PRESIDENT'S TECHNOLOGY AWARD 2026

WU JIAN, A*STAR National Metrology Centre
THOMAS TING CHENG HEONG, Maritime & Port Authority of Singapore
YU SHENGKAI, A*STAR National Metrology Centre
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"For their contributions to advancing the integration of measurement science, digital integrity assurance and standards-based regulatory frameworks to transform marine fuel custody transfer in Singapore's bunkering ecosystem, setting a new global and local standard for, accuracy, transparency and data assurance while reinforcing Singapore's position as the world's leading bunkering hub."

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By reshaping how marine fuel is measured, verified, and assured in the world's busiest bunkering port, this work has nurtured the development of a measurement science-based and digitally assured ecosystem. For more than a decade, it has enabled the transition from manual, dispute-prone processes to traceable, tamper-evident systems—establishing a new global benchmark for integrity in a sector that handles over 1/6th of the world's bunker trade, representing a US$33 billion industry in Singapore. Recognising long standing challenges in fuel accountability, disputes, and inefficiencies inherent in conventional dipstick measurement – a volumetric tank based measurement – a systematic transition to mass flow based approaches using Coriolis mass flow meters was undertaken. Although the mass flow meter has been widely adopted in other industries for relatively simple measurement processes, its application in bunkering had presented significant challenges due to dynamic ship-to-ship operating conditions, variable flow conditions and complex bunkering processes, making it challenging to consistently meet the regulatory accuracy limit set by in the International Organization of Legal Metrology requirements (OIML R 117).

What was established was a reliable measurement traceability framework for bunkering custody transfer, supported by an uncertainty framework developed in accordance with fundamental metrological principles. It also delivered an onboard performance evaluation methodology capable of verifying metering-system performance under actual bunkering conditions. Together, these advances enabled fuel delivery measurement to be traceable, accurate, and transparent across the custody transfer operation, forming the scientific foundation of Singapore Standard SS:648 and enabling the Maritime and Port Authority of Singapore's (MPA) world-first mandatory Mass Flow Metering (MFM) framework for bunkering. The implementation has reduced the number of legal disputes arising from contentious fuel bunkering by up to 70%. The work has been elevated internationally as International Organization for Standardization ISO:22192, the first international standard for MFM marine-fuel custody transfer. Ports including Rotterdam, Fujairah and Ningbo have begun adopting the standard, in turn opening the way for Singapore's local surveyors to extend their services to these ports. As Singapore moved towards digitalised bunkering through the Electronic Bunker Delivery Note (eBDN), it became essential that digital bunkering data remained complete and untampered as it travelled across multiple vendors and proprietary systems. Extending measurement science from physical quantities into the data chain, the team created the passive listener device for verifying the integrity of digital

bunkering data. This framework addressed a key barrier to trusted digital bunkering and underpins the updated SS:648 and the new SS:709 enabling the handling of high-volume data transfer accurately and reliably, reflecting about 150,000 tons of bunker fuel being bunkered daily. The impact has been substantial. Digital bunkering became mandatory in the Port of Singapore in April 2025, the first such implementation at scale anywhere in the world, and is expected to save the industry close to 40,000 man-days each year.

Each member brought a distinct strength to this convergence. Mr Wu led the development of the metrological framework and the on-board verification methodology; Mr Ting drove the national digital-bunkering roadmap and regulatory transformation; Dr Yu pioneered the data-integrity inspection methodology; and Mr Tan engineered the reference hardware, including the passive listener device.

Apart from the core team, this development work involved a wide range of stakeholders across agencies, including the Agency for Science, Technology and Research National Metrology Centre (A*STAR NMC), MPA, the Singapore Standards Council (SSC), the Competition and Consumer Commission Singapore (CCS) Weights and Measures Office, the Singapore Chemical Industry Council (SCIC), the bunkering committee, bunkering shipping lines, surveyors, bunkering operators, fuel suppliers, and meter vendors. Their direct and indirect contributions were instrumental in the success of this work.