

MCERTS Bulletin 27 – Installation and use of Area-Velocity flowmeters in free surface flows

This bulletin should be read in conjunction with the MCERTS standard *Minimum Requirements for the Self-Monitoring of Flow*.

Flow measurement installations incorporating area-velocity (AV) measurement systems that require an MCERTS certificate against the standard '*Minimum Requirements for the Self-Monitoring of Flow*', shall be certified with reference to the additional requirements in this bulletin.

This bulletin provides information on the installation, use and assessment of flow measurement systems that utilise the area-velocity (AV) measurement technique which need to be certified against the MCERTS standard '*Minimum Requirements for the Self-Monitoring of Flow*'.

For the purposes of this bulletin, an area-velocity flowmeter is one which includes three principal components – a level sensor which measures the depth of fluid in a channel or partially filled pipe, a velocity sensor that measures a characteristic fluid velocity and a flow computer that takes inputs from these sensors and uses those measurements to determine the volumetric flow-rate.

There are a wide variety of area-velocity meters using different combinations of sensor techniques. These include types directly in contact with the fluid and sensors which do not contact the fluid (non-contact) for both the level and velocity components.

It is recommended that those considering deploying an area-velocity meter should carry out a site investigation before deciding on a particular technical approach. This should include identification of the velocity profile. Potential users should also refer to the relevant MCERTS product certificate to determine the suitability of a device for a particular application.

General requirements

- 1 This bulletin applies to flow measurement systems (flowmeters) which incorporate sensors for fluid velocity and fluid depth, the measurements from which are combined to give the volumetric flow-rate in an open channel or partially filled pipe. The sensors may be mounted above the fluid (non-contact) or within the fluid (contact).
- 2 Any new or replacement flowmeter shall hold product certification under the MCERTS Standard: *Performance Standards and Test Procedures for Continuous Water Monitoring Equipment – Part 3*. The certification range (minimum to maximum) should be appropriate to the installation. For area velocity flowmeters, this shall include the ranges over which the instrument is certified with respect to velocity, channel width and fluid depth.
- 3 The response time of the flowmeter shall be considered where pumped flows or rapidly changing flows are experienced in the channel. Any potential errors associated with the response time with respect to changes in flows and pump cycles shall be included within the assessment of the measurement uncertainty.

Location and installation

- 4 The flowmeter shall be installed in a defined **measurement section**. This shall comprise a straight, stable length of channel or pipe with a constant cross section and with a length which is sufficient to create a fully developed flow profile at all expected flowrates.

Note: This will normally require at least 20 channel widths/pipe diameters upstream and 5 channel widths/pipe diameters downstream of the flowmeter.

- 5 A site which does not have a fully developed flow profile can be certified if the MCERTS inspector is satisfied that that the flow measurement uncertainty conforms to the MCERTS requirements at all expected flow rates. Alternative measures which can be used could include additional sensors; flow conditioners; baffles, on site calibration or other techniques.
- 6 The base of the measurement section shall be level or have a gradient of less than 1%. The variation in channel width/pipe diameter along the measurement section shall be no more than $\pm 2.5\%$.
- 7 No obstacles, such as sample hoses and ladders, should be installed in the measurement section. The effect of any obstacles shall be taken into account in the assessment of the uncertainty.
- 8 The flowmeter sensors shall be mounted such that they are level, secure and stable.
- 9 For a flowmeter with a single velocity sensor, the velocity sensor should be installed midway across the channel $\pm 5\%$. For channels where multiple velocity sensors are required, the spacing of the sensors across the channel shall be in accordance with the manufacturer's recommendations.
- 10 The location of the flowmeter shall allow the measurement section to be maintained without damaging or affecting the performance of the flowmeter.
- 11 The location of the flowmeter shall enable access to the equipment for routine checks, maintenance and MCERTS verification.
- 12 Access to the measurement section shall allow its dimensions to be checked in order to assess the uncertainty of the flow measurement system.
- 13 The fluid surface at the point of measurement should be free from foam, standing waves, eddies and water level fluctuations within the response time of the flowmeter across the width of the channel. *Note: Some non-contact velocity sensors require some degree of surface turbulence in order to operate correctly.*
- 14 Installation and maintenance of air firing ultrasonic level sensors as part of an area velocity flowmeter shall follow the guidance in Appendix 4 (excluding A4.5, A4.21 and A4.22) of the *Minimum Requirements for the Self-Monitoring of Flow*.
- 15 Level and velocity sensors shall be protected from the impact of environmental conditions as recommended by the manufacturer. For example, some non-contact velocity sensors can be affected by rainfall in the instrument's measurement field.
- 16 Set-up and commissioning of the flowmeter shall ensure that uncertainties caused by software settings, instrument response times, rolling averages and measurement sequences, etc. are minimised with respect to site conditions.

Maintenance

- 17 The flowmeter shall be maintained and calibrated in accordance with the manufacturer's instructions and recommendations. At some locations additional maintenance may be required.
- 18 The sensors and the measurement section shall be kept free from sediment and other fouling material.
- 19 Maintenance activities shall not affect the positioning and alignment of the sensors.

Verification

- 20 A method for the verification of the flowmeter, whether it is mounted in either a channel or within a pipe, shall be included in the installation design. The verification method should not interfere with the flow measurement.
- 21 For flowmeters mounted in partially filled pipes, access shall be provided for flow rate checks to be made, for example using an insertion flowmeter.
- 22 Flowmeter settings shall be checked to ensure that they are appropriate for the location of the flowmeter.
- 23 The flowmeter water-level reading(s) shall be verified by comparison against level(s) measured using another method (for example a reference plate in the case of a non-contact level sensor), taking account of the datum used by the flowmeter to calculate the water depth.
- 24 The velocity profile in the channel should be measured vertically across the width of the channel and an estimate made of the symmetry (or otherwise) of the horizontal flow profile. With this data an estimate may be made of the mean velocity in the channel (check gauging).

The minimum number of verticals shall be as follows:

Channel width	Number of verticals
≤ 200 mm	1
> 200 but ≤ 500 mm	3
> 500 mm	5

Additional verticals should be used if required. (Note : ISO 748:2007 describes a method for measuring flow in asymmetric natural channels where the flow profile is unknown.)

The velocity profile should be compared to the velocity profile expected by the instrument settings.

The estimated mean velocity should be used with the validated level measurement to provide an independent estimate of volumetric flow against which readings from the installed flowmeter can be compared. The number of points used shall be taken into account in assessing the uncertainty of the check method. The uncertainty arising from fewer than the recommended number of points is likely to be too high to enable a valid check measurement to be made, unless the channel upstream of the point where the measurements are being undertaken is long (more than 20 times the channel width), uniform, straight and free from obstruction.

- 25 Flow velocity checks should be carried out at one or more representative flow-rate(s).
- 26 Where possible, a zero flow check shall be carried out.
- 27 The possibility of increased uncertainty at high flows due to additional surface turbulence should be considered in the assessment of uncertainty.
- 28 Where possible, the measured velocity versus volumetric flow rate relationship should be verified at two flow-rates, for example by comparison with an installed structure or other temporary measurement device. (Note : any temporary measurement device should conform to the requirement in clause 20.)
- 29 An estimate shall be provided of the uncertainty of the flowmeter verification method.