PIANC
The World Association for Waterborne Transport Infrastructure

PIANC WG 182
Joint WG

UNDERWATER ACOUSTIC IMAGING OF WATERBORNE TRANSPORT INFRASTRUCTURE

TERMS OF REFERENCE

1. Historical background - Definition of the problem

Sonar has been used for decades in the maritime industry to obtain hydrography surveys and ensure safe navigation of vessels. Sonar technologies have evolved over the past few decades to also provide high-resolution imagery benefiting waterborne transport infrastructure. At this time, however, there is limited information available to facility owners, asset managers, engineers, and marine construction contractors on the best way to use the various forms of acoustic imaging.

There are many types of sonar technologies, and these devices can be classified into two broad categories based on the final data product: two-dimensional and three-dimensional. A two-dimensional acoustic image provides visual representation similar to "photographs" of the submerged portions of the infrastructure. A three-dimensional acoustic image consists of data points, each point with a unique x, y, and z coordinate. The data points are then compiled to create a point cloud computer model, similar to above-water LIDAR technology.

Underwater acoustic imaging technologies are regularly utilized to supplement diving inspections as well as to provide additional information in situations unsafe for diver investigations. Potential applicability of acoustic imaging includes rapid condition assessment; erosion/scour detection and documentation; underwater observation during construction activities to facilitate contractor operations, or by owner for QC purposes; and enhancing diver safety and efficiency at challenging dive sites.

Underwater acoustic imaging is conducted around the world. As facility owners, consultants, and contractors consider their options for underwater observations—in particular, the use of underwater imaging—there needs to be careful consideration for assuring qualified personnel, proper equipment and proper deployment techniques, and a basic understanding of the technical limits of each type of imaging technology. Because of this need, it is important that information on this topic be disseminated across the globe in a PIANC publication.

2. Objectives

The working group will publish a document on the use of underwater acoustic imaging related to waterborne transport infrastructure. This publication will provide best practice information. Various types of sonar technologies will be discussed including Single-Beam Echosounder Sonar, Side-Scan Sonar, Sector-Scanning Sonar, Mechanical Scanning Multi-Beam Sonar, Real-time Multi-Beam Sonar, and Swath Multi-Beam Sonar. Information will be provided on using both 2-D and 3-D images as part of other tasks. Case studies will include construction quality verification; monitoring the integrity of marine structures as part of routine maintenance; and documenting navigational hazards to aid in the removal effort. The document will refer to the technologies in general terms only without mention of specific manufacturers or brand names. However, an extensive list of all sonar device products and specifying organizations may be provided in the appendix so readers can obtain more information if desired.

3. Earlier reports to be reviewed

While there has never been a PIANC document covering the topic of underwater imaging, the following reports relate to the need for infrastructure observations:

- PIANC (2013) Report WG129, Waterway Infrastructure Asset Maintenance Management, PIANC, Brussels.

- PIANC (2008) Report WG103, Life Cycle Management of Port Structures – Recommended Practice for Implementation, PIANC, Brussels.

- PIANC (2006) Report WG25, Maintenance and Renovation of Navigation Infrastructure, PIANC, Brussels.

4. Scope

Assessment of the available body of knowledge on this topic indicates the need for additional documented case studies and a summary of the advantages and limitations of acoustic imaging. Therefore, the working group will report on this topic related to the use of acoustic imaging for underwater inspection in several situations including:

- Design Stage Data Gathering (e.g., new marine construction, rehabilitation of port/harbour structures, extension of breakwaters, etc.)

- Construction Monitoring Underwater (e.g., quality control, progress payments, pre-/post site conditions, etc.)

- Maritime Security Threat Assessments (e.g., detection of submerged explosives, intruder detection, etc.)

- Documented Visual Representation (e.g., as-built plans, large scale defects on a structure, or submerged object / obstruction documentation)

- Diver Safety and Efficiency Enhancement (e.g., challenging dive sites such as fast current, heavy debris, extreme depth, polluted water, and dangerous marine life)

- Rapid Condition Assessment (e.g., verification of marine facility structure after an incident such as seismic event, vessel impact, extreme weather, etc.)

- Erosion/Scour Detection and Documentation (e.g., seabed/channel bottom movement monitoring and foundation exposure information)

- Evaluation of Infrastructure (e.g., maintenance decision-making data, asset management input, etc.)

5. Intended product

The report will be an international practice document for facility owners to resource the most appropriate technology and utilize the information with most efficient means depending on use (2-D images, 3-D images, point-cloud comparison studies, etc.) in the maritime industry.

6. Working Group Membership

It is anticipated that an international working group will be appointed with members experienced with underwater acoustic imaging infrastructure. One individual without detailed knowledge of acoustic imaging may be useful in the working group so long as they have other sonar surveying or transport inftrastructure management experience to contribute.

7. Relevance to countries in transition

Underwater imaging technologies can be used to help facility owners detect underwater obstructions and build more economical and durable structures.

8. Climate Change

Water transport infrastructure will greatly be affected by climate change, and underwater imaging can be used by facility owners to deal with higher and lower water levels, as well as other effects of climate change such as scour due to extreme weather events.

Rising sea levels will result in flooding and disruption in marine infrastructure. Assessment of the effects of sea level rise requires good understanding of the construction of marine infrastructure, construction, orifices, inlets, and outlets, as well as the condition of such structures. Diving and underwater imaging is frequently used to accomplish these sea level rise impact studies. This report will cover aspects of how underwater imaging technology can be innovatively used to plan for and monitor the effects of climate change on the water transport infrastructure.