



ICOLD Technical Committee I – Public Safety Around Dams (November 19, 2021)

Abstract

The following is a report of activities from ICOLD Committee I, Public Safety Around Dams prepared for the ICOLD AGM held November 19, 2021

Submitted by: T. Bennett, Chair and P. Lilley, Vice-Chair

T. Bennett, Chair ICOLD Committee I

November 15, 2021

Contents

Executive Summary	4
Committee, Activities and National Committee updates	6
1. Committee Membership	6
2. Terms of Reference (2016-2022)	6
3. (Draft) Technical Bulletins	7
3.1 Bulletin B1 – Public Safety Principles	8
3.2 Bulletin B2 – Public Safety Assessments	8
3.3 Bulletin B3 – Technical Applications	9
3.4 Bulletin B4 – Incident Management	9
3.5 Committee Teleconference Meetings	10
4. International Public Safety Incident Database	11
5. National Committee Updates	14
5.1 Brazil	14
5.2 Canada	14
5.3 China	15
5.4 France	16
5.5 New Zealand	16
5.6 Norway	17
5.7 Sweden	17
5.8 United Kingdom	17
5.9 United States	19
Appendix A – Committee Membership	21
Appendix B – Draft Bulletins, Tables of Contents	26
Bulletin B1 – Public Safety Principles	27
Bulletin B2 – Public Safety Assessments	30
Bulletin B3 – Technical Applications	32
Bulletin B4 – Incident Management	33

Executive Summary

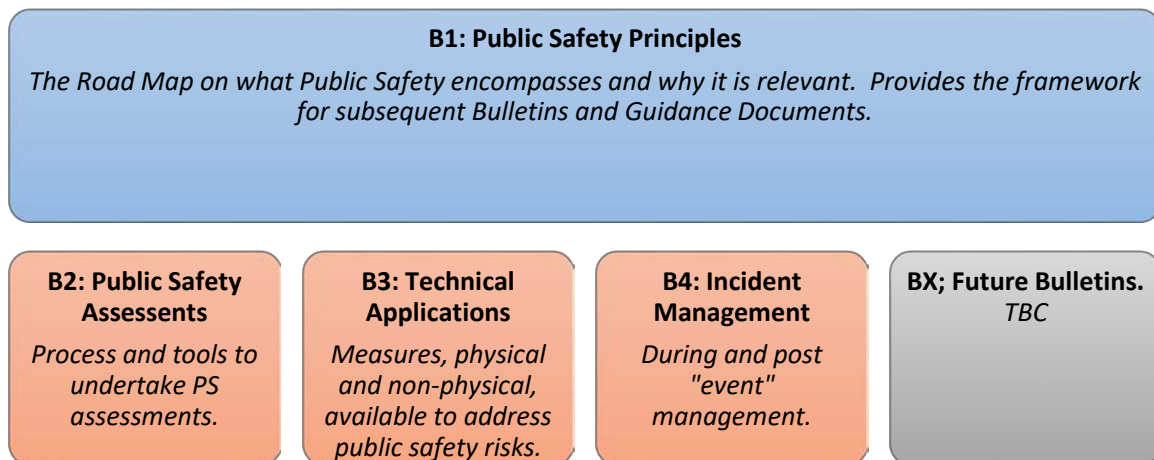
The Committee has membership from 26 participating National Committees as shown in Figure 1 – with a list of members included in Appendix A.

The Committee has functioned effectively during our virtual meetings over the past year when considering the impacts of COVID-19 in terms of restricting in-person meetings since June 2019 and limiting member’s availability – this has delayed timely completion of the Bulletins. Work to maintain the database of international incidents has however progressed well during this period with regular updates to keep the information current.

As well as work on the Bulletins and maintaining the incident database, the Committee also serves to foster the continuous sharing of practices through the National Committees which contributes to improvements in the safety of the public who may interact with dams and their operations. A synopsis of the National Committee updates is included in Section 5 of this report.

The most recent full update of the Committee’s work was presented to ICOLD during a workshop held during the ICOLD 2019 meeting in Ottawa. However, as part of the XXXIII - Seminário Nacional de Grandes Barragens hosted by the Brazilian National Committee (CBDB) 60th Annual meeting, October 27-28, 2021 the Committee was invited to present on our work (see Section 5.1 of this report). This was a very successful event, which hopefully will lead to further engagement with other South American countries in the work of ICOLD and the Committee.

The Committee is working on a series of four [4] Bulletins, which will form the framework for the ICOLD guidance on Public Safety Around Dams. The approach the Committee has proposed provides the flexibility to add additional guidance bulletins that may be identified as work progresses. It is also intended that the guidance material prepared has relevance across the full spectrum of users that have an interest in public safety. Segmenting the material therefore allows individual users to access knowledge most applicable to their area of interest.



Framework for ICOLD Public Safety Bulletins

In terms of the Committee work Bulletins B1 and B4 are the most developed, and have been the focus of the Committees work in 2021 – the Committee anticipates these will be ready for National Committee review in Q1 2022 – with the aim to incorporate the comments and propose the Bulletins during the ICOLD 2022. The remaining two Bulletins will follow in 2023. Outlines of the various Bulletins is included in Section 3 of this report and Appendix B.



ICOLD Committee I – Public Safety Around Dams
Figure 1 - Participating National Committees

Committee, Activities and National Committee updates

1. Committee Membership

Committee membership remains relatively stable, with a complete list of members provided in Appendix A.

This past year Mr. Tatsu Hamaguchi (JAPAN), a long standing and most valued member from Japan retired from the Committee. Mr. Hamaguchi was recognized at the Committee's November 2, 2021 meeting for his outstanding contribution over the years. The Committee welcomed Mr. Hideshi Sasahara (JAPAN) as the new member from Japan during the same meeting.

The Committee also welcomed during the year the new membership from MYCOLD, with En Rahsidi Sabri Muda representing Malaysia.

During the year, Mr. Steve Hocking (USA) co-opted member, notified the Committee that he would be unable to continue with his co-opted membership due to increasing personal and work commitments. Mr. Hocking will continue to participate on the USSD committee and will provide any input to ICOLD Committee I through their member William Foos (USA).

The Committee has also reached out to RUSCOLD and SANCOLD for nomination of replacement members from Russia and South Africa respectfully.

2. Terms of Reference (2016-2022)

The Committee's terms of reference and deliverables are:

- 1.1. Prepare a series of ICOLD Technical Bulletins on Guidelines for Public Safety Around Dams which includes such aspects as; managed systems approach to public safety, hazard identification and risk assessment, universally recognized symbols to mark public safety hazards and self-assessment tools and incident reporting. The guidance is to address a broad spectrum of dams including hydropower structures and low-head weirs.
- 1.2. Consider the issue of Public Safety Incidents including:
 - the establishment of clear criteria for describing public safety incidents and a format for reporting to be applied by the National Committees and organizations wishing to track the occurrences in a consistent manner.
 - development of a database encompassing public safety incidents
- 1.3. Support the Committee on Public Relations for the preparation of information and education documents concerning public safety around dams

Communications

- 2.1. Coordinate Committee activities with the Committee on Dam Safety in areas of mutual and overlapping concerns
- 2.2. Remain in contact with Chairman of other ICOLD Committees in order to insure coherent works and publications concerning dam safety
- 2.3. Liaise with international agencies and Committees of ICOLD member countries according to the needs.

It has been proposed that Committee I consider when the terms of reference come for renewal in 2022 to request a mandate for dam safety emergency management along the lines of:

Prepare a State of Practice and ICOLD Technical Bulletin on Emergency Management for Dam Safety that serves to inform good practice related to the preparedness, response and recovery phases of emergency management for owners, regulators and communities impacted by the potential for dam failure.

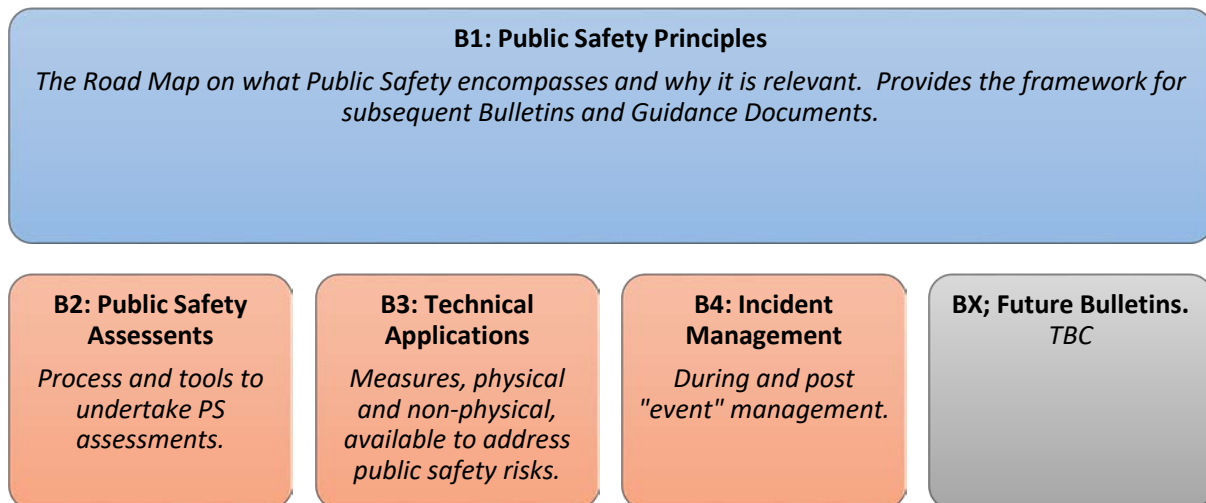
This issue will be discussed by the Committee, in the context of completing the current mandate and deliverables related to public safety around dams. Input will be requested from other relevant ICOLD Technical Committees, before proceeding with this proposal for consideration/endorsement by the National Committees at the ICOLD 2022 AGM.

3. (Draft) Technical Bulletins

GENERAL COMMENTS

Public Safety Around Dams encompasses the identification, management and treatment of all risks to the public created by the presence of the dam and its operation, but excludes those risks associated with dam failure. This is a substantial scope particularly when there is only a modest range of existing guidance material on which to draw. For this reason, the Committee has opted to prepare a number of separate Bulletins the cover both the philosophy and purpose of Public Safety, and the mechanisms by which risks can be identified, assessed and managed.

The Committee is working on a series of four [4] Bulletins, which will form the framework for the ICOLD guidance on Public Safety Around Dams. The framework and outlines of each of the Committee's four [4] Bulletins were presented during a workshop held during the ICOLD 2019 Annual meeting in Ottawa. Positive feedback was received from the workshop participants, which the Committee has considered during the subsequent work.



Framework for ICOLD Public Safety Bulletins

The approach the Committee has proposed provides the flexibility to add additional guidance bulletins that may be identified as work progresses. It is also intended that the guidance material prepared has relevance across the full spectrum of users that have an interest in public safety. Segmenting the material therefore allows individual users to access knowledge most applicable to their area of interest.

In terms of the Committee work Bulletins B1 and B4 are the most developed, and have been the focus of the Committees work in 2021 – the Committee anticipates these will be ready for National Committee review in Q1 2022 – with the aim to incorporate the comments and propose the Bulletins during the ICOLD 2022. The remaining two Bulletins will follow in 2023. What follows is a brief synopsis of each Bulletin.

3.1 Bulletin B1 – Public Safety Principles

This Bulletin is the overarching “Parent” document that provides the road map under which more targeted and detailed bulletins provide guidance in specific areas. In this context it is designed to be relevant to all potential users; from those primarily involved in broader governance aspects of public safety to those tasked with specific analysis, implementation or incident management. This Bulletin therefore provides;

- the principles that underpin an effective Public Safety system and culture,
- an overarching road-map on what public safety is and why it is relevant,
- a lead in to subsequent Bulletins and Guidance Documents,
- the overall management system with reference to Bulletin 154 (Dam Safety in the Operational Phase),
- concepts around training for the owner and stakeholders, benchmarking and self-assessment tools, as well as those used to monitor the effectiveness of the system.

In progressing this work a "maturity matrix" approach has been adopted for which should be useful for National Committees to make an assessment regarding the level of advancement of public safety practices compared to industry practice. This includes explicit consideration of the system maturity required rather than simply the highest level of maturity attainable.

A range of case studies are provided to demonstrate the wide range of issues, potential situations and possible responses. A draft Table of Contents is included in Appendix B.

3.2 Bulletin B2 – Public Safety Assessments

Public Safety Around Dams includes hazards which may be encountered by the public around a dam, such as those associated with:

- swift and turbulent currents near to intakes and spillways,
- changes in flows and water levels associated with the operation of spillway gates,
- falls from heights off a dam, or
- accidental contact with the mechanical and electrical components of a spillway gate.

For the purpose of this Bulletin it will focus on identifying various hazards that exist due to the presents and the intended operations of a Dam and appurtenant structures. Because of the often-close proximity and coordinated nature of hydropower and dam operations, especially in terms of flows and water levels, some aspects of hydropower facilities are covered within Public Safety Around Dams.

This Bulletin describes the various frameworks for completing a public safety assessment of the risks, based on the hazards, in order to inform the selection of the appropriate physical and operational control measures. A draft Table of Contents is included in Appendix B.

3.3 Bulletin B3 – Technical Applications

This Bulletin covers the measures available to treat/ mitigate public safety risks identified during the public safety assessments described in Bulletin B2. The Bulletin provides an extensive description of the available measures, both physical and non-physical, and includes:

- signage
- fencing
- safety booms and marker buoys
- audible sirens and visual alerts (e.g. strobes)
- stepped opening of spillway gates and other operational considerations
- pre-release warning patrols and site security
- video surveillance and other techniques
- public education

The Bulletin also covers the on-going operation, maintenance and testing considerations for the various controls such that the public safety managed system aspects of the technical applications are addressed. A draft Table of Contents is included in Appendix B.

3.4 Bulletin B4 – Incident Management

This Technical Bulletin provides guidance on management of incidents occurring at dams related to public safety. The study of incidents oftentimes forms the basis to improve safety; guarding against workplace hazards as well as driving changes in the public domain as they relate to accident prevention. Learnings can be derived from data analysis across a spectrum of incidents to identify systemic issues, as well as the detailed assessment of individual cases in order to understand the risks associated with a particular set of hazards.

The intent of this Bulletin is to:

- define a public safety incident
- discuss the benefits of implementing a management system for incident reporting

- provide examples of public safety incident data analysis to illustrate how it can inform program improvements
- present examples of good practice for incident reporting
- provide a sample public safety incident reporting system for National Committees and organizations to consider adopting
- present examples of good practice for rescue operations, i.e. response
- document case studies and the lessons learned

In terms of the dam industry, there are a number of well documented case histories of dam failures and various databases have attempted to collate them. However, when compared with other hazardous industries dam safety incident reporting is considered to be poorly undertaken. Reports of dam failure often lack sufficient details to fully understand the modes of failure and the interdependencies, and unlike other industries, there are very few reports of near misses which can provide important lessons towards mitigating risks. In regards to public safety around dams the industry is at an even more infantile stage in terms of the maturity of our incident reporting; with virtually no documented case studies available in the literature and little in the way of databases.

In order to close this information gap this Bulletin describes an incident reporting process which can be applied by owners and regulators to improve their practices regarding public safety around dams. The process can be extended, enabling owners and regulators to collect information on their dams, as well as to track incidents that are reported through other sources in order that lessons can be drawn from beyond their organizations and jurisdictions. The reporting of public safety incidents:

- ensures that managers within an organization are informed in a timely manner
- meet regulatory requirements;
- maintain adequate records of the events; and
- identify systemic issues and develop continuous improvements initiatives.

To the extent practical this Bulletin aligns with the terminology adopted by organizations engaged in tracking drowning fatalities, primarily the World Health Organization (WHO) and the International Life Saving Society. A draft Table of Contents is included in Appendix B.

3.5 Committee Teleconference Meetings

During 2021, the Committee met virtually on the following dates for the purpose of advancing progress on the Bulletins:

- March 31
- April 13
- May 4, 11 & 27
- October 12
- November 2

4. International Public Safety Incident Database

One of the important deliverables of the Committee has been completed in the form of the development of an International database of public safety incidents, as reported at the Vienna 2018 ICOLD Congress during the AGM. Incidents and case histories continued to be collected and entered into the International Public Safety Incident Database which is being maintained by Ontario Power Generation (CANADA).

The database now includes over 1400 incidents a number of which are referenced in the Bulletins as illustrative case studies. While the database includes incidents and case histories from around the world, there is a predominance of the incidents coming from North America, the United Kingdom, Australia/New Zealand and India, with few records from Latin America and Asia.

Included amongst the numerous incidents reported in the past year have been those involving:

- Spurious operations of spillway gates leading to multiple fatalities in Canada (October 1, 2020 Cleveland Dam, 2 fatalities) and Taiwan (September 13, 2020 Wujie Dam, 4 fatalities) causing release of water without warning of the public
- Low head dams leading to multiple fatalities in the United Kingdom (October 30, 2021 Haverfordwest Weir, 4 fatalities) and United States (June 17, 2021 Eden Dam, 5 fatalities) when members of the public cascaded over the spillways of the dam in inflatable rafts and paddleboards.
- Boating mishaps involving multiple fatalities in Uganda (August 30, 2020, Kiira Dam, 4 fatalities) and South Korea (August 5, 2020, Euiam Dam, 6 fatalities) where strong currents drew the vessels through the spillway gate openings at these hydropower facilities.
- The case studies collected also include numerous examples of single fatalities resulting from public safety accidents at dams or due to their operations, as well as near misses where rescue operations have mitigated what would have otherwise been tragic events.

Information from the database has been disseminated at various conferences and Committee meetings with the following representing typical outputs:

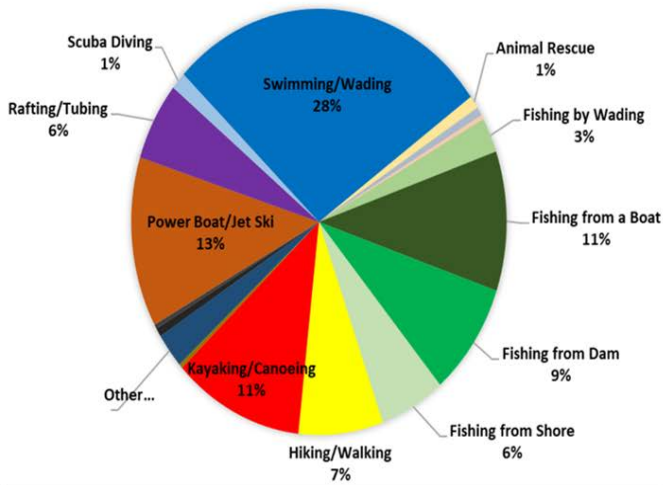
INCIDENT SUMMARY: 23 year old kayaker drowned after being caught in the hydraulic currents at the base of the dam. In attempting to recover the body, the local fire department boat was caught in the same hydraulic resulting in the death of one first responder.

Gadsden Dam, Alabama April 25, 2015

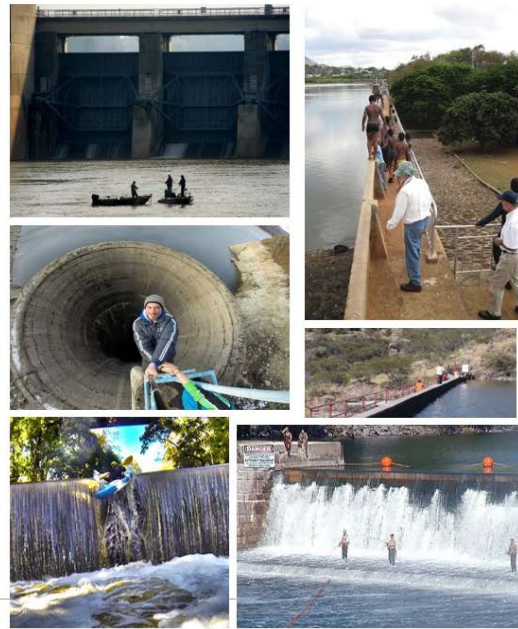
Detailed information:

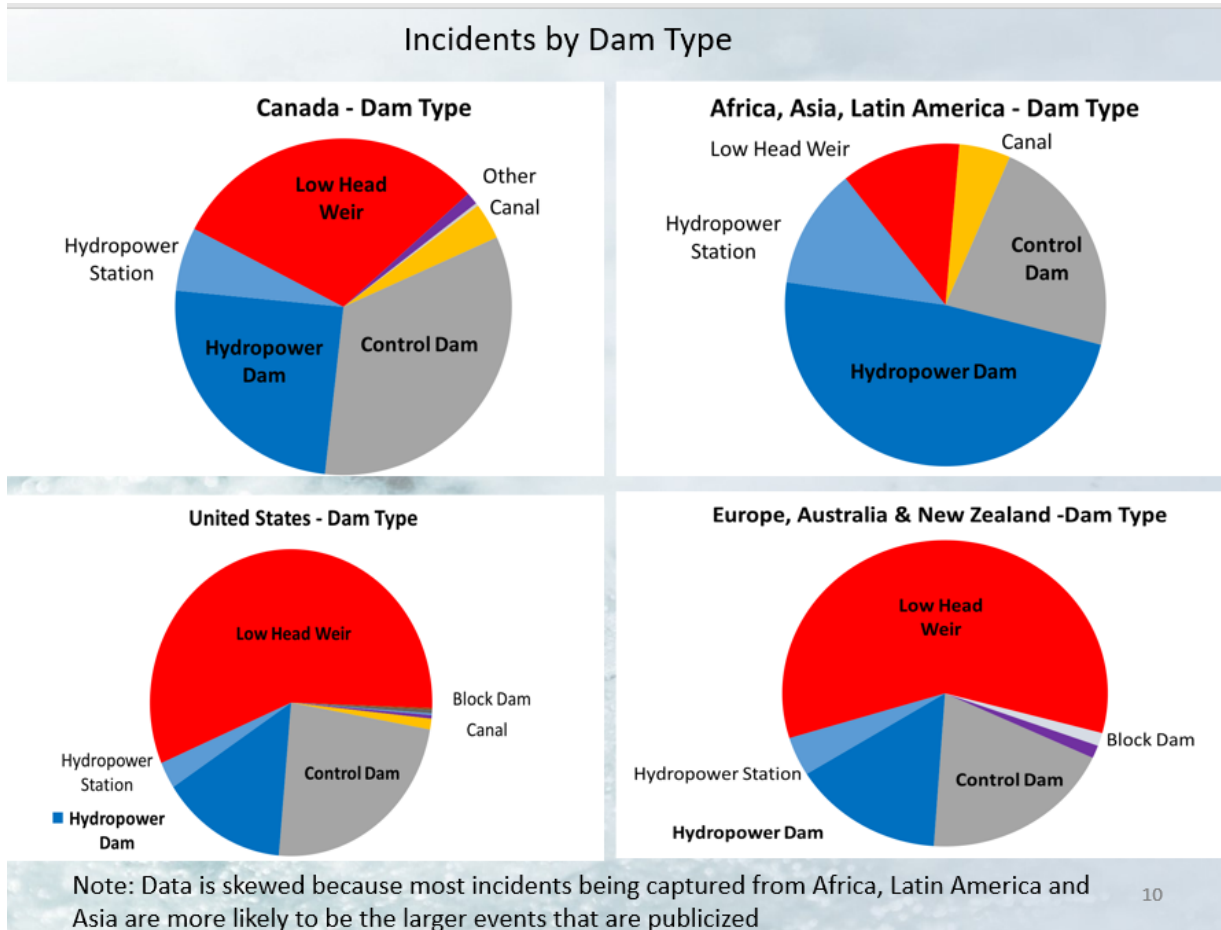
- Incident Details
- Dam
- Victims
- Rescue Operations
- Supporting Documentation

Activity at Time of Fatality (Canada)

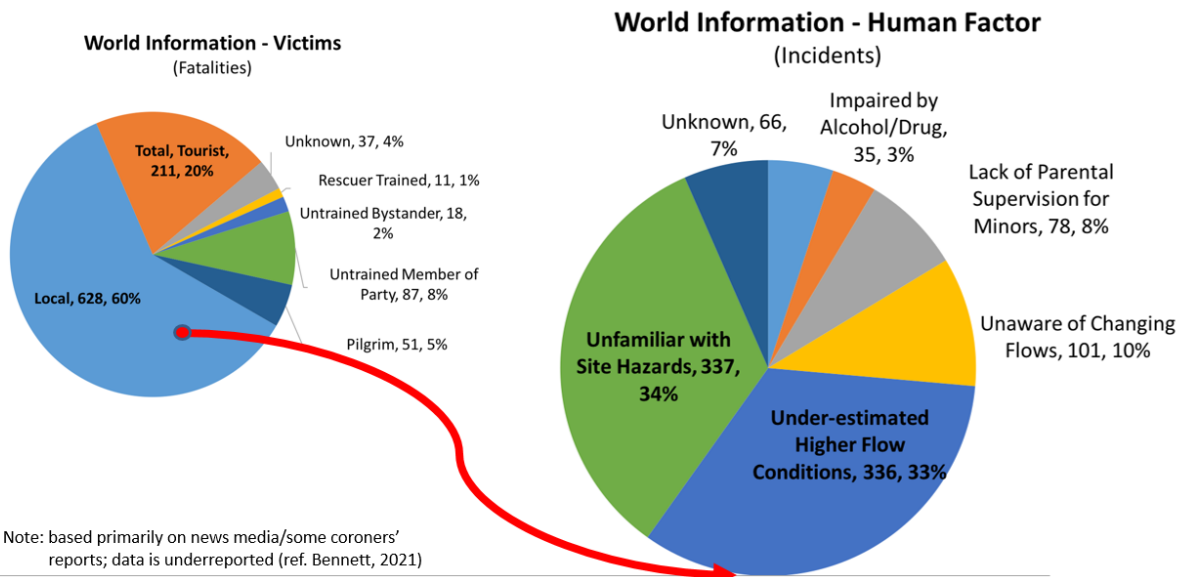


* Note: based primarily on news media/some coroners' reports; data is underreported (ref. Bennett, 2021)





Victim Type involved in Incidents



5. National Committee Updates

The following represent a synopsis of some of the National Committee updates that have been provided during the Committee’s teleconference meetings held throughout the past year.

5.1 Brazil

The Brazilian National Committee, through their Committee member (Ricardo Aguiar Magalhaes) invited the ICOLD Committee I to lead a session on public safety around dams during their XXXIII - Seminário Nacional de Grandes Barragens, October 28, 2021. In all ICOLD Committee I made the following eight [8] presentations:

- ICOLD Public Safety Around Dams Committee: State of Art – T. Bennett
- ICOLD Bulletin – B1 / Public Safety Around Dams - Principles and Overview - Peter Lilley
- ICOLD Bulletin – B2 / Public Safety Risks Assessments – W. Foos
- ICOLD Bulletin – B4 / Public Safety Incident Management and Reporting – A. Swindon
- Canada: Public Safety & Security for Dams: Integrated Surveillance for Actionable Intelligence & Decision Support – S. Jerome
- Both Dam and Public Safety Incident – B. Geisseler
- Larji Dam - Spillway Opening (2014) – Lessons Learned – T. Bennett
- Japan: Kurodura Dam Accident (1999), Kakigawa Dam Incident (06/2017) – T. Yamaguchi

The event was very well received, providing an excellent opportunity for the Committee to disseminate information related to the Bulletins, as well as to attract interest from Brazil and other participating South American countries, to contribute to the public safety incident database.

5.2 Canada

The Canadian Dam Association has developed a ½ day training workshop to introduce dam owners, consultants, regulators to public safety around dams. This training workshop nicely compliments the 2 ½ day in-class Public Safety Risk Assessment Training program that the CDA has delivered to over 450 participants since it was developed in 2021. The Public Safety Awareness training was developed in early 2021, and rolled out in 3 separate training sessions over the course of the year to ~ 120 participants, including at the CDA virtual conference in October.

The CDA Public Safety Working Group is embarking on a new initiative to provide additional guidance on completing a public safety hydraulic assessments in order to define areas of the river that can become dangerous due to the operation of a dam or hydropower station. When completed this document will supplement the CDA Guidelines for Public Safety Around Dams.

The University of Saskatchewan, Department of Civil Engineering continues with its research program related to low-head dams in terms of reducing the safety risks due to the reverse hydraulics.

In October 2020, a serious accident occurred at the Cleveland Dam, in Vancouver, BC. wherein a spillway gate operated in a spurious manner. The sudden release of water resulted in two

fatalities and a number of anglers being swept downstream and fortunately self-rescuing. The accident remains under investigation.



Cleveland Dam, Vancouver (October 1, 2020)

During 2021 there were two [2] fatalities associated with small control dams in Canada. These events, as well as events documenting near misses, have been included in the public safety incident database.

5.3 China

In 2021, two incidents involving public safety accidents at dams in China were entered into the database, fortunately neither of which resulted in fatalities. One of the involved 2 teenage girls who required rescue when water levels and flows suddenly increased while they were standing on a low-head weir taking a selfie-photo. There have been a number of similar incidents occur internationally – this risk-taking activity should be described in the Committee’s Bulletins.



Wanrong River Dam, Jishou City (May 11, 2021)

The other incident involved a young boy who was playing in the water near a dam on the Lijiang River, Guangxi Province on July 24, 2021 when he accidentally fell into the hydraulic. Fortunately, a trained rescuer was near to the scene and was able to resuscitate child.

5.4 France

In 2021, three incidents involving public safety accidents at dams in France were entered into the database. The most serious of the incidents involved 2 paddle-boarders who were swept over a low head dam in the City of Le Mans on June 6, 2021. One of the victims was rescued, while unfortunately, the other drowned in the hydraulic.



Barrage Passeelle d'enfer in Le Mans (June 6, 2021)

The other incidents involved boaters being drawn towards a dam where the passengers required rescue (barrage Château-Gontier-sur-Mayenne, March 13, 2021 and barrage Rance tidal power plant, July 13, 2021). In the case of the barrage Rance incident it was demonstrated the successful application of a safety restraint boom in preventing the disabled boat from cascading over the structure.

5.5 New Zealand

Public safety around dams and waterways is becoming more recognised in New Zealand as an area of emerging importance. NZSOLD is in the early phase of developing a scope to update its 2015 NZ Dam Safety Guidelines. This update will include expanding the current guidance material provided, in the guidelines, on Public Safety.

The expanded guidance on Public Safety will either be in a form of a stand-alone module within the Dam Safety guidelines or remain incorporated as an expanded section within the existing "Life Cycle Management Module" (a collection of emerging areas of importance). The NZ Dam Safety Guidelines are prepared from the technical bulletins published by ICOLD and other internationally recognised references, with additional NZ-specific guidance provided as needed.

At an individual dam owner level, public safety reviews are starting to be undertaken at a more regular and comprehensive basis although only by a limited number of owners.

5.6 Norway

Information was provided regarding a recent public safety incident in Norway in a Norwegian newspaper – where three persons disappeared in a boat during a flood near to a hydropower facility that is currently under construction. The dam was in place at the time of the incident, however the power plant has not yet been commissioned, and there was no signage or other control measures present: Bygger kraftverk i Tokagjelet – sikringstiltak er ikke på plass – NRK Vestland.

5.7 Sweden

The Dam Safety Program at Energiforsk, a Swedish research and knowledge institute that advances and coordinates energy research, is in 2021 financing a project aiming at providing a guide for dam owners to identify and assess risks and dangers regarding public safety around dams and hydropower plants, and to analyse and prioritize safety measures. The guide will be a first step towards an industry-wide methodology. The need for a guide initiated in a status report on dam owners' and authorities' public safety actions carried out by the Swedish National Grid (Svenska Kraftnät) in 2020. The project is carried out by a consultant firm with representatives from dam owners and authorities in a reference group.

The 2023 ICOLD Annual Meeting will take place in Gothenburg, Sweden 11-15 June, 2023: <https://icold-cigb2023.se/>. SwedCOLD is very much looking forward to the ICOLD communities participation and hopefully technical sessions dealing with practical applications of public safety around dams.

5.8 United Kingdom

There continues to be a significant number of public safety incidents involving relatively low dams and weirs associated with old canal and navigation systems in the United Kingdom. A number of the incidents involved children, with the drownings including members of the public attempting to rescue the victims.

The most tragic on the incidents occurred on October 30, 2021 when 4 members of a paddleboarding club drowned at the Haverford West Weir in Wales, while a further 5 members had to be rescued.



Wales - Haverfordwest Weir, October 30, 2021, 4 Fatalities

Other recent incidents occurring in the UK that were entered into the database included:

- Darley Abbey Weir, River Derwent, July 27, 2021 swimmer rescued from the hydraulic
- Diglis Weir, River Severn, May 27, 2021, 2 boaters rescued from going over the weir
- Newbury Weir, Kennet and Avon Canal, May 18, 2021 3 year old boy drowns when he tripped and fell into the river upstream of the weir and cascaded over the spillway. The boys mother who attempted to rescue her son managed to survive after being rescued by emergency services.
- Glebe Hill Manor, River Cusher, February 21, 2021 2 kayakers rescued after going over the spillway and being trapped in the hydraulic
- Berkshire Weir, River Thames, June 26, 2020, 2 recent immigrants from Syria drowned and a third was rescued after getting caught in the hydraulic downstream of the dam. One of the victims was attempting to rescue his friend when he was caught in the current.



Berkshire Weir, River Thames, June 26, 2020, 2 fatalities

- Bathampton Weir, River Avon May 30, 2020, similar to the June 26th event at the Berkshire Weir, 2 recent immigrants from Goa drowned and a third was rescued after getting caught in the hydraulic downstream of the dam. One of the victims was attempting to rescue his friend when he was caught in the current.
- Diglis Weir, River Severn, October 10, 2020 a 50 year old woman swimmer was rescued by emergency services at the same location as the May 27, 2021 incident. The Diglis Weir is the site of numerous incidents over the years.

- Darlington Weir, River Tees August 18, 2020 – a 15 year old boy drowned trying to rescue his younger brother who was swimming near the weir and became trapped in the downstream hydraulic. The boys had recently immigrated from Syria.



**Darlington Weir, River Tees August 18, 2020 – 15 year old drowns
(note the rescue throw buoy at the site)**

- Saxon Mill Dam, River Avon August 21, 2020 - 3 young boys (11 – 12 years of age) were rescued by emergency services after becoming trapped in the hydraulic downstream of the dam while swimming.
- South Cumrian Weir, River Duddon – two, 13 year old boys were rescued by one of their mothers when they were caught in the hydraulic of the weir. The mother herself nearly drowned in attempting the rescue and herself needed to be rescued by emergency services who responded to the scene.

5.9 United States

Within the United States there are two very active Committee’s that are addressing the issue of public safety around dams, those being USSD and ASDSO. The ASDSO website at www.damsafety.org contains a very good reference for public safety around dams, including links to incidents that have occurred in the United States over the past number of years.

There are three main initiatives underway in the United States:

- Low-head Dam inventory – this initiative is aimed at creating a national inventory of low-head dams using a GIS based framework to map the locations. The information will eventually benefit State regulators who may not have such low head dams within their

State inventories, but who are taking steps to address hazards associated with these so-called ‘drowning machines’.

- Low-head Dam Public Education – this initiative is intended to both inform the public about the hazards associated with low-head dams and the “drowning machine” effects created at the outfall to the ogee sections, as well as to the owners and regulators to inform them about the various techniques to mitigate the impacts of these structures, including the option to remove or modify them to eliminate the reverse hydraulics.
- FEMA National Signage Guideline – this initiative scheduled for completion in 2021 is intended to create a guideline for owners and regulators to reference when recommending warning signs to be erected at dams and hydropower facilities in the United States. The guideline is building off of existing standards which various US based agencies have developed, as well as the work of the Canadian Dam Association with the CDA Guidelines for Public Safety Around Dams (2011)
- Canal Safety Challenge – this initiative founded by US Bureau of Reclamation (USBR) established a prize fund to solicit ideas to improve canal safety for both public and animals. The intent to help reduce the number of drownings occurring in canals throughout the United States. The competition set to be completed by December 2021, was to solicit competitors to solve tough issues, advance research, and spur innovation. Phase 1 of the challenge found 18 eligible submissions that were narrowed to three winners that received \$50,000 each to further develop a prototype. Phase 2 (November 15- 23) the three finalists will use USBR’s Hydraulics Laboratory, to demonstrate and have their prototypes tested. The overall winner will receive \$100,000 prize. Details of the competition are available at <https://www.usbr.gov/research/challenges/>.

Appendix A – Committee Membership

ICOLD Committee

COMMITTEE I

PUBLIC SAFETY AROUND DAMS

Chaired by: Tony Bennett – CANADA

Comité CIGB

2020 - 2023

SÉCURITÉ DU PUBLIC PRÈS DES BARRAGES

Contact: tony.bennett@opg.com

<p>Tony Bennett Director, Dam and Public Safety Ontario Power Generation 14000 Niagara Parkway RR#1 Niagara-on-the-Lake, Ontario Canada L0S 1J0 Phone: (905) 262-2667 Cell: (416) 938-9747 tony.bennett@opg.com bennett.tony8@gmail.com (alt.)</p>	CANADA	Chair
<p>Peter Lilley Independent Consultant Past Chair NZSOLD 355 Gluepot Road Orangi Tauranga Postal Code 3173 New Zealand Phone (Mob): +64 21 957937 peterlilley68@gmail.com</p>	NEW ZEALAND	Vice Chair
<p>Angus Swindon Director, Tasset Consulting Hobart, Tasmania Cell: +61 429 000 605 aswindon@tassetconsult.com</p>	AUSTRALIA	
<p>Burkhard Rüdissler Federal Ministry for Sustainability and Tourism Water Management, Dam Surveillance & Commission on Dams Marxergasse 2, 1030 Vienna, Austria Phone: 43 1 71100 60 7562 Burkhard.Ruedisser@bmnt.gv.at</p>	AUSTRIA	
<p>Michael Berger Consultant Phone: 43 664 655 1393 michael.berger@tuwien.ac.at</p>	AUSTRIA (co-opted member)	
<p>Helmut Czerny helmut.czerny@bmlfuw.gv.at</p>	AUSTRIA (Alternate Member)	

<p>Ricardo Aguiar Magalhães Rua Teixeira de Freitas, 490/1201 - Bairro Santo Antônio 30350-180 Belo Horizonte – MG BRAZIL Telephone: +55 31 999 573 878 contato@ideiajato.com.br</p>	<p>BRAZIL</p>
<p>David Bonin Senior Hydraulic Engineer HATCH 500 Portage Avenue Sixth Floor Winnipeg, Manitoba, R3C 3Y8 CANADA Office: (204) 786-8751 Mobile: (204) 792-0211 DBonin@hatch.ca</p>	<p>CANADA (co-opted member)</p>
<p>Xiuli Zhang (Ms.) Chief Engineer Dam Safety Supervision Center State Electricity Regulatory Commission of China. Office: +86 571 8807860 Mobile: +86 13957169950 zhang_xl@ecidi.com xwyao.zju@gmail.com (Xiaowen Yao Asst.)</p>	<p>CHINA</p>
<p>Professor Ashraf S. Elsahaal Chair of the Egyptian National Committee aaselashaal@yahoo.com</p>	<p>EGYPT</p>
<p>Alain Gariel DPIH Direction Industrie Sûreté Hydraulique Phone: +33143690606 Mobile: +33671603311 alain.gariel@edf.fr</p>	<p>FRANCE</p>
<p>Alain Petitjean (retired 2019)</p>	
<p>Bettina Geisseler Rechtsanwältin/ Lawyer GEISSELER LAW Im Rebstall 1 D 79112 Freiburg GERMANY Office: + 49 7665 – 939 02 46 Mobile: + 49 160 - 972 60 945 geisseler@geisseler-law.com</p>	<p>GERMANY</p>
<p>Balraj Joshi Chairman and Managing Director (retired) NHPC Limited (former org.)</p>	<p>INDIA</p>

Robert (Purba) Sianipar Deputy Chairman for Infrastructures (retired) Batam Indonesia Free Zone Authority (former org.) Pulau Batam, Indonesia Phone: (+62)8127028382 prmsianipar@yahoo.com	INDONESIA
Taghi Ebadi 3 rd Floor, No. 1 Shahrzaz Alley Kargozar Ave., Dastgerdi St. Tehran, Iran Postal Code 1919834453 Phone: +98 21 22225756 Cell Phone: +98 912 2042085 Ebadi.ta@gmail.com ircold@neda.net (alternative)	IRAN
Hideshi Sasahara Japan Water Agency hideshi_sasahara@water.go.jp	JAPAN
Tatsuo Hamaguchi (retired 2021)	
S. Rahsidi No. 1, Kawasan Institusi Penyelidikan, Jalan Ayer Itam 43000 Kajang MALAYSIA 019-3826797 Mycold.publicsafety@gmail.com	MALAYSIA
Bassey Nkposong Engineer Cross River Basin Development Authority Basin Town, 8 Miles Calaber 540221 NIGERIA Mobile : 08033484132 basseynkposong@yahoo.com	NIGERIA
Stella Nneka Arachie Federal Ministry of Water Resources Old Secretariat Block P.M.B 159, Garki, ABUJA 23401 NIGERIA Phone: +23436046611 sarachie@yahoo.com	NIGERIA (alt. Member)
Anne-Marit Ruud Principal Specialist, Production, Operation and Maintenance, Civil Statkraft Energy AS Lilleakervn 6, PO Box 200 Lilleaker 0216 Oslo, Norway Cell: +47 91 55 67 36 anne.marit.ruud@statkraft.com	NORWAY

Ambrosio Ramos

Chairman, Comité Panameño de Presas
Panama
La chorreia
Box 1015-00009
Phone: +507 2542980
aramos@aramoshidro.com

PANAMÁ

Dr. Alfons P. Pak (retired 2019)

RUSSIA (request sent to RUSCOLD for new member, March 5, 2020)

Dr. Andrej Kryzanowski

Professor of Hydraulic Engineering
Faculty of Civil and Geodetic Engineering
University of Ljubljana
Hajdrihova 28,
SI-1000
Ljubljana, Slovenia
Phone: +386 1 425 40 52
andrej.kryzanowski@fgg.uni-lj.si

SLOVENIA

Ms Zandile Mathe (retired 2019)

SOUTH AFRICA (note sent to SANCOLD new member, March 5, 2020)

Carlos Granell Ninot

Secretary General
SPANCOLD
Spain
Secretariogeneral@spancold.es

SPAIN

Anna Engström Meyer

elberedskap, dammsäkerhet
Svenska Kraftnät
Box 1200
172 24 Sundbyberg
Sturegatan 1
SWEDEN
Telefon: +46 010 475 83 42
anna.engstrommeyer@SVK.SE

SWEDEN

Alexandra Beckstein

Specialist, Supervision of Dams
Federal Department of the Environment, Transport, Energy and Communications DETEC
Swiss Federal Office of Energy SFOE
Supervision of Dams
Mühlestrasse 4, 3063 Ittigen,
Postal address: Swiss Federal Office of Energy, 3003 Bern
Phone: +41 58 462 76 89
Alexandra.Beckstein@bfe.admin.ch

SWITZERLAND

Sam Tudor

Welsh Water
Dinas Depot
Llanwda, Gwynedd
Wales, United Kingdom
LL54 5UD
Phone: +44 786 7 395 423
Samuel.Tudor@dwrcymru.com

UNITED KINGDOM

William (Bill) Foos

Director of Security and Safety Services
Gannett Fleming
Denver, Colorado
UNITED STATES
Office: 303-390-3977
Mobile: (717) 571-3412
wfoos@gfnet.com

UNITED STATES

Steve Hocking (retired 2021)

UNITED STATES (Co-opted Member)

Julio C. Patrone

Dams and Reservoirs Chief
U.T.E. (Usinas y Trasmisiones Eléctricas)
Secretario, Comité Uruguay de Grandes Presas
Paraguay 2431
Office 629
Montevideo, Uruguay
Postal Code: U800
Phone: 005982 2000996
JPatrone@ute.com.uy

URUGUAY

Appendix B – Draft Bulletins, Tables of Contents

Bulletin B1 – Public Safety Principles

Contents

Acknowledgements	4
1. Introduction.....	10
1.1. Scope of Committees Work.....	10
1.2. Scope of Bulletin.....	11
1.3. Bulletin Structure	12
2. Principles of Public Safety	14
2.1. Introduction.....	14
2.2. Scope and Definition	14
2.3. Fundamental Objective	15
2.4. Principles of Public Safety	16
3. Current Status and State of Practice	18
3.1. Introduction.....	18
3.2. State of Practice	18
3.3. Regulation	18
3.4. Existing Guidance Material.....	21
3.4.1. Guidelines	21
3.4.2. Benchmarking Tools.....	21
3.4.3. Incident Records	22
3.4.4. Signage.....	22
3.4.5. Industry Awareness	22
3.4.6. Public Awareness	22
3.4.7. Low Head Dams and Weirs	22
4. Establishing the Context.....	24
4.1. Introduction.....	24
4.2. External and Societal Perspective	24
4.3. Organisational Perspective.....	25
4.4. Scope and Schedule.....	26
4.5. Gaps in Guidance.....	27
4.5.1. Regulation	27
4.5.2. Incident Reporting	27
4.5.3. Low Head Dams and Weirs	27
4.5.4. Hydraulic Assessments.....	28
4.5.5. Industry Awareness	28
4.5.6. Public Awareness	29

4.5.7.	Standardisation of Measures	29
4.5.8.	Industry Benchmarking Tools	29
4.5.9.	Moderate Flood Events	29
5.	Managed System	31
5.1.	Policies and Objectives	32
5.1.1.	Purpose	32
5.1.2.	Responsibility	32
5.1.3.	Guidance	32
5.2.	Planning and Assessments	33
5.2.1.	Purpose	33
5.2.2.	Responsibility	34
5.2.3.	Guidance	34
5.3.	Design and Implementation	35
5.3.1.	Purpose	36
5.3.2.	Responsibility	36
5.3.3.	Guidance	36
5.4.	Monitoring and Evaluation	37
5.4.1.	Purpose	37
5.4.2.	Responsibility	37
5.4.3.	Guidance	38
5.5.	Audit and Review	39
5.5.1.	Purpose	39
5.5.2.	Responsibility	40
5.5.3.	Guidance	40
5.6.	Continuous Improvement	40
5.6.1.	Purpose	41
5.6.2.	Responsibility	41
5.6.3.	Guidance	41
5.7.	Summary of Managed System Approach	44
6.	Case Studies of Public Safety Risk	47
6.1.	Introduction.....	47
6.2.	Dam Structures.....	47
6.3.	Low Head Weirs.....	47
6.4.	Intakes and Outlets	47

6.5.	Operational Changes	47
6.6.	Seasonal / Temporal Risks	47
6.7.	Competing / Alternative Uses	47
6.8.	Less Common Examples	48
7.	Education Awareness and Learning	49
7.1.	Introduction.....	49
7.2.	Organising Education and Training.....	50
7.3.	Public Education and Training	50
8.	System Performance, Review and Assessment.....	52

Bulletin B2 – Public Safety Assessments

Table of Contents

ACKNOWLEDGEMENTS

PREFACE

1. INTRODUCTION – SCOPE OF THE BULLETIN	9
1.1 Scope of Public Safety Assessments.....	9
1.2 Synopsis of Report.....	10
1.3 Framework of a Managed System for Public Safety.....	11
2. OVERARCHING PRINCIPLES OF A PUBLIC SAFETY ASSESSMENT	12
2.1 Principles of Public Safety.....	12
2.1 Justification.....	13
2.2 Fundamental Public Safety Objectives.....	13
2.3 Introduction to Public Safety Assessment.....	13
2.3.1 Organizing Resources to Prepare for Assessment.....	14
2.3.2 Evaluating the Site.....	14
2.3.3. Preparing the Hazard Portfolio.....	17
2.3.4 Determining Probability.....	18
2.4 Management Focus.....	18
3. Undertaking the Assessment Process	19
Step 1 – Establish Boundaries of Site Components.....	19
Step 2 – Identify Public Activities within Each Component.....	20
Step 3 – Identify the Hazards within Each Component.....	21
3.1 Hazard Identification Process.....	23
3.1.1 Site Inspection.....	24
3.1.2 Review of Operating Procedures.....	25
3.1.3 Tabletop Review.....	26
3.1.4 Hydraulic Assessment.....	26
4 Risk Assessment	27
4.1 Risk Treatment.....	31
5. Documentation	32
6. References	33
Technical Publications.....	33

Guidelines	35
Websites	36
Glossary	37
Definition of Words Used	37
APPENDICES	41
Risk Assessment Processes Templates	41
Public Safety Assessment Report Template.....	42
Public Safety Assessment Sample Checklist.....	43

Figure 1 Elements of a Management System.....	12
Figure 2 Hazard Identification Process.....	24
Figure 3 Risk Evaluation Matrix of CDA.....	29
Figure 4 The Cycle of Risk-assessment.....	29
Figure 5 Example of a risk matrix.....	30
Figure 6 Phased Approach to Risk Treatment.....	32

Bulletin B3 – Technical Applications

Table of Contents

No index entries found.
Chapter 1: Introduction
Chapter 2: Assessment Findings
Chapter 3: Planning and Selection
Chapter 4: Mitigation, Control, and Notification Measures
Chapter 5: Implementation
Chapter 6: References
Chapter 7: Glossary.....
Appendices

Bulletin B4 – Incident Management

TABLE OF CONTENTS

1.	INTRODUCTION – SCOPE OF BULLETIN	11
1.1.	DEFINITIONS OF PUBLIC SAFETY INCIDENTS	11
1.2.	UNDERSTANDING PUBLIC SAFETY HAZARDS	12
1.2.1.	Fall from Heights.....	12
1.2.2.	Reverse Hydraulics.....	12
1.2.3.	Strong Currents at Intakes and Discharge Points.....	12
1.2.4.	Rapid Changes to Flows and Water Levels.....	12
1.2.5.	Spillway Gates – Guarding and Mis-Operation.....	13
1.3.	LEGAL CONTEXT.....	13
1.4.	BENEFITS OF INCIDENT REPORTING	14
2.	STAGES OF A PUBLIC SAFETY INCIDENT	16
2.1.	BOWTIE DIAGRAM OF A PUBLIC SAFETY INCIDENT	16
2.2.	SOCIETAL AND ORGANIZATIONAL PREVENTATIVE MEASURES - STAGE 1	16
2.3.	CONTROL MEASURES, PHYSICAL AND OPERATIONAL – STAGE 2	17
2.4.	PUBLIC SAFETY INCIDENT – STAGE 3.....	17
2.5.	MITIGATION AND RECOVERY MEASURES – STAGE 4	17
2.6.	OUTCOMES DRIVING CHANGE, ORGANIZATIONAL AND SOCIETAL– STAGE 5	17
3.	SYSTEMS TO CLASSIFY A PUBLIC SAFETY INCIDENT	19
3.1.	NATIONAL LIFE SAVING SOCIETIES – DROWNING DATABASES.....	19
3.2.	FRANCE – CLASSIFICATION AND REPORTING	19
3.3.	FERC – CLASSIFICATION AND REPORTING	19
3.4.	DEFRA – CLASSIFICATION AND REPORTING	19
3.5.	OTHER NATIONAL COMMITTEE OR ORGANIZATION REPORTING SYSTEM.....	20
3.6.	SAMPLE DAM OWNER’S - PUBLIC SAFETY INCIDENT REPORTING SYSTEM	20
4.	SAMPLE PUBLIC SAFETY INCIDENT REPORTING SYSTEM	23
4.1.	DAM	23
4.2.	CONTROL MEASURES	23
4.3.	INCIDENT LOCATION	23
4.4.	ACTIVITIES.....	23
4.5.	CONTRIBUTING FACTORS	23
4.6.	MITIGATING FACTORS	23
4.7.	VICTIMS.....	23
4.8.	RESCUE.....	23
4.9.	INVESTIGATIONS	24
4.10.	CORRECTIVE ACTIONS	24
5.	PUBLIC SAFETY RESCUE	25
5.1.	UNDERSTANDING REVERSE HYDRAULICS.....	25
5.2.	RESCUE PROCEDURES	25
5.3.	RESCUE EQUIPMENT AND PHYSICAL CONTROL MEASURES	25
5.4.	RESCUE TRAINING.....	26
6.	INVESTIGATION OF INCIDENTS.....	28
6.1.	ROLES AND RESPONSIBILITIES.....	28
6.2.	TECHNIQUES	28
6.3.	DOCUMENTING CORRECTIVE ACTIONS AND LESSONS LEARNED	28
7.	DATA ANALYSIS OF PUBLIC SAFETY INCIDENTS.....	29
7.1.	DAM TYPE.....	29
7.2.	ACTIVITIES	30
7.3.	VICTIMS	30

7.4.	RESCUE	30
8.	CASE STUDIES.....	31
8.1.	OPERATION OF SPILLWAY GATES AND HYDROPOWER STATIONS	31
8.1.1.	France (1996), Barrage de Notre-Dame de Commiers – EDF/ National	31
8.1.2.	JAPAN, Kurokura Dam Accident (1999)	31
8.1.3.	Kajigawa Dam Incident, June 2017, Japan.....	33
8.1.4.	Canada (2002), BARRETT CHUTE – OPG/ CDA (National) Guidelines	34
8.1.5.	India (2014), Larji Dam – Spillway Gate – Control Measure Mtce.	34
8.1.6.	Cambodia – New Hydropower Plant Start-Up, Hydraulic Assessments	36
8.1.7.	Taiwan (2020) – Spurious Spillway Gate Operation	36
8.2.	LOW HEAD DAMS AND WEIRS.....	36
8.2.1.	USA, Harrisburg Dam – Low Head Weir, Multiple Fatalities	36
8.2.2.	CANADA, CALGARY WEIR – Whitewater Park Redevelopment & Lifejackets..	36
8.2.3.	USA, Duke Energy Eden Dam (2021).....	36
8.2.4.	USA, Low Head Dam Removal Example	36
8.3.	CONTROL MEASURE FAILURES	36
8.3.1.	Canada, 2008 Joquiere Dam, Control Measure Effectiveness	36
8.4.	FALL FROM HEIGHTS	36
8.4.1.	Example of High Risk activity (e.g. Australian skateboarders).....	36
8.5.	OTHER TYPES OF PUBLIC SAFETY INCIDENTS	36
8.5.1.	Slovenia (2010) – Construction Hazard	36
8.5.2.	Australia, Bedford Weir (2008) - both dam and public safety incident	36
8.5.3.	Africa, 2021 example of dry dam overflow	36
8.5.4.	Examples of Near-miss	36
9.	REFERENCES.....	37

FIGURES; TABLES

Figure 1 - Framework for Public Safety Around Dams Bulletins	5
Figure 2 - Bowtie Diagram of a Public Safety Incident.....	15
Figure 3 - Management of Public Safety Incidents	Error! Bookmark not defined.
Figure 4 - Site Layout of the Larji Dam Accident (ref. Bennett, 2014)	33
Figure 5 - Search Operations Underway on the Beas River, Downstream of the Larji Dam	34
Table 1 - Public Safety Incident and Reportable Event Classification Criteria and Initial Notification Requirements.....	37