BOOK REVIEW

An Introduction to LNG Bunkering, by Nigel Draffin, (Petrospot Ltd, 2013), 61pp., £45.00, ISBN: 978-1-908663-15-3.

Over the past two years, there are very few sectors of the global energy market that have captured the attention of industry the way that liquefied natural gas (LNG) has. With significant new conventional and unconventional gas discoveries being announced with increasing frequency, project sponsors are diligently working to identify new market opportunities for natural gas. Last year dozens of announcements were made detailing projects for the construction, and operation, of LNG fuelled vessels. This past October, DNV GL, the world's largest ship classification society, released recommended best practices for LNG bunkering. One month later, Washington State Ferries completed a three-year study describing the risks and benefits of converting its Issaquah class ferries to run on LNG. As of January 2014, more than 40 vessels are being evaluated for, or being converted to operate on, LNG.

Nigel Draffin's book, *An Introduction to LNG Bunkering*, therefore comes at an opportune time. Draffin, the author of five previous books on bunkering, draws on nearly 50 years of shipping experience, with a wide-ranging background from ship engineer, to economics analyst and a founding member of the International Bunker Industry Association.

The forward by Mogens Bech of the Danish Maritime Authority sets the stage nicely. Tighter emissions standards, together with increasingly competitive shipping economics, are forcing ship owners to carefully consider fuel options. Mr Draffin's preface then goes on to identify the intended readership of his book, noting that his text is designed to provide assistance to those with a working knowledge of ships and bunkering, but with little background in natural gas as a vessel fuel, or LNG as a storage medium. He elaborates on Bech's comments regarding the importance of developing maritime fuels which can help reduce sulphur and nitrous oxides, as well as greenhouse gas emissions.

The book's "Introduction" provides a brief overview of the evolution of LNG as a marine fuel, starting with the construction of the Methane Princess in 1963, before reviewing the abundant reserves of conventional and unconventional natural gas around the globe and the growing efficiencies to be achieved in LNG applications in the maritime industry.

Chapter One is particularly helpful for readers without a technical background. Through a series of tables and schematics the author explains the physics behind the use of natural gas as a fuel, the definitions commonly encountered within the industry, and the three types of gas engines. This discussion then provides the foundation for Chapter Two, which explores some of the risks associated with LNG storage and use as a marine fuel, including roll over, rapid phase transition, weathering, sloshing, methane slip and boiling liquid explosion (BLEVE) events.

Chapter Three, with its discussion on questions of safety, will be seen as one of the most important Chapters in the book. Draffin provides an overview of onboard LNG and compressed natural gas (CNG) storage tanks, and then examines the various types of onshore LNG storage facilities available. There is a brief reference to the IGC Code applicable to onshore storage and a discussion on safe zones, (also known as exclusion zones in many jurisdictions), but the discussion is briefer than most readers will likley be seeking. A discussion of the 1944 Cleveland Incident, the safety lessons learned from that accident, and the regulations developed by industry following the accident, would have been a welcome addition to this Chapter.

Chapters Four, Five and Six move the discussion into the technical realm. The information is well organised, well presented, and instructive. Chapter Four begins with an explanation of the need to use an onship vaporisation system which allows for the more efficient vaporisation of the LNG, and then reviews the various options available for onboard fuel systems. The review of learning from the LNG shipping industry regarding onboard re-liquefaction of boil off gas will be of interest to industry, although it would have been interesting to also provide a brief review of the pioneering work done with respect to the Q-Flex and Q-Max vessels in 2010 and 2011.

Chapter Five examines onboard fuel systems, and Mr Draffin summarises steps required in order to reduce hazardous zones in areas such as the fuel tank room (Zone 0), the gas valve room (Zone 1) and the engine room (Zone 2). This discussion, while instructive, seems rushed in places and additional explanations would have been of assistance for readers seeking to further their knowledge. The balance of the Chapter is more complete and provides a very good summary of the safety systems required onboard to ensure proper gas detection and gas extraction, as well as the importance of double walled piping and the emergency shutdown system. The explanations on these issues are simple, to the point, and helpful.

The final section of Chapter Five provides brief comments on LNG bunker barges and LNG road tankers. Both are relevant to the discussion regarding storage and safety, but the topics arguably would have fit more comfortably elsewhere in the book. Although important issues are raised, readers interested in the growing use of LNG as transportation fuel would likley have welcomed additional discussion on the topics of LNG road tankers.

Bunkering procedures are addressed in Chapter Six. This is one of the best discussions in Draffin's book, compete with clear explanations and helpful schematics. The preliminary overview of existing LNG bunkering procedures in the automotive practice provides a helpful starting point for the examination of possible modifications which may be required for bunker transfer. The text begins with the establishment of the safe zone and a review of the bunker transfer equipment. For industry practitioners, it would have been interesting to have a brief discussion on the various safe zones required in various jurisdictions around the world, in order to develop a sense as to how differing regions regard LNG risks. The ensuing explanation regarding the matter of connection is very instructive and the diagrams which follow are clear. The book then reviews issues including cool down, the importance of ensuring that all lines are inert before gas can be introduced, as well as line purging and custody transfer risks.

Chapter Six concludes with an overview of the Stockholm Ferry Project, and describes the fuelling of the *Viking Grace*. The explanation is clear and assists in putting the earlier discussion on process and safety issues into context.

In Chapter Seven, the author reviews the training requirements for those working with LNG bunkering. Mr Draffin touches briefly on the Standards of Training, Certification & Watchkeeping, although again it would have been interesting to learn more about the STCW Convention, and the changes made in 1995 when the US Coast Guard commenced discussions with the International Maritime Organization (IMO). The balance of the Chapter, and its discussion on risk identification and mitigation, reads well. Particularly welcome is the review of recent IMO developments, including the interim IGF Code and the revisions being made to the SOLAS Convention. Chapter Seven provides a valuable summary of the current international Conventions.

Chapter Eight provides an overview of the vessels presently using LNG fuels. We learn that the Norwegian shipping industry leads the way, but the discussion on the tax benefits made available to industry in order to encourage the use of LNG is absent. Similarly, the reference to current restrictions regarding international trade gives rise to reader curiosity, and a more fulsome discussion would have been welcome. That said, it is recognised that Mr Draffin's background is in industry, and not in law, and that the focus of the book is on technical, rather than commercial issues.

Draffin's Chapter Nine, a discussion on commercial considerations relating to LNG bunkering, will be particularly helpful to commercial teams, as it provides a brief review of matters of gas and LNG quality and the price adjustments that necessarily arise.

Given Mr Draffin's extensive experience, a final Chapter with his observations regarding industry trends and his expectations for the near and long term would have been welcome. Without any type of conclusion or views on the industry's future, the book comes to an end rather abruptly. While the list of abbreviations and the appendices detailing additional reading material are welcome, a brief Chapter with the author's concluding views would have been valuable.

In all, the book is well organised, well illustrated, and very readable. The writing is instructive and concise. Those interested in increasing their understanding on LNG bunkering will benefit from Mr Draffin's extensive experience. If one were to identify a shortcoming, it is simply that this topic could have readily supported further discussion in those areas indicated. This concern, however, is a minor one, and Mr Draffin is to be commended for this valuable contribution to this rapidly developing area.

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