Introduction of an Emergency Response Plan for flood loading of Sultan Abu Bakar Dam in Malaysia

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Abstract. Sultan Abu Bakar Dam Emergency Response Plan (ERP) is designed to assist employees for identifying, monitoring, responding and mitigation dam safety emergencies. This paper is outlined to identification of an organization chart, responsibility for emergency management team and triggering level in Sultan Abu Bakar Dam ERP. ERP is a plan that guides responsibilities for proper operation of Sultan Abu Bakar Dam in respond to emergency incidents affecting the dam. Based on this study four major responsibilities are needed for Abu Bakar Dam owing to protect any probable risk for downstream which they can be Incident Commander, Deputy Incident Commander, On-Scene Commander, Civil Engineer. In conclusion, having organization charts based on ERP studies can be helpful for decreasing the probable risks in any projects such as Abu Bakar Dam and it is a way to identify and suspected and actual dam safety emergencies.

1. Introduction

Essentially, to prevent emergency incidents with colossal number of human from happening in regular life is very difficult. A dam safety emergency is an event which could potentially lead to dam failure and need to be taken care with a massive plan. Events that could result in a dam safety emergency include large floods, earthquakes, explosions, cracks appearing in the embankment, landslide/slippage, unexplained increases in seepage, operational incidents and sabotage. Therefore, an Emergency Response Plan (ERP) is required in order to prevent critical incidents being occurred. ERP can be defined as the detailed contingency program that includes actions that have to be taken in order to control and/or minimize the impact of an emergency situation [1]. ERP is an important method for dealing with different types of accidents, such as fires, explosions, toxic releases, earthquakes, floods, typhoons, and landslides [2]. One of the important parts of ERP scheme is related with definition of key responsibilities due to management of any probable risk events. The objective of this study is developing an ERP as a guideline to set up the communication human resources between correspond people to the key places at emergency time for Sultan Abu Bakar Dam. In this study, ERP of Sultan Abu Bakar has two stages Emergency Response Plan namely Dam Safety Event and Dam Safety Emergency.
2. Application of Sultan Abu Bakar Dam ERP

The development of a comprehensive ERP requires a systematic review of the dam on-site, and the assumption of possible risk scenarios [3]. When the real emergency situation occurred, the staff could not manage any problem properly without previous training and enough knowledge. Therefore, a complete ERP must be effectively developed and distributed to the appropriate human resources to prevent delaying corrective actions [4]. For the first step, Table 1 has been suggested for Sultan Abu Bakar dam owing to identification required human resources for following emergency management team by attribute authority and responsibility. However, all the personnel in the Emergency Management team chart are not involved with dam safety Emergency Response Plan.

The main authorities and related responsibilities required as key persons in Sultan Abu Bakar Dam are summarised in Table 1. In Table 1, the four authorities are the most important persons to conduct Sultan Abu Bakar Dam ERP. Everyone with responsibilities can delegate some or all of their responsibilities to the next most senior person if possible. Furthermore, if the delegated person is unreachable, the next most senior person should be contacted automatically to assume that role. Basically, Incident commander (IC), who is responsible for management of any probable risk, can take final decision and suggests solutions to perform in ERP outline. Next, Deputy Incident Commander (DIC) can be responsible to assist of IC in most of the events. Moreover, DIC can take final decision when IC is absent. On-Scene Commander is a person who is involved with a team to analyse the disaster and preparing the results and consequently the reports for finding the solutions. Also, management of executive parts can be related with On-Scene Commander. Finally, civil engineers can be assigned to fix and management of sub-sections. Usually, civil engineers should take any order by IC to perform any solution for possible risk.

![Figure 1. Suggested organization chart for Emergency Management Team](image-url)
Table 1. Responsibility of Emergency Management Team in Sultan Abu Bakar Dam

| Authority                  | Responsibilities                                                                                                                                 |
|----------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|
| Incident Commander (IC)    | • Highest authority for responding to operate directly during emergency events<br>• Managing responsibilities for dam safety emergencies and implementation required procedures<br>• Responsible for the reports of dam safety events and emergencies<br>• Assessing and monitoring of probable risks of Sultan Abu Bakar Dam are well predicted<br>• Establish an Emergency control Centre (ECC) at a safe location<br>• Responsible in maintaining a formal log of the entire event                                                                 |
| Deputy Incident Commander  | • Next person in charge to take the responsibility of the Incident Commander (IC) if the IC cannot be reached<br>• Assist IC in organizing the ECC<br>• Establish regular meeting to have dynamic and activate mobilize planning, logistic and finance section |
| On-Scene Commander         | • Acting as chief respondent at the beginning of emergency events<br>• Assessment of the scale of incident<br>• Establishment of Incident Command Post (ICP).<br>• Providing updated information pertaining to the development of the event to IC<br>• Management of emergency operations at the scene of the incidents<br>• Managing power generation units during emergencies<br>• Handling and controlling situations with Emergency Response Team (ERT) before the arrival of aid team |
| Civil Engineer             | • Conducting dam inspection and reports on the condition of Sultan Abu Bakar Dam under Incident Commander<br>• Performing possible remedial actions as instructed under the Incident Commander |

2.1. Establishment of ECC

During both Dam Safety Event and Dam Safety Emergency, Incident Commander must establish an ECC at a safe and stable location with the most communication channels available – landline telephone, mobile telephone, radio telephone, fax, e-mail, and radio and television facilities. As the conditions during dam emergencies are uncertain, it may be a good option to have a satellite phone or trunk radio that is useful during power breakdown or when the telecommunication signal go off.

2.2. Contents in Dam Safety Event and Dam Safety Emergency

For section in Dam Safety Event and Dam Safety Emergency which including flood loading, earthquake loading and normal loading Dam Safety Event, each of these section has a further three parts:

- **Information and triggers**, which describes potential dam safety incidents and prescribes trigger levels – it is essential for users to read,
- **A flowchart**, which illustrates how the emergency incident will be handled and splits the response into four distinct sections - Figure 2 shows the flowchart interpretation using colour code and box types. ‘Event Identification’ (yellow), ‘Initial Response’ (green), ‘Dam Safety Emergency’ (red) and ‘End Event/Emergency’ (blue).
An action list, which contains the details behind the various sections of the flowchart – the ‘who does what during a dam safety emergency, and when, where and how’.

Figure 2. Interpretation of the Flowchart

3. Triggering Level in Sultan Abu Bakar Dam ERP
A dam safety event gives rise to concern that the safety of the dam may be deteriorating such that action must be taken to prevent the development of an emergency condition. Notification is made to appropriate emergency response agencies to enable them to prepare for the implementation of downstream responses such as evacuation of the population at risk. Dam safety event types have been grouped together based on the loading condition under type of occurrence such as flood loading, earthquake loading and normal operation dam safety events. Table 2 describes potential dam safety incidents and prescribes trigger levels. A flood loading dam safety event is initiated when the water level obtained at Dam Safety Level and increased. While such flood is still well within the design capacity of the spillway at Sultan Abu Bakar Dam, it represents a prudent dam safety practice. Considerable flooding downstream of the dam can be expected.

Table 2. Sultan Abu Bakar Dam Safety Triggering Level

| Triggering Level          | Action                                      | Message Recipients |
|---------------------------|---------------------------------------------|--------------------|
| Dam Safety Event          | • Declare Dam Safety Event                   | 1. TNB*            |
|                           | • Confirm complete evacuation at Bertam Valley | 2. MKN** Pahang    |
|                           | • Activate control spilling                 | 3. Police Pahang   |
|                           | • Inform state agencies                     | 4. Fire Brigade Pahang |
| Dam Safety Emergency      | • Declare Dam Safety Emergency              | 1. TNB             |
| End of Event              | • End of Dam Safety Emergency               | 2. MKN Pahang      |

*TNB-Tenaga Nasional Berhad
**MKN-Majlis Keselamatan Negara

4. Response to the flood loading dam safety
Once a flood Dam Safety Event is identified, the On-Scene Commander shall alert the Incident Commander by issuing a ‘Dam Safety Event’ message. This then triggers a process where the dam and its surrounds are immediately inspected and reported on by the Civil Engineer for the duration of the
flood to detect signs indicative of potential dam failure. The Incident Commander must continue to monitor the situation from the ECC. If the water level continues to rise above Dam Safety Emergency level and it is predicted that serious structural damage to the dam is suspected or confirmed, the Incident Commander must declare a Dam Safety Emergency. If the water level reaches near of Event level and the procedure pretends that the water level is decreasing, and doesn’t cause any serious structural damage to the dam, it is considered that the event is finished.

5. Conclusion
Emergency Response Plan (ERP) is prepared for dam management and supporting personnel in the early detection of the emergency conditions which could endanger the integrity of the dams. ERP provides emergency condition and timely notification to relevant emergency management agencies. The Emergency Management Team need to comply with the assigned obligations regarding mischances after the ERP has been started by the incident commandant. The responsible person in the team should do their responsibilities with the fastest and proper way according to established ERP to prevent the loss of life, environmental degradation and structural damage to the dam. The implementation of ERP through training is important for emergency preparedness to the team in minimising the impact to the society and environment due to dam failure.

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References
[1] Lariyah M S, Hidayah B, Sivadass T, Rahsidi S M, Azwin Zailti A R and Zuraidah A 2014 Implementation of Dam Safety Management Program: From Theory to Practice in Malaysia, Applied Mechanics & Materials, 567 583-588.
[2] Tseng J M, Shu C M, Horng, J J, Kuan C M, and Hsu H I 2007 Planning an Emergency Response Center in Southern Taiwan science park, Trans IChemE Part B, 85(B2) 125-132.
[3] Fitzgerald M E 1996 The Emergency Response Plan: Key to Compliance with the Emergency Response Provisions of the Hazardous Waste Operations and Emergency Response Standard, Applied Occupational and Environmental Hygiene, 11(9), 1154-1162.
[4] Tseng J M, Liu M Y, Chang R H, Su J L, and Shu C M 2008 Emergency Response Plan of Chlorine Gas for Process Plants in Taiwan, Journal of Loss Prevention in the Process Industries, 21 393-399.