Hazard Analysis

Public Safety

Assessing risks of hydroelectric power generating facilities

By J.F. Kim Froats and B. Tanaka

PUBLIC SAFETY in and around hydroelectric power generating stations has become a primary concern among senior management of companies that operate such facilities (Avista). Waterways in the vicinity of hydroelectric power plants are used for public recreational activities; these uses must be balanced with the risks associated with hazards that exist in those locations, such as strong currents, rapidly rising water levels and rugged topography.

According to National Safety Council (NSC), drowning is a major hazard to members of the public who engage in recreational activities such as boating, fishing and swimming. In 2001, recreational boating resulted in 701 deaths in the U.S.; of these, 445 fatalities could have been avoided had the victim been wearing a life jacket (NSC). Drowning has an overall fatality rate of 1.15 per 100,000 in the U.S. (NCIPC).

Although the number of fatalities involving hydroelectric generating stations is a small percentage of these overall fatalities, operators of such facilities need to ensure that public safety risks are adequately addressed. Many general risk assessment approaches can be used to determine the extent of the risk present (Andres 20; Cohrssen and Covello 1; Covello, et al 164; NRC 26). This article reviews a simplified risk assessment methodology adopted by Ontario Power Generation to address such risks. It should be noted that this type of assessment targets public recreational risks and is not intended for security or terrorist prevention activities. Other forms of evaluations and assessment methodologies should be used to evaluate those risks for hydroelectric facilities.

Hazards Description

The obvious major hazard to the public is drowning due to the vast quantities of deep water usually found in fast-flowing conditions. Falling—either into water or onto rough terrain due to the presence of rock cuts, rocky cliffs and steep shorelines—is another significant hazard (Figure 1).

The U.S. Federal Energy Review Commission has produced guidelines that detail many of these hazards (FERC). In addition, U.S. Dept. of the Interior, various state agencies and U.S. Army Corps of Engineers provide an overview of the hazards associated with hydroelectric facilities and related structures (U.S. Dept. of the Interior; Pennsylvania Fish and Boat Commission; U.S. Army Corps of Engineers).

A risk assessment is the first step in an entity's efforts to formulate a public waterway safety management plan. The following discussion reviews typical hazards encountered, common public interactions near hydoelectric stations and other factors that may contribute to such hazards.

Each water conveyance facility, including powerhouses and control dams, can include any or all of the following component structures and associated hazards: 1) headpond; 2) water conveyance structure (which includes dam structure, power intake canal, including overflow spill walls, stop log sluices and sluice gates); 3) spillway; 4) powerhouse tailrace; and 5) downstream. Although not exhaustive, the following discussion identifies potential public safety hazards; it is intended to be an aid for completing the risk assessment template.

Headpond

The headpond (upper reservoir) can be hazardous to boaters and swimmers. If not properly identified or highlighted, buoys and booms can be dangerous. Furthermore, floating debris that has collected near booms or adjacent to structures can be dangerous to individuals near the generating facility. In addition, in areas where forestry operations have previously used the waterways for floating logs to mills, old logs and debris can be a concern; these often get trapped at reservoirs on the waterways.

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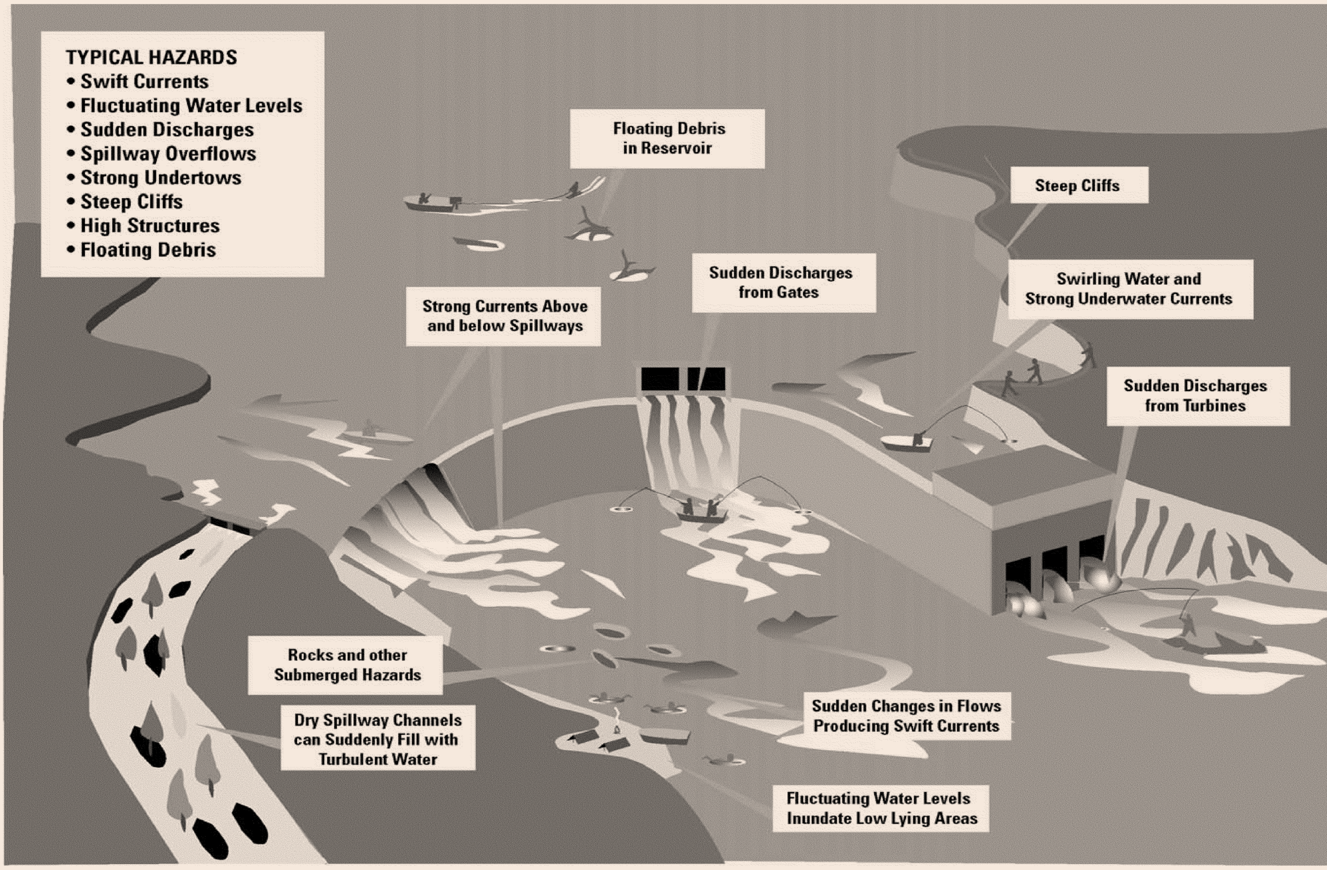
Figure 1

Hydroelectric Facility Layout



Water Conveyance Structures

Dam Structures With or Without Intake Facilities

Currents in powerhouse intake areas are moderately swift, especially during periods of maximum generation. Intake areas usually have trash racks to prevent a person from being drawn into a turbine, although some sites operate without these racks. However, at most sites, it is hazardous to swim or boat near intake areas because a person could be pinned against the trash racks, making escape improbable.

Inlets to conduits, tunnels and submerged intakes are extremely dangerous to swimmers and boaters as well. From the surface, such areas may offer little visible evidence of the dangerous undercurrents. Headgate structures near entrances to canals often create hazards as water flows under or through the gate openings or trash racks. In addition, there is danger of individuals falling from dams, wing walls or headgate structures into reservoirs or rocky areas.

Power Intake Canal

Concrete and naturally lined power intake canals can create hazards should persons enter the channel, whether in a boat or directly in the water, due to high water flow, steep, slippery and highly sloped surfaces, and associated generating equipment.

Overflow Spillways

Overflow spillways are particularly dangerous, as they may be difficult to recognize from the reservoir due to their low profile and lack of concrete superstructure above. Unprotected boaters and swimmers can be drawn over them.

Sluice Gates & Stop Log Sluices

Sluice gates (which open/close to control the water flow) pose several hazards both upstream and downstream of the structures. Upstream, when gates are raised to a point where their bottoms are just below the water surface, people unfamiliar with the operation may not easily recognize that dangerously strong currents are present just below the surface. With the sluice gates in this position, the water surface is often fairly calm and it is not apparent that they are raised.

Stop log sluices, where water discharges over the logs, may sluice boaters/swimmers over the structure. However, these structures are easier to recognize than overflow spillways due to the profile of the deck above the openings. When winter logs are in place, stop log sluices can yield the unrecognized hazard of strong subsurface currents. In these cases, discharge flow is not evident from the upstream side, as all logs appear to be still in the sluiceway openings.

Table 1

Hazards Associated with Hydroelectric Generating Station Component Structures

Component	Hazard
Headpond	•Significant accumulation of floating debris collecting near booms or structures.
Dam structure with or without intake facilities for power generation equipment	•Currents in the powerhouse intake areas are moderately swift, especially during periods of maximum generation. •Pinning against trash racks making escape improbable. •Inlets to conduits, tunnels, inverted siphons or sagpipes are extremely dangerous—little visible evidence of the dangerous undercurrents. •Headgate structures near entrances to canals create hazards as water flows under or through the gate openings or trash racks.
Power intake canal	•High velocities, steep and slippery sloped surfaces.
Overflow spillways and stop log sluices	•Overflow spillways may be difficult to recognize from the reservoir. •Water discharges over the stop log sluices may be difficult to identify.
Sluicegates and stop log sluices	•Upstream issues when gates are raised and bottoms of the gates are below but near the water surface—can be difficult to recognize dangerous currents below the surface. •Flashboards may be designed to collapse during high water periods, creating a sudden increase in flow. •When spillway gates are raised, unexpected discharges can be hazardous. •Deep, submerged spillways and outlet works are generally safe. However, since these spillways cannot be seen from the surface, they are particularly dangerous to swimmers and scuba divers.
Powerhouse tailrace	•Sudden increases in tailrace flows can be very hazardous.
Downstream and natural channels	•Water conveyance facilities are typically located in steep terrain and canyons; these areas are naturally hazardous, but the water conveyance facility could make access easier. Often, the spillway, powerhouse and other project facilities can be obscured from view by natural topography. •Long tailrace and sluiceway channels may create standing turbulent wave action that can pose a particular hazard for boaters caught upstream of standing waves during a substantial increase in spill operations or generation discharge flow. •Consider areas downstream that are out of regular view by staff.
Recreational facilities (boat ramps, canoe portages, hiking trails) near water conveyance facilities	•Designated swimming areas should be isolated from boating areas, and located in safe waters away from sudden dropoffs, swift currents or other dangers. •Recreational facilities near water conveyance facilities bring the public closer to these facilities.
Bridges	•Hazards for sailboaters and boaters. •Public access bridges and over the waterway—driving hazard should be considered.
Other facility structures/ features	•Danger of falling from dams, wing walls, catwalks or headgate structures into waterways.
Natural and other hazards	•Submerged stumps, protruding rock formations and inundated concrete structures with low water levels. •Floating debris near and adjacent to structures.

Spillways

Spillways (a passage for surplus water to run over/around an obstruction) equipped with flashboards are used to raise the reservoir level to increase storage and operating head; they do not spill water under normal circumstances. At some locations, flashboards are removed in order to pass water/ice during spring freshet. The flashboards may also be designed to collapse during high water periods, creating a sudden increase in water flow.

Spillway releases can create turbulent and dangerous flows downstream. When spillway gates are raised, the unexpected discharges can be hazardous to those on the shore or in the water downstream. Submerged spillways and outlet works are considered to be relatively safe because the hazardous currents are well below the surface. However, since these spillways cannot be seen from the surface, they are a danger to swimmers and scuba divers.

Powerhouse Tailrace

Powerhouse tailrace areas are usually more haz-

Table 2

Public Interaction Near Waterways

Hazards	Types of Public Interaction
	Summer/Fall Public Activities
Drowning (fatality) Physical trauma (permanent and partial disability) Falls Other injuries Property loss	Fishing (wading or shoreline) Boating (power) Canoeing/kayaking Swimming/scuba diving Diving/jumping/climbing Water skiing Trespassing/entering/vandalism ATV/dirt bike Camping Others
	Winter Public Activities
Drowning (fatality) Physical trauma (permanent and partial disability) Falls Property loss	Snowmobiling Ice fishing Skating/cross-country skiing on headpond Hiking/snowshoeing along shoreline Others

ardous than intake areas. Sudden increases in tailrace flows occur when generators go on line; these can be very hazardous to anyone near the shoreline, or those wading or boating in the tailrace areas.

Downstream & Natural Channels

Many hydroelectric facilities are constructed to take advantage of unique natural topography. As a result, sites are often located in steep terrain, canyons or near channels that are used primarily for power production. These areas are naturally hazardous. However, the facility can make these areas more accessible, a factor that should be considered in any plan for preventing public access or providing safety controls. In addition, since spillways, powerhouse and other project com-

Figure 2

Risk Assessment Worksheet: Part 1

PUBLIC ACTIVITIES *(Column 1)*	STRUCTURE SYSTEM & PHYSICAL CHARACTERISTICS *(Column 2)*																					Column 3	*(Column 4)*	*(Column 5)*	*(Column 6)*	*(Column 7)*	*(Column 8)*
	High Currents	Rapidly changing water levels	Ungated spillway	Configuration (topography, rock cuts, line of sight etc.)	Slope Instability	High Slopes (Difficult to Exit)	High Wind	Floating Debris	High Structures (> 10 m to next level)	Operations Remote	Operations Automatic	Operations Locally by Operator	Exposed Machinery	Exposed Electrical Equipment	Vehicles & Roadways	THIN ICE (WINTER)	ICE RIDGES	Plant Operation Type [Peaking vs Continuous)]				CONSEQUENCE RATING(= MRPH Rating: (Low Medium, High,) 3, 5)	PPROBABLITIY RATING OF PUBLIC INTERACTION (1-5) (Column	Risk Ranking (1-25)	Description of Minimum Controls	CONTROLS IMPLEMENTED	COMMENTS
HEADPOND																											
SUMMER/ FALL PUBLIC ACTIVITIES																											
FISHING (wading or shoreline)																											
BOATING (Power)																											
CANOEING / KAYAKING																											
SWIMMING/SCUBA																											
DIVING/JUMPING/ CLIMBING																											
WATER SKIING																											
TRESPASSING /ENTERING/VANDALISM																											
ATV /DIRT BIKE																											
CAMPING																											
WINTER PUBLIC ACTIVITIES																											
SNOWMOBILING																											
ICE FISHING																											
SKATING /XC SKIING ON HEAD POND																											
HIKING /SNOWSHOEING ALONG SHORELINE																											
	FACILITY ELEMENT: TOTAL OF ACTIVITY RISK RANKING RESULTS																										0
WATER CONVEYANCE (intake, canals, dam structure, etc.)																											
SUMMER/ FALL PUBLIC ACTIVITIES																											
FISHING (wading or shoreline)																											
BOATING (Power)																											
CANOEING / KAYAKING																											
SWIMMING/SCUBA																											
DIVING/JUMPING/ CLIMBING																											
WATER SKIING																											
TRESPASSING /ENTERING/VANDALISM																											
ATV /DIRT BIKE																											
CAMPING																											
WINTER PUBLIC ACTIVITIES																											
SNOWMOBILING																											
ICE FISHING																											
SKATING /XC SKIING ON HEAD POND																											
HIKING /SNOWSHOEING ALONG SHORELINE																											
	FACILITY ELEMENT: TOTAL OF ACTIVITY RISK RANKING RESULTS																										0

ponents can be obscured from view by natural topography, individuals may unknowingly enter dangerous areas if access is allowed or adequate safety devices are not provided.

Long tailrace and sluiceway channels may create standing turbulent wave action that can pose a particular hazard for boaters caught upstream of standing waves during a substantial increase in spill operations or generation discharge flow. Furthermore, consideration should be given to areas downstream of component structures that are out of regular view of operating staff located at facilities where public interaction is common (e.g., boat ramps, canoe portages, hiking trails, scenic lookouts).

Hazardous conditions at many public recreation areas, scenic overlooks and trails on or near hydroelectric power generating facilities are of particular concern and may require special consideration. Adequate fencing should be installed in high-use areas. In addition, natural and other hazards, such as submerged stumps, protruding rock formations and inundated concrete structures within leased or

Figure 3

Risk Assessment Worksheet: Part 2

PUBLIC ACTIVITIES *(Column 1)*	STRUCTURE SYSTEM & PHYSICAL CHARACTERISTICS *(Column 2)*																					Column 3	*(Column 4)*	*(Column 5)*	*(Column 6)*	*(Column 7)*	*(Column 8)*
	High Currents	Rapidly changing water levels	Ungated spillway	Configuration (topography, rock cuts, line of sight etc.)	Slope Instability	High Slopes (Difficult to Exit)	High Wind	Floating Debris	High Structures (> 10 m to next level)	Operations Remote	Operations Automatic	Operations Locally by Operator	Exposed Machinery	Exposed Electrical Equipment	Vehicles & Roadways	THIN ICE (WINTER)	ICE RIDGES	Plant Operation Type [Peaking vs Continuous)]				CONSEQUENCE RATING(~ MRPH Rating: (Low Medium, High,) 3, 5)	PPROBALITIY RATING OF PUBLIC INTERACTION (1-5) (Column	**Risk Ranking (1-25)**	Description of Minimum Controls	CONTROLS IMPLEMENTED	COMMENTS
SPILLWAY																											
SUMMER/ FALL PUBLIC ACTIVITIES																											
FISHING (wading or shoreline) BOATING (Power) CANOEING / KAYAKING SWIMMING/SCUBA DIVING/JUMPING/ CLIMBING WATER SKIING TRESPASSING /ENTERING/VANDALISM ATV /DIRT BIKE CAMPING																											
WINTER PUBLIC ACTIVITIES																											
SNOWMOBILING ICE FISHING SKATING /XC SKIING ON HEAD POND HIKING /SNOWSHOEING ALONG SHORELINE																											
FACILITY ELEMENT: TOTAL OF ACTIVITY RISK RANKING RESULTS																											0
TAILRACE																											
SUMMER/ FALL PUBLIC ACTIVITIES																											
FISHING (wading or shoreline) BOATING (Power) CANOEING / KAYAKING SWIMMING/SCUBA DIVING/JUMPING/ CLIMBING WATER SKIING TRESPASSING /ENTERING/VANDALISM ATV /DIRT BIKE CAMPING																											
WINTER PUBLIC ACTIVITIES																											
SNOWMOBILING ICE FISHING SKATING /XC SKIING ON HEAD POND																											
FACILITY ELEMENT: TOTAL OF ACTIVITY RISK RANKING RESULTS																											0
DOWNSTREAM																											
SUMMER/ FALL PUBLIC ACTIVITIES																											
FISHING (wading or shoreline) BOATING (Power) CANOEING / KAYAKING SWIMMING/SCUBA DIVING/JUMPING/ CLIMBING WATER SKIING TRESPASSING /ENTERING/VANDALISM ATV /DIRT BIKE CAMPING																											
WINTER PUBLIC ACTIVITIES																											
SNOWMOBILING ICE FISHING SKATING /XC SKIING ON HEAD POND HIKING /SNOWSHOEING ALONG SHORELINE																											
FACILITY ELEMENT: TOTAL OF ACTIVITY RISK RANKING RESULTS																											0
SUM OF ALL FACILITY ELEMENTS: TOTAL OF ALL ACTIVITY RISK RANKING RESULTS																											0

Table 3

Description of Physical Characteristics to Assist in Using Risk Rankings

The following describes in greater detail what is meant by the physical characteristics mentioned in Figures 2 and 3.

Characteristic	Description
High current	>0.9 m/s (~2mph)
Rapidly changing water levels	>0.005 m/s (1 ft./min.)
Spillway	gated spillway or ungated spillway
Configuration (e.g., topography, rough terrain, line of sight)	no spillway, short spillway, minor drop, high spillway, clear view, relatively smooth river bed, restricted view of spillway, rough river bed
Slope instability	solid footing available vs. slippery surfaces or scree
High slopes (difficult to exit)	>40 percent grade
High wind	high winds >20kph more than 25 percent of the time
Floating debris	no debris vs. significant debris
High structures (>10m to next level)	no high structures vs. high structures accessible
Operations remote	operations done from a distance operating center
Operations automatic	automatic operations with no human intervention
Operations locally by operator	[- 2] = If operator present, this contributes to reduced potential for adverse outcomes due to training, and disciplined observation and monitoring.
Exposed machinery	No exposed machinery vs. exposed machinery
Exposed electrical equipment	0 = No exposed electrical equipment; 2 = exposed electrical equipment
Vehicles and roadways (0-3)	No roadways, no vehicles likely vs. accessible roads and numerous vehicles
Thin ice (winter) (0-4)	Stable ice cover vs. thin or negligible (deceptive) ice cover
Ice ridges (0-3)	No ice ridges vs. significant ice ridges regularly formed
Plant operation type [peaking (5) vs. continuous (1)]	
Description of current controls	This is a listing of available controls in place at the facility for the particular system components. Additional control information is mentioned here.

owned lands, may present serious hazards to boaters and swimmers. Table 1 presents a full description of the nature of hazards associated with these component structures.

Types of Public Activities Near Waterways

The types of activities that occur at or near a facility vary greatly from site to site. Factors that influence activities and, therefore, required control measures, include reservoir size and depth; whitewater or other boating opportunities upstream and downstream of the facility; presence of sport fish species; amount and type of public access at or near the site; location of parks and recreation areas at or near the site; and any federal, state and/or provincial and local ordinances regarding speed and type of watercraft allowed. In addition, construction or major maintenance activities may present unique public waterway safety concerns that require special control measures; these must be addressed on a project-specific basis.

For the purposes of this risk assessment methodology, consider as a minimum the following list of public interactions with the waterway and adjacent lands: fishing, boating (power and sailing; canoe/kayak), swimming/scuba diving, diving/jumping/climbing, water skiing, trespassing/entering/vandalism, camping, ATV/dirt biking, snowmobiling, ice fishing, cross-country skiing and hiking/snowshoeing along the shoreline (Table 2).

Geographic Extent of Responsibility

Hydroelectric power generating facility (or plant) staff should work with appropriate stakeholders (e.g., corporate staff, legal counsel and engineering personnel, local representatives of federal, state and/or provincial government agencies) to determine, wherever possible, the geographic extent to which the facility's operation may impact a waterway. This impact should be judged in terms of variable volume and speed of water released that will result in any significant changes to flows and water levels. It is important to think in terms of the whole waterway that is impacted by water management decisions and the related flows and volumes of water which are released through water conveyance structures.

Assessment of Public Safety Hazards

This information will be helpful in conducting a thorough risk assessment:

- facility maps and drawings that clearly indicate all spillways, intakes, canals, tailrace areas and extent of reservoir inundation;
- documents that describe the extent of hydroelectric operators rights at the facility including Water Power Lease Agreements (WPLA), license of occupation and property deeds;
- existing public waterway safety site plans;
- photographs—including aerial images;
- facility security reports;
- past public waterway safety incident reports;

•regulatory requirements for public safety (if applicable);

•external experience from other jurisdictions.

When conducting a risk assessment of a hydroelectric facility, it is best to break down the facility into its major components (e.g., headpond and intake, sluicegate structure and spillway channels, tailrace area, downstream).

Risk Assessment Methodology

Risk can be expressed as a function of the potential consequence of an event and the probability of its occurrence: risk = consequence x probability. To assess public safety recreational risk exposure, staff must estimate the risk, which is a function of the consequence of public interaction with the specific configuration of each site and the degree (or probability) of public interaction with a given facility. As noted, for this assessment, each site is divided into five components: headpond, water conveyance structures, spillway, tailrace and downstream.

Public Use at Specified Locations Within the Facility

Following is a template that can be used to identify hazards associated with hydroelectric generating operations and to assess the risk associated with these hazards and types of public interaction.

Step 1

Using the experience of local operations personnel, the plant should identify those public interactions that are known to take place at each specified location in the facility. A risk assessment worksheet can be used to facilitate this process (Figures 2 and 3). A mark would be placed in any column that describes this physical location.

Step 2

The maximum consequence rating is then assigned for the particular activity at the particular location. Consequences could be categorized into five ratings:

•1 = No Adverse Consequence

•2 = First Aid/Self-Rescue

•3 = Medical Treatment/Rescue Required

•4 = Critical Injuries

•5 = Fatality or Permanent Disability.

Step 3

Next, plant staff should estimate the probability of public interaction with the site. This is done by estimating the number of visits expected to a given site during a season, again on a scale of one to five:

•1 = Fewer than 10 visits per year

•2 = 10 to 100 visits per year

•3 = More than 100 to 500 visits per year

•4 = More than 500 to 5,000 visits per year

•5 = More than 5,000.

Step 4

Next, the risk exposure value for the particular activity should be calculated. To do this, the staff should multiply the consequence rating (Figure 2, column 3) by the probability of public interaction (Figure 2, column 4). This product will yield the risk exposure value for that particular activity in that particular component of the hydroelectric facility. Table 3

Table 4

Control Measure Notations

Control Measure	Notation
Safety booms and buoys	SB
Signage	S
Audible warning devices and video surveillance	AV
Fencing and barricades	FB
Operational controls (procedures)	OP

Figure 4

Public Safety Risk Ranking

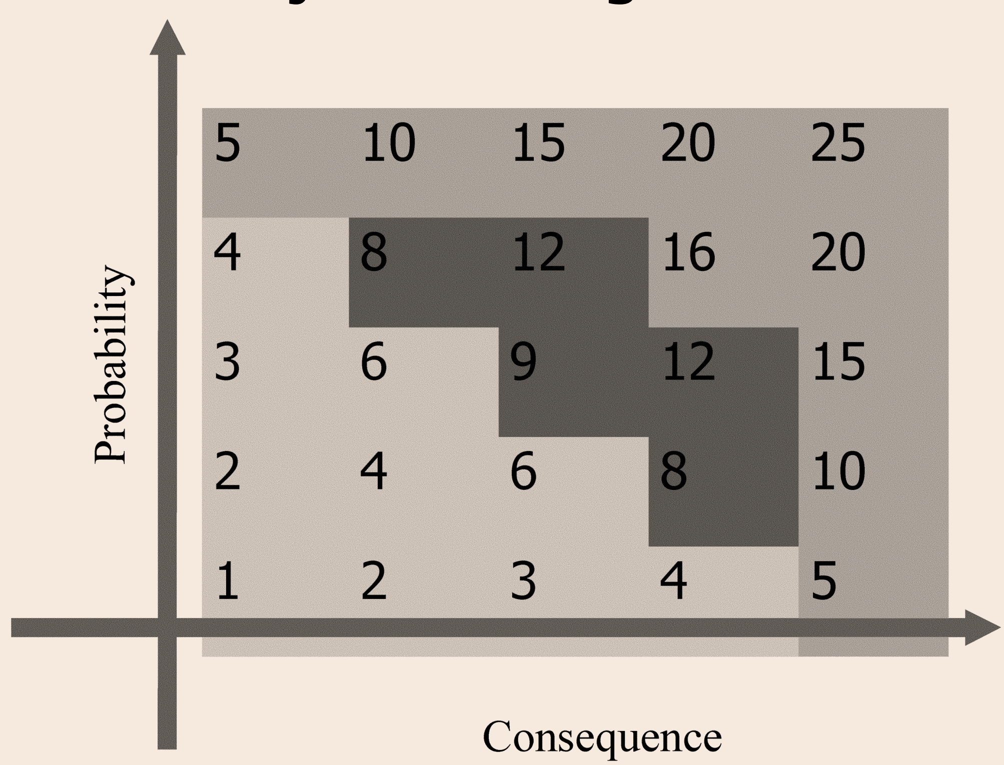


Figure 5

Waterway Public Safety Management Plan

Public Safety Management Plan (PSMP)

Facility Name:______________________________

Rev. 01
Plant Group: ______________
Date: ______________

Purpose:
This PSMP contains the following information relevant to this facility/location:
- roles and responsibilities;
- location public safety risk assessments (LPSRA);
- specific one-time action items (notifications in maintenance program);
- recurring maintenance activities;
- site plans showing control measures and property boundaries;
- public education plan associated with this location.

This PSMP addresses public safety issues at __________ by identifying the interaction the public may have with the principal operational elements of the facility. These normally are:
- headpond
- water conveyance
- spillway
- tailrace
- downstream

This PSMP lists the hazards to the public resulting from the operation of the facility and describes the existing control measures that are to be maintained on a periodic basis.

Responsibilities: *In the space below or as an attachment, identify individual responsibilities for public safety at the facility. Include managers, employees or any individuals with specific roles relating to public safety.*

Name:
Position:
Role/responsibility:

Description: *In the space below, describe the facility to which the plan applies. Please* ***attach a site map*** *showing:*
1) The geographical area covered by the plan.
2) The location and types of the control measures in place:
- *safety devices (booms and buoys);*
- *warning signs;*
- *fencing and barricades;*
- *operational procedures;*
- *public outreach and communication activities;*
- *other public safety controls.*

3) Areas within the plan administered by other jurisdictions, such as federal, state and/or provincial recreation areas; other power companies; or federal or state agencies, etc.

Consequences & Probability of Public Interaction: *Attach the risk assessment for the location noting the types of public interaction, the maximum reasonable potential for an adverse consequence resulting from the activity and the estimate of degree of public interaction.(See guideline on risk assessment for examples).*

provides guidance for determining the extent of risk associated with a facility's physical characteristics.

This results in a risk ranking for each type of interaction for each component of the facility within a 5 x 5 matrix, yielding a risk ranking from 1 to 25 (Figure 4). These values can then be summed by component or by activity to develop a general risk summary for the facility.

Step 5

The next step is to identify barriers and controls in place to mitigate the identified risks. The risk assessment process will identify those components that present the greatest public safety exposure. In addition, performing a risk assessment for the five facility components is the first step in formulating a public waterway safety management plan that may be required by relevant regulatory bodies and related dam safety legislation. Information that can facilitate this process includes existing public waterway safety site plans; site photographs (including aerial images); facility security reports; and past public waterway safety incident reports. The assessment team should list all controls and barriers currently in place using the notations listed in Table 4.

As the final step, the facility should repeat steps 1 through 5 until all known public interactions have been addressed.

Conclusion

The primary benefit of taking a systematic, comprehensive approach to evaluating public safety risk at a hydroelectric facility is that the most reasonable public interactions are identified and ranked. A facility should then seek to implement controls where there exists a public safety risk that is deemed as high. Each individual firm determines what level of risk it is willing to tolerate and at what level it will demand specific controls be implemented. This allows for a better analysis of risk and how to mitigate it.

In addition, each facility should document its respective public safety actions in a site-specific plan (Figures 5 and 6). This risk assessment process also permits comparisons across facilities, which helps an organization set priorities for risk mitigation strategies and limited financial resources.

Using a standardized public safety recreational risk assessment methodology, a hydroelectric facility can ensure that equal judgment is applied and similar level of controls are implemented across an organization to ensure appropriate management control. Such control is commensurate with the risk the public faces when interacting near such a facility. ■

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Figure 6

Waterway Public Safety Management Plan

Public Safety Management Plan (PSMP)

Facility Name:______________________

Rev. 01
Plant Group: ______________
Date: ______________

Control Measures: *In the space below, describe any hazards to the public (see risk assessment matrix for examples). Describe the control measures employed (e.g., removal of hazard, public education, emergency escape measures, restraints, warning signs/devices). Where applicable, please **include** photographs. Where installation or an activity is required, **include** a schedule of implementation. NOTE: Caution must be exercised when providing escape measures to ensure they do not provide a greater risk through improved access to a hazardous area (i.e., weigh precaution vs. misuse) See standard operating procedures for additional signage information.*

Applicable Standards: See specifc business unit requirements and workplace instructions and procedures (WIP) on the following:

Signage: All new signage shall be in accordance with the requirements of the signage standard or WIP. Signs shall be assessed for condition and compatibility with the requirements. Existing signage in good condition with a clear message can be retained until its service life is complete.

Fencing & Barricades: Where security or safety fencing or barricades/guard rails are required it shall comply with Fencing and Security Standards of the corporation. Security fencing shall be used where intentional or accidental entry would pose a real threat of injury or death and liability on the part of corporation. Safety fencing, barricades and other controls, including security patrols shall be used to prevent accidental entry.

Booms: Safety booms intended as positive boater restraints or to defined "Hazard Areas" shall be constructed and installed in accordance with business unit standard or WIP on Booms & Buoys.

Buoys: Buoys intended to designate Hazard Areas or to act as navigational aids shall comply with the appropriate Coast Guard regulation: for Canada see: Canadian Aids to Navigation http://www.ccg-gcc.gc.ca/cen-arc/mns-snm/mns-snm_e.htm.

Example Only:

Element	Control Measures	Number	Type
Headpond	Signage	2 6	Dangerous Waters—Red No Trespassing—Yellow
Boom	Floats steel, with 3 anchors	32	
Fencing	100m 60m	8 foot with barbed wire from structure on east & west shores	
Buoys	6	Registered with the Coast Guard and Ministry of Natural Resources (or other regulatory agency)	
Barricades	4	Jersey barriers leading to access roads on east and west shores	

Inspection & Maintenance Program:

1) Provide details of an inspection program, identifying hazards and control measures inspected, frequency of inspection, means of recording inspections and the correct reporting procedure.
2) Provide details of the maintenance program. Identify any schedules established for routine repairs or improvements.
3) Provide a schedule for inspections that demonstrates due diligence in managing the hazards present (or as attachment).

For each hazard/control measure inspected, inspection records should identify:

1) Date of inspection.
2) Name of person performing inspection.
3) Control measures/devices inspected and their condition.
4) Corrective actions necessary.
5) Confirmation of any corrective actions completed.
6) Acknowledged by (signature).
7) Inspection and maintenance form.