GOVERNMENT OF INDIA
CENTRAL WATER COMMISSION
DAM SAFETY ORGANISATION

Guidelines for Development and Implementation of Emergency Action Plan (EAP) for Dams

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PREFACE

Building a dam ensures a large number of potential benefits, but it also creates a structure with potential hazards, which may result from its failure. When a dam fails, due to unprecedented rainfall, earthquake, landslide, poor maintenance and/or sabotage; the huge volume of water stored transforms into a flood wave, which may cause severe damages to the lives and properties situated downstream. The effect of such a disaster can be mitigated to a great extent, if the resultant magnitude of flood peak and its time of arrival at different locations downstream of the dam could be estimated, facilitating planning of the emergency action measures. It is, therefore, necessary to have a thorough and consistent planning for any such eventuality to help save lives and reduce property damage in areas that would be affected by dam failure and to put in place an action plan to cope with such an emergency.

An Emergency Action Plan (EAP) is a formal document that identifies potential emergency conditions at a dam and specifies preplanned actions to be followed to minimize property damage and loss of life. The EAP contains procedures and information to assist the dam owner in taking necessary actions in time to moderate or alleviate the problems, in addition to issuing early warning and notification messages to responsible emergency management authorities, viz., District Magistrate / Collector, Armed forces, Paramilitary forces, Project Authorities and other Central/ State Agencies. It also contains inundation maps to show the emergency management authorities of the critical areas for necessary relief and rescue actions in case of an emergency. In a nutshell, it outlines "who does what, where, when and how" in an emergency situation or unusual occurrence affecting the dams.

In India, there are about 4050 completed large dams and another 475 are under construction (as per National Register of Large Dams – 2002). Emergency Action Plans are, however, not available for most of the completed large dams. The National Water Policy, 2002, recognizing this deficiency, has stressed for preparation of EAP for all large dams. As such, formal guidelines are needed to help dam owners to effectively develop and implement EAPs for dams in consultation with local emergency management authorities. Accordingly, National Committee on Dam Safety at its 27th meeting held on 27th September, 2005 has finalized these Guidelines for Development and Implementation of Emergency Action Plan for Dams.

The studies carried out and efforts made by S/Shri M.K. Sinha & K.L. Tripathy, Directors in the Dam Safety Organisation and other Officers / Staffs under the overall guidance of Shri B.M. Upadhyay, Chief Engineer, Dam Safety Organisation, CWC, which led to drafting of these Guidelines are commendable. I hope these Guidelines will be of immense help to all State Govts. and other dam owners in preparing Emergency Action Plan for all dams so that the people in the downstream areas be assured of effective & timely action in emergency cases for protection of their lives & properties.

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CHAPTER I

INTRODUCTION

1.1 General

Dams store large amount of water. Uncontrolled or excessive release of such a huge amount of water has great potential for loss of life and damage to property in the downstream areas due to excessive flooding. Such situations can occur due to several reasons, such as, breach of dam on account of earthquake, landslide and/or sabotage; excessive release of water on account of extreme storm events, etc. It is, therefore, necessary to have a thorough and consistent planning for any such eventuality to help save lives and reduce property damage in areas that would be affected by dam failure or operation and putting in place action plans to cope with such an emergency. It is exactly for this reason that Ministry of Environment & Forest through its notification no. SO 60(E) dated 27-01-94 on Environment (Protection) Rules 1986 has made Disaster Management Plan or Emergency Action Plan a mandatory requirement for obtaining statutory environmental clearance for all river valley projects.

An Emergency Action Plan (EAP) is a formal document that identifies potential emergency conditions at a dam and specifies preplanned actions to be followed to minimize property damage and loss of life. The EAP specifies actions the dam owner should take to moderate or alleviate the problems at the dam site as well as in the areas downstream of the dam. It contains procedures and information to assist the dam owner in issuing early warning and notification messages to responsible emergency management authorities, viz., District Magistrate / Collector, Armed forces, Paramilitary forces, Project Authorities and other Central/ State Agencies. It also contains inundation maps to show the emergency management authorities of the critical areas for necessary relief and rescue actions in case of an emergency.

In India, there are about 4050 completed large dams and another 475 are under construction (as per National Register of Large Dams ï 2002). Emergency Action Plans are, however, not available for any of the completed large dams. The National Water Policy, 2002 recognizing this deficiency has stressed for preparation of EAP for all large dams. As such, formal guidelines are needed to help dam owners effectively develop and implement EAPs for dams. This process includes coordination, planning and joint exercises involving both the EAPs of the dam owner and relief & rescue plans of local emergency management authorities.

1.2 Scope

Emergency Action Plan (EAP) is intended to help emergency officials, save lives, minimize damages to property, structures and inhabitations and also to minimize environmental impacts in the event of flooding caused by large releases from the dam, dam failure or in other such events that present hazardous conditions. The EAP will guide the dam operation supervisory personnel in identifying, monitoring, responding to and mitigating emergency situations. It outlines ñwho does what, where, when and howò in an emergency situation or unusual occurrence affecting the dams.

Certain causes such as heavy floods or dam failure may create emergency conditions at the dam site as well as in the areas downstream of the dam that will require warning, evacuation of the population at risk or other response actions. The EAP is intended to interface with the emergency operation plans of other Local, District and State agencies to ensure effective and timely implementation of response actions.

1.3 Inputs

The following are the main inputs for preparation of an emergency action plan:

(i) Probable Maximum Flood (PMF) / Standard Project Flood (SPF) / 500 / 100 yearsôreturn period Flood hydrographs for the dam;
(ii) Flood hydrograph due to combination of PMF / SPF coupled with dam break;
(iii) Inundation maps under different situations, viz., Dam break, PMF, SPF, 500 / 100 yearsôreturn period Flood, etc.;
(iv) Assessment of safe carrying capacity of the downstream channel and the safe levels;
(v) Assessment of potential damage to lives and properties at the dam site as well as in the areas downstream of the dam; and
(vi) Assessment of resources for relief & rescue measures.

1.4 What is an EAP?

An Emergency Action Plan, or EAP, is a formal plan that identifies potential emergency conditions at a dam and prescribes the procedures to be followed to minimize property damage and loss of life.

An emergency in terms of dam operation is defined as a condition which develops unexpectedly, endangers the structural integrity of the dam and / or safety of lives and properties at the dam site as well as in the areas downstream of the dam, and requires immediate action.

Every EAP has to be tailored to site-specific conditions and to the requirements of the owner agency and local emergency management authorities

1.5 Why an EAP?

Apart for statutory reasons, an EAP is needed for two main reasons:

- To preplan the coordination of necessary actions by the dam owner and the responsible Local & State officials to provide for timely notification, warning, and evacuation in the event of an emergency.
- To reduce the risk of loss of life and property damage, particularly in downstream areas, resulting from an emergency situation.

The design, construction, operation & maintenance, and inspection of dams are all intended to minimize the risk of future dam failures. Despite the adequacy of these programmes and their implementation, situations do sometimes develop that may result in dam failure or excessive release of water. Therefore, it is prudent for dam owners to identify conditions which could lead to failure, in order to initiate emergency measures that could prevent or minimize the damages to life and property.

CHAPTER II

DEVELOPING AN EAP

2.1 Steps in Developing an EAP

Careful and coordinated planning with all involved parties will lay the foundation for a thorough and practical emergency action plan. The process of developing an EAP generally follows the nine steps listed below:

Step 1: Determine the potential inundated area, by defining PMF / SPF/ 500 / 100 yearsô flood / dam break flood profiles downstream of the dam. Conditions to be considered may include:

- Fair-weather dam failure at normal full pool levels.
- Design flood with and without failure.
- As appropriate, other flood flow conditions, with and without failure, to determine the worst-case scenarios.

Step 2: Prepare inundation maps which clearly depict the flooded areas under conditions mentioned at step 1.

Step 3: Determine & identify those situations or triggering events that would initiate an emergency action, and specify the actions to be taken and by whom.

Step 4: Identify all jurisdictions, agencies and individuals who will be involved in the EAP. Discuss the development of the EAP with these parties. This interaction should include discussion on the need for and operation of an emergency operations centre and reception centre, as well as a discussion of evacuation (destinations, priorities & procedures), post-flood actions (recovery & cleanup), and other measures in the event of an emergency.

Step 5: Identify primary & auxiliary communications systems, both internal (between persons at the dam) and external (between dam personnel & outside entities).

Step 6: List and prioritize all persons and entities involved in the notification process, and draft the Notification Flowchart.

Step 7: Develop a draft of the EAP. A suggested format for an EAP is described in the next chapter, along with suggestions for what content might be important to be included in the EAP.

Step 8: Hold coordination meeting(s) with all parties included in the notification flowchart for review and comments on the draft EAP. Some non-governmental experts can also be invited.

Step 9: Make any revisions, obtain the necessary approvals / concurrences on EAP and disseminate the EAP to those who have responsibilities under the plan.

2.2 Coordinating the development of the EAP with all participants

Development of the EAP must be coordinated with all entities, jurisdictions and agencies that would be affected by a dam failure, or that have statutory responsibilities for warning, evacuation and post-flood actions. The finalized EAP will, therefore, realistically take into account each organizationôs capabilities and each participant will be fully aware of individual responsibilities. Appropriate levels of management must be involved in developing the EAP to ensure that each entity will agree to execute its responsibilities under the plan.

CHAPTER III

COMPONENTS OF AN EAP

3.1 General

It is essential to have a thorough and consistent emergency action plan for required levels of preparedness that may save lives and reduce property damage in areas affected by dam operation or failure. To achieve this, some guidelines about format and components of an EAP are described in this chapter. While the format described is only suggestive, the use of this format will help to ensure that the EAP is comprehensive and all essential components get included. This chapter also provides a checklist that can be used in evaluating an EAP to ensure that sufficient information is presented in the document.

3.2 Components of an EAP

An EAP has seven basic components. These components will be discussed in greater detail in subsequent paragraphs and include the following:

3.2.1 Notification flowchart

A Notification Flowchart is a schematic representation of the hierarchy for notification in an emergency situation, including who is to be notified, by whom and in what priority. The flowchart should be prominently displayed in the EAP document; often it is in the beginning of the EAP.

3.2.2 Responsibilities

A determination of responsibility for EAPï related tasks must be made during the development of the plan. Generally speaking, owners are responsible for the development & maintenance of the EAP, and for activating the notification procedures of the plan. Local & State officials having statutory obligation are responsible for warning & evacuation within the affected areas. The EAP must specify the person(s) responsible for declaring an emergency under various circumstances, and for initiating emergency actions. In doing so, the plan must be site-specific, since local conditions at all dams are different.

3.2.3 Emergency identification, evaluation and classification

It is necessary to determine and identify the situation(s) or triggering event(s) that initiate or require an emergency action. The establishment of procedures for reliable and timely recognition of emergency situations is imperative. If time permits, an emergency situation should be evaluated and confirmed by

an experienced and qualified engineer. Finally, to determine the appropriate course of action, the emergency situation or triggering event should be classified according to its urgency.

3.2.4 Notification procedures

Notification procedures should be developed to ensure timely notification of persons responsible for taking emergency actions. The procedures should be brief, simple, and easy to implement.

3.2.5 Preventive action

Preventive action is a general term used to refer to both preplanned and emergency actions that are aimed at preventing failure of a dam and minimizing loss of life and property damage. A few of the preventive actions that a dam owner might take are to ensure access to the dam site under adverse conditions, provide emergency flood operating instructions, and arrange for equipment, labour & materials for use in emergency situations.

3.2.6 Inundation map

An inundation map delineates the areas that would be flooded as a result of a dam failure or unusually large spillway releases. An inundation map is sometimes supplemented by a narrative description of the areas that would be flooded.

3.2.7 Appendices

One or more appendices, containing supporting materials used in the development and maintenance of the plan, are usually included in the EAP document.

CHAPTER IV

FORMAT OF AN EAP

4.1 Suggested format for an EAP

An EAP can be organized in whatever format seems most useful for those involved in the plan. However, one format is described below to serve as a guideline. The following is a sample of six-part format for an EAP with description of contents applicable to each section of the EAP:

- Part I -- Introductory
- Part II -- Responsibilities
- Part III -- Emergency procedures
- Part IV - Preventive actions
- Part V -- Inundation maps
- Part VI - Appendixes

It is helpful to place the EAP in a loose-leaf binder, so that outdated pages (or the entire EAP) can easily be removed and replaced with updated information, to ensure a complete, updated and workable plan.

The contents and a suggested format for an EAP are listed briefly below:

4.2 Introductory

4.2.1 Title page / cover sheet

An EAP document's cover identifies it as an Emergency Action Plan and specifies the dam for which it is developed. For some dams, different EAPs may be developed for different emergency situations or conditions, each with its own specific procedures to be followed. In such instances, separate and distinct title pages or cover sheets are essential, so that personnel can be sure that they are using the right plan for the circumstances.

4.2.2 Notification Flowchart

The EAP should begin with a Notification Flowchart clearly summarizing the following information for each of the emergency conditions considered:

(a) Who is responsible for notifying each owner representative(s) and / or public official (s) ?

(b) Who is to be notified?

(c) Prioritized order in which individuals are to be notified?

This should include individual names and position titles, office & home telephone numbers and alternative contacts & means of communication (e.g. mobile phones)

Some of the emergency conditions to be considered are:

(a) Failure is imminent or has occurred.

(b) Potential emergency situation has developed or is developing.

(c) Flooding is occurring or is expected.

The flowchart should be easy to follow under emergency conditions and should normally be limited to one page. Colour coding (i.e., using different coloured lines to trace the proper sequence of notification under various emergency conditions) will prove helpful. Narrative information supplementing the flowchart should be provided in the section discussing notification procedures.

Additional copies of the flowchart should be readily available to each individual having responsibilities under the plan and should be kept up-to-date through tests and revisions.

A typical Notification Flowchart is shown in Figures 1 & 2 annexed. These are only sample flowcharts. A flowchart must be tailored to the specific needs and notification priorities of the dam to which it applies.

4.3 Responsibilities

The plan should specify the person(s) or organization responsible for the maintenance and operation of the dam and the persons or groups responsible for implementing various phases of the EAP. Some specific responsibilities to be considered are described below.

4.3.1 Owner's responsibility

The duties of the owner or the owner's designated representatives in implementing the EAP should be clearly described. Some suggestions for information to be included in this section are listed below:

(a) Determine and identify the condition(s) or triggering event(s) that initiate or require emergency actions and specify the actions to be taken and by whom.

(b) Provide guidance on how to communicate the emergency situation to those who need to be contacted.

(c) Include sample warning messages tailored to specific situations.

(d) Describe who is responsible for taking specific actions at the dam after the notification procedures have been implemented. For example, spell out procedures for opening spillway gates, especially if a certain sequence is required, and opening / closing water intakes, as appropriate. (This information should be available in the established procedures for reservoir operation.)

(e) Provide instructions for the operation of the project during the anticipated emergency. Specific actions should be discussed under the section ñPreventive Action.ò

(f) Encourage local officials to develop a plan to safeguard life and property from flooding due to the dam fail or passing unusually large flows through its spillway system. This plan should include, as a minimum, procedures for an emergency operations centre, evacuation and post-flood actions.

An example outlining the dam ownerôs authority and responsibility and how they are delegated, is given below. The headings and information listed below are generic and need to be tailored as necessary to reflect the appropriate organizational structure and responsibilities.

(i) (Dam Ownerôs) _____ office

As the dam owner, the _____ is responsible for maintaining a safe dam, which includes management of operations, maintenance, repair & rehabilitation functions.

Additionally, in an emergency situation, the dam owner, or designee, is responsible for making internal and external notifications, implementing response and mitigation actions at the dam and documenting all activities.

(ii) (Dam Supervisory Office) _____

The _____ is responsible for performing (list specific aspects of duties delegated by dam owner)_____.

(iii) (If applicable, additional levels of Dam Supervisory office) _____

The_____is responsible for performing (list specific aspects of duties delegated by dam owner) _____

(iv) (If applicable) 24 hour Control or Operation Centre _____

The_____is responsible for performing (list specific aspects of duties delegated by dam owner)_____.

(v) (If applicable, Operator Supervisory Office) _____

The_____is responsible for performing (list specific aspects of duties delegated by dam owner)_____.

(vi) Dam Operator

The Dam Operator, employed by_____, resides (location of Dam Operatorôs residence) at_____. The Dam Operator is responsible for performing (list specific aspects of duties delegated by dam owner).

(vii) Local Emergency Management Authority

Local Emergency Management Authority, i.e., Local, District and State authorities are responsible for beginning the call down sequence initiating and coordinating emergency operations, carrying out warning and evacuation of populations at risk and other response actions under their authorities.

4.3.2 Responsibility for notification

The person(s) authorized to notify local officials should be determined and clearly identified in the EAP. The dam owner is responsible for notifying the appropriate officials when flooding is anticipated, or a failure is imminent or has occurred. However, under certain circumstances, such as when failure is imminent or has occurred, the responsibility and authority for notification may have to be delegated to the dam operator or a local official. Such situations should be specified in the EAP.

The India Meteorological Department (IMD), Central Water Commission and / or other State and Central agencies have the general responsibility for issuing flood warnings. It will, therefore, be desirable to notify the IMD, CWC or other appropriate agency of any pending or actual dam break flooding, so that its facilities can enhance warnings being issued.

4.3.3 Responsibility for evacuation, rescue & relief

In the federal set up of India, the basic responsibility for undertaking rescue, relief and rehabilitation measures in the event of a disaster is that of the State Government concerned. At the State level, response relief and rehabilitation are handled by Departments of Relief & Rehabilitation. The State Crisis Management Committee is set up under the Chairmanship of Chief Secretary, who is the highest executive functionary in the State. All the concerned Departments and organisations of the State and Central Government

Departments located in the State are represented in this Committee. This Committee reviews the action taken for response and relief and gives guidelines/directions as necessary.

Generally a control room is established under the Relief Commissioner. The control room is in constant touch with the climate monitoring/forecasting agencies and monitors the action being taken by various agencies in performing their responsibilities.

The district level is the key level for disaster management and relief activities. The Collector / District Magistrate is the chief administrator in the district. He is the focal point in the preparation of district plans and in directing, supervising and monitoring calamities for relief. A District level Coordination and Relief Committee is constituted and is headed by the Collector as Chairman with participation of all other related government and non governmental agencies and departments in addition to the elected representatives. The Collector is required to maintain close liaison with the district and the State Governments as well as the nearest units of Armed Forces/Central police organisations and other relevant Central Government organisations like Ministries of Communications, Water Resources, Health, Drinking Water, Surface Transport, who could supplement the efforts of the district administration in the rescue and relief operations. The efforts of the Government and non-governmental organisations for response and relief are coordinated by the Collector/ District Magistrate. The District magistrate / Collector and the Coordination Committee under him reviews preparedness measures prior to an impending hazard and coordinate response when the hazard strikes. As all the Departments of the State Government at the district level report to the Collector, there is an effective coordination mechanism ensuring holistic response.

The existing mechanism for disaster management prevailing in the State concerned should be utilized for warning, evacuation, rescue & relief planning. However, it should not be assumed that the governmental entities are the only way for evacuation of people. There may be situations in which routine notification and evacuation will not suffice, as in the case of a resident located just below the dam. In this case, it should be arranged to notify and evacuate that person directly. This procedure should be coordinated with the appropriate public officials.

4.3.4 EAP Coordinator's responsibility

If appropriate, designate an EAP coordinator, who will be responsible for EAPï related activities, including (but not limited to) preparing revisions to the EAP, establishing training seminars, coordinating EAP drills, etc. This person should be well conversant regarding the EAP as any involved parties can contact and have any questions about the plan.

4.3.5 Approval of the plan

The EAP should include a section that is signed by all parties involved in the plan, where they indicate their approval of the plan and agree to their responsibilities in its execution. Including the approval signatures is essential in an EAP, as it assures that all parties involved are aware of and understand the EAP and agree to do their assigned roles, as soon as an emergency takes place.

4.4 Emergency procedures

4.4.1 Emergency identification, evaluation & classification

The EAP document should include a discussion of procedures for timely and reliable identification, evaluation and classification of existing or potential emergency conditions. Major elements of these procedures are:

(i) A listing of the conditions or events which could lead to or indicate an existing or potential emergency. Situations involving flood emergencies due to a breach or other structural failure as well as a major flood without a breach should be included. Unusual situations such as those caused (a) by overtopping of a dam due to insufficient spillway capacity during large inflows to the reservoir, (b) by seepage or piping through the dam over long internal conduits, (c) slope embankment slides, (d) earthquake damage & liquefaction of earthen dam due to earthquakes, and (e) landslide generated waves within the reservoir. Hydraulics, hydrodynamics, hydrology, sediment transport mechanics and geo-technical aspects are all involved in breach formation and eventual dam failure. The prominent causes can be listed as follows:

(1) Extreme storm
(2) Landslide
(3) Earthquake
(4) Overtopping
(5) Structural damage
(6) Piping
(7) Equipment malfunction
(8) Foundation failure
(9) Sabotage

The above unusual situations can be divided into 3 categories:

(a) Hydrologic: These are related to flooding due large releases, seepage, slumping, piping, embankment cracking, embankment deformation, embankment overtopping, movement of concrete section (sliding or over turning) settlement, failure of spillway gates or supporting structures, spillway & outlet works releases, equipment malfunction, etc.

(b) Earthquake: These are related to impact of earthquake at dam which could lead to embankment piping, embankment cracking, embankment deformation, liquefaction and movement of concrete section, etc.

(c) All other events: These are related to hazardous material spills / releases, equipment failures, security / criminal actions, fish / wildlife impacts, wildfires, structural fires, landslides, extreme storm, sabotage, etc. One or more of the above unusual situations will initiate declaration of an emergency for internal alert or external alert.

(ii) A brief description of the means by which potential emergencies will be identified, including the data & information collection system, monitoring arrangements, surveillance, inspection procedures and other provisions for early detection of conditions indicating an existing or potential emergency.

Emergency events occur with unusual situations varying degrees of severity and predictability. An emergency may develop gradually and be steadily monitored providing ample response time. Conversely, an emergency may develop suddenly requiring immediate emergency response to prevent devastating loss of life or impacts to structures or the environment. The following definitions are used to classify emergency events according to an ascending and progressive order of severity to which the dam downstream or off-site population, structures or environment are threatened. Condition may dictate that situation is classified as imminent without passing through the less severe situations. A smooth transition should occur, if the situation is classified as ñdevelopingò prior to ñimminent.ò

Assessment of degree of seriousness of unusual situation is required. It may be classified as the Blue, Yellow, Orange and Red level alert according to their seriousness.

Guidelines lie mainly in the interface between the internal and external emergency planning, being the two main aspects of the following:

(a) Definition of alert levels: If an incident happen with the dam or problem arises related with the dam over its foundations or with landslides into the reservoir, earthquakes, adverse meteorological situations or any other, alert must be given to civil protection system. The gravity of the problem

may obviously vary with the situation, but in order to assure that all the entities involved in emergency actions are behaving in accordance with the situation, the alert levels need to be previously defined, and must be the same for the internal and external emergency plan of each dam.

These alert levels are established in colours, from Blue, the lowest level that corresponds to a routine or normal situation, to Red, corresponding to a serious or catastrophic situation.

The alert levels defined are presented in Table 1. Its underlying philosophy relates the gravity of dam problems with the expected impacts in the downstream valley and the likelihood of the total dam rupture.

(b) Alert and warning systems: When facing problematic situation, the entity exploring the dam must judge the corresponding alert level and notify the civil protection system, in order to allow the development of the necessary actions, according to the situation.

If the dam rupture is very likely (orange alert level) or imminent (red level), give ñexternal alertò signal and the entity exploring the dam must warn population downstream of the dam. In orange level, the warning indicates people to be ready for evacuation and in red alert to evacuate quickly.

Given that a dam rupture can be very sudden, it is assumed that people leaving up to a certain distance downstream of the dam have to evacuate by their own means, with no time to wait for civil protection help.

(iii) Procedures, aids, instructions and provisions for interpreting information and data to assess the severity and magnitude of any existing or potential emergency should be clearly defined. An example of this type of document that might be included in the EAP is shown in Table 1.

4.4.2 Notification procedures

The notification portion of the EAP should contain a listing of all persons to be notified in the event that an emergency condition develops. This list should include individual names and position, titles, locations, mobile, office & home telephone numbers and radio communication frequencies and call signals (if available) for owner personnel, public officials and other personnel, including alternates. For each type of emergency situation, the EAP should clearly indicate who is to make a call, to whom it is to be made and in what priority.

The number of persons to be notified by each responsible individual in the notification plan should be kept to a minimum. The number of calls will in some cases be governed by what other responsibilities the caller has been assigned.

For each emergency condition that is anticipated, the plan should describe actions to be taken and contacts to be made. Priority of notification will depend upon the actual emergency situation.

The following individuals or agencies, where applicable, should be considered for inclusion in the notification procedures:

(i) Residents and property owners located immediately downstream of the dam within the area of potential inundation, where available warning time is very limited.

(ii) Owner personnel

(iii) Law enforcement officials

(iv) Operators of upstream and downstream dams or water-retention facilities

(v) Appropriate State and local agencies

(vi) Managers and operators of recreation facilities

(vii) Others, as appropriate

The plan should designate a spokesperson to disseminate information. The news media, including radio, television and newspapers, should be utilized to the extent available and appropriate. Use of news media should be preplanned to the extent possible by the dam owner and / or public officials. Notification of the news media may be done by the dam owner or by public officials, depending on the type of emergency. Notification plans should define emergency situations for which each medium will be utilized and should include an example of a news release that would be the most effective for each possible emergency.

The information which should be conveyed during notification can be given in the following pre-scripted message (for use by incident commander, or designee, when making notification):

(i) This is (name, title, agency)_____monitoring_____dam.

(ii) The date is_____and the time is_____.

(iii) The conditions at the dam are (describe situation and include damages, outflows, reservoir elevation, potential or actual failure and non-hydrological hazard, etc.).

(iv) We will notify you if the conditions at the dam change. We will give you the next briefing at_____hours or sooner.

(v) For further information, contact _____ at _____.

(vi) This message will be sent to you in the text form of (fax or other).

Table 1
Alert levels for Dam Break Planning

Type of alert	Alert level	Situation	Response system	Engineer in charge Actions
INTERNAL ALERT	Blue	No immediate off-site impact anticipated or detection of anomalies in the dam or other events that do not compromise the structural dam safety nor its operational elements, and do not make unviable the dam observation system. Situation is stable or developing very slowly. The gravity of existing problems must let belief that no consequences are expected in the valley downstream of the dam.	Direct Command System	1. Measures to solve problem. 2. Give internal alert signal of blue level. 3. Make notification in chart No.1. Inform to: - Dam Owner (CE)
	Yellow	Existence of anomalies or events that might comprise up to some degree. The structure and / or operational dam safety or the dam observation system, assuming that eventual small consequences downstream the dam can happen: 1. Existence of meteorological adverse conditions; 2. Detection of anomalies in: - dam structural elements, or; - dam operational elements, or - dam observation system. 3. Existence of foundation problems 4. Situation is developing slowly	Direct Command System	1. Measures to solve problem 2. Give internal alert signal of yellow level 3. Make notifications in chart No.1 4. Inform to - Dam owner (CE) - EE - E-in-C - District Collector (if necessary)
EXTERNAL ALERT	Orange	Situation with high probability of dam failure, belief that it might not be possible to control the situation, and might cause serious consequences downstream of the dam: 1. Detection of severe anomalies in - dam structural elements, or - dam operational elements 2. Existence of severe foundation problems 3. Occurrence of floods with high recurrence interval. 4. Dam owner / operator need assistance from outside agencies or jurisdiction. 5. Situation is progressing rapidly. 6. ñSome amount of timeòis available for analysis, decisions and mitigation to be made before off-site impact may occur.	Incident Command System	1. Measure to solve problem. 2. Give external alert signal of orange level. 3. Implement Incident Command System. 4. Make notification in chart No.2 5. Inform to - District Collector - CE - E-in-C - State Flood Control Cell 6. Warning ï Population downstream the dam to be ready for evacuation.
	Red	Situation of inevitable catastrophe 1. Imminence of dam failure 2. Dam failure 3. ñLittle or no time is availableòfor analysis, decisions & mitigation to be made before downstream of dam impacts occur. 4. Situation is worsened and a breach is apprehended. 5. ñLittle or no time is availableòfor analysis, decisions and mitigation to be made before off-site impact occur.	Incident Command System	1. Give external alert signal of red level. 2. Make notification in chart No.2. 3. Informs to: - Authority - Dam owner (EE, CE) - Civil protection (District Collector) Commissioner - E-in-C - State Flood Control Cell - Warning: Population downstream of the dam to evacuate quickly.
ACTION		Dam is failing or failed		1. Call and coordinate with - Civil Protection (Collector & SP) - -CE 2. Inform Commissioner and E-in-C 3. Ensure official notifications are made.

Event Report: Once notified of an event, initial documentation of that event is critical. The in-charge shall ensure that the following report forms are to be used when recording various emergency situations and unusual occurrences:

(i) Emergency Event / Unusual Occurrence Report ï for reporting emergency events and unusual occurrences other than earthquakes, bomb threats and oil & hazardous spills (Form 1)

(ii) Earthquake Damage Report ï for reporting earthquakes (Form 2)

(iii) Bomb Threat Report ï for reporting bomb threats (Form 3) (Given as Annexes)

In addition to these report forms, all persons involved, including their names, title & phone numbers and all agencies notified should be documented. Also, recommendations for corrective actions to be taken, sources of funding required and status of incident should be included in the report.

It is desirable for all officials receiving reports from dam operating personnel to maintain a diary and tape recorded messages, if possible. Photographs are essential to provide complete documentation.

The in-charge will ensure that formal status report for the dam facility is developed during emergency events. The report should contain the date, time, location of observation and the reservoir elevation. During periods of flooding, high inflow and reservoir elevations (approaching or above maximum water level), the elevations should be monitored and read hourly and attendance at the dam should be 24 hours a day.

The EAP for the dam includes a range of expected action that the dam operating personnel, and other appropriate district and reclamation personnel would implement for each response level and include appropriate notifications that need to be made by every organization in the chain.

4.5 Preventive actions

The EAP should describe preventive actions to be both prior to and following the development of emergency conditions, to prepare for any emergency. Preventive actions involve the installation of equipment or the establishment of procedures for one or more of the following purposes:

Y Preventing emergency conditions from developing, if possible, or warning of the development of emergency situations.

Y Facilitating the operation of the dam in an emergency situation.

Y Minimizing the extent of damage resulting from any emergency situations that do develop.

The need for timely action in an emergency situation cannot be overemphasized. The EAP should contain a discussion of provisions for surveillance and detection of an emergency situation and should clearly indicate that it can be implemented in a timely manner. An important factor in the effectiveness of the EAP is the prompt detection and evaluation of information obtained from instrumentation and / or physical inspection procedures.

The EAP should include a discussion the time factor from the actual occurrence of an emergency to awareness of the emergency and its effect on the workability of the EAP. Timely implementation of the EAP is a crucial element in its effectiveness.

There are several types of preventive actions that should be considered when developing an EAP. These actions include:

4.5.1 Surveillance

When a dam is not continuously monitored then failure would endanger human life or cause significant property damage. It is imperative that procedures be developed to identify conditions requiring emergency actions and to promptly alert public safety officials responsible for evacuating residents who would be affected in the event of an emergency at the dam. In order to be able to promptly notify responsible officials of emergency conditions, a dam owner or ownerôs representative must receive a timely warning that an emergency has developed or is developing. The information received must be clear and concise, so that the responsible official(s) may react with confidence and activate the EAP, if necessary, without requiring personnel to visit the site to verify conditions.

At important dams, the dam owner should also consider installing a remote surveillance system that includes instrumentation and telemetering facilities at the dam site, to provide a continuous reading of headwater and tail water levels at a central operations control centre that is manned 24 hours a day. The system should include a computer at the operations centre to monitor the data and to activate an audible alarm whenever the rate of change of the headwater or tail water over a given period of time exceeds prescribed limits. The alarm also should be activated if the headwater or tail water elevations exceed prescribed maximum or minimum levels. Design of the system must be site-specific. The limits programmed in a system must account for changes in headwater and tail water levels that would occur during dam operation, floods, maintenance, etc.

Provisions should be made for the alarm to sound when there is an interruption of power to, and loss of communication with, the monitoring instrumentation. (When the dam engineer-in-charge lives close to the project, consideration should also be given to having an alarm in the officialôs house.) When power to or communication with the site instrumentation is interrupted, urgent action should be initiated so that the same is returned to normal. Operation of the alarms should be checked periodically. Proper functioning of alarms should be

confirmed by testing. For instance, annual testing of the plan might be initiated by causing one of the alarms to go off.

Reaction time must be minimized when inhabited structures are located immediately downstream of the dam. When these conditions exist, special procedures may need to be included in the EAP to notify the occupants. Local public safety officials should be fully involved in the development of these procedures.

The EAP should describe any instrumentation for monitoring the behaviour of the dams, and explain how warning systems would be implemented. Instrumentation responses should be instantaneous to facilitate immediate action by operators.

The plan should also describe procedures for providing round-the-clock surveillance for periods of actual or forecasted high flows. It may be necessary to post a special observer to the dam during these periods and not rely on the instrumentation alone. In addition, it is recommended that an expert observer be at the dam when flood conditions or signs of serious structural distress have been identified.

In case remote surveillance at the dam is not applicable, that fact should be stated in the EAP. In such cases, for proper monitoring of the surveillance, the following procedure can be adopted:

(i) Attendance: The dam should be properly manned all the year round. There should be a full time dam operator (Sub-Engineer). Further, arrangement should be made for alternate personnel who will attend to the dam duties the dam operatorôs absence.

(ii) Daily reports: Daily reports about stage of the reservoir filling and condition and behaviour of the dam must be submitted by the Engineer responsible for continuous vigilance of the dam to his immediate superior.

(iii) Operation of storage reservoir: It is very necessary to lay down operating procedures of all storage reservoirs with the objective to limit the flood stages in the river downstream and with maximum feasible utilization of the flood capacity of the river channel downstream of reservoirs, consistent with the safety of the dam. A proper reservoir operation schedule should be in place.

For this purpose, a schedule of opening and closing the gates to limit the reservoir levels to pre-set gauges should be laid down. Schedule for the dam as per Operation & Maintenance Manual should be strictly adhered. The entire capacity of the reservoir is used for active conservation. When the reservoir rises above active conservation, operation will be in accordance with the standing operating procedures. Inflow forecasting arrangement should be made for easy operation of the gates. The engineer in-charge should inform immediately to the flood maintenance engineer downstream and flood-fighting centre of the releases from the reservoir.

4.5.2 Access to the site

The description of access should focus on primary and secondary routes and means for reaching the site under various conditions (e.g., foot, boat, motor vehicle, helicopter, etc.). Also detail the expected response (travel) time.

4.5.3 Response during periods of power failure

Discussion in the EAP of the response to potential or actual emergency conditions during periods of power failure should:

- Describe actions to be taken to illuminate the spillway operating deck, and other actions that will facilitate the operation of gates or other emergency equipment.
- Explain how the emergency operations centre, spillway gates, etc., are to be operated during the power failure.
- Describe any special procedures for contacting or notifying the proper personnel, local officials or others during a power failure.
- Discuss in detail the expected response time for verifying an emergency and implementing the EAP under such condition.
- Include any other special instructions for the dam operators or local officials.

4.5.4 Response during periods of adverse weather

Discussion of emergency response under adverse weather conditions should:

- Describe in detail the actions to be taken.
- Describe methods of access to the site (e.g., foot, boat, motor vehicle or other modes).
- Discuss in detail the expected response time.
- Include any other special instructions for the dam operators or local officials.

4.5.5 Alternative systems of communication

The description of the availability and use of alternative communication systems at the site should:

- List alternative channels of communication to be used in case of failure of the primary system or failure of other systems immediately available.

- Y Explain proper procedures for activating the alternative channels of communication.

- Y Include any other special instructions.

4.5.6 Emergency supplies and resources

There are certain planning and organizational measures that can help dam personnel and local officials manage emergency situations more safely and effectively. These measures include:

4.5.7 Stockpiling materials and equipment

Where applicable, document should describe:

- Y Materials needed for emergency repair, their location, source and intended use. Materials should be as close as possible to the dam site.

- Y Equipment to be used, its location and who will operate it.

- Y How the contractor is to be contacted.

- Y Any other people who may be needed (e.g., labourers, engineers), and how they are to be contacted.

4.5.8 Coordinating information on flows

Where applicable, the EAP should describe:

- Y The need for coordination of information on flows based on weather and runoff forecasts and action required in case of any failure or other emergency condition. It should describe how the coordination is achieved and the chain of communication, including names and day / night telephone numbers of responsible people. Coordination with the India Meteorological Department (IMD) or other appropriate agency recommended to monitor storms, river stages and flood waves resulting from a dam break. The IMD or other appropriate agency like CWC, etc., may also be able to supplement the warnings being issued by using their own communication system.

- Y Additional actions contemplated to respond to an emergency situation or failure at a dam. This includes action during the periods of darkness, inclement weather and non-business hours.

- Y Actions to be taken to lower the reservoir water level elevation, if applicable. The EAP should describe when and how this action should be taken. If not applicable, that fact should be stated in the EAP.

- Y Actions to be taken to reduce inflow to the reservoir from upstream dams or control structures. The EAP should provide instructions for operators or other persons responsible for contact with other owners on when and how these actions should be taken. If such actions do not apply, that fact should be stated in the EAP.

- Y Actions to be taken to reduce downstream flows, such as increasing or decreasing outflows from downstream dams or control structures on the waterway on which the dam is located or its tributaries. The EAP should provide instructions for operators or other responsible persons on when and how these actions should be taken. If such actions do not apply, that fact should be stated in the EAP.

It should also describe any other appropriate actions to be taken. If coordination of information on flows is not applicable, that fact should be stated in the EAP.

4.5.9 Providing alternative sources of power

Where applicable, the EAP should describe the alternative sources of power for spillway gate operation and other emergency uses. The EAP should list the location of each power source, its mode of operation and, if portable, the means of transportation and routes to be followed. The EAP should include the name and day / night telephone numbers of the operator or other responsible person. If this action is not applicable, that fact should be stated in the EAP. If any of these measures apply, they should be discussed in EAP.

Finally, EAP should also include any other site-specific actions devised to mitigate the extent of possible emergencies.

4.6 Inundation Maps

Whenever communities or significant numbers of dwellings are located in the floodplain downstream of a dam, inundation maps are usually needed to develop an adequate evacuation plan. These maps show an outline of the area covered by the dam break or excessive release flood in enough detail to identify dwellings and other significant features that are likely to be directly affected. Mapping is generally accomplished by superimposing the flood outline on an existing map. Estimated flood travel time and depth at selected locations should be included on the map. The maps should be of sufficient scale and detail to identify clearly the areas that would be flooded if large flows occurred from dam failure, mis-operation or extreme storms. Clarity and simplicity are important. Therefore, such a large scale has been adopted for the map so that all important features can be identified. The maps are generally prepared on the basis of computer simulation of Dam Break Modelling. This study should be done by a competent authority / agency with proper inputs so that the inundation maps give an accurate idea of the areas likely to be submerged under various conditions.

Since local officials are likely to use the inundation maps for evacuation purposes, a note should be included on the maps to advise that, because of the method, procedures and assumptions used to determine the flooded areas, the limits of flooding shown and flood wave travel times are approximate and should be used only as a guideline for establishing evacuation zones. Areas inundated in an actual event will depend on actual failure conditions and may differ from areas shown on the maps.

Generally, an inundation map depicting both breach and large flood conditions should be included in the plan. Although additional conditions could be covered, caution should be used to keep the plan simple enough to be clear and understandable. Generalized breach inundation maps may be used in the plan if sufficient for clearly depicting the inundated areas. Generalized maps may need to be supplemented with larger scale and more detailed maps in some areas. The mapping and the number of different flooded areas should be coordinated with local officials who are developing evacuation plans. It may be appropriate to supplement the inundation maps with water surface profiles in critical areas.

It is recommended that the best available maps should be used for evacuation planning. Topographic or orthographic mapping or street maps may prove best. The lines delineating the inundated area should be drawn in such thickness or form (e.g., solid line, dashed, dotted line) as to identify the inundated limits as the main features of the map, but not bold enough to obliterate features, which would be inundated by the flood waters.

When plotting inundation limits between cross sections used for the analysis, the lines should reasonably reflect the change in water levels caused by topographic patterns and manmade features. Colour-coded maps are recommended.

When inundation lines enter the area of an existing reservoir, they should represent an increase in the water level of the reservoir. If this increased water level overtop the dam impounding the reservoir, appropriate inundation lines should extend downstream of the dam.

For dams not in series but which affect a common downstream area, it is usually adequate to consider the breach condition for each dam individually, unless special conditions warrant multiple failure considerations. Breach inundation lines of such dams should then consist of a line enveloping the lines for the individual breaches when common areas would be inundated.

If inundation maps are to be shown on several pages, a map index should be included to orient the individual pages. Inundation maps should suitably be updated after a period of time if there is significant change in the downstream area due to human activities.

4.6.1 Index maps

A list of town & villages, important public buildings & installations, railway lines, railway stations, Post & Telegraph offices and roads which may come under the flood line, prohibitive zone, restrictive zone and caution zone are to be marked on index map. List of villages with their population may be enclosed in the report. The index maps should be prepared to the scale of 1:50000.

4.6.2 Detailed maps

In respect of cities or towns and the villages falling in the likely inundation area of dam break floods, detailed contour maps of the entire area showing contours at 0.5 m intervals should be prepared. The hypothetical dam break flood line, the 25 & 50 years return period outflow and the maximum spillway design discharge flood line (wherever relevant), various populated sectors, streets & roads, public buildings, important installations and all prominent places must be marked on these plans. Detailed maps should be prepared on the available town planning or city survey or land record plans or village maps. Detailed inundation maps should be prepared to the scale of 1:10000. Normally such maps are available for the command area of irrigation projects having direct canals. These maps with additional surveys covering the likely inundation area will also serve the purpose in majority of the cases.

4.6.3 Maximum Inundation Maps

The Maximum Inundation Maps show the area which would be flooded in the event of a failure of the dam with the reservoir at pre-specified breach elevation and depths with different coloured area. The map also shows the area affected by a maximum spillway release of discharge with the reservoir at specified RL by the pink area. Also insert and describe table showing flood depths.

4.6.4 Leading Edge Times Maps

Leading edge times maps show the travel time of flood water in the event of failure of dam and maximum spillway release in hours with different colours. Also insert and describe table showing travel times.

4.6.5 Other Maps

Layout plan showing head works, plan showing position of rain gauge stations in catchment area and plans showing position of wireless or other communication means and other relevant maps should also be given.

4.7 Appendices

Following the main body of the plan, several appendices, for a more clear division of information should be included, which contains basic information

about the dam, data used in the development of the EAP and instructions for the maintenance of the plan.

Listed below are some of the specific topics to be covered in the appendices accompanying the EAP:

4.7.1 Description and location of the dam

First appendix should summarize the principal features of the dam and give a listing of the Salient Features, besides providing key drawings and/or photographs of the dam and appurtenances. Such an appendix could also describe the upstream and downstream areas and topography and establish the location of the dam, using maps and narrative description.

4.7.2 Investigation and analysis of dam break floods

This appendix can identify and briefly describe the method and assumptions selected to identify the inundated areas and a brief description of the methodology and outputs of the dam break modelling performed.

4.7.3 Training

Training of people involved in the EAP should be conducted to ensure that they are thoroughly familiar with all elements of the plan, availability of equipment and their responsibilities & duties under the plan. Technically qualified personnel should be trained in problem detection and evaluation and appropriate remedial (emergency and non-emergency) measures. This training is essential for proper evaluation of developing situations at all levels of responsibility which, initially, is usually based on onsite observations. A sufficient number of people should be trained to ensure adequate coverage at all times.

A training plan could be included as an appendix to the EAP. Exercises simulating dam failures are excellent training mechanisms for ensuring readiness. Cross-training in more than one responsible position for each individual is advisable in order to provide alternates. A careful record by roaster should be kept of training completed and refresher training conducted.

4.7.4 Testing

The EAP should prepare scenarios for the various emergency conditions and a plan to test the state of training and readiness of key personnel responsible for actions during an emergency, to make sure that they know and understand the procedures to be followed and actions required. Any special procedures required for nighttime, weekends and holidays should also be included. The tests should involve a drill simulating emergency conditions, preferably up to but not including actual evacuation. Coordination and consultation with local government, law enforcement officials and other organizations involved is desirable in order to

enhance the realism of the drill. Their involvement will perfect the close coordination with agencies necessary for a successful execution of the plan in an actual emergency. The drills should be analysed in detail and the plan should be revised to correct any deficiencies noted.

4.7.5 Updating

The EAP should be updated promptly after each change of personnel involved or their telephone numbers. The exercise should be conducted together with local government officials, for a comprehensive review of the adequacy of the EAP at intervals not to exceed one year. During the review, an evaluation of any amendments to guidelines or changes in downstream human habitation or in the reservoir should be made to determine whether any revisions to the current plan (including inundation maps) are necessary that would improve the workability of the plan. These revisions must be made in consultation with the appropriate public agencies. Reviews should be conducted on or about the same date each year. If no revision is necessary, a statement that the review was made and no revision to the plan was necessary should be provided to each recipient of the original plan.

Copies of any revisions that do result from updating the plan or from periodic testing of the plan should be furnished to all individuals to whom the original plan was distributed. A procedure should be established to ensure that all copies of the plan are revised.

4.7.6 Posting of the Notification Flowchart

An up-to-date copy of the Notification Flowchart and / or list should be posted in prominent locations at the dam site or local emergency operations centre. The flowchart should be posted at each phone and radio transmitter at the dam, powerhouse (if applicable), emergency operations centre and at all other desirable locations. The locations of the posted flowcharts should be indicated in the EAP.

A copy of the complete, up-to-date EAP should also be available to the dam operators, emergency operations centre personnel and local officials. The location of each copy should be stated in this section of the EAP.

4.7.7 Recording of emergency conditions

A record of all telephone or radio reports of emergency conditions and facility failures and actions initiated should be kept at all steps of the communications network. Each call should be recorded in chronological order to maintain continuous records during an incident. A log could be developed and kept as an appendix to the EAP, for documenting emergency conditions, facility failures and actions initiated & carried out.

CHAPTER V

CHECKLIST FOR EVALUATING THE EAP

5.1 General

Upon completion of a first draft of the Emergency Action Plan, it should be reviewed to evaluate its workability and comprehensiveness and to make sure that nothing has been overlooked. Each entity and / or person involved should be asked to review the plan and comment on its adequacy. A checklist such as below may help carry out this task.

5.2 Development of the Plan

5.2.1 Overview

./ Are reporting procedures clear enough in showing what data must be collected and what information should be reported?

./ Are terms in the plan defined so that users will have no questions about the nature of the situation?

- Failure Vs impending failure
- Emergency situation Vs potential problem
- Amount of time before a crisis occurs

5.2.2 Problem identification

./ Are the following indicators of potential failure covered in the plan?

- Slumping / sloughing
- Erosion
- Riprap displacement
- Slides on dam or abutments
- Increased amount of seepage
- Cloudy seepage
- Boils
- Piping
- Whirlpools (vortices)
- Settlement
- Cracks

- Bogs
- Sinkholes
- Abnormal instrumentation readings
- Failure of operating equipment
- Water in the intake tower
- Other

./ Are all events that could cause either a dam failure or flooding covered in the plan?

- Earthquake
- Storms
- Structural problem
- Massive landslide
- Volcanic eruption
- Fire
- Sabotage
- Sudden water releases
- Other potential disasters

./ Does the problem identification show all the possible locations of the problem?

./ Are the above indicators and events sufficiently defined so that the user can understand them?

./ Does the plan identify the cause of the problem?

./ Can the user ascertain the seriousness of the problem (i.e. determine when the problem becomes an emergency)?

./ Can the user determine what action is needed?

./ Can the user ascertain exactly when to notify local officials and which local officials to notify, depending on the nature of the problem?

./ Can the user determine what equipment or supplies are needed for each type of problem?

./ Does the format of the plan easily link problem identification with the action to take, notification to make and equipment and supplies to use?

./ Does the plan include a list of historical problems or a list of the most common problems for that type of dam?

5.2.3 Notification

./ Does the plan contain a list of key dam personnel and local officials in charge of evacuation which shows the following information?

- Which officials to call first,
- Their day / night telephone numbers / mobile phone numbers,
- Technical experts and their fields of expertise,
- At what point technical and / or evacuation experts should be called (triggering mechanisms),
- The names of their alternates, and
- Their responsibilities

./ Does the plan's format allow the user to find the name of the primary contacts quickly? Has the order of notification been prioritized?

./ Does the plan show the user's (dam owner / personnel and local officials) responsibility / authority in the event of a total loss of communications?

./ Does the plan describe the communications system?

- Normal conditions
- Backup
- Radio call numbers and frequencies
    - For onsite radios
    - For those to be notified

./ Does the plan include procedures for downstream warning?

- Availability of equipment
- Levels of responsibility for warning
- Downstream operators
- Other dams
- Industries
- Other agencies
- Recreational users

5.2.4 Local coordination

./ Was the development of the plan coordinated with local officials during the planning phase?

- Owner / staff and / or agency input into plan
- Local officials and / or agenciesô input into the procedures for emergency operations center, evacuation and post-flood operations
- Utilization of existing local plan

./ Do the inundation maps provide sufficient information and explanation?

- Language understandable?
- Terms explained?
- Map usage explained?
- Criteria explained?
- Travel time shown?
- Maximum elevations for each depicted event shown?
- Floodplain information available?
- Areas impacted within flood boundaries clearly shown?

5.2.5 Resources

./ Are resources adequately identified?

- Equipment and sources specifically described, including the contact name & telephone numbers?
- Supplies and suppliers specifically described, including the contact name & telephone numbers?
- Repair material and erosion protection material described?
- Arrangements to share with government entities described?

5.2.6 Review

./ Was a comprehensive review of the plan conducted at the time it was developed?

- Is it technically accurate?
- Is it workable?
- Does it comply with criteria?
- Is it comprehensive as a whole?
- Is it presented effectively?

5.3 Implementation of the plan

5.3.1 Local coordination

./ Was the plan (complete with notification list and inundation map) sent to all appropriate officials? Is a list of these officials maintained?

./ Have local officials had a briefing or other explanation of the plan? Is a record of such explanation maintained?

- Notification procedures clarified
- Communications network explained
- Points of contact exchanged
- Maps explained
- Basic project data explained

./ Have effective lines of communication for emergency conditions been set up?

./ Has agreement between the dam owner and local officials been reached with respect to roles and responsibilities during a dam emergency? Is the agreement in writing?

./ Has the dam owner reviewed local evacuation plans and provided feedback to local officials?

5.3.2 Testing

./ Has a plan for testing the EAP been developed?

./ Have drills been conducted? Is a schedule of drills maintained?

./ Have the following elements of the plan been tested?

- Problem identification
- Emergency scenarios notification of dam owner and operating staff
- Notification of local officials and others
- Communication system
- Equipment (including remote sensing equipment)

./ Were all appropriate personnel involved in the drills?

- Ownerôs personnel
- Dam safety personnel
- Maintenance personnel

- Support staff
- State & local officials
- Contractors & suppliers

5.3.3 Personnel and resource readiness

./ Are all appropriate employees familiar with the EAP?

./ Do all appropriate employees have access to the plan?

./ Have all appropriate personnel received training in the following areas?

- How to use the plan, including the notification flowchart and inundation map
- Identifying a problem
- Identifying the severity of a problem
- Using the communications equipment
- Using the notification subplan
- Using the evacuation subplan
- Overall dam safety

./ Is dam attendance appropriate?

./ Are key personnel available 24 hours a day?

./ Is the division of personnel into emergency response teams appropriate?

./ Do employees & local officials understand their roles during emergencies?

./ Do key employees & local officials have access to the dam during emergencies?

./ Are resources ready?

- Equipment available up-to-date and in working condition
- List of contractors up-to-date
- Supplies on hand or readily available

5.3.4 Reviewing and updating

./ Is the plan reviewed at least annually? Periodically?

./ Are notification procedures regularly updated?

- Names & telephone numbers of key staff

- Names & telephone numbers of local officials
- Names & telephone numbers of contractors

./ Are the following conditions confirmed during the review?

- Drills conducted
- Personnel trained
- Communications equipment operational
- Other equipment operational
- Access to dam clear
- Downstream warning system in place and operational
- Inundation maps still current
- Evacuation routes and priorities still current
- New problems accounted for in the plan

CHAPTER VI

MAINTAINING AN EAP: OVERVIEW

6.1 Introduction

Even after the Emergency Action Plan has been developed, approved and distributed, the job is not done. Without periodic updation, the EAP will become outdated, lose its effectiveness and be no longer workable. If the plan is not tested, those involved in its implementation may become unfamiliar with their roles. If the plan is not updated, the information contained in it may become outdated and useless. This chapter explains the proper procedures for maintaining an EAP, including methods for testing and evaluating the plan and also for reviewing & updating it.

6.2 Testing the plan

It is essential that an EAP be tested periodically by conducting an emergency drill. Testing is necessary to train participants, as well as to identify weaknesses in the plan. Annual testing is recommended.

The testing should be done by developing a realistic scenario under which the EAP would be implemented. The scenario should be different every year. In addition, different levels of the notification hierarchy should be tested each time an emergency drill is conducted.

The merits of a surprise drill versus a planned one should be considered. While a planned drill will allow participants to rehearse their roles in the EAP, a surprise drill can be more educational, since it will be more realistic and may reveal areas in which the plan can be modified to make it more workable.

At least once every five years, a drill should be conducted that is coordinated with all State officials having responsibilities under the plan. The involvement of State emergency services can be encouraging and can foster enthusiasm for the maintenance & timely implementation of the EAP.

6.3 Reviewing the test results

Immediately following a test or actual emergency, a review should be conducted with all parties involved. The responses to the scenario should be checked at all levels. The review should discuss and evaluate the events prior to, during and following the test or actual emergency; actions taken by each participant; the time required to become aware of an emergency and implement the EAP; and what improvements would be practicable for future emergencies. The purpose of the review is to identify deficiencies in the plan such as wrong telephone

numbers on the notification chart, inundation maps with inaccurate information and problems with funding, procedures, priorities, responsibilities assigned, materials, equipment & manpower.

After the review has been completed, the plan should be revised, if necessary, and the revisions disseminated to all parties involved.

6.4 Updating the plan

In addition to regular testing, a periodic (at least annual) review of the overall plan should also be conducted to assess its workability and efficiency and to plan for the improvement of weak areas.

Some updating of the plan, such as discovering incorrect or outdated information, will be accomplished during emergency drills. But there are other aspects of the EAP that need to be examined on a regular basis. For example, making a periodic review of the downstream area, to identify changes (new developments, etc.) that might affect the priority of notification & evacuation and the information shown on inundation maps updating contact details, etc.

Again, once the plan has been revised, the updated version ï or simply the affected pages ï should be distributed to all parties involved. It is recommended that the entire EAP be reprinted and distributed to all parties at least every five years.

Note: The distribution of copies of the EAP and Notification Flowchart (if issued separately) must be controlled and documented, to ensure simultaneous updating of all copies.

GLOSSARY

The EAP should include a glossary that defines technical terms used in the EAP, some of which can be as follows:

Bench Mark: A permanent or temporary monument of known elevation above sea level, used as a vertical reference during construction and for topographical surveys.

Breach: An opening through a dam resulting from partial or total failure of the dam.

Dam: A barrier constructed across a watercourse for the purpose of storage, control or diversion of water.

Emergency: A condition which develops unexpectedly, endangers structural integrity of a dam and / or downstream property & human life and requires immediate action.

Emergency Action Plan (EAP): A formal plan of procedures designed to minimize consequences to life & property in the event of an emergency at a dam.

Failure: The catastrophic breakdown of a dam, characterized by the sudden, rapid and uncontrolled release of impounded water.

Floodplain: The downstream area that would be inundated or otherwise affected by the failure of a dam or by large flows.

Flood profile: An elevation view showing the relationship of the water surface elevation and natural ground elevations for a discharge at a given location along longitudinal segments of a watercourse for a flood event. The flood event may either be a dam failure or a normal flow condition.

Flood routing: The process of determining progressively over time the amplitude of a flood wave as it moves past a dam or downstream to successive points along a river or stream.

Headwater: The water immediately upstream of a dam. The water surface elevation varies due to fluctuations in inflow and the amount of water passed through the dam.

Hydrograph: A graph showing the discharge, stage, velocity or other hydraulic property with respect to time at a particular point on a watercourse.

Inflow Design Flood: The flood hydrograph used for the design of a dam and its appurtenant structures, particularly the spillway and outlet works and for determining maximum temporary storage and height of dam requirements.

Instrumentation: The use of special devices to obtain critical scientific measurements of engineering structures.

Inundation map: A map showing areas that would be affected by flood conditions and / or by an uncontrolled release of reservoir water due to the failure of a dam.

Sensitivity Analysis: An analysis in which the relative importance of one or more variables thought to have an influence on results of the study being conducted is determined.

Spillway: A structure over or through which flood flows are discharged. If the flow is controlled by mechanical means, such as gates, it is considered a controlled spillway.

Tail water: The water in the natural stream immediately downstream from a dam. The water surface elevation varies with discharge from the reservoir.

Annexes

F O R M 1

Emergency Event / Unusual Occurrence Report

For use when reporting emergencies or unusual occurrences other than earthquakes, oil and hazardous substance spills and bomb threats. For any of the three aforementioned emergencies, use the appropriate report form. Because this is a general form, there will be sections that do not pertain to the emergency. Only fill out those sections that are applicable to the emergency.

Date: _____ Time: _____

Location: _____

Brief description of events (include caller's name and phone numbers)
_____
_____
_____

Pertinent Data:

Size of affected area: _____

Extent of damage: _____

Effect on operations: _____

Possible cause: _____

Rates of discharge: _____

Appearance of discharge: _____

Forebay elevation: _____

Appearance of forebay: _____

Forebay rise rate:_____ Tailbay rise rate: _____

Weather conditions: _____

Injuries / loss of life: _____

Witness: _____

Other:_____

F O R M 2

Earthquake Damage Report : For Reporting Earthquakes

The_____dam (latitude_____ longitude_____) lies within Seismic Zone_____where major damage can be expected from earthquakes. The dam has the possibility of being subject to moderate to severe ground shaking from nearby or, distant, moderate to large magnitude earthquakes.

Earthquake Damage Report:

Date: _____ Time: _____

Person Reporting Information : _____

Feature Affected:_____

Description of Earthquake Effects : *

On structural conditions:

Type of damage (slides, subsidence, etc.)_____

Location: _____

Severity: _____

Movement (direction, magnitude)_____

Deflection or Settlement Readings: _____

Effect on Adjoining Structures: _____

On Hydraulic Conditions:

Type of effect (leakage or stoppage)_____

Location: _____

Size of affected structure:_____

Estimated flow or change in flow: _____

Nature of discharge (including sediment): _____

Wave action damage : _____

Other:_____

Site conditions:

Water surface elevation / stoppage_____

Location: _____

Size of affected area:_____

Estimated flow or change in flow: _____

Nature of discharge (including sediment): _____

Wave action damage : _____

Other:_____

Action:

Change in operation_____

Emergency repairs_____

Surveillance_____

Regional assistance needed (examination)_____

Public information provided _____

* To facilitate analysis of conditions, a map should be prepared showing the location and extent of all damaged areas such as subsidence areas, seeped areas, springs and any other pertinent data, including the dates of readings and site conditions at the time of observation. This map should be revised periodically to show changing condition until they are stabilized.

F O R M 3

Bomb Threat Report : For Reporting Bomb Threat

BOMB THREAT

Place this card under your telephone

Question to ask:

1.	When is bomb going to explode? ----------	15	**CALLER'S VOICE**
2.	Where is it right now? ----------	----------Calm	---------- Nasal
3.	What does it look like?	---------- Angry	----------Stutter
4.	What kind of packet is it?	----------Excited	----------Lisps
5.	What will cause it to explode?	---------- Slow	---------- Raspy
6.	Did you place the bomb?	----------Rapid	----------Deep
		----------Soft	----------Ragged
		----------Loud	----------Clearing throat
		----------Laughter	---------- Deep breathing
		----------Crying	----------Cracking voice
		----------Normal	----------Excited
		----------Distinct	----------Disguised
		----------Slurred	----------Accent
			----------Familiar
7.	Why?	If voice is familiar, who did it sound like?	
8.	What is your address?	16	**BACKGROUND SOUNDS**
9.	What is your name?	-----Street noises	----------Factory
10	**EXACT WORDING OF THE THREAT**	----------Motor	----------Machinery
		----------Crockery	--------Animal noises
		----------Voices	----------clear
		--------PA system	----------static
		----------Music	----------local
		----House noises	---------long distance
		----------Cellular	Other----------
		----------Office Machinery	----------
	OTHER INFORMATION	17	**THREAT LANGUAGE**
11	Sex of caller : M or F accent / race:	-------Wellspoken (educated)	----------Incoherent
		----------Foul	----------Taped
		----------Irrational	----------Message read by threat maker
12	Age --------- Length of call: ----------	18	**REMARKS**
13	Number at which call is received ----------	Report call immediately to: Phone No. ------- Date ----------	
14	Time ---------- Date ----------	Name : ---------- Position: ---------	

Name of Project:
Summary sheet for _____
_____ Dam Emergency Action Plan

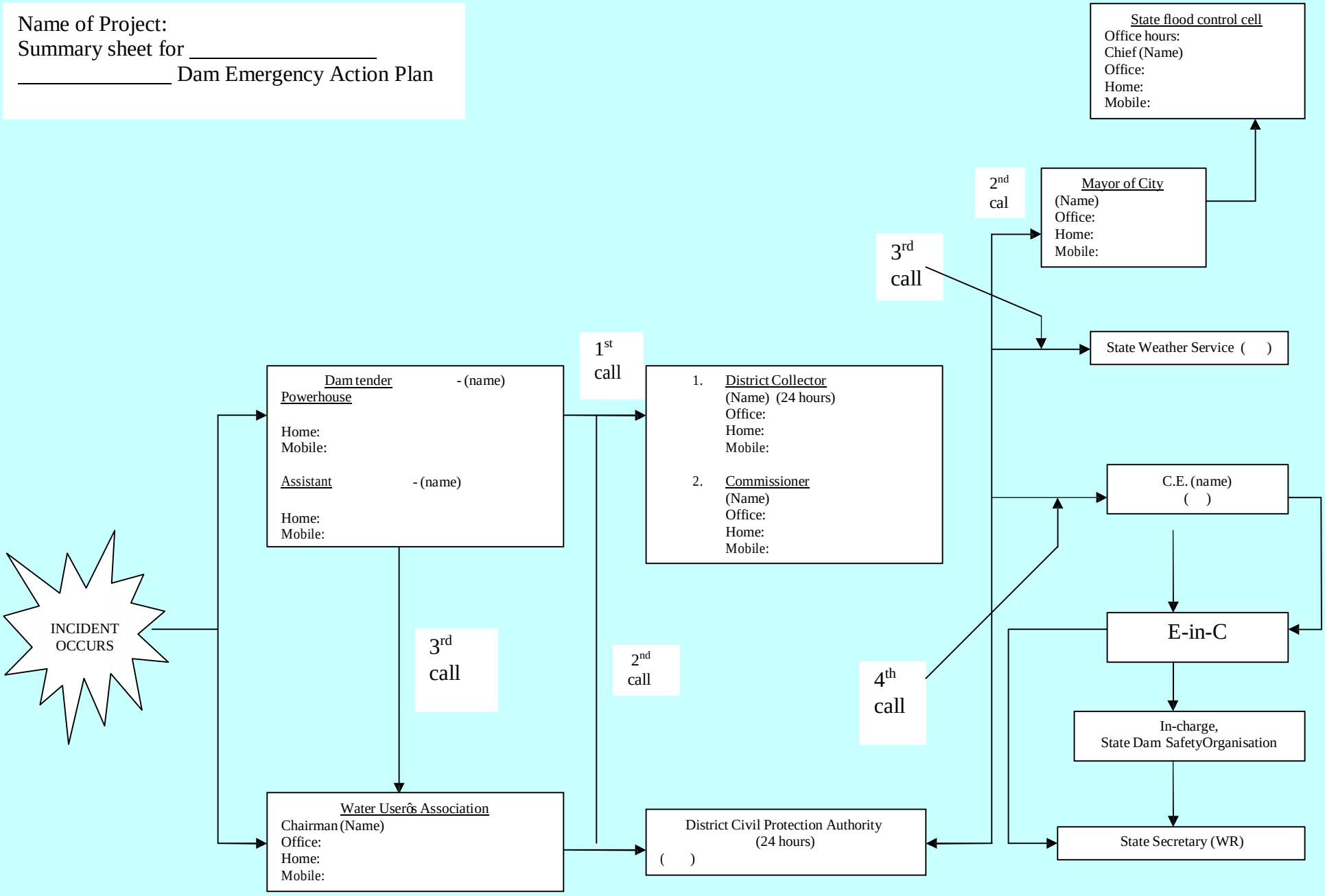
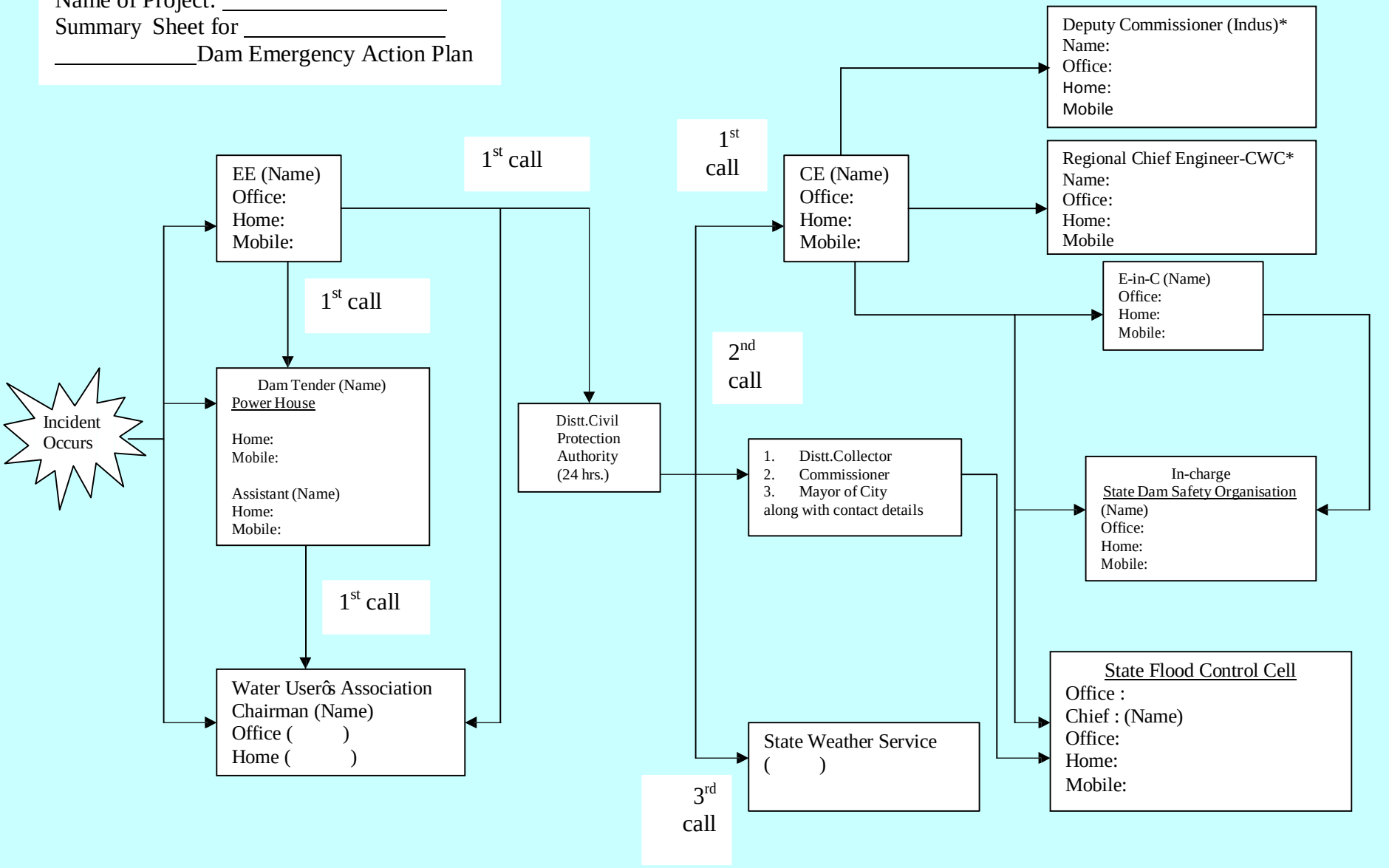


Fig.1 : IMMINENT SITUATION : NOTIFICATION CHART # 2

Name of Project: _____
Summary Sheet for _____
_____Dam Emergency Action Plan



LEGEND :
Internal Alert Notification (internal notifications) _____
Developing Situation Notifications _____
(internal & external notifications)

Fig.2 : Internal Alert & Developing Situation Notification

*For Indus Basin (Eastern&Western Rivers)