

Appendix SIR-D CHD Dam Safety Emergency Response Plan

Dam Safety
Emergency Response Plan

General Procedures

Forward

Dam Safety Emergency Response Plans (ERP's) are a key component of any dam owner's dam safety program. Canadian Hydro Developers, Inc. will prepare ERP's for its hydroelectric developments throughout Canada.

Canadian Hydro Developer's ERP's will be developed in accordance with the requirements of Canadian Dam Association (CDA). CDA has prepared and published Dam Safety Guidelines as a national standard for dam safety in Canada.

CDA Dam Safety Guidelines state that ERP's be prepared for any dam for which advanced warning of flood inundation would reduce upstream or downstream damage. The ERP is therefore a formal written plan that documents the procedures and processes that a dam owner would follow in the event of an emergency at a dam. The ERP demonstrates the dam owner's preparedness to respond promptly and efficiently.

ERP's are prepared in the interest of public safety. In the event of an emergency, an effective, well-tested ERP will increase public safety and reduce property damage.

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List of Abbreviations

CDA	Canadian Dam Association
CHD	Canadian Hydro Developers, Inc.
CPL	Canadian Projects Limited
EHSMS	Environmental Health and Safety Management System
ERP	Emergency Response Plan
RCMP	Royal Canadian Mounted Police

1 General

1.1 Introduction

CHD owns and operates twelve hydroelectric developments throughout Canada. The use of dams in these developments creates a requirement for a comprehensive dam safety program. A key component of any dam safety program is the development of an ERP.

CHD's ERP's will be prepared in general accordance with the requirements of the Canadian Dam Association's (CDA) Dam Safety Guidelines. CHD is committed to reviewing dam structures to assess safety levels. Likewise, dam design is reviewed with regards to standards for dam safety. This plan is developed in the interest of public safety should an unlikely emergency situation arise.

1.2 Purpose of the Plan

The purpose of the ERP is to

- provide a plan which facilitates public safety by notifying all appropriate authorities,
- provide information to all stakeholders to allow for an informed evaluation to be made during emergency events,
- provide plans of actions for foreseeable flood emergencies affecting safety of dams and affected property downstream,
- initiate action to carry out repairs and reduce the hazard if possible.

The plan is intended to assist CHD, local community authorities, EMO, RCMP, and other agencies in responding swiftly and effectively in the event of a dam safety emergency at any hydroelectric development.

1.3 Responsibilities

The persons identified in this ERP with primary responsibility for emergency response are listed below.

Assistant Manager, Hydro Operations

- Receive and accurately document all details of reported of emergency conditions, using the Emergency Report Form provided in Appendix C.
- Initiate the notification process following initial report of an emergency.
- Ensure that all **Primary Responders** are promptly contacted. This includes;
 - CPL Dam Engineer
 - Facility Manager
 - Manager, Hydro Division
- Provide ongoing communications support to all staff as required.
- Deploy resources as required to prevent/delay/mitigate the incident.
- Co-ordination with engineers, consultants, and contractors.
- Co-ordinate with the Facility Manager regarding immediate decisions for operation of the dam and/or power plant.
- In conjunction with the CPL Dam Engineer, decide if/when to recommend evacuation.

Facility Manager

- Verify site conditions.
- Coordinate all activities at the dam site.
- Make immediate decisions regarding operations of the dam and/or power plant during an emergency (in co-ordination with the Assistant Manager, Hydro Operations).
- Coordinate with local municipal authorities as required.

CPL Dam Engineer

- Ensure that all persons dealing with an incident are informed of the proper ERP protocol to be followed.
- Evaluate the risks associated with the dam incident.
- Provide all relevant hydrotechnical information, based on inundation studies/maps.
- In conjunction with the Assistant Manager, Hydro Operations, assess the level of emergency and determine the appropriate response measures to be taken (i.e., monitoring, stand-by, evacuation).
- ERP document control.

Manager, Hydro Division

- Ensure overall activities are co-ordinated.
- Liaison with CHD senior management.
- Liaison with outside agencies
- Coordinate all appropriate media relations.

1.4 Dam Surveillance

As part of CHD's Environmental Health and Safety Management System (EHSMS), dam inspections/surveillance will be carried out on a regularly scheduled basis, as outlined below.

- Surveillance site visits will be completed by CHD operations field staff at all forebay dams on a monthly basis.
- Site inspections will be completed by CHD operations field staff at all storage reservoir dams on a quarterly basis.
- Engineering dam safety inspections by CPL Civil Engineering staff on a bi-annual basis.
- Independent engineering consultants are scheduled to perform comprehensive dam safety reviews on a 6 to 8 year cycle at all developments.

Dam surveillance is also carried out after and/or during significant events.

All sites are visited daily by CHD field operations staff. These visits involve monitoring of water levels and visual inspections of the dam, spillway, and penstock.

1.5 Outside Agencies

A copy of the ERP will be provided to outside agencies involved in the emergency response procedures associated with any CHD hydro development. A list of Registered ERP Holders will be provided in Appendix A.

- Each listed agency will be asked to be involved in the review and modification of the plan and therefore minimize the potential for incorrect interpretation;
- Each listed agency will be asked to assist in the co-ordination of the duties of the agencies.

2 Emergency Identification

2.1 Potential Dam Failure

Potential dam failure is defined as a hazardous condition at the dam which, if not attended to, may develop into an emergency situation. If detected early enough, potential emergencies can be evaluated and preventive or remedial actions taken.

Listed below are examples of conditions, which could potentially lead to failure of the dam if mitigative measures are not taken. Respective inspection checks are also listed.

- Excessive/increased amounts of seepage;
 - check toe and abutments for any new seeps and abnormal increase in quantities of seepage, or any indication of muddy or silty flow.

- Cracking on the dam crest;
 - check for settlement,
 - check for erosion,
 - check for sink holes.

- Cracks on the upstream and downstream face;
 - check for settlement,
 - check for erosion or slumping,
 - check for sink holes,
 - check for existence of deep transverse cracks from reservoir to downstream face,
 - if concrete;
 - check for cracking in concrete sections,
 - check for cracking at concrete joints.
 - if timber;
 - check for condition of cribbing,
 - check for leakage under cribbing,
 - check for condition of ballast.
 - if rock fill;
 - check for erosion of rock fill,
 - check for seepage or wet areas,
 - check for signs of movement.

- Spillway
 - check spillway to ensure no obstruction or blockage due to ice or debris.
 - if concrete;
 - check for cracks in the concrete,
 - check for cracks in the concrete abutments,
 - check for displacement or movement of concrete monoliths or abutments.
 - if timber;
 - check for condition of cribbing,
 - check for leakage under cribbing,
 - check for condition of ballast.
 - if rock fill;
 - check for erosion of rock fill,

- check for seepage or wet areas,
- check for signs of movement.

- High inflows;
 - check for water levels that are higher than normal reservoir levels,
 - check weather forecast for expected amounts of precipitation,
 - check weather forecast for mild winter temperatures which may lead to rapid/excessive snowmelt.

- Widespread flooding;
 - perform an overall site inspection.

2.2 Dam Failure

Dam failure is defined as the failure of the dam itself or its foundation, which results in large or rapidly increasing uncontrolled releases of water from the reservoir. It can be identified by the formation of a breach in the dam or foundation. It is impossible to determine how long it will take for a complete failure to occur once a significant breach has formed.

Once CHD has determined that there is no longer any time available to attempt corrective measures to prevent failure, a warning will be issued to the effect that failure is imminent or has occurred.

3 Emergency Response

3.1 Access to the Site

An important factor in responding to an emergency is access to the site. This access can be severely hampered during major storms. Such storms also cause floods creating a requirement to get to the site. This section provides information on gaining access to the site and the various methods available.

Vehicles

Depending on plant location, CHD plant operations staff are equipped with the following types of vehicles;

- Four wheel drive passenger automobiles
- Off-road vehicles (Snowmobile and ATV's)

Any additional vehicles which will be required to access the site will be provided from rental companies at the nearest location if necessary.

Road Access

Most developments have gravel access roads to all structures allowing access by passenger vehicles. However, various portions of several roads may be susceptible to wash-outs during extreme flooding conditions. A four wheel drive vehicle is therefore recommended in gaining access to any site.

For winter access to the structures it can be generally assumed that roads may be snow covered and potentially icy. In such a case, snowmobiles may be required for access to the dam sites. Access to some dam sites during spring can have the added difficulty of some deep pockets of snow and some open areas. During these times an eight wheel all terrain vehicle may be required.

Air Access

Generally, the only type of aircraft which could be used in an emergency or non-emergency situation would be helicopter. Telephone numbers are provided in Appendix B of helicopter services in the case of an emergency.

3.2 Response during Darkness and Adverse Weather

Periods of Darkness

CHD emergency response teams are equipped to respond during periods of darkness. Diesel generators and/or mobile lighting plants will be provided from rental companies at the nearest location for additional lighting requirements if necessary.

Periods of Adverse Weather

The response plan is unchanged in principle in periods of adverse weather. CHD emergency response teams are equipped to handle extreme working conditions resulting from adverse weather.

3.3 Power Sources

Powerhouse

Electric power for the powerhouse is most often provided through a three phase station service from the neighboring substation. Should the station service become inoperable, some form of a backup is provided in the powerhouse such as a battery bank or auxiliary power unit.

Impact on Communication Systems

- **Telephones** - Phones are provided in all of CHD's powerhouses. Communication through these phones will not be affected by power outages but only by failure of the communications line to the plant.
- **Cellular Phones** - Cellular phone coverage is not reliable in all developments and should be treated as such.

Emergency Power Sources

Loss of power from the plants will require an emergency power source to allow repairs for lighting, pumping, tools, etc. This power requirement can be met by renting gas and/or diesel generators from a nearby rental shops.

3.4 Incidental Procedures during Breach

It is important that information relating to the breach be recorded. Staff shall be assigned to obtain the following information provided they do not compromise their own personal safety;

- size and rate of development of the breach,
- reservoir and dam conditions prior to breach,
- changes in the reservoir level during the breach,
- spillway and penstock conditions,
- status of generating unit.

In order to assist in the collection of such data, photographic and video records may be made to assist in determining the cause and mode of development of the breach.

3.5 Mitigative Measures

The following describes remedial actions which may be taken given various dam designs and conditions.

(a) Overtopping by Flood Waters

The following measures can be taken to prevent failure when the dam is overtopped by flood waters;

- operate the plant(s) to the maximum safe capacity,
- place sandbags along the crest to increase freeboard and force more water through the spillway and outlet,
- provide erosion-resistant protection to the downstream slope by placing geotextile plastic sheets or other materials over eroding areas,
- create additional spillway capacity by creating a controlled breach in a low embankment section where the foundation materials are erosion resistant .

(b) Loss of Freeboard or Dam Cross Section due to Storm Wave Erosion

In the case of loss of freeboard or dam cross section due to storm wave erosion, the following measures should be implemented;

- place additional riprap or sandbags in damaged areas to prevent further embankment erosion,
- lower the water level to an elevation below the damaged area,
- restore freeboard with sandbags or earth and rockfill,
- continue close inspection of the damaged area until the storm is over.

(c) Slides on the Upstream or Downstream Slope of the Embankment

Slides on the upstream or downstream slope of the embankment dictate that the following measures be taken;

- lower the water level to an elevation considered safe given the slide condition (if the outlet is damaged or blocked, pumping/siphoning or a controlled breach may be required),
- restore lost freeboard if required by placing sandbags or filling in the top of the slide,
- stabilize slides on the downstream slope by weighting the toe area with additional soil, rock or gravel.

(d) Cracks in the Upstream Concrete Face

The following actions should be taken in the case of excessive cracking in the upstream concrete face or reduced abutment support;

- lower the water level by releasing it through the outlet,
- attempt to block water movement through the dam by placing geotextile or plastic sheets on the upstream face
- continue lowering the water level until a safe elevation is reached,
- continue operating at a reduced level until the repairs can be made.

(e) Erosion Flows through the Embankment, Foundation, or Abutments

When erosion flows occur through the dam, embankment, foundation, or abutments, the following actions should be taken;

- plug the flow with whatever is available (hay bales, bentonite, or plastic sheeting if the entrance to the leak is in the reservoir basin),
- lower the water level until the flow decreases to a non-erosive velocity or until it stops,
- place a protective sand and gravel filter over the exit area to hold material in place,
- continue lowering the water level until a safe elevation is reached,
- continue operating at a reduced level until repairs can be made.

(f) Failure of Appurtenant Structures such as Outlets or Spillways;

If gates or other appurtenant structures fail, the following actions should be taken;

- implement temporary measures to protect the damaged structure, such as closing an outlet or providing temporary protection for a damaged spillway,
- employ experienced professional divers if necessary to assess the problem and possible implement repair,
- lower the water level to a safe elevation (if the outlet is inoperable, pumping/siphoning or a controlled breach may be required).

(g) Mass Movement of the Dam on its Foundation (Spreading or Mass Sliding Failure)

A mass sliding failure should be dealt with through the following actions;

- immediately lower the water level until the excessive movement stops,
- continue to lower the water until a safe level is reached,
- continue operating at a reduced level until repairs can be made.

(h) Excessive Seepage and High Level Saturation of the Embankment

If excessive seepage and high level saturation of embankment is encountered;

- lower the water to a safe level,
- continue frequent monitoring for signs of slides, cracking or concentrated seepage
- continue operation at a reduced level until repairs can be made.

(i) Excessive Settlement of the Embankment

In the case of excessive settlement of the embankment the following actions should be taken;

- lower the water level by releasing it through the outlet or by pumping/siphoning or a controlled breach,
- if necessary, restore freeboard, preferably by placing sandbags,
- lower water to a safe level,
- continue operating at a reduced level until repairs can be made.

(j) Loss of Abutment Support or Extensive Cracking in Concrete Dams

The following actions should be taken in the case of reduced abutment support or extensive cracking;

- lower the water level by releasing it through the outlet/sluice gate, and by closing upstream control structures (if applicable),
- implement notification procedures,
- attempt to block water movement through the dam by placing plastic or geotextile sheets on the upstream face.

4 Notification

The ERP sets forth the chain of command to be followed (for notification purposes) in response to an emergency situation. Discussed below are the proper notification procedures to be followed in the case of;

- **Dam Incident,**
- **Dam Failure.**

4.1 Notification Procedures - Dam Incident

Any employee who learns or suspects for good reason that a potential dam breach exists shall immediately report the situation to the **Assistant Manager, Hydro Operations** as a **Dam Incident**. Phone Numbers are provided in the Communications Directory (Appendix B). Observers of an incident shall provide the **Assistant Manager, Hydro Operations** with the following information:

- Name and call back number,
- Location of the Dam Incident (development, structure, location on the structure, extent),
- Type of problem,
- Risk of deterioration,
- Reservoir and tailwater elevations,
- Prevailing weather conditions,
- Other pertinent information.

In addition to observed dam conditions which could potentially lead to failure (e.g. cracks, seepage, erosion), field personnel should also alert the Assistant Manager, Hydro Operations of any other condition which may develop into an emergency situation (e.g. high inflows, spillway blockage).

The **Assistant Manager, Hydro Operations** shall keep a written record of any information provided by the observer on an Emergency Report Form as provided in Appendix C.

Upon a report of a **Dam Incident**, the **Assistant Manager, Hydro Operations** shall immediately contact the Initial Responders listed below, providing as much detail as possible.

Initial Responders
1. Facility Manager
2. CPL Dam Engineer
3. Manager, Hydro Division

When a member of the public (or an otherwise untrained observer) reports a Dam Incident, the **Assistant Manager, Hydro Operations** shall treat it with added caution. When conveying the details of the incident to the three **Initial Responders**, the Assistant Manager, Hydro Operations should make clear where the report originated. In such cases, a member of the power plant operations staff should verify actual site conditions as soon as possible.

In some cases, alternate contact persons are identified in the notification chart. Alternates have full authority to respond in the absence of the primary contact person.

4.2 Notification Procedures - Dam Failure

The notification process will follow the following four steps in the case of a reported dam failure.

- **Initiate Notification Procedures**
- **Observe and Verify Breach (or other site conditions)**
- **Evacuation**
- **Media Contacts**

1. Initiate Notification Procedures as Shown on Notification Charts

- Immediate notifications are to be made. Notifications are listed in the order of increasing priority, in an attempt to maximize time available for safe evacuation of threatened downstream populations and for remedial action to minimize flood effects. The following **Initial Responders** should be contacted immediately following all reported incidents;

Initial Responders
1. Facility Manager
2. CPL Dam Engineer
3. Manager, Hydro Division

- If any individual responsible for making further notifications cannot be reached, it is the responsibility of the caller to find alternates and/or to notify those who would have been contacted by the missing individual/agency.
- Any of the three **Initial Responders** listed above may specify additional people or agencies that should be notified (refer to Communications Directory in Appendix B for a complete list of phone numbers). The **Initial Responders** may also initiate action that may reduce downstream hazards.
- The **Assistant Manager, Hydro Operations** shall complete and distribute a written report of the emergency situation (Emergency Report Form).

2. Observe and Verify Breach

When the **Assistant Manager, Hydro Operations** gets a call from an observer (whether employee or other) an Emergency Report Form (Appendix C) shall be used to record all relevant information.

Verification of a **Dam Failure** is primarily the responsibility of the **Facility Manager** (or a delegate), assuming quick access to the site is possible. A **Dam Failure** may otherwise be called without the benefit of visual verification based on other sources of information (e.g. water level indicators, reports from residents).

When a member of the public (or an otherwise untrained observer) reports a **Dam Failure**, the **Assistant Manager, Hydro Operations** shall treat it with added caution. When conveying the details of the incident to the three **Initial Responders**, the Assistant Manager, Hydro Operations should make clear where the report originated. In such cases, one of the **Initial Responders** will make a decision on the credibility of the report. In any case, a member of the power plant operations staff should verify actual site conditions as soon as possible.

When a trained employee reports a **Dam Failure**, all communications as outlined in the Notification Charts will immediately commence. Furthermore, the Facility Manager will immediately initiate all appropriate site response activities.

3. Evacuation

Evacuation of any inhabited areas, which could be inundated, is the responsibility of the municipalities and RCMP. CHD will provide relevant information to these agencies in support of the decision-making process regarding evacuation or other appropriate downstream responses.

4. Media Contacts

Emergency announcements through the local media will generally be the responsibility of the **Manager, Hydro Division**.

5 Maintenance and Testing

5.1 ERP Maintenance

The ERP will be reviewed annually, or as often as otherwise deemed necessary by the CPL Dam Engineer or the Assistant Manager, Hydro Operations and revised accordingly. Revisions will also be made as required to reflect personnel changes. Contact names, job titles, and telephone numbers are updated as changes take place

Copies of the ERP are distributed by the Assistant Manager, Hydro Operations to all Company personnel who have primary responsibility for dam safety as detailed in the Plan, as well as some outside agencies. A complete list of Registered ERP holders will be provided in Appendix A. Amendments to the ERP, and other document control issues, are also the responsibility of the Assistant Manager, Hydro Operations

5.2 ERP Testing

There are several purposes for conducting test exercises of the ERP. First, the execution of a test ensures the ERP document is complete and current. ERP tests help to identify components of the ERP that must be updated. As well, test exercises ensure responsibilities outlined for various positions in the Company accurately reflect the required duties during emergency situations. Finally, ERP tests provide a means for assessing the Company's overall preparedness and readiness to effectively respond in the event of a dam safety emergency.

The ERP will be tested every three years to five years to ensure that it functions as intended. The plan is revised accordingly based on the results of test exercises.

Tests may range from a limited table-top exercise to a full scale simulation of an emergency event.

All external and local government agencies are to be invited to participate in testing of the ERP procedures. Participation may vary from clerical reporting functions to on-site involvement with simulated emergencies.

6 Communications

6.1 Communications Directory

A detailed Communications Directory is provided in Appendix B. It contains specific contacts that may be necessary in response to an emergency situation. The Communications Directory complements, rather than replaces, the Notification Chart.

Contents of the Communications Directory are grouped as follows;

1. Canadian Hydro Developers, Inc.
2. Provincial Government
3. Federal Government
4. Engineering Consultants
5. Helicopter Services
6. Contractors & Suppliers

6.2 Communications with News Media

It is the responsibility of the **Manager, Hydro Division**, to coordinate all external communications with news media. All media requests received by CHD personnel should be directed immediately to the **Manager, Hydro Division**, who will determine the appropriate means of response.

Appendix A
Registered ERP Holders

Appendix B
Communications Directory

Appendix C
Emergency Report Form

Emergency Report Form

1. REPORT

- Name and position of person calling in :

Name _____ Position _____ Tel No. _____
Date _____ Time _____

- Identification of Dam :

Name _____ Location _____ Reservoir _____

- Description of the Problem :

Type of Event :	_____ Breach	_____ Potential Breach
	_____ Structural Damage	_____ Dirty Water Flow
	_____ High Water Levels	_____ Other

Size of Breach _____

Rate of Enlargement _____

Size of Uncontrolled Flow _____

Rate of Increase in Flow _____

Time of Start of Breach _____

Cause _____

- Other Observations :

Reservoir Water Level _____

Water Level Rising/Falling _____

Is the Situation Worsening _____

Current Weather Condition _____

Weather Forecast _____

- General Comments :

- Person Taking Call :

Name _____
Signature _____

2. VERIFICATION

- Method of Verification :

_____	Recognition of Caller
_____	Caller's Demonstrated Knowledge of CHD Systems
_____	Corroborative Evidence from Current Weather Conditions
_____	Obtaining the Observer's Name, Tel. No., Location

3. NOTIFICATION

- Time of Notification of;

Facility Manager _____

CPL Dam Engineer _____

Manager, Hydro Division _____

Appendix D
ERP Revisions and Testing

Table E.1
Record of Revisions

Revision No.	Details

Table E.2
Schedule of ERP Testing

Date	Details