this in 2008 Swedenergy developed "Guidelines for the Safety of the General Public at Dam Facilities and Associated Water Courses" for all Swedish hydro power companies operating within the association.

The Swedish guidelines are based on the underlying principle that the main responsibility for safety rests on the individual. Each person has a basic responsibility to be aware of the dangers and to take appropriate precautions. On the other hand, it is in line with Swedish power companies' responsibility policy for life and safety to, as far as reasonably practicable, prevent accidents involving the public from occurring around dam and hydropower installations.

Given this background, Vattenfall issued the following policy and strategy, fully in line with its values and moral responsibility. In addition to protecting the public, it also serves to protect the company brand and enhance the competitiveness.

Policy

- Electricity production will take place in a responsible and cost-effective manner, without compromising safety.
- It is our endeavour to use systematic safety work in order to protect the life and health of people who are near our dam installations, as far as is reasonably practicable. Each person has an important responsibility to ensure that they are aware of the dangers and to observe warnings.
- Our goal is that if a person has observed the care mentioned above, it should not be more dangerous to be close to one of our installations than to similar undeveloped waterway.

Strategy

Our safety goals are achieved by:

- informing and warning
- preventing inadvertent risk-taking
- hindering conscious risk-taking
- facilitating rescue wherever possible
- collaborating with representatives from local society (county council, emergency services, schools, voluntary organizations etc)

These preventive measures will be adapted to suit local conditions and requirements, and will be prioritized on the basis of risk, in order to achieve the greatest possible social benefit.

Public safety is a component of total safety, and forms an integrated part of our safety management system

Progress

All the Power companies in Sweden within the Swedenergy association are in the process of implementing the general guidelines issued in 2008. This includes risk analyses, information activities, new signage, new booms and buoys.

As a first step, a common set of warning signs were developed to avoid confusion with different signs for different companies. The efficiency of the signs has been scientifically validated through a series of focus group tests with members of the public. The picture below shows examples of two of the signs. The first one showing the opening of gates and the second one is warning for the subsequent flood wave.



Examples of Swedish Warning Signs

United Kingdom

In the UK reservoir safety is 'regulated' currently by the Reservoirs Act 1975. This Act is being amended to 'strengthen' its requirements, and these amendments are currently in the House of Lords for consideration.

This Act has no provisions within it associated with Public Safety although it is clear that, under common law, owners have some responsibilities to protect the public.

There are three major hydropower operators in the UK, Scottish & Southern Energy (SEE), Scottish Power, and First Hydro. Each of these companies clearly invest in warning the public about issues associated with their plants but these are initiatives which the companies pursue independently.

Clearly public safety issues apply to all other types of reservoirs in the UK – but perhaps in slightly different ways.

In the UK a Government Initiative has recently produced 'coarse' inundation maps for all reservoirs, some 2100 dams, subject to the Act in England and Wales. These maps identify those areas which might need evacuation should an emergency occur.

In addition the Water Act of 2003 requires high consequence dams to have an 'on site plan' – a plan that an owner would activate to obtain pumps, materials etc to achieve a drawdown should an emergency occur, and also an 'off site plan'.

The 'on site plan' seeks to prevent failure or mitigate against failure. The 'off site plan' is the plan that the Local Resilience Form (LRF) and the associated emergency services would put into effect to bring about an evacuation of people.