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Hydrometry — Position fixing equipment for hydrometric boats

Mesure de débit des liquides dans les canaux découverts — Équipement de localisation de bateaux hydrométriques

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Foreword

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The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

ISO 6420 was prepared by Technical Committee ISO/TC 113, *Hydrometry*, Subcommittee SC 5, *Instruments, equipment and data management*.

Introduction

The necessity of positioning hydrometric boats arises in several types of measurements on open channels or lakes, reservoirs and estuaries. First, it is necessary to position a boat on a measuring section in order to conduct the appropriate observations of velocity and depth for a discharge measurement. Position fixing also is required for collecting suspended sediment and bedload samples at appropriate verticals on a river cross section. Similarly, positioning of a boat is needed for morphological surveys and sediment sampling of lakes, reservoirs and estuaries.

This standard provides information for positioning hydrometric boats with various methods ranging from standard surveying equipment to navigation systems employing signals from the constellation of satellites.

Hydrometry — Position fixing equipment for hydrometric boats

1 Scope

This International Standard specifies methods of determining the position of hydrometric boats based on satellite navigation systems and/or with respect to known points on the banks of rivers, estuaries or lakes. It applies to electronic positioning equipment and conventional surveying techniques.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application.

ISO 748, Measurement of liquid flow in open channels using current meters and floats

ISO 772, Hydrometry – Vocabulary and symbols

ISO/TS 25377, Hydrometric uncertainty guidance

ISO/TR 24578, Hydrometry – Acoustic Doppler Profiler – Method and application for the measurement of flow in open channels

3 Terms and definitions

For the purpose of this International Standard, the definitions given in ISO 772 apply.

4 Requirements for position fixing

The necessity of using position fixing equipment arises in two types of measurements on open channels or lakes, reservoirs and estuaries. First, it is necessary to position a boat on a measuring section in order to conduct the appropriate observations of velocity and depth for a discharge measurement (see ISO 748). The use of acoustic Doppler current profilers for making discharge measurements (see ISO ISO/TR 24578) has largely diminished the need for position fixing equipment for hydrometric boats when making discharge measurements. However, there are still some types of measurements when verticals on a cross section must be positioned for velocity and depth determinations. Position fixing also is required for collecting suspended sediment and bedload samples at appropriate verticals.

The second type of measurements requiring position fixing are morphological surveys of lakes, reservoirs and estuaries. Position fixing is required to determine the positions at which depth observations and bottom samples are obtained.

5 Position fixing equipment for streamgauging and sediment sampling

5.1 General

There are different types of position-fixing equipment. This clause will describe the following: measuring tapes, tag lines, global navigation satellite systems (GNSS), a combination of targets and electronic distance measuring equipment, electronic surveying equipment, and theodolites and stadia rods.

5.2 Tapes and tag Lines

Tapes and tag lines are the most frequently used means for width measurements when measuring rivers by boat or wading. Steel measuring tapes with markings at meters and 10^{ths} of meters are used in streams and rivers less than 50 meters wide. A typical tag line consists of a marked corrosion-resistant steel cable that is 2

to 3 mm in diameter. The diameter of the tag line depends on the width of the channel, the velocity of the water and whether or not the same tag line is used for holding the boat and for determining its position. Larger diameter tag lines may be needed if used for dual purposes. Tag lines are typically marked at intervals of 5 to 10 m with double markings at 50 and 100 m. Tag lines are commonly used on channels up to 300 m wide, however, the accuracy of the distance measurements depends on cable tension. Long tag lines are usually wound on a drum having a diameter of at least 0.3 m and equipped with a cranking and braking mechanism.

Caution should be used when tapes and tag lines are used to position hydrometric boats on navigable rivers. An observer on the river bank should be available to alert the hydrographers of approaching boats and also alert boat operators of the tape or tag line. Other operators may be required to temporarily remove the tape or tag line to allow boat passage through the measuring section.

5.3 Global navigation satellite systems

5.3.1 General

Navigation systems that use GNSS technology are used on larger rivers that are too wide for stringing a tagline. These systems provide reliable location and time information, in all weather conditions and at all times, anywhere on or near the Earth when and where there is an unobstructed line of sight to four or more satellites in the constellation of satellites.

There are two operational GNSS. The NAVSTAR Global Positioning System (GPS) was developed by the U. S. Department of Defense; it is composed of 24 satellites. GLONASS was developed by the Soviet Union and is operated by the Russian Aerospace Defense Forces; it also is composed of 24 satellites. Other global or regional systems under development include Galileo being developed by the European Union, Compass being developed by China, and IRNSS, a regional system being developed by India.

There are two general operating methods by which satellite-derived positions can be obtained; either absolute point positioning or relative (differential) positioning. With absolute point positioning, measurements of the distance to each individual satellite are made by analysing the time it takes for a signal to travel from a satellite to the antenna of the navigation system. Trilateration is then used to establish the receiver's position. The accuracy of the position is about 3 m or less[3]. Differential positioning is the technique or method used to position one point relative to another. Differential positioning requires a ground station within line of sight distance of 20 km or less. Differential positioning can provide a relative accuracy of a few centimetres[2]. Receivers with real-time kinematic (RTK) technology can provide a relative accuracy of 1-2 cm. Some RTK-enabled receivers are able to use satellite-broadcasted corrections and provide very accurate positioning over much longer distances. There is an added cost of using broadcasted corrections from private satellite.

5.3.2 Hydrometric application

Satellite navigation systems allow operators to preselect transects and verticals for making depth and velocity determinations. The systems consist of a receiver, navigation software, and a digital display that shows the position of the boat on the cross section. Navigation systems facilitate the measurement of depth and velocity or the collection of samples at verticals with only a boat operator and one hydrographer.

5.3.3 System specifications

There are a wide range of navigation systems that can be used for hydrometric applications. Systems should have the following minimum capabilities for positioning boats on river cross sections:

- Ability to receive signals from more than one global or regional satellite navigation system and ground reference stations
- Sufficient channels to receive signals for up to 12 satellites
- Water proof or resistant so electronics will not be damaged during rain or spray from waves
- A digital display that shows the boat position, cross section and waypoints (verticals)

- A sunlight mode so the system can be operated in direct sunlight
- Ability to store 100 or more waypoints (verticals)
- An alarm system to indicate when the boat drifts for the cross section or designated waypoint (vertical)
- Output function for transferring position information to a discharge measurement application

5.4 Targets and electronic distance measuring equipment

5.4.1 General

Targets are used to align the boat on the cross section, and range finders or other distance measuring equipment are used to position the boat on the correct vertical. This approach usually requires a boat operator to align the boat on the cross section between the targets, a hydrographer to make the depth and velocity measurements, and another individual on the river bank or on the boat to read and record the distance measuring equipment. Communication between the shore personnel and the boat operator is done using hand signals or radios.

5.4.2 Targets

The technique requires that two targets be positioned on each bank to give the line of the cross section. The size and type of the targets will depend on the channel width. To ensure sufficient accuracy of the line, the spacing between the targets on each bank should not be less than 10 percent of the channel width.

5.4.3 Electronic distance measuring devices

Electronic distance measuring devices use visible or infrared electromagnetic waves. Laser rangefinders can be used to measure horizontal distances ranging from 20 to 4,000 m. The optimum setup consists of a single lens or binocular rangefinder and a reflector or multiple reflectors. The rangefinder can be used on the boat with reflectors mounted on the near-shore targets on each bank or the rangefinder can be used on one bank with a reflector mounted on the boat. The accuracy of rangefinders is a function of beam divergence. Units used for measuring distances greater than 500 m should have good optics with tightly collimated beams to hold focus.

Distance measuring instruments using radio waves operate on the principle that if a carrier is frequency modulated, it will exhibit a phase shift that is proportional to the distance travelled and to the modulating frequency. By using a number of modulating frequencies and comparing the phase shifts of a signal that has travelled between a master unit and a remote unit to a reference signal, it is possible to determine distance within 1-2 mm over a distance of 1500 m. For streamgauging applications, the master unit is set up on one streambank and the remote unit or prism reflector is mounted on the hydrometric boat.

The accuracy of the distance measurement is affected by the angle of the line-of-sight from horizontal. The master unit should be levelled, and the prism reflector should be mounted at the same height above an arbitrary datum as the master unit.

5.5 Electronic survey instruments

A total station is an electronic/optical instrument used in modern surveying. The total station is an electronic theodolite (transit) integrated with an electronic distance meter (EDM) to read slope distances from the instrument to a particular point. For hydrometric applications, the total station is positioned and levelled on the cross section on one bank of the river and a prism reflector is mounted on the hydrometric boat. A typical total station can measure distances with an accuracy of about 1-2 mm + 1,5 ppm over a distance of up to 1500 m[1].

This method requires a boat operator, a hydrographer, and an instrument operator on the river bank. The boat is maintained on the cross section at the appropriate vertical by radio communication or hand signals between the instrument operator and the boat operator.