Preparing for Transport of Liquefied Natural Gas (LNG) Through the Panamá Canal

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ABSTRACT

While the efforts of the National Response Team (NRT) - Panama Canal (in Spanish, Autoridad del Canal de Panamá or ACP) Subcommittee are primarily focused on environmental protection issues, there is evidence that these same concerns may simultaneously have tremendous economic impact. The basis for the Memorandum of Agreement (MOA) between the ACP and NRT agencies was conceived over concerns for pollution events within the area of responsibility of the ACP. In keeping with the spirit of the MOA the Subcommittee has made giant strides improving the preparedness and response capabilities of the ACP. In doing so, the economic interests of the ACP as well as the countries of Panama and the United States have all benefited. Any impacts that may interrupt the day-to-day operations of the Panama Canal would have deleterious worldwide economic effects. We will discuss the increase in LNG vessel traffic

over the years since the opening of the expanded locks and the preparedness activities of the two groups.

INTRODUCTION

On June 26th, 2016, the new expanded Panamá Canal, also called the Third Set of Locks Project, was inaugurated. This new project doubled the capacity of the Panamá Canal by adding a new lane of traffic allowing for a larger number of ships, and increasing the width and depth of the lanes and locks allowing larger ships to pass. This expanded Canal allows larger ships, called NeoPanamax, to transit. NeoPanamax ships are about one and a half times the previous Panamax size and can carry over twice as much cargo.

The expanded Panamá Canal comprises of the following (see Figures 1 & 2): Two new sets of locks, Agua Clara (Atlantic side) and Cocoli (Pacific side), one each on the Atlantic and Pacific sides, and excavated new channels to the new locks. Widened and deepened existing channels. Raised the maximum operating water level of Gatun Lake.

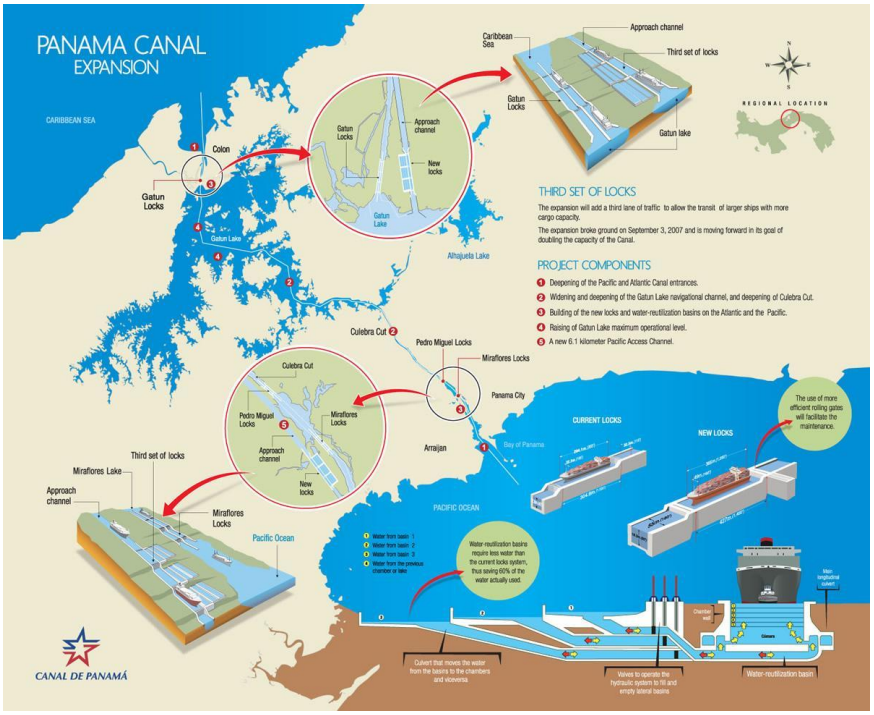

Figure 1. Panamá Canal expansion project illustration. (Credit: ACP)

Figure 2. Panamá Canal expansion project illustration. (Credit: ACP)

A national referendum under the government of Panamá's President Martín Torrijos approved the proposal of the Third Set of Locks Project by a 76.8 percent majority on October 22nd, and the Cabinet and National Assembly followed suit. The project formally began in 2007. On March 2nd, 2018, the Panamá Canal Authority announced that 3,000 Neo-Panamax ships had crossed the canal expansion during its first 20 months of operation.

Prior to this expansion, liquefied natural gas (LNG) was not carried through the Canal primarily because most LNG carriers were post-Panamax size ships. The expansion project coupled with the United States energy renaissance and expected emergence of LNG exports from the US make the Panamá Canal a key maritime resource to reduce time and cost of transit to markets in the Pacific. Once the Canal expansion project was completed, the new lock system and Canal waterways became large enough to accommodate most LNG carriers.

Figure 3. LNG tanker in new expanded lock. (Photo Credit: ACP)

Containerships represent more than half of the traffic through the expanded Canal, followed by liquefied petroleum gas (LPG) carriers and LNG carriers. Other segments such as bulk carriers, tankers, car carriers and passenger vessels have also transited the Neo-Panamax Locks.

LNG ships began using the waterway for the first time after the opening of the expanded Canal. Since then, this segment has experienced steady growth. More than 90 percent of the LNG world's fleet can now transit the Panamá Canal, which opened the doors to a new market and allows LNG producers in the United States to send natural gas to Asia at competitive prices.

BACKGROUND

National Response Team: The National Response Team (NRT) is comprised of representatives of 15 federal agencies, each with responsibilities and expertise in various aspects of emergency response to oil and hazardous substance pollution incidents. The NRT has nationwide responsibilities for interagency planning, policy, and coordination for pollution incidents of all sizes and kinds. The NRT meets regularly and provides policy guidance and assistance. The NRT may be activated during an incident, if needed, to provide national-level advice and assistance, as well as access to member agency resources that could not be provided at the Regional Response Team (RRT) level. The NRT also engages the private sector in prevention, preparedness, and response efforts. The NRT encourages innovation and collaboration to increase the effectiveness of industry compliance with planning and response regulations. The NRT does not receive direct appropriations for its activities.

Panamá Canal Authority: The Panamá Canal Authority (in Spanish, Autoridad del Canal de Panamá or ACP) is an autonomous legal entity of the Republic of Panamá, established under public law (Title XIV of the National Constitution), with exclusive charge of the operation, administration, management, preservation, maintenance, and modernization of the Canal, as well as its activities and related services, pursuant to legal and constitutional regulations in force, so that the Canal may operate in a safe, continuous, efficient, and profitable manner.

Memorandum Of Agreement (MOA): The NRT-ACP MOA, formally known as the *Agreement Between the United States Department of State [DOS], the United States Environmental Protection Agency [EPA], the United States Coast Guard [USCG], and the Autoridad del Canal de Panamá [ACP] Regarding Assistance with Respect to Certain Environmental Pollution Incidents in the Panamá Canal Area* was signed by all parties on 1 April 2002.

The Agreement provides the basis for the NRT-ACP relationship, stresses the importance of the Panamá Canal in international trade and commerce, and both Panamá's and the United States' interest in ensuring safe unencumbered operations in the Canal. Consequently, the Parties have continued to develop and refine procedures that facilitate timely and appropriate supplemental assistance in the event of a significant pollution incident within the Canal Area. As part of these ongoing efforts, and mandated in the Agreement, annual exercises are held with the NRT and ACP to ensure continuity of communications, planning, and improvement of emergency response operations in the Canal. It is intended that the assistance, which may be provided by the US agencies, will supplement activities undertaken by the ACP or by private sector response capability in support of the ACP.

CALCULATING THE BENEFITS OF US LNG EXPORTS

The US Coast Guard's Liquefied Gas Carrier National Center of Expertise Summer 2019 Newsletter, Issue 7 states that over the past 10 years the liquefied gas industry has continued its growth and impact on ports throughout the country. There are now eight LNG export terminals either under construction or in operation. Additionally, there are nine US Flagged LNG fueled vessels operating in the US

According to an American Petroleum Institute (API) report, "The Expanded Panamá Canal opened in 2016. Makes US LNG more cost competitive in Asia due to lower shipping costs." Additionally, the report goes on to acknowledge that the expanded Panamá Canal will increase the world gas market size; make LNG more competitive with pipelined gas and other fuels; improve US competitiveness; and reduce the world LNG price.

A 2018 report by Texans for Natural Gas quantifies the economic benefits of LNG export activity – in direct investment and jobs and generated tax revenue – for the state and the country as well. Expansion of the Freeport LNG export terminal is expected to employ more than 3,500 workers during the four- to five-year construction phase, the report says. It is estimated the project will generate between $5.1 billion and $7.4 billion in economic benefits per year. That is just one project. The report points out "Nationally, Texas LNG export facilities could create more than 136,000 jobs, with an economic impact of more than $145 billion."

LNG Allies released an updated report that summarizes the potential for significant economic benefits and job growth from the US LNG industry. The report, conducted by ICF Inc., used the most current US Energy Information Administration (EIA) data based on three

cases in their 2018 Annual Energy Outlook (AEO) released in Feb. 2018. The three cases include the Reference Case, the High Oil & Gas Case, and the High Oil Price Case.

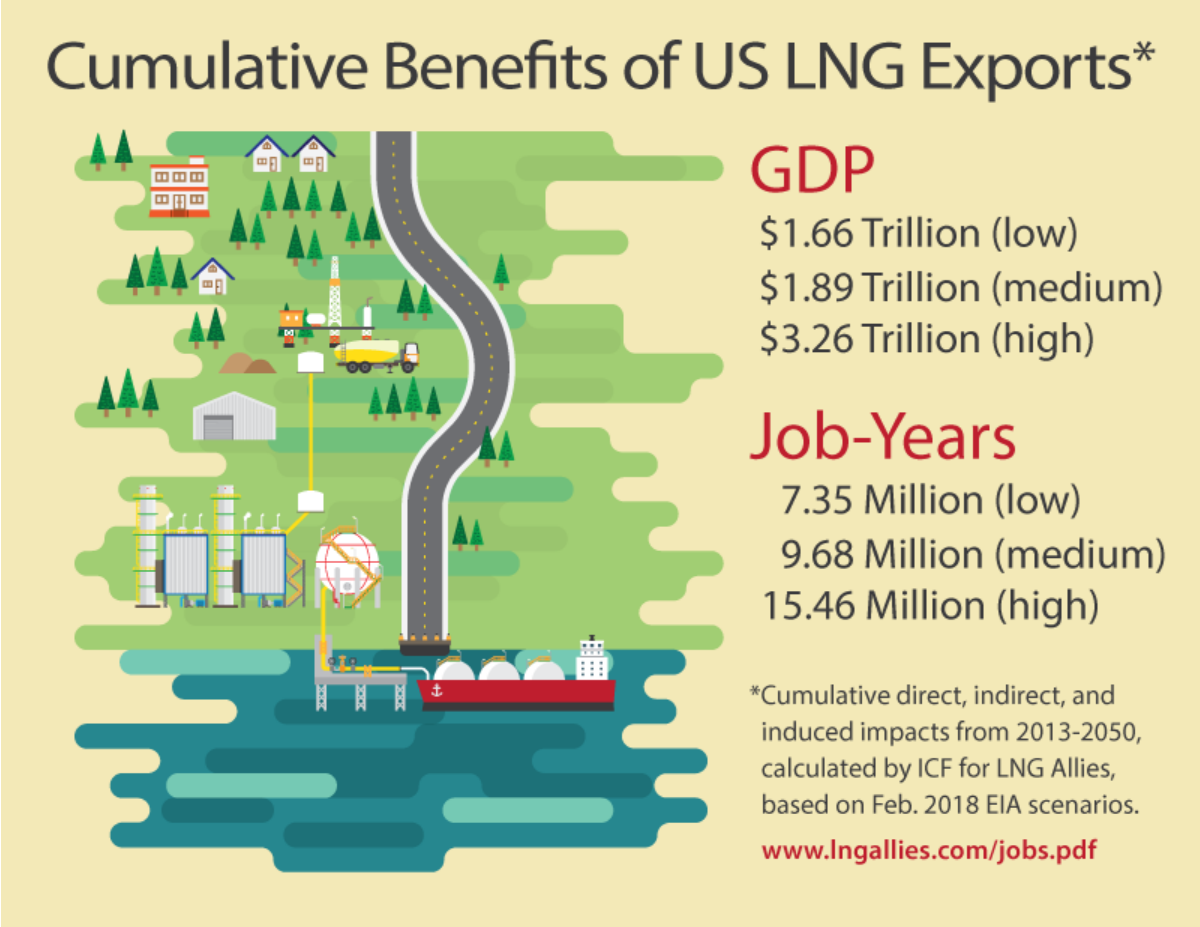

Figure 4. Infographic on LNG economic impacts. (Credit: LNG Allies)

Key findings from the new ICF study include the direct, indirect, and induced value added from 2013 to 2050 for the three AEO 2018 cases:

- The cumulative economic impact from LNG plants will range from $716 billion to $1.267 trillion.
- LNG plants would support 2 million to 3.9 million job-years.

- Considering the whole value chain (LNG and natural gas supply) the cumulative economic benefits from US LNG exports would range from $1.664 trillion to $3.255 trillion and 7.346 to 15.459 million job-years.

"US LNG exports are driving the transformation of the international gas trade to an increasingly well-connected global market," said LNG Allies President & CEO Fred H. Hutchison. He added, "This updated report shows LNG exports also provide important economic benefits to the United States, by stimulating job creation, increased economic activity, and tax revenues."

NRT-ACP SUBCOMMITTEE ACTIVITIES RELATED TO LNG

The NRT-ACP Subcommittee membership consists of involved NRT agencies and the ACP. Members include representatives from the USCG, EPA, National Oceanic and Atmospheric Administration (NOAA), Navy Supervisor of Salvage (SupSalv), DOS, the US Embassy in Panamá, and the ACP represented by the Unidad de Planificación, Preparación y Respuesta. The responsibilities of the Subcommittee mainly reflect the engagement outlined in the MOA. The Subcommittee plans the annual exercises, maintains the Incident Response Guide, participates in training activities, and handles requests for assistance. Additionally, the Subcommittee facilitates the execution of Incident Specific Agreements (ISA) for training, exercises, or actual pollution incident support.

While the expansion project was underway, the ACP approached the NRT-ACP Subcommittee requesting aid in educating Canal personnel on transporting LNG through the canal area of responsibility.

Through a series of seminars, workshops, site surveys, group discussions, and exercises jointly coordinated between the NRT-ACP Subcommittee, the ACP was prepared to safely handle the transit of LNG vessels upon opening the new expanded lock system. Originally, LNG vessel traffic was restricted to daylight operations and one-way traffic. On 28 June 2018, after two years of operations without incident, the ACP announced that it was prepared to double the LNG transit capacity (see press release at end of document). This decision is directly related to the preparatory efforts conducted by the NRT-ACP Subcommittee activities.

SUMMARY OF ACTIVITIES AND CHRONOLOGY

2011 Workshop for LNG

Initiating in 2011, the ACP and NRT organized a workshop to evaluate the considerations needed to transit LNG through the expanded Canal.

The workshop invited NOAA, Department of Energy (DOE), academics and USCG experts and was scheduled on November 16-17, 2011. It addressed the following topics:

- International LNG Industry Overview through a discussion on LNG production, shipment & consumption worldwide;
- Recent, important government and private studies, including the overview of Sandia and Lloyd's studies;
- New US planning requirements for LNG Vessel Salvage & Marine Firefighting Plans;
- Computer based modeling of different LNG incidents; and
- Worker health and safety precautions during LNG incident response.

2015 NRT visit to Panamá Canal

In 2015, ACP requested NRT representatives review the implications of LNG carrier transits through the Panamá Canal with considerations for safety, security, emergency preparedness and environmental impacts.

From May 26 to 28, 2015, the US delegation, which consisted of representatives from the USCG Liquefied Gas Carrier National Center of Excellence (LGC NCOE), USCG HQ Security Office, and NOAA SSC, met in Panamá City to visit the new expanded locks and review the capabilities of the ACP to handle LNG vessels once the expansion was complete.

The team was provided access to many aspects of the Canal, its resources and personnel which allowed a complete understanding of what a full transit of the Canal entails, from arrival to departure, including anchorage, the approaches, and passage through the new and old locks and various cuts in the Canal. In addition, the team witnessed support and response resources to include the Marine Traffic Control Center, Emergency Management Center, Canal Protection Boats, and Canal Tugs. During the two-day review period, the team focused on the ability of the ACP to ensure safety, security, and environmental protection and compared what they saw to measures employed in the United States for LNG transits.

The United States delegation's observations and conclusions were shared with the Administrator and his staff and discussed:

- Potential need for contingency and safety/security management plans.
- Potential need for providing training & exercises
- Potential need to address measures to prevent damage from a fire in the approach to the locks

- Potential need to identify lock gate and lock wall material strength in high/low temperatures
- Potential need for public outreach and development of public affairs plan

In conclusion, after a brief but thorough visit, the team agreed that the ACP has sufficient measures already in place to ensure safe, secure, and clean transport of LNG through the Canal.

Visit to USA LNG Terminals

Continuing with the LNG transport and emergency planning process, the Unites States Coast Guard's LGC NCOE coordinated a reciprocal visit through the auspices of the NRT-ACP Subcommittee for two representatives of the ACP. The LGC NCOE was established in 2009 and the scope of its expertise includes: foreign and domestic flagged vessels and barges that carry liquefied gases in bulk, commercial ships that utilize LNG as a fuel, and the safety and engineering systems associated with LNG/LPG storage facilities. This follow-on visit was held June 1st-5th, 2015, and included visits to the USCG LGC NCOE in Port Arthur, TX, USCG Headquarters in Washington, DC, and LNG facilities and USCG Sector offices in Port Arthur, TX, Baltimore, MD, and Boston, MA. The mission of this trip was for the ACP to gain further understanding of how LNG is handled differently in various US ports.

The ACP exposure to US terminal operations helped defining various criteria and best practices in security, protection and emergency response that the Canal can subsequently implement for the expanded Canal. In addition, it identified the most important emergency scenarios for which the ACP developed the appropriate response strategies. In the security and health aspect, the ACP team was able to collect information from US experts to define the inspection criteria that apply to LNG vessels while transiting the Canal.

Additionally, this experience allowed ACP to better grasp the United States requirements for the establishment and operation of LNG terminals. The information obtained supported the current ACP requirements for the terminals that operate within its jurisdiction, and was used to further support national requirements.

2015 Invitation to the Liquefied Gas Senior Executive Forum

In 2015, the USCG invited the ACP to participate in the Natural Gas Forum for Senior Executives organized by the USCG LGC NCOE. It aimed to prepare key personnel within several institutions and agencies in safety, protection and emergency preparedness for the liquefied gas industry, with emphasis on LNG. The benefits for the ACP were:

- Finalized details with the USCG LGC NCOE concerning the course for inspectors to be held in Panamá from January 20-22, 2016.
- Obtained detailed information to develop fire and vapor control strategies in the locks.
- Obtained information for inclusion in the Canal's LNG contingency plan.

After all the above activities, the result was a mutually beneficial exchange between the NRT and the ACP.

Training

The NRT, through the USCG LGC NCOE, have maintained support with training and advice during all these years.

The LNG Inspector Training has been delivered in Panamá four times (January 2016, November 2016, January 2018 and May 2019). The training covered >100 ACP personnel

including Canal port captains, tug captains, firefighters, boarding officers, contingency planning specialists, and safety officers.

After further advice and contacts provided by NRT, ACP was able to contract several training sessions on LNG marine firefighting. In 2015, following a NRT recommendation, ACP contracted private training services of a reputable provider to train 80 firefighters on LNG and LPG response in the marine environment. Two years later, the same company provided marine firefighting training for additional ACP firefighters.

Exercises

Since 2016 the NRT-ACP exercises (known as EcoCanal) have included LNG components in their scenarios, as the current significant transiting commodity of the Canal. The 2016 EcoCanal exercise additionally involved a seminar focusing on LNG concerns. The LNG seminar included training presentations, a brief on the LNG response procedures (the newly developed component of the ACP Contingency Plan), and a facilitated discussion (workshop) of coordination protocols between the ACP and Government of Panamá agencies for a response to a LNG incident.

EcoCanal 2017 consisted of a tabletop exercise. The scenario used concerned an allision of the LNG vessel against the South approach wall of the Cocolí Lock. As a result of the hypothetical accident, the ship suffered damage to the hull and a fire in the compressor room.

EcoCanal 2018 was a functional level exercise designed to test several components of the Panamá Canal Contingency Plan, including, among others, the establishment of an Incident Management Team (IMT) to guide mitigation actions, interaction with the NRT, and validate the various guidelines and checklists established to respond to an incident of this nature. EcoCanal

2018 also included a LNG seminar to raise the participants level of knowledge on LNG. The attendees included both ACP personnel and the participants from Panamanian government agencies.

Modeling

NOAA Scientists provided training and modeling support for the Panama Canal Authority (ACP). Oceanographers Christopher Barker and Dylan Righi visited the responders at the Sección de Respuesta a Emergencias (Emergency Response Section), ACP (Panama Canal Authority) May 21-23, 2019 to provide training and support for an updated version of NOAA's General NOAA Operational Modeling Environment (GNOME) model for the Panama Canal. Following the expansion project, which involved multiple changes to the canal and its approaches (deepening, widening, and straightening), and the management of water in the canal system, previous hydrodynamic models needed updating. NOAA is working with ACP staff to update oil spill models developed before the expansion project to accommodate the changes in shoreline and water flows.

In order to improve modeling algorithms, NOAA oceanographers met with the ACP's hydrographers, meteorologists, hydrologists, and navigation support personnel to better understand the operation of water flow in the canal, and gather data necessary to calibrate the oil spill models.

In addition to gathering data, NOAA oceanographers gave lectures on oil chemistry, properties, weathering, transport and modeling to the ACP response personnel. This visit was part of the long standing relationship between the ACP, NOAA and the US Coast Guard under the MOA to support spill response preparedness in the Panama Canal.

CONCLUSIONS

While the efforts of the NRT-ACP Subcommittee are primarily focused on environmental protection issues, it can be seen from the above evidence that these same concerns may simultaneously have tremendous economic impact. The basis for the MOA between the ACP and NRT agencies was conceived over concerns for pollution events within the area of responsibility of the ACP. In keeping with the spirit of the MOA the Subcommittee has made giant strides improving the preparedness and response capabilities of the ACP. In doing so, the economic interests of the ACP, as well as the countries of Panama and the United States, have all benefited. Any impacts that may interrupt the day-to-day operations of the Panama Canal would have deleterious worldwide economic effects. Table 1 catalogs the increase in LNG vessel traffic over the years since the opening of the expanded locks.

Table 1. Summary of LNG Transits since the Expanded Canal Opening (June 26, 2016)

TRANSITS OF NEOPANAMAX LNG VESSELS IN THREE FISCAL YEARS (2016-2018)

Total of Transits	Laden Transits	Ballast Transits	From US Laden Transits	From US Total Cargo
464	281	183	232	15.5 million metric tons

TRANSITS OF NEOPANAMAX LNG VESSELS IN FISCAL YEAR 2016

Total of Transits	Laden Transits	Ballast Transits	From US Laden Transits	From US Total Cargo
15	9	6	5	308 thousand metric ton

TRANSITS OF NEOPANAMAX LNG VESSELS IN FISCAL YEAR 2017

Total of Transits	Laden Transits	Ballast Transits	From US Laden Transits
159	96	63	4.9 million metric tons

TRANSITS OF NEOPANAMAX LNG VESSELS IN FISCAL YEAR 2018

Total of Transits	Laden Transits	Ballast Transits	From US Laden Transits	From US Total Cargo
290	176	114	155	10.3 million metric tons

Source: ACP

PRESS RELEASE BY THE ACP

Panamá Canal Lifts Restrictions on LNG Transits, Offers Added Capacity to Shippers

Date: 28-JUN-2018

At the World Gas Conference in Washington, DC, the Panamá Canal Authority confirmed plans to lift self-imposed daylight and encounter restrictions to provide additional LNG transit opportunities.

June 27, 2018, Washington, DC - In anticipation of LNG transit needs, the Panamá Canal will lift self-imposed daylight and encounter restrictions on LNG vessels, Deputy Administrator Manuel E. Benitez announced today during a press briefing at the World Gas Conference in Washington, DC. The changes will go into effect October 1, 2018.

"Lifting daylight restrictions means LNG vessels will be able to transit the locks at night - as vessels in other segments currently do," explained Mr. Benitez during a presentation. "Lifting encounter restrictions means LNG vessels will be able to navigate Gatun Lake at the same time, allowing two different LNG vessels to transit the Canal the same day in two different directions. Together, these changes will provide more flexibility and time during the day to transit LNG vessels, and result in an opportunity for LNG shippers to compete for a second booking slot."

Currently, with these restrictions in place, the Panamá Canal provides one dedicated reservation slot to LNG carriers per day. This equates to seven dedicated LNG booking slots per week. This is more than the current demand from LNG shippers, who average 5.5 transits per week. In addition to the one dedicated slot, the Canal frequently works with customers to transit vessels that arrive without a prior reservation, so long as the day's vessel mix allows. The

waterway has regularly transited two LNG vessels the same direction in the same day, and demonstrated the ability to transit up to three vessels the same day in the same direction during periods of uncharacteristically high demand.

"By lifting these restrictions on October 1, the Canal will unleash even more capacity for LNG," said Silvia de Marucci, Executive Manager, Economic Analysis and Market Research Division at the conference. "In addition to the one reservation it guarantees each day, the Canal will soon offer LNG shippers, for the first time, the opportunity to compete among our wider vessel segments to book a second daily slot."

The opportunity to compete for this new, second slot has never been available to LNG shippers before. And it will be offered on top of the Canal's continued efforts to transit LNG vessels that arrive early for their reservations or without one altogether - a commitment to customer service which has been evident ever since the Expanded Canal unlocked the waterway to LNG in June 2016.

Over the past two years, the waterway has welcomed a total of 372 LNG transits. All LNG vessels that arrived with reservations were transited on time, except for one which arrived late. Of the 35 that arrived without a reservation, the Canal transited 30 of these ships the same day, and the remaining five transited with limited wait. Today, there is currently no wait for LNG vessels to transit the waterway.

The Canal's decision to lift these restrictions follows it gaining considerable experience transiting LNG vessels the past two years. It also comes at an opportune time in the market. According to the Canal, LNG transits at the waterway are expected to grow by more than 50 percent by the end of FY 2018 compared to FY 2017, for which it stands ready to receive. The

Canal currently - as it always has - provides more than enough capacity for LNG vessels and will continue to do so as demand grows.

As the trade of, and interest in, LNG continues to rise, these new measures will ensure the Canal remains one step ahead of demand and is able to offer the same service, flexibility and opportunity that it always has to keep global trade moving safely and swiftly.

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