

Regional and National Training on PDG 2023
April to June 2023



Preliminary Design Guidance 2023





PDG 2023 Section 8 - Navigation



Overview

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- Why?
- Lessons learned from PNPCA
- Lessons learned from other international standards

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Background

Why?

- Potential opportunities for economic development of the region, mainly through enhanced electricity supply, improved conditions for inland navigation will go along with major impacts and other development risks in the four MRC Member Countries
- Inland waterway transport is a vital link in the transport network not only between the MRC Member Countries, but also with PR China and the rest of the world
- Article 9 of the 1995 Agreement mandates freedom of navigation along the Mekong River and dams are required to ensure that they do not pose an additional obstacle to navigation.
- Long-term nature of planning and investment for navigation locks are crucial. After dams, locks are the biggest and most expensive structures on a navigable river.

Lessons learned from PNPCA

Typical comments:

- The need/the importance of the second lock line. How the proposed site for the second lock line suitable for the engineering approach.
- The Navigation ship lock should be designed to create attraction flow to make it function as fish passage.
- Lock chamber filling program for small boats vs. big barges
- Sediment monitoring and management inside the ship-lock
- Risks from rapid water fluctuations
- Operation and Risk management, linkage with other transportation facilitates such as ports, waiting areas
- Shore/land approach

Lessons learned from other international standards

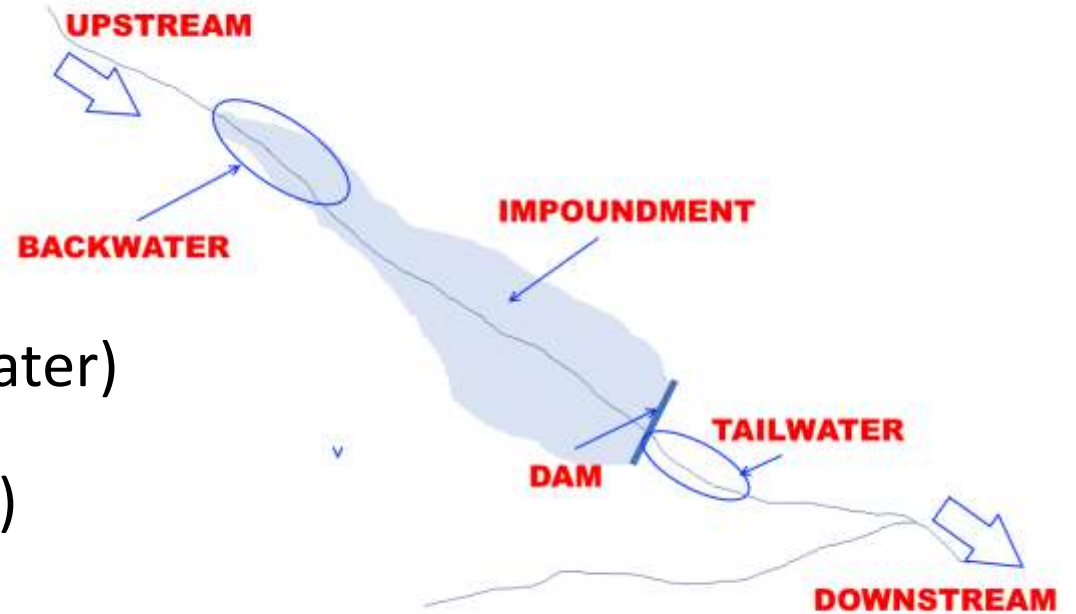
PIANC

- Lock approach layout
- Alignment requirements - approach channels
- Design for Minimizing Operating and Maintenance Costs
- Lock downtime: causes and costs
- Safety against flooding
- Ship collision with lock gates



Identified areas to address

- ❖ The ship lock and its appurtenances
- ❖ The approach channels
- ❖ The upper part of the impoundment (the backwater)
- ❖ The disturbances from dam-operations (flushing)
- ❖ Monitoring (during construction and operation)



Section 8.1 Objectives

Hydropower dams are a hindrance to navigation and a potential stop. The design objectives of the PDG are:

- Continuation of the navigation along the Mekong mainstream (primary objective);
- Ensure consistent design and operation of ship locks on all mainstream dams;
- Dam-infrastructure should not impede future navigation potential development, especially related to lock chamber dimensions (second line of ship locks);
- Lock operations to be fast, safe and by reliable technology.



Section 8.2 Risks

Lock Approaches up- and downstream:

- no straight line, poor visibility;
- sediment deposition in up- and downstream channels;
- strong side currents, especially in downstream approach channel;
- ships cannot stop and bump into the downstream mitre gate or mask wall (called “bull nose”);



Section 8.2 Risks

Lock chamber and gate design:

- heavy turbulences during filling lock chamber with side- and mushroom shaped currents, producing longitudinal standing wave
- sunken debris in gate chambers and in front of the gate sill impact from vessels hitting chamber walls during entering the lock chamber;
- wrongly berthed ships inside the lock chamber (line hooks instead of floating bollards)
- man over board (from heavily shaking and bumping vessels);
- ships cannot stop and bump into the mitre gate or mask wall;



Section 8.2 Risks

Culvert Design and Operation:

- Cavitation at the tainter valves and inside the culverts for locks with lift of over 25 meters.
- Un-balanced filling of lock chamber producing standing wave.

Lock structure:

- Earth quakes;
- Differential settlements over the length of the lock chamber and lock heads;
- Seepage under lock



Section 8.2 Risks

Impoundment:

- excessive sediments in the upstream backwaters of the impoundment;
- hidden submerged obstacles, mostly in the upper part of the backwater;



Sediment flushing operations:

- sudden release of huge volumes of water causes flashflood in downstream area;
- this also produces a negative wave in the upstream area, propagating upstream and sweeping boats from their [poor] moorings;

Section 8.3 Pre-project Monitoring and Assessments

- Consider up- and downstream HPP's in a cascade in terms of navigation, especially those completed (Xayaburi);
- Consider the current and future proposals for improvement of [remaining] free flow sections, amongst others:
 - Development Plan on International Navigation on the Lancang-Mekong River (2014-2025);
 - Condition survey of dangerous areas between Luang Phabang and Pakse;
 - Condition survey of dangerous areas between Huay Xay and Luang Phabang
- Obtain full knowledge of basic geological, geomorphologic, hydrologic and hydraulic conditions of the dam site;
- Obtain full knowledge of adequate channel clearance in the ship lock accesses, with eventual dredging requirement and rock removal.

Section 8.4 Specific design and operational guidance

The PIANC report nr. 106 – 2009 on **“Innovations in Navigation Lock Design”** should be considered as an overall guidance for the developer in the preparation of his PNPCA report.



Section 8.4 Specific design and operational guidance

Risk	Mitigation	part 1
Structural integrity	Construction should be earthquake resistant with no differential settlements; Full knowledge of geological and geo-morphological conditions of the site;	
Lock approaches	Straight line with good approach visibility; Navigational hazard management measures; Sediment management measures; Debris management measures;	
Lock chambers	Protective measures for ship impacts; Adequate mooring facilities; Camera surveillance, emergency stop facilities;	
Filling lock chambers	Reprogram opening sequence for filling valves; Reshape culverts and filling orifices;	
Cavitation avoidance	Lifts of over 35m = tandem locks Lifts from 25m on: special precautions for cavitation avoidance	

Line hooks in Chamber walls

Section 8.4 Specific design and operational guidance

Risk	Mitigation	part 2
Interruption of existing navigation	Alternative solution for transshipping goods, cargo and passengers during construction; Information on construction progress to waterway transport operators;	
Sudden water release (flushing operations)	Cascade Joint Operating Rules and Project-specific Operating rules to control water levels from dam operations; Early warning notifications up- and downstream Safety inspections ahead of major water level changes	

Section 8.4 Specific design and operational guidance

Topic	Recommendation
Lock Dimensions	Conform to Xayaburi ship lock: min. 120x12x4m
Lockage time and availability	Time to be as short as possible. PIANC guideline for hawser forces. Operate 12h./day. Outages max. 2% of operational time. Scheduled maintenance during 9 days following Cascade Joint Operating Rules.
Approaches	3 zones according to PIANC: lay-by zone, waiting zone and overnight zone. All zones connected to land by walkway or floating pontoons
Service life	Functional life time = 100 year. Various component lifetimes suggested.
Expansion	Sufficient place for second line of locks. Responsible for construction of second line of locks when total nr. of lockages reaches for 2 consecutive years 80% of the total maximum possible lockages
Further design guidance	Rolling overhead crane recommended (multiple purposes) Ship lock as additional fish passage New technologies and innovations welcome on certain conditions As-built drawings to be submitted after completion of construction.



Overhead rolling crane with cantilevers on both sides

Section 8.5 Construction and Operation Stage Monitoring and Assessments

- Monitoring and assessment to optimize operational efficiency;
- Regular inspection and monitoring of:
 - Eventual settlement including cracks in the construction;
 - Testing and inspection of Electromechanical equipment (gates, valves, security systems, etc)
 - Testing Emergency systems;
 - Record navigation movements in both directions (River Information System?);
 - Keep log-book of potential problems and disturbing events form navigation in lock chamber and approaches;
 - Yearly Bathymetric survey (after flood season) in access channels and approaches;
 - Yearly Bathymetric survey of most upwards impoundment backwater for sediment depositions and navigation hazards.

Thank you

