Mr W Verhagen

Rijkswaterstaat Nordzee

Lange Kleiweg 34

2288 GK Risjwijk

The Netherlands

**Review and amendment of IALA Guideline 1058**

The IALA ANM Committee wishes to thank the Netherlands for the comments provided to assist the update of IALA Guideline 1058 on the Use of Simulation as a Tool for Waterway Design and AtoN Planning.

The current version of the guideline is targeting AtoN managers, providers and users at a high level addressing design and planning of AtoN placement by use of various simulator tools.

The guideline has been reviewed taking comments received from The Netherlands1 into consideration.

Many relevant comments have been considered and used for the amendment of the guideline, some of which have not been used as they were considered to be too technical for this high level document and possibly should be included in a new and more technical IALA Guideline on simulation. Likewise, some comments relating to risk assessment aspects have not been considered as they should be included in existing IALA guidance on risk management.

**Task**

The current guideline 1058 has been reviewed and amended in order to provide high level guidance on the use of simulation as a tool for waterway design and AtoN planning.

Attached, at Annex A, is the complete set of comments received from The Netherlands indicating the ANM Committee’s response and comments as they apply to the amendment of IALA Guideline 1058.

Annex A The IALA ANM Committee’s response to comments received from The Netherlands on IALA Guideline 1058.

1. The IALA ANM Committee’s response to comments received from The Netherlands on IALA Guideline 1058

**TO: ANM Committee (15th session)**

**Cc: Custodians of document 1058 Ed1 (ANM15-12-5)**

**Pernilla Bergstedt**

**Hendrik Eusterbarkey**

**THE NETHERLANDS**

**CONTRIBUTION, COMMENTS AND PROPOSALS**

**FOR SUBSTANTIAL MODIFICATIONS AND ADDITIONS TO DOCUMENT ANM15-12-5**

**1058 Ed1**

**the Use of Simulation as a Tool for Waterway Design and AtoN Planning\_Dec2007**

**by**

**ERNST BOLT MINISTRY OF TRANSPORT, PUBLIC WORKS AND WATERMANAGEMENT  
DEVELOPMENTTEAM NATIONAL NAUTICAL TRAFFIC MODEL (NVM)**

**RAYMOND SEIGNETTE PORT OF ROTTERDAM**

**JAN RICKEN NETHERLANDS COASTGUARD**

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| --- | --- | --- | --- | --- |
| **Section** | Where | Proposed action | Specification of Netherland comments | IALA ANM response |
| 1 | Whole section | Needs further clarification and/or discussion | Section 1 says:  *“Simulation tools are capable of providing realistic and accurate results to input to the investigation and evaluation of channel and port design. The purpose of simulation for AtoN design, planning and evaluation is to identify and mitigate the risks for the mariner operating in a specific waterway, channel and port area. It also includes evaluation of channel layout, placement and technical specification of AtoN and manoeuvring aspects."*  With this text it is suggested that the outcome/results of the simulations will provide a good prediction of the expected practice. However, appearances are deceptive as each model is only a restriction of reality.  To our opinion it will be an improvement to the text to *“recommend simulation tools as aids to enhance the process of weighing the various alternatives (e.g. designs or safety measures)”.*  The relative differences of simulation results are valuable; however the absolute results are just a restricted approach of what may be expected. | Comments noted and the text is revised as indicated below.  Simulation tools are capable of providing realistic and accurate results as input to the investigation and evaluation of channel and port design. The purpose of simulation for AtoN design, planning and evaluation is to identify and mitigate the risks (quantitatively) for the mariner operating in a specific waterway, channel and port area. It also includes evaluation (qualitatively) of channel layout, placement and technical specification of AtoN and manoeuvring aspects. |
| 4.1 | After 1st 2 bulleted items | Delete | ; | Noted and revised |
| 5 | Whole section | New text | See attachment | It is assumed the Attachment I is suggested to be included in Annex A, section 5 and not Section 5, which is covering planning  ANM Acknowledge the content of the suggested Attachment I. However, it is felt that the current guideline should be kept at high level without going into too many details. Consequently the comment has led to a discussion of a suite of IALA guidelines hereunder a possible guideline on risk assessment tools. |
| 6 | List of cap | Add | * calculation of hydrodynamic interaction forces and moments between vessels * need to simulate manoeuvring behaviour of tugs, and which way the tugs need to be controlled | Hydrododynamic interaction forces and moments between vessels are a part of a vessels manoeuvring behaviour and hence, covered by bullet no. 7.  The content of the second bullet is acknowledged and the bullet list of section 6 will be amended accordingly.   * Allow simulation of manoeuvring behaviour of tugs and operational conditions related to control of tugs and the manoeuvring space that tugs require. |
| 7 | After paragraph “The geographical database…” | Insert | The environmental conditions (waves, current, wind) are usually defined location dependent. Separate models may be needed to prepare these conditions before commencing the simulations. | Section 7 will be amended with the following wording after the paragraph “The geographical database….”  The environmental conditions (waves, current, wind) depends on local conditions. Depending on the complexity of the local environmental conditions, separate hydrodynamic modelling tools may be required to generate data for the environmental conditions as input to the simulations. |
| Annex A 1.1 | After 3rd paragraph | insert | The tool is also useful in selecting suitable scenarios for a full-mission simulator research. The tool provides information about physical feasibility of a scenario, i.e. whether it is possible to steer the vessel along a desired track within the physical limits. | Comment noted and amended accordingly. |
| Annex A 1.1 | 4th paragraph | Replace by | The tool can be applied in a deterministic manner: the helmsman is replaced by an autopilot which reacts with a determined response to deviations from the track. As this autopilot is fed with perfect knowledge of the state of the vessel and the environmental influences, it is not certain that a human operator will be able to produce the same results. The subsequent full-mission simulator research fills this in.  Another way to apply the tool is in a probabilistic mode. In this setup the uncertain knowledge of the helmsman and variations in his behaviour are represented by stochastic functions. By repeating the simulation many times with new stochastic deviations (a so-called Monte Carlo process), an impression of the variations in tracks is obtained. Of course, the width of this swept path is very much dependent on the choice of the stochastic parameters. | Annex A, section 1 will be amended with the following wording after 4th paragraph “The simulations are often ….”  The tool can be applied in a deterministic manner: the helmsman is replaced by an advanced autopilot which reacts with a determined response to deviations from the track. As this autopilot is fed with perfect knowledge of the state of the vessel and the environmental influences, it is not certain that a human operator will be able to produce the same results. The subsequent full-mission simulator research fills this in.  Another way to apply the tool is in a probabilistic mode. In this setup the uncertain knowledge of the helmsman and variations in his behaviour are represented by stochastic functions sometimes referred to as a numerical navigator. Hence, the numerical navigator represents the behaviour of various Captains way of manoeuvring the vessel.. By repeating the simulation many times with new stochastic deviations (a so-called Monte Carlo process), a number of different tracks are obtained forming a swept path, which can be analysed statistically. The width of swept path significantly depending on the choice of the stochastic parameters. |
| Annex A 1.1 | 1st Disadvantage | Delete “not real time” | This is an advantage because calculations can be much faster. If, for some reason, it is important to run real time it is easy to force the model do so. | Annex A, section 1, “Disadvantages will be revised as follows:  1st disadvantage “real time….” to be deleted |
| Annex A 1.1 | 2nd Disadvantage | Consider further specification, what was meant here? | I imagine this applies to all models? The stochastic parameters mimicking the human in the loop are disputable, however. Perhaps it is advisable to use the stochastic variations only for environmental conditions, so that it is clear that the simulation represents the ideal autopilot only. | 2nd disadvantage to be deleted.  Annex A, section 1 is amended with a new bullet.   * Not a real human navigator in the loop. Autopilots do not replicate human behaviour and computer models of human behaviour may have limitations   Caution should be taken in relation to assumptions introduced in the models of either advanced autopilot or numerical navigator by requesting documentation of the underlaying auto pilot or numerical navigator.  A figure illustrating all the components that may be simulated in fast time simulation including the human operator has been included in the main section describing fast time simulation. |
| A – 2. 2 | Figure 1 | Add title | single display system with outside view and external handle box | Comment acknowledged |
| A – 2. 2 | Figure 2 | Add title | Multi-display system | Comment acknowledged |
| A – 2. 2 | 3rd par. last sentence and 4th par | Replace by | As the simulations normally involve a single person, communication with other ships, port and VTS facilities is not simulated. Other traffic may be in the simulation but will just follow pre-programmed tracks. | Comment acknowledged. The suggested wording will replace last sentence of paragraph 4 and paragraph 5. |
| A – 2. 2 | Advantages | add | * visualisation can make issues clear also for non-mariners | Annex A, section 2 will be amended with the following wording:   * Can be used as visualisation tool for non-mariners, however, great care should be taken in relation to the restricted visual image,that may provide a too simple view for decision making. |
| A - 2 | Advantages | delete |  | Delete 3rd advantage “dynamic modification to model parameters possible at all times such as AtoN positions |
| A – 2. 2 | disadvantages | add | * the required input preparation, especially for 3D mode, approaches that of a Full-Mission simulation * it may be questioned whether the advantages justify the extra costs compared to fast-time simulation | Comments not included   * It is possible to use simple 3D models and library of AtoN, that are perfectly suitable for preliminary evaluation * Depending on the number of vessels to investigate combined with the number of environmental conditions and layouts one method may be to be preferred over another in relation to required time for preparations and simulation time. In other words it is not given that fast-time simulations are less time consuming compared to real-time simulations. The suggested amendment will not be added to the guideline |
| A – 3. 3 | 5th advantage | Consider clarification or deletion | Not clear what is meant by this. | 5th advantage will be deleted  Main section will be amended with the following wording after section 5:  Modification of model parameters such as AtoN positions and characteristics can be changed from one simulation to the next. |
| A – 3. 3 | Advantages | add | * may be made movable (e.g., built into a standard container) | Comment acknowledged. The following wording will be added to the bulleted list of advantages:   * may be made transportable (e.g., built into a standard container or air freights boxes) |
| A – 3. 3 | Last disadvantage | Add fundament  (or leave out) | What cues then? What differences are there with the Full Mission simulator?  The outside viewing angle is usually larger for the F.M., but if needed an extra monitor may be added to provide the relevant sector.  The image quality itself is usually better than a projected FM image. | The last bullet of the list of disadvantages will be revised as follows:   * there may still be missing cues due to rudimentary instrumentation (soft instruments) or limited field of view that make the simulator system inadequate to validate a final design or position of AtoN in a proposed waterway. In general terms, it is important for a final validation, that realism of the simulated scenarios is sufficiently high for mariners to act and manoeuvre the vessel in the simulator as in real life. This is typically obtained in a full-mission simulator. |
| A – 4. | Figure 7 top right | Replace picture | (is also tug bridge picture) | (is also tug bridge picture)  Figure 7 illustrates a system consisting of several coupled simulators, where the top right picture in this setup simply works as the assisted vessel, in this case an LNG vessel. It makes sense to show all simulators and their respective role in the setup, hence the photo will not be removed or replaced |
| A – 4. | Disadvantages | Add | * qualified mariners and/or local pilots (in two shifts) needed during entire simulation period * for statistical reliability, many mariners/pilots should each perform a number of simulations * the (unwanted) training effect of simulating the same scenario a number of times is unknown * the effect of the relatively short simulation, allowing for a sustained high attention level, is unknown | * qualified mariners and/or local pilots needed during entire simulation period is a cost driver, but should not be seen as an disadvantage in itself for the quality of the validation. Hence the first comment is not added to the list of disadvantages * In an ideal world it would be beneficial if mariners/pilots participate in repeated simuations for statistical reliability and this is sometimes seen. But normally full-mission studies are qualitative (expert judgements) and not a statistical exercise. Statistical data are typically obtained by use of fast-time simulators or desk top simulators. Hence, the second comment is not relevant for full-mission simulations and the comment will not be added to the list of disadvantages. * The situation that a pilot or Captain gain experience with the operation during a simulation, is as stated not known but is not necessarily a disadvantage. Hence, the third comment is not added to the list of disadvantages:   The following wording will be added to the list of disadvantages:   * the effect of the relatively short simulation time (compared to real life operation on a bridge), allowing for a sustained high attention level, is unknown. |
| A - 5 | Entire section | replace | See following text. | See above. This comment seems to be a replication of the comment stated under section 5. |

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## 5. Traffic models

Attachment I

A number of models have been developed to assess the nautical safety of a shipping area, either or not in comparison to a reference situation. Usually the safety is expressed as the expected number of accidents of a specific type per year in the area concerned (as this should be a very small number the reciprocal value is often presented: e.g. one accident in 15 years). The models may be classified as follows:

### Geometrical models

In this type of model, traffic flows are assigned to tracks with a certain lateral distribution. The transits of individual ships are not simulated, but instead the geometrical probability that ships come close to each other forms the basis for the probability of an accident. As the ships are not simulated there is no way a ship can react on the vicinity of another in order to avoid contact.

The translation from geometrical probability to the probability of an accident can be based directly on accident statistics, by calculating the geometrical probability for a reference area of which a sufficiently long record of accident data is available. The assumption is then that the observed ratio of accident probability to geometrical probability can be used as a scaling factor to calculate the accident probability from the geometrical probability in the new situation.

Different refinements may be applied to get a closer relationship between the number of accidents and a calculated exposure. The exposure is again based on the geometrical probability, but more details of the possible causes of an accident are included.

To clarify this, two ways to model the contact of a ship with a fixed object are described here.

* The intended track of the ship traffic is represented by a line or line segments. To describe the fact that the individual ships do not stay exactly on this line, a lateral distribution of the traffic has to be specified. This could be a normal distribution centred on the intended track, or a distribution derived from AIS tracks in an existing situation. The portion of the lateral distribution that runs over the obstacle is used as the exposure. It is clear that this exposure is very dependent on the choice of the intended track and the variance of the lateral distribution.
* Just as before an intended track is assumed. If a ship is to hit the obstacle, she has to leave this track somewhere and keep this wrong course long enough to reach the obstacle. Thus, for each infinitesimal part of the track the probability that the object would be hit may be expressed as a function of the necessary course shift and the distance to the object. By integrating this figure over the entire track an exposure can be calculated.

The first method is purely geometrical whereas the latter uses an analysis of the possible development of an accident.

The geometrical models may generally also be classified as macroscopic (based on traffic flows, not on individual ships) and static (no means of reacting on situations as they develop during the simulation).

### Maritime Traffic Simulation models

This type of models involves the simulation of individual ships. Each ship gets its own manoeuvring characteristics, intended track, etc. and tries to follow this track during the simulation as an autonomous agent. When a traffic situation develops where ships would approach each other too close, this should be detected and the responsible ‘agent’ should alter his speed and/or course. This behaviour may based on relatively simple rules, to comply with the collision regulations and other (local) constraints, but also a more sophisticated model representing the behaviour of a ‘human operator’ may be used. Although such a model may eventually produce a traffic behaviour that very much seems to resemble what is seen in practice, the question remains how one should judge on the safety (expressed as an expected number of accidents per year) of the simulated scenario. Even if a (near) accident would occur in the simulation, it is more likely than not that this is due to a shortcoming in the modelling of the agent.

In some cases this problem is solved by, again, using accident statistics. If the simulation model is used to reduce complicated traffic situations to a combination of elementary situations, there may be enough accident data to determine a reliable accident rate for each elementary situation. Some models attempt to model the human operator in such detail that fault mechanisms, which eventually may lead to an accident, can be described. The necessary parameters for this model may (partly) be based on studies on the behaviour and functioning of human operators in other fields, such as process industry, aviation or military operations.

These models may also be classified as microscopic (describing the manoeuvring of individual ships) and dynamic (during the simulation, the ships react on traffic situations that occur).

### Which traffic model?

Each model has its specific strengths and weaknesses. No model exists that is capable to answer all questions in this field; which model is preferred and what level of detail is required depends on what problems have to be addressed and what data are available. AIS data is an increasingly important source to analyse and to calibrate models of the behaviour of vessels and ship traffic, but AIS data do not reveal everything and do not provide predictions.

Developments are still ongoing, and possibly the strongest points of different models will be combined.