LUANG PRABANG HPP

Dam Safety

Decmber 2019

CONTENTS

- Basic Studies
  - Flood Hydrology
  - Probabilstic and Deterministic Seismic Hazard Assessment
- Design Criteria
  - Hydraulic Design Criteria
  - Seismic Design Criteria
- Stability Checks
- Monitoring Program
- Emergency Planning and Dam Break Analysis

Basic Studies

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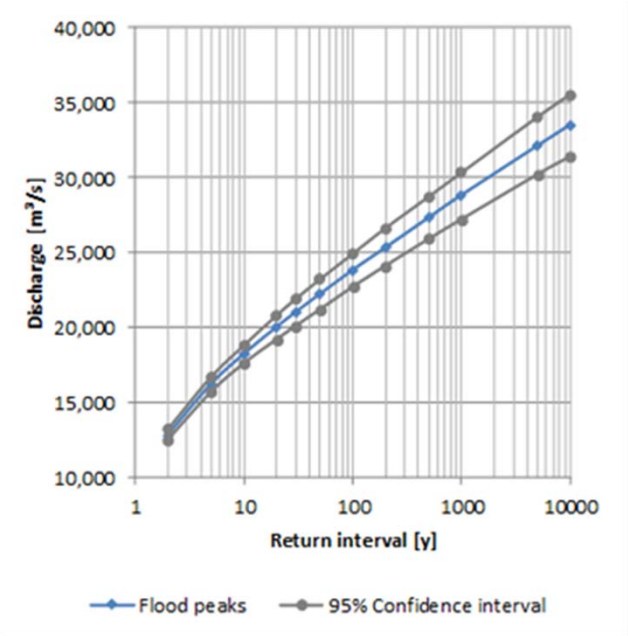
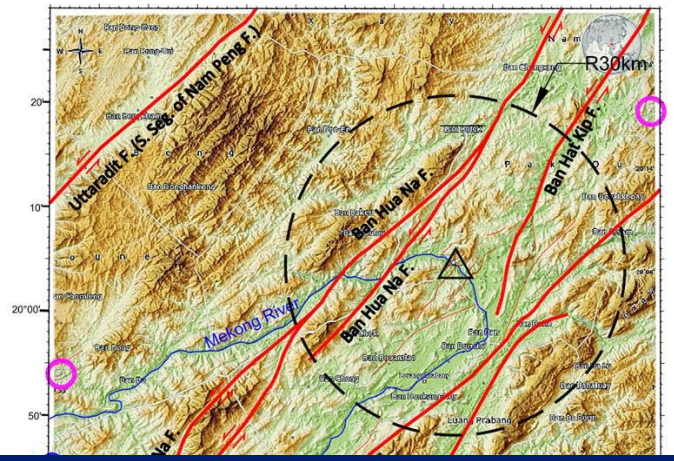
Basic Studies

- Flood Hydrology
  - Statistical Flood Hydrology
    - **10,000 yr flood: 33,500 m³/s**
  - PMP/PMF Study
    - **PMF: 41,100 m³/s**



- Seismic Hazard Assessment



Design Earthquake	Analysis Method	Return Period (year)	Peak Ground Acceleration (g)	
			Horizontal	Vertical
CE	Probabilistic	50	0.06	0.04
OBE	Probabilistic	145	0.13	0.10
DBE	Probabilistic	475	0.23	0.18
MDE	Probabilistic	2,475	0.37	0.310
SEE	Probabilistic	10,000	**0.49**	**0.40**
SEE	Deterministic	------	**0.49**	**0.40**

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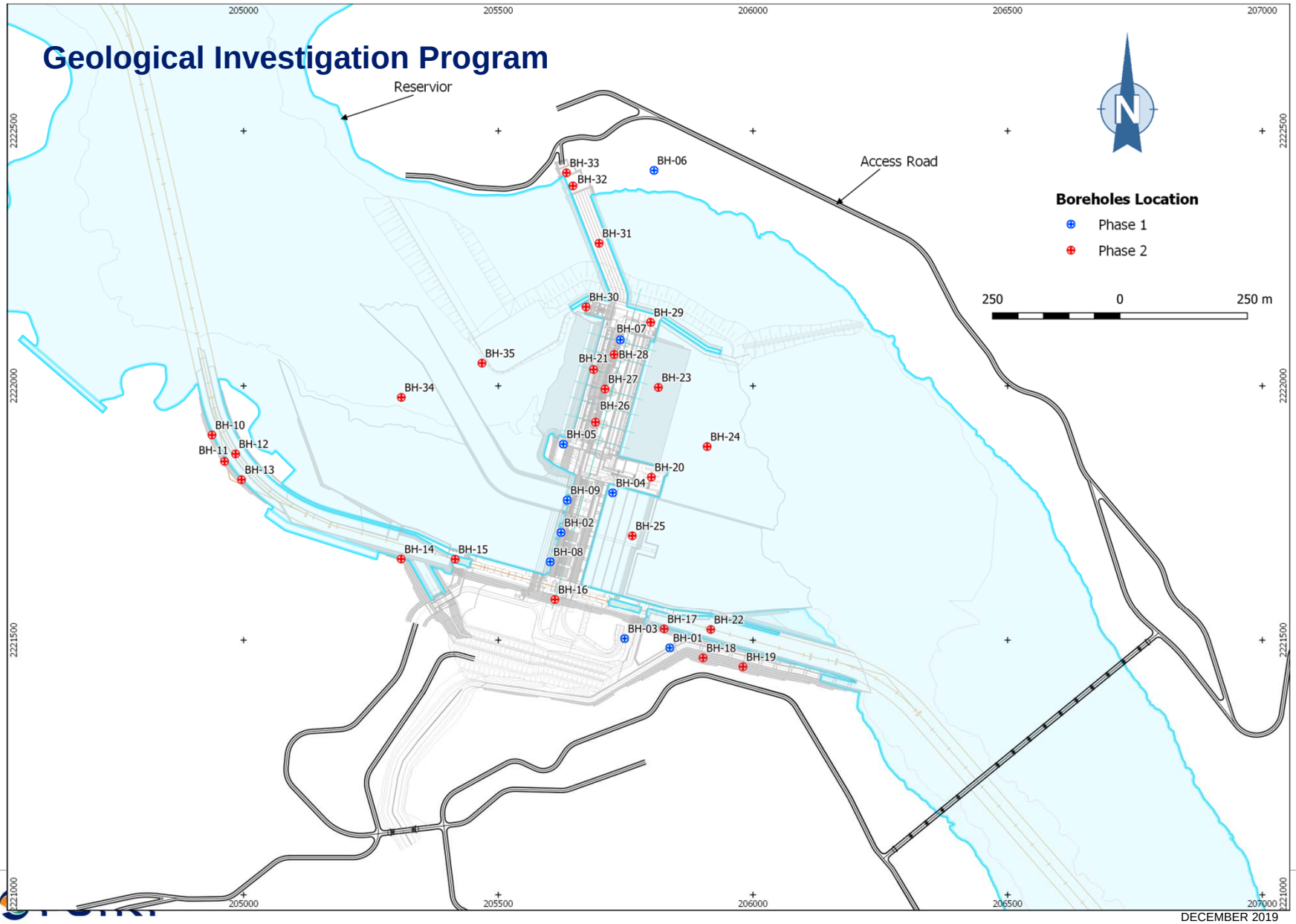
Geological Investigation Program



Design Criteria

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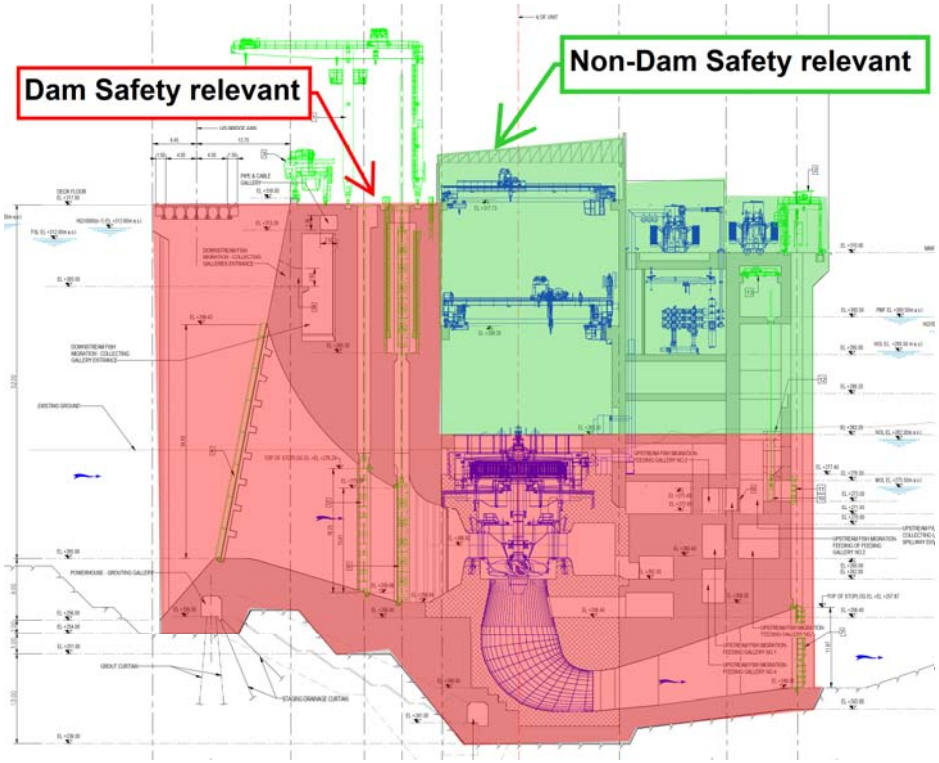
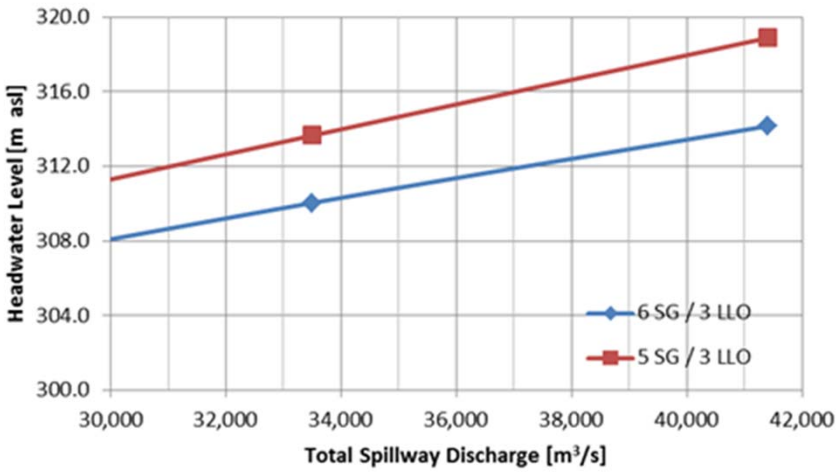
Design Criteria

- Seismic Design Criteria
  - Dam Safety Relevant Structures -> SEE
  - All other structures -> DBE



- Hydraulic Design Criteria
  - Design Flood: 10,00 yr flood, (n.1)-rule
  - Safety Check Flood: PMF
- Hydraulic Model Tests
  - Flume tests for the Spillway carried out
  - Spillway Capacity is given
  - Test on overall model are ongoing



Stability Checks

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Stability Checks

- Standards
  - USACE manual
  - LEPTS (Lao Electric Power Technical Standards)
- Load Cases
  - Usual, Unusual and Extreme Load cases
  - Floatation, Sliding and Rotation/Overturning
- Dam Safety relevant Structures
  - Navigation Lock
  - Spillway
  - Powerhouse, incl. Right and Left Pier
  - Closing Structure

- Results of Stability Checks
- Navigation Lock
  - Upper Lock not critical
- Spillway
  - Current design is conservative
- Right Pier
  - Right Pier is not critical (potential for optimization)
- Powerhouse
  - Relevant and already optimized
  - Safety requirements are fulfilled
  - Revision after layout is revised (hydraulic contours of draft tube as per equipment supplier)
- Left Pier
  - Left Pier is not critical (potential for optimization)
- Closing Structure
  - Relevant
  - Safety requirements are fulfilled

Monitoring Program

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Monitoring Program

- Relevant during impounding and operation
- General
  - **Visual Inspections:** Regular inspections by O&M staff
  - **Survey Monitoring:** Measurement of surface displacements and deformations
  - **Monitoring Instruments:** Deformation, water pressure, etc.
- Dam Instrumentation
  - Parameters and Instruments as below:

Parameter	Monitoring Instruments
Displacement, movement, settlement	Jointmeter, Rocmeter, Inclinometer, Levelling bolt, Stationary light reflector
Water level, water pressure	Gauge, Observation well, Piezometer
Leakage/ seepage	Flowmeter, Piezometer
Climate	Weather station
Dynamic response (seismicity)	Strong Motion Accelerator

Monitoring Instrument	Behaviour	Reading	No
El. Piezometer (EP)	Water Level Uplift Pressure	Automatic	40
Flowmeter (FM)	Water Leakage	Automatic	10
3D-Jointmeter (TJM)	Movement Displacement Settlement	Automatic	75
Rocmeter (RM)	Movement Displacement Settlement	Automatic	20
Inclinometer (IM)	Movement Displacement Settlement	Manual	3
Groundwater Observation Well (OW)	Water Level Uplift Pressure	Manual	10
Strong Motion Accelerometer (SMA)	Dynamic Response	Automatic	2
Leveling Bolt (LB)	Movement Displacement Settlement	Manual	50
Stationary Light Reflector (SR)	Movement Displacement Settlement	Manual	30
Weather Station	Rainfall Intensity Temperature Relative Humidity Barometer Wind Velocity Evaporation Pyranometer	Automatic	1

Emergency Planning and Dam Break Analysis

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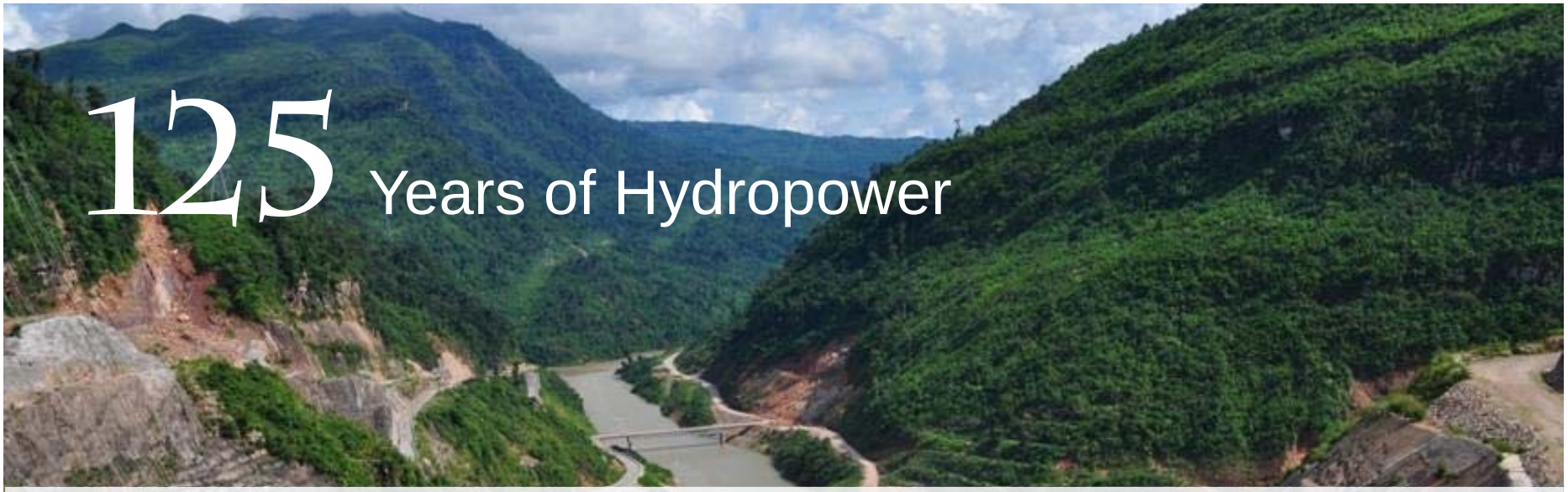
Emergency Planning and Dam Break Analysis

- Emergency Action Plan
  - Objectives:
    - Guidelines for emergency management
      - For abnormal events, accidents, emergency events
      - Roles, responsibilities, response, communication procedures
      - For all stakeholders of the project
    - Guidelines for O&M
      - Flood operation, training, inspection, …
  - Organization
    - Internal Organization
      - Activities and Resposibilities of Owner
    - External Organization
      - Responsibilities of Lao authorities
- Dam Break Analysis
  - Basis for EAP planning (warning and evacuation planning)
  - Results shown as Inundation maps
- Bam Break Scenarios
  - Natural floods
    - Carried out for different return periods
    - 100, 1,000, 10,000 yr and PMF
  - Mis-Operation of Spillway
    - Cyber-Attack: All gates opened simultaneously
  - Dam Break flood assessment
    - Breach development at RCC Closing Structure
    - Failure of one block and the two neighboring blocks within 0.5 hrs



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