NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE
Maritime Energy & Sustainable Development Centre of Excellence
College of Engineering
SCIC SINGAPORE CHEMICAL INDUSTRY COUNCIL
Standards Development Organisation

REPORT
Case Study on the Benefits of TR 48: 2015 Bunker Mass Flow Metering for Bunkering Industry in Singapore

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LIST OF ABBREVIATIONS

A*Star	Agency for Science, Technology and Research
ESG	Enterprise Singapore
IBIA	International Bunker Industry Association
ISO	International Organization for Standardization
MESD CoE	Maritime Energy and Sustainable Development Centre of Excellence
MFM	Mass flow meter
MFMs	Mass flow meter system
MFO	Marine Fuel Oil
MPA	Maritime and Port Authority of Singapore / Implementing Authority
ROB	Remaining on Board
SCIC	Singapore Chemical Industry Council
SDO@SCIC	Standards Development Organisation @ Singapore Chemical Industry Council
SS 600	Singapore Standard SS 600: 2014 Code of Practice for Bunkering
SS 648	Singapore Standard 648: 2019 Code of Practice for Bunker Mass Flow Metering
TR 48	TR 48: 2015 Technical Reference for Bunker Mass Flow Metering
VLSFO	Very Low Sulphur Fuel Oil
WG	Working Group
WMO	Weights and Measures Office of Enterprise Singapore

EXECUTIVE SUMMARY

Background

Bunkering is the process of supplying marine fuel to vessels in the context of custody transfer. The Technical Reference for Bunker Mass Flow Metering (TR 48) was established for the benefit of the whole bunkering industry in Singapore. The purpose is to enhance the efficiency of bunkering operators and promote best practices in the measurement of bunker fuel delivered so as to improve the competitiveness of the port of Singapore. TR 48 spells out the principles, requirements and procedures for bunker custody transfer from a bunker vessel to a receiving vessel using a mass flow meter system. With effect from 1 Jan 2017, it became mandatory to use the MFM system approved by the Implementing Authority for all Marine Fuel Oil (MFO) bunker deliveries in the Port of Singapore[1]. Unless there is a breakdown in the MFM system preventing its usage and requiring a return to using SS 600, all the volumes in Singapore port limits are currently delivered through the MFM system. As of 1 July 2019, TR 48 was applied to the delivery of distillates.

After approximately two years of implementation experience, TR 48 has now progressed to become a full Singapore Standard SS 648, which was implemented on 1 May 2020. TR 48 will continue to be used until the end of Nov 2020 to ease the transition to SS 648. SS 648 is not substantively different from TR 48 so the benefits observed with TR 48 are not expected to be impacted when SS 648 replaces TR 48.

Following on the heels of the national implementation by MPA, SCIC[2] commissioned this independent case study with MESD CoE[3] at NTU[4] and an ISO methodology expert. This was done with the approval and support of ESG[5] to validate the impacts of TR 48 using the ISO methodology for the assessment of the economic benefits of standards. The Implementing Authority was supportive of this study which will be the first of its kind to focus on the impact of TR 48 on the bunkering industry in Singapore.

Key members of the Technical Committee for Bunkering and Working Group for MFM acting in their individual capacities did the preparatory work for the TR 48 case study and assisted in the development of the structure of the case study. They were involved in the identification and contact of the 10 organisations in the 3 stakeholder groups to be interviewed; the development of the initial draft value chains for the 3 stakeholder groups after consultation with the ISO methodology expert; the identification of possible impacts of TR 48; identification of the Working Committee convenor and members, resulting in one of its members taking on the Working Committee convenorship and in its participation in the identification of potential IHLs to participate in this case study. The Advisory Committee had industry veterans involved in their individual capacities and government agencies who represented their own organisations. ESG became a member of the Advisory Committee after the formal approval of the case study. The Advisory Committee's role was to provide technical direction and guidance on TR 48 and the bunkering industry to the Working Committee. The Working Committee members were present in their

[1] Maritime and Port Authority of Singapore. Mass Flow Meter for Bunkering. Retrieved from https://www.mpa.gov.sg/web/portal/home/port-of-singapore/services/bunkering/mass-flow-meter-for-bunkering
[2] Singapore Chemical Industry Council
[3] Maritime Energy and Sustainable Development Centre of Excellence
[4] Nanyang Technological University
[5] Enterprise Singapore

individual capacities and are bound by confidentiality agreements on the information obtained through interviews with all stakeholders.

The gathering and compilation of concrete evidence of the benefits would strengthen the recognition of TR 48 among global bunkering stakeholders and ultimately encourage and facilitate the international application of TR 48, which forms the basis of two ISO standards for MFM on the receiving ship and on the bunker vessel. ISO 21562: Bunker Fuel Mass Flow Meters on Receiving Vessel – Requirements was published in July this year. ISO 22192: Bunkering of Marine Fuel Using the Coriolis Mass Flow Meter System is expected to be published by end of 2020.

TR 48 Background

Bunker fuel measurement during bunkering traditionally employed the tank gauging method. This is a time consuming and laborious process. Bunkering needed to move into the digital age by employing digital technology for direct measurement, to further improve efficiency and productivity. The mass flow meter system, based on the principles of metrology and system integrity, applies digital technology and has features superior to the tank gauging method.

Led by the National Technical Committee for Bunkering, a Working Group was appointed to develop the Technical Reference (TR 48) on Bunker Mass Flow Metering under the Singapore standardisation programme administered by SPRING Singapore, known as ESG with effect from Apr 2019. The Standards Development Organisation at Singapore Chemical Industry (SDO@SCIC) was appointed by SPRING in 2011 to support the Chemical Standards Committee and its committees, including the Bunkering Technical Committee and Working Group. The TR was completed after extensive consultation with various stakeholders which included the trials initiated and led by the Technical Committee and the Working Group as well as MPA-coordinated trials. Both the initial trials and the MPA coordinated trials had the benefit of key technical advice from both the Technical Committee and Working Group. The trials used mass flow meters that were verified and sealed by the Weights and Measures Office (WMO) under SPRING Singapore, as it was then known, and the trials' data were analysed by the Agency for Science, Technology and Research (A*STAR)'s National Metrology Centre to determine the performance of the MFM system. This standards project started in 2009 and progressively achieved innovative breakthroughs and crossed milestones, including developing new metrological and security frameworks, trial methodologies and protocols, selection and installation requirements, delivery procedures and dispute resolution procedures. By 2015, the new standard, TR 48 on Bunker Mass Flow Metering based on the project outcomes was published by SPRING Singapore, as it was then known.

TR 48 for Bunker Mass Flow Metering is a technical document covering the set of core requirements for metering system qualification, installation, testing, procedures and documentation for bunker custody transfer using the Coriolis mass flow metering system. TR 48 operates in the custody transfer context with stringent demands on the bunker tanker to ensure accurate quantity determination and the requirements on operational procedures. Approval tests help to ensure the security and integrity of the transfer process and representative fuel sampling during bunkering to vessels.

Higher efficiency, increased productivity and time savings in bunkering processes were expected to accrue to the buyer, supplier, supply tanker and other parties in the transaction. Greater transparency and availability of comprehensive data improved operational control and would be expected to result in lower incidences of disputes. It was expected to set uniform specifications, requirements, processes and

procedures to facilitate fair trade. Improved Health, Safety and Environment (HSE) with the move away from tank sounding was also expected. The MFM system was expected to enhance integrity, transparency and increase productivity. Best bunkering practices were expected to encourage more ship owners to have their vessels to call at Singapore to take bunkers.

Objective

The objective of this independent case study is to determine the quantitative and qualitative economic benefits of TR 48 in the delivery of Marine Fuel Oil (MFO) to the key stakeholder groups (bunker suppliers, ship owners/operators, the Implementing Authority) based on the ISO methodology for the assessment of the economic benefits of standards. The data collected will then be assessed and extrapolated to the Singapore bunkering ecosystem and its related maritime services and the port of Singapore. The project timeline for this case study was from Apr 2019 to Feb 2020.

Scope

The scope of work and the methods used include:

i. A literature review of Singapore bunkering industry and comparison of SS 600 and TR 48;
ii. Development of an assessment framework to evaluate the impact of TR 48 versus SS 600 based on the latest ISO methodology[6] to determine the economic benefits of standards;
iii. Collection of data through questionnaires and interviews with identified key stakeholder groups;
iv. Lastly the analysis of the impacts of TR 48 relative to SS 600 (the previous standard mandated for all bunkering operations in Singapore) for the key groups of stakeholders with impact extrapolation to the Singapore bunkering industry and its related maritime services.

Assessment based on ISO Methodology

In total, ten companies/organisation belonging to the three key stakeholder groups – bunker suppliers, ship owners and the Implementing Authority were involved. International and local companies were represented in the bunker suppliers and ship owners selected. Although this is a limited sample, it has been verified with industry veterans that the selected companies/organisations represent a good and valid sample of their peers in the application of TR 48 for the industry.

The data requested in the questionnaire was over the period of 2014 to 2018 and beyond for the comparison of SS 600 and TR 48. This span of years that covers the period before and after the implementation of TR 48[7] would help in the assessment of the impacts.

In assessing the impact of TR 48 versus SS 600, this case study analysed the relevant business functions of the bunkering industry value chain, as practiced respectively by the three key stakeholder groups[8]. The results on the operating indicators of each business function are presented according to financial, semi-quantitative[9] and qualitative impacts. The ISO methodology aims to identify the impact of standards and

[6] ISO Methodology 2.0. (2013). Economic benefits of standards. *Geneve: ISO.*

[7] Not all the interviewees were able to provide the data over this period. The data from post-June 2019 will not be considered due to the transition to VLSFO to comply with IMO Sulphur Cap in 2020.

[8] MFM Installation not included in assessment as both standards are on bunkering operations

[9] The term "semi-quantitative" refers to impacts which cannot be converted into financial impacts because they depend on additional measures which companies need to take.

to quantify these in financial terms and qualitative form. Revenues and costs caused by factors other than the standards are not considered. The changes in operations were not uniformly applied by all stakeholders due to differences in internal practices and would account for the range in the benefits shown. Individual stakeholders could realise the full potential of the benefits of TR 48 in deciding to dispense with operational practices e.g. with tank sounding that would no longer be required under TR 48. The extrapolated financial benefits for the bunkering ecosystem are based on estimates of what the potential benefit could be, if all stakeholders had similar internal practices

Conclusions

Financial

This study concluded that the implementation of TR 48 has resulted in an estimated potential annual net saving between USD 59.3 million to USD 146.6 million for the Singapore bunkering ecosystem. The key impacts on the business functions are the reduction in the cost of operation (66.3%-76.0%) for bunker suppliers and ship owners through the saving in manpower time and more efficient processes. This is followed by the saving in dispute resolution (33.9 % - 25.6%) for bunker suppliers and ship owners through the reduction in quantity disputes and the time associated with managing it. The increase in cost observed (~0.6%-2.3%) came from the bunker suppliers and Implementing Authority having to spend more time in the engineering function to verify and clear the approval of MFM test and other equipment maintenance activities, respectively. Even though there is a small increase (~0% -0.1%) in cost for Implementing Authority, the overall benefits to the bunker suppliers and ship owners can be perceived as indirect benefits for the Implementing Authority as their main function is to guarantee the reliability, fairness and transparency of the overall bunkering and port operation.

Semi-quantitative[10]

In term of semi-quantitative impacts, they differ according to the different stakeholders and are summarised below:

Bunker suppliers can potentially reassign shipboard manpower (up to two, according to this study) during the bunkering operation to either perform other tasks or to afford them opportunities to rest. This will benefit the bunker suppliers either in terms of increased productivity for the bunkering process or compliance with mandatory rest periods of the Maritime Labour Convention, which specify the maximum work time and minimum rest time. Bunker suppliers surveyed have also observed an increase of 20%-60% in bunker sales volume (with an increase in bunker vessels for some suppliers), with the implementation of TR 48 mentioned as one of the many contributing factors. Knock-on effects would be more loadings from terminals and higher turnarounds. The development of TR 48 as well as the mandatory implementation of TR 48 could be inferred at best, to have influenced the exit of some bunker suppliers from the market and one of its possible knock-on effects would be the increased bunker sales volume noted by the suppliers interviewed. (For more details, see the section on “Reputation and

[10] The term “semi-quantitative” refers to impacts which cannot be converted into financial impacts because they depend on additional measures which companies need to take.

Competitiveness" below). This increase in bunker sales volume by the bunker suppliers would be consistent with the reported increase in total bunker volumes after TR 48 was implemented.

For the ship owners, the impact in this category from one respondent was the reduction in time and manpower to carry out ROB inspection (50% reduction) and spot checks (33% reduction). Other respondents did not change their ROB processes after TR 48 implementation or were not able to comment on this impact as they had no clear evidence.

Data handling benefits for the Implementing Authority showed a 90% improvement in the time needed for the handling of bunker data after TR 48. Positive data handling benefits for suppliers and ship owners were reported under qualitative impacts. The Implementing Authority also reported there are 3 hours saving for each quantity dispute investigation after TR 48.

Qualitative

Qualitatively, the primary impacts of TR 48 for the Singapore bunkering sector can be summarised in a top line statement as the improvement in the efficiency and productivity of the delivery of an assured quantity of bunker fuel in a transparent manner, leading to a system having a high trust quotient. Expanding on this theme, the following provide fuller details:

- Improved scheduling for most of bunker suppliers;
- Improved inventory management for half of the ship owners with the remaining still being conservative and relying only on their ROB checks for each delivery for inventory management;
- TR 48 has also initiated the digitization of the sector through the use of modern measuring and data processing equipment.

The qualitative impacts mentioned above elevated the reputation of Singapore bunkering industry and the competitiveness for legitimate players vying for business from their international clients, the ship owners.

Reputation and Competitiveness of Singapore's port

All the respondents from stakeholder groups were positive with regards to the impact of TR 48 on the reputation of Singapore's bunkering industry. Fewer incidences of short supply and disputes were two key points highlighted by ship owners as being critical issues leading to their decision to purchase bunkers in Singapore. The resultant market consolidation of bunker suppliers after TR 48 was mentioned by several of the respondents from the bunker supplier and ship owner groups but only as an observation. The available records of the number of suppliers immediately before and after 2017 did not manifest this drop although a steady trend of decline was observed from the available statistics from 2010. A point worth noting is that TR 48 development commenced in 2009 and there was substantive pushback from bunker suppliers to the Implementing Authority and the Technical Committee's efforts in the development of TR 48. The economic recession in 2008 would also possibly have some bearing on the exit of bunker suppliers. Despite the feedback from key stakeholders suggesting that a link exists between TR 48 implementation and the decision by some bunker suppliers to exit the market, clear statistical evidence is unavailable. At best, it may be inferred that the development of TR 48 as well as the mandatory implementation of TR 48 could have influenced some bunker suppliers to leave the market.

Important factors like the improved transparency resulting from TR 48 implementation, stringent regulation and oversight from Implementing Authority have resulted in a more efficient and faster bunkering operation from a bunker vessel to a receiving ship. The bunker suppliers, ship owners and Implementing Authority interviewed agreed that the mandatory usage of TR 48 had indeed resulted in raising the reputation of the port of Singapore, with the bunker suppliers and ship owners interviewed also highlighting the exit of outlier players offering contrarian pricing as one of the key factors contributing to this outcome. Particularly strong feedback was received from a number of ship owners on how TR 48 had reduced the significant losses experienced previously during the custody transfer of bunker fuel and thereby raising Singapore's trust quotient and reputation. The "Cappuccino" effect was also observed by the various stakeholders interviewed to have disappeared. The feedback from the Advisory Committee was that it would be more a case of the "Cappuccino" effect having largely disappeared. Major bunkering ports like Rotterdam, Fujairah and ports in China were also reported to be looking at Singapore's use of TR 48 to assess the feasibility of adoption. The Implementing Authority's strong support of the plans for TR 48 implementation and their strategic involvement in the initiation and development of TR 48 with their role as co-chair of the WG for MFM were also key to the success of the implementation of TR 48.

Other impacts

Lastly, there was a lot of feedback from bunker suppliers observing the high initial costs incurred to set up the MFM system. Although this factor was not included in the scope of this study as it is a pre- TR 48 process and a prerequisite for implementing TR 48, there were extensive discussions nevertheless on this topic. The general consensus from the key stakeholders is that this cost is the "price" which had to be paid in exchange for the overall substantive benefits of the system mentioned earlier. Similarly, it should be noted that subsidies granted by the Implementing Authority were also not included in the scope of this study. There were other observations captured from the respondents like the higher market share which evolved due to the resultant matrix of fewer competitors, more customers and fewer price distortions between retail and wholesale/bulk bunker fuel price. This study is not able to conclusively link these observations as direct impacts resulting from the implementation of TR 48. It was nevertheless noted as these observations were commonly fedback by the respondents. It was also observed that some of the positive changes in operations were not uniformly applied by all stakeholders due to differences in internal practices. The potential benefits of TR 48 concluded in this study could be further realized if such practices are implemented across all related stakeholders.

An observation can also be made that many of the expected benefits of TR 48 when it was launched in 2015 turned out to be similar to the benefits determined or observed in this case study. Higher efficiency and productivity with time savings on bunkering processes for ship owners and bunker suppliers were determined in this study. Greater transparency and availability of comprehensive data resulted in lower incidences of disputes and better operational control. It was also observed that a number of ship owners highlighted that the implementation of TR 48 encouraged them to have their vessels to call at Singapore to take bunkers as a matter of choice.

<u>Recommendation</u>

It was observed that whilst there are positive and significant impacts resulting from the implementation of TR 48, some of the changes in operations giving rise to them were not uniformly applied by all stakeholders due to differences in internal practices. The potential benefits of TR 48 concluded in this

study can be further realized if such changes in operation can be implemented across all related stakeholders. For future work, further studies may be carried out to investigate the impact of TR 48 on the other stakeholders in the bunkering ecosystem who are not covered in this study.

Table 1 List of Advisory Committee members

No.	Name	Representation	Designation	Background
1	Seah Khen Hee	Individual Capacity	Chairman	Technical Committee for Bunkering, SDO@SCIC
2	Capt. Yoon Peng Kwan	Individual Capacity	General Manager	Fleet Division, Pacific Lines International
3	Neo Tiau Gee Simon	Individual Capacity	Executive Director	SDE International Pte Ltd (Previously Regional Manager of IBIA Asia till Jul 2019)
4	Rahul Choudhuri	Individual Capacity	Managing Director	(Asia, Middle East, Africa), Veritas Petroleum Services Pte Ltd
5	Chew Siu Keong	MPA	Assistant Director	Bunker Services, MPA
6	Loh Yuan He	MPA	Senior Manager	Bunker Services, MPA
7	Steven Phua	ESG	Deputy Director	Standards (IEC & Manufacturing), Enterprise Singapore

Note: A two-day Basic Bunkering Course (SS 600:2014 & TR 48:2015) was provided by IBIA Asia on a complimentary basis to the NTU MESD members.

Table 2 List of Working Committee members

No.	Name	Representation	Designation	Organisation
1	Lee Wai Pong	Individual capacity	Deputy Chairman	Technical Committee for Bunkering, SDO@SCIC
2	Dr Lam Siu Lee, Jasmine	Individual capacity	Centre Director, Associate Professor	MESD CoE, Nanyang Technological University
3	Koh Eng Kiong	Individual capacity	Assistant Centre Director	MESD CoE, Nanyang Technological University
4	Ang Zhi Qian	Individual capacity	Project Manager	MESD CoE, Nanyang Technological University
5	Yang Mengyao	Individual capacity	Research Associate	MESD CoE, Nanyang Technological University
6	Susan Chong	Individual capacity	Advisor	SDO@SCIC
7	Elane Ng	Individual capacity	Assistant Manager	SDO@SCIC
8	Reinhard Weissinger	Individual capacity	Lecturer, Standardization and Sustainability (Former Senior Expert, Research and Education, ISO Central Secretariat).	University of Geneva