

FREQUENTLY ASKED QUESTIONS ON THE USE OF MASS FLOW METER (MFM) FOR BUNKERING

Q1: Is MFM a recent technology? Has it been tried and tested?

A: MFM is not a recent technology. The First Industrial Patent for the MFM dates back to the 1950s and the first meter was manufactured in 1970s. Today it's widely used in industries such as the Oil & Gas, Chemical, Life Sciences, F&B etc. American Petroleum Institute (API) has approved the use of MFM for custody transfer in 2002. (API MPMS 5.6 Coriolis flowmeters).

Q2: How does the MFM measure mass directly?

A: The MFM operates on the Coriolis principle which measures the oscillation frequency (ie: twisting) of the measuring tubes in the meter. The sensors, at the inlet and outlet ends, register the resultant phase shift in the tube's oscillation geometry and compute the rate of mass flow.

Q3: Why has it taken so long for bunker quantity measurements to adopt metering while automobile fuels retailers has adopted metering for some time?

A: The use of MFM system for bunkering is not a "plug & play" system. From our experience in the test bedding programme, we learnt that the piping configuration on each bunker tanker might vary. A proper set-up, including the piping configurations, is crucial to ensure the optimal performance of the entire MFM system.

In 2009, MPA and SPRING Singapore jointly initiated a multi-stakeholder Working Group (WG) on Mass Flow Metering under the direction of the Technical Committee (TC) for Bunkering, to develop and validate the use of MFM for bunkering. The WG on Mass Flow Metering comprises of experts from the National Metrology Centre, National Weights and Measures Agency, Shipping lines, Meter Manufacturers, Flow & Calibration Testing Lab, Bunker Craft Operators, Bunker Surveyors, Bunker Suppliers, Bunkering/Shipping Associations and the Regulatory Authority. Since 2011, MPA and the WG for Mass Flow Metering have conducted extensive trials to ensure that the system is suitable for Singapore's bunkering environment. With the success of the trials, MPA approved the first MFM for official custody transfer in the Port of Singapore in June 2012. The first MFM approved was an Emerson's meter. The second MFM, produced by Endress & Hauser, was approved in Oct 2013. .

It is important to note that the approval for custody transfer is not a system-type approval. All individual MFM systems need to undergo and pass the physical acceptance test before approval is granted by MPA.

Q4: What is the difference between SS 600 and the TR on Bunker Mass Flow Metering?

A: SS 600 (Singapore Standard Code of Practice for Bunkering) specifies the processes and procedures, requirements, roles and responsibilities of all parties concerned, by the delivery of bunkers by bunker tankers, including documentation, equipment standards and verification processes during a bunkering operation. It covers pre-delivery, actual delivery and post-delivery checks and documentation. The quantity determination is based on bunker tanker measurement using the tank gauging method.

A Technical Reference (TR) is a provisional standard made available for application over a period of two years. The aim is to use the experience gained to update the TR so that it can be adopted as a Singapore Standard. Users of the TR are invited to provide feedback on its technical content, ease of use and clarity. Feedback can be submitted using the form provided in the TR. At the end of the two years, the TR will be reviewed taking into consideration any feedback in its

development into a Singapore Standard, if found suitable.

The TR for Bunker Mass Flow Metering (TR48) documents the principles, requirements and procedures in the application of mass flow metering for bunkering. It covers the requirements of metering system qualification, installation, testing, procedures and documentation for bunker custody transfer using the Coriolis mass flow metering system. The TR is based on the current knowledge, extensive field trials and experience gained in the new application of Coriolis mass flow metering technology for the bunkering industry and has been put in force since 1 June 2016

Q5: What are the 3rd party certifications or audits that MFM installations are subjected to?

A: MFMs are calibrated in accordance with ISO/IEC 17025 requirements. All MFM systems onboard bunker tankers are to be evaluated and approved by MPA, before they are allowed to be used for custody transfer of bunkers. These MFM systems would be required to meet the requirements set by SPRING Singapore's Weights & Measures Office and Singapore's National Metrology Centre prior to the approval by MPA.

Q6: How reliable is the MFM system and are there any contingency plans when the system breaks down?

A: There are minimal moving parts in the system and MFMs have been reliably employed in other applications. MFM systems are also equipped with an uninterrupted power source (UPS) for a period sufficient to retrieve data in the event of a power failure.

In the unlikely event of MFM stoppage or failure prior to or in the middle of bunkering operations and the delivery cannot be continued, pumping shall cease immediately and the meter's totaliser readings shall be recorded. The stoppage/ failure shall be reported to MPA. Tank gauging, in accordance with SS 600, shall be used to determine the remaining quantity to be delivered and a separate BDN shall be issued. The final quantity delivered shall be the sum of the quantities determined from the meter readings and the tank gauging recorded in the respective BDNs.

This procedure is covered under the Metering Procedure of the TR48.

Q7: What is the approval process for MFM system and what is the downtime expected?

A: The approval for MFM is an 8-step process (Annex A) covering from system procurement until the final approval for custody transfer. The entire process is estimated to take around 4 months. However, the downtime for the bunker tanker is approximately 1.5 weeks.
(Installation: 1 week, acceptance test: 3 days).

Bunker tanker operators and owners are advised to approach MPA should they wish to enquire on the approval process for MFM systems for new bunker tankers that are intended to be registered as a port limit bunker tanker in Singapore.

Q8: What happens when there is a difference between the reading of MFM and the terminal delivered figure during loading?

A: All custody transfer meters used in terminals are required to follow the requirements as stipulated by SPRING Singapore. SPRING Singapore's requirement for the MFM is similar.

Our trial results showed that the variance between the MFM reading and the terminal delivered figure are within the industry acceptable variance of 0.5%. In addition, there is no change from

the current arrangement and procedures when bunker tankers load from terminals. In the event of a bunker quantity dispute, the bunker tanker should raise a note of protest as per current practice. In such situation, the bunker tanker will be able to understand the loading operation in greater details through the recorded data.

Q9: How often will calibration be done and how is it done?

A: SPRING Singapore requires calibration process to comply with ISO/IEC 17025 and performance of the meter meeting the requirements in OIML R117. The current requirement is for the meter to be calibrated every 3 years from date of approval by MPA or as required by MPA. Unlike traditional geared meters, MFM does not have mechanical parts or moving parts and therefore the need for re-calibration is relatively lower. The current approved meters were evaluated and are still performing in good condition.

Under the current practice, the MFM is required to be re-calibrated by the SPRING Singapore's designated Authorised verifier or Recognised Testing Laboratory (RTL) for flowmeter. The bunker craft operator should time such operation to coincide with its docking schedule to reduce the downtime for the bunker tanker.

Q10: Will my bunker tanker still be allowed to perform MFO bunker delivery via sounding (SS600) once the MFM system is approved for use by the bunker tanker??

A: The use of MPA-approved MFM for MFO delivery is **mandatory from 1 Jan 2017**.

MPA reminds all licensed bunker suppliers and bunker craft operators to adhere strictly to the revised terms and conditions of their bunker licences. MPA will take firm action against any licensee who has acted in contravention of their licences, including suspending or revoking their bunker licences, as appropriate.

Q11: How is the testing of MFM system conducted?

A: Since 2011, MPA and the Working Group had conducted extensive trials on the MFM at varying operating conditions to ensure that the system is suitable for Singapore's bunkering environment.

All meters approved for custody transfer meets the recommendations set by the Organisation of Legal Metrology (OIML)'s R117:2007 standard - an international recommendation for measuring system for liquids other than water.

The meters are calibrated by the RTL and results reviewed by SPRING Singapore before it is installed on the bunker tanker. Once fitted on-board and sealed, all MFM systems have to undergo 3 rounds of test. During the tests, the entire delivery system are put through the verification process to ensure all pass-by are blanked out and sealed. Sealing is to be done by an independent party to ensure the integrity of the system. The data collected during the test were sent to Singapore's National Metrology Centre for validation.

Q12: How do I ensure the integrity of MFM system is not compromised?

A: MPA requires the meter system set up without any by-pass of flow after the meter. Any by-pass system on bunker tankers shall be blanked out and sealed.

Under TR48, the opening and closing procedures for a bunker delivery differs from that of SS 600. All bunker tankers installed with the MPA-approved MFM are to maintain the latest seal verification report and metering system diagram indicating all the sealing points. The vessel representative and bunker surveyor, if engaged, are required to check and ensure all listed seals are intact. They shall sign on the Mass Flow Metering System Seal Checklist to indicate that the

seals are intact. The same should be done for the closing procedure.

Other than the Mass Flow Metering System Seal Checklist, the Meter Reading Record Form and Bunker Metering Ticket generated by the system will provide an additional layer of security. These requirements are stated in the TR48.

Q13: How will transparency be enhanced when compared to tank sounding?

A: There is continuous digital data captured during the delivery process, the data can be viewed in the form of a delivery profile at any instance in time, and we are able to trace the amount of mass transferred. The MFM system is also able to detect changes in operating conditions e.g. when we change supply tank, or when we clear the lines at the end of the delivery. The delivery profile data can be extracted from the system, if required.

Q14: Is there still a need for bunker surveyors for deliveries done via the mass-flow meters?

A: Yes. The role of bunker surveyor being an independent party to witness and ensure compliance to bunker delivery processes remains unchanged.

There is a change in the function of bunker surveyors for MFM deliveries. For example, the surveyor is required to cross check the seal verification report and the actual physical seals at various locations in the MFM system. This procedure is to ensure the integrity of the entire MFM system before and after the delivery. The detailed actions required from bunker surveyors are covered in TR48. MPA has a programme planned to train bunker surveyors for bunker delivery using MFM.

MPA is also looking to expand the scope of work for surveyor and exploring the possibilities to train bunker surveyor to perform zero verification for approved MFM system.

Q15: What is the difference between the MID approved and MPA approved MFM?

A: MID approved meter is primarily used in European countries. Measuring system directive (MID) is a Type Approval of the meter. MPA approval has the additional requirement of the acceptance test. It is the approval of the MFM system instead of the instrument.

Annex A

Step	Certification stages	Details	Endorsing Party
1	Procurement of MFM system	1. Sizing of MFM (correct operating range)	MPA
2	Arrival of MFM system	1. Complete water calibration 2. Submission of all required documents to SPRING Singapore	
3	SPRING Singapore's Weights & Measures Office's approval	1. Level 1 & 2 approval	SPRING Singapore's Weights & Measures Office
4	Installation of MFM system	1. Installation 2. Development of sealing plan	
5	MFM System Commissioning	1. Submission of class endorsed revised piping diagram and proposed seals location for endorsement by MPA. 2. Submission of MFM vendor and Bunker Craft operator's attestation on system & crew readiness for acceptance test 3. Completion of sealing by SPRING Singapore's Weights & Measures Office & Authorised Verifier/ authorised organisation(s)	MPA
6	Acceptance test of MFM system	1. 3 runs of test (3 x loadings and 3 x deliveries) Test date and test platform to be approved by MPA.	Test Surveyor, Test Coordinator
7	Verification of MFM system	1. Submission of test data and test documents	Singapore National Metrology Centre
8	Submission of documents to MPA for approval	1. Submission of all relevant documents	MPA

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