

## Research on capacity improvement of LNG berth in ningbo port

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### Abstract

In the past few decades, LNG has played an increasingly important role in the global energy system, with increasing supply and demand. In 2018, global LNG trade grew rapidly, reaching 291 million tons, up 10.4% year-on-year. China imports 38.13 million tons of LNG, becoming the world's second largest LNG importer. With ever increasing domestic demand, increasing LNG ship to the port number, in the current navigation mode, LNG ships vulnerable to relatively strict navigable conditions roads and traffic control and not under the influence of factors such as unberthing as planned, yes LNG ship, or waiting time increases, causing the clearance delays occur. It is urgent to improve the capacity of LNG berth.

### Keywords

LNG , Mobile safety zone, The berth.

### 1. Introduction

As the import of LNG increases, the frequency of receiving and unloading LNG ships at domestic LNG terminals increases significantly. In the winter of 2018, 11~13 LNG ships should be received and discharged in a single month at the peak period of ningbo LNG terminal, and one LNG ship should be received and discharged in an average of 2~3 days. Under the circumstance that the external transport capacity of LNG receiving station meets the resource supply arrangement, the passing capacity of LNG berth becomes the key factor affecting the resource supply arrangement. Meanwhile, with the subsequent expansion projects of the receiving station coming into production, the passing capacity urgently needs to be further improved. The growth of ningbo LNG ships is shown in the figur.

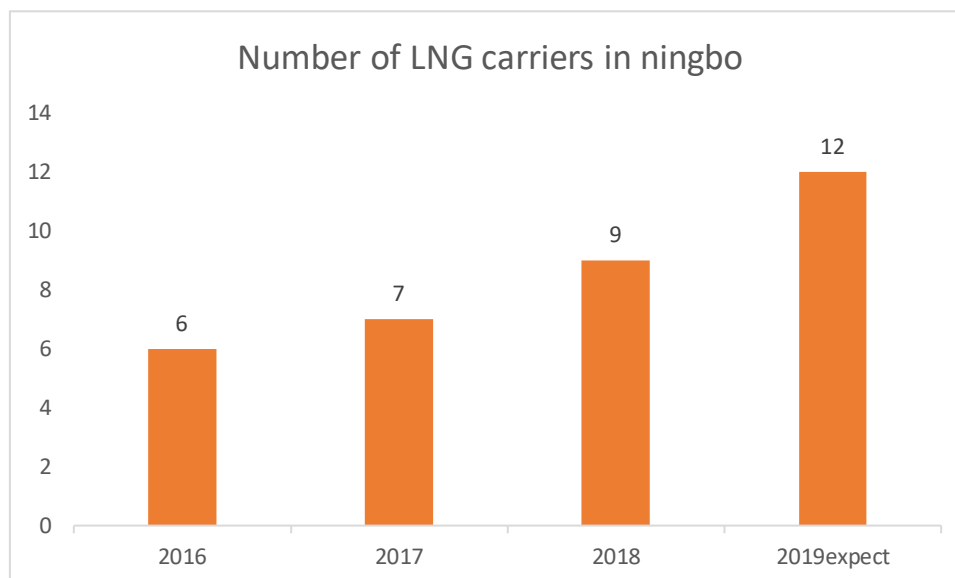


Figure. 1 changes in the number of LNG ships at ningbo LNG terminal

In the protection of LNG ship navigation safety, job security and technology is feasible under the premise of fully optimize the current LNG ship navigation limit condition and operation management mode, or shorten the LNG carrier waiting time, improve LNG berth capacity, solve ChanGong pin

storage system construction under the background of winter protection for port discharge during LNG ship quantity cannot meet the demand of problem, comprehensive promotion LNG berth capacity, fully release the potential of receiving station.

**1.1 Ningbo LNG receiving station**

Ningbo LNG terminal acceptance station is located at 29°53 'N; 122°05 'e, on the north side of the chuanshan peninsula. The inlet and outlet channels of ningbo LNG ships are public channels with a high density of navigable ships. The water depth of the channels is 22.5 meters, 38 nautical miles long and over 700 meters wide, and the water depth at the front of the terminals is 16 meters. According to statistics, considering the influence of wind, wave, fog, thunderstorm and other factors on the annual operating days of the terminal, the annual average operating days of the receiving station is 30 days

**1.2 Two-way navigation of ningbo LNG terminal**

The setting range of horizontal safe distance of LNG ships is the key factor affecting whether LNG ships can operate in both directions. For some narrow navigation channels, the entry and exit of LNG ships and other large ships can only be controlled in one direction. In terms of wide navigation channels, two-way navigation of LNG ships can be considered when the requirement of setting safe horizontal distance for LNG ships is ensured.

According to the design specifications of LNG terminals published in 2016, relevant calculation methods are proposed for the width of two-way navigable channels of LNG ships, but the calculation methods do not take into account the setting requirements of lateral safe distance. Based on the original calculation model, the optimized calculation model of two-way navigable channel width of LNG ships is proposed.

$$W=c_1+0.5(A1+A2+B1+B2)+C2+L_s$$

The formula: Width of track of LNG ship (m); A2 -- width of track where other ships will be encountered (m); B1 - ship width of LNG carrier;B2 - will meet his ship wide; C1 -- rich width (m) between LNG ship and channel bottom sideline; C2 will meet the rich width (m) between other ships and the bottom edge of the channel, Ls - the clear distance between ships. The channel is shown in figure 2

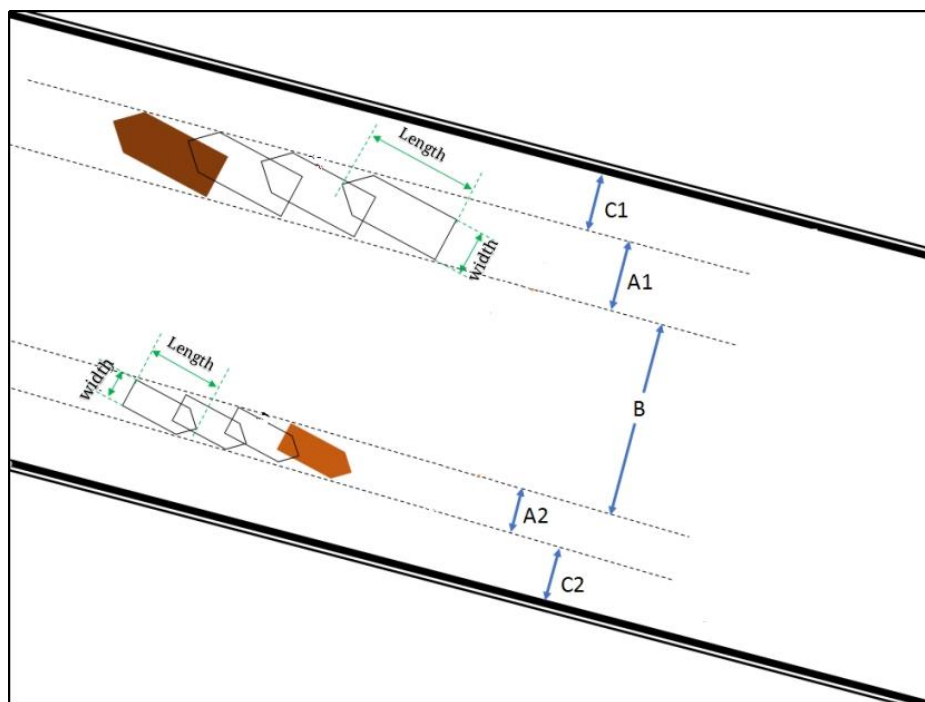


Figure. 2 Two-way intersection of LNG ships

LNG ships entering ningbo port:

Table 1 design represents ship type

Ship type	Master (m)	Ship width (m)
266,000 square meters LNG carrier	345	55
217,000 square meters LNG carrier	315	50
217,000 square meters LNG carrier	293	46

It can be calculated by taking the meeting between 266,000 square meters LNG ship and 300,000 ton oil ship

Table 2 calculation of channel width

The channel	A1 (m)	C2 (m)	A2 (m)	C2 (m)	B min (m)	B max (m)
1200m	162.0	87.0	170.2	90	60	637

The approach channel of ningbo LNG terminal is divided into four sections. Four sections, namely, the deep water channel section, the channel section, the ordinary channel section and the wharf front area, have a total length of about 30nm. Among the four segments, only the fourth segment can realize two-way traffic between 266,000 square meters LNG ships and 300,000-ton oil tankers, while the other segments cannot complete two-way traffic. However, under the condition that the cross-flow velocity is less than 0.5m/s, an LNG ship of 217,000 square meters can realize two-way navigation with a 300,000-ton tanker.

Optimization measures: reasonable lateral safe distance range of LNG ships should be set and escort ships should be strengthened, so as to relax the current one-way traffic control of LNG ships in narrow channels and reduce the adverse impact of LNG ships' entry and exit on the channels and port production and operation by fine scheduling management.

### 1.3 Emergency anchorage installation

LNG emergency anchorage is a necessary supporting facility to ensure the safety of LNG ships and terminals in emergency. The emergency anchorage should be located where LNG ships can be quickly evacuated, and the anchorage should not be too far away from the LNG terminal.

According to statistics, the anchorage conditions of LNG receiving stations in various domestic ports are not the same. Some LNG receiving stations have LNG special anchorage (dalian, tangshan, east guangdong), some have LNG emergency anchorage (tianjin, fujian, zhuhai), and some have both LNG special anchorage and LNG emergency anchorage (Shanghai, hainan).

For the LNG receiving station in ningbo port, there is no LNG emergency anchorage. During the guarantee period of winter supply, the emergency evacuation and anchorage safety of LNG ships cannot be guaranteed,

Optimization measures: for ningbo port, a receiving station with a large amount of LNG transportation, the need for emergency anchorage is more urgent. Support construction of LNG emergency anchorage should be implemented as soon as possible to ensure the anchorage safety of LNG ships in emergency state. An emergency anchorage shall be reserved for LNG ships during the winter warranty period, and the emergency anchorage requirements of LNG ships shall be given priority.

### 1.4 Optimization of inbound and outbound traffic organization based on mobile security zone

Setting up a mobile security zone for LNG ships is an effective means to ensure the safe navigation of LNG ships in and out of the port. According to the design specifications for LNG terminals

published in 2016 and the practices of typical LNG receiving stations abroad, large LNG ships can set up mobile security zones and escort ships to ensure the safe navigation of LNG ships in and out of the port. At present, the transportation modes of LNG ships entering and leaving ports at home and abroad are mainly in the form of sealing traffic management and setting up mobile security zone. The specific control methods are shown in table 3.

Table 3 domestic and foreign mobile security zone setting standards

Institution or organization	Security and mobile security area
Montreal, France	2n mile in front, 2n mile in back, and around to both sides
St. Peter's bay, California, USA	The first 0.5n mile, the second 0.25n mile, and the left and right 0.25n mile
Louisiana, USA	First 2n mile, second 1n mile, left and right to both sides
Cook island, Alaska, USA	Around 0.5 n mile
Chesapeake bay, Maryland, USA	Around 0.25 n mile
Taichung port, Taiwan	First 2n mile, second 1n mile, left and right 150m each
Meizhou bay, fujian	The first 1.5n mile, the second 0.5n mile, and the left and right 750m each
Shenzhen dapeng bay	Around 2 n mile
Ocean hill harbor	Four times the length of the ship, four times the width of the ship, and six times the width of the ship

For the sweeping closure of navigation, exclusive only allows the LNG carrier navigation mode of traffic control is beneficial to ensure the safety of LNG ship, but may cause unnecessary waste of shipping resources, sweeping closure of navigation time is longer, will affect the port of the whole operation ability, and the production of other berth operations have a negative impact.

Optimization measures: referring to the design specifications of LNG terminals and the operation and management practices of typical LNG terminals in foreign countries, there is no mandatory requirement for sealing the shipping of LNG ships. In combination with the navigation conditions of domestic LNG receiving stations and the navigation needs of LNG ships, the operation and management experience of domestic and foreign LNG receiving stations can be used for reference, and the navigation safety of LNG ships in and out of ports can be better guaranteed by reasonably setting the safe area and escorting ships.

### 1.5 Optimize the shipping arrival and departure time of ningbo LNG terminal

Reasonable arrangement of the time of entry and exit of LNG ships can ensure the timely entry and exit of LNG ships and minimize the impact of the entry and exit of LNG ships on the overall operation efficiency of the port area. Considering the strong planning of LNG transport, the arrival of LNG ships is generally on time, so there are few delays when LNG ships enter the port. However, for LNG ships leaving the port, if they cannot leave the port at the time window of 8:00 am after unloading, they will have to wait until the next morning to leave the port, resulting in long stay of LNG ships at the port and affecting the capacity of LNG berth.

Optimization measures: (1) during the guarantee period in winter, the arrival and departure time of LNG ships should be brought forward to 07:00 in the morning; Further ensure the window of departure time of LNG ships in the afternoon.

(2) Open a flexible window for LNG ships to enter and leave the port in the afternoon according to the specific operation time and schedule of LNG ships.

The arrival and departure of LNG ships will have the least impact on other ships in the port area by entering and leaving the port first or last in a day or in each dispatching batch. Combined with the existing dispatching mode in the port area, the LNG ships will be the first or last to leave the port in the afternoon. According to the port area in the afternoon the whole ship into the port scheduling batch arrangement, the first or last to enter the port.

### 1.6 Research on operation restriction conditions of LNG receiving station in ningbo port

There are strict restrictions on the berthing velocity of LNG receiving station in ningbo port. Currently, the berthing time is 0.5 hours after the zhenhai high tide and 1.5 hours after the zhenhai high tide. This method mainly considers the requirements of the flow velocity limit, and LNG ships must be berthing during the daily gentle flow period. Resulting in a significant increase in the waiting time of LNG ships.

Optimization measures: considering the geographical location of ningbo LNG receiving station, the waters at the front of the wharf are effectively covered by islands and reefs and the velocity is relatively low. In the ballast berthing state, the area affected by the flow of LNG ship decreases, and the influence of the flow decreases compared with that of the full load berthing state, so it is relatively easy to operate. Therefore, for ningbo LNG receiving station, restrictions on the ballast velocity and time window of LNG ships can be relaxed.

### 1.7 Security measures

The terminal of LNG ships in ningbo port needs to be equipped with more tugboats, and the number of tugboats assisting the operation should be increased while optimizing and relaxing the restrictions on the flow rate of LNG ships' ballast and berthing velocity and the wind conditions of entering port. In order to provide effective reference for the navigation supervision of LNG ships, it is necessary to improve the velocity measuring device, and to set up the current measuring device meeting the requirements of maritime authorities at the key position of the shirzhimen channel and the front of the terminal for monitoring the velocity of navigation channels and terminals. Strengthen the acquisition of meteorological forecast information, understand meteorological changes in advance, and take adequate safety precautions against the impact of adverse meteorological elements on navigation safety.

## 2. Conclusion

(1) The two-way navigation of LNG ships and some representative ships can be realized in the xizhi gate channel under different navigation conditions by reasonably setting the safe distance of LNG ships and carrying out fine dispatching, combining with VTS supervision and strengthening ship escort, etc.

(2) The ballast berthing of LNG ships in a wide channel can greatly relieve the navigation pressure of zhimen channel and reduce the impact on the core port area.

Accelerate the establishment of emergency anchorage for ships at ningbo LNG receiving station.

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