# Theme B

# Navigational Aspects

## Chairman

Mr. O. Gredal

Mr. O. Gredal is Director General of the Royal Danish Administration of Navigation and Hydrography, member of IALA Executive Committee and chairman of IALA Technical Committee for International Unification of Buoyage Systems. Mr. Gredal received the Distinguished Public Service Award medal 1980.

## Technical Programme

The following papers were presented:

- Y. Fujii, Japan
  An Integrated Study on the Probability of Marine Traffic Accidents, the Traffic Capacity and Traffic Management.

- J. Vendrell, United Kingdom
  Minimizing the Risk with Vessel Traffic Management Systems.

- E.F. Greneker, J.L. Eaves, M.C. McGee, U.S.A.
  Bridge Ship Collision Electronic Detection and Early Warning.
  Presented by Mr. M.C. McGee.

- E. Goodwin, United Kingdom
  Marine Traffic Flows with Reference to Fixed Offshore Structures.

- J.J. Puglisi, J.R. Riek, U.S.A.
  Offshore Structures and Navigation Risk Management.
  Presented by Dr. J.R. Riek.

- V. Ligthart, The Netherlands
  Nautical Aspects and Risk of Collisions for Offshore Structures.

- J.S. Gardenier, U.S.A
  Safety of Bridges and Offshore Structures - the Role of Ship Simulation.

- K. Meurs, J.W. Oosterbaan, The Netherlands
  Simulation of Bridge Passage in High Wind.
  Presented by Mr. K. Meurs.

- U. Rabien, Fed. Rep. of Germany
  Transportation Risk Modeling of Tanker Ship Operation.

- J.J. Blok, J.N. Dekker, The Netherlands
  Hydrodynamic Aspects of Ships Colliding with Fixed Structures.
  Presented by Mr. J.N. Dekker.

## Discussion and Comments

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Paper Title : Minimizing the Risk with Vessel Traffic Management Systems
Presented by: Captain John Vendrell, Vendrell Associates Limited, U.K.

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Discussion by: Professor John Kemp, City of London Polytechnic, U.K.

Our own studies on the incidence of collisions in the English Channel suggest that the reductions noted by Captain Vendrell have occurred in areas where traffic separation schemes have been established but a similar reduction is observed whether or not radar surveillance is in force. It therefore seems that it would be more effective to designate recommended routes in the vicinity of platforms rather than to attempt to "control" ships by radar from the platforms. In fact it is difficult to see how control could be exercised without the basis of a route structure which ships would normally be expected to follow, in the same way that air traffic control can only be exercised on the basis of an accepted structure of airways.

Answer by: Captain John Vendrell.

Routing is an integral part of V.T.M.S., other essential components are Surveillance and Enforcement. Routing alone will produce statistical evidence of success in as much as most, but not all, mariners are sufficiently disciplined to be relied on to conform.

In the Dover Strait and particularly in low visibility, Radar Surveillance is essential to keep account of cross-channel traffic - including high speed Hovercraft and Hydrofoils, west bound traffic requiring to cross the east bound lane to the French Ports and east bound vessels turning northwards at the Sandettie Bank and Noord Hinder as well as free access traffic proceeding in all directions in the inshore waters on either side of the Channel. Enforcement is by reporting to National Authorities their shipping that transgress the rules. However, a feature of Radar Surveillance is its ability to record activity for "Action Playback". The availability of such "evidence" is usually sufficient to ensure compliance with "Advice".

Proliferation within the Oil and Gas Fields include Mobile Rigs constantly shifting their locations. VTMS Routing, Surveillance and Enforcement is now necessary and rapidly becoming essential. Routing will obviously require continuous updating.

I am not suggesting that Platforms control Shipping other than within their 500 metre Radius of Authority. Routing, Surveillance and Enforcement must devolve upon National or International Bodies.

The most outstanding example of a modern integrated VTM System is to be found in the Harbour Control of Gothenburg, Sweden.

Paper Title : Bridge Ship Collision Electronic Detection and Early Warning
Presented by: Mr. M.C. McGee, Georgia Institute of Technology, U.S.A.

Discussion by: Mr. G.H. Patrick Bursley, National Transportation Safety Board, U.S.A.

The technical problems associated with ship impacts on bridge piers, bridge structures, and offshore structures and the underlying risk analyses are necessarily based on a given location and alignment of a bridge or a particular site for an offshore structure. Lest the point be overlooked in the search for the solutions to technical problems I would suggest that the initial ingoing that must be made is whether the risk of a ship collision can be reduced, i.e., is the location (and alignment) of the bridge or structure optimal with respect to the navigational difficulties which the mariner encounters in the waterway. Minor adjustments in location (and alignment) not only are generally more feasible than initially may be acknowledged but frequently they can drastically reduce the probability of a collision with an obvious effect on the risk analysis and the necessary ameliorative measurer.

Answer by: Mr. E.F. Greneker, Mr. J.L. Eaves, and Mr. M.C. McGee.

We agree that location (and alignment) are important considerations when designing new bridges or structures over waterways, but we doubt that minor adjustments in location (and alignment) of the bridge or structure would drastically reduce the probability of a collision. Our research indicates that most collisions can be attributed to human error and adverse weather. A collision warning/avoidance system based on radar technology can detect an off-course ship, even in adverse weather, and alert the ship's pilot in sufficient time to prevent a collision.

Paper Title : Offshore Structures and Navigation Risk Management
Presented by: Dr. J.R. Riek, CAORF, U.S.A.

Discussion by: Dr. Arne Jensen, Technical University of Denmark, Denmark

As we know that it is complex situations which create risk I want to know if your model for simulation can be used by two or three independent captains at the same time, for study of their behaviour and unexpected situations not covered by rules?

Answer by: Dr. J.R. Riek.

The CAORF has a second location called the Human Factors Monitoring Station which has been configured to simulate a second, lower fidelity bridge to be used in conjunction with the main bridge. Using these two positions, we have conducted some initial work in the area of interactive collision avoidance. The U.S. Maritime Administration has plans under consideration to construct a secondary, permanent bridge location to be used with the main CAORF bridge in a formal investigation into the problem of interactive collision avoidance. Plans for constructing a third interactive bridge are not likely to materialize in view of collision statistics which indicate the small importance of "third vessels" in collision situations.

Discussion by: Capt. J. Vendrell, Vendrell Associates Ltd., U.K.

Would Dr. Riek clarify whether there was any different response to deviation in the offshore channel from the hypothesis of a platform positioned on the boundary as distinct from a drill ship with outlaid mooring extending into the channel.

Answer by: Dr. J.R. Riek.

The possibility of different deviation responses due to the presence of a platform or drill ship was not tested. At the time this study was conducted (3 years ago), the plan was to use dynamically positioned drill ships in the channel which would obviate the problems associated with moorings extended into the paths of passing ships. It is possible, however, that consideration of such a possibility (i.e., outlaid moorings) contributed to a generalized amalgamation of perceived risk and, even though moorings were not actually present in the situation simulated, affected the magnitude of course deviation.

Discussion by: Mr. Per Laheld, Det Norske Veritas, Norway

We have recently in VERITAS developed a mathematical model based on differential games computing continously the optimum evasive manoeuver for a ship in a scenario of several ships and fixed objects.

We are not able to test it out in our National Simulator Center in Trondheim because it is only used for training in coastal areas for training purposes with few moving objects.

I wonder whether your R&D simulator might be used for testing our model?

Answer by Dr. J.R. Riek.

The question of validating a mathematical maneuvering model is quite interesting and one in which CAORF would very much like to become involved. Since I do not have an understanding of the technical details of your model, I am not able to give a qualified affirmative answer to your question. However, if you are willing to provide additional information to CAORF, then we would be most interested in developing a cooperative program to test the model on the simulator.

Discussion by: Dr. M.A.F. Pyman, Technica, U.K.

Is there a known record of vessel infringements in the Santa Barbara channel?- In particular, does the record suggest that infringements are due to aberrations on the pair of normally competent experienced masters, or due to inadequately manned and operated vessel with much less predictable movement.

Answer by: Dr. J.R. Riek.

The Vessel Traffic Separation Scheme was introduced into the Santa Barbara Channel in 1969. During the time since its introduction, there has been no record of ship collisions with other ships or oil platforms. In particular, there has been no systematic study of traffic to record observations which would be correlated with ship master experience or level of manning. The assessment of ship traffic to date suggests that the vast majority of vessels do adhere to established traffic lanes.

Discussion by: Dr. David Ball, Simon Engineering Labs, Univ. of Manchester, U.K.

It has been pointed out earlier today that the human factor is an important part of collision risk. The results given for the Santa Barbara simulation led to the recommendation that a separation zone is advisable. However, the results also show a large variety of behaviour on the behalf of the masters for the same ship in the same condition. Is it not important to investigate the reasons why there is this range of behaviour as this is important in itself in the possibility of an accident occurring and in understanding the role of the human factor?

Answer by: Dr. J.R. Riek.

The maneuvering responses of the masters in the Santa Barbara simulation did display a measure of variability. However, the variability was in terms of magnitude, and not in terms of direction. In maneuvering in response to the stationary drill ship, masters maneuvered always to the north, away from the stationary ship. There were no occurrences of maneuvers toward the stationary ship into the Separation Zone. In terms of direction of maneuver, there was perfect consistency. While an understanding of the reasons for the observed variability in magnitude of maneuver would be of value, the precise description of the many different motivating factors would probably prove difficult given the limited budget of time and money. In its place, we were satisfied with demonstrating the direction of maneuver and estimating its approximate magnitude.

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Paper Title : Safety of Bridges and Offshore Structures - the Role of Ship Simulation
Presented by: Dr. John S. Gardenier, U.S. Coast Guard, U.S.A.

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Expansion in the oral presentation by Dr. Gardenier:

The least useful part of a risk analysis is the numerical probability estimation. Such numbers tend to be highly uncertain for new projects and are not very useful regardless of accuracy. There are two probability distributions - that of ship impact and that of severity. The exposure term for impacts is likely to be ship visits. The impact probability distribution is likely to be the negative binomial distribution, a variant of the Poisson distribution. The severity distribution has been found in the case of oil spills to follow either the lognormal distribution or the inverted gamma distribution. Something similar is likely to pertain to structure impacts by ships. (Although the very rare extreme impact is the object of concern, the greatest number of impacts can be expected to cause little or no damage).

The greatest value of risk analysis is to identify and prioritize risk causal factors. In this effort, complementory methods are needed: ducumentary research, observation of similar operations, interviews with mariners, and systems analysis, such as fault tree analysis. (The latter need not be quantitative, as long as they employ structured logic.)

An interdisciplinary team should formulate proposed solutions to the risk sources. The proposed solutions should be evaluated using fast time and real time simulation. The real time runs should be carefully formulated using statistical experiment design theory.

An example of a thorough risk management study is contained in two volumes:

"Deepwater Port Approach/Exit Hazard and Risk Analysis" and
"A Simulator Study of Deepwater Port Navigation in Low Visibility".

Both are summarized in the author's paper in "Proceedings of the 1981 Oil Spill Conference" sponsored by the U.S. Coast Guard, American Petroleum Institute and Environmental Protection Agency. Available from the American Petroleum Institute, Washington, D.C.

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Paper Title : Simulation of Bridge Passage in High Wind.
Presented by: Mr. K. Meurs, Maritime Research Institute Netherlands, The Netherlands.

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Addition by Mr. K. Meurs and Mr. J.W. Oosterbaan

The following suggestions were made by a special working group set up by the Port Authority of Rotterdam:

1. Research into the effect of a high wind-screen on the Western side of the Canal. Prevailing strong winds are from the West. Results will be known in July '83.

2. Adaptation of tug boat assistance. Instead of a single wire attachment tug-autocarrier 2 cross-wires to be used, each crosswire on a separate winch.

3. In general allocation of a small group of pilots to specific situations is now being discussed within the Port Authorities Pilot Organisation.

Paper Title : Hydrodynamic Aspects of Ships colliding with Fixed Structures
Presented by: Mr. J.N. Dekker, Netherlands Ship Model Basin, The Netherlands.

Discussion by: Mr. G. Woisin, Private Consultant, F.R.G.

At first I want to congratulate Mr. Dekker on the very fine, the outstanding form of his oral presentation. Together with Mr. Blok he deals with the so-called added masses in the case of a collision. These added masses of course are only a model of thinking instead of a strict interpretation of the hydrodynamic phenomena.

I want to point out to some literature obviously unknown to the authors. In Italy, West-Germany and Japan similar hydrodynamic model tests have been conducted already 17 to 25 years ago in connection with the development of nuclear propelled merchant ships (1, 2, 3).

Particularly, I want to mention the Japanese model tests published by the wellknown prof. Motora et al. They were the first to distinguish three magnitudes to be used in the different equations:

a) of impact forces,
b) of conservation of momentum, and
c) of conservation of energy,

as far as these equations are used in the classical integrated theory of impact named to Newton. Only in cases of the start of an impact or of an extremely short duration of an impact the three different magnitudes of added masses will be the same.

In Hamburg/Germany, model tests had been conducted using linear and other spring characteristics, also for a constant impact force, and for different underkeel clearances and own speeds of the rammed vessel. I admit there had sometimes been difficulties to reproduce results accurately with a different but equivalent test set-up. I believe this depends on hydrodynamical instabilities. Due to their figures the authors also experienced some relevant scatter in their results.

In view of the low impact speeds hardly exceeding a half knot together with linear spring characteristics of no more than 20 MN/m resulting both in relatively small impact forces, I presume the experimental results are suitable for berthing contacts with fendered structures rather than for collisions with structures not fendered or not sufficiently fendered. The theory presented may be of general use, however.

(1) Spinelli, F.: Défense des réacteurs nucléaires des navire contre les abordages. ATMA Paris, Session 1962.

(2) Motora, S., M. Fugino, M. Sugiura and M. Sugita: Equivalent Mass of Ships in Collisions. In: Selected Papers from The Journal of The Society of Naval Architects of Japan 7 (1971), 138-148 (from J.S.N.A. Japan 126, Dec. 1969).

(3) Woisin, G.: Shiffbauliche Forschungsarbeiten für die Sicherheit Kernenergiegetriebener Handelsschiffe. Jb. der Schiffbautechnischen Gesellschaft Bd. 65, 1971, s. 225-263.

Answer by: Mr. J.N. Dekker.

The idea at the beginning of the now presented test series was to do a systematic test series of direct use to the engineering practice, especially the engineering practice in jetty and fender design, in such a way that the experimental data could be used directly in the design consideration.

This means that the basis of the program was a systematic series of berthing tests.

That explains the rather low collision speeds used in the experiments.

At the time not very much experimental data on this topic was available. We may point out that the three publications Mr. Woisin is referring to concern ship to ship collisions and therefore the aim of those test programs was totally different from the test series presented now.

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