Public Safety Around Dams

Ontario Power Generation's Approach

BY TONY BENNETT AND LYLE ROWAT

The Lifesaving Society of Canada reports that in the 10-year period from 1995 to 2004 there were 27 fatalities associated with dams. While one would have to go through the details of the individual coroner's reports to determine the circumstances surrounding the incidents, even this level of review points out the need for programs to address the issue of public safety around dams and hydropower facilities. Yet dam owners and regulators have disproportionately focused the dam industry on issues related to protection against various dam failure scenarios.

In part, this has arisen from the fact that the life safety consequences associated with issues of public safety around dams are generally much lower than those associated with the catastrophic failure of a dam. However, when the frequency of the actual public safety events are contrasted with the fact that in Canada there have only been five recorded fatalities associated with dam failures since 1912, one can easily conclude that the acute public safety risks are much greater and certainly deserving of attention.

In developing the Waterways Public Safety Program at Ontario Power Generation (OPG), it was identified that a managed system approach was fundamental to the long-term success of the program.

The first step with any managed system is to provide the policy statement including governing principles on which the program is based. Within OPG, the overarching principles include such elements as:

- Integrating public safety considerations into normal business practices and decisions;
- Applying conservative decision making principles regarding operations where there are issues of public safety;
- Seeking partnership opportunities that enhance public safety awareness and address public safety issues.

Risk Assessment

OPG has developed a public safety risk assessment process that provides a systematic means of documenting the rationale for instituting control measures at the facility for the protection of the public. The key steps are:

- Identifying each type of known public interaction at a facility;
- Identifying the hazards associated with those interactions;
- Assigning a rating of likelihood and consequence for each separate public interaction at a facility;
- Assigning a risk rating, with a risk matrix, for each public interaction.

This risk rating is assigned to each component present at a facility. These components are the headpond, tailrace, spillway, upstream area and downstream area, as illustrated in Figure 1. This allows each component to have

continued on page 28

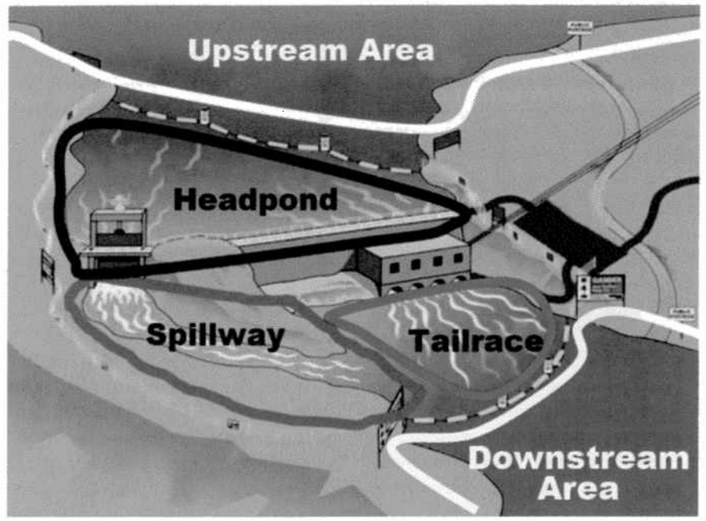

Figure 1: Major components of a dam site.

continued from page 27

control measures suitable to the risk and activity installed without forcing unnecessary control measures for the other components.

In conducting the risk assessment, consideration is given to such factors as seasonal and daily weather effects. For example, during the summer, or other periods of low flow, the public may anticipate that there is a lower likelihood that conditions can change rapidly. There may also be a perception amongst the public that spill operations are only associated with rainfall or snowmelt events, and therefore there may be a general lack of awareness that spill can also result from other factors such as changes in generation or previous precipitation events in upstream areas of the basin.

The quality of the risk assessment depends on the degree of site-specific knowledge, which is best obtained from experienced staff working at the location or engaged in its operation. One of the challenging aspects of the risk assessment is in estimating the frequency of public interaction. Often times, staff is only present during the day from Monday to Friday at a facility. For this reason it is necessary to do some spot checks during potential high use periods, e.g., after work hours, on weekends, major holidays, etc.

As part of the managed system, a new public safety risk assessment must be completed every three years. Some key questions that are asked at this time are:

- Has the degree of public interaction changed?
- Are there new public interactions occurring at the site?
- Have the potential consequences changed for a specific public interaction?
- Have there been changes to the operating procedures for the dam or hydroelectric station?
- Have any new structures been added or existing structures modified since the last risk assessment?

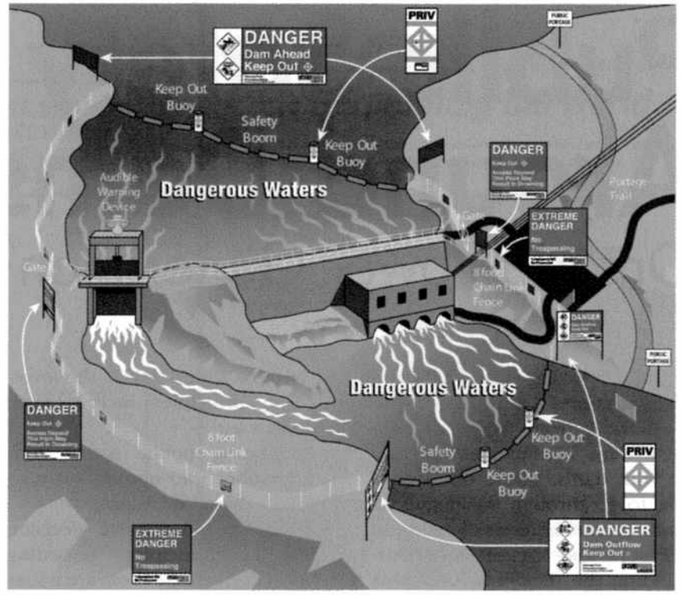

Figure 2: Public safety control measures.

Control Measures

Once the risk assessment is complete, it can now be used to provide guidance in implementing control measures as a means to reasonably lower the risk to an acceptable level.

The model OPG has adopted is that every water conveyance structure will have an established hazardous area, which is typically adjacent to the structure (Figure 2). This geographic area is easily recognizable by the fact that the control measures work in harmony to delineate the perimeter of this hazardous area. These control measures can be either operational or physical.

Hazardous areas can be categorized as either a dangerous area or a warning area.

A dangerous area is an area where there is a reasonable likelihood of serious injury or a fatality as a result of human exposure to hazards created by the water conveyance structure or its operation.

For example, at a typical water conveyance structure the dangerous area would include the area immediately upstream and downstream of the water passages. Red danger signs physically delineate this area with other control measures installed as required (Figure 3).

A warning area is one where there is a reasonable likelihood of minor injury as a result of human exposure to hazards created by the water conveyance structure or its operation. Hazards within this area are typically of low enough risk as to require only the area to be delineated

Figure 3: Danger sign.

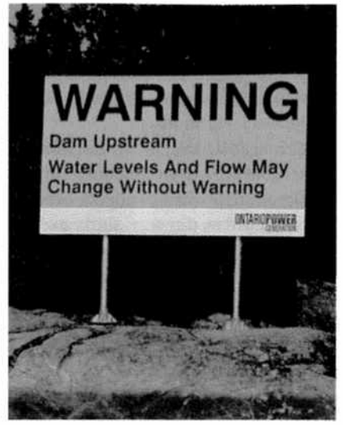

Figure 4: Warning sign.

by "yellow warning" signs with no further control measures required (Figure 4).

Warning signs would also be used to delineate areas where there is a likelihood for the public to become stranded as a result of operations requiring first responder type rescue but unlikely to result in injury unless the individual(s) re-entered the waterway.

Not all structures are the same when looking at the likelihood or the consequence of a potential adverse incident involving a member of the public. A reasonable approach is thus taken in implementing a variety of control measures, which are commensurate with the risk determined for each facility.

As a minimum, OPG uses signage, sluicegate audible alarms, a stepped approach to sluicegate openings and public education. If additional control measures are required to reduce the risk, then one or more of the following may need to be implemented to target the specific public interaction(s):

- Operating procedures;
- Safety buoys;
- Safety booms;
- Fencing & barricades;
- Security patrols;
- Video surveillance.

People approaching water conveyance structures are not always aware of their existence or of the hazards present. It is important for these people to be made aware of the hazard before they enter the hazardous area. It is for this reason that signage out at the perimeter of the hazardous area is critical.

Signage

There is an expectation from the public that signs will indicate ownership, allowable access areas and hazardous areas. Signage is one of the most effective means of notifying the public of potential hazards. With the one exception of standard No Trespassing signs, OPG identifies both the hazard and the required action (Figure 5). All OPG signs have a consistent approach to sizing, colour, and format. All waterway signs are sized and placed at the extent of the "Dangerous Waters" area, so they are readable by the public approaching that area along the shore or from the waterway. Waterway signs within hearing distance of

continued on page 30

Figure 5: Keep out sign.

continued from page 29

any spillway audible warning device or within visual distance of any strobe lights include wording explaining the purpose of the audible alarm and/or strobe lights.

Once it has been determined if the sign should be a danger sign (red) or warning sign (yellow) and the message text selected, the next key item is its size. All signs must be large enough to be read at the expected distance. This viewing distance is the primary factor in determining the size of the message text lettering and the overall dimensions of the sign itself. OPG typically uses one inch of message text height to every 33 feet of viewing distance.

Though OPG mainly uses the English language on its signs, there are locations where it has made sense to install French and Ojibway signs also.

Red waterway danger signs are, as a minimum, installed one upstream, one downstream, and at the land access point(s) to the water conveyance structure. The upstream and downstream waterway signs are located at the extent of the dangerous area.

Operating Procedures

Operating procedures can be an effective means of mitigating public safety hazards. Documented site-specific operating procedures for water conveyance structures must consider:

- Increments of sluice gate opening during spill operations;
- Sequence and duration of audible alert signals;
- Requirements for visual observations (on-site or via surveillance cameras), including specifically where these are needed;
- Requirements for specific notification of the public and/or key downstream stakeholders of impending spill operations;

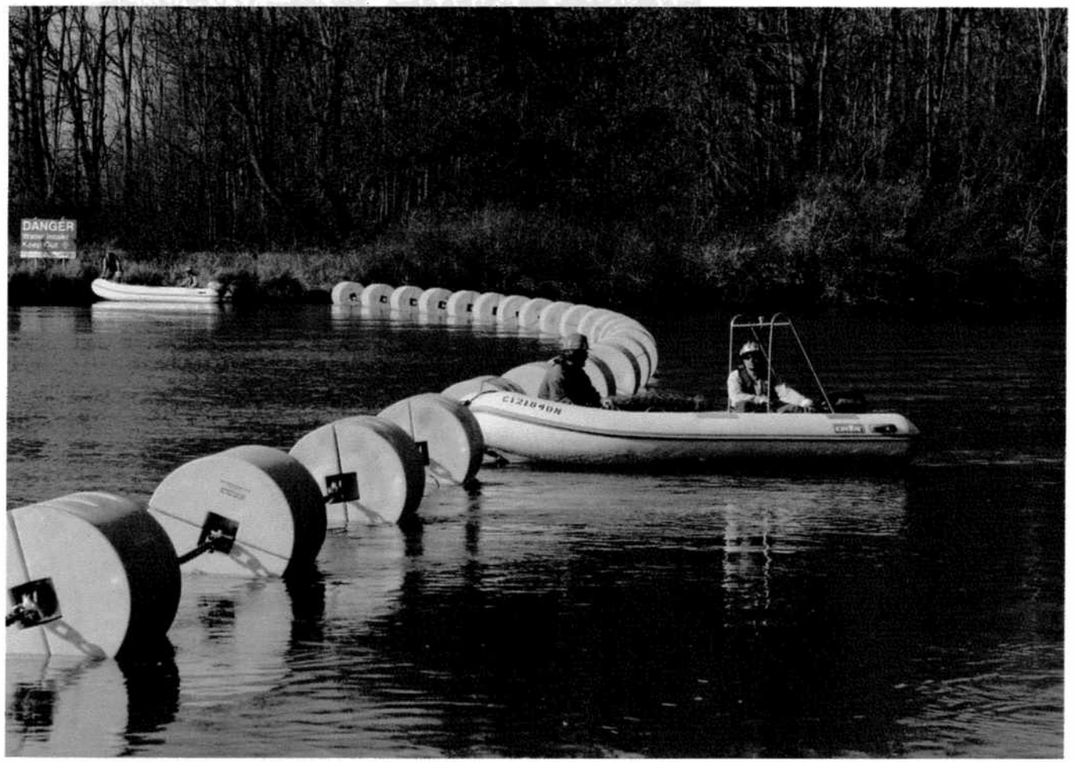

Figure 6: Installation of upstream public safety boom.

- At OPG, all sluicegates are opened in increments to provide sufficient warning to persons who may be in the spillway channel, allowing them to safely exit and to minimize the hazard downstream.

Audible and Visual Danger Signals

The public has an expectation that audible alerts and/or strobe lights will be activated for hazardous spillway operations. At OPG, audible warning devices are used to notify the public of impending spill operations downstream of all remotely and automatically controlled sluice gates.

If members of the public are in the hazardous "danger" area, they have deliberately chosen to ignore signage or other control measures indicating the danger and that they are to "keep out." An audible alarm will sound prior to and during the initial opening of all sluice gates as they are raised from the sill. After the initial opening, an audible alarm is sounded for any step in gate movement that creates a hazardous increase in water level or flow in the spillway channel.

Safety Booms and Buoys

A buoy is an individual "float" anchored in the waterway as an aid to navigation. It is a floating sign utilizing colours and markings established by the Canadian Coast Guard under the Private Buoy Regulations. Buoys are used to communicate hazards, speed limits and other restrictions to boaters and can be owned by the government or private parties. In OPG, the white hazard buoy is used.

A boom is defined as a floating device that consists of horizontal floats, connection hardware, anchors and buoys (Figure 6). The buoys will be either part of the boom or located immediately in front of the boom on the "public" side. Buoys are recognized as the standard across Canada for identifying the existence of waterway hazards.

A safety boom delineates the perimeter of an established dangerous waterway area and act as a physical restraint device for stranded boaters or swimmers to prevent them from entering the dangerous waterways area.

Safety booms are also orientated at an angle to the flow to promote self-rescue of stranded boaters and swimmers. It is critical that the eye brow created in the curve of the safety boom is not downstream of the anchor points thereby hindering self rescue.

All booms on a navigable waterway require approval under the Navigable Waters Protection Act prior to their installation. In OPG, as a minimum, upstream safety booms are installed to delineate the dangerous waterways area:

- Upstream of all overflow spillways;
- Upstream of all flashboard installations;
- At the upstream entrance to all power intake canals;
- Upstream of all sluice gates and stoplog spillways where the risk rating is medium or above;
- Upstream of all intakes where the risk rating is medium or above.

Fencing and Barricades

Fencing and/or barricades are used to control access to water conveyance structures and provides barriers restricting public access to hazardous areas on OPG property. Fencing is only used if it is clearly evident that signage is not effective in stopping undesirable behaviour.

Barricades, (e.g., handrails), may be an adequate control measure given the reasonable likelihood of someone attempting to climb over or through it and given the level of hazard they could be exposed to. Through the risk assessment process, if a barricade is determined to be inadequate to control access then fencing is installed.

In the case of barricades or vehicle gates used to restrict public access to OPG Property, they are typically constructed and installed so as not to create additional hazards. Reflective tape or signs are installed upon the barricade or vehicle gate to aid in reasonably identifying it. Signs are also considered for warning the public in advance of them coming upon the barricade or vehicle gate.

continued on page 32

continued from page 31

Security Patrols and Video Surveillance

If evidence exists on a consistent basis that the public is ignoring the physical control measures discussed thus far it may be necessary to implement security patrols and/or video surveillance. Security patrols are an excellent deterrent to undesirable behaviour. One drawback is that the public may learn the timing of regular patrols and for this reason patrols should be random. The number of patrols can also vary in an attempt to target the expected high periods of public interaction.

Video surveillance technology has seen great strides in recent years resulting in web based applications, easy user controls, exceptional imaging and the ability to record video for prosecution purposes. The significant drawback though with video surveillance is the large amount of communication bandwidth required at the facility. This can be overcome through the installation of fibre-optic cable.

Public Education

Given the natural setting of water conveyance structures and the publics' rights to navigation, it is important to recognize that a key component in managing public safety is to engage the public in understanding the hazards associated with the facilities and their operation. Components of a public education program have two basic goals:

1. Raise the general awareness of the hazards associated with water conveyance structures;
2. Communicate the location of unique hazards associated with specific individual sites.

The first goal is generally addressed through generic advertising strategies. Within the scope of the work are print or broadcast media messages, brochures, posters and other educational materials directed at specific target audiences who may encounter OPG facilities. Aligned with this program are partnership arrangements with other organizations involved in public education to facilitate the distribution of materials and messaging.

The second goal recognizes that certain members of the public, owing to their location, can be targeted for education regarding the hazards associated with a specific site. These would include such site-specific initiatives as:

- Ensuring posters/ brochures are provided to local tourist boards, cottagers associations and parks.
- Informing local campgrounds, resorts and outfitters of the hazards associated with entering OPG sites, including spillways.
- Informing local municipalities, Conservation Authorities and the Ministry of Natural Resources of the specific hazards in order that the information can be included in any educational material that they may produce.
- Informing local enforcement agencies (e.g. OPP, Municipal Policing, MNR – Conservation Officers) of the dangerous waterway areas around OPG facilities in order for trespass violations to be enforced.

Maintenance

As part of the managed system for public safety, a maintenance management system is required so that all control measures are inspected and tested at least annually. In some instances the maintenance cycle for physical control measures needs to be increased as a result of regular vandalism.

Public Safety Incident Reporting

The purpose of reporting, recording and investigating public safety incidents is to identify gaps, opportunities for improvement and corrective actions to mitigate undue risk to the public due to OPG operations or facilities. Past incident reports also act as a tool to evaluate the effectiveness of physical control measures and provide important input to the risk assessment process to understand public interactions specific to the site.

Waterways Public Safety Management Plan

OPG has a formal waterways public safety management plan in place for every water conveyance structure. Each Waterways Public Safety Management Plan identifies all site specific aspects and contains the following key elements:

- Roles & responsibilities;
- A summary of the results of the Risk Assessment;
- A summary of the maintenance program for the public safety control measures;
- Documented rationale that addresses unique conditions not provided for in OPG's procedures;
- Scaled site plans showing locations of the control measures, hazardous areas and the property boundaries;
- Any specific public education programs or site-specific notifications to other landowners, stakeholders or members of the public, including the frequency for any follow-up notifications.

OPG is committed to improving public safety around dams as both a steward on the rivers where it has facilities and as a member of all the communities surrounding those facilities and rivers. ■

Tony Bennett is the Director of Dam Safety and Emergency Preparedness at Ontario Power Generation and can be contacted at (905) 262-2667 or tony.bennett@opg.com. Lyle Rowat is the Senior Advisor, Emergency Preparedness and Public Safety, Ontario Power Generation, (905) 262-2666 or lyle.rowat@opg.com