

# TECHNO-ECONOMIC ASSESSMENT STUDY FOR ROGUN HYDROELECTRIC CONSTRUCTION PROJECT

## PHASE II: PROJECT DEFINITION OPTION

### VOLUME 6: RISK ANALYSIS

#### ANNEX

## EMERGENCY PREPARDNESS PLAN (EPP) – BROAD FRAMEWORK

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## 1 INTRODUCTION

### 1.1 Scope

According to the terms of reference for Phase II (6.20 – Risk Evaluation/Assessment and their Mitigation): *“The Consultant shall prepare the outlines of an Instrumentation Plan to monitor the behaviour of the Dam through its life time and a broad framework Emergency Preparedness Plan for the contingency of dam failure.”*

The aim of this note is to present a broad framework of the Emergency Preparedness Plan (EPP), based on the international standards and the experience of the Consultant. A detailed Emergency Preparedness Plan shall be prepared for the next stages of the studies, based on the methodology and considerations presented in this report.

Regarding the Instrumentation Plan, requested in the Terms of Reference, the main points are presented in the report RP56 - Design of Alternatives (cf. paragraph 3.7). A detailed report must be done for the next stages of the studies.

It is to be noted that the Instrumentation plan and the Emergency Preparedness Plan (EPP) must be performed for the dam, but also for all the other appurtenant facilities.

### 1.2 Definition of an Emergency Preparedness Plan (EPP)

An Emergency Preparedness Plan (EPP) shall be prepared, tested, issued and maintained for any dam whose failure could be expected to result in loss of life as well as for any dam for which advanced warning would reduce upstream or downstream damage. The emergency could be, for example, failure of essential equipment such as flood control gates, slope failure in the upstream reservoir having the potential to cause dam failure, or a complete failure of the dam caused by overtopping, earthquake or piping.

First, in order to establish the Emergency Preparedness Plan (EPP), preliminary studies must be done. The aim of these studies is to obtain all the input data necessary for the EPP (Regional context, Risk identification, Dam Break Flood Hazard Analysis (DBHA)...).

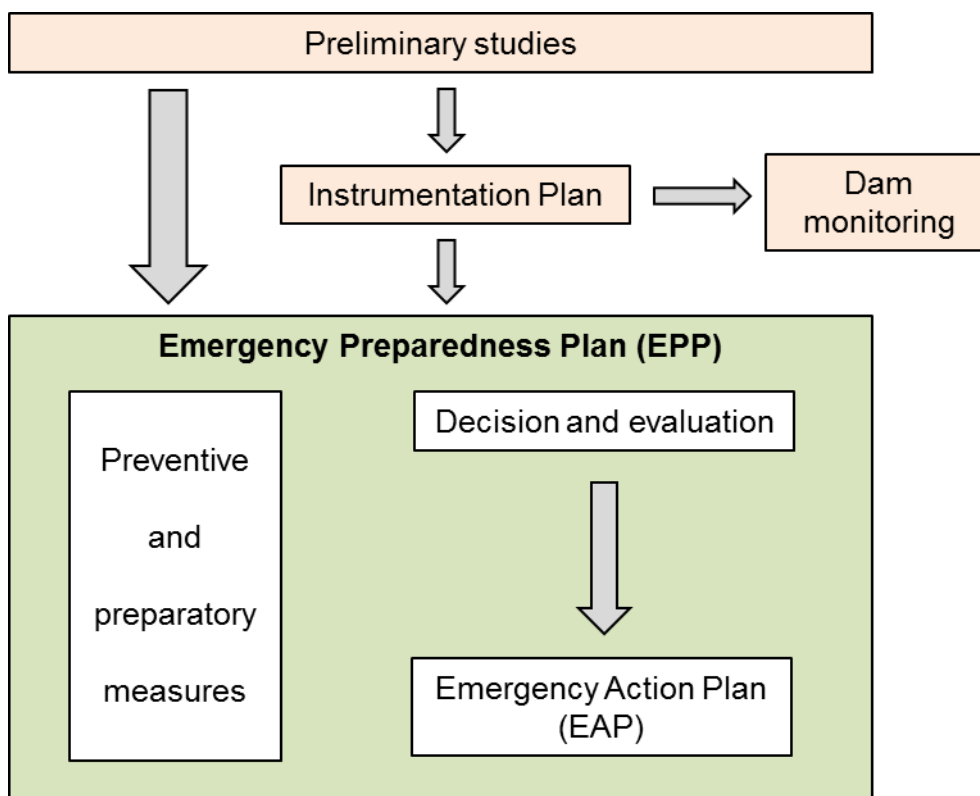
The preliminary studies are used to define the Emergency Preparedness Plan, but also the Instrumentation Plan necessary for the Emergency Preparedness Plan.

It is to be noted that the Instrumentation Plan cannot be included in the Emergency Preparedness Plan (EPP) because the aim of this plan is not only dedicated to the EPP. It is also useful to follow the dam and appurtenant facilities independently of an emergency

Taking into account these data, an Emergency Preparedness Plan (EPP) is elaborated , including the following points (cf. Figure 1):

- Preventive and preparatory measures ;
- Decision and evaluation ;
- Emergency Action Plan (EAP).

The contents of the EPP and the preliminary studies are detailed in the following parts of this report.



**Figure 1: Emergency Preparedness Plan (EPP) – Definition**

## 2 PRELIMINARY STUDIES AND INVESTIGATIONS

### 2.1 Regional context

In order to establish an Emergency Preparedness Plan in agreement with countries and organizations concerned by a potential risk (high floods, dam break) in relation with Rogun dam break, it is necessary to analyse in details the regional context. This section can be divided as follow:

#### Legal and institutional frame

Remind in this section the norms and laws in relation with the management of catastrophes in Tajikistan and Riparian countries concerned by the Emergency Preparedness Plan.

#### Administrative organization

Remind in this section the main points about administrative organization of Tajikistan and Riparian countries concerned by the Emergency Preparedness Plan. Describe also the division and organization of territory.

#### Environmental context

Remind in this section the following points:

- Physical Environment:
  - o Description of Amu Darya basin;
  - o Climate;
  - o Seismicity.
- Biological environment
  - o Protected areas;
  - o Flora;
  - o Fauna.
- Population in the area.

#### Socio-economic context

Remind in this section the followings points:

- Demography;
- Socio-cultural context;

- Economic context
  - o Agriculture;
  - o Fishing;
  - o Manufactures ;
  - o Roads ;
  - o Others activities.

## 2.2 Risk identification

List here the conditions or events which could lead to or indicate an existing or potential emergency. Situations involving flood emergencies could occur as a result of such as for example piping, floods, earthquake, sabotage or landslide induced waves.

This section shall refer to the following reports:

- Risk Analysis (Phase II - Report RP53);
- PFMA (Potential Failure Mode Analysis) of the dam, which has to be performed separately.

## 2.3 Dam Break Flood Hazard Analysis (DBHA)

*Reference: ICOLD, Bulletin 111 – Dam break flood analysis*

A dam-break flood hazard analysis (DBHA) can be performed in three steps, as follow:

**Step 1: Definition (statistically) and simulation (model)** of the dam break event in order to produce a sequence of dam-break discharge hydrographs. This step also includes the definition of dam break mode (breach or piping), and the description of cases studied in Step 2.

**Step 2: Flood routing of the modelling of the dam-break wave propagation downstream** from the dam, with numerical model (1D or 2D) depending of the site topography. Output requirements are discharge, stage and velocity hydrographs at important locations and longitudinal profiles at certain times.

**Step 3: Inundation (Flood) maps and hazard evaluations** are done by using the results of the dam-break analysis and the information on infrastructure, property and the population at risk, in the area which would be flooded by a potential dam-break. Hazard analyses the maximum flood elevations in the study area (steady state situation).

Inundation mappings are needed by local authorities to develop an adequate Emergency Action Plan (EAP).

The maps should delineate the areas that would be flooded as a result of a dam failure. Inundation maps are used both by the dam owner and emergency management officials to facilitate timely notification and evacuation of areas affected by a dam failure or flood conditions.

The maps should be developed at a scale sufficient to be used for identifying downstream inhabited areas within the area subject to possible danger. Inundated areas should be clearly identified. It may be appropriate to supplement the inundation on the maps with water surface profiles showing the elevation before failure, the peak water surface elevation after failure, the travel time for wave front and the location of structures at critical locations.

As a result, the following maps must be done:

- Maps indicating water depths for various time of propagation (15 minutes, 30 minutes, 1 hours, 3 hours, ...);
- Maps indicating maximum water depths on the area inundated;
- Maps indicating maximum risk index (for example:  $I = [\text{maximum water depth}] \times [\text{maximum - velocities}]$ );
- Maps indicating the villages, cities, accommodations and infrastructures and specifying the level of risk for each one;
- Maps for different return period floods (for example  $T = [100; 200, 500; 10\ 000, \text{PMF}]$  years) and different type of failure (complete/partial, for Stage 1 dam/Complete dam, by Piping/Breach,..).

## 2.4 Emergency resources and means

Other investigations must be performed in order to identify the emergency resources and means available in case of emergency:

- Remedial measures:
  - o Technical consultancies, Panel of experts ...available in case of emergency.
  - o Source of equipment: the location and availability of equipment and contractors that could be mobilized in case of an emergency should be included;
  - o Emergency power sources: details on the location and operation of emergency power sources;
  - o Stockpiling supplies and materials; the location and availability of stockpiled materials and equipment for emergency;
  - o ....
- Communication systems: description of the communication systems available to transfer information in the region in case of emergency (telephone, satellite, television, radio...).
- Access to the site: description of the available access in the region.

## **2.5 Meetings and investigations with populations, administrations and authorities**

The preparation of an Emergency Preparedness Plan requires meetings and investigations with the populations, administrations and authorities of Tajikistan and Riparian countries in order to:

- Collect the necessary data and discuss it;
- Identify the main sites concerned;
- Establish a permanent discussion.

These meetings and investigations represent a significant part of the preliminary works necessary to establish the Emergency Preparedness Plan.



### 3 EMERGENCY PREPAREDNESS PLAN (EPP)

The organization of the Emergency Preparedness Plan (EPP) is the following:

- 1 Preventive and preparatory measures**
  - 1.1 Dam and appurtenant works monitoring systems
  - 1.2 Early warning system
  - 1.3 Emergency resources
  - 1.4 Training
    - a. *Staff on site*
    - b. *Administrations and authorities*
    - c. *Population*
  
- 2 Evaluation and decisions**
  - 2.1 Roles and responsibilities
  - 2.2 Definition of alert levels
    - a. *Alert level 1*
    - b. *Alert level 2*
    - c. *Alert level 3*
    - d. *Alert level 4 (if defined)*
  
- 3 Emergency Action Plan (EAP)**
  - 3.1 Alert level 1
  - 3.2 Alert level 2
  - 3.3 Alert level 3
  - 3.4 Alert level 4 (if defined)

More details are given below. It is reminded that this document is a broad framework of the Emergency Preparedness Plan (EPP), therefore a detailed EPP must be established during the new stages of the project, based on these considerations.

<b>1.</b>	<b>Preventive and preparatory measures</b>
1.1	<u>Dam monitoring system</u>
	<p>The dam and appurtenant works monitoring system permits to identify as soon as possible a phenomenon which can cause an emergency situation, and certify that the structure has an acceptable level of risk.</p> <p>The dam monitoring system includes:</p> <ul style="list-style-type: none"> <li>- Visual inspections during regular visits made by the operator;</li> <li>- Additional inspection after an exceptional event (flood, seism...);</li> <li>- Inspections made by a panel of experts (every year, five, or ten years, ...);</li> <li>- Instrumentation.</li> </ul> <p>In this section, a summary of the dam monitoring system must be reminded in order that everyone involved can reach the data relative to the dam and appurtenant facilities health (See also the Instrumentation Plan).</p> <p>It must be also specified the actions necessary to maintain the dam monitoring system.</p>
1.2	<u>Early warning system</u>
	<p>The Early warning system includes the means necessary to detect a hydrological or meteorological event which can cause an alert situation. It includes a monitoring system and model of evaluation.</p> <p>A monitoring system must be installed in order to measure precipitations, temperatures, and snowfall on the Vakhsh river basin.</p> <p>Based on these data, a model must be performed to evaluate and forecast their evolution in order to anticipate an alert situation. The time interval at which this propagation model is to be updated with new data and re-run may be weekly, daily or even hourly (if necessary), depending upon the velocity of response of the basin and on the importance of the event under observation.</p> <p>The output of this model is a flood forecast information that is to be integrated as soon as available into the emergency evaluation and decision process.</p>
1.3	<u>Emergency resources</u>
	<p>The emergency resources concerned (as defined in the preliminary studies):</p> <ul style="list-style-type: none"> <li>- <u>Remedial measures:</u> <ul style="list-style-type: none"> <li>○ Technical consultancies, Panel of experts ...available in case of emergency;</li> <li>○ Source of equipment: the location and availability of equipment and contractors that could be mobilized in case of an emergency should be included;</li> <li>○ Emergency power sources: details on the location and operation of emergency power source;</li> <li>○ Stockpiling supplies and materials: the location and availability of stockpiled materials and equipment for emergency;</li> </ul> </li> </ul>

	<p style="text-align: center;">○ ....</p> <ul style="list-style-type: none"> <li>- <u>Communication systems</u>: description of the communication systems available to transfer information in the region in case of emergency (telephone, satellite, television, radio...).</li> <li>- <u>Access to the site</u>: description of the available access in the region.</li> </ul> <p>In these sections, a list of these emergency resources is necessary in order to check at any time these means are available and in good conditions in case of emergency.</p>
1.4	<u>Training and awareness</u>
	<p>The awareness and preparation to the risk of dam break are necessary to establish an Emergency Preparedness Plan (EPP).</p> <p>Depending on the role and responsibilities of people concerned in the framework of the Emergency Preparedness Plan (EPP), various training can be envisaged for:</p> <ul style="list-style-type: none"> <li>- Staff on site;</li> <li>- Administrations and authorities;</li> <li>- Population.</li> </ul> <p>Regarding Staff on site, Administrations and local authorities, the trainings must be defined in this section detailing the actors, objectives and schedule of each one.</p> <p>The means to make aware the population must be defined in this section.</p> <p><b>a. Staff on site</b></p> <p>The staff on site is generally responsible for realising the first steps of the emergency plan. This is the reason why the staff must know perfectly all the procedures in case of emergency, in order that the information in relation with an observation of an anomaly can be broadcast as soon as possible to the person in charge.</p> <p>The staff must be trained in order to react adequately to every situation which can affect the dam safety. This preparation permits to reduce the improvisation of staff on site in case of emergency.</p> <p>These training must insist in the observations and events in relation with the project safety.</p> <p>[Detail here the training for Staff on site]</p> <p><b>b. Administrations and authorities (of Tajikistan and Riparian countries)</b></p> <p>The administrations and authorities play a key role to inform the populations in case of emergency. This is the reason why they must receive specific trainings.</p> <p>[Detail here the training for Administrations and authorities]</p> <p><b>c. Population (of Tajikistan and Riparian countries)</b></p>

	<p>The population of Tajikistan and Riparian countries concerned must be informed about the risk of dam failure. Various means can be implemented to aware the population, for example: phone/SMS, radio, television, meetings, door-to-door or distribution of guide book. The guide book can be overall in order to have a quick access to the notification procedures.</p>
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[Detail here the means used to aware population]

2.	<b>Evaluation and decisions</b>
2.1	<u>Roles and responsibilities</u>
	<p>Define in this section the role and responsibilities of each party/authority involved in the implementation of the Emergency Preparedness Plan:</p> <ul style="list-style-type: none"> <li>- Operator;</li> <li>- Emergency services;</li> <li>- Dam owner;</li> <li>- Police;</li> <li>- ...</li> </ul>
2.2	<u>Definition of alert level</u>
	<p>The standard practice is to define three/or four alert levels (to precise during the newt stages of the studies).</p> <p>This classification permits to specify the information addressed to the population in case of emergency, and also the measures necessary.</p> <p>The alert levels are progressive, and the process is done in order that additional measures are taken into account when the alert level increases (as defined in the figure below).</p> <div data-bbox="343 1041 1385 1556" data-label="Diagram"> </div> <p style="text-align: center;"><b>Figure 2: Definition of Alert levels</b></p> <p>The Alert levels 1, 2 and 3 (if level 4 is defined) permit a progressive mobilization of resources, necessary if the Alert level 3 (or 4 if defined) is going off. However, the Alert level 3 (or 4 if defined) can be done directly in case of unpredictable situation. The Alert level 3 (or 4 if defined) induces the complete evacuation of the population in the area concerned.</p> <p>It is necessary to define the criteria used to define each alert level.</p> <p>These criteria refer to the analysis and interpretation of monitoring data inspection. The treatment of monitoring data is managed with a computer system. However the observations made on site following a site visit or inspections, can initiate an alert level.</p>

If the criteria defined are checked, the Emergency Action plan is initiated at the corresponding alert level.

For example, the criteria can be water level, water pressure, settlements, ...

**a. Alert level 1**

[Detail here the criteria used to define Alert level 1]

**b. Alert level 2**

[Detail here the criteria used to define Alert level 2]

**c. Alert level 3**

[Detail here the criteria used to define Alert level 3]

**d. Alert level 4 (if defined)**

[Detail here the criteria used to define Alert level 4]

3.	Emergency Action Plan (EAP)
	<p>The Emergency Action Plan (EAP) is initiated as soon as criteria of alert levels 1, 2, 3 or 4 are checked.</p> <p>The notification flow chart is used to implement the Emergency Action Plan (EAP). It defines clearly the role of each participant in the broadcasting of information, their interactions, and the priority order.</p> <p>This chart must be sent to every people and administration concerned, and regularly updated. It must include the following data:</p> <ul style="list-style-type: none"> <li>- Priority order for information broadcasting;</li> <li>- Position, name, first name of each person involved, and every phone number and radio frequencies necessary to contact them;</li> <li>- The information to broadcast for each participant;</li> <li>- The means used to broadcast the information;</li> <li>- The action to implement (evacuation of the population, ...)</li> </ul> <p>It must be specified also the measures to implement in case of specific conditions for each Alert level. These specific conditions can correspond to:</p> <ul style="list-style-type: none"> <li>- Response during period of darkness;</li> <li>- Response during period of adverse weather.</li> </ul> <p>The measures to return to safe situation must also be defined in the framework of the Emergency Action Plan (EAP) for each Alert level.</p> <p>These measures must be implemented when the emergency situation is managed (no alert level in progress).</p> <p><b>[Include here the measures to return to a safe situation]</b></p> <p><i>An example is given below, and must be adapted to Rogun project during the next stage of the studies.</i></p> <ul style="list-style-type: none"> <li>- <i>Check the security of flooded access (roads, street, ways, bridges);</i></li> <li>- <i>Wash the flooded accesses (roads, street, ways, bridges);</i></li> <li>- <i>Start the extermination of rats in the flooded areas, take measures to gather the dead rats and animals, and clear the alive rats;</i></li> <li>- <i>Fixe an hour of reintegration and inform the population;</i></li> <li>- <i>Check the complete sewer network and remove all the materials embarrassing the water flow;</i></li> <li>- <i>Check the drinkable network conditions;</i></li> <li>- <i>Check the drinkable water quality (specialized organism involved);</i></li> <li>- <i>Proceed to the progressive reintegration of population;</i></li> <li>- <i>Remove progressively the security barriers and emergency signing;</i></li> <li>- <i>Proceed to the cleaning and checking of public building and drain the flooded underground;</i></li> <li>- <i>Examine the food in shops and restaurants;</i></li> <li>- <i>Inform population about the hygiene measures;</i></li> <li>- <i>Close the temporary accommodations;</i></li> </ul>

	<ul style="list-style-type: none"> <li>- Summarize the damages for citizens and companies;</li> <li>- Advise the victims about the help services available. If necessary, organize public meetings;</li> <li>- Inform population, public security and media about the end of emergency operations;</li> <li>- Close the operations paper;</li> </ul> <p>Organize a feedback meeting and write an event report.</p>
3.1	<b>Alert level 1</b>
	<p>[Include here :</p> <ul style="list-style-type: none"> <li>- Notification flow chart and description;</li> <li>- Measures in specific conditions;</li> <li>- Measures to return in a safe situation.]</li> </ul>
3.2	<b>Alert level 2</b>
	<p>[Include here :</p> <ul style="list-style-type: none"> <li>- Notification flow chart and description;</li> <li>- Measures in specific conditions;</li> <li>- Measures to return in a safe situation.]</li> </ul>
3.3	<b>Alert level 3</b>
	<p>[Include here :</p> <ul style="list-style-type: none"> <li>- Notification flow chart and description;</li> <li>- Measures in specific conditions;</li> <li>- Measures to return in a safe situation.]</li> </ul>
3.4	<b>Alert level 4</b>
	<p>[Include here :</p> <ul style="list-style-type: none"> <li>- Notification flow chart and description;</li> <li>- Measures in specific conditions;</li> <li>- Measures to return in a safe situation.]</li> </ul>