



**BETTER SHIPS, BLUE OCEANS**

## **Collision frequencies for platform L07-F**

A SAMSON case study

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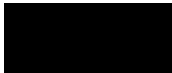
# Collision frequencies for platform L07-F

## A SAMSON case study

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## 1 INTRODUCTION

ENI has requested MARIN to perform a ship collision risk study for a new platform location L07-F in the North Sea. The proposed location for the platform is 26 nm northwest of Vlieland, see Figure 1-1.

This study is performed for two scenarios, one that is based on the current traffic around the platform (2024) and one that takes into account one of the proposed wind farm search areas “Lagelander”. Within the latest “Partiële Herziening of the “Program Noordzee”<sup>1</sup> the windfarm area of “Lagelander” will be reconsidered. Due to the windfarm area “Lagelander” the traffic near the proposed location L07-F will change (increase), therefore both scenarios (2024 and representing 2030) are taken into account in this study.

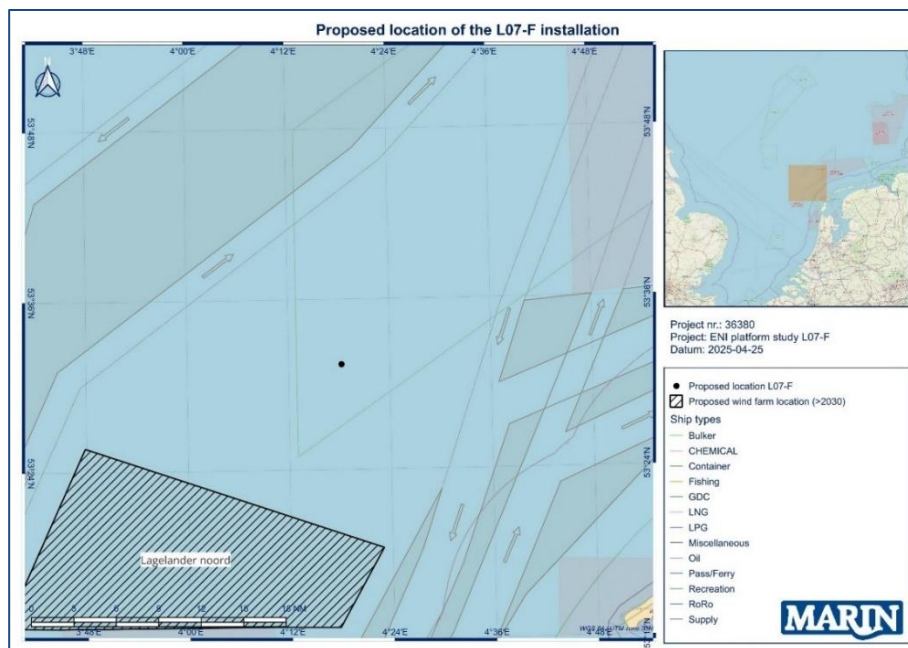


Figure 1-1 Location of the platform L07-F with surrounding traffic separation schemes.

This report describes the assumptions, approach and results of the collision risk assessment for the platform. A short description of the model is given in Chapter 2. Chapter 3 contains the different input parameters and some traffic pictures. The results are presented in Chapter 4 and the overall findings of this study are presented in Chapter 5.

### 1.1 Objectives

The objective of this study is to determine the collision risk for platform L07-F for the scenario representing the current traffic load around the platform location and a future situation 2030 (including wind farm Lagelander).

This is achieved by determining the collision frequencies for the offshore installation by passing ships based on recent AIS data from 2024. For the future situation the main traffic routes passing the windfarms are relocated, resulting in more traffic passing the proposed location of L07-F.

The collision frequencies are given for various energy classes, based on the characteristics of the colliding ships.

Determining the consequences of a collision for the platform is not part of the study.

<sup>1</sup> <https://www.platformparticipatie.nl/programmanoordzee/default.aspx>

## 2 DESCRIPTION OF THE MODEL

This chapter gives a description of the model used to determine the collision risk. In the first section, the general outline of the model is presented. The second section describes the part of SAMSON, which is used to calculate frequencies and impacts of ship-platform collisions.

### 2.1 AIS-data

Since January 2005, it is mandatory for all merchant vessels over 300 Gross Tonnage (GT) to send out AIS-messages. These messages contain information about the ship, such as the Maritime Mobile Service Identity (MMSI)-number, ship type, ship size, and position of the vessel. The messages containing the GPS-position of the vessel are broadcasted every 2 to 10 seconds. This system is developed for collision avoidance, but it is also a valuable source of information on the behaviour of ships. The AIS-data is received by base stations of the Dutch Coastguard along the coast and on some offshore platforms and sent to the Coastguard Centre in Den Helder. MARIN is allowed to use the data for research applications, for example to improve and/or build up the traffic image of the whole North Sea. In addition, analyses of the data are performed to improve the knowledge about the behaviour of vessels at sea.

### 2.2 Traffic model

The AIS-data is combined with modules of the SAMSON-model: the Safety Assessment Model for Shipping and Offshore in the North Sea. This model was developed for the Dutch Ministry of Transport, Public Works and Water Management and is used for the calculation of frequencies and consequences of all sorts of accidents at sea. An important input for SAMSON is the traffic database, consisting of waypoints and connecting links. For each link (line), the number of movements per year for certain ship types and sizes is defined in the traffic database.

### 2.3 Ship – Platform collision model

Within this study, the ship-platform collision model of SAMSON is used. This is one of the casualty models of SAMSON. Due to different causes, a ship can collide with a platform or drilling platform. In the SAMSON-model, two types of collisions with an object are distinguished: ramming and drifting collisions. Both are shortly described below:

- A **ramming** collision occurs when a ship, during normal operation, is on a collision course with a platform and then a navigational error occurs. This error is not detected until after the point of no return, and then the ship collides with the platform. The collision may be at high or low speed depending on the time lapse between the point of no return and the implementation of a corrective action after the detection of the error.
- A **drifting** collision occurs when a ship in the vicinity of a platform/rig experiences a failure in the propulsion engine or in the steering equipment. Since the ship slowly becomes uncontrollable as it loses speed, the combined effect of wind, waves and current may carry it towards the platform. If dropping anchor does not help or is not practical and the repair time exceeds the available time, the ship may collide against the platform/rig. This generally happens at a low speed.

A more theoretical description of the model is enclosed in APPENDIX 1.

### 2.3.1 Probability calculation

For both types of collisions, two probabilities are calculated:

- the probability on the initial event leading to the collision
- the probability that this event will in fact lead to a collision

The product of both probabilities is the probability of a collision. In this section, some explanation is given on the considerations in the determination of the probabilities.

For *ramming*, the initial event is a *navigational error* resulting in a situation in which the ship is on a collision course with the platform. Such an error can for instance occur in case the navigator has left the bridge, or a mistake is made in setting the course, e.g. through incorrect instruments or reading there-of. Heart attack, drunkenness and sleep deprivation are contributory factors to the navigational error. Other infrequent factors are criminal negligence of duty and suicidal behaviour. It is also known that vessels use the platform as a fixed waypoint for navigation: this means that a vessel is oriented towards the installation with the intent of changing navigating away from the collision course well before arriving at the location.

If the error happens at a large distance from the platform, there is a probability that the error can be corrected before the ship collides with the platform. For instance, when the navigator has left the bridge and finds his vessel on a collision course upon his return, he will try to avoid the collision by giving a "full astern" or by initiating an emergency turn. This might prevent the collision or at least reduce the impact.

For *drifting*, the initial event is an *engine failure* resulting in a situation in which the ship is on a drifting collision course with the platform. In this case, there is a probability that the engine is repaired in time and that as such a collision can be averted. Another possibility is that the vessel successfully drops its anchor before it hits the platform. However, dropping the anchor is not always possible due to the presence of cables and pipelines. In addition, the success rate of the action, dropping the anchor, depends strongly on the weather conditions. A number of other methods like ballasting, use of rudder and bow thrusters can be used to obtain a small change in the drifting direction of the ship.

### 2.3.2 Kinetic energy classes

The result of the calculations is the collision frequency per year, divided over a number of kinetic energy classes. As such, collisions with high and low impact energy can be distinguished. The kinetic energy for the ramming and drifting collision used in these calculations is the worst-case energy value as if the contact with the platform or rig takes place in the direction of the movement of the centre of gravity of the ship. This is certainly not always the case, because of the following reasons:

- for ramming, a platform/rig is not always hit frontally. As a result, a part of the energy may not have to be resisted by the platform;
- for drifting, the first contact point can be spread over the whole length of the ship. The impact energy only approaches the energy value from the calculations when the first contact point lies near the middle of the ship.

### 3 INPUT FOR THE COLLISION RISK CALCULATIONS

This chapter describes the input for the SAMSON model. The input consists of two main elements. The characteristics of the platform, the size and heading, but also the position which is a parameter for the metocean traffic data to be used. This is described in section 3.1. Second, section 3.2, the traffic database, is an element that defines the exposure of vessel traffic to the platform location.

#### 3.1 Platform characteristics

The location of the platform (Table 3-1) was provided by ENI. The orientation of the platform, within the SAMSON-model, is defined as the smallest angle between the geographical North and the direction of the longest side of the platform.

Table 3-1 Platform characteristics used in calculations.

	Position [UTM]		Length [m]	Width [m]	Orientation (clock wise)
	x	y			
L07-F	586496.47	5931302.61	30	28.5	135°

Although the upper structure of the platform is high above the water surface, the length and width of the largest deck level are taken as the basis for the platform dimensions. This results in a higher collision frequency than when the jacket is taken as the platform contour. The main reason to do this is that the ships, which are considered to actually threaten the platform integrity when colliding, reach the upper structure. These are the larger vessels, small vessels could sail below the upper structure without touching the upper structure. The result of this assumption is an conservative estimation of the collision frequency.

#### 3.2 Traffic database

AIS data for the year 2024 from the Dutch coastguard was collected for a region around the platform.

In Figure 3-1 all tracks from May and October 2024 of so-called route bound vessels (cargo, tanker and passengers) in the neighbourhood of the platform location are presented and a similar picture for the non route bound vessels (fishing, work ad recreational vessels) is depicted in Figure 3-2. Figure 3-1 shows that in the present situation a number of vessel pass at the south side of the platform location. These are mainly cargo vessels (bulker and container) sailing between the Netherlands and the UK.

All traffic is used to create a route network with weighted links, where the weight corresponds to the number of ships that traverse that link on a yearly basis. A density map is created from those AIS data points that cannot be assigned to a link, using square cells with an area of 16 km<sup>2</sup> (4 x 4 km cells).

The route network created in the cumulative effects research [Ref 1.] has been used as a basis for the route bound traffic database. The traffic intensities on the various routes has been determined using the AIS-data for 2024. Traffic that could not be assigned to the route structure was defined as non route bound traffic and added to the density map that is used as input for SAMSON. The final input is shown in Figure 3-3. Due to windfarm "Lagelander" some existing traffic routes that cross the proposed windfarm area in the current situation are reallocated. These are mainly vessels crossing the area in east-west direction, sailing between the Netherlands and the UK. These vessels will sail more north in the situation in which the windfarm will be present, resulting in more traffic passing the proposed platform location for L07-F. The situation representing 2030 does not include an increase in traffic per link, it only represents a relocations of the present traffic to include the proposed windfarms. The resulting route bound traffic database is shown in Figure 3-4.

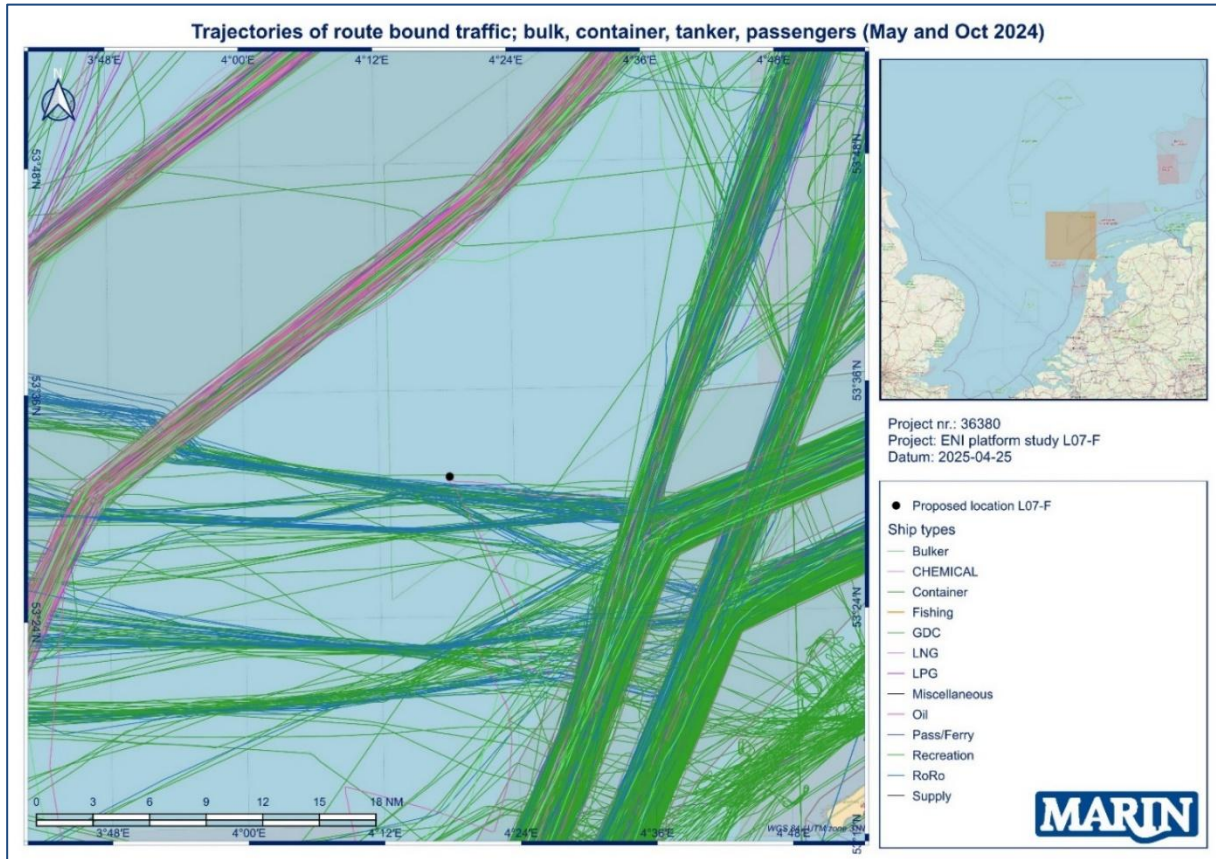


Figure 3-1 The trajectories of route bound vessels in the area of platform L07-F in May and October 2024.

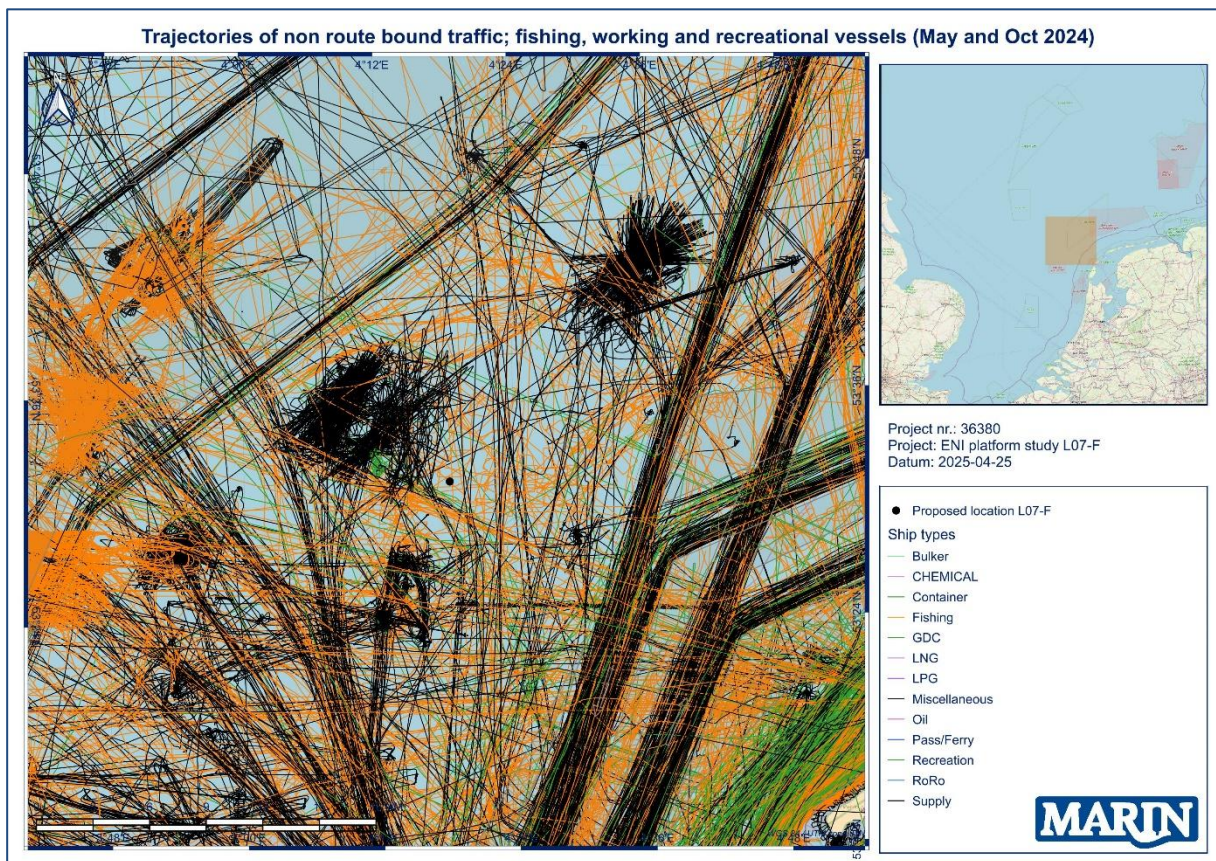


Figure 3-2 A sample of the trajectories of non route bound vessels in the area of platform L07-F in May and October 2024.

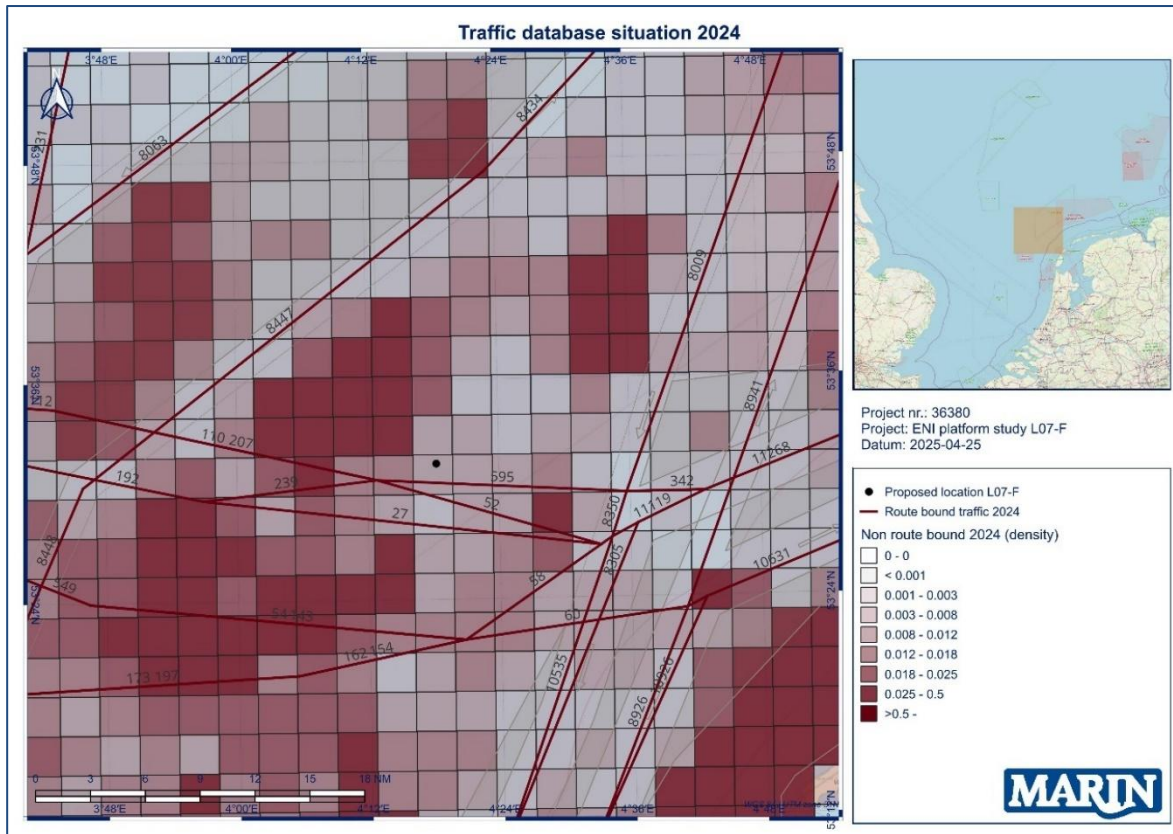


Figure 3-3 The traffic database. The lines represent the route network. The numbers on the lines are the number of ships that traverse the line in a year. "density" is the density map for NRB traffic, it corresponds to the average number of ships inside a grid cell during 2024.

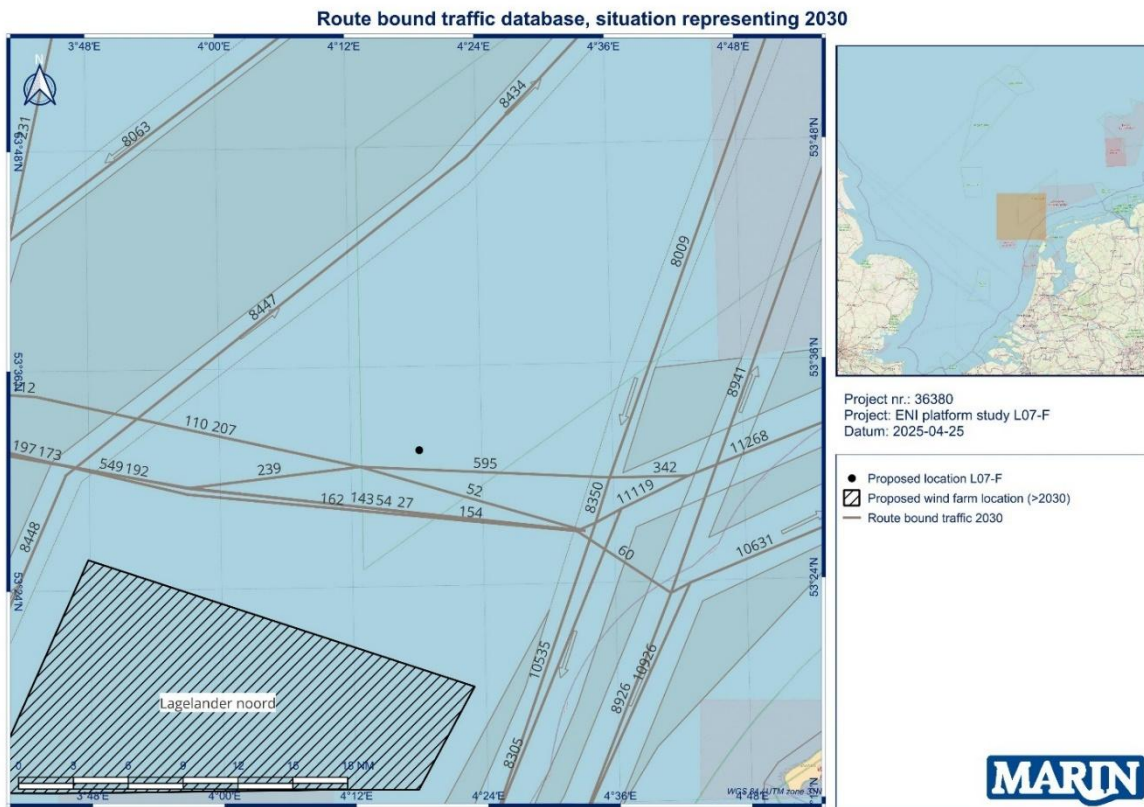


Figure 3-4 Route bound traffic database for the situation including windfarm "Lagelander" (2030)

## 4 RESULTS

The SAMSON model has been run for the 2024 traffic database and a traffic database representing the 2030 scenario (including “Lagelander” windfarm). The results are described in this chapter.

The overall collision frequencies for the proposed location are presented in Table 4-1. Collision frequencies are split per size and energy class and visualized in Figure 4-1, Figure 4-2, Table 4-2 and Table 4-3.

*Table 4-1 Summary of collision frequencies for the platforms using traffic from 2024 and expected situation in 2030.*

Platform	Year	Non-route bound <sup>2</sup>	Route bound	Total probability	Once every ... year
L07-F	2024	3.30E-04	2.80E-04	6.10E-04	1640
L07-F	2030	3.35E-04	2.94E-04	6.29E-04	1589

*Table 4-2 The different size classes for ships for RB and NRB traffic.*

Size	Non-route bound (GT)	Route bound (GT)
1	0 - 50	0 - 1000
2	50 - 100	1000 - 1600
3	100 - 500	1600 - 5000
4	500 - 1000	5000 - 10000
5	1000 - 1600	10000 - 30000
6	1600 - 5000	30000 - 60000
7	5000 - 10000	60000 - 100000
8	10000 - 1000000	100000 - 1000000

<sup>2</sup> Traffic that could not be assign to the main traffic routes (route structure) that are part of the route bound traffic database

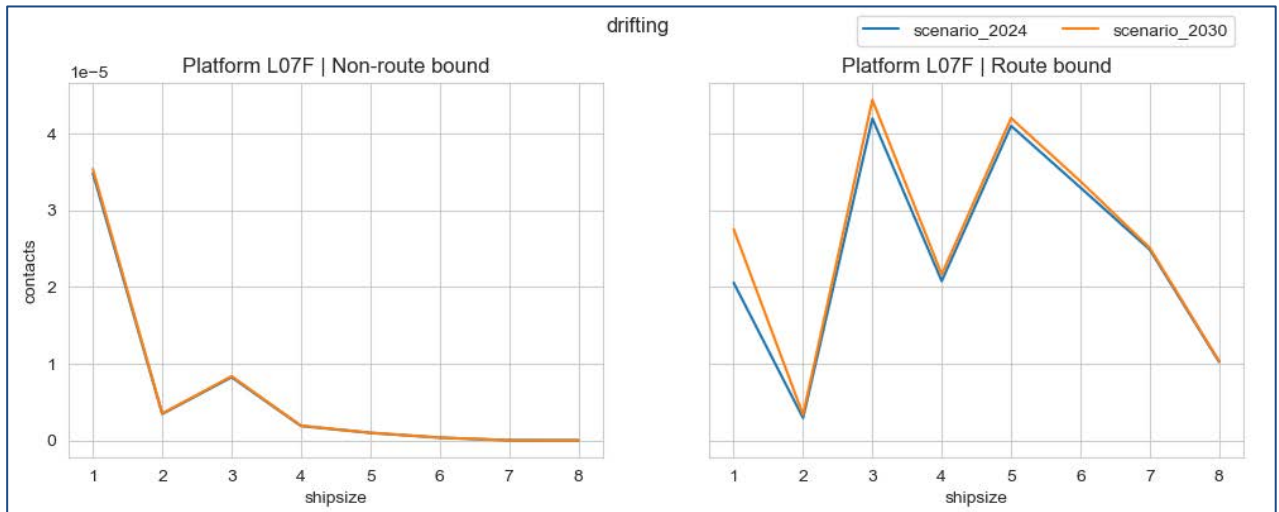


Figure 4-1 The probability of drifting collisions per size class.

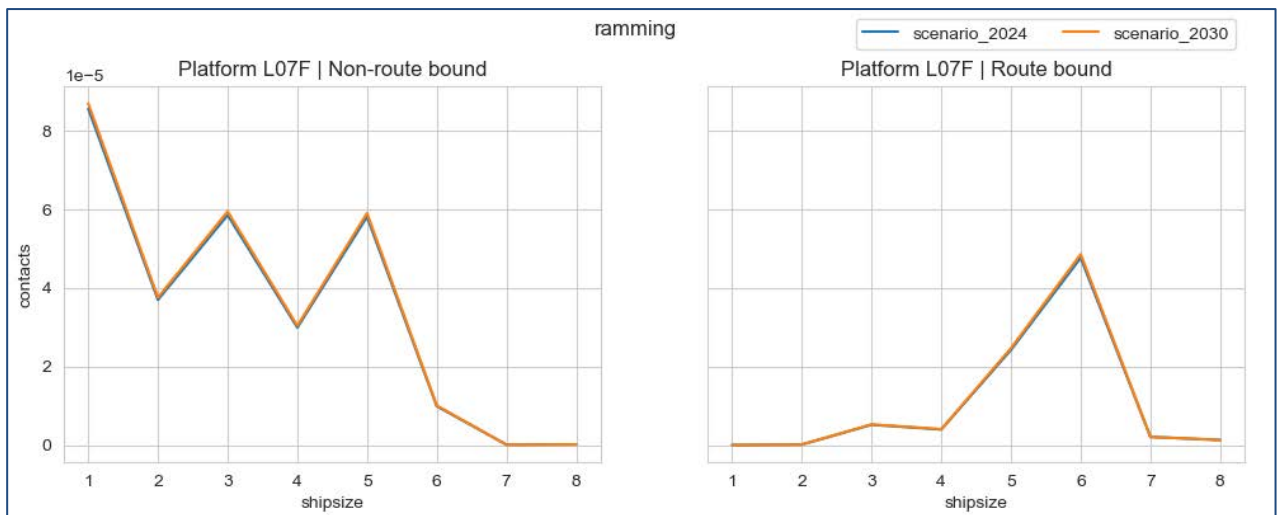


Figure 4-2 The probability of ramming collisions per size class.

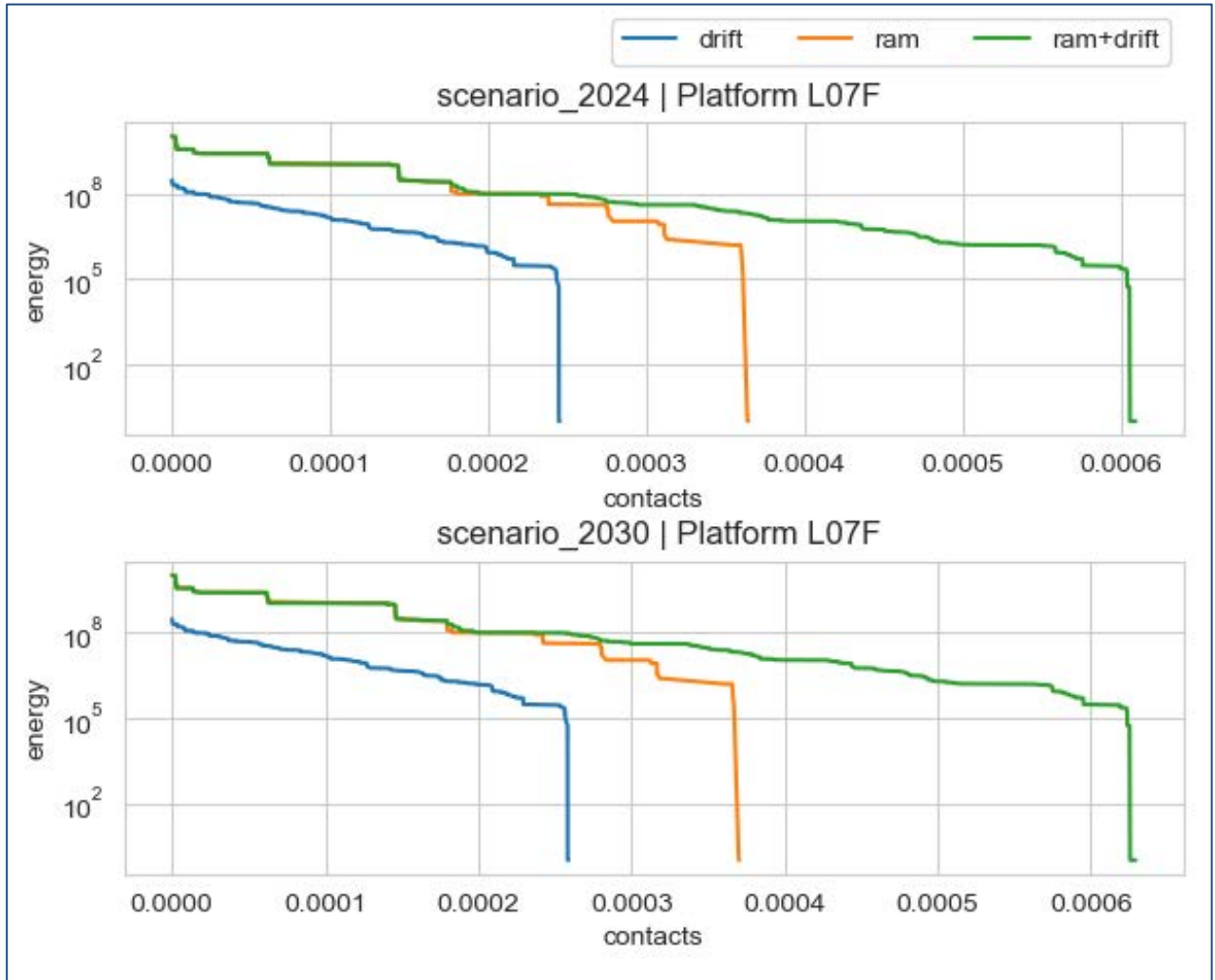


Figure 4-3 Frequency of ramming's / driftings / "rammings+driftings" per year above a certain kinetic energy value for the platform and both scenarios. Note that the x axes are different across the plots.

Table 4-3 Collision frequencies per year for different energy classes – scenario 2024

Platform	Energy (MJoules)	Drifting	Ramming	Total	Once every ... year
L07-F	<1	4.62E-05	4.59E-06	5.08E-05	19685
	1-3	3.87E-05	4.81E-05	8.68E-05	11521
	3-5	2.14E-05	2.08E-07	2.16E-05	46296
	5-10	2.41E-05	4.54E-06	2.86E-05	34965
	10-15	2.65E-05	3.10E-05	5.74E-05	17422
	15-50	4.72E-05	3.78E-05	8.50E-05	11765
	50-100	2.72E-05	5.82E-05	8.54E-05	11710
	100-200	1.36E-05	3.52E-06	1.71E-05	58480
	>200	4.25E-07	1.76E-04	1.77E-04	5650

Table 4-4 Collision frequencies per year for different energy classes – scenario 2030

Platform	Energy (MJoules)	Drifting	Ramming	Total	Once every ... year
L07-F	<1	4.97E-05	4.66E-06	5.44E-05	18382
	1-3	4.42E-05	4.89E-05	9.31E-05	10741
	3-5	2.23E-05	2.12E-07	2.25E-05	44444
	5-10	2.51E-05	4.62E-06	2.97E-05	33670
	10-15	2.74E-05	3.15E-05	5.88E-05	17007
	15-50	4.81E-05	3.84E-05	8.65E-05	11561
	50-100	2.79E-05	5.91E-05	8.70E-05	11494
	100-200	1.37E-05	3.59E-06	1.73E-05	57803
	>200	4.28E-07	1.79E-04	1.80E-04	5556

## 5 CONCLUSION

The collision frequency was determined for the proposed location of platform L07-F. The total collision frequency was determined to be  $6.10E-04$  (once every 1640 years) for the scenario based on the traffic situation of 2024. For the future situation including the windfarm "Lagelander" the total expected collision frequency is  $6.29E-4$  (once every 1589 years).

## REFERENCES

- [Ref 1.] Y. Koldenhof  
SAMSON-analyse Wind op Zee; versnellingsopgave 2030 met doorkijk naar 2040  
MARIN, 31797-1-MO-rev.1.0, August 2022

## ABBREVIATIONS

AIS	= Automatic Identification System
RB	= Route bound
NRB	= Non-route bound
SAMSON	= Safety Assessment Model for Shipping and Offshore on the North Sea
TSS	= Traffic Separation Scheme
NUI	= Normally Unattended Installation
HKW	= Hollandse Kust West
HKZ	= Hollandse Kust Zuid
WTW	= Walk to Work system
DP	= Dynamic Positioning
ERTV	= Emergency Response Towing Vessel
SAMSON	= Safety Assessment Model for Shipping and Offshore in the North Sea
MMSI	= Maritime Mobile Service Identity
IALA	= International Association of Marine Aids to Navigation and Lighthouse Authorities
VTS	= Vessel Traffic Services
IMCA	= International Marine Contractors Association

# APPENDIX

## APPENDIX 1 DESCRIPTION OF THE SHIP-OBJECT CONTACT MODEL SAMSON

### Description of the ship-object contact model

Two causes of contact between a ship and an object are revealed during accident analyses:

- a contact as a result of a navigational error,
- a contact as a result of a mechanical failure of the engine or steering engine.

The first type is due to a human failure in the vicinity of an object that cannot be recovered or is first recovered after the point of no return. In some cases, the forces of nature are too large to be compensated for with the power on board. In these cases, the navigator made the mistake to be too close to an object and the vessel has insufficient means to deal with the situation.

The second type is the result of a power failure near an object.

Both accident types have a common characteristic: the vessels are close to an object.

### Contact with an object as a result of a navigational error (ramming)

In Figure A1-1 a vessel is shown at a distance  $x$  from the last waypoint. The vessel proceeds to the next waypoint where the vessel has to change course. For a given position of the vessel, 3 lines are drawn on either side of the vessel track with an interval of  $10^\circ$ . The object near the vessel is defined as a selection of straight lines between different points. These straight lines are characterized by two geographic positions. In the figure, they are denoted as 1 and 2.

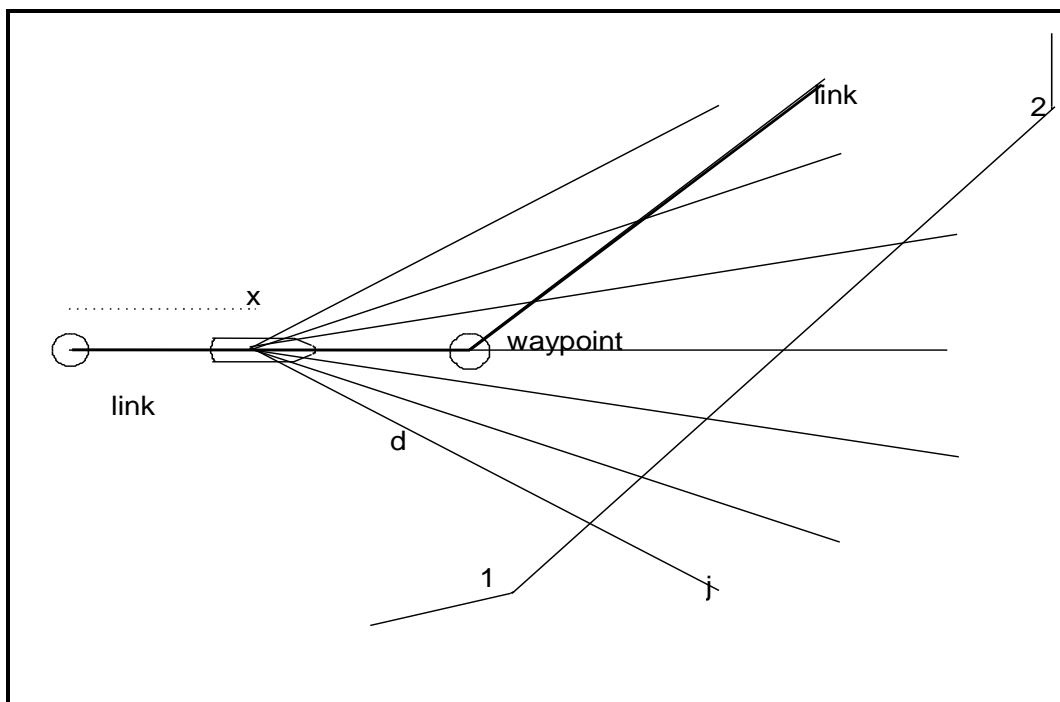


Figure A1-1 Definition of ramming opportunity

Contact with the object (ramming) due to a navigational error can start at every position. The speed at which the navigational error occurs is assumed to be equal to the service speed. The distance to the object, which is expressed by the number of ship lengths, is determined both for the initial course line and for the six new lines. The directions are weighed as follows: 0.05, 0.1, 0.2, 0.3, 0.2, 0.1, 0.05. The number of ship lengths that are available in each direction towards the object indicate the available time for the navigator to mitigate the consequences of his mistake. The probability of a navigational error is related to the distance as follows:

$$p_{nav} = \int_{x_1}^{x_2} e^{-a \frac{d_{\psi}(x)}{L_i}} dx \quad (1)$$

with:

a	=	Danger measure
$d_{\psi}$	=	Distance of the vessel on the link to the object in direction $\psi$
$L_i$	=	Ship length of class i
x	=	Position of the vessel on a link
$p_{nav}$	=	probability of a navigational error

The best fit between the predicted number of accidents and observed number was found for  $a = 0.1$ . This means that the probability of a contact by a navigational error at 6 ship lengths is more than 4 times as large as the probability after a navigational error at 20 ship lengths away from the object. The ramming opportunity is now given by the following expression.

$$RO_k = \sum_{\psi} \sum_i p_{\psi} N_{ij} \int_{x_1}^{x_2} e^{-a \frac{d_{\psi}(x)}{L_i}} dx \quad (2)$$

with

$N_{ij}$	=	Number of vessels using link j of vessel class i
$p_{\psi}$	=	Probability of a course in direction $\psi$
$RO_k$	=	Ramming opportunity for an object on link k

The number of contacts can be calculated when the ramming opportunity is known:

$$\#contacts_{NE} = CASRAT_{RO} \sum_k RO_k \quad (3)$$

with:

NE	=	navigational error
$CASRAT_{RO}$	=	matrix with contact rate for contacts due to a navigational error, $0.65 \cdot 10^{-4}$ for each ship.

### Contact as a result of an engine failure (drifting)

A contact with an object as a result of an engine failure can, in principle, be initiated at any position of the vessel. The vessel can drift in any direction indicated by the environmental conditions. The distance to the closest object line is a measure for the time available to repair the engine. In this model, the drifting speed is assumed to depend on the Beaufort class.

The probability of an engine failure with a given duration is determined according to the following information:

- a failure between 2 and 6 hours has a frequency of 3R
- a failure of more than 6 hours has a frequency of R

with:

R = probability that a vessel has an engine failure of more than 6 hours (number/year)

The value of R is determined using the Lloyds casualty database by the assumption that all vessels with an engine failure of more than 6 hours are assisted by a tug. This number is known. The corresponding value of R equals  $10^{-6}$ /year.

To determine whether drifting results in a contact with an object, two times should be compared:

1. the drifting time: the time between the initiation of the engine failure and the time that the vessels hits an object, and
2. the repair time: the duration of the engine failure.

In other words: a contact occurs when the engine repair time is longer than the drifting time.

We suppose that the engine failure rate can be described by a probability function as follows:

$$p(t) = ce^{-t/T} \quad (4)$$

with:

p(t) = probability of engine failure of a certain time (t)  
 c = first engine failure parameter  
 t = engine time failure  
 T = second engine failure parameter

The parameters c and T are calculated using the number of failures with a duration of more than 6 hours and the number of failures between 2 and 6 hours.

$$c = 2.774R$$

$$T = 2.885$$

The probability that the duration of engine failure is larger than the drifting time is given as follows:

$$P(t > t_s) = \int_{t_s}^{\infty} 2.774 \text{Re}^{-t/2.885} dt = 8 \text{Re}^{-t_s/2.885} \quad (5)$$

with:

$t_s$  = drifting time

The number of vessels that will hit the object on the danger miles  $DM$  for a given link  $k$  for Beaufort scale  $b$  can be determined by the provision of the danger miles  $DM$ :

$$DM_{bk} = \sum_n \sum_{n\psi} \sum_i p_n p_{n\psi} N_{ik} \int_{x_1}^{x_2} P(t > d_{n\psi}(x) / v_{dbin}) dx \quad (6)$$

In this equation the following parameters are used:

$b$	= Beaufort class
$DM_{bk}$	= Danger miles for link $k$ and Beaufort scale $b$
$d_{n\psi}$	= Distance of a point $x$ on a link to the object
$i$	= ship class
$k$	= link
$n$	= loading condition
$N_{ik}$	= Number of vessels in vessel class $i$ on link $k$
$p_{n\psi}$	= Probability of a wind direction
$p_n$	= Probability of a loading condition
$v_{dbin}$	= Resulting drifting speed of ship $i$ in loading condition $n$ at Beaufort scale number $b$
$x$	= Integration limits are determined by the geographical constraints

The number of contacts is determined by a summation of all links multiplied by the engine failure rate as follows:

$$\#contacts_{EF} = CASRAT_{EF0-7} \sum_k \sum_{b=0}^7 p_b DM_{bk} + CASRAT_{EF8up} \sum_k \sum_{b=8}^{11} p_b DM_{bk} \quad (7)$$

$CASRAT_{EF0-7}$	= Engine failure rate for 0-7 Beaufort
$CASRAT_{EF8up}$	= Engine failure rate for 8-11 Beaufort
$p_b$	= Probability of Beaufort class $b$

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