

# Investigation of the Emergency Action Plan for Dams

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## Abstract

The flood events got highly effected on the dam site in the recent decades. Design, construction, operation, maintenance, and inspection of dams are intended to minimize the risk of dam failures. Despite adequacies of these programs and their implementations, situations may develop sometimes leading to dam failures structural or operational. Enormous amounts of water flow out of a dam when it fails catastrophically, or excess water is released through the spillways to protect the dam from failure during extreme weather conditions. The current phenomenon adversely affects people, infrastructure, and the environment downstream of the dam. An accurate implemented EAP is a positive step can take to accomplish dam safety objectives, to protect lives and property, and to reduce damage to the environment. The current study presented the procedure of EAP preparation. Prepared a principle flowchart and level of warning and emergency action plan for downstream of dam.

**Keywords: Emergency Action Plans, Dam.**

## 1. INTRODUCTION

Dams are built to control and store water for purposes such as irrigation, hydroelectric, flood mitigation, recreation, and water quality control. Dams can be made from earth, rocks, concrete and are usually constructed on rivers. Whenever people live in an area that could be flooded by the failure of a dam, an emergency potential is assumed to exist. An emergency in terms of dam operation is defined as an impending or actual sudden release of water caused by an accident or failure of a dam. The release of water may endanger human life or downstream property [1].

For reduction loss of lives and property in emergency condition require to corporation between dam owners and the authorities of downstream settlements. The document that presents the measurements and duty of dam owners and downstream responsible people for emergency condition called Emergency Action Plan. An Emergency Action Plan (EAP) is a formal document and part of dam safety plan that identifies potential emergency conditions at a dam and specifies preplanned actions to be followed to minimize property damage and loss of life in the event of a dam failure [2].

This flow can cause four dam safety emergency level categories as follow:

- High Flow
- Non-Failure
- Potential Failure
- Imminent Failure

### High Flow

The High Flow emergency level indicates that flooding is occurring on the river system, but there is no apparent threat to the integrity of the dam. The High Flow emergency level is used by the dam owner to convey to outside agencies that downstream areas may be affected by the dam's release. Although the amount of flooding may be beyond the control of the dam owner, information on the timing and amount of release from the dam may be helpful to authorities in making decisions regarding warnings and evacuations. If the High Flow emergency level is used, dam owners should consider developing a table that correlates gate openings and/or reservoir levels to outflows, expected downstream impacts, and agencies that will be contacted.

### Non-Failure

The Non-Failure emergency level is appropriate for an event at a dam that will not, by itself, lead to a failure, but requires investigation and notification of internal and/or external personnel. Examples are new seepage or

leakage on the downstream side of the dam, presence of unauthorized personnel at the dam, and malfunction of a gate.

Some incidents, such as new seepage, may only require an internal response from the dam owner. Others, such as a gate malfunction, may lead to unexpected high releases that could pose a hazard to the downstream public and would require the notification of outside agencies.

### **Potential Failure**

The Potential Failure emergency level indicates that conditions are developing at the dam that could lead to a dam failure. Examples are rising reservoir levels that are approaching the top of the non-overflow section of the dam, transverse cracking of an embankment, and a verified bomb threat. Potential Failure should convey that time is available for analyses, decisions, and actions before the dam could fail. A failure may occur, but predetermined response actions may moderate or alleviate failure.



**Figure 1. California's Oroville Dam (2017)**

### **Imminent Failure**

The Imminent Failure emergency level indicates that time has run out, and the dam has failed, is failing, or is about to fail. Imminent Failure typically involves a continuing and progressive loss of material from the dam. It is not usually possible to determine how long a complete breach of a dam will take. Therefore, once a decision is made that there is no time to prevent failure, the Imminent Failure warning must be issued. For purposes of evacuation, emergency management authorities may assume the worst case condition that failure has already occurred.



**Figure 2. Failure of Teton Dam (Idaho) from seepage (1976) [2]**

## 2. OVERVIEW OF EAP

Five steps should generally be followed when an emergency incident is detected at a dam. These steps the EAP response process as follow:

- Step 1. Event Detection
- Step 2. Emergency Level Determination
- Step 3. Notification and Communication
- Step 4. Actions to be Taken
- Step 5. Termination and Follow-up

The five steps to take during an emergency event are illustrated in the flowchart shown in Figure 1.

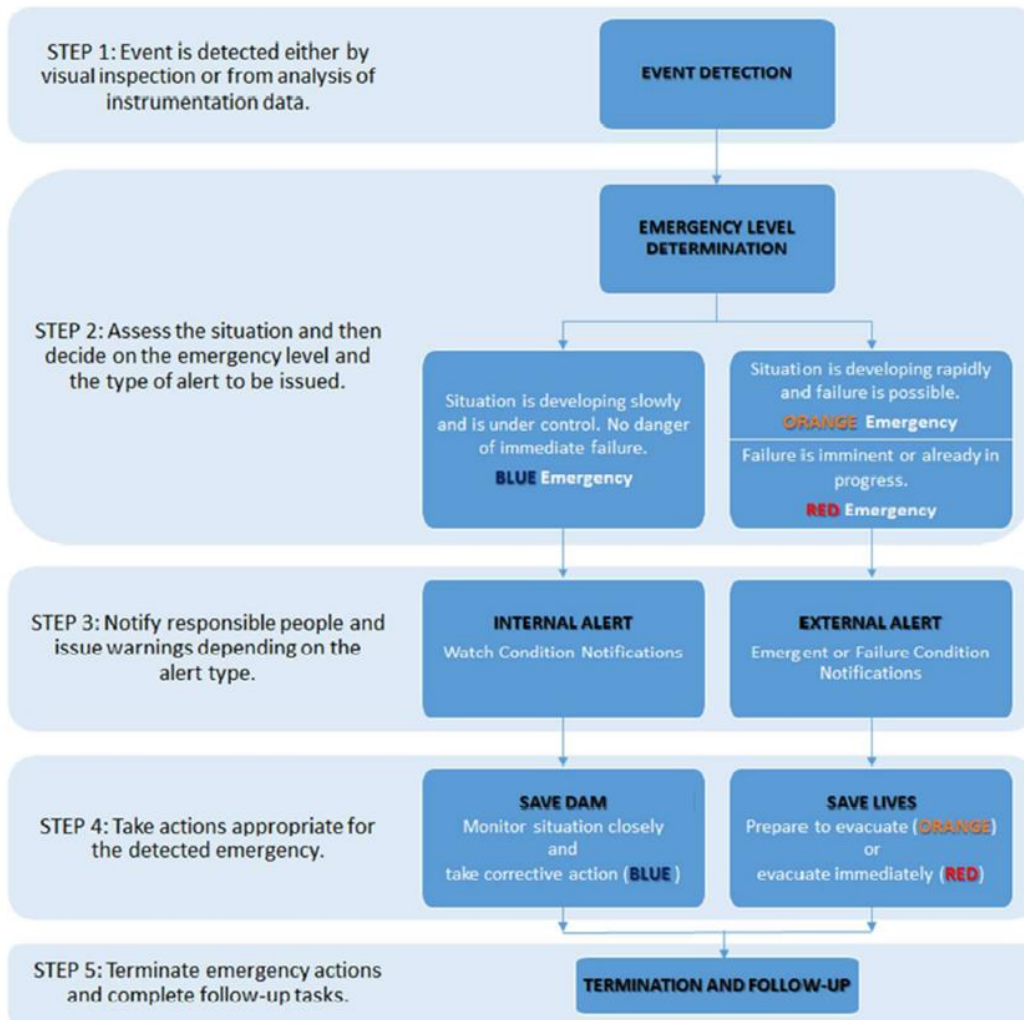


Figure 3. Flowchart showing the five-step response process of an EAP for a dam [3].

The anticipated emergency conditions are as follow:

- BLUE emergency level
- ORANGE emergency level
- RED emergency level

### BLUE emergency level

This is a 'watch' condition initiated when a problem has been detected at the dam that requires constant monitoring but is manageable by dam personnel. The 'watch' condition will continue until the problem is corrected or the condition is elevated to a 'possible' dam failure and the appropriate warning is issued.

### **ORANGE emergency level**

The owner or the operator has determined that there is a high probability of dam failure and an uncontrollable release from the reservoir. However, time is available for analysis, decisions, and actions before the dam could fail, such actions may moderate or alleviate failure.

### **RED emergency level**

The dam is about to fail or has already failed. A flood wave is either currently or will soon be moving downstream. Destruction can be expected from the flood wave and the evacuation of downstream areas should be carried out in accordance with local plans.

## **2.1 EVENT DETECTION**

Unusual conditions are unique to each dam and, to the extent possible, should be identified in the EAP. The following information should be considered for inclusion in the plan to assist the dam owner/operator in this step:

- Measures for detecting existing or potential failures
- Operating information, such as normal and abnormal reservoir level data
- Description of monitoring equipment, such as water level sensors and early warning system
- Monitoring and instrumentation plans
- Inspection procedures
- Process for analyzing and confirming incoming data

## **2.2 EMERGENCY LEVEL DETERMINATION**

After an unusual condition is detected and confirmed, the dam owner or operator will classify the condition of incident in to one of the established emergency levels based on the severity of the initiating condition or triggering events. Both the dam owner and disaster management authorities should understand the emergency levels and each other's respected responses.

The EAP should describe how each emergency level applies to the particular dam. Information to assist the dam owner in determining the appropriate emergency level should be developed and included in the EAP.

## **2.3 NOTIFICATION AND COMMUNICATION**

After the emergency level at the dam has been decided, notifications are made in accordance with the EAP's Notification Flowcharts. Details on the use of the Notification Flowcharts and any additional contact information should be provided in the EAP. When developing notification and communication procedures, dam owners should coordinate closely with disaster management authorities. When performing notification and communication activities, it is important that people speak in clear, nontechnical terms to ensure that those being notified understand what is happening at the dam, what the current emergency level is, and which actions to take.

## **2.4 ACTION TO BE TAKEN**

After the initial notifications have been made, the dam owner/operator will act to save the dam and minimize impacts to life, property, and the environment. During this step, there is a continuous process of action taking, assessing the status of the situation, and keeping others informed through communication channels established during the initial notifications. During an incident, safety and security measures should be implemented to secure the affected operational areas at the dam to protect operations and the public, and permit an effective performance of emergency response actions.

## **2.5 TERMINATION AND FOLLOW-UP**

The EAP should explain the expected termination and follow-up procedures for dam safety incidents and emergencies. This step should explain the process to follow and the criteria for determining that the incident at the dam has been resolved.

Generally, the dam owner/operator, or the dam safety expert, is responsible for notifying the authorities that the condition of the dam has been stabilized. Disaster management officials are responsible for declaring an end to the public emergency response

### **3. TRAINING AND EXTECISE**

Training and exercise plans should be designed and developed by those entities with responsibilities identified in the EAP.

#### **TRAINING**

The people involved in the implementation of the EAP should be receive training to ensure that they are thoroughly familiar with all elements of the plan, the available equipment, and their responsibilities and duties under the plan.

#### **EXTECISE**

If the EAP action items and procedures are not exercised periodically, those involved in its implementation may lose familiarity with their roles and responsibilities. A proposed exercise schedule and plans for an EAP exercise program should be included in the EAP. Plans for conducting an evaluation of the exercise and for updating the EAP based on the outcome of the evaluation should be considered.



**Figure 4. EAP exercise [2]**

### **4. CONCLUSIONS**

In this paper, the process of EAP for floods caused by dam break events was presented. It concerned on main information and format of EAP. Because of climate change and uncertainty about floods of rivers and dam failure events, it is necessary to concern on populated cities downstream of dams and extracts a simple EAP for dam break crisis preparations and management.

### **5. REFERENCES**

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