IW GUIDELINES FOR NAVIGATION AVAILABILITY ASSESSMENT

PROPOSED TECHNICAL WORKING GROUP

TERMS OF REFERENCE (Focus on Locks)

1. Background

A high navigation availability is requested by owners and by transport companies in inland waterways and specifically for locks (for example 99.9 % of time for each lock of the Seine Nord Canal is expected and 99 % at the scale of the whole canal). The Navigation availability does not include the planned maintenance. So, the question is how to assess this availability rate?

High navigation availability is a condition for a high transport performance. This is a request not only for new construction, but also for existing ones for which there is a need of improvement/renovation.

To obtain high navigation availability and high reliability a relevant maintenance strategy is required (predictability is also important for logistic chains). Therefore, the designer and the operator are both involved, and there are also issues related to costs, contracts and responsibility share. Nowadays, design and maintenance are often considered separately. That's perhaps why it is difficult to find clear guidelines about global navigation availability despite there are a lot of existing knowledge and methods about reliability.

However, high navigation availability and reliability remain an expectation of the operators. So, it will be useful to propose methods to assess best possible navigation availability and reliability. The question of synergy and consistency between maintenance and design has to be addressed as well as the question of risk of failure.

2. Objectives of the WG

Provide recommendations to designers and operators, about the most suitable methods to assess and obtain the navigation availability and reliability from design to operation, for future locks and existing ones as well. **Navigation locks will be taken as reference IW infrastructure**, but the recommendations may also be relevant for tunnels, ship lifts and moving bridges.

These recommendations must use existing specialized knowledge about reliability, asset management, maintenance and other technical topics, and considerations about responsibility sharing and contracts to give a global view.

It is of great interest to assess the return of invest. The WG should compare how much effort will be required to achieve the highest achievable level of availability and reliability. Mitigation measures should be discussed

3. Existing Reports

A lot of theoretical or practical points have been already addressed in previous PIANC guidelines (asset management, maintenance, SHM) or national guides (USA, the Netherlands, etc.).

Main PIANC reports dealing with this subject are:

- PIANC WG 199: "Health Monitoring".
- PIANC WG 138: "Mechanical and Electrical Engineering".
- PIANC WG 140: "Semi-Probabilistic Design Concept for Inland Hydraulic Structures".
- PIANC WG 129: "Waterway Infrastructure Asset Maintenance Management".
- PIANC WG 119: "Inventory of Inspection and Repair Techniques of Navigation Structures".
- PIANC WG 111: "Performance Indicators for Inland Waterways Transport".
- PIANC WG 106: "Innovations in Navigation Lock Design".
- PIANC WG 206: "Design of Navigation Locks".

This WG-report will be complementary to PIANC WG 266: "Capacity Augmentation and Structural Expansion of Existing IW Facilities".

4. Scope

The scope focuses on navigation lock but may be relevant for all other IW infrastructures (weirs, tunnels, ship lifts, moving bridges, pumping stations, banks) but not on impact of the traffic management, navigation accidents and water resources (keeping the WG scope limited), strikes, etc.

The issues included in the scope, because they contribute to global navigation availability, are:

a) Concept of availability of a waterway's infrastructure (or a facility) for operation and navigation
b) Technical reliability and robust design
c) Maintenance, organization and operation
d) Cost of navigation availability
e) Contracts and responsibility sharing with regards to the navigation availability ratio achieved (or not achieved)

These issues are already studied in various PIANC WGs (see list above). **So, the goal of this WG is not to make additional technical developments about these specific issues** but mainly to analyse their contributions, interactions and synergy to the navigation availability and reliability assessment.

The main sections of WG report will be:

a) Concept of navigation availability of IW facilities for operation and navigation (definitions)

Clear concepts and definitions will be an imperative starting point for the Working Group.

The navigation availability is the percentage of time during which a waterway (or a facilities) can be used.

Several considerations are useful to define navigation availability and to be adapted to the service level of the waterway:

- A difference should be made between planned maintenance, and traffic interruptions (or breakdown), especially from the user point of view, and other unplanned and uncontrolled events as strikes, accidents, droughts, floods.
- The time during which a facility (as a lock) is not available can be composed of many short traffic interruptions or a small number of long traffic interruptions, with different consequences. Traffic interruption duration is an important criterion.
- Waterway navigation availability and lock availability are different because it's possible to have parallel locks, and the global IW navigation availability depends on all lock operations.
- How to measure navigation availability and to consider it as a performance indicator of the waterway (which is important for users). Is it necessary to know it in real time?

The WG will explain how a request of xx.x % of availability of the waterway constraints the reliability that must be reached for each facility of the waterway.

b) Technical reliability and robust design and redundancy

For a future new lock or any waterway infrastructures, it's necessary to have a high reliability and a robust design.

The reliability is based on detailed design of all the components (devices/features), and well-known methods exist (see existing WGs):

- Identification of the manufacturer of each device (reliability curves)
- Use of experience of failure rate of each part or organ
- Perform detailed Operational Condition Assessment (OCA) of elements and/or risk analysis of gates and valves to identify failure possibilities, for example using FMEA (Failure Mode and Effect Analysis)
- Use redundancy when the risk is too high
- Design for maintainability (it should be necessary to systematically get the advices of the future operators about design to facilitate future maintenance)
- Use of proven technologies or innovative technologies. Robust design must include relevant methods:
- Integration of socio-environmental aspects, which can lead to changes in strategies for both the design and operation of infrastructures

- Close collaboration between designers, operators and regulators to ensure a comprehensive approach

For existing locks and waterways

- The assessment of navigation availability can be based on identification and analysis of main types of existing breakdowns and accidents: causes, consequences, protections, etc.
- Perform detailed Operational Condition Assessment (OCA) of elements and/or risk analysis of gates and valves to identify failure possibilities, for example using FMEA (Failure Mode and Effect Analysis).
- Then, to improve navigation availability, a relevant first step is just to solve or reduce existing problems one by one. However, if a higher availability level is expected, methods used for future new construction design can be applied.
- Some problems are usually difficult to forecast (debris flow, etc.) at the design step, but are well known by experience. It could be interesting to define practical methods for existing locks, based on collecting information and statistic, and identification of the weak points:
  - Advanced methods to forecast failures (as Markov chains) could be used (see PIANC WG 129 on Asset Management),
  - Simplified method to assess safety and reliability could also be developed. For example: identification of main risks and possible accidents, identification and control of safety chains (a safety chain comprises methods, technical devices, and procedures implemented to reduce the probability of unwanted events).

c) Maintenance, organisation and operation

- The main goal of maintenance is to guarantee an expected reliability level: preventive maintenance, monitoring, change before wearing, etc.
- To reduce navigation non-availability time and the repair time, it's mandatory to:
  - Plan spare parts close to the concerned infrastructure (lock, etc.)
  - Identify critical organs whose failure induce a breakdown of the navigation
  - Have an onsite repair capacity to avoid transport and reduce repairing time (if the maintenance team is not onsite, the distance is a parameter to consider)
  - Have specialised technicians in the staff to repair various kind of traffic interruptions
  - Hire external contractors for some specialised repairs (as divers)
  - Avoid problem in maintenance organisation
  - Have a capacity to deal with emergencies

- Maintainability is linked to design and is also a key point for maintenance and repairing efficiency. It could be useful to define maintainability more precisely and give recommendations about, for example, easy access for staff and cranes, capacity to change devices.

- The operation must guarantee availability too. Operators of the infrastructures (locks) must be properly trained and qualified to manage operations safely.

d) Cost of navigation availability and reliability

For new locks or existing ones, improve navigation availability has a cost. An optimisation must be done between acceptable cost and navigation availability target, compared with the consequences on traffic breakdowns. This point must be considered for design and maintenance measures.

e) Contracts and responsibility sharing

The global navigation availability is the result of relevant design, construction, maintenance, so that, if there is a failure, the responsibility should be shared. Therefore, the design has to include maintenance considerations. The questions to deal with are:

What is the relevant design contract to guaranty and reach such navigation availability?

- How to control it ?
- On which criteria to accept the final design and consider that it meets the requirements about navigation availability ?
- How to avoid a confusion between responsibilities ?

5. Suggested Final Products

- Propose methods to assess IW navigation availability and how to implement navigation availability rate as a requirement in project
- Provide recommendations including on operational methods
- Examples of real experiences (case studies)

If possible:

- the report will discuss the navigation availability assessment at the level of a full waterway (as SNE canal) and not only at the level of locks.
- the report may compare the proposed method for IW infrastructure with methods used for railways and roads.

6. Recommended Members

Members of waterways operators, private companies, experts in design and maintenance of IW. Jurists will also be strongly welcomed.

7. Relevances

Relevance for Countries in Transition

Special considerations will be included for countries in transition.

Climate Change

Efficiency and performance of waterways are impacted by climate change (as the lack of water resource). When traffic interruptions are avoided, time and energy are saved.

Working with Nature

This criterion is not specifically relevant for this WG.

UN Sustainable Development Goals

Reliability of IW may contribute to the UN Goal 9: "Build Resilient Infrastructure, Promote Inclusive and Sustainable Industrialization and Foster Innovation".

An efficient infrastructure can also reduce waste of time, materials, water and contribute to the UN Goal 13: "Climate Actions."