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"Waterway Suitability Assessment: Art and Science"

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Abstract

The purpose of this paper is to briefly explain the Waterway Suitability Assessment (WSA) process required for U.S. liquefied natural gas (LNG) terminals, highlight the quantitative risk assessment tools utilized and how they work together to adequately assess the risks, and introduce qualitative best-practices to reduce review time and improve stakeholder collaboration and receptivity. As each maritime port has a different composition of commercial vessel traffic and operating practices, these tools and methods are combined to form a Risk-Based Approach, rather than a prescriptive assessment tool, ensuring a holistic understanding and mitigation plan concerning localized LNG transportation.

Introduction

As the United States continues to evolve as a significant global exporter of LNG, ports nationwide are assessing their existing waterway infrastructure for the suitability of multiple proposed projects within their regions. The Federal Energy Regulatory Commission (FERC) serves as the principal governing authority ensuring compliance with the National Environmental Policy Act (NEPA) regarding LNG project approvals, yet they specifically request the U.S. Coast Guard (USCG) to assist in vetting maritime safety and security concerns through the Coast Guard Interagency Agreement. Among other things, the Coast Guard's primary responsibility in this process is the review of the applicant's Letter of Intent (LOI) and Waterway Suitability Assessment (WSA), and the issuance of their Letter of Recommendation (LOR).

At issue is how the applicant and the USCG are to objectively determine the level of risk of a particular project and its associated traffic and to evaluate that risk specific to each port. For example, how would LNG operations on the Mississippi River compare to those on the Delaware River? Furthermore, how would the potential risks and mitigations be explained to the local maritime stakeholders and general public with confidence that the risks have been completely, objectively, and fairly been considered?

Several quantitative tools are utilized during the assessment process such as the Sandia National Laboratories "zones of concern[1]", industry-recognized risk assessment methodologies, and the

[1] SAND2004-6258, *Guidance on Risk Analysis and Safety Implications of a Large Liquefied Natural Gas (LNG) Spill Over Water*, Sandia National Laboratories, 2004.

Coast Guard's Risk Management Quick Reference Tool[2]. Additionally, Chapter 33 of the Code of Federal Regulations (CFR), subchapter 127 (33 CFR 127) and USCG Navigation & Vessel Circular (NVIC) 01-2011 detail the regulatory items to be fulfilled for a complete and standardized evaluation. However, as each port has a different composition of vessel traffic, natural & industrial characteristics, and operating practices, these tools are combined to form a Risk-Based Approach, rather than a prescriptive assessment tool.

Additionally, in addition to risk assessment methodologies and scientific tools, there are several qualitative best-practices that can be employed to streamline the assessment process, improve stakeholder communication and education, and derive a more holistic understanding and mitigation plan concerning the risk of introducing LNG transportation within our ports.

History of the WSA

Before addressing the different tools and methodologies that comprise a WSA, it is important to address the history of the evaluation process and how it has evolved over time.

The United States has had a long history of overseeing the safety and security of LNG production and transport, with the first international export out of Lake Charles, Louisiana, taking place in January of 1959. Moreover, the first four import terminals were constructed in the 1970's (Lake Charles, Louisiana; Everett, Massachusetts; Elba Island, Georgia; and Cove Point, Maryland). While early regulatory frameworks were in place at the time, it wasn't until the terrorist attacks of September 11th, 2001, that the concern for a systematic approach to mitigating safety and security risk arose.

Sandia National Laboratories published a report in December 2004[3], that set out to standardize the evaluation of LNG spill consequences over water. The Lab, working with members of the government and industry, looked at the probability, hazards, consequences, and mitigations of different intentional and unintentional release scenarios. The product of their research was the formulation of the "zones of concern" that addressed the severity of hazards within different distances from the spill as they relate to fire and vapor dispersion. These zones, discussed in greater detail later on, would serve as a fundamental evaluation tool in the WSA process.

NVIC 05-2005 was published by the USCG on June 14th, 2005, with the intent of providing safety and security analysis guidelines for the development of the WSA. National policy was needed to address risk mitigation as it related to LNG projects, with the USCG assisting FERC in the NEPA process by addressing marine operations. This would formally introduce the concept of the WSA, as well as the LOR. At the time, the WSA was required by FERC regulations (18 CFR) and not USCG regulations. Later that same year, 18 CFR's 153 & 157 were amended to have WSA's submitted as part of the FERC pre-filing process.

[2] COMDTPUB P16700.4, Encl (7) to Navigation and Vessel Inspection Circular (NVIC) 01-2011, "Guidance Related to Waterfront Liquefied Natural Gas (LNG) Facilities", January, 2011.
[3] SAND2004-6258, *Guidance on Risk Analysis and Safety Implications of a Large Liquefied Natural Gas (LNG) Spill Over Water*, Sandia National Laboratories, 2004.

NVIC 05-2008 was published December 22nd, 2008, in order to provide further clarification to the WSA process, including the LOR, LOR Analysis, submission timelines, and the role of the USCG in the NEPA process. "Change 1" of the same NVIC was published March 18th, 2009. Additionally, that same month Sandia Laboratories released a second report[4] in order to account for the spills from larger vessels expected to call on LNG terminals in the United States.

In April of 2009, the WSA requirement was also codified in 33 CFR 127 in order to align with USCG regulations. Finally, NVIC 01-2011, published in January of 2011, further clarified that the LOR serves as a recommendation to FERC of the suitability of the waterway, as well as specifics on the release of the LOR.

What is the purpose of the WSA?

The WSA fundamentally allows the applicant and the USCG to answer the questions, "Is the introduction of LNG operations in a particular waterway posing an unsuitable risk? What mitigation measures may be required? In the end, is the waterway suitable given the operation, potential accidental and incidental incidents, exposures, and current levels of controls? What additional measures should be imposed to make it acceptable?" By determining the impacts of a potential LNG waterfront terminal (Terminal) itself and the LNG Carrier (LNGC) traffic on the waterway and surrounding areas, the WSA provides a complete picture of the potential risk, assisting FERC in their approval process and the development of mitigation strategies.

According to the regulatory requirements mentioned above, this is achieved via the following steps:

- Characterization of the existing port where the proposed Terminal is to be located
- Characterization of the existing vessel traffic of the port; all types
- Evaluation of the "zones of concern" over the proposed LNGC route
- Evaluation of the navigational feasibility of the LNGC route
- Performance of a risk assessment of the potential risks
- Evaluation of potential mitigation strategies

However, there isn't a single tool that encompasses all of these data points, but several tools work together in order to provide the Captain of the Port (COTP), and thus FERC, with enough detail to make an adequate assessment. These quantitative tools, paired with certain qualitative best-practices, produce the best end product in the form of a well informed and reasonably-derived LOR.

Quantitative tools working together to determine total risk

1.) Risk Assessment Methodology

[4] SAND2008-3153, *Breach and Safety Analysis Spills over Water from Large Liquefied Natural Gas Carriers*, Sandia National Laboratories, 2008.

In NVIC 01-2011, the USCG calls for a risk assessment tool that provides an industry-accepted methodology for approaching risk. There are several tools that could be utilized for this process; the ANSI/API 780 standard published by the American Petroleum Institute is one methodology example that has been utilized in several WSA studies. These methodologies provide a systematic approach to assessing risk, allowing the assessors to objectively quantify how risky a particular project will be through a ranking matrix.

The selected methodology should serve as a framework to guide the thought processes of the evaluators and stakeholders, as well as providing for a sequential decision-making path. Furthermore, it should incorporate all the individual tools mentioned below into a congruent and cohesive whole. As discussed later on, this is especially effective when conducted in a group setting.

2.) Sandia National Lab Reports 2004 and 2008

As mentioned previously, Sandia's studies evaluated the probabilistic accidental and intentional events leading to varying sizes of containment breaches for an LNGC. According to their work, the size of the accidental breaches of containment were estimated to be $<2m^2$, with intentional attack events yielding more significant calculated breach sizes ranging from $2\text{-}12m^2$, with a calculated "nominal" breach size of $5m^2$. As expected, the more conservative measurements are utilized. The different spill impacts, or "zones of concern", are based on the expected spill rate and volume from these breaches of containment.

Zone 1: This area has the most severe consequences around the LNGC, with significant damage or disruption to infrastructure or assets possible within 500 meters of the vessel. In this zone, the breach of a single tank was modeled, with vapor cloud dispersion and fire being the imminent hazards. In this zone, the recommended mitigation measures include vessel security zones, positive vessel control, and waterway traffic management.

Zone 2: An area with less severe consequences, this zone extends from 500 to 1,600 meters, modeling a single tank intentional breach with vapor cloud dispersion and fire again being the possible imminent hazards. In this zone, the recommended mitigation measures include community education, early warning systems, and shelter areas.

Zone 3: This final area extends from 1,600 to 3,500 meters, and is expected to have the least likelihood of severe consequences. Unlike the other two zones, a cascading failure (the breach of three tanks) was modeled, yet only faced the possible hazard of an unignited vapor cloud. In this zone, the recommended mitigation measures include the elements recommended in Zone 2, with an emphasis on an unignited vapor cloud.

When these zones are transposed over the LNGC's expected transit route, the varying levels of risk to surrounding communities and infrastructure can be easily assessed. The measured risk is then a cumulative impact of the severity of the zone and the "sensitivity" of the area, such as a highly-populated area or one containing several critical infrastructure assets.

3.) USCG Risk Management Quick-Reference Tool (SSI)

The USCG also provides the Risk Management Quick-Reference Tool as an enclosure to NVIC 01-2011 in order to quickly reference common, specific risk factors that have been identified for LNGC traffic and the recommended management strategies for those risks. As this information contains sensitive security information (SSI), this Tool must be requested from the USCG on a need-to-know basis.

While the specific details of the Tool cannot be published due to the sensitive nature of the contents, it can generally be described as a three-step sequence evaluating where the "zones of concern" intersect with different concentrations of populated or critical infrastructure/asset areas, the different attack or accident types possible, and the risk management strategies to mitigate those incidents. While the management strategies are not prescriptive, they are generally recommended.

Qualitative methods to improve the overall process

Thus far the different technical items and tools that comprise the WSA have been discussed, yet the available guidance doesn't prescribe exactly "how" to conduct a WSA. In the following sections, several best-practices will be shared that have been observed in several successful WSA submissions. These include early engagement with key governmental and commercial stakeholders, real-time "workshop" risk assessment, early navigational simulations and studies, and stakeholder/public education. These practices greatly enhance the quality of the assessment performed, while potentially reducing review time and reducing associated staff-hours of the COTP.

1.) Early engagement with key stakeholders

Most companies would not expect to develop a project without engaging local entities for support early on, yet the degree of information-sharing and collaborative efforts can vary widely from firm to firm. Under the guise of strategic advantage, some firms provide very little in the way of design and operating practices, even under the protection of an non-disclosure agreement. This can be especially true when developing a project in an unfamiliar area where the firm does not have a pre-existing presence. However, there is a real value in reaching out to key maritime stakeholders early on in the WSA and project development phase.

The key objective of early engagement is building trust, recruiting advocates, and gaining local insight. Without early engagement, local stakeholders could begin to feel isolated from a project, breeding distrust and increasing the chances of opposition. Additionally, an applicant could miss valuable insights that could save time and development capital.

Of particular importance would be the following local entities:

Port Authority

Naturally, the local Port Authority can assist with site vetting, land acquisition, local contacts, and permitting. Whether or not the Terminal is to be located on port property, the Port Authority

can typically serve as an early advocate for project development, as the local economy would benefit.

First Responders

Involving the local law enforcement, fire, medical, and emergency planning entities early on will allow the applicant to better understand the capabilities and potential gaps of the local emergency response services, as well as provide education and collaboration for entities that have not experienced LNG operations in their area. Moreover, it will begin the conversation of potential cost-sharing needs that will be required for the development of the Terminal's Emergency Response Plan. Additionally, FERC typically wants to see a healthy level of engagement during the permitting process.

USCG units

As the LOR will come from the local COTP, the local field unit (Sector, Marine Safety Unit, etc) with jurisdiction will need to be involved from the very beginning. The LOI, Preliminary WSA, and Follow-on WSA will be routed through the local unit for signature. Additionally, the local unit can assist with area contacts and introductions, interagency meetings, as well as applicable regulations and guidance.

Pilot Associations

For navigational feasibility and proof-of-concept development, the local channel pilots should be engaged very early on. Having a navigation simulation study performed prior to the "workshop" setting (discussed later on) allows for the pilots to share an objective, technical opinion on the safety and feasibility of the project from a navigational perspective. Additionally, they can address potential design concerns that are much easier to correct earlier on in the engineering and design phase.

Neighboring terminals

Understanding the navigational and operational practices of neighboring facilities helps mitigate potential conflicts early, instead of finding out potential issues later on in a more public setting. The benefit of understanding neighboring terminal operations is the ability to address mutual safety concerns, using the discussion to actually lobby for mutually beneficial safety protocols.

Marine Stakeholders & Associations

Involving representatives from other channel users such as the deep-draft, "brown-water," and recreational boating communities early on allows for potential concerns to be addressed and educated before they reach an unnecessary level of public scorn. Furthermore, this actually shows a greater level of transparency and objectivity in assessing potential risks to the port as a whole. Additionally, the COTP can see that several groups that would usually be involved in separate "ad hoc" meetings were involved in the conversation and contributing to the overall quality and objectivity of the assessment.

If the prospective port has a Harbor Safety Committee or some form of professional maritime association, the above-mentioned entities can typically be found in one place.

2.) Workshop method in order to discuss the assessment in real-time versus "ad hoc"

NVIC 01-2011 recommends that the USCG COTP conduct "ad hoc" meetings with relevant stakeholders in order to discuss the proposed project and any associated risks. While these meetings can be conducted in a vacuum, there are several disadvantages to this approach. First, many potential concerns and assumptions of risk can be resolved immediately through the sharing of relevant information with the right people in the room. For example, if a neighboring terminal manager is concerned with the potential impacts of a passing LNGC on their berth, having a real-time discussion on the navigation studies, passing-ship studies, and "zones of concern" with the pilots and project managers in the room could easily resolve the matter. Likewise, the COTP or his/her representative can witness the collaborative efforts of the stakeholders, giving them a better sense of the quality of the WSA being conducted and the education they are receiving on the project.

Second, this again saves the COTP time versus presenting the same information multiple times in a "silo" fashion. Additionally, the burden of knowledge or credibility doesn't rest solely on the shoulders of the presenting COTP, but on those of the project managers and industry experts such as the pilots and third-party consultants. Without a real-time, collaborative discussion, repetitive and time-consuming meetings are required, with the possibility of inconsistent messaging and reception.

3.) Navigation simulations with local pilot associations

Conducting a navigation feasibility study earlier on is a great way to gain early buy-in from the pilots, as well as serving as a design and proof-of-concept validation. Additionally, it also allows for design modifications as needed, before the location and engineering drawings are finalized.

Several successful projects brought the local pilots to a professional bridge simulator in the beginning of the design phase, conducting multiple "runs" under varying conditions on the modeled waterway. This served to evaluate the safety of the vessel operations in a simulation of the actual waterway in very realistic conditions. From this experience, the pilots and operators can determine what standards of care would be needed for LNGC's calling on the proposed terminal, as well giving the pilots the assurance of the feasibility of navigating and docking different LNGC's at the proposed site location. Furthermore, for waterways without existing LNG operations, this could be the first interaction a pilot may have with an LNGC and her unique handling characteristics.

Additionally, the pilots can provide feedback on the design and location of the proposed project. During one project, the simulations were used to redesign the turning basin three times until it met the safety standards of the local pilots in regard to passing traffic. Had this been done later on in the project, it could have generated costly revisions in terms of schedule and development capital. Ultimately, having the support of the local pilot association from a technical perspective is a crucial

early-step in the life of the project. Also, the COTP will heavily consider the input of the pilots in their assessment and LOR issuance if the simulations are performed prior to the completion of the WSA. Without completing this modeling beforehand, the project risks unforeseen operational flaws and the possibility that the WSA will be halted until the work performed.

4.) Stakeholder Education

Taking place at both the WSA "workshop" and public open-house forums, education provided on the physical properties and characteristics of LNG, as well as the risks, turns skeptics and stakeholders into powerful advocates and allies. Using technical studies can be used earlier on to educate professional groups such as the pilots and marine stakeholders due to their mechanical and operational backgrounds. These key players can then serve as "ambassadors" for a project once they have been satisfied themselves in regard to the safety and mitigation measures proposed.

Once stakeholders and members of the public see that the introduction of LNG into a commercial port is an easily-mitigated risk, perception on the impact to existing traffic and potential safety hazards tend to diminish. Similar to early outreach, this builds trust and recruits advocates. Once potential fears and rumors are addressed, opposition tends to diminish. However, failure to properly educate the stakeholder population can lead to unnecessary oppositions that can attract unwanted political attention.

Conclusion

The WSA can be viewed as a systematic approach to qualitatively assessing the risks involved in introducing LNG operations to a specific port, utilizing several scientific tools in unison. Consequence modeling, paired with industry-accepted assessment methodologies and general USCG recommendations provide a complete picture of the potential risks and their associated mitigation strategies.

Furthermore, while there are several ways to approach and compile the basic regulatory requirements of the WSA, it cannot be stressed enough the importance of open-and-early stakeholder communication and collaborative real-time risk assessment. While the applicant and the COTP can achieve the same degree of analysis and subsequent LOR through a more isolated approach, it can cost both parties unnecessary man-hours and schedule delays, while also risking stakeholder pushback if they weren't included or weren't fully educated on the risks and mitigation. Therefore, it is recommended that applicants and the associated COTP utilize the best-practices outlined above, supplementing the required regulatory items.

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