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Transportation Safety Board
of Canada



Bureau de la sécurité des transports
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BST

Investigation Summary

Capsizing with Loss of Life Small Fishing Vessel *Le Marsouin I*

Quebec Region Standing Committee on Fishing
Vessel Safety
Rimouski, 16 February 2011

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TSB Mission

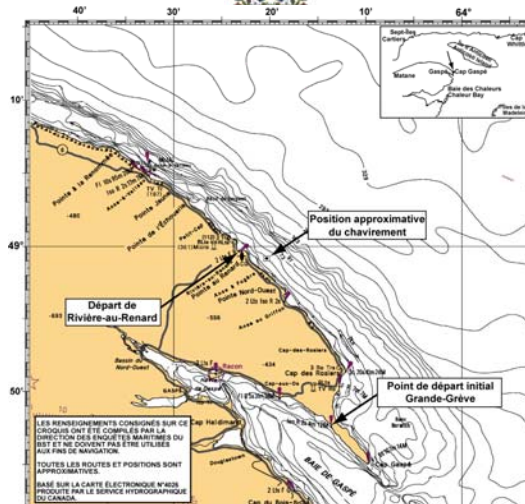
« advance transportation safety »

- ★ **By conducting independent investigations into transportation occurrences in order to make findings as to their causes and contributing factors.**
- ★ **It is not the function of the Board to assign fault and determine civil or criminal liability.**

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18 May 2009 - *Le Marsouin I* after capsizing



Area of the Occurrence



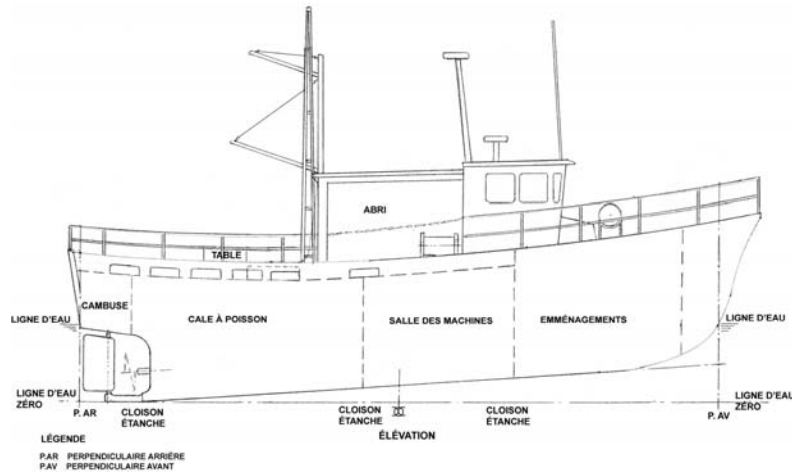
Description of Le Marsouin I

- ★ Fifth of a series of 11 boats
- ★ Built in 1981
- ★ Decked, hull built of glass-reinforced plastic
- ★ 4 compartments
- ★ 3 watertight bulkheads
- ★ Length 12.95 m
- ★ Gross Tonnage 24.58 tons

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Le Marsouin I after capsizing



Profile View of Le Marsouin I



History of the Voyage - Le Marsouin I

- ★ 18 May 2009, at 0645, departed Grande-Grève with a crew of 3
- ★ Crab fishing in the morning
- ★ Discharged at Rivière-au-Renard during afternoon
- ★ At 1720, departed for return trip
- ★ Light winds, quartering seas, waves 1 m
- ★ Slight rolling and pitching
- ★ At 1738, heeled to stbd, & capsized rapidly



Search and Rescue Operation

- ★ **No Mayday call**
- ★ **At 1740, resident called police**
- ★ **Search and Rescue Ressources**
- ★ **One survivor, 2 deceases**

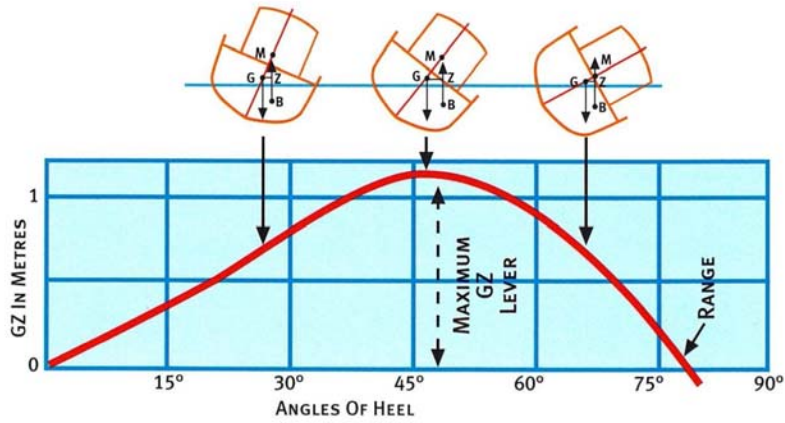
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TSB Investigation Activities

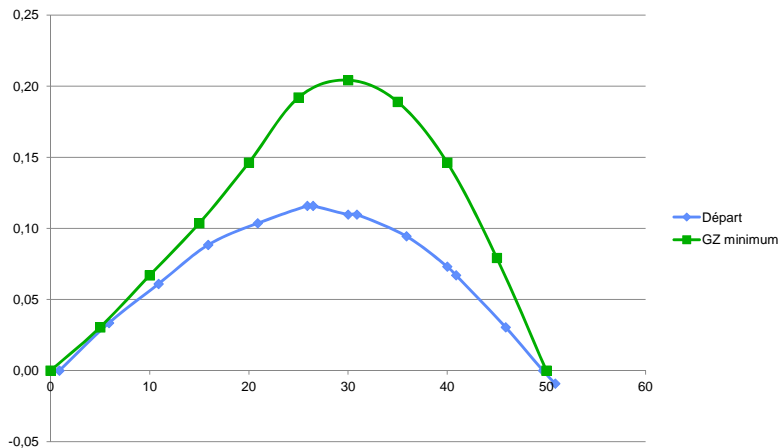
- ★ **Establish facts and cause(s)**
- ★ **Stability as a major factor**
- ★ **Inspection and Stability Test**
- ★ **Determining the lightship characteristics**
- ★ **Modeling the hull**
- ★ **Stability Assessment in Calm Waters**

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Typical Righting Arm Curve (GZ), as a function of the angle of heel

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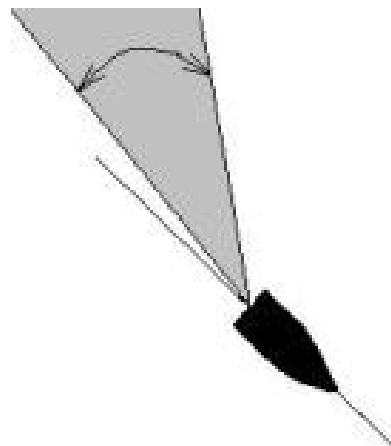
Comparison of righting arm curve in the departure condition with the minimum GZ



Sea Conditions during Capsizing

- ★ **Wave Height (0,5 à 1 m)**
- ★ **Wave Direction (320 à 350 degrees)**
- ★ **Vessel's Heading (135 degrees)**
- ★ **Stern and Quartering Seas**
- ★ **Angle of Encounter on Port Quarter**
- ★ **Wave Period (3 to 4.5 seconds)**
- ★ **Period of Encounter (9 to 26 seconds)**

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Angle of encounter of the wave with the boat



Threats of navigating in following and quartering seas

- ★ **2 dangerous phenomena**
- ★ **Surfing**
- ★ **Broaching**
- ★ **Risks recognized by IMO**

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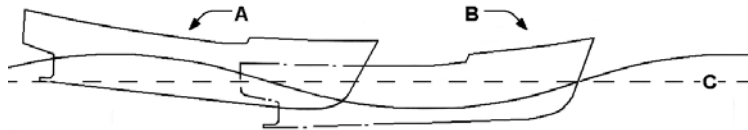
Factors Affecting Vessel Stability in Waves

- ★ **Position of wave crest along the hull**
- ★ **Wave Height**
- ★ **Ratio of wave height / length**
- ★ **Angle of encounter of the waves with the vessel**

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Position of Wave Crest

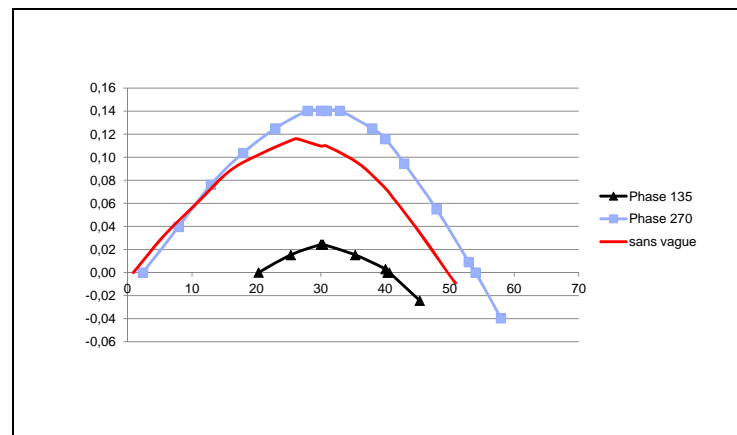


A : 135° (worst-case condition)

B : 270° (best-case condition)

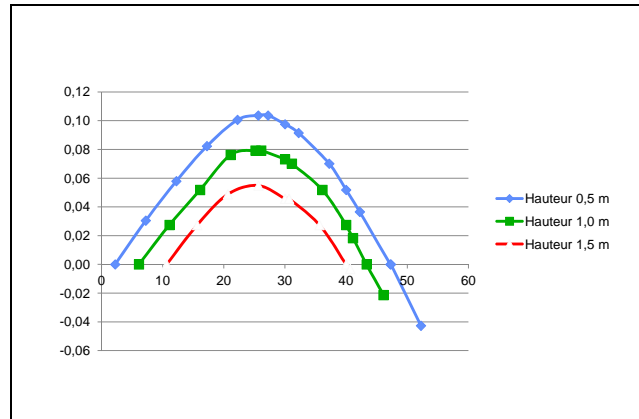
C : mean sea level

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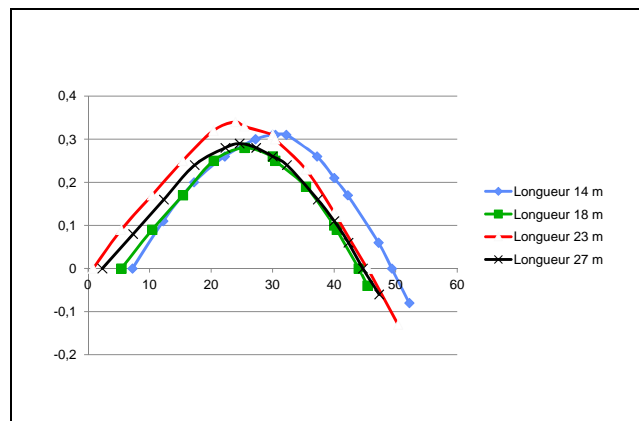
GZ Curves as a function of the position of the wave crest

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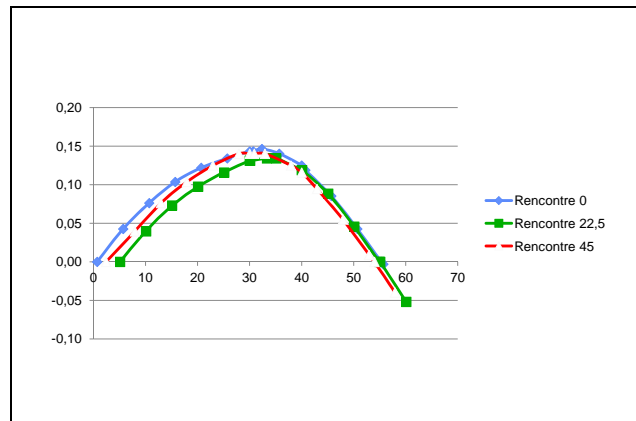
GZ Curves as a function of wave heights

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GZ Curves as a function of wave height /
length ratio

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GZ Curves as a function of the angles of encounter

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Findings as to Causes of Capsizing

- ★ In its departure condition, *Le Marsouin I* had limited stability, even in calm waters. Once underway in the presence of following and quartering seas, the vessel's stability was further reduced.
- ★ As a result of following and quartering seas, the vessel attained a large enough angle of heel such that it reached its angle of vanishing stability and capsized.

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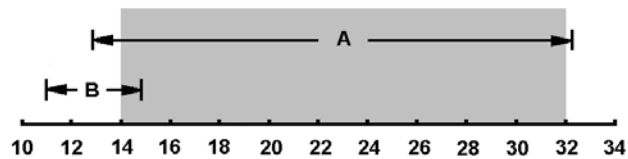
Risk Factors for Surfing and Broaching

- ★ **Period of Encounter with the waves**
- ★ **Wave Length**
- ★ **Vessel Speed**
- ★ **Wave Height**

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Critical Wave Lengths for Le Marsouin I



A : Risks of surfing.

B : Risks of broaching.

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Vessel's Critical Speed

- ★ **Similar to the wave speed**
 - ★ **Plus or minus 10% - surfing**
 - ★ **Plus or minus 15% - broaching**

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Critical Wave Height

- ★ **Greater than 4% of the vessel's waterline length for surfing and broaching**

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Summary of Critical Conditions and Level of Risks for Le Marsouin I

Critical Conditions	Level of risk during the accident	
	Navigation sur la crête (Surfing)	Tombée en travers (Broaching)
Period of encounter	High	Low
Wave Length	High	Low
Vessel Speed	Medium	Medium
Wave Height	Medium	Medium

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Corrective Measures

- ★ **Knowledgable about sea conditions**
- ★ **Vigilance**
- ★ **Training**
- ★ **Stability Assessment**
- ★ **Modify the vessel's speed**
- ★ **Modify the vessel's heading**

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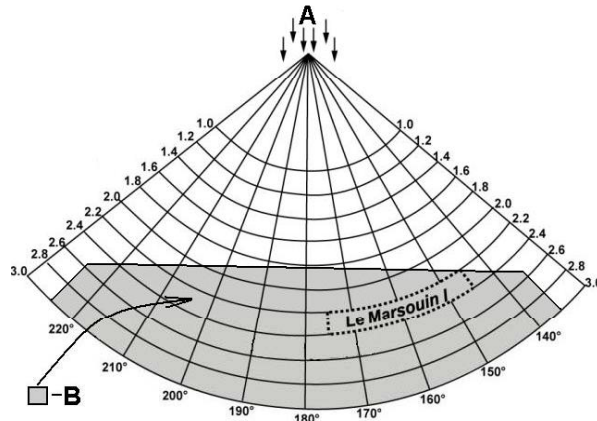


Diagram of risk of surfing

A : Wave Direction ; B : Risk Zone

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Thank

Questions?

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