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LNG 2006

IMPACT OF CALLS OF LNG CARRIERS ON VESSEL TRAFFIC HANDLING IN THE PORT OF ROTTERDAM

VERSION 0.3

DELFT, 18 OCTOBER 2006

A. FRIMA

SUMMARY AND CONCLUSIONS

The study described in this report has been set up to determine the quantification of delay of non-LNG vessels, due to dedicated handling of LNG calls. The study focuses on the Port of Rotterdam, where LNG carriers call to the terminals Gate, LionGas and the 4th PET in the years 2010, 2020 and 2035. All performed studies and results are focused only on seagoing vessels.

To ensure thorough quality control, this study has been carried out under the supervision of a reference group consisting of independent consultants, the Port of Rotterdam Authority and pilot organization.

The simulation model was used as developed by TBA. Within this model, the port of Rotterdam is considered to be built up by a set of waterway sections. For each section, traffic rules exist that prohibit or allow vessels of various classes to overtake or encounter each other. Vessels navigating the waterway check their ability to sail a certain section when arriving at its boundary. Based on the vessels already navigating in the section and the enforced rules, the vessel will enter or wait until no conflicts exist. The experienced delay represents a speed reduction in the previous section. This 'local' approach is an important characteristic of the TBA model.

* *Phase 1: Validation "LNG Verkeersonderzoek 2005"*

During Phase 1 was determined whether the TBA simulation model is capable of determining the impact on traffic flow as a result of LNG calls. This validation was carried out against the background of a previous study performed in 2005 [ref1]. During this validation phase, the traffic volume for the year 2020 was used.

Based on the simulation results of the TBA model for 2020, for each passage of a LNG carrier 3 other vessels are delayed for more than 10 minutes. On average, these vessels are delayed for 34 minutes. These results are a good match to manual calculations.

The results mentioned above are significantly lower than earlier results reported by Harboursim [ref2]. This can be explained by the difference of approach of both models in modeling traffic flow. After detailed descriptions of the TBA model and subsequent assessment of its practicability for this study, it was decided to use the TBA model for phases 2 and 3.

* *Input phases 2 and 3*

During phases 2 and 3, the impact on the traffic flow was studied based on current traffic rules (version 5.2, appendix I). In this version, the current LNG safety regime is included.

Within phase 2, LNG carriers are set to use both LionGas en Gate terminals. Phase 3 also simulates LNG calls towards the 4th PET terminal. For phases 2 and 3 the model has been equipped with new modules to simulate class 6 reservations and separation distances between vessels sailing in the same direction.

* *Results 2010 phases 2 and 3*

The maximum percentual increase in mean Turn Around Time (TAT), due to LNG calls, is experienced by class 3 vessels to the Calandkanaal in phase 3 where all 3 LNG terminals are in operation. The TAT increase is 0.35%, which corresponds to an increase of the mean waiting time from 2.3 to 3 minutes.

The largest mean waiting time is experienced by class 5 vessels towards Maasvlakte I: 17.8 minutes without LNG calls up to 18.3 minutes in phase 3 where 201 LNG carriers will visit Rotterdam each year.

* *Results 2020 phases 2 and 3*

The maximum percentual increase in mean TAT, due to LNG calls, is experienced by class 3 vessels to the Calandkanaal in phase 3 where all 3 LNG terminals are considered. The increase is 0.55%, which corresponds to an increase of the mean waiting time from 2.3 to 3.8 minutes.

The largest mean waiting time is experienced by class 5 vessels towards Maasvlakte I: 15.5 minutes without LNG calls up to 16.6 minutes in phase 3 where 363 LNG carriers will visit Rotterdam each year.

* *Results 2035 phases 2 and 3*

The maximum percentual increase in mean TAT, due to LNG calls, is experienced by class 3 vessels to the Calandkanaal in phase 3 where all 3 LNG terminals are considered. The increase is 0.75%, which corresponds to an increase of the mean waiting time from 2.2 to 4.1 minutes.

The largest mean waiting time is experienced by class 5 vessels towards Maasvlakte I: 17.6 minutes without LNG calls up to 19.2 minutes in phase 3 where 445 LNG carriers visit Rotterdam each year.

The relative small impact caused by LNG calls can be explained by two main reasons:

- Relative small number of LNG calls

For the various scenarios simulated in this study, the number of LNG carriers that visits the port of Rotterdam varies from 0.4 to 1.2 per day versus 120 to 175 non-LNG carriers. This ratio is indicative for the fact that a large number of vessels will sail without experiencing direct or indirect impact of LNG carriers.

- **Lenient traffic user rules**

When regarding the enforced traffic user rules for the encounters between LNG carriers and non-LNG carriers, it can be seen that only some of the sections sailed by LNG carriers prohibit the encounters with other vessels. Especially classes 4, 5 and 6 are not allowed to encounter LNG carriers in various sections, as indicated within the figure below.

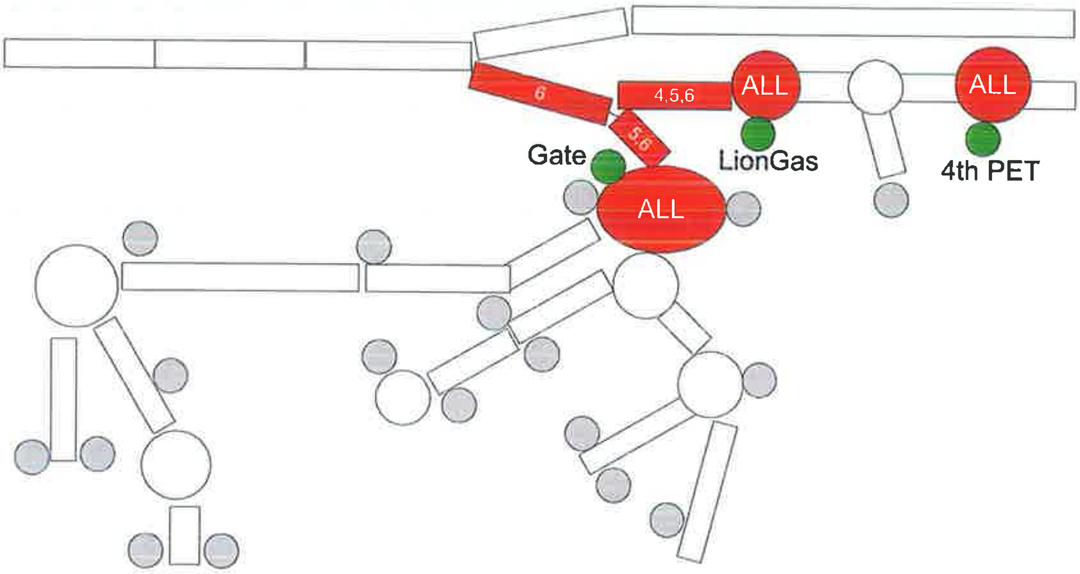

Figure 11 (Chapter 2) Indication of rules set for encounters with LNG carriers

* *Animation*

During this study, an animation was created that demonstrates the different rules and principles as they exist within the TBA simulation model.

LIST OF DEFINITIONS AND ABBREVIATIONS

* *LNG*

Liquefied natural gas.

* *Turn Around Time (TAT):*

The time spent by a vessel sailing. Mooring activities at the quay are included, as is the turning in designated areas. TAT does not include the time a vessel is moored at the quay, nor does it include anchorage time. Waiting time is part of the Turn Around Time.

* *Direct waiting time*

Waiting time experienced by vessels in order to avoid an encounter in opposite direction with a LNG carrier within a waterway section where it is prohibited.

* *Indirect waiting time*

Additional waiting time experienced by vessels caused by the presence of LNG carriers, without direct waiting times.

* *Total impact LNG calls*

Total increase of TAT experienced by vessels as a result of the calls of LNG carriers.

* *Time Around Reservation (TAR)*

Additional time set around the reservations of sections made by LNG carriers. This extra time allows unforeseen small delays of other vessels not to cause prohibited meetings with LNG carriers. TAR is used within the simulation model of TBA and explained in detail in section 1.5.

* *Turn (in dutch 'zwaaien')*

Turning of a vessel in a designated area before or after visiting a terminal.

* *Service time*

The time a vessel is moored at a quay to unload and load. This service time is not part of the Turn Around Time of a vessel.

* *Cross route and crossing vessels*

These terms are used to indicate the situation where vessels are sailing crossing trajectories.

TBA

LIST OF REFERENCES

- Ref 1 : LNG Verkeersonderzoek 2005, HbR/SIMZ, Dhr. R. Seignette, 14 februari 2006
- Ref 2 : Simulatiestudie Vaartijden MV1 en MV2 met beinvloeding door LNG-carriers, dhr. Ir. R. Groenveld, januari 2006.
- Ref 3 : Analyse Turn Around Tijden MV1 en MV2 v. 0.3, TBA, januari 2006

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APPENDICES

SCOPE AND INTRODUCTION

In 2005 a study was performed to determine the impact of possible LNG calls on a fluent and safe traffic flow within the port of Rotterdam. Through track-time diagrams, VTS simulator runs and simulations with the model Harboursim the expected delays of traffic flow were determined. The outcomes of both methods differ significantly and are considered indicative for upper (Harboursim) and lower boundary (track-time diagrams) of expected delays.

Based on a request by Havenbedrijf Rotterdam (HbR), end of 2005, TBA has developed a simulation model. This model was used to determine the impact of traffic increase on the Turn Around Time of vessels towards Maasvlaktes I en 2. During this research, the LNG terminals LionGas, Gate and 4th PET and the LNG carriers towards these terminals were not taken into account.

HbR issued the request to perform an additional simulation study to determine the impact of LNG calls to the 3 LNG terminals as considered.

The executed phases, from which results are described in this reports, are threesome:

1. Phase I: Validation "LNG Verkeersonderzoek 2005" [ref1]

Phase 1 was set up with 2 objectives. The first consisted of determining the impact of LNG calls based on the model of TBA, in perspective of [ref1]. In addition, this phase was used to determine whether the TBA model could accommodate possible strategic measures to optimize traffic flow over a period of several days.

2. Phase 2: Impact LNG calls to LionGas and Gate

During phase 2 the impact of LNG calls to the terminals of LionGas and Gate was determined for the traffic volumes of 2010, 2020 and 2035. The model, as developed during phase 1, was used. The input parameters were adjusted to meet the conditions set by the Port of Rotterdam LNG project.

3. Phase 3: Impact LNG calls to LionGas, Gate and the 4th PET

Phase 3 was used to determine the impact of LNG calls to LionGas, Gate and the 4th PET terminal for the traffic size of 2010, 2020 and 2035. The model developed during phase 1 was used.

All performed studies and results are focused on seagoing vessels. Inland vessels and their behaviour within the port of Rotterdam are outside the scope of this study.

1 PHASE 1: VALIDATION LNG VERKEERSONDERZOEK 2005

1.1 Introduction

In 2005 a study was performed towards the impact of possible LNG calls on a fluent and safe traffic flow within the port of Rotterdam. Through simulations with the model Harboursim and track-time diagrams the expected delays of traffic flow were determined. The outcomes of both methods differ and are considered indicative for upper (Harboursim) and lower boundary (track-time diagrams) of expected delays.

1.2 Objective

Phase 1 was set-up with two objectives.

At first, phase 1 was carried out to validate and adapt the existing TBA model in reference to prior studies [ref1]. 2020 was used as year of reference. The port layout within the model was altered to facilitate the handling of LNG carriers at LionGas and Gate. Based on the results, the capability of the model to determine the impact of LNG calls was discussed and determined with the various parties involved.

A second objective within phase 1 was to determine whether the TBA model is able to simulate strategic measures carried out by traffic management in order to achieve a fluent handling of vessels over a period of several days.

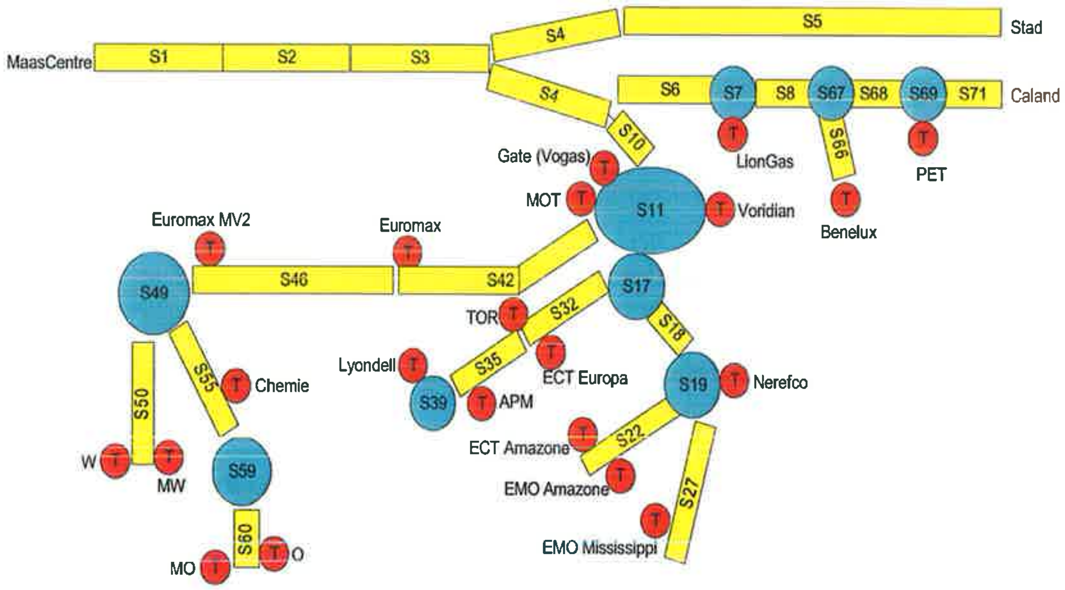


Figure 1 Fairway configuration

1.3 Approach

For answering the objective, the simulation model of TBA is used as developed during a prior study [ref3]. Within this model the port of Rotterdam is considered to be built up by a set of waterway sections, figure 1. For each section, traffic rules exist that prohibit or allow vessels of various classes to overtake or encounter each other. Vessels navigating the waterway check their ability to sail a certain section when arriving at its boundary. Based on the vessels already in the section and the enforced rules, the vessel will enter of wait until no conflicts exist. The experienced delay represents a speed reduction in the previous section. This 'local' approach is an important characteristic of the TBA model.

For phase 1, the model is equipped with extra sections and terminals. In addition, the model has been modified to accommodate reservations by LNG carriers in order to ensure their undelayed passage. Also manual calculations were carried out to create indicative values for the impact of LNG calls on other traffic.

Throughout this study, TBA has worked in close contact with a reference group existing of experts and independent consultants. This group has reviewed all presented results and has been involved in the validation of the simulation model.

To validate the model, the set of traffic user rules, turning times en vessel speeds were used from earlier studies. Table 1 shows the vessels classes used within this study.

Class	Length (m)	Draught (m)
1	< 120	
2	120 - 200	
3	200 - 300	
4	> 300	< 14,3
5 (semi-geulers)	> 300	14,3 - 17,4
6 (geulers)	> 300	> 17,4
7 (LNG carriers)	max. 315	max. 13
8 RoRo	max. 215	max. 7

Table 1 Vessel classification

Class 8 represents the RoRo vessels. Since rules and velocities are similar to class 2, RoRo vessels are treated as class 2 vessels. This results in the model using 7 classes. However, RoRo vessels are set to use their own generators.

1.4 Manual calculations

As indicated, manual calculations are also used during validation. The calculations were carried out to determine indicative values for the impact of LNG calls. This section describes the method behind the manual calculations. A simplified example is used. Results are presented in section 1.8. Note that the method is purely based on encounters in opposite direction.

Figure 2 Diagram manual calculation

* *Example*

Within the example in figure 2, it is prohibited for a class 4 vessel to encounter a LNG carrier in opposite direction in section 4. A LNG carrier travels this section for 30 minutes, the class 4 vessel for 20 minutes. The LNG carrier arrives at t at the left side of the section. To allow uncompromised passage, from t-20 minutes no class 4 vessels may have entered the section. In addition, no class 4 vessels can enter between t and t+30. Through summation, the LNG carrier closes the section for a window of 50 (=20+30) minutes for class 4 vessels in opposite direction. To determine how many class 4 vessels are delayed by the passage of the LNG carrier, the amount of class 4 vessels arriving by the hour is used. If each day 45 vessels arrive of class 4, then 1.56 vessels are 'caught' by the LNG window per day (=(45/24)*(50/60).

1.5 Simulation of LNG calls

The existing TBA model is used. This model is described in [ref3]. This section indicates what alterations were made within the model to imitate LNG calls and their impact.

LNG carriers are set to sail between 0.00 and 4:00 hours (LNG window). When a LNG carrier arrives or departs, all other vessels are to adapt their passage time in order to facilitate undelayed passage of the LNG carrier. Therefore, LNG carriers make reservations at the sections that they will sail for the time they will be sailed. The time a LNG carrier will reserve a section is increased by an extra margin, called Time Around Reservation (TAR). This is done in order to create an extra space for non-LNG carriers to be able to experience small unforeseen delays without causing conflicts with LNG carriers. The usage of TAR within the model of TBA is further explained within Appendix J

Non-LNG carriers will check, before arriving from sea or departing at a terminal, if sections are reserved by LNG carriers for the time they expect to travel them. When so, and rules prohibit the encounter, the vessel will wait either at Maascentre or at its terminal until no conflicts will occur. It should be noted that this approach differs from the 'local' check as normally performed by vessels when entering a waterway section. Delay times caused by LNG carriers are experienced either at Maascentre or at a terminal.

When a vessel at Maascentre or at a terminal is waiting to avoid a prohibited encounter with a LNG carrier, this waiting time is registered as direct waiting time. Vessels that are delayed directly can cause delay time to other vessels. These vessels are indirectly influenced by the presence of a LNG carrier. This delay is called indirect waiting time.

RoRo vessels are scheduled to travel outside the LNG window with an extra margin. Between 22:00 and 5:00 o'clock, no RoRo vessels arrive or depart.

1.6 Traffic user rules and conditions

* *Traffic user rules/ input*

The traffic user rules used during phase 1 are noted in appendix H, version 4.4. Service times, the amount of ships, turn-parameters and speeds are noted in respectively in appendix C, D, E, and F.

* *Conditions*

The following principles and conditions are used within phase 1:

- LNG carriers pass through the port during LNG windows. These windows are set from 0:00 tot 4:00 o'clock.
- RoRo vessels are set to travel outside the 22:00 to 5:00 o'clock window, in order to avoid encounters with LNG carriers.
- Between two LNG carriers sailing in opposite direction a separation time of 45 minutes is used in order to create a safety area between two LNG carriers. When a departing LNG carrier passes Maascentre, an arriving LNG carrier is allowed to enter after 45 minutes. This means that outgoing LNG carriers will travel before the arrival of inbound LNG carriers. This condition will be removed for phases 2 and 3 because new insights have shown that the prescribed safety area is not required.
- Tidal windows are not set within the model.
- The impact of meteorological conditions is not simulated within the model (wind, waves etc.).
- Departing vessels (leaving terminal) have right of way over incoming vessels. Geulers (class 6) have right of way over other vessels.

- Mooring activities are not simulated within the model. For correct comparison, mooring times are added to the TAT. Note, in the previous study of TBA ([Ref 3]) mooring times were not added to the TAT.
- Vessels that are not allowed to overtake, will sail behind each other and if necessary reduce speed. Within the model used during phase 1, no separation distance between vessels is used. For phases 2 and 3, this separation distance will be implemented as is described later in this report.

1.7 Scenarios

The following 2 scenarios for year 2020 were simulated during phase 1.

- No LNG calls to the port of Rotterdam
- 242 LNG calls to the Gate and LionGas terminals per year

1.8 Results

The results from phase 1 are split into two separate parts. The first part focuses on the direct delay time experienced by vessels due to LNG carriers. The second part relates to the total impact of LNG passages, both direct and indirectly. Note that a LNG "passage" refers to a single movement either inbound or outbound.

* *Direct impact by LNG carriers*

Direct delay evolves when a non-LNG carrier waits in order to avoid a forbidden encounter with a LNG carrier in a specific section. The direct impact of a LNG passage is determined through simulation and manual calculation. Table 2 shows the results of both methods. The results of Track-Time analysis [ref1] are also noted in the table. Track-time analyses are also focused on direct impact.

As can be concluded from table 2, the three methods come round to the same amount of vessels directly delayed by a LNG passage (3 to 3.5). The average impact for a delayed vessel is about 25 minutes.

Note that the simulation results indicate the direct impact of LNG calls on other vessels. Indirect impact of LNG calls, both negative and positive, are not considered within these results. These results are based on the traffic user rules as used in prior studies [ref2]. The results of phases 2 and 3, as described in the following chapters, are based on more lenient rules towards LNG passages and should therefore not be compared to the results presented above. Also the results of phases 2 and 3 indicate indirect impact, which is not included in table 2.

For 1 LNG passage		Track Time diagram	Manual calculation	Simulation TBA
TOTAL	# Influenced vessels	3,5	3,2	3,2
	Impact per vessel (min)	25,5		25,2
LionGas				
Inc. LNG	# Influenced vessels	4	3,2	3
	Impact per vessel (min)	28,12		26,6
Outg. LNG	# Influenced vessels	2	3,1	2,8
	Impact per vessel (min)	13,7		23,8
Gate				
Inc. LNG	# Influenced vessels	5	3,8	4
	Impact per vessel (min)	31,4		30,1
Outg. LNG	# Influenced vessels	3	2,7	2,8
	Impact per vessel (min)	20,2		17,9

Table 2 Direct impact of LNG passage

* ***Total impact LNG carriers (direct + indirect)***

The total delay caused by LNG carriers is determined with the TBA simulation model. The model reports all delays caused by the presence of LNG carriers. On occasion, vessels experience a positive impact on their Turn Around Time. For instance, a LNG carrier might have "cleared path" for another vessel, decreasing its TAT. Therefore, the results in table 3 show both negative and positive influenced vessels. The results are obtained by simulation of 2 identical sets of vessels and the recording of any deviation of Waiting Times. As reference, the results from Harboursim are noted in the right column [ref2]. Harboursim only records vessels with an increased Waiting Time.

	Simulation TBA				Harboursim
	>0 minutes		>10 minutes		> 10 minutes
Positive/negative	Negative	Positive	Negative	Positive	Negative
# Influenced vessels	4,8	1,2	3,1	0,3	12
Mean Impact per vessel [minutes]	23,5	8,3	33,9	22,1	53,7

Table 3 Total impact per LNG passage 2020

From table 3 can be seen how both simulation models come to different results (3.1 vs. 12). In addition, the size of impact differs significantly (33.9 vs. 53.7 minutes). Section 1.9 will go into these differences. The following histogram shows the amount of vessels that, within one year, experience a deviating waiting time due to LNG calls. The red bars indicate vessels with an increased WT. The green bars indicate the number of vessel with a reduced WT.

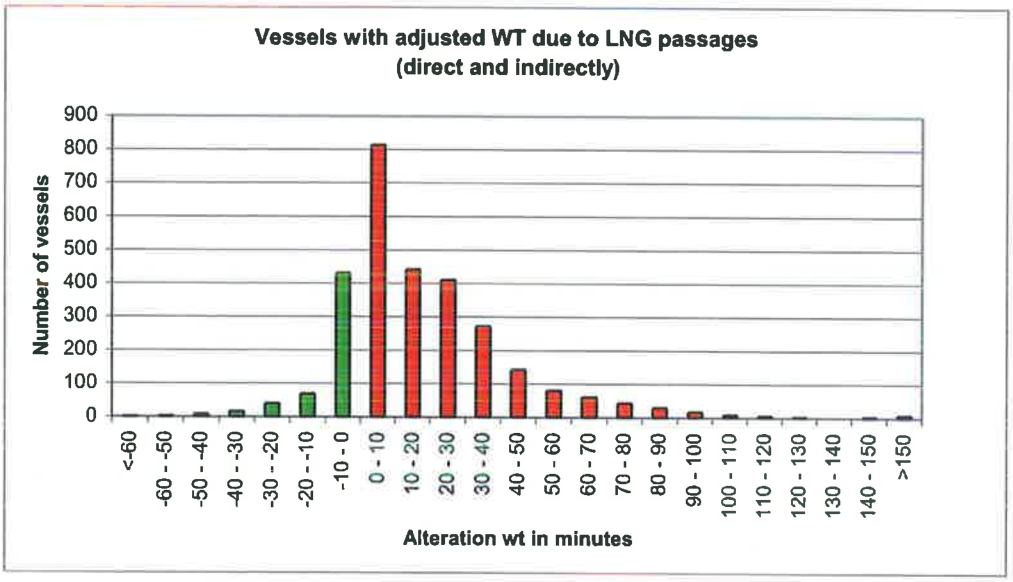


Figure 3 Impact histogram vessels with altered WT

From the histogram can be read that individual changes of the WT are commonly less than 60 minutes. On exceptional occasions, vessels experience an increase of WT over 150 minutes.

* *Impact LNG carriers on Turn Around Times*

The following graphs show the change of the average TAT, waiting time included, for vessels towards a certain destination caused by LNG calls. In addition, the change of TAT as reported by Harboursim [ref2] is noted.

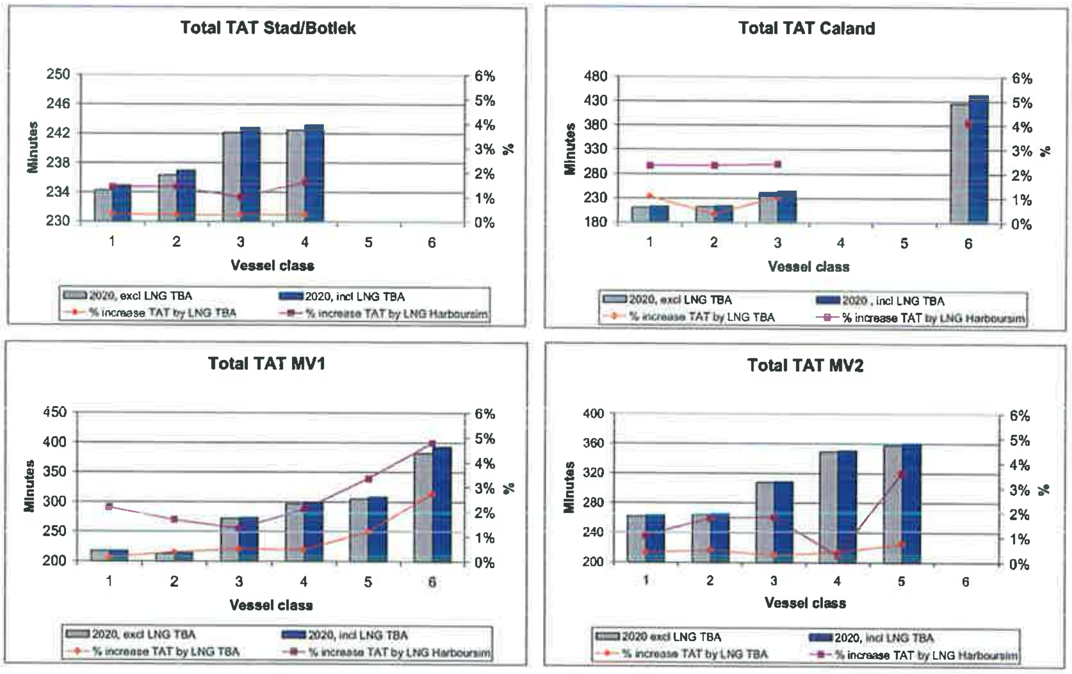


Figure 4 Total impact LNG calls 2020: TBA and Harboursim

The increase of TAT due to LNG calls for classes 1 to 5 are limited up to 2% for all destinations. These values vary from 1 to 4% within Harboursim.

1.9 Review results

The results as reported by the TBA model differ significantly from the results from Harboursim. Where TBA simulation shows that for each LNG passage approximately 3 other vessels are delayed, Harboursim indicates 12 delayed vessels. The average delay time from Harboursim is 53 minutes versus 34 minutes recorded by TBA.

The difference between the results of both models can be explained by three fundamental differences between the modeling approaches, as described below.

* *Route check*

One difference is situated in the principle of checking sailing routes and the existing traffic user rules. Within Harboursim, vessels check on arrival at the first section or departure at the terminal their ability to sail their full track without conflicts. The vessel is only allowed to start her trip when its complete track can be sailed without forbidden encounters with other vessels. When this check is performed and a vessel is not allowed to depart, it waits a certain amount of time before her ability to sail is checked again.

The TBA model approaches the route check from a different perspective. Instead of checking the complete route, each vessel only checks whether he is allowed to sail the next waterway section, based on the traffic user rules, instead of its entire route. When it is not allowed to sail its next section, it waits a certain time representing a reduced speed within its previous section.

This last method, where vessels only check their local ability to sail, creates a less rigid situation as opposed to the method within Harboursim. A more detailed description of the TBA model can be found in [ref3].

* *Route check interval*

For waiting vessels, Harboursim checks the ability to depart every two minutes. If a vessel can't sail because the check detects a conflict, then the vessel has to wait. Two minutes later the same check is performed. In the TBA model a vessel performs a local check to sail its next section. When a vessel is not allowed to travel the next section he will perform the check again when the signal arrives that the contents of the waterway section has been changed. In other words, the recheck is linked to the status of the section and therefore responds immediately to any changes possibly creating the possibility to sail.

* *Number of vessels with an altered WT and therefore altered TAT*

On arrival or departure of a vessel, Harboursim checks the entire route of the vessel for possible conflicts. When a vessel encounters a delay, the vessel has to wait until the entire route is free of conflicts. A consequence is that the vessel sails its entire route at a different time encountering "new situations" at its entire track. The TBA model performs this check per section. If a vessel encounters an indirect delay in a section, it will wait at the beginning of the section. As a result, only the remaining part of the route will be sailed on a different time. The chance that a delayed vessel disturbs the sailing of other vessels is therefore smaller in the TBA model then in Harboursim. Hence, a smaller number of vessels experience an altered WT (and TAT).

The differences mentioned above explain that more vessels are influenced by LNG-carriers in Harboursim then in the TBA model.

1.10 Conclusions

Based upon the similarities of the results from the manual calculations and the simulation results, as well as the considered differences between Harboursim and the TBA model, it can be concluded that the TBA model is capable of simulating the impact of the LNG-calls correctly.

The next section will briefly go into the second objective of phase 1: the determination of the possibility to equip the TBA model with a module to create strategic traffic management.

1.11 Implementation of strategic traffic management

The second objective for phase 1 was to determine whether the TBA model could be equipped with additional modules to simulate strategic traffic management. Strategic measures are measures to plan arrivals or departures of non-LNG carriers in advance and to coordinate smooth traffic flow.

During phase 1 it became clear that the TBA model at present is not equipped to simulate strategic traffic management. To implement a planning module within the model that is able to optimize the traffic flow and port planning is beyond the scope of this project. The model has been set-up as an operational model with various tactical modules.

Further discussion on the subject of implementing strategic traffic management into the model should be held when simulations indicate that certain vessels, sorted by class or destination, experience unacceptable waiting times that in reality would be avoided by strategic measures.

2 Phases 2&3: LNG calls LionGas, Gate, 4th PET

2.1 Introduction

During phases 2 and 3, the impact on the traffic flow in the port of Rotterdam was determined as a result of LNG calls towards the LionGas and Gate terminals for phase 2 as well as LNG calls towards LionGas, Gate and 4th PET for phase 3.

In addition, during these phases several specific requirements for the simulation model were formulated and implemented.

2.2 Objective

The objective of phase 2 is to determine the impact of LNG calls towards the Gate en LionGas terminals on other traffic. Within the simulation for phase 3, LNG carriers towards the 4th PET terminal are also added. Both phases are simulated with the amount of vessels for 2010, 2020 and 2035.

2.3 Traffic user rules and conditions

* *Traffic user rules*

The traffic user rules used for phases 2 and 3 are based on the most recent insight provided by the Port of Rotterdam Authority. The set of rules is referred to as version 5.2 and can be found in Appendix I. A remark should be made on the subject of the rules for LNG carriers. The traffic user rules of version 5.2 based on insight as they exist June 2006, are more lenient than the rules used in prior studies.

* *Explicit rules sections 6 and 10 for vessels on crossing trajectories*

In addition to the rules described above, the model has been equipped to avoid crossings between LNG carriers and non-LNG carriers within the sections 6 and 10. The rules from table 4 are applied. The location of both sections can be found in figure 1 within paragraph 1.2.

LNG situation	Prescribed rules
Incoming LNG carrier through section 6 to LionGas or 4th PET	• Outgoing vessels through section 10 are prohibited. • Incoming vessels trough section 10 are allowed.
Incoming LNG carrier through section 10 to Gate	• Outgoing vessels through section 6 are prohibited. • Incoming vessels trough section 6 are allowed.
Outgoing LNG carrier through section 6 to Maascentre	• Outgoing vessels through section 10 are prohibited. • Incoming vessels through section 10 are prohibited.

Table 4 Rules for angle-encounters sections 6 and 10

* *Conditions*

The conditions and principles described in section 1.6 still stand for phases 2 and 3 with the exception of the following:

- A separation time of 45 minutes at Maascentre between outgoing and incoming LNG carriers is not applied anymore. This is in accordance with the enforced traffic user rules.
- Opposite to phase 1, within phases 2 and 3 vessels sailing in the same direction, that are not allowed to overtake, maintain a prescribed separation distance. This module and its impact is explained in section 2.4.
- Class 6 vessels create reservations in the same manner as the LNG carriers, as explained in section 1.5.
- No wind and tidal conditions are included.

2.4 Separation distance between vessels

In phases 2 and 3, vessels are set to keep a safety distance to other vessels, therefore a separation time is introduced. The separation time depends on the type of the last vessel and section. Separation time only applies when vessels aren't allowed to overtake each other. The separation time is modeled in the following manner:

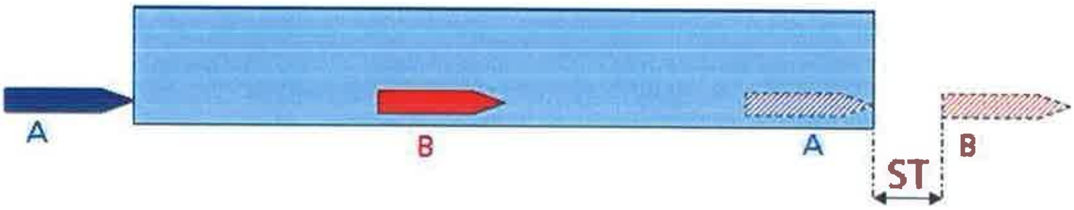


Figure 5 Separation module TBA model

When vessel A arrives at the section, it spots the presence of vessel B in this section. Vessel A determines the time when the rear end of vessel B will leave the section. The prescribed separation time ST is added to this time. The result of this summation is the earliest time that the front of vessel A is allowed to arrive at the end of the section. Vessel A calculates her required speed to arrive at the end of the section on the determined time. If this speed is higher then maximum speed, vessel A sails at maximum speed. If the calculated speed is lower then maximum speed, vessel A reduces its speed to the calculated speed. The prescribed separation times used in phases 2 and 3 are noted in Appendix G.

The implementation of the separation module causes an increase of Turn Around Times of 1 to 3 minutes, depending on vessel class and destination. This implicates a maximum increase in TAT of 1% due to this new module. Within phases 2 and 3, the separation module will be used.

2.5 Scenarios

The following 6 scenarios were simulated during phases 2 and 3:

- LNG calls to the Gate and LionGas terminals (phase 2)
- LNG calls to the Gate, LionGas and 4th PET terminal (phase 3)

Scenario	Phase	Year	Gate terminal	LionGas terminal	4th PET terminal	Total
1	2	2010	67	67	-	134
2		2020	121	121	-	242
3		2035	148	167	-	315
4	3	2010	67	67	67	201
5		2020	121	121	363	363
6		2035	148	167	130	445

Table 5 Number of LNG calls phases 2 and 3

2.6 Results

The graphs below display the increase of mean TAT for vessel classes towards different destinations. Similar graphs that display the mean waiting times are shown in appendix A.

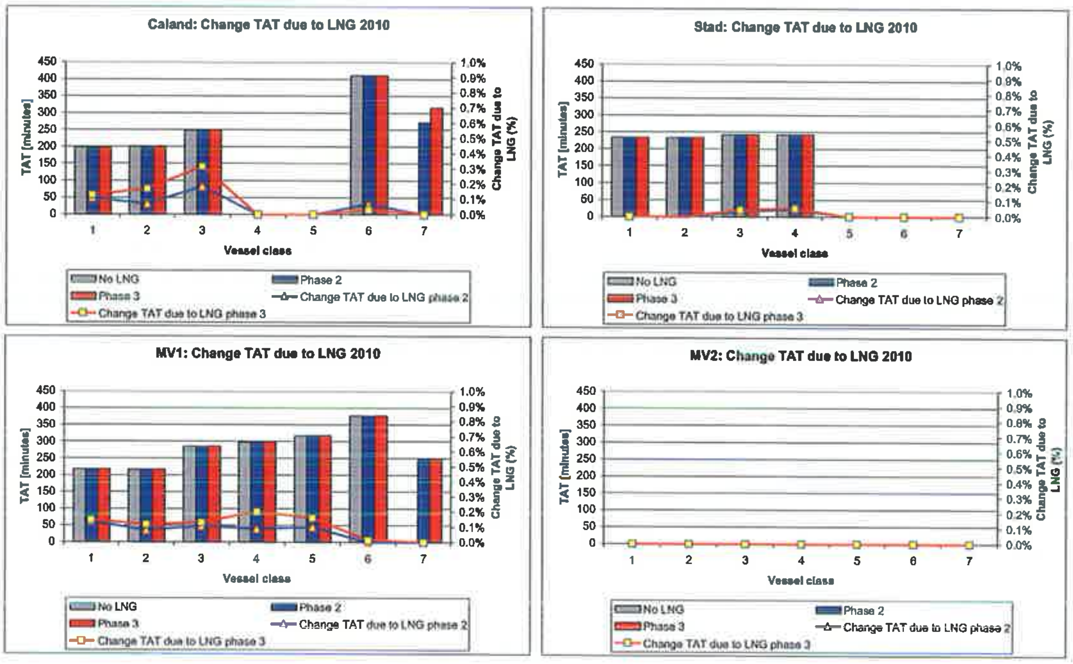


Figure 6 Impact LNG calls 2010

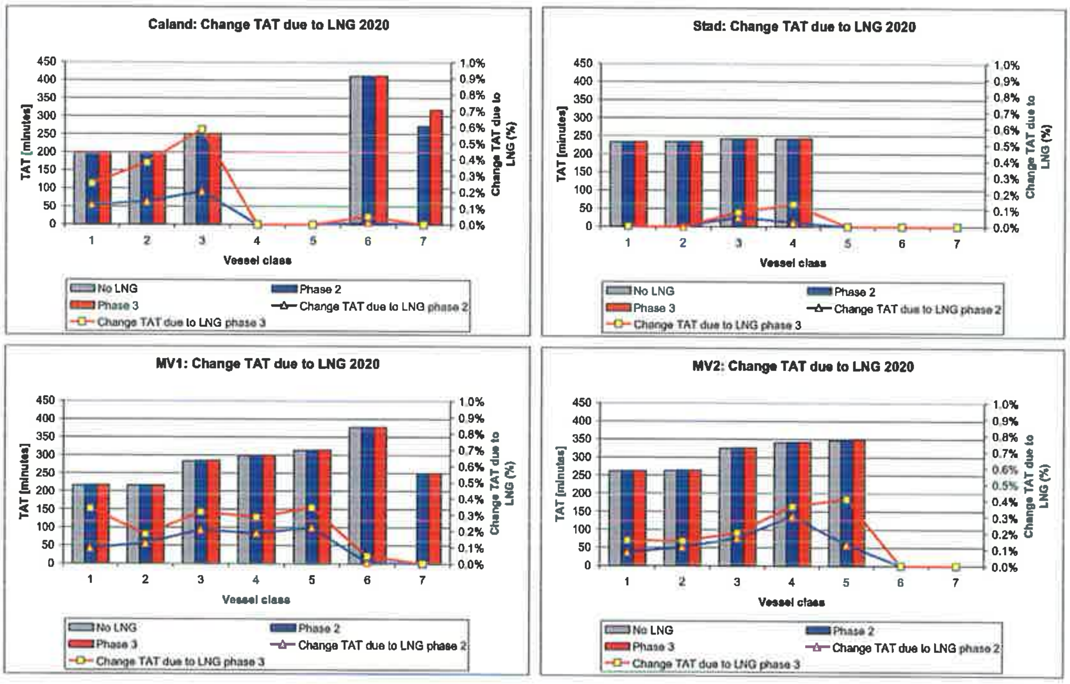


Figure 7 Impact LNG calls 2020

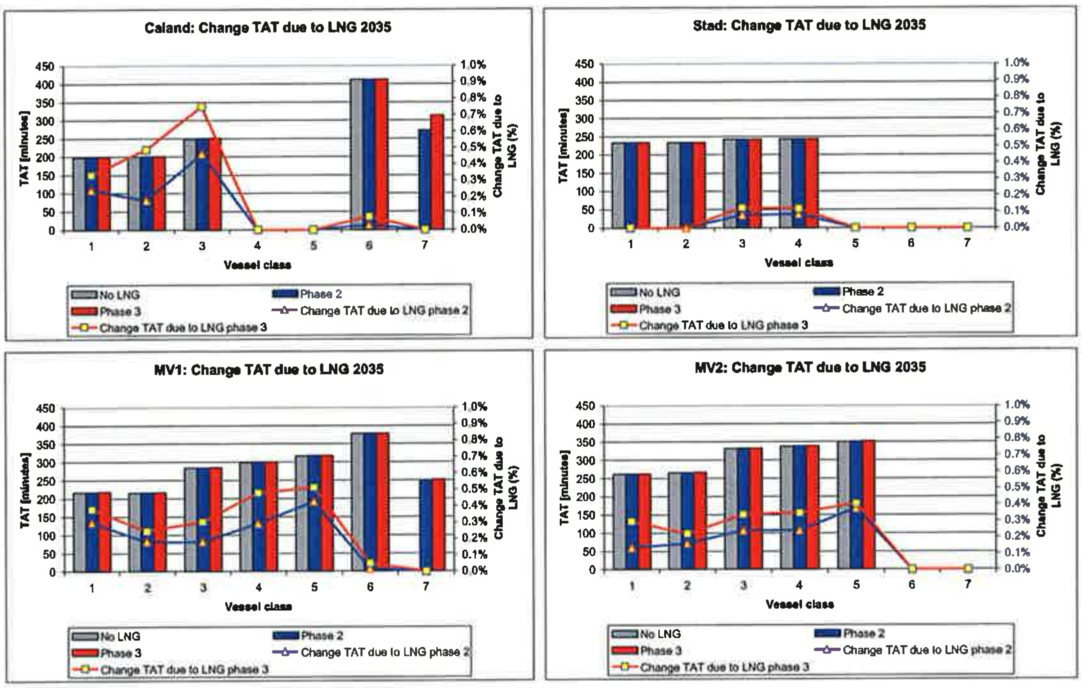
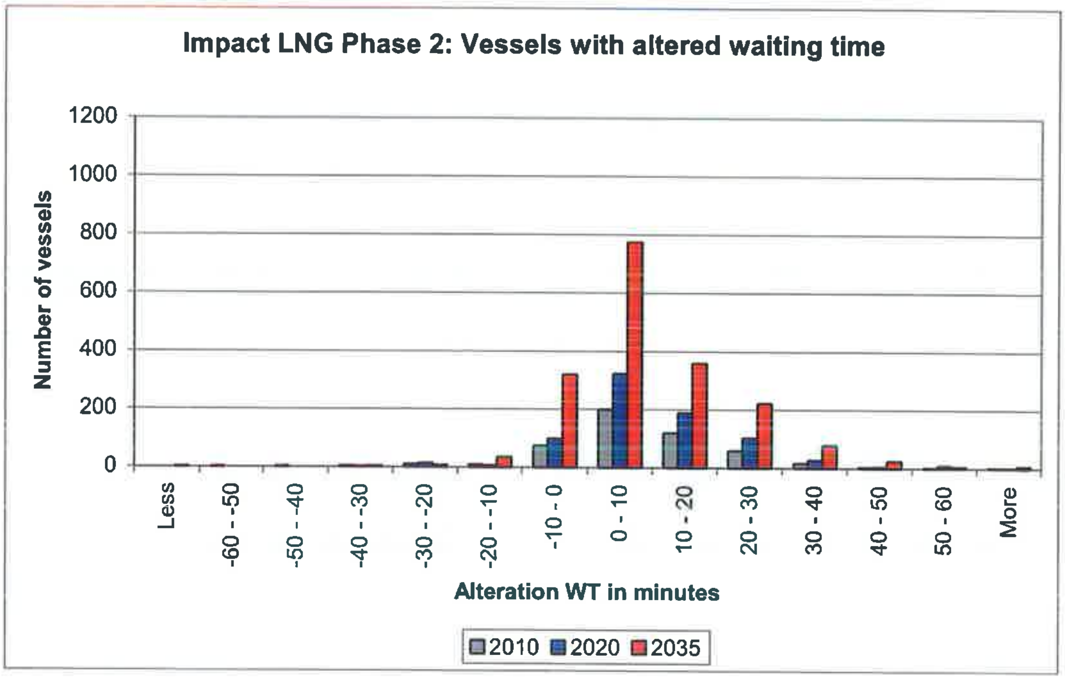


Figure 8 Impact LNG calls 2035

The results of phases 2 and 3 as displayed in these graphs show that visits of LNG carriers to both terminals have less than 1% impact on the Turn Around Time non-LNG vessels for 2010, 2020 and 2035.

* *Distribution of impact*

Since the TAT's in the presented results are average values, it is required to indicate how the impact of LNG calls is distributed. For both phases 2 and 3, these graphs are shown below. It can be seen that some vessels experience a reduction in their WT (and TAT) as an impact of the presence of LNG carriers.



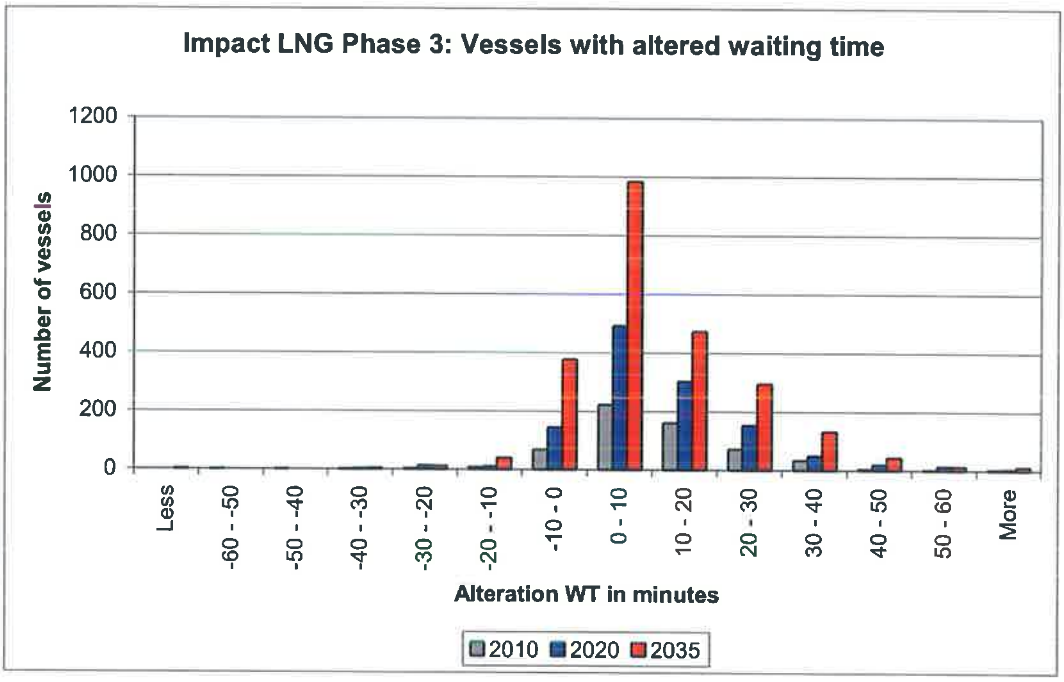


Figure 9 Distribution LNG impact on WT for phases 2 and 3

* *Impact per LNG passage*

On the next page, table 6 indicates the mean individual impact of one LNG carrier visiting the Port of Rotterdam.

	Phase 2			Phase 3		
Year	2010	2020	2035	2010	2020	2035
LNG visits per year	134	242	315	201	363	445
Total number of influenced vessels*	509	787	1847	588	1213	2385
Average number of influenced vessels per visit of LNG carrier **	3.8	3.3	5.9	2.9	3.3	5.4
Average change WT per influenced vessel (minutes) *	+8.2	+10	+9.2	+11	+11	+10.2

** Numbers are based both on vessels with an increased as a decreased TAT due to the passages of LNG carriers.*

*** A visit is defined as both the incoming and the outgoing passage of a LNG carrier.*

Table 6 Number of influenced vessels per LNG visit

When regarding the table above, two matters are to be considered.

At first it can be seen that within phase 3, in which an extra LNG terminal is operational, the average number of influenced vessels per LNG carrier decreases (3.8 to 2.9). This can be explained by the fact that the extra LNG carriers to the 4th PET influence less vessels than the other terminals and therefore decreases the *average number* of influenced vessels.

Secondly, when regarding the figures for phase 2, a drop can be seen from 2010 to 2020 in the average number of influenced vessels (3.8 to 3.3). Figure 9 has shown that a peak exists for the vessels delayed by LNG carriers for a period of 0 to 10 minutes. It is known that this peak of vessels, with minimal delay, varies significantly between simulation runs. This variation reflects on the *average number* of influenced vessels.

2.7 Review of results and conclusions

In perspective to the TAT, the impact on the traffic flow of LNG calls to 2 or 3 terminals is less than 1%. The results show that the maximum increase of the mean Turn Around Time is experienced by class 3 vessels towards Caland in the year 2035 when all 3 LNG terminals are in use and 445 LNG carriers visit the port of Rotterdam. This class experiences an increase in waiting time from 2.2 to 4.1 minutes.

The relative small impact caused by LNG calls can be explained by two main reasons:

- Relative small number of LNG calls

For the various scenarios simulated in this study, the number of LNG carriers that visits the port of Rotterdam varies from 0.4 to 1.2 per day versus 120 to 175 non-LNG carriers. This ratio is indicative for the fact that a large number of vessels will sail without experiencing direct or indirect impact of LNG carriers.

- Lenient traffic user rules

When regarding the enforced traffic user rules for the encounters between LNG carriers and non-LNG carriers it can be seen that only some of the sections sailed by LNG carriers prohibit the encounters with other vessels. Especially classes 4, 5 and 6 are not allowed to encounter LNG carriers in various sections. In the figure 10, the sections with limiting rules in relation to LNG encounters in opposite directions are marked red. The limited vessel classes are noted in the sections. The sections marked with "ALL" indicate those sections where LNG carriers turn, prohibiting all encounters with other vessels.

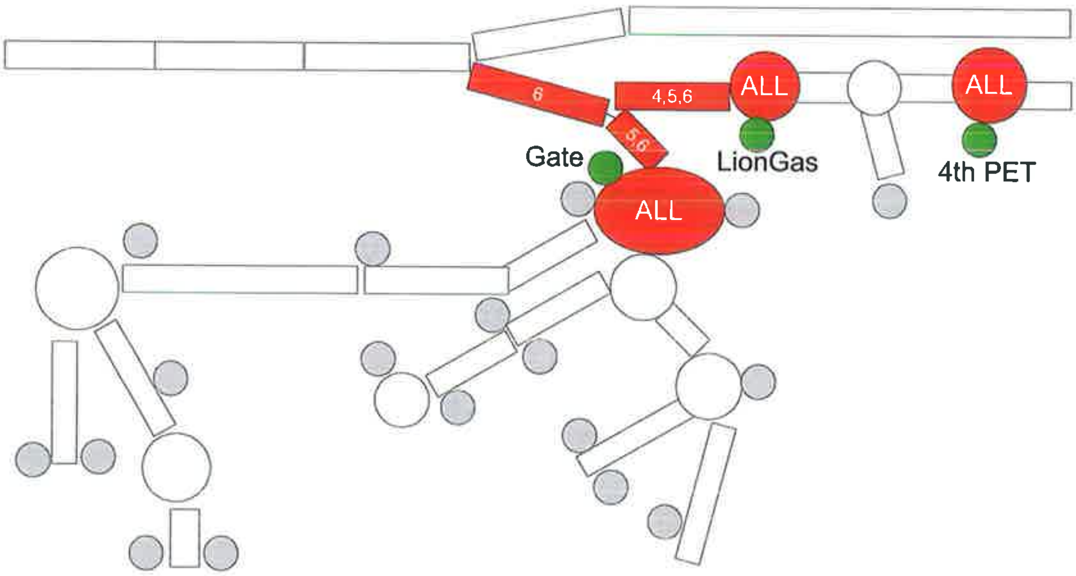


Figure 10 Indication of rules set for encounters with LNG carriers

2.8 Considerations on delay time related to speed adjustments

The TBA model is set up based on the principle that vessels, when forced to wait before entering a section, will be able to absorb this delay by speed reduction in the previous sections. Due to this approach, it was investigated whether vessels will drop their speed below the prescribed minimum. For each class of vessels, the prescribed minimum speed per section is noted in Appendix F. This section will relate to that validation, based on the results from phase 3, 2035.

![TBA logo]

For vessels of class 4 and 5 to specific destinations, analyses have been carried out on the variations in speed during simulation. This was done to ensure that maritime pilots remain comfortable and that average speeds do not drop below the minimum required speed for sustaining manoeuvrability in situations where tugboat assistance is not active.

* *Validation example, class 4 vessels to ECT Amazone*

Figure 11 shows the speed adjustments for class 4 vessels towards ECT Amazone. The graph shows that within certain sections, the mean speed for delayed vessels drops below the required minimum to maintain manoeuvrability. More details regarding these sections are given in table 7.

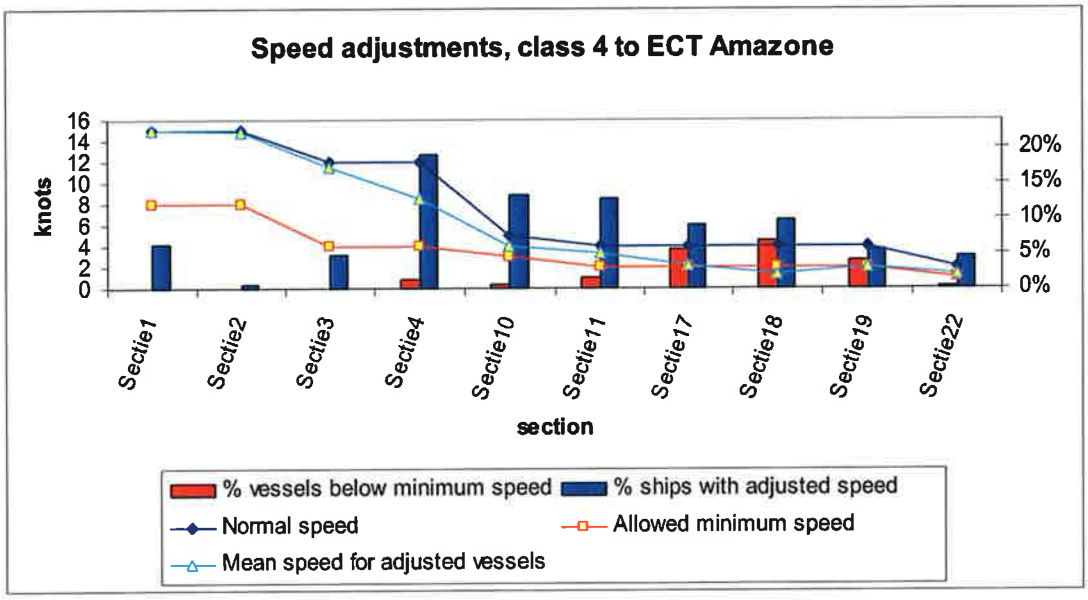


Figure 11 Speed adjustments, class 4 to ECT Amazone

Section	% vessels with speed below minimum	# vessels below minimum speed per year
11	1.5 %	6
17	6 %	23
18	7 %	28
19	4 %	16

Table 7 Details speed adjustments, class 4 to ECT Amazone

Within these sections were vessels are forced to drop their speed below the required minimum, tugboat assistance will be available assuring safe passage of these vessels.

All graphs for classes 4 and 5 are displayed in appendix K. Classed 4 and 5 are used for validation because they are subject to more limiting rules than other classes. Class 6 is left out because these vessels make use of reservations and are therefore experience no delay.

Validation on the speed adjustments caused by the approach of the TBA model has shown that for all sections where the adjusted speed drops below the minimum, tugboat assistance will be available to provide manoeuvrability. The approach of negotiating possible conflicts within sections locally is therefore valid.

Input parameters on speeds for the various sections (Appendix F) show that connected sections on occasion prescribe largely differing speeds. For instance, section 4 and 10 note a difference of 7 knots (12 versus 5). The TBA model does not account for delay time or space requirements to allow a fluent change of speed between sections.

A: WAITING TIMES PHASES 2 AND 3

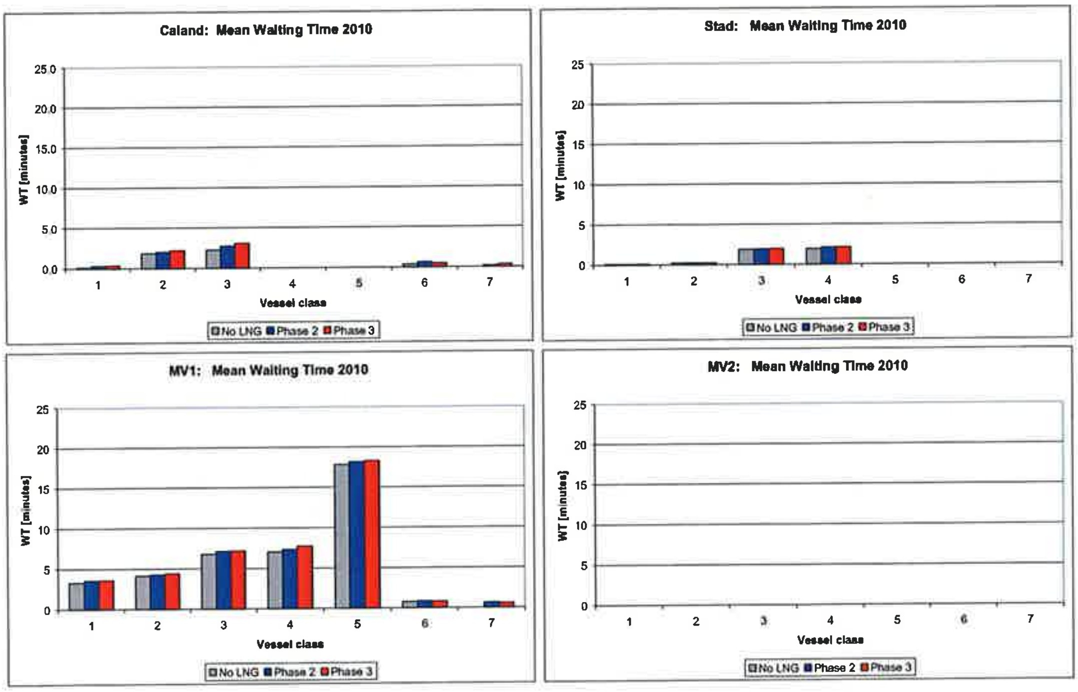


Figure 12 Waiting Time 2010

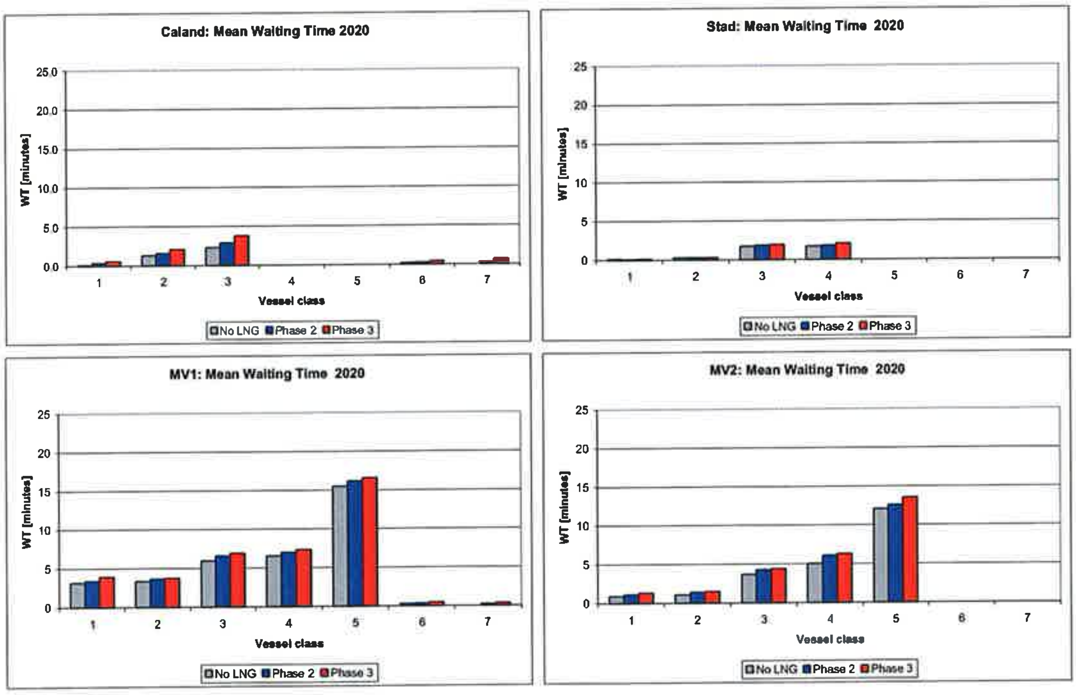


Figure 13 Waiting Time 2020

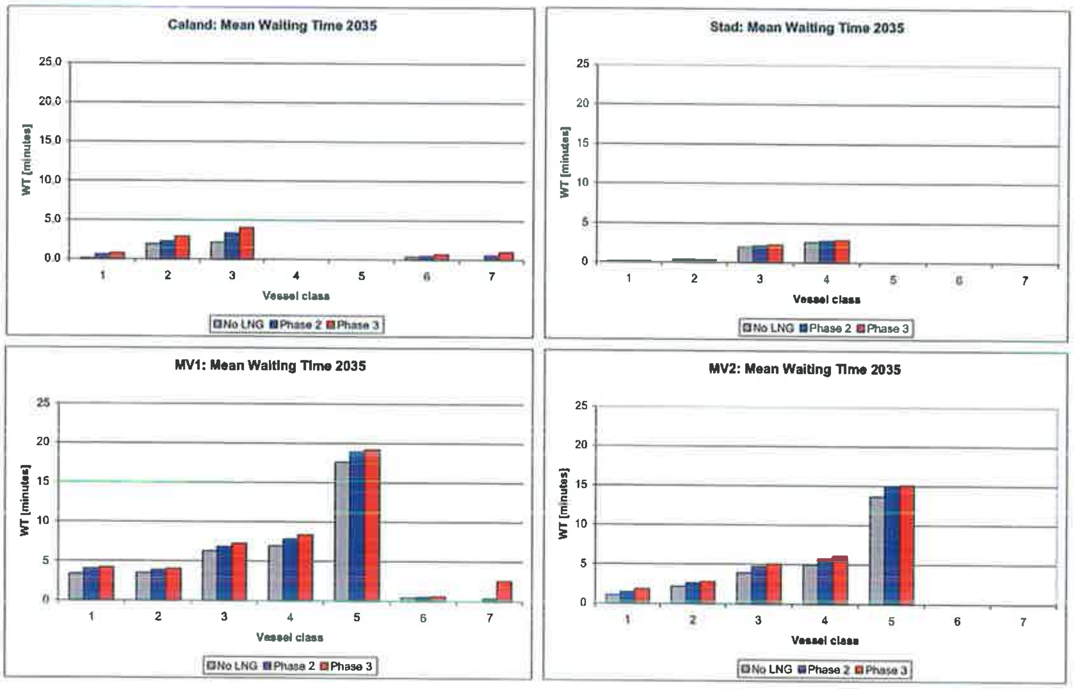


Figure 14 Waiting Time 2035

B: Waterway Sections

Within the simulation model, the waterway is divided into several sections as can be seen below. The sections are not displayed to their true scale. The modeling approach for the TBA simulation model allows for sections to be merged together. Two sections can be merged when no deviating rules exist or when sections are very small causing them to have insignificantly impact on traffic flow. In some cases, sections could be merged due to a very low number of passages. Table 7 displays the original set of sections defined by the Port of Rotterdam Authority. Table 8 shows the sections used within the simulation model of TBA.

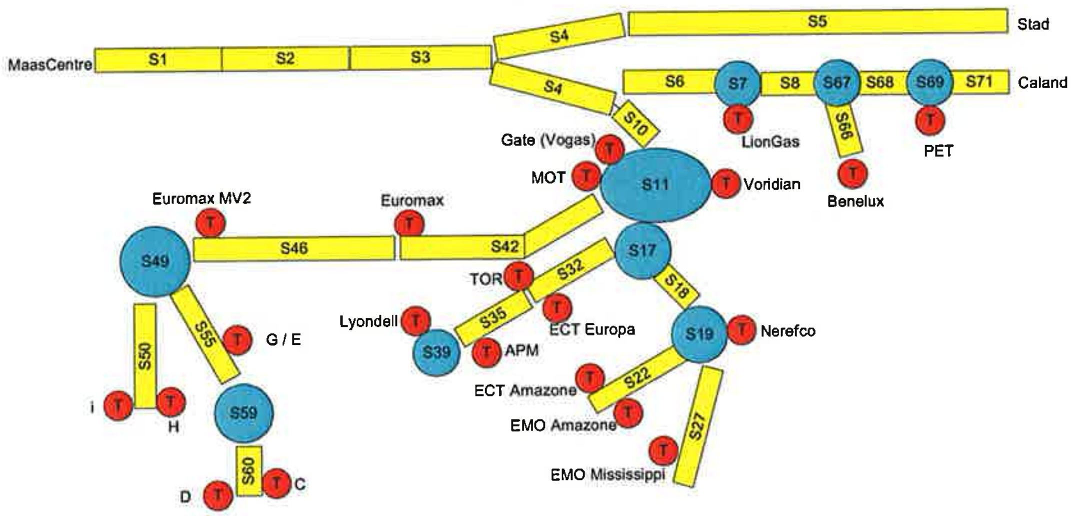


Figure 15 Fairway configuration (paragraph 1.2)

Within phase 1, vessels with destination Caland leave the model after section 7. In simulation for phases 2 and 3, the vessels also sail through sections 8, 66, 68, 69 and 71.

TBA

nr.	Description section
1	From buoy E 13 till buoy Maas Centre (MC) via Eurogeul
2	From MC till 'recommended crossing for small craft' via Maasgeul
3	From 'recommended crossing for small craft' till Maasmond
4	From Maasmond till Scheidingsdam ('low light')
5	From Scheidingsdam to Botlek en Stad
6	From Scheidingsdam till entrance LionGas Basin via Calandkanaal
7	Manoeuvring area off entrance LionGas basin
8	From man.-area off entrance LionGas basin till entrance Beneluxhaven
9	Manoeuvring area in LionGas basin
10	From Scheidingsdam till manoeuvring area in Beerkanaal
11	Manoeuvring area in Beerkanaal
12	From manoeuvring area in Beerkanaal to Tennesseehaven
13	Mooring area in Tennesseehaven
14	From manoeuvring area in Beerkanaal till entrance VOGAS location
15	Mooring area at VOGAS location
16	From Mooring area VOGAS location to Scheidingsdam
17	Manoeuvring area east of Delta peninsula
18	From man.-area east of Delta till man.-area entrance Amazonehaven
19	Manoeuvring area off entrance Amazonehaven
20	From man.-area entrance Amazonehaven till intrance 6th Pet.
21	Mooring area in 6th Pet. haven
22	From man.-area entrance Amazonehaven to Amazonehaven
23	From Amazonehaven to ECT berth
24	Mooring area off ECT berth in Amazonehaven
25	From Amazonehaven to EMO berth
26	Meergebied langs kade EMO in Amazonehaven
27	From man.-area Amazonehaven to Missippihaven
28	From Missippihaven to EMO berth
29	Mooring area off EMO berth in Missippihaven
30	From man.-area Beerkanaal to entrance 8th Pet.
31	Mooring area in 8th Pet.
32	From man.-gebied east of Delta to Europahaven east
33	From Europahaven east to ECT berth
34	Mooring area off ECT berth in Europahaven
35	From Europahaven east to Europahaven west
36	From Europahaven west to APM berth
37	Mooring area off APM berth in Europahaven
38	From Europahaven west to man.-area Europahaven
39	Man.-area Europahaven west
40	From man.-area Europahaven west to mooring area Lyondell
41	Mooring area Lyondell
42	From man.-area Beerkanaal to Yangtzehaven east
43	From Yangtzehaven east to Yangtzehaven centre
44	From Yangtzehaven centre to Euromax berth in MV2 (F)
45	Mooring area off Euromax berth in Yangtzehaven

46	Off Yangtzehaven centre to Yangtzehaven west
47	From Yangtzehaven west to Euromax berth in MV2 (F)
48	Mooring area off Euromax berth MV2 (F)
49	Man.-area Yangtzehaven west
50	From man.-area Yangtzehaven west to dock 2
51	From dock 2 to berth of terminal I
52	Mooring area off berth of terminal I
53	From dock 2 to berth of terminal H
54	Mooring area off terminal H
55	From man.-area Yangtzehaven west to Verbindingskanaal
56	From Verbindingskanaal to berth of terminal E
57	Mooring area off terminal E
58	From Verbindingskanaal to turning area off terminal G
59	Turning area off terminal G
60	From terning area off terminal G to dock 1
61	From dock 1 to berth of terminal D
62	Mooring area off terminal D
63	From dock 1 to berth of terminal D
64	Mooring area off terminal C
65	Mooring area off DFDS terminal (TOR Line in MV1)
66	From entrance Beneluxhaven till man.-area Beneluxhaven
67	Manoeuvring area in Beneluxhaven
68	From entrance Beneluxhaven to man.-area off 4th Pet
69	Manoeuvring area off entrance 4th Pet
70	Manoeuvring area in 4th Pet
71	From man.-area off entrance 4th Pet to 5th and 7th Pet (Europort)

Table 8 Original section listing

Section	Access to terminals	Combination of	Length (nm)
S1	-	-	6.0
S2	-	-	4.0
S3	-	-	2.0
S4	-	-	1.6
S5	Stad	-	12.5
S6	-	S6	0.9
S7	LionGas, Caland (Phase 1)	S7, S9	0.2 (2.1 Phase 1)
S8*	-	-	1.4
S10	-	-	0.7
S11	MOT, Voridian	S11, S12, S30 **	0.5
S17	-	-	0.2
S18	-	-	0.3
S19	Nerefco	S19, S20	0.2
S22	ECT, EMO (both Amazone)	S22, S23, S25	0.4
S27	EMO (Mississippi)	S27, S28	1.0
S32	TOR, ECT (Europa)	S32, S33	0.7
S35	APM	S35, S36, S38	0.8
S39	Lyondell	S39, S40	0.2
S42	Euromax	S42, S43	1.8
S46	Euromax MV2	S46, S47	1.4
S49	-	S49	0.3
S50	W, MW (MV2)	S50, S51, S53	0.7
S55	Chemie (MV2)	S55, S56, S58	0.6
S59	-	S59	0.3
S60	MO, O (MV2)	S60, S61, S63	0.5
S66*	Benelux	S66	0.5
S67*		S67	0.2
S68*	-	-	0.5
S69*	PET	S69, S70	0.2
S71*	Caland (Phase 2 and 3)	-	2.1
* Extensions for phases 2 and 3. In Phase 1 vessels to Caland leave the model after Section 7.		**Sail time S30 is included in service time MOT	

Table 9 Waterway sections, length and combinations as used within the model

T B A

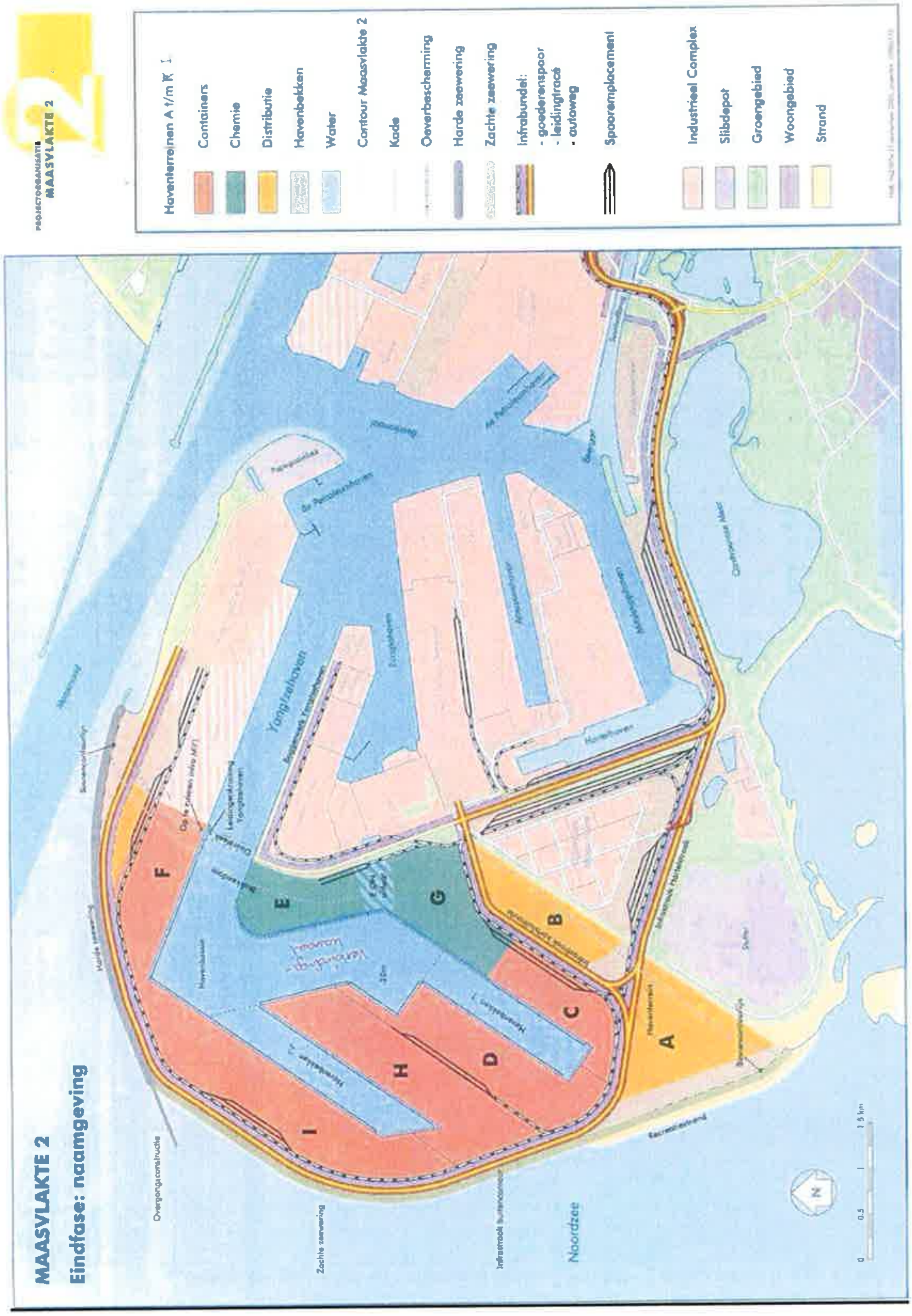


Figure 16 Geographical map Maasvlakte 1 and 2

F: Sailing speed per section

For each vessel class and waterway section, the maximum allowed speeds are prescribed in knots [nm/hr]. These velocities will be maintained by vessels when undelayed passage is possible. The prescribed minimum speeds are noted within brackets and are based on ref [3].

Section	1	2	3	4	5	6	7
S1	15	15	15	15	15	10	15
S2	15(8)	15(8)	15(8)	15(8)	15(8)	10(5)	15
S3	15(8)	15(8)	12(5)	12(4)	12(4)	7(5)	7
S4	15(6)	15(6)	12(3)	12(4)	12(4)	4(3)	5
S5	12(4)	12(4)	12(4)	12(4)	nvt	nvt	
S6	10(4)	10(4)	6(4)	5(3)	5(3)	4(1)	3
S7	10	10	6	5	5	4	3
S8	8	8	6	4	4	3	3
S10	8(4)	8(4)	6(4)	5(3)	5(3)	4(1)	4
S11	6(4)	6(4)	4(2)	4(2)	4(2)	3(1)	2
S17	6(4)	5(3)	4(2)	4(2)	4(2)	3(1)	
S18	6(4)	5(3)	4(2)	4(2)	4(2)	3(1)	
S19	6(4)	5(3)	4(2)	4(2)	4(2)	3(1)	
S22	3(2)	3(2)	3(2)	2(1)	2(1)	nvt	
S27	4(2)	4(2)	4(4)	nvt	4(2)	2(1)	
S32	5(3)	5(3)	5(3)	3(1)	3(1)	nvt	
S35	5(3)	5(3)	3(3)	3(1)	3(1)	nvt	
S39	3(1)	3(1)	nvt	nvt	nvt	nvt	
S42	7(4)	7(4)	6(4)	6(3)	6(3)	nvt	
S46	5(4)	5(4)	5(3)	5(3)	5(3)	nvt	
S49	4(3)	4(3)	3(2)	3(2)	3(2)	nvt	
S50	4(3)	4(3)	3(2)	3(2)	3(2)	nvt	
S55	4(3)	4(3)	4(3)	3(2)	3(2)	nvt	
S59	4(3)	4(3)	4(3)	3(2)	3(2)	nvt	
S60	4(3)	4(3)	3(2)	3(2)	3(2)	nvt	
S66	8	8	6	4	4	3	
S67	8	8	6	4	4	3	
S68	8	8	6	4	4	3	3
S69	8	8	6	4	4	3	3
S71	6	6	4	3	3	3	

Table 15 Sailing speed Phase 1, 2 and 3 [knots], prescribed minimum within brackets

G: Separation times phases 2 and 3

For each ship class and waterway section separation times are prescribed in minutes.

Section	1	2	3	4	5	6	7
S1	0.1	0.1	0.1	0.1	0.1	5.1	0.1
S2	0.1	0.1	0.1	0.1	0.1	5.1	0.1
S3	0.1	0.1	0.1	0.1	3.7	5.5	0.1
S4	0.1	0.1	2.8	3.5	3.7	6.6	4.0
S5	0.1	1.7	2.8	3.5			
S6	1.1	1.8	3.5	4.6	4.9	6.6	5.2
S7	1.1	1.8	3.5	4.6	4.9	6.6	
S8	1.2	1.9	3.5	5.1	5.4	7.5	5.2
S10	1.2	1.9	3.5	4.6	4.9	5.3	4.5
S11	1.3	2.1	4.1	5.1	5.4	6.1	6.6
S17	1.3	2.3	4.1	5.1	5.4	6.1	
S18	1.3	2.3	4.1	5.1	5.4	6.1	
S19	1.3	2.3	4.1	5.1	5.4	6.1	
S22	2.4	3.8	6.2	7.6	8.0	7.8	
S27	1.6	2.6	4.1	0.0	5.4	7.8	
S32	1.4	2.3	3.7	5.9	6.3		
S35	1.4	2.3	4.8	5.9	6.3		
S39	1.9	3.0					
S42	1.3	2.0	3.5	4.3	4.5		
S46	1.4	2.3	3.7	4.6	4.9		
S49	1.6	2.6	4.8	5.9	6.3		
S50	1.6	2.6	4.8	5.9	6.3		
S55	1.6	2.6	4.1	5.9	6.3		
S59	1.6	2.6	4.1	5.9	6.3		
S60	1.6	2.6	4.8	5.9	6.3		
S66	1.2	1.9	3.5	5.1	5.4	6.1	
S67	1.2	1.9	3.5	5.1	5.4	6.1	
S68	1.2	1.9	3.5	5.1	5.4	6.1	
S69	1.2	1.9	3.5	5.1	5.4	6.1	
S71	1.3	2.1	4.1	5.9	6.3	6.1	

Table 16 Separation times between vessels, phase 2 and 3 (minutes)

H: Traffic user rules phase 1 version 4.4

The following notation is used:

0: Overtake or encounter is not allowed within a section between classes.

1: Overtake or encounter is allowed within a section between classes.

-1: Used to indicate the classes which do not use a specific section.

Overtaking							
Section 1	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	1	1
Class 2	1	1	1	1	1	1	1
Class 3	1	1	1	1	1	1	1
Class 4	1	1	1	1	1	1	1
Class 5	1	1	1	1	1	1	1
Class 6	1	1	1	1	1	1	1
Class 7	1	1	1	1	1	1	1

Encounter							
Section 1	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	1	1
Class 2	1	1	1	1	1	1	1
Class 3	1	1	1	1	1	1	1
Class 4	1	1	1	1	1	1	1
Class 5	1	1	1	1	1	1	1
Class 6	1	1	1	1	1	1	1
Class 7	1	1	1	1	1	1	1

Overtaking							
Section 2	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	1	1
Class 2	1	1	1	1	1	1	1
Class 3	1	1	1	1	1	1	1
Class 4	1	1	1	1	1	1	1
Class 5	1	1	1	1	0	0	0
Class 6	1	1	1	1	0	0	0
Class 7	1	1	1	1	0	0	0

Encounter							
Section 2	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	1	1
Class 2	1	1	1	1	1	1	1
Class 3	1	1	1	1	1	1	1
Class 4	1	1	1	1	1	1	1
Class 5	1	1	1	1	1	1	1
Class 6	1	1	1	1	1	0	0
Class 7	1	1	1	1	1	0	0

Overtaking							
Section 3	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	1	1
Class 2	1	1	1	1	1	1	1
Class 3	1	1	1	1	1	1	1
Class 4	1	1	1	1	1	0	0
Class 5	1	1	1	1	0	0	0
Class 6	1	1	1	0	0	0	0
Class 7	1	1	1	0	0	0	0

Encounter							
Section 3	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	1	1
Class 2	1	1	1	1	1	1	1
Class 3	1	1	1	1	1	1	1
Class 4	1	1	1	1	1	1	1
Class 5	1	1	1	1	0	0	0
Class 6	1	1	1	1	0	0	0
Class 7	1	1	1	1	0	0	0

Overtaking							
Section 4	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	1	0
Class 2	1	1	1	1	1	1	0
Class 3	1	1	0	0	0	0	0
Class 4	1	1	0	0	0	0	0
Class 5	1	1	0	0	0	0	0
Class 6	1	1	0	0	0	0	0
Class 7	0	0	0	0	0	0	0

Encounter							
Section 4	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	1	0
Class 2	1	1	1	1	1	1	0
Class 3	1	1	1	1	1	0	0
Class 4	1	1	1	1	1	0	0
Class 5	1	1	1	1	0	0	0
Class 6	1	1	0	0	0	0	0
Class 7	0	0	0	0	0	0	0

TBA

Overtaking							
Section 5	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	-1	-1	-1
Class 2	1	1	1	1	-1	-1	-1
Class 3	1	1	0	0	-1	-1	-1
Class 4	1	1	0	0	-1	-1	-1
Class 5	-1	-1	-1	-1	-1	-1	-1
Class 6	-1	-1	-1	-1	-1	-1	-1
Class 7	-1	-1	-1	-1	-1	-1	-1

Encounter							
Section 5	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	-1	-1	-1
Class 2	1	1	1	1	-1	-1	-1
Class 3	1	1	1	1	-1	-1	-1
Class 4	1	1	1	1	-1	-1	-1
Class 5	-1	-1	-1	-1	-1	-1	-1
Class 6	-1	-1	-1	-1	-1	-1	-1
Class 7	-1	-1	-1	-1	-1	-1	-1

Overtaking							
Section 6	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	1	0
Class 2	1	1	1	1	1	1	0
Class 3	1	1	1	0	0	0	0
Class 4	1	1	0	0	0	0	0
Class 5	1	1	0	0	0	0	0
Class 6	1	1	0	0	0	0	0
Class 7	0	0	0	0	0	0	0

Encounter							
Section 6	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	1	0
Class 2	1	1	1	1	1	1	0
Class 3	1	1	1	1	1	1	0
Class 4	1	1	1	0	0	0	0
Class 5	1	1	1	0	0	0	0
Class 6	1	1	1	0	0	0	0
Class 7	0	0	0	0	0	0	0

Overtaking							
Section 7	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	1	0
Class 2	1	1	1	1	1	1	0
Class 3	1	1	1	0	0	0	0
Class 4	1	1	0	0	0	0	0
Class 5	1	1	0	0	0	0	0
Class 6	1	1	0	0	0	0	0
Class 7	0	0	0	0	0	0	0

Encounter							
Section 7	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	1	0
Class 2	1	1	1	1	1	1	0
Class 3	1	1	1	1	1	1	0
Class 4	1	1	1	0	0	0	0
Class 5	1	1	1	0	0	0	0
Class 6	1	1	1	0	0	0	0
Class 7	0	0	0	0	0	0	0

Overtaking							
Section 10	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	1	0
Class 2	1	1	1	1	1	1	0
Class 3	1	1	1	1	0	0	0
Class 4	1	1	1	1	0	0	0
Class 5	1	1	0	0	0	0	0
Class 6	1	1	0	0	0	0	0
Class 7	0	0	0	0	0	0	0

Encounter							
Section 10	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	1	0
Class 2	1	1	1	1	1	1	0
Class 3	1	1	1	1	1	1	0
Class 4	1	1	1	1	0	0	0
Class 5	1	1	1	0	0	0	0
Class 6	1	1	1	0	0	0	0
Class 7	0	0	0	0	0	0	0

Overtaking							
Section 11	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	1	0
Class 2	1	1	1	1	1	1	0
Class 3	1	1	1	1	1	1	0
Class 4	1	1	1	1	0	0	0
Class 5	1	1	1	0	0	0	0
Class 6	1	1	1	0	0	0	0
Class 7	0	0	0	0	0	0	0

Encounter							
Section 11	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	1	0
Class 2	1	1	1	1	1	1	0
Class 3	1	1	1	1	1	1	0
Class 4	1	1	1	1	1	1	0
Class 5	1	1	1	1	0	0	0
Class 6	1	1	1	1	0	0	0
Class 7	0	0	0	0	0	0	0

Overtaking							
Section 17	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	0	-1
Class 2	1	1	1	1	1	0	-1
Class 3	1	1	0	0	0	0	-1
Class 4	1	1	0	0	0	0	-1
Class 5	1	1	0	0	0	0	-1
Class 6	0	0	0	0	0	0	-1
Class 7	-1	-1	-1	-1	-1	-1	-1

Encounter							
Section 17	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	0	-1
Class 2	1	1	1	1	1	0	-1
Class 3	1	1	1	1	1	0	-1
Class 4	1	1	1	1	1	0	-1
Class 5	1	1	1	1	0	0	-1
Class 6	0	0	0	0	0	0	-1
Class 7	-1	-1	-1	-1	-1	-1	-1

Overtaking							
Section 18	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	0	0	-1
Class 2	1	1	0	0	0	0	-1
Class 3	1	0	0	0	0	0	-1
Class 4	1	0	0	0	0	0	-1
Class 5	0	0	0	0	0	0	-1
Class 6	0	0	0	0	0	0	-1
Class 7	-1	-1	-1	-1	-1	-1	-1

Encounter							
Section 18	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	0	0	-1
Class 2	1	1	0	0	0	0	-1
Class 3	1	0	0	0	0	0	-1
Class 4	1	0	0	0	0	0	-1
Class 5	0	0	0	0	0	0	-1
Class 6	0	0	0	0	0	0	-1
Class 7	-1	-1	-1	-1	-1	-1	-1

Overtaking							
Section 19	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	0	0	-1
Class 2	1	1	0	0	0	0	-1
Class 3	1	0	0	0	0	0	-1
Class 4	1	0	0	0	0	0	-1
Class 5	0	0	0	0	0	0	-1
Class 6	0	0	0	0	0	0	-1
Class 7	-1	-1	-1	-1	-1	-1	-1

Encounter							
Section 19	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	0	0	-1
Class 2	1	1	0	0	0	0	-1
Class 3	1	0	0	0	0	0	-1
Class 4	1	0	0	0	0	0	-1
Class 5	0	0	0	0	0	0	-1
Class 6	0	0	0	0	0	0	-1
Class 7	-1	-1	-1	-1	-1	-1	-1

Overtaking							
Section 22	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	0	-1	-1
Class 2	1	0	0	0	0	-1	-1
Class 3	1	0	0	0	0	-1	-1
Class 4	1	0	0	0	0	-1	-1
Class 5	0	0	0	0	0	-1	-1
Class 6	-1	-1	-1	-1	-1	-1	-1
Class 7	-1	-1	-1	-1	-1	-1	-1

Encounter							
Section 22	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	0	-1	-1
Class 2	1	1	0	0	0	-1	-1
Class 3	1	0	0	0	0	-1	-1
Class 4	1	0	0	0	0	-1	-1
Class 5	0	0	0	0	0	-1	-1
Class 6	-1	-1	-1	-1	-1	-1	-1
Class 7	-1	-1	-1	-1	-1	-1	-1

Overtaking							
Section 27	Vessel classes						
	1	2	3	4	5	6	7
Class 1	0	0	0	0	0	0	-1
Class 2	0	0	0	0	0	0	-1
Class 3	0	0	0	0	0	0	-1
Class 4	0	0	0	0	0	0	-1
Class 5	0	0	0	0	0	0	-1
Class 6	0	0	0	0	0	0	-1
Class 7	-1	-1	-1	-1	-1	-1	-1

Encounter							
Section 27	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	-1	1	1	-1
Class 2	1	1	0	-1	0	0	-1
Class 3	1	0	0	-1	0	0	-1
Class 4	-1	-1	-1	-1	-1	-1	-1
Class 5	1	0	0	-1	0	0	-1
Class 6	1	0	0	-1	0	0	-1
Class 7	-1	-1	-1	-1	-1	-1	-1

Overtaking							
Section 30	Vessel classes						
	1	2	3	4	5	6	7
Class 1	-1	-1	-1	-1	-1	-1	-1
Class 2	-1	-1	-1	-1	-1	-1	-1
Class 3	-1	-1	-1	-1	-1	-1	-1
Class 4	-1	-1	-1	-1	-1	-1	-1
Class 5	-1	-1	-1	-1	0	0	-1
Class 6	-1	-1	-1	-1	0	0	-1
Class 7	-1	-1	-1	-1	-1	-1	-1

Encounter							
Section 30	Vessel classes						
	1	2	3	4	5	6	7
Class 1	-1	-1	-1	-1	-1	-1	-1
Class 2	-1	-1	-1	-1	-1	-1	-1
Class 3	-1	-1	-1	-1	-1	-1	-1
Class 4	-1	-1	-1	-1	-1	-1	-1
Class 5	-1	-1	-1	-1	0	0	-1
Class 6	-1	-1	-1	-1	0	0	-1
Class 7	-1	-1	-1	-1	-1	-1	-1

Overtaking							
Section 32	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	-1	-1
Class 2	1	1	1	1	1	-1	-1
Class 3	1	1	1	0	0	-1	-1
Class 4	1	1	0	0	0	-1	-1
Class 5	1	1	0	0	0	-1	-1
Class 6	-1	-1	-1	-1	-1	-1	-1
Class 7	-1	-1	-1	-1	-1	-1	-1

Encounter							
Section 32	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	-1	-1
Class 2	1	1	1	1	1	-1	-1
Class 3	1	1	1	1	1	-1	-1
Class 4	1	1	1	0	0	-1	-1
Class 5	1	1	1	0	0	-1	-1
Class 6	-1	-1	-1	-1	-1	-1	-1
Class 7	-1	-1	-1	-1	-1	-1	-1

Overtaking							
Section 35	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	-1	-1
Class 2	1	1	1	0	0	-1	-1
Class 3	1	1	1	0	0	-1	-1
Class 4	1	0	0	0	0	-1	-1
Class 5	1	0	0	0	0	-1	-1
Class 6	-1	-1	-1	-1	-1	-1	-1
Class 7	-1	-1	-1	-1	-1	-1	-1

Encounter							
Section 35	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	-1	-1
Class 2	1	1	1	1	1	-1	-1
Class 3	1	1	1	0	0	-1	-1
Class 4	1	1	0	0	0	-1	-1
Class 5	1	1	0	0	0	-1	-1
Class 6	-1	-1	-1	-1	-1	-1	-1
Class 7	-1	-1	-1	-1	-1	-1	-1

Overtaking							
Section 39	Vessel classes						
	1	2	3	4	5	6	7
Class 1	0	0	-1	-1	-1	-1	-1
Class 2	0	0	-1	-1	-1	-1	-1
Class 3	-1	-1	-1	-1	-1	-1	-1
Class 4	-1	-1	-1	-1	-1	-1	-1
Class 5	-1	-1	-1	-1	-1	-1	-1
Class 6	-1	-1	-1	-1	-1	-1	-1
Class 7	-1	-1	-1	-1	-1	-1	-1

Encounter							
Section 39	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	-1	-1	-1	-1	-1
Class 2	1	0	-1	-1	-1	-1	-1
Class 3	-1	-1	-1	-1	-1	-1	-1
Class 4	-1	-1	-1	-1	-1	-1	-1
Class 5	-1	-1	-1	-1	-1	-1	-1
Class 6	-1	-1	-1	-1	-1	-1	-1
Class 7	-1	-1	-1	-1	-1	-1	-1

Overtaking							
Section 42	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	-1	-1
Class 2	1	1	1	1	1	-1	-1
Class 3	1	1	1	1	0	-1	-1
Class 4	1	1	1	1	0	-1	-1
Class 5	1	1	0	0	0	-1	-1
Class 6	-1	-1	-1	-1	-1	-1	-1
Class 7	-1	-1	-1	-1	-1	-1	-1

Encounter							
Section 42	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	-1	-1
Class 2	1	1	1	1	1	-1	-1
Class 3	1	1	1	1	1	-1	-1
Class 4	1	1	1	1	1	-1	-1
Class 5	1	1	1	1	1	-1	-1
Class 6	-1	-1	-1	-1	-1	-1	-1
Class 7	-1	-1	-1	-1	-1	-1	-1

Overtaking							
Section 46	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	-1	-1
Class 2	1	1	1	1	1	-1	-1
Class 3	1	1	1	1	0	-1	-1
Class 4	1	1	1	1	0	-1	-1
Class 5	1	1	0	0	0	-1	-1
Class 6	-1	-1	-1	-1	-1	-1	-1
Class 7	-1	-1	-1	-1	-1	-1	-1

Encounter							
Section 46	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	-1	-1
Class 2	1	1	1	1	0	-1	-1
Class 3	1	1	1	0	0	-1	-1
Class 4	1	1	0	0	0	-1	-1
Class 5	1	0	0	0	0	-1	-1
Class 6	-1	-1	-1	-1	-1	-1	-1
Class 7	-1	-1	-1	-1	-1	-1	-1

Overtaking							
Section 49	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	-1	-1
Class 2	1	1	1	1	1	-1	-1
Class 3	1	1	1	1	1	-1	-1
Class 4	1	1	1	1	0	-1	-1
Class 5	1	1	1	0	0	-1	-1
Class 6	-1	-1	-1	-1	-1	-1	-1
Class 7	-1	-1	-1	-1	-1	-1	-1

Encounter							
Section 49	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	-1	-1
Class 2	1	1	1	1	1	-1	-1
Class 3	1	1	1	1	1	-1	-1
Class 4	1	1	1	1	1	-1	-1
Class 5	1	1	1	1	1	-1	-1
Class 6	-1	-1	-1	-1	-1	-1	-1
Class 7	-1	-1	-1	-1	-1	-1	-1

Overtaking							
Section 50	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	-1	-1
Class 2	1	1	1	1	1	-1	-1
Class 3	1	1	1	1	0	-1	-1
Class 4	1	1	1	1	0	-1	-1
Class 5	1	1	0	0	0	-1	-1
Class 6	-1	-1	-1	-1	-1	-1	-1
Class 7	-1	-1	-1	-1	-1	-1	-1

Encounter							
Section 50	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	-1	-1
Class 2	1	1	1	1	1	-1	-1
Class 3	1	1	1	1	0	-1	-1
Class 4	1	1	1	1	0	-1	-1
Class 5	1	1	0	0	0	-1	-1
Class 6	-1	-1	-1	-1	-1	-1	-1
Class 7	-1	-1	-1	-1	-1	-1	-1

Overtaking							
Section 55	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	-1	-1
Class 2	1	1	1	1	1	-1	-1
Class 3	1	1	1	1	0	-1	-1
Class 4	1	1	1	1	0	-1	-1
Class 5	1	1	0	0	0	-1	-1
Class 6	-1	-1	-1	-1	-1	-1	-1
Class 7	-1	-1	-1	-1	-1	-1	-1

Encounter							
Section 55	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	-1	-1
Class 2	1	1	1	1	1	-1	-1
Class 3	1	1	1	1	1	-1	-1
Class 4	1	1	1	1	1	-1	-1
Class 5	1	1	1	1	1	-1	-1
Class 6	-1	-1	-1	-1	-1	-1	-1
Class 7	-1	-1	-1	-1	-1	-1	-1

Overtaking							
Section 59	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	-1	-1
Class 2	1	1	1	1	1	-1	-1
Class 3	1	1	1	1	1	-1	-1
Class 4	1	1	1	1	0	-1	-1
Class 5	1	1	1	0	0	-1	-1
Class 6	-1	-1	-1	-1	-1	-1	-1
Class 7	-1	-1	-1	-1	-1	-1	-1

Encounter							
Section 59	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	-1	-1
Class 2	1	1	1	1	1	-1	-1
Class 3	1	1	1	1	1	-1	-1
Class 4	1	1	1	1	1	-1	-1
Class 5	1	1	1	1	1	-1	-1
Class 6	-1	-1	-1	-1	-1	-1	-1
Class 7	-1	-1	-1	-1	-1	-1	-1

Overtaking							
Section 60	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	0	0	-1	-1
Class 2	1	1	1	0	0	-1	-1
Class 3	1	1	1	0	0	-1	-1
Class 4	0	0	0	0	0	-1	-1
Class 5	0	0	0	0	0	-1	-1
Class 6	-1	-1	-1	-1	-1	-1	-1
Class 7	-1	-1	-1	-1	-1	-1	-1

Encounter							
Section 60	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	-1	-1
Class 2	1	1	1	1	1	-1	-1
Class 3	1	1	1	1	0	-1	-1
Class 4	1	1	1	1	0	-1	-1
Class 5	1	1	0	0	0	-1	-1
Class 6	-1	-1	-1	-1	-1	-1	-1
Class 7	-1	-1	-1	-1	-1	-1	-1

I: TRAFFIC USER RULES PHASES 2 AND 3 VERSION 5.2

The following notation is used:

0: Overtake or encounter is not allowed within a section between classes.

1: Overtake or encounter is allowed within a section between classes.

-1: Used to indicate the classes which do not use a specific section.

Overtaking							
Section 1	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	1	1
Class 2	1	1	1	1	1	1	1
Class 3	1	1	1	1	1	1	1
Class 4	1	1	1	1	1	1	1
Class 5	1	1	1	1	1	0	1
Class 6	1	1	1	1	0	0	1
Class 7	1	1	1	1	1	1	1

Encounter							
Section 1	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	1	1
Class 2	1	1	1	1	1	1	1
Class 3	1	1	1	1	1	1	1
Class 4	1	1	1	1	1	1	1
Class 5	1	1	1	1	1	1	1
Class 6	1	1	1	1	1	0	1
Class 7	1	1	1	1	1	1	1

Overtaking							
Section 2	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	1	1
Class 2	1	1	1	1	1	1	1
Class 3	1	1	1	1	1	1	1
Class 4	1	1	1	1	1	1	1
Class 5	1	1	1	1	0	0	0
Class 6	1	1	1	1	0	0	0
Class 7	1	1	1	1	0	0	0

Encounter							
Section 2	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	1	1
Class 2	1	1	1	1	1	1	1
Class 3	1	1	1	1	1	1	1
Class 4	1	1	1	1	1	1	1
Class 5	1	1	1	1	1	0	1
Class 6	1	1	1	1	0	0	1
Class 7	1	1	1	1	1	1	1

Overtaking							
Section 3	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	1	1
Class 2	1	1	1	1	1	1	1
Class 3	1	1	1	1	1	1	1
Class 4	1	1	1	1	1	0	0
Class 5	1	1	1	1	0	0	0
Class 6	1	1	1	0	0	0	0
Class 7	1	1	1	0	0	0	0

Encounter							
Section 3	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	1	1
Class 2	1	1	1	1	1	1	1
Class 3	1	1	1	1	1	1	1
Class 4	1	1	1	1	1	1	1
Class 5	1	1	1	1	0	0	1
Class 6	1	1	1	1	0	0	1
Class 7	1	1	1	1	1	1	1

Overtaking							
Section 4	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	1	1
Class 2	1	1	1	1	1	1	1
Class 3	1	1	0	0	0	0	0
Class 4	1	1	0	0	0	0	0
Class 5	1	1	0	0	0	0	0
Class 6	1	1	0	0	0	0	0
Class 7	1	1	0	0	0	0	0

Encounter							
Section 4	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	1	1
Class 2	1	1	1	1	1	1	1
Class 3	1	1	1	1	1	0	1
Class 4	1	1	1	1	1	0	1
Class 5	1	1	1	1	0	0	1
Class 6	1	1	0	0	0	0	0
Class 7	1	1	1	1	1	0	0

Overtaking							
Section 5	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	-1	-1	-1
Class 2	1	1	1	1	-1	-1	-1
Class 3	1	1	0	0	-1	-1	-1
Class 4	1	1	0	0	-1	-1	-1
Class 5	-1	-1	-1	-1	-1	-1	-1
Class 6	-1	-1	-1	-1	-1	-1	-1
Class 7	-1	-1	-1	-1	-1	-1	-1

Encounter							
Section 5	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	-1	-1	-1
Class 2	1	1	1	1	-1	-1	-1
Class 3	1	1	1	1	-1	-1	-1
Class 4	1	1	1	1	-1	-1	-1
Class 5	-1	-1	-1	-1	-1	-1	-1
Class 6	-1	-1	-1	-1	-1	-1	-1
Class 7	-1	-1	-1	-1	-1	-1	-1

Overtaking							
Section 6	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	1	1
Class 2	1	1	1	1	1	1	1
Class 3	1	1	1	0	0	0	0
Class 4	1	1	0	0	0	0	0
Class 5	1	1	0	0	0	0	0
Class 6	1	1	0	0	0	0	0
Class 7	1	1	0	0	0	0	0

Encounter							
Section 6	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	1	1
Class 2	1	1	1	1	1	1	1
Class 3	1	1	1	1	1	1	1
Class 4	1	1	1	0	0	0	0
Class 5	1	1	1	0	0	0	0
Class 6	1	1	1	0	0	0	0
Class 7	1	1	1	0	0	0	0

Overtaking							
Section 7	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	1	1
Class 2	1	1	1	1	1	1	1
Class 3	1	1	1	0	0	0	0
Class 4	1	1	0	0	0	0	0
Class 5	1	1	0	0	0	0	0
Class 6	1	1	0	0	0	0	0
Class 7	1	1	0	0	0	0	0

Encounter							
Section 7	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	1	1
Class 2	1	1	1	1	1	1	1
Class 3	1	1	1	1	1	1	1
Class 4	1	1	1	0	0	0	0
Class 5	1	1	1	0	0	0	0
Class 6	1	1	1	0	0	0	0
Class 7	1	1	1	0	0	0	0

Overtaking							
Section 8	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	1	1
Class 2	1	0	0	0	0	0	0
Class 3	1	0	0	0	0	0	0
Class 4	1	0	0	0	0	0	0
Class 5	1	0	0	0	0	0	0
Class 6	1	0	0	0	0	0	0
Class 7	1	0	0	0	0	0	0

Encounter							
Section 8	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	1	1
Class 2	1	1	1	1	1	1	1
Class 3	1	1	1	1	1	1	1
Class 4	1	1	1	1	1	1	1
Class 5	1	1	1	1	1	1	1
Class 6	1	1	1	1	1	0	1
Class 7	1	1	1	1	1	1	1

Overtaking							
Section 10	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	1	1
Class 2	1	1	1	1	1	1	1
Class 3	1	1	1	1	0	0	1
Class 4	1	1	1	1	0	0	1
Class 5	1	1	0	0	0	0	0
Class 6	1	1	0	0	0	0	0
Class 7	1	1	1	1	0	0	1

Encounter							
Section 10	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	1	1
Class 2	1	1	1	1	1	1	1
Class 3	1	1	1	1	1	1	1
Class 4	1	1	1	1	0	0	1
Class 5	1	1	1	0	0	0	0
Class 6	1	1	1	0	0	0	0
Class 7	1	1	1	1	0	0	1

Overtaking							
Section 11	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	1	1
Class 2	1	1	1	1	1	1	1
Class 3	1	1	1	1	1	1	1
Class 4	1	1	1	1	0	0	1
Class 5	1	1	1	0	0	0	0
Class 6	1	1	1	0	0	0	0
Class 7	1	1	1	1	0	0	1

Encounter							
Section 11	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	1	1
Class 2	1	1	1	1	1	1	1
Class 3	1	1	1	1	1	1	1
Class 4	1	1	1	1	1	1	1
Class 5	1	1	1	1	0	0	0
Class 6	1	1	1	1	0	0	0
Class 7	1	1	1	1	0	0	1

Overtaking							
Section 17	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	0	-1
Class 2	1	1	1	1	1	0	-1
Class 3	1	1	0	0	0	0	-1
Class 4	1	1	0	0	0	0	-1
Class 5	1	1	0	0	0	0	-1
Class 6	0	0	0	0	0	0	-1
Class 7	-1	-1	-1	-1	-1	-1	-1

Encounter							
Section 17	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	0	-1
Class 2	1	1	1	1	1	0	-1
Class 3	1	1	1	1	1	0	-1
Class 4	1	1	1	1	1	0	-1
Class 5	1	1	1	1	0	0	-1
Class 6	0	0	0	0	0	0	-1
Class 7	-1	-1	-1	-1	-1	-1	-1

Overtaking							
Section 18	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	0	0	-1
Class 2	1	1	0	0	0	0	-1
Class 3	1	0	0	0	0	0	-1
Class 4	1	0	0	0	0	0	-1
Class 5	0	0	0	0	0	0	-1
Class 6	0	0	0	0	0	0	-1
Class 7	-1	-1	-1	-1	-1	-1	-1

Encounter							
Section 18	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	0	0	-1
Class 2	1	1	0	0	0	0	-1
Class 3	1	0	0	0	0	0	-1
Class 4	1	0	0	0	0	0	-1
Class 5	0	0	0	0	0	0	-1
Class 6	0	0	0	0	0	0	-1
Class 7	-1	-1	-1	-1	-1	-1	-1

Overtaking							
Section 19	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	0	0	-1
Class 2	1	1	0	0	0	0	-1
Class 3	1	0	0	0	0	0	-1
Class 4	1	0	0	0	0	0	-1
Class 5	0	0	0	0	0	0	-1
Class 6	0	0	0	0	0	0	-1
Class 7	-1	-1	-1	-1	-1	-1	-1

Encounter							
Section 19	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	0	0	-1
Class 2	1	1	0	0	0	0	-1
Class 3	1	0	0	0	0	0	-1
Class 4	1	0	0	0	0	0	-1
Class 5	0	0	0	0	0	0	-1
Class 6	0	0	0	0	0	0	-1
Class 7	-1	-1	-1	-1	-1	-1	-1

Overtaking							
Section 22	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	0	-1	-1
Class 2	1	0	0	0	0	-1	-1
Class 3	1	0	0	0	0	-1	-1
Class 4	1	0	0	0	0	-1	-1
Class 5	0	0	0	0	0	-1	-1
Class 6	-1	-1	-1	-1	-1	-1	-1
Class 7	-1	-1	-1	-1	-1	-1	-1

Encounter							
Section 22	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	0	-1	-1
Class 2	1	1	0	0	0	-1	-1
Class 3	1	0	0	0	0	-1	-1
Class 4	1	0	0	0	0	-1	-1
Class 5	0	0	0	0	0	-1	-1
Class 6	-1	-1	-1	-1	-1	-1	-1
Class 7	-1	-1	-1	-1	-1	-1	-1

Overtaking							
Section 27	Vessel classes						
	1	2	3	4	5	6	7
Class 1	0	0	0	0	0	0	-1
Class 2	0	0	0	0	0	0	-1
Class 3	0	0	0	0	0	0	-1
Class 4	0	0	0	0	0	0	-1
Class 5	0	0	0	0	0	0	-1
Class 6	0	0	0	0	0	0	-1
Class 7	-1	-1	-1	-1	-1	-1	-1

Encounter							
Section 27	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	-1	1	1	-1
Class 2	1	1	0	-1	0	0	-1
Class 3	1	0	0	-1	0	0	-1
Class 4	-1	-1	-1	-1	-1	-1	-1
Class 5	1	0	0	-1	0	0	-1
Class 6	1	0	0	-1	0	0	-1
Class 7	-1	-1	-1	-1	-1	-1	-1

Overtaking							
Section 32	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	-1	-1
Class 2	1	1	0	0	0	-1	-1
Class 3	1	0	0	0	0	-1	-1
Class 4	1	0	0	0	0	-1	-1
Class 5	1	0	0	0	0	-1	-1
Class 6	-1	-1	-1	-1	-1	-1	-1
Class 7	-1	-1	-1	-1	-1	-1	-1

Encounter							
Section 32	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	-1	-1
Class 2	1	1	1	1	1	-1	-1
Class 3	1	1	1	1	1	-1	-1
Class 4	1	1	1	0	0	-1	-1
Class 5	1	1	1	0	0	-1	-1
Class 6	-1	-1	-1	-1	-1	-1	-1
Class 7	-1	-1	-1	-1	-1	-1	-1

Overtaking							
Section 35	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	-1	-1
Class 2	1	1	0	0	0	-1	-1
Class 3	1	0	0	0	0	-1	-1
Class 4	1	0	0	0	0	-1	-1
Class 5	1	0	0	0	0	-1	-1
Class 6	-1	-1	-1	-1	-1	-1	-1
Class 7	-1	-1	-1	-1	-1	-1	-1

Encounter							
Section 35	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	-1	-1
Class 2	1	1	1	1	1	-1	-1
Class 3	1	1	1	0	0	-1	-1
Class 4	1	1	0	0	0	-1	-1
Class 5	1	1	0	0	0	-1	-1
Class 6	-1	-1	-1	-1	-1	-1	-1
Class 7	-1	-1	-1	-1	-1	-1	-1

Overtaking							
Section 39	Vessel classes						
	1	2	3	4	5	6	7
Class 1	0	0	-1	-1	-1	-1	-1
Class 2	0	0	-1	-1	-1	-1	-1
Class 3	-1	-1	-1	-1	-1	-1	-1
Class 4	-1	-1	-1	-1	-1	-1	-1
Class 5	-1	-1	-1	-1	-1	-1	-1
Class 6	-1	-1	-1	-1	-1	-1	-1
Class 7	-1	-1	-1	-1	-1	-1	-1

Encounter							
Section 39	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	-1	-1	-1	-1	-1
Class 2	1	0	-1	-1	-1	-1	-1
Class 3	-1	-1	-1	-1	-1	-1	-1
Class 4	-1	-1	-1	-1	-1	-1	-1
Class 5	-1	-1	-1	-1	-1	-1	-1
Class 6	-1	-1	-1	-1	-1	-1	-1
Class 7	-1	-1	-1	-1	-1	-1	-1

Overtaking							
Section 42	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	-1	-1
Class 2	1	0	0	0	0	-1	-1
Class 3	1	0	0	0	0	-1	-1
Class 4	1	0	0	0	0	-1	-1
Class 5	1	0	0	0	0	-1	-1
Class 6	-1	-1	-1	-1	-1	-1	-1
Class 7	-1	-1	-1	-1	-1	-1	-1

Encounter							
Section 42	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	-1	-1
Class 2	1	1	1	1	1	-1	-1
Class 3	1	1	1	1	1	-1	-1
Class 4	1	1	1	1	1	-1	-1
Class 5	1	1	1	1	1	-1	-1
Class 6	-1	-1	-1	-1	-1	-1	-1
Class 7	-1	-1	-1	-1	-1	-1	-1

Overtaking							
Section 46	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	-1	-1
Class 2	1	0	0	0	0	-1	-1
Class 3	1	0	0	0	0	-1	-1
Class 4	1	0	0	0	0	-1	-1
Class 5	1	0	0	0	0	-1	-1
Class 6	-1	-1	-1	-1	-1	-1	-1
Class 7	-1	-1	-1	-1	-1	-1	-1

Encounter							
Section 46	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	-1	-1
Class 2	1	1	1	1	1	-1	-1
Class 3	1	1	1	1	1	-1	-1
Class 4	1	1	1	1	1	-1	-1
Class 5	1	1	1	1	1	-1	-1
Class 6	-1	-1	-1	-1	-1	-1	-1
Class 7	-1	-1	-1	-1	-1	-1	-1

Overtaking							
Section 49	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	0	0	0	-1	-1
Class 2	1	1	0	0	0	-1	-1
Class 3	0	0	0	0	0	-1	-1
Class 4	0	0	0	0	0	-1	-1
Class 5	0	0	0	0	0	-1	-1
Class 6	-1	-1	-1	-1	-1	-1	-1
Class 7	-1	-1	-1	-1	-1	-1	-1

Encounter							
Section 49	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	-1	-1
Class 2	1	1	1	1	1	-1	-1
Class 3	1	1	1	1	1	-1	-1
Class 4	1	1	1	1	1	-1	-1
Class 5	1	1	1	1	1	-1	-1
Class 6	-1	-1	-1	-1	-1	-1	-1
Class 7	-1	-1	-1	-1	-1	-1	-1

Overtaking							
Section 50	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	0	0	0	-1	-1
Class 2	1	0	0	0	0	-1	-1
Class 3	0	0	0	0	0	-1	-1
Class 4	0	0	0	0	0	-1	-1
Class 5	0	0	0	0	0	-1	-1
Class 6	-1	-1	-1	-1	-1	-1	-1
Class 7	-1	-1	-1	-1	-1	-1	-1

Encounter							
Section 50	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	-1	-1
Class 2	1	1	1	1	1	-1	-1
Class 3	1	1	1	1	0	-1	-1
Class 4	1	1	1	1	0	-1	-1
Class 5	1	1	0	0	0	-1	-1
Class 6	-1	-1	-1	-1	-1	-1	-1
Class 7	-1	-1	-1	-1	-1	-1	-1

Overtaking							
Section 55	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	0	0	0	-1	-1
Class 2	1	0	0	0	0	-1	-1
Class 3	0	0	0	0	0	-1	-1
Class 4	0	0	0	0	0	-1	-1
Class 5	0	0	0	0	0	-1	-1
Class 6	-1	-1	-1	-1	-1	-1	-1
Class 7	-1	-1	-1	-1	-1	-1	-1

Encounter							
Section 55	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	-1	-1
Class 2	1	1	1	1	1	-1	-1
Class 3	1	1	1	1	1	-1	-1
Class 4	1	1	1	1	1	-1	-1
Class 5	1	1	1	1	1	-1	-1
Class 6	-1	-1	-1	-1	-1	-1	-1
Class 7	-1	-1	-1	-1	-1	-1	-1

Overtaking							
Section 59	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	0	0	0	-1	-1
Class 2	1	0	0	0	0	-1	-1
Class 3	0	0	0	0	0	-1	-1
Class 4	0	0	0	0	0	-1	-1
Class 5	0	0	0	0	0	-1	-1
Class 6	-1	-1	-1	-1	-1	-1	-1
Class 7	-1	-1	-1	-1	-1	-1	-1

Encounter							
Section 59	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	-1	-1
Class 2	1	1	1	1	1	-1	-1
Class 3	1	1	1	1	1	-1	-1
Class 4	1	1	1	1	1	-1	-1
Class 5	1	1	1	1	1	-1	-1
Class 6	-1	-1	-1	-1	-1	-1	-1
Class 7	-1	-1	-1	-1	-1	-1	-1

Overtaking							
Section 60	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	0	0	0	-1	-1
Class 2	1	0	0	0	0	-1	-1
Class 3	0	0	0	0	0	-1	-1
Class 4	0	0	0	0	0	-1	-1
Class 5	0	0	0	0	0	-1	-1
Class 6	-1	-1	-1	-1	-1	-1	-1
Class 7	-1	-1	-1	-1	-1	-1	-1

Encounter							
Section 60	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	-1	-1
Class 2	1	1	1	1	1	-1	-1
Class 3	1	1	1	1	0	-1	-1
Class 4	1	1	1	1	0	-1	-1
Class 5	1	1	0	0	0	-1	-1
Class 6	-1	-1	-1	-1	-1	-1	-1
Class 7	-1	-1	-1	-1	-1	-1	-1

Overtaking							
Section 66	Vessel classes						
	1	2	3	4	5	6	7
Class 1	-1	-1	-1	-1	-1	-1	-1
Class 2	-1	-1	-1	-1	-1	-1	-1
Class 3	-1	-1	-1	-1	-1	-1	-1
Class 4	-1	-1	-1	-1	-1	-1	-1
Class 5	-1	-1	-1	-1	-1	-1	-1
Class 6	-1	-1	-1	-1	-1	-1	-1
Class 7	-1	-1	-1	-1	-1	-1	-1

Encounter							
Section 66	Vessel classes						
	1	2	3	4	5	6	7
Class 1	-1	-1	-1	-1	-1	-1	-1
Class 2	-1	-1	-1	-1	-1	-1	-1
Class 3	-1	-1	-1	-1	-1	-1	-1
Class 4	-1	-1	-1	-1	-1	-1	-1
Class 5	-1	-1	-1	-1	-1	-1	-1
Class 6	-1	-1	-1	-1	-1	-1	-1
Class 7	-1	-1	-1	-1	-1	-1	-1

Overtaking							
Section 68	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	1	1
Class 2	1	0	0	0	0	0	0
Class 3	1	0	0	0	0	0	0
Class 4	1	0	0	0	0	0	0
Class 5	1	0	0	0	0	0	0
Class 6	1	0	0	0	0	0	0
Class 7	1	0	0	0	0	0	0

Encounter							
Section 68	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	1	1
Class 2	1	1	1	1	1	1	1
Class 3	1	1	1	1	1	1	1
Class 4	1	1	1	1	1	1	1
Class 5	1	1	1	1	1	1	1
Class 6	1	1	1	1	1	0	1
Class 7	1	1	1	1	1	1	1

Overtaking							
Section 69	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	1	-1
Class 2	1	0	0	0	0	0	-1
Class 3	1	0	0	0	0	0	-1
Class 4	1	0	0	0	0	0	-1
Class 5	1	0	0	0	0	0	-1
Class 6	1	0	0	0	0	0	-1
Class 7	-1	-1	-1	-1	-1	-1	-1

Encounter							
Section 69	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	1	-1
Class 2	1	1	1	1	1	1	-1
Class 3	1	1	1	1	1	1	-1
Class 4	1	1	1	1	1	1	-1
Class 5	1	1	1	1	1	1	-1
Class 6	1	1	1	1	1	0	-1
Class 7	-1	-1	-1	-1	-1	-1	-1

Overtaking							
Section 71	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	1	-1
Class 2	1	0	0	0	0	0	-1
Class 3	1	0	0	0	0	0	-1
Class 4	1	0	0	0	0	0	-1
Class 5	1	0	0	0	0	0	-1
Class 6	1	0	0	0	0	0	-1
Class 7	-1	-1	-1	-1	-1	-1	-1

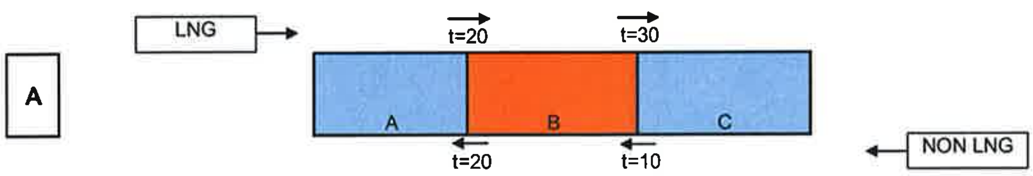
Encounter							
Section 71	Vessel classes						
	1	2	3	4	5	6	7
Class 1	1	1	1	1	1	1	-1
Class 2	1	1	1	1	1	1	-1
Class 3	1	1	1	1	1	1	-1
Class 4	1	1	1	1	1	1	-1
Class 5	1	1	1	1	1	1	-1
Class 6	1	1	1	1	1	0	-1
Class 7	-1	-1	-1	-1	-1	-1	-1

J: TIME AROUND RESERVATION MODELLING (TAR)

As mentioned in section 1.5, the TBA approach for modeling of LNG carriers requires the use of a Time Around Reservation (TAR). This appendix will describe why TAR is applied. In short, the TAR is used to give extra 'space' to the LNG carriers in order to make sure they will not be delayed by non-LNG carriers. Regard the example below.

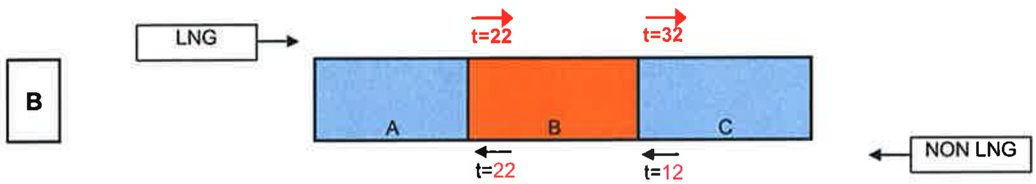
* *Situation A*

The LNG carrier will make reservations for section B from t=20 to t=30. The non-LNG vessel will check his arrival (t=10) and departure (t=20) and notices that he does not need to adjust his departure time from Maascentre or its terminal. He will have left section B when the LNG carrier arrives.



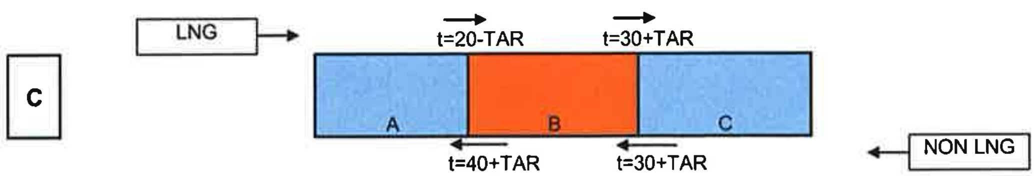
* *Situation B*

Before arriving at section B, the non-LNG vessel has experienced unforeseen delay of 2 minutes. This causes him to still be present in section B when the LNG carriers arrives, causing the LNG carrier to wait. Because the LNG carrier has made reservations for its entire track, this delay is unacceptable.



* *Situation C*

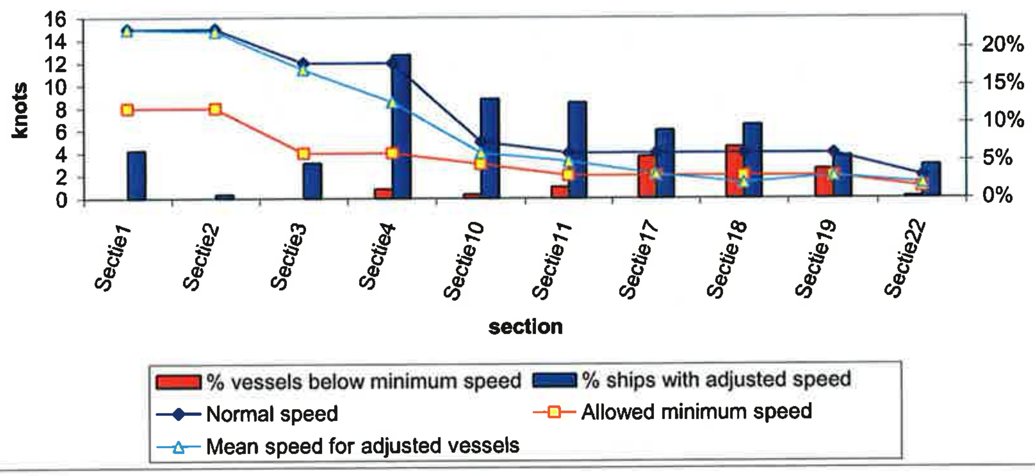
To prevent delay of the LNG carrier by the small unforeseen delay of the non-LNG vessel (situation B), Time Around Reservation is introduced. This TAR is an extra time set around the reservations of LNG carriers. Based on this 'larger' reservation, the non-LNG vessel will adjust his departure time at Maascentre of terminal.



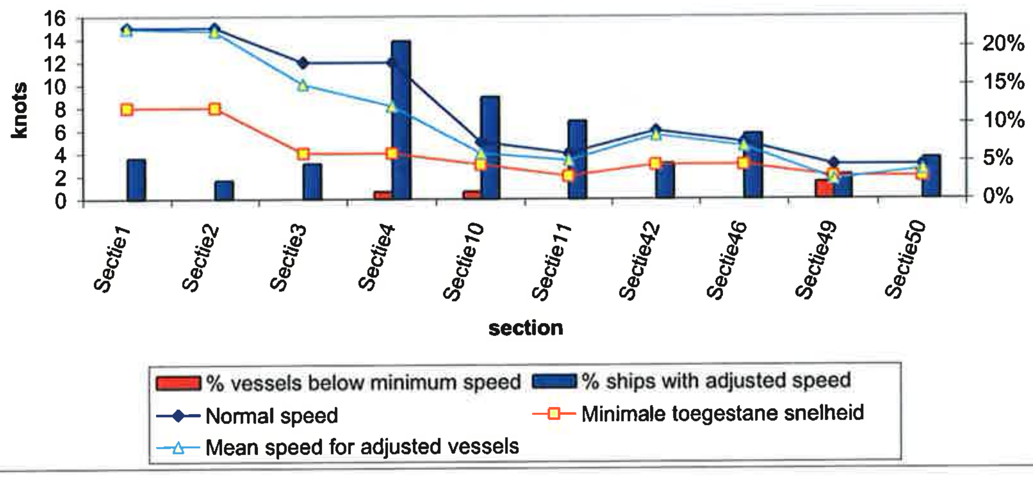
Various experiments have shown that a TAR of 4 minutes ensures the undelayed passage of LNG carriers. The use of TAR has insignificant impact on the Turn Around Time of non-LNG carriers.

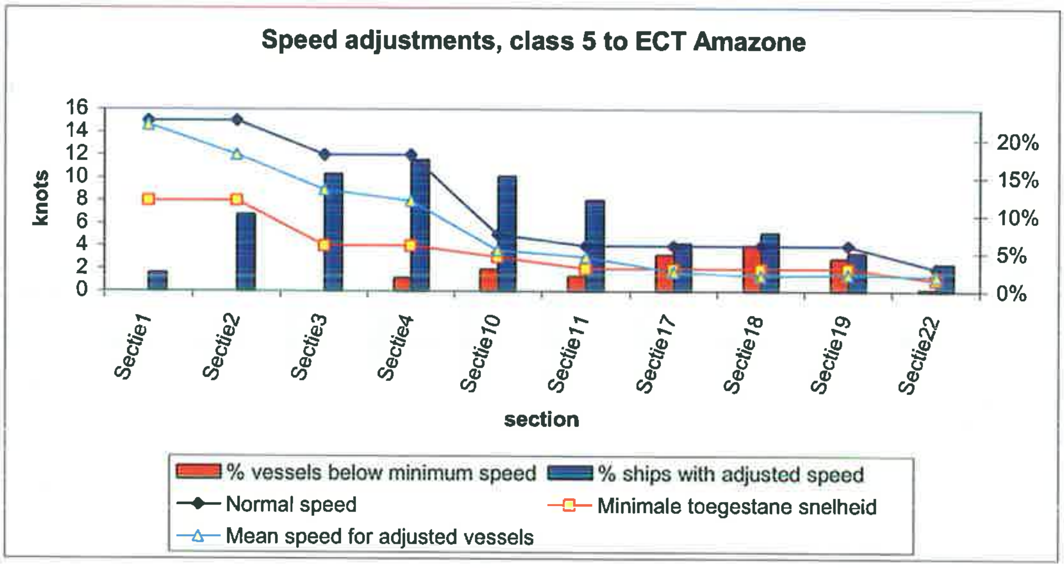
K: Validation speed adjustments

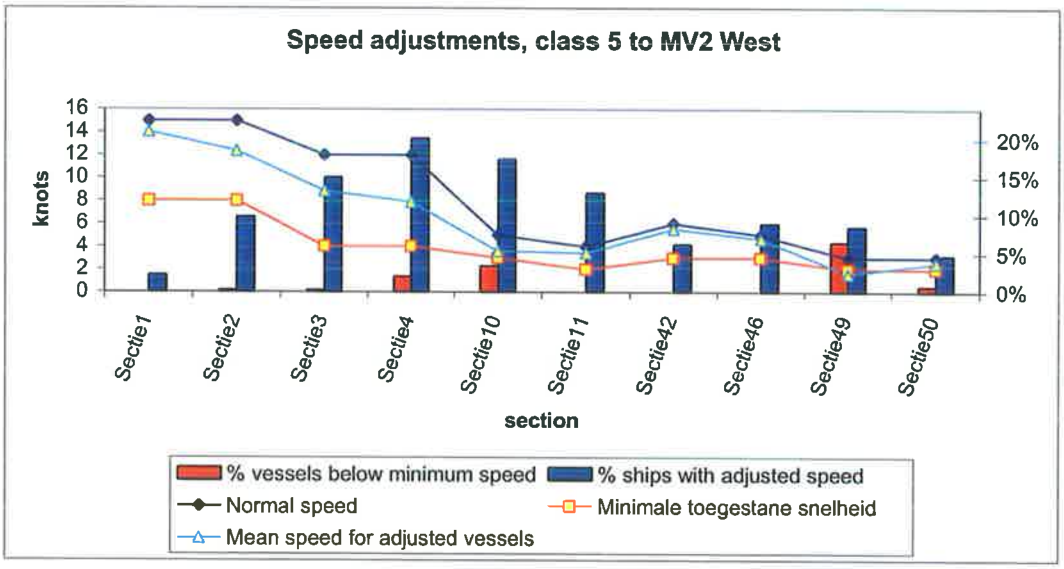
Speed adjustments, class 4 to ECT Amazone



Speed adjustments, class 4 to MV2 West




Speed adjustments, class 5 to ECT Amazone
knots
16
14
12
10
8
6
4
2
0
20%
15%
10%
5%
0%
Sectie1
Sectie2
Sectie3
Sectie4
Sectie10
Sectie11
Sectie17
Sectie18
Sectie19
Sectie22
section
% vessels below minimum speed
% ships with adjusted speed
Normal speed
Minimale toegestane snelheid
Mean speed for adjusted vessels


Speed adjustments, class 5 to MV2 West
knots
16
14
12
10
8
6
4
2
0
20%
15%
10%
5%
0%
Sectie1
Sectie2
Sectie3
Sectie4
Sectie10
Sectie11
Sectie42
Sectie46
Sectie49
Sectie50
section
% vessels below minimum speed
% ships with adjusted speed
Normal speed
Minimale toegestane snelheid
Mean speed for adjusted vessels