Nautical Safety Study for Marsaxlokk and Valletta: Means and measures to improve safety

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ABSTRACT: On behalf of the Malta Maritime Authority and through a EU Framework Contract with JacobsGIBB Ltd, MARIN conducted a Nautical Safety Study for the ports of Marsaxlokk and Valletta.

The article provided is a joint effort of the MMA and MARIN giving an overview of the extensiveness of the study and its main results. In short, the article addresses the following:

1. Nautical Safety Study for Marsaxlokk and Valletta Harbours; consisting of
   a. Fast-time simulation study, using four vessels and simulating 60 scenarios covering a variety of environmental situations for both ports.
   b. Risk Analysis study, using the entire traffic image near Malta and resulting in calculated risk levels for collisions, strandings, rammings and driftings. These calculations are done for three different pilot stations since the project also required a review of existing pilot stations.
   c. Real-time simulation study, using six different vessels investigating the operational envelope for both ports.
2. Development of a Pilot and Tug Master Training Programme.
3. Execution of the Full-Mission Simulations of the Pilot and Tug Master Training Programme.
4. Development of two port safety manuals, one for each port, stating best practices, guidelines and giving example manoeuvres.
5. Development of technical specifications for new Pilot Launches.

1 Introduction

In 2003 a new Pilotage Organisation, the Malta Maritime Pilots Cooperative was set up and a service agreement between the MMA and the newly formed Organisation was signed. As part of the agreement the MMA obliged to provide the necessary training for serving pilots during the first three years. Another development that is relevant is the fact that Malta has now joined the EU - In this regard the study may also be considered as an integral part of effectively implementing the traffic monitoring directive 2002/59 “with a view to enhancing the safety and efficiency of maritime traffic”.

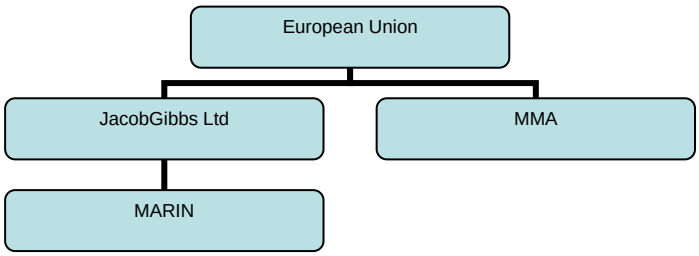
Resulting from development works over the last decade, the volume of traffic and goods handled in the Malta ports has grown significantly. The number of pilot acts has already risen to 9000 per year for the two ports of interest:

- The port of Valletta, and
- The port of Marsaxlokk, in particular the Oil Terminal operated by Oiltanking and the Container terminal

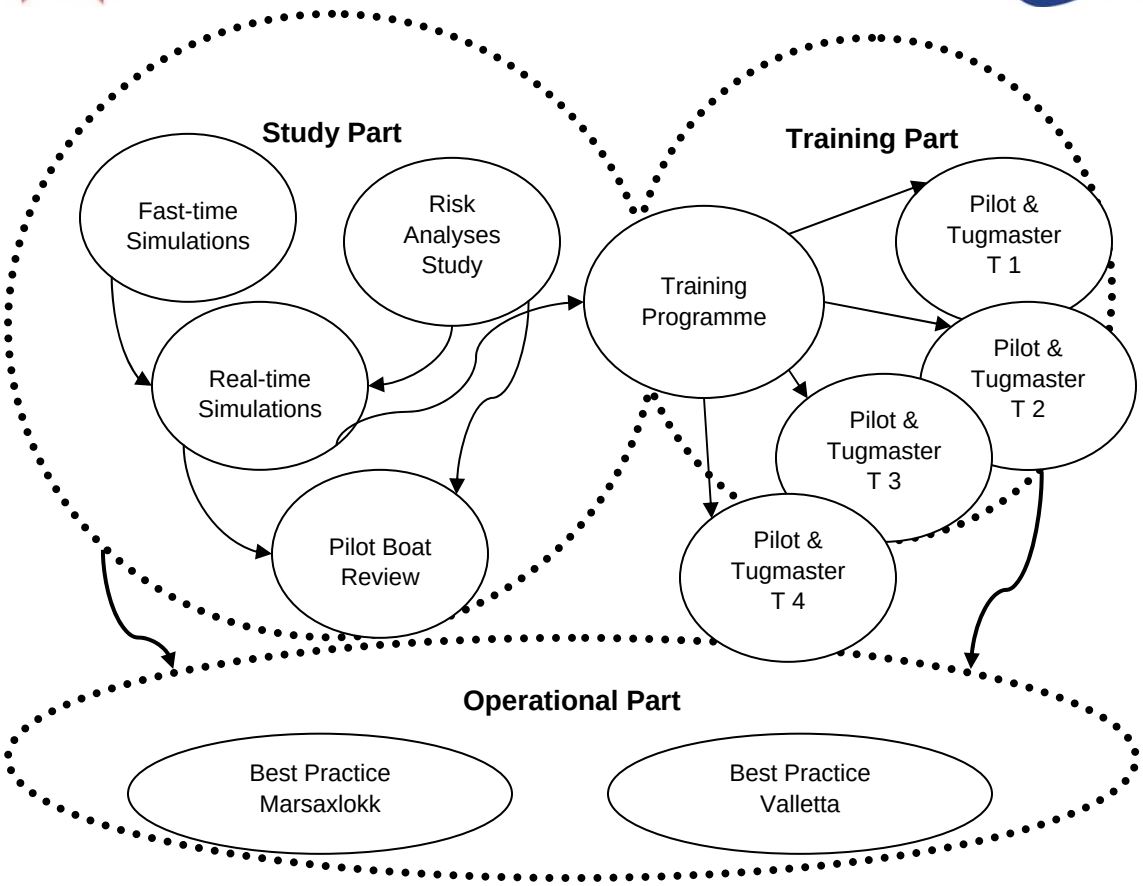
Aerial picture of Valletta

2 Nautical Safety Study – Overview & Objectives

The Malta Nautical Safety Study is executed under a EU Framework Contract with JacobsGIBB Ltd, using the facilities and experience of the Maritime Research Institute Netherlands (MARIN).



The study is conducted on behalf of the Malta Maritime Authority (MMA) and it consists of the following components:



The principal objectives of this project are to:

1. Conduct a Nautical Safety Study for Marsaxlokk and Valetta Harbours. The results will be used as input for the Best Practice Manuals of both ports.

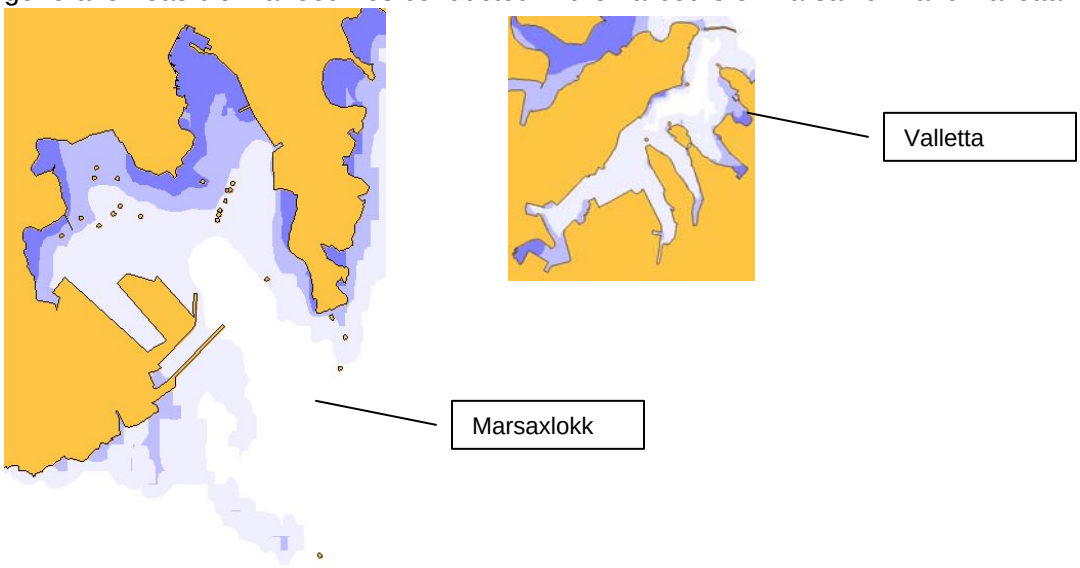
2. Develop and define a Pilot and Tug Master Training Programme. The results from Objective 1 will be used as input.

3. Organise and deliver Full-Mission Simulator training for the Pilots and Tug Masters. The simulator training will be based on the specific ports of Marsaxlokk and Valetta using the determining vessel types and MARIN's Full-Mission Simulators (Bridge I and II). The precise scenarios will be determined under Objective 2.

Each of the components of the project is shortly discussed in the following sections.

3 Fast-Time Simulations

The reason to conduct fast-time simulations is to obtain insight in the operational envelope in general of feasible manoeuvres conducted in the harbours of Marsaxlokk and Valletta.



During the fast-time simulation study, the following vessels are used:

Ship's type	Loa	Lpp	B	T	Displ	Power	RPM	Speed	Bow thrust	Stern thrust
	[m]	[m]	[m]	[m]	[tons]	[kW]	[rpm]	[kn]	[kW]	[kW]
Marsaxlokk										
Tanker	277	266	42.2	15.2	154,700	12,177	85	13.4		
Container	347	332	42.9	13.1	117,300	54,860	94	22	2,500	
Container	382	365	57	14.5	197,900	2x51,480	94	22.8	3,000	
Valletta										
Cruise	290	260	36	7.4	48,490	20,000	80	13.7	4,500	3,000

Table 1

Table 2 shows the environmental situations that were investigated.

	Marsaxlokk					
	ESE		**WSW**		**WNW**	
Exceedance	**Wind [kn]**	**Wave [Hs]**	**Wind [kn]**	**Wave [Hs]**	**Wind [kn]**	**Wave [Hs]**
10%	11 - 16	1.5 - 2.0	11 - 16	1.5 - 2.0	17 - 21	2.0 - 3.0
5%	17 - 21	2 - 3	17 - 21	2 - 3	22 - 27	3 - 4
1%	22 - 27	3 - 4	22 - 27	2 - 3	22 - 27	3 - 4
	Valletta					
	ENE		**E**		**ESE**	
Exceedance	**Wind [kn]**	**Wave [Hs]**	**Wind [kn]**	**Wave [Hs]**	**Wind [kn]**	**Wave [Hs]**
10%	11 - 16	1 - 1.5	11 - 16	1 - 1.5	11 - 16	1.5 - 2.0
5%	11 - 16	1.5 - 2.0	17 - 21	2 - 3	17 - 21	2 - 3
1%	22 - 27	2 - 3	22 - 27	3 - 4	22 - 27	3 - 4

Table 2

Thus, well over 60 simulations are conducted using SHIPMA as fast-time simulation tool. The tool is often used in conceptual design studies allowing easy comparison of different design alternatives. The vessel is steered by a sophisticated autopilot, using a track-following algorithm and sets of instructions regarding speed, tug use, thrusters use and whether or not a power burst is allowed.
The results of each simulation run are assessed with safety criteria regarding *space* and *controllability*.

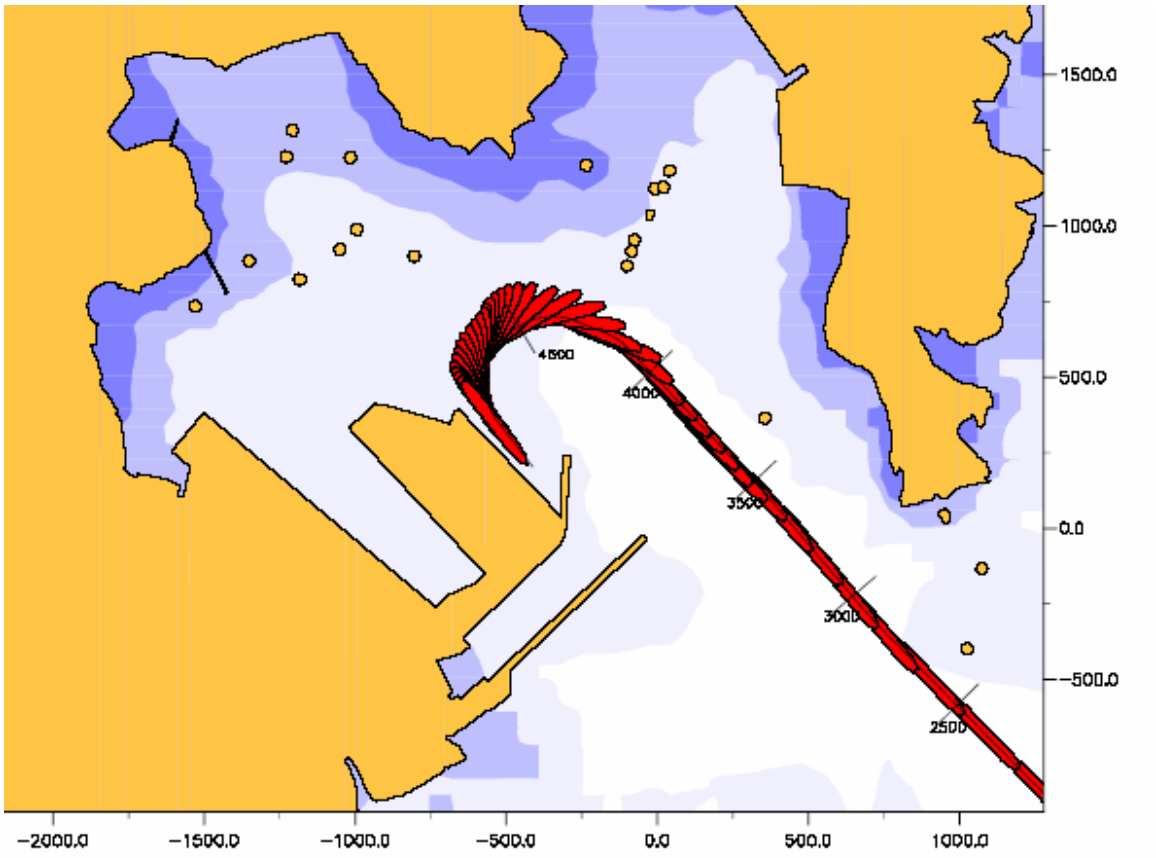


Figure 1

An example of an entrance manoeuvre with a 347 m container vessel in Marsaxlokk is shown in Figure 1.

The findings in terms of feasibility are presented in Table 7 and 8. These are used to determine the scenarios of interest for real-time simulations.

Marsaxlokk								
Vessel	**Terminal 1, Container 347x42.9x13.1m**							
Wind direction	**ESE**			**WSW**			**WNW**	
Exceedance	**10%**	**5%**	**1%**	**10%**	**5%**	**1%**	**10%**	**1%**
Assessment								
Vessel	**Terminal 2, Container 347x42.9x13.1m**							
Wind direction	**ESE**			**WSW**			**WNW**	
Exceedance	**10%**	**5%**	**1%**	**10%**	**5%**	**1%**	**10%**	**1%**
Assessment								
Vessel	**Terminal 1, Container 382x57x14.5m**							
Wind direction	**ESE**			**WSW**			**WNW**	
Exceedance	**10%**	**5%**	**1%**	**10%**	**5%**	**1%**	**10%**	**1%**
Assessment								
Vessel	**Terminal 2, Container 382x57x14.5m**							
Wind direction	**ESE**			**WSW**			**WNW**	
Exceedance	**10%**	**5%**	**1%**	**10%**	**5%**	**1%**	**10%**	**1%**
Assessment								
Vessel	**Oil Terminal, Tanker 277x42.2x15.2m**							
Wind direction	**ESE**			**WSW**			**WNW**	
Exceedance	**10%**	**5%**	**1%**	**10%**	**5%**	**1%**	**10%**	**1%**
Assessment								

Table 3: Marsaxlokk

Valletta									
Vessel	**Pinto Wharf, Cruise 290x36x7.7m**								
Wind direction	**ENE**			**E**			**ESE**		
Exceedance	**10%**	**5%**	**1%**	**10%**	**5%**	**1%**	**10%**	**5%**	**1%**
Assessment									

Table 4: Valletta

Green : Feasible
Orange : Doubtful and to be further tested in the real-time study
Red : Not Feasible

4 Risk Analyses Study

The Risk Analyses Study (RAS) uses SAMSON to conduct a risk calculation of various events. The system diagram of SAMSON is shown in Figure 2.

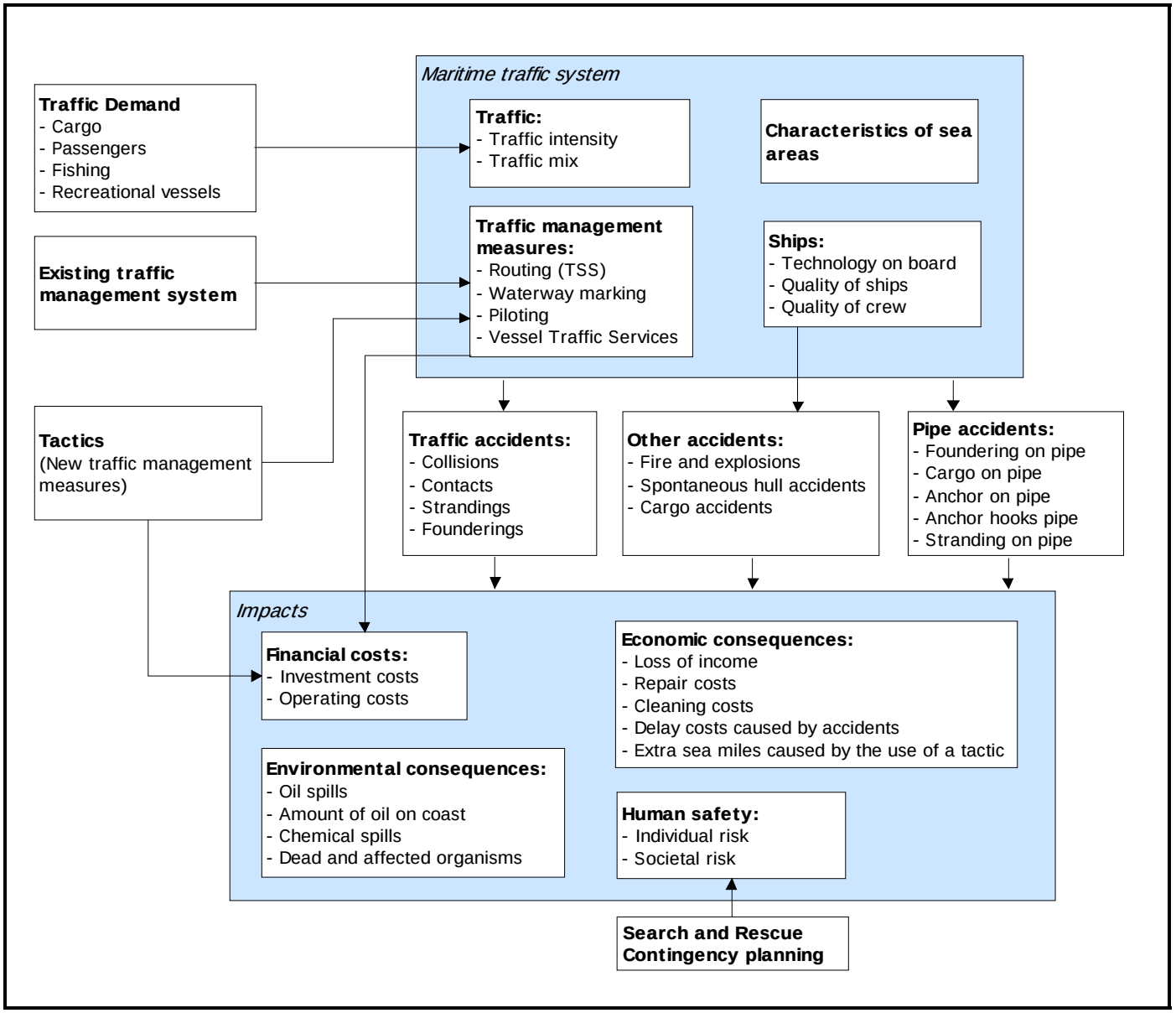


Figure 2

The Maritime Traffic System is built up for the area near Marsaxlokk and Valletta.

The frequencies of different events are assessed with the casualty models of the SAMSON[1]-model. The model is developed for the assessment of probabilities and consequences for all type of accidents and is used to assess (predict) the impact of all type of measures that influence the safety level.

In this particular study the objectives for the risk analysis study (RAS) for Marsaxlokk and Valletta address the following:

- Calculation of the risk levels of relevant casualty types for the *present and predicted future traffic image*.
- Calculation of the risk levels of relevant casualty types for *three different locations of the pilot station* at Valletta and Marsaxlokk.
- Interpretation of the calculated risk levels in relation to international accepted levels

The main conclusions and recommendations from the RAS are:

- ship-ship collisions only provide a small contribution to the general risk level.
- the largest contribution to the total risk level is made by stranding on the coastline due to a navigation error. In Marsaxlokk this event can happen once every 2 years (for the present situation) and in Valletta once every 4 years.
- the contact probabilities decrease when the location of the pilot station is chosen further outside the harbour entrance.
- the location 3 nm from the breakwater head (in Marsaxlokk and in Valletta) gives the largest decrease in contact probabilities.
- In total the contact risk in Marsaxlokk decreases for once every 2 years to once every 4 years (for the 3 nm pilot station).
- In Valletta the decreasing effect of changing the location is less, from once every 4 years in the present situation to once every 5 years when the pilot station is located 3 nm from the break water.

5 Real-time Simulation Study

Detailed 3 dimensional geographical databases of the two ports have been developed for use on MARIN's Full-Mission Simulators during the Real-time Simulation Study (RT Study) as well as four Training Batches on Pilot and Tug Master training.

Figure 3 Oiltanking berth Marsaxlokk

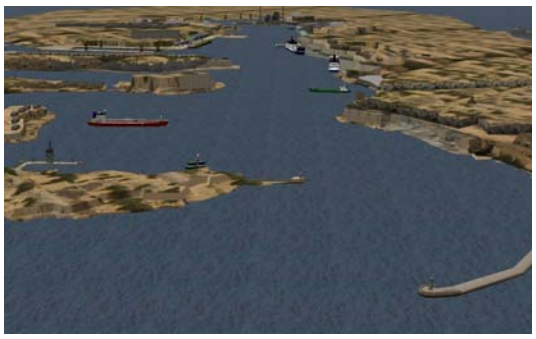


Figure 4 Valletta

In April 2005, almost 50 simulation runs were conducted on MARIN's Full-Mission Simulator. These manoeuvres were all conducted by Maltese Pilots and also Tugmasters of TugMalta were actively involved. In general, the assessment of the results is done at two levels:

I. a qualitative assessment using opinions of pilots, tug masters and the simulator supervisor
II. a quantitative assessment using numerical analyses

With respect to the first one (I), the opinion of the professional mariners participating in the RT study is gathered on a consensus basis. With respect to the second one (II), specific safety criteria are used and the logged data of each simulation run is objectively checked with the safety criteria.

The operational envelopes for the manoeuvres investigated are shown in table 5 and 6.

Green = Safe
Orange = Restricted (separate criteria)
Red = Unsafe

Marsaxlokk								
Vessel	Terminal 1 N Container 347x42.9x 14.5 m / 13.1 m							
Wind direction	ESE			WSW			WNW	
Exceedance	10%	5%	1%	10%	5%	1%	10%	1%
Wind speed [kn]	16	21	27	16	21	27	21	27
Assessment								
Vessel	Terminal 2 N Container 347x42.9x 14.5 m / 13.1 m							
Wind direction	ESE			WSW			WNW	
Exceedance	10%	5%	1%	10%	5%	1%	10%	1%
Wind speed [kn]	16	21	27	16	21	27	21	27
Assessment								
Vessel	Terminal 2 S Container 347x42.9x 14.5 m / 13.1 m							
Wind direction	ESE			WSW			WNW	
Exceedance	10%	5%	1%	10%	5%	1%	10%	1%
Wind speed [kn]	16	21	27	16	21	27	21	27
Assessment								
Vessel	Oil Terminal, Tanker 277x42.2x15.2m							
Wind direction	ESE			WSW			WNW	
Exceedance	10%	5%	1%	10%	5%	1%	10%	1%
Wind speed [kn]	16	21	27	16	21	27	21	27
Assessment								

Table 5: Assessment Marsaxlokk

Valetta								
Vessel	Pinto Wharf, Cruise 290x36x 7.7m / 7.4m							
Wind direction	ESE			E			NW	
Exceedance	10%	5%	3%	10%	5%	1%	? %	10%
Wind speed [kn]	16	21	24	16	21	27	16	21
Assessment								
Vessel	Flagstone Wharf, Bulkcarrier 201x29.4x11.7m							
Wind direction	ESE			ENE			NW	
Exceedance	10%	5%	1%	10%	5%	1%	10%	1%
Wind speed [kn]	16	21	27	16	21	27	21	27
Assessment								

Table 6: Assessment Valletta

Guidelines were provided on the meaning of these operational envelopes for vessels of different sizes for which no simulations were conducted.

During the RT study, the following subjects were discussed and lead to further consideration.

- Tug requirements, both at present as well as for the midterm future (< 5 years)
- Pilot station
- Cruise Vessels
- Pilot boat
- Aids to Navigation
- Navigational Aids
- Best Practice Manual
- Bathymetry
- Wind and wave monitoring and prediction
- Current at port entrances
- Contingency plans.

The main findings of the RT study are:

General Assessment

I. In general, both Marsaxlokk and Valetta are considered as natural harbours that offer shelter for most environmental directions and allow the operations considered in this study with a relatively large operational envelope. The exposure of the infrastructure of both ports to emergency situations is considered as relatively low.

Operational Envelope

II. The operational envelope for Marsaxlokk for the vessels investigated is given in Table 5

III. The operational envelope for Valetta for the vessels investigated is given in Table 6. The findings for the 290 m cruise vessel are not automatically valid for all cruise vessels calling at Valletta.

Tug Requirements

It is recommended that the tug fleet is modernized in such a way that in the short term (one year) one modern tug with a bollard pull of 65 – 70 tons is added and that in the medium term (three years) another modern tug of 65 – 70 tons is added as well.

IV. For departure manoeuvres at Marsaxlokk and Valetta it is recommended that at least one tug accompanies the ship until it is actually passing the breakwater.

Pilot Station

V. It is recommended that the Pilot station of Marsaxlokk is moved to a position 3 nautical miles from the breakwater and that the Pilot station of Valetta is moved to a position 2 – 3 nautical miles from the breakwater.

Other Matters

VI. For night time manoeuvres it is recommended the Pilots and MMA consider additional measures at Marsaxlokk to improve the visibility of the quays.

VII. It is recommended that for large vessels (Marsaxlokk over 300 m, Valetta over 200 m) the use of an accurate and reliable electronic chart positioning system is taken into consideration.

VIII. It is recommended that a wave recorder buoy be placed near the new pilot station.

IX. For wind, it is recommended that:

- A good wind forecast system is set-up with other Maltese authorities
- Anemometers should be placed at certain sensitive locations

X. It is recommended that a warning system is set-up in particular for the E / SE wave climate and that timely departure of vessels in the port is considered as one of the precautionary measures.

6 Pilot Boat Review

In view of the existing plans for a new pilot boat it was considered prudent that the study took into account what the effect was of its findings on the requirements and capability of a new pilot boat. To this extent the pilot boat review covered the following steps:

1. description of present pilot boats
2. future requirements (all weather capability)
3. concise field investigation (looking at other areas where pilot boats are required to operate in waves)
4. concise literature study (looking at fast monohulls, SWATH and RIB twisted bottom concept)
5. conclusions and recommendations, stating as a minimum that:
   - the operational speed must be in excess of 20 knots
   - boarding must be possible up H_s in the order of 3 – 4 m provided that the large vessel can offer a good lee
   - even In rough weather manoeuvring capabilities must be good
   - 14 m is considered as a minimum required length.

7 Training Programme

A detailed training programme was developed based on the results of the various studies. The training programme utilises simulator scenarios that were also used during the RT study and that were further optimised to maximise training value for both Pilots and Tugmasters.
In total, four training batches were completed, each time for four Pilots and four Tugmasters.
During all courses, people with a managerial position at MMA and at Tug Malta Ltd were actively involved as well.

Each course consisted of a Bridge Resource Management (BRM) and Shiphandling part.

One should note at this stage that the participation of Tug Malta, who also co financed the project by extending the number of simulation days was considered as quite important since it provided Pilots and Tugmasters with an opportunity to interact and exchange experiences and ideas out the usual working environment, thus providing an opportunity for a better appreciation of the job in hand.

BRM
The Bridge Resource Management course is the official SAS-BRM course. This course is strongly recommended by the IMO. The course consists of CBT modules, cases and discussions and is run by a SAS-trained workshop leader. MARIN conducts this BRM course on a regular basis as part of pilot training and in combination with the Dutch Pilot Organisation. Separate BRM-Certificates were issued by the SAS.

Shiphandling
The shiphandling part is conducted on the Full-Mission Simulators in a combined mode. This means that a Pilot is operating FMB I and that a Tugmaster is handing FMB II which is modelled as a tug at the time.
All scenarios are set-up for Marsaxlokk and Valetta Harbours, matching the detailed description of the developed training programme.

Figure 5 FMB II as ASDtug

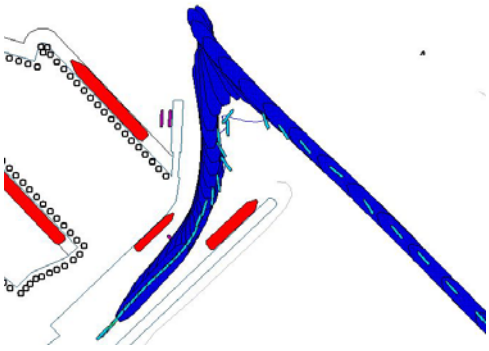


Figure 6 Oiltanking berth Marsaxlokk

8 Best Practice Manuals

It was decided that for each of the ports a document would be made available containing descriptions and guidelines on how the manoeuvres could best be conducted.
The examples of best practices are taken from the runs of the RT study and the training sessions. For each of the manoeuvres clear and simple guidelines are provided on aspects such as approach strategy (course & speed), tug use, swinging etc. for different environmental conditions and a graphical example (figure 6) is shown.

9 Summary

Over the last decades, significant developments have taken place for the two large ports of Malta. Malta developed its position as a major container hub in Marsaxlokk and at the same time it strengthened its position as an attractive cruise vessel destination in Valletta.

The ever growing ship sizes went almost unnoticed, at least at the level of operational guidelines. As it appeared, there was no clear set of rules defining the *operational envelope* under which manoeuvres were considered to be feasible. In practice, this has meant that the pressure of the economic system was felt directly on the operational level where Pilots and Tug masters were expected to cope with the situation at hand. This has now come to an end. For the majority of the manoeuvres, the situations under which the operations can be conducted safely have been charted out in detail and have resulted in clearly defined operational limits. Outside those limits, the operation is temporarily put on hold – sometimes causing delays – until the situation comes within limits again. Surely, a *delay can be an economic loss*, however, as this kind of delay is for safety reasons only, it is ***probably a huge cost saver*** which should be guarded by all stakeholders.