



PDG 2023 - Section 7 - Dam Safety



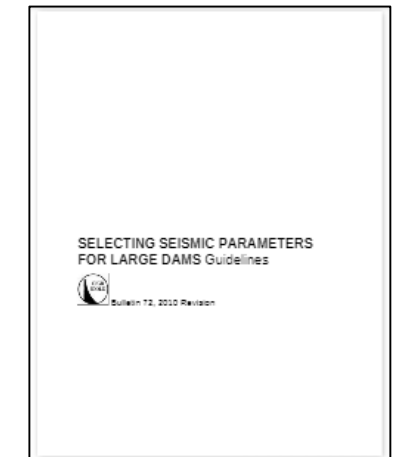
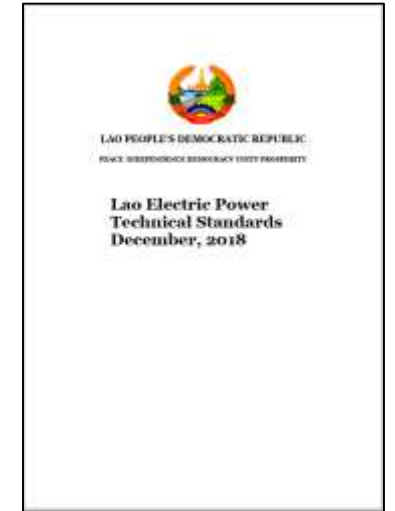
Dam Safety – Relevant Guidance documents

- Preliminary Design Guidance
 - Compliance will promote good practice and a common approach to mainstream projects
 - 2022 Version has been updated based on PNPCA experience and is now approved
 - Developers must make every effort to update their final designs to achieve compliance
- World Bank Operational Policy 4.37
 - Compliance with OP 4.37 is effectively required by PDG CI 275
 - Basic requirements:
 - Appoint a Dam Safety Review Panel of at least 3 members (PDG CI 277 - before PNPCA submission)
 - Detailed plans for:
 - Quality Assurance, instrumentation, O&M and Emergency Preparedness (too early for PNPCA?)



Dam Safety – Relevant Guidance documents

- National Standards
 - Compliance with host country national standards is a legal requirement and a PDG CI 12 requirement
 - Some national standards, e.g. LEPTS, impose design standards that are more onerous and detailed than PDG
- ICOLD Bulletins
 - ICOLD Bulletins are not design standards but present good current practice
 - PDG requires compliance with specific ICOLD Bulletins such as B148 (PDG CI 263 - seismic design)



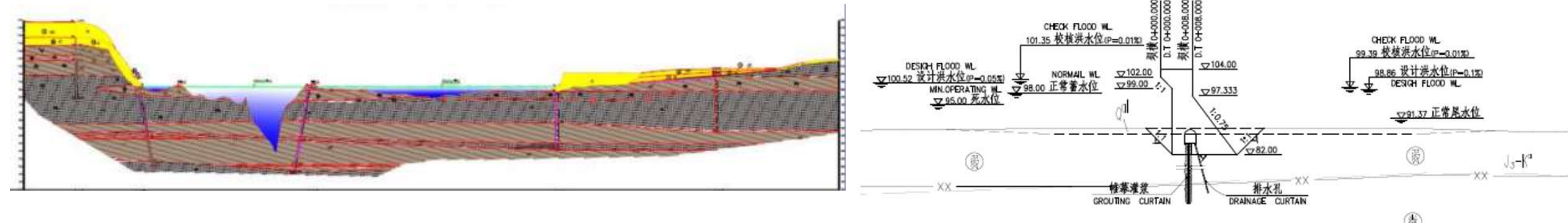
Dam Safety – Relevant Guidance documents

- Contractor Design Standards
 - Adoption of contractor home country design standards is typically proposed by developers because of familiarity, but this approach will not always achieve compliance with PDG and national standards, and could lead to an inconsistent approach for mainstream projects



Dam Safety – Geology

- Uncertain geological & foundation conditions are mentioned as a risk in PDG CI 259
- Uncertainties are likely to be exposed and resolved during construction. At PNPCA stage a basic understanding of foundation conditions is required so that high level design solutions can be selected, and the construction budget adjusted to be adequate
- Detailed reviews by DSRP during construction should resolve critical issues
- Key issues include joint & bedding orientation, weak layers, potential seepage paths and bearing capacity



Dam Safety – Seismicity

- Seismic design is covered in PDG CI 262 & 263
- Basically, PDG requires ICOLD B148 to be followed. ICOLD B120 is also mentioned. The ICOLD approach differs from many national & contractor design standards
- ICOLD proposes three events:
 - SEE > MCE (deterministic) or MDE (probabilistic 10,000 yrs) – survive without failure
 - OBE (145 yrs) – minor damage, fully functional
 - DBE (475 yrs) – for non-critical appurtenant structures



Dam Safety – Seismicity

In addition to basic dam stability, consider the seismic performance of vulnerable critical structures such as high vertical gates & hoists



Dam Safety – Flood Safety

- Flood events are the major cause of dam failures
- Extreme flood hydrology is always uncertain, and a conservative design approach is required
- PDG CI 264 & 265 require:
 - PMF is selected as Check Flood – to be survived without failure
 - Design Flood is survived without damage
- Some host country standards (e.g. LEPTS) impose higher standards



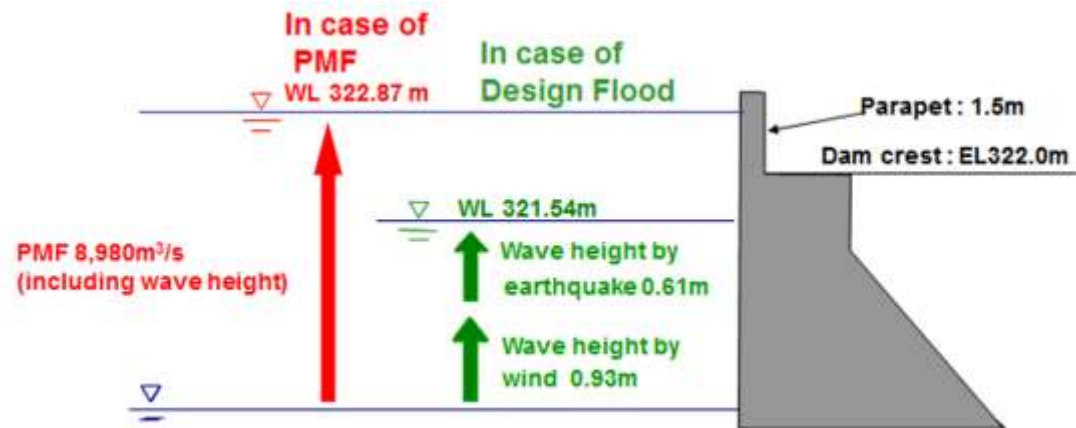
Dam Safety – Flood Safety

A common problem is design of downstream energy dissipation to a lower standard than the spillway. Some national design standards accept this approach. This is unsatisfactory and has caused critical damage to major structures



Dam Safety – Flood Safety

Freeboard – No specific requirements in PDG but a critical variable, particularly if there are embankment sections or weak abutments. LEPTS has specific requirements

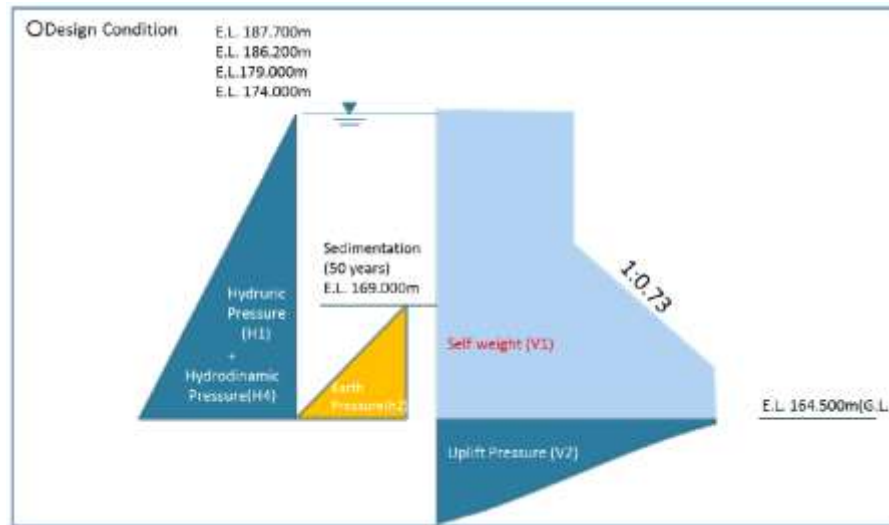


Gate type & power systems – High reliability and redundancy required for gated spillways. Mentioned as a risk in PDG Cl 267, and requirements for reliability in Cl 276.



Dam Safety – Stability

- Stability failures are rare but have occurred. Generally, distress is apparent well before failure and will provide warning
- PDG does not mention specific requirements. Risk mentioned in PDG Cl 259. Some national standards (e.g. LEPTS) specify required FOS's. Design issues should typically be identified by DSRP before construction

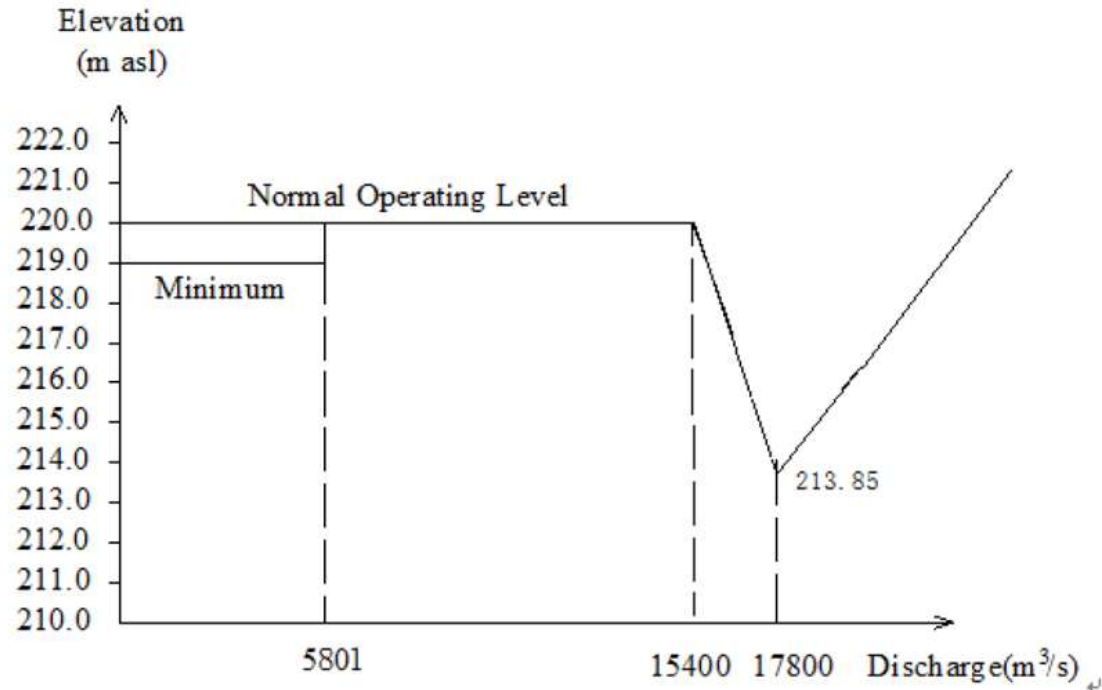


Dam Safety – Reservoir Operation

- Operation of gated spillways is a critical public safety issue:
 - Upstream backwater effect may cause flooding and place people and property at risk
 - Downstream discharge strategy and ramp rates may cause navigation hazard, avoidable ecological damage and place people and property at risk.
- Upstream impacts cannot be controlled for severe events (1995 Mekong Agreement)
- Advance reservoir drawdown might be appropriate to limit upstream flooding
- Downstream releases need to be managed and limited to acceptable ramp rates provided dam safety is not jeopardised (PDG provides guidance on ramp rates)
- Joined up cascade operation for flood management would be advantageous but will require a central authority to manage this process



Dam Safety – Reservoir Operation



Flood Management at Sanakham



Changing upstream and downstream water levels are a risk to people & river craft



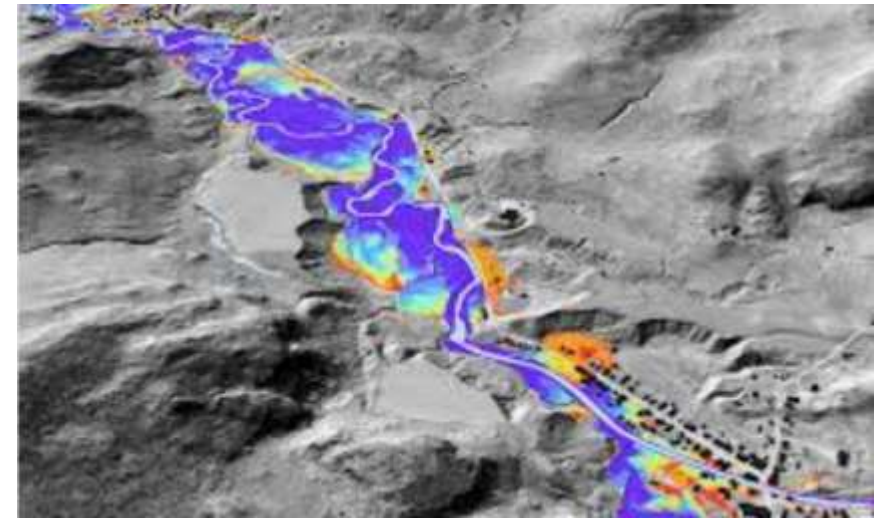
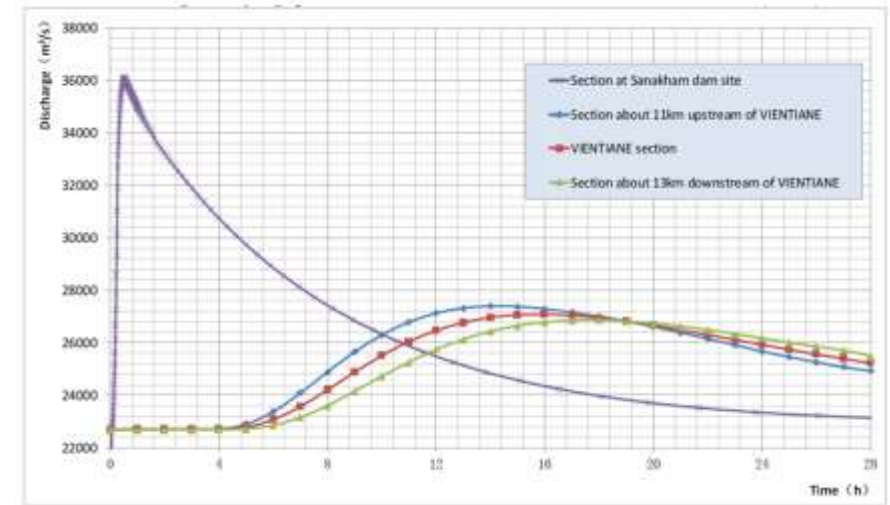
Dam Safety – Dam Safety Review Panel (DSRP)

- Best value from the DSRP is obtained if appointed early in the project development phase when basic decisions are being made and construction budgets are being formulated. However, typically appointment only occurs at Financial Close
- PDG CI 277 requires appointment before PNPCA submission
- PDG CI 277 also requires DSRP composition and TOR to be generally in accordance with WB OP 4.37, i.e. three independent experts
- DSRP appointment is a host Government responsibility, but it would be appropriate for MRC to be consulted, particularly where transboundary issues are a consideration



Dam Safety – Dam Break Study

- Downstream inundation studies are required by PDG CI 267 for:
 - Natural floods
 - Incorrect operation of gates
 - Dam break
- Results should identify people and property at risk and inform operating strategy and Emergency Preparedness



Dam Safety – Emergency Preparedness

The most important characteristics of an effective EPP are:

- Simple and accessible – response charts on the office wall?
- Up to date
- Regular training & drills so that all concerned know what to do



Dam Safety – Emergency Preparedness

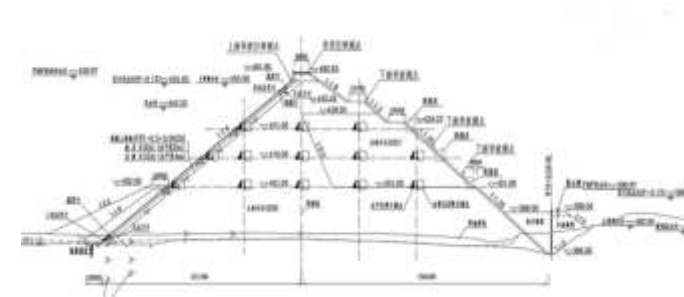
Options for preparing & warning communities at risk include:

- Lectures in schools & community centres
- Joint programmes with local authorities
- Posters & publicity material
- Signage for evacuation routes
- Fixed speakers or sirens with solar charged batteries and remotely activated
- Mobile phone notification apps



Dam Safety – Instrumentation

- Instrumentation is essential for performance monitoring and early warning of potential problems
- WB OP 4.37 requires an instrumentation plan
- Output data will be reviewed in normal O&M procedures and be linked to trigger points in the EPP
- A general plan should be available at the PNPCA stage, but details will only be finalised once foundation excavation has been undertaken and detailed design has developed
- A Failure Modes Assessment completed in accordance with PDG CI 266 will identify critical locations that require specific monitoring



Dam Safety – Dam Safety Management System (DSMS)

Dam Safety – Public Safety

- PDG does not mention any specific requirements for public safety around hydropower facilities
- A common source of accidents around hydropower facilities is public safety including:
 - Access to dangerous areas and open waterways
 - Lake craft approaching spillways and intakes
 - Fishing and swimming in active areas of the project
 - Use of project roads
- A detailed review of public safety around hydropower facilities is always required



Dam Safety – Transboundary Impacts

- Mainstream dams have the potential to cause transboundary impacts
- Potential transboundary dam safety impacts arise from:
 - Modification of flood events through reservoir and spillway gate operation
 - Reservoir drawdown and sediment flushing programmes
 - Errors in spillway gate operation
 - Full station trip
 - Dam breach
- The PNPCA submission should include sufficient studies to assess the potential for these events to cause transboundary impacts and the proposed mitigations



Dam Safety – Lessons Learned

- The revised PDG covers dam safety requirements in a comprehensive and appropriate manner
- The level of detail requested at the PNPCA stage is greater than might be expected for some topics including:
 - Flood forecasting and warning system (CI 295)
 - Monitoring and adaptive management (CI 292)
 - Plans for the DSMS (CI 283) and the associated documentation
- Following the Luang Prabang PNPCA several draft Clauses were reconsidered including:
 - CI 256 relating to consistent cascade design standards when national standards vary
 - CI 265 requirements for design and check flood do not align with LEPTS

