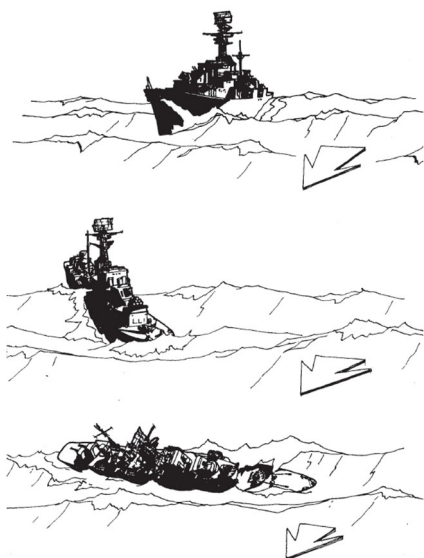




## Surf-riding & Broaching JIP

When sailing in following seas, difficulty in steering and keeping the desired course is not uncommon. In many normal operative conditions, this difficulty results in moderate motions well manageable by the crew. However, in rough seas, poor course-keeping can lead to dangerous dynamic instabilities. Events as surf-riding and broaching are likely to happen in following seas, and they are responsible of severe and sudden losses of control that put at risk the safety of the ship. Thanks to the increasing interest in the topic, surf-riding and broaching are object of scientific research since about 50 years. Some of the main publications on the subject are listed in the reference section at the end of this flyer.

A Joint Industry Project (JIP) is proposed to study this problem, with the aim of finding operative and design solutions to mitigate and assess the risk connected to surf-riding and broaching. The research is intended to take place at MARIN, which is one of the few research institutes in the world that allows extensive model testing in following seas.



*Dynamics of a broaching, picture taken from ref. [4]*

### Objectives

- Univocal definition of surf-riding and broaching. Direct on-field experience and observations of ship operators would be helpful to enrich theoretical descriptions of the problem with practical knowledge. By this addition, it would also be possible to define robust criteria and prediction tools ultimately useful to optimise the design of vessels prone to dynamic instability in following seas.
- Mitigation of risk. Several parameters play a role in the occurrence of surf-riding and broaching-to: model experiments can highlight reliably the most important ones and how they affect the ship behaviour.
- Assessment of risk. This project will put into practice the guidelines developed by the International Maritime Organization through the Second Generation Intact Stability Criteria (IMO SGISC). The knowledge acquired by the application of IMO SGISC would help the participants towards compliant and safer ships.

## Organisation

If a sufficient number of parties will show interest, a concrete scope of work proposal will be prepared and presented to all participants. Depending on the number and on the feedbacks of participants, the extension of the scope might vary and a list of work packages might be defined.

Throughout the JIP, MARIN will act as Project Manager and Coordinator for all participants.

The JIP itself will be managed in a democratic manner, with all participants having an equal vote. A set of project milestones will be defined. MARIN will organise several general meetings with the complete JIP group to discuss the results and set the overall course for the project.

All participants will have exclusive access to the project deliverables through a confidential project server. The project findings will be kept confidential within the JIP group for a certain period of time as to be defined by the group. Any information will only be released into the public domain (e.g. conference papers) upon approval of the JIP group.

For more information contact MARIN:

Christian Lena

T + 31 629 70 18 27

E c.lena@marin.nl

or

Matteo Bonci

T + 31 317 49 32 23

E m.bonci@marin.nl

## Preliminary scope of work

### Phase 1

Along with a detailed literature review, it is considered of importance to get in touch with experienced people at sea: captains, helmsmen, pilots. Their contribution would help to understand when sailing in stern quartering seas become dangerous relatively to sea conditions and ship type. This would be the first step for univocal surfing and broaching definition, that would lead to strong definition criteria of these phenomena.

### Phase 2

Organise extensive model testing in MARIN facilities with the final objective to highlight the most influential parameters causing the inception of surf-riding and broaching.

### Phase 3

Develop practical methodology to assess and mitigate the risk of occurrence of surf-riding and broaching, both at design and operative stages.

### Time schedule

The project is envisaged to run for 1 to 1.5 years. The approximate time frame for the main milestones is as follows:

- Gathering of participants, collection of feedbacks and final project proposal: Q1 – Q2 2021.
- Project kick-off: Q2 2021.
- Literature review and experience gathering from sea experiences men: Q3 to Q4 2021.
- Model tests: Q1 2022.
- Guidelines definition: Q2 2022.

### Interested parties

The proposed Joint Industry Project is open for all interested parties. In view of the challenges to be addressed, the project is expected to be of most interest to:

- Passenger vessel designers (yachts and ferries, ...);
- Navies;
- Shipyards;
- Ship owners;
- Classification societies.

## References

- [1] M. Bonci; 'The Manoeuvrability of High-Speed Craft in the Following Sea', PhD Thesis, Delft University of Technology, 2019.
- [2] N. Umeda and M. Hamamoto; 'Capsize of Ship Models in Following/quartering Waves: Physical Experiments and Nonlinear Dynamics', Philosophical Transactions of the Royal Society of London, Series A: Mathematical, Physical and Engineering Sciences, 2000.
- [3] K.J. Spyrou; 'Dynamic Instability in Quartering Seas: The Behavior of a Ship During Broaching', Journal of Ship Research, 40-1, p. 46-59, 1996.
- [4] J.E. Conolly; 'Stability and Control in Waves: A Survey of the Problems', Journal of Mechanical Engineering Science, 14-7, p. 186-193, 1972.