Application risk analysis simulation method of ship manoeuvring in restricted area

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Objectives

• Define and recognize maneuverability safety
• Define and recognize maneuver related risks
Introduction

• The IMO standards on maneuverability evolved over a long period of time
• Applicable to vessels with length over 100 m and gas/chemical carriers, regardless of length but do not apply to high speed craft.
• All types of rudders and propulsion devices are covered by these standards.
• These standards are based on the assumption that the maneuverability of a vessel can be judged by comparing some characteristics of trajectories of standard maneuvers.
  • Turning ability; measured by tactical diameter and advance of the turning circle maneuver;
  • Course changing and yaw checking ability, measured by the first and the second overshoot angles of the zig-zag maneuvers.
  • Initial turning ability, measured by distance traveled before a vessel changes course 10 degrees during a zig-zag maneuver;
  • Stopping ability, measured by the track reach from a crash stop test.
  • Straight line stability / course-keeping ability is also included in the standards. The measure is the width of the instability loop obtained from a spiral maneuver
### Example IMO standards

<table>
<thead>
<tr>
<th>Measure of maneuverability</th>
<th>Criteria and standard</th>
<th>Maneuver</th>
<th>IMO Requirement and Status</th>
<th>Rating System by (Barr <em>et al</em> 1981)</th>
<th>ABS Guide Requirement and Status</th>
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</thead>
<tbody>
<tr>
<td>Turning Ability</td>
<td>Tactical Diameter</td>
<td>Turning Circle</td>
<td>Mandatory, $TD&lt;5L$</td>
<td>Rating: Marginal to Superior</td>
<td>Mandatory, rated $Rtd\geq1$</td>
</tr>
<tr>
<td></td>
<td>Advance</td>
<td></td>
<td>Mandatory, $AD&lt;4.5L$</td>
<td>No criteria</td>
<td>Mandatory, not rated $AD&lt;4.5L$</td>
</tr>
<tr>
<td>Course Changing and Yaw Checking Ability</td>
<td>First Overshoot Angle</td>
<td>10/10 Zig-zag test</td>
<td>Mandatory $\alpha10_1\leq f_{101}(L/V)$</td>
<td>Rating: Marginal to Superior</td>
<td>Mandatory, rated $R\theta_{10}\geq1$</td>
</tr>
<tr>
<td></td>
<td>Second Overshoot Angle</td>
<td></td>
<td>Mandatory $\alpha10_2\leq f_{102}(L/V)$</td>
<td>No criteria</td>
<td>Mandatory, not rated $\alpha10_2\leq f_{102}(L/V)$</td>
</tr>
<tr>
<td></td>
<td>First Overshoot Angle</td>
<td>20/20 Zig-zag test</td>
<td>Mandatory $\alpha20_1\leq25$</td>
<td>Rating: Marginal to Superior</td>
<td>Mandatory, rated $R\theta_{20}\geq1$</td>
</tr>
<tr>
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<td>Distance traveled before 10 degrees course change</td>
<td>10/10 Zig-zag test</td>
<td>Mandatory $l_{10}\leq2.5L$</td>
<td>Rating: Marginal to Superior</td>
<td>Mandatory, rated $Rt\geq1$</td>
</tr>
<tr>
<td>Stopping Ability</td>
<td>Track Reach</td>
<td>Crash stop</td>
<td>Mandatory $TR\leq15L$</td>
<td>No criteria</td>
<td>Mandatory $TR&lt;15L$</td>
</tr>
<tr>
<td></td>
<td>Head Reach</td>
<td></td>
<td>None</td>
<td>Rating: Marginal to Superior</td>
<td>Mandatory Rated $Rts\geq1$</td>
</tr>
<tr>
<td>Straight Line Stability and Course Keeping Ability</td>
<td>Residual turning rate</td>
<td>Pull-out test</td>
<td>Recommended $r\neq0$</td>
<td>No criteria</td>
<td>Recommended $r\geq0$</td>
</tr>
<tr>
<td></td>
<td>Width of instability$^2$ loop</td>
<td>Simplified spiral</td>
<td>Recommended $\alpha\leq f_{0}(L/V)$</td>
<td>No criteria</td>
<td>Recommended Not rated $\alpha\leq f_{0}(L/V)$</td>
</tr>
</tbody>
</table>

Source: “Rating-Based Maneuverability Standards” Belenky and Falzarano
Design elements important to maneuverability

- Rudder size and effectiveness
- Ability to transit at slow forward speed
- Propulsion and propeller characteristics
- Number of available engine reversals
- Adequate horsepower for control
- Extra reserve rudder angle needed to allow for ship crabbing from wind forces or moored ship suction
- Visibility from bridge and bridge arrangement
- Hull form squat (trim and sinkage) characteristics and effect of bank forces on moorings and passing ships
- Air draft
- Emergency anchoring ability
- Amount of tow line leads and line access

Source: “Rating-Based Maneuverability Standards”, Beleny, & Falzarano
What are limited waters

• Definition: (IMO) water area of depth up to 40 m and distances to nearest navigational obstruction less than 3 m.

• Straits, outlets of rivers, channels, water area port and other water areas with comparatively small surface and depth.

• They are characterized by
  • limited possibilities of maneuvering,
  • necessity of maneuvering in accordance with planned tracks at definite trajectories, with participation of pilot or individually,
  • necessity of adaptation of movement to local rules,
  • occurrence of navigational natural obstructions (shallows, reefs and other) or artificial (wrecks, mine fields)

Source: “The Role Of Navigational Risk Assessment During Ship’s Manoeuvring In Limited Waters” Wieslaw Galor
Characteristics of limited waters

- Geometrical dimensions of water area (width, depth), the shape and various dimensional characteristics,
- Port structures (locks, wharfs, navigational markings- fixed and floating),
- Hydro- and meteorological conditions (currents, tides, unprofitable directions, wind directions, ice),
- Other Traffic (vessels) that restricts accessible water area for navigating or for maneuvering,
  - Large (sea-going) ships
  - Large number of other vessels like barges, bunkers, fishing boats, ferries of local service, that make maneuvering of sea – going ships more difficult
- Navigational obstacles like ships on anchor, moored ships, docks, dredgers, hydrographical ships,
- Activity at ports/areas like modernization, reconstruction or new construction that restrict movement of ships,
- AIS Systems and their required accuracy, (VTMIS, LRIT, AIS, ...)
- Other rules (international and local) putting into ships trajectory of movement
Safety of navigation

• Objective: to be safe so that no navigational accident will occur, or if it occurs, the consequences are manageable (incl. no: loss of human life, health damages, damage or loss of cargo and of ship, environmental pollution, damage to a port structures, financial losses,...)
Probability of an accident

- Navigational accident free performance of a maneuver in specific conditions
- Error-free performance of the navigator
- Technical reliability of the ship
- Other factors (out and large)
Some criteria of ship safety assessment

• The limited area is characterized by a great number of risks
• The following safety shipping conditions should be monitored:
  • Maintain the **under keel clearance**,  
  • Maintain the **proper distance** to navigational obstacles,  
  • Maintain the proper **air drought**,  
  • Collision **avoidance** with other floating structures,  
  • Maintain the proper **berthing kinetic energy**,  
  • Control all **weather related conditions**.
At the same time

• Be as quick as possible
• “empty the room” fast (or “quick and dirty”)
• Comply with all the precautions and formalities...
Some Risks

• External hazards:
  • Hydrometeorological conditions (wind, current, waves, tides)
  • improper ship-berth interaction during berthing,
  • improper ship performance during the navigation along the approach channel
    • Drift,
    • Course
    • Position along the approach channel,
  • Traffic
    • Non-standard initial position,
    • Non-standard speed.

• Internal hazards
  • Human factor
  • Technical failures
Homework

• Select one of the two
  • Pushing Tin
    (https://www.youtube.com/watch?v=cBfKmhB9Wbo)
  OR
  • The hardest maneuver I’ve ever seen
    (https://www.youtube.com/watch?v=vLCuNbO5Bhw)

• Using the Bow-Tie approach, list the 5 most important events, their threats and their consequences
End of Session

Thank you for your attention!

Q&A
More info?

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