Inland vessels at sea: A useful contradiction to solve missing links in waterway systems

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Introduction

- PIANC INCOM/MARCOM Expert Group
  “Direct Access to Maritime Ports by Adapted Inland Waterway Vessels”

- Maritime ports with no or insufficient connection with inland waterway system

- Solution: cover limited trajectory at sea by inland vessels
Introduction

- **Terminology:**
  - estuary vessels – estuarine vessels
  - fluvio-maritime vessels
  - inland vessels also used for non-international sea voyages
  - sea-river vessels

- United Nations – Economic Commission for Europe – Glossary for Transport Services:
  - “sea-river traffic”

**Additional requirements:**

- additional wave loads (bending moments, shear forces, torsional moments, accelerations, ...)
- avoid flooding of the holds, avoid excessive water on deck
- avoid slamming loads

**Additional restrictions:**

- loading condition (minimum/maximum draft/GM)
- hydro/meteo limitations (wind/waves)
Introduction

Local problem ➔ local solution:
- Zeebrugge (B)
- Le Havre (F)
- Venice – Ravenna (I)
- ...
  (see PIANC Report No. 118)

Local regulations + class rules & regulations
- lack of uniformity?
- contradictions with international guidelines/regulations?
- different levels of safety?

Overview

- Introduction
- Local Regulations: Belgium (Zeebrugge)
- Local Regulations: France (Le Havre)
- Other Regulations
- Discussion
- Closing Remarks – Recommendations
Local regulations: Belgium (Zeebrugge)
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- **1962: Service Rule on estuary traffic (BSI)**
  - Class: range of navigation – suitable scantlings
  - Additional requirements:
    - Freeboard
    - Strength
  - \( H_s < 1.2 \text{ m} \) or \( \text{wind} < 5 \text{ Bf} \)
  - Mostly (bunkering) tankers

- **1980s: harbour expansion**

- **2000s: increased importance of container traffic**

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Estuary vessels:

- 2004 – 2007: individual studies – $H_s \leq 1.60 – 1.75 \text{ m}$
- 2007: Royal Decree

Requirements:

- Full ADNR certification
- Crew: specific STCW certification
- “Restricted seaworthiness”
  - Equipment, MARPOL, COLREG
  - STABILITY: almost identical criteria to the IMO Code on intact stability, including Severe wind and rolling criterion
  - Fire safety, freeboard, container stowage, structural strength, draft scales, manoeuvrability, navigation aids, communication equipment, propulsion, bilge pumps, electrical installations, fire fighting, anchor, personal life saving, bulwarks, railings
- Probabilistic criteria (“RISK ANALYSIS”)
Local regulations: Belgium (Zeebrugge)

Requirements:

- Full ADNR certification
- Crew: specific STCW certification
- "Restricted seaworthiness"
- ... 
- Probabilistic criteria ("RISK ANALYSIS")
  - Not required for $H_s \leq 1.20$ m
    - minimum freeboard / height of hatch covers
  - Required for $H_s > 1.20$ m
Local regulations: Belgium (Zeebrugge)

**Risk Analysis – Probabilistic Criteria**
- Probability calculations:
  - Ship's lifetime: 20 years
  - 300 round trips / year

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**Risk Analysis: Criteria**
- Green water (foredeck):
  \[ \leq 1 / \text{lifetime} \]
- Slamming (bow emergence):
  \[ \leq 1 / \text{year} \]

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Risk Analysis: Criteria

Cargo holds/tanks:
Exceedance of reference level
≤ 1 / lifetime

Exceedance of aft deck / bulwark level
≤ 1 / lifetime
Local regulations: Belgium (Zeebrugge)

**Risk Analysis: Criteria**
- Roll angle
  - $2/3$ of flooding angle
  - or maximum in stability curve
  - or 15 deg
  - limited to $1/\text{lifetime}$
- Wave bending moment
- Wave torsional moment
- Lateral acceleration

1/\text{lifetime}

Present fleet:
- 9 bunkering tankers (6 with $H_s > 1.2$ m)
- 2 car carriers
- 4 container carriers
- 1 multipurpose barge
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- **Local Regulations: France**
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Local Regulations: France (Le Havre)

- **Background**
  - 2005: container terminal *Port 2000*
Local Regulations: France (Le Havre)

**Background**
- 2005: container terminal *Port 2000*

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**Legislation: northern access to Port 2000**

- **Arrêté du 10 janvier 2007 relatif à la navigation de bateaux fluviaux en mer pour la desserte de Port 2000**
  (Decree of 10 January 2007 w.r.t. the navigation of inland vessels at sea for the access to Port 2000), modified 2012

- **Conditions for navigation:**
  - Significant wave height < 1.20 m
  - Wind speed < 21 knots
  - Visibility > 2 nm
Local Regulations: France (Le Havre)

Legislation: northern access to Port 2000

- Requirements for ships:
  - Built > 1997, double hull, equipped for containers, class, RVBR, ADNR, ...
  - Minimum values for freeboard & safety distance
    - reduction possible if proved to be safe by seakeeping model tests or calculations

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- Seakeeping tests/calculations:
  - Irregular, long-crested waves, significant wave height 1.20 m
  - Wave direction / ship speed:
    - 0 deg (following seas) minimum manoeuvring speed
    - 45 deg (quarter following seas) minimum manoeuvring speed
    - 90 deg (beam seas) zero speed
    - 135 deg (quarter head seas) maximum sustained speed
    - 180 deg (head waves) maximum sustained speed
  - Probability of water ingress during 1 hour < 50%
Local Regulations: France (Le Havre)

Legislation: northern access to Port 2000

Requirements for ships:
- Seakeeping tests/calculations:
  - Irregular, long-crested waves, significant wave height 1.20 m
  - Wave direction / ship speed:
  - Probability of water ingress during 1 hour < 50%
  - Based on *Interim guidelines for open-top container ships* (IMO 1994)
    - $H_s = 8.5$ m
    - Hourly rate of ingress of green water
    - Bilge-pump capacity

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Local Regulations: France (Le Havre)

Legislation: southern access to Port 2000

- Arrêté du 30 août 2007 relatif à la navigation de bateaux fluviaux "porte-conteneurs" en mer pour la desserte de Port 2000 par l’estuaire de la Seine
- Refers to Division 229
  (= French regulation for maritime cargo vessels operated in sheltered maritime stretches, i.e. < 5 nm from harbour waters)
- No quantitative criteria w.r.t. freeboard / safety distance
- Reference to International Load Line Convention, with possible exemption to be granted by authority
- Authorities have to give additional indication w.r.t. wave conditions
  ➔ in practice: Hs = 2.0 m

Local Regulations: France (Le Havre)

Present fleet

- N: 2 operators / 5 inland vessels
- S: 1 operator / 1 sea-going vessel
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Other Regulations

- Classification societies
  - Germanischer Lloyd (GL):
    \[\text{IN}(0) - \text{IN}(0,6) - \text{IN}(1,2) - \text{IN}(2)\]
  - Bureau Veritas (BV):
    \[\text{IN}(0) - \text{IN}(0,6) - \text{IN}(x) \quad (1,2 < x < 2)\]
  - Lloyd’s Register (LR):
    Zone 1: \(H_s < 1.6\) m (95% of observed waves)
    Zone 2: \(H_s < 1.0\) m
    Zone 3: \(H_s < 0.5\) m
Other Regulations

Classification societies
- Strength (scantlings)
  - Additional vertical wave bending moment & shear force
  - Except for IN(0) or Zone 3
- Stability
  - LR: –
  - BV/GL:
    - minimum requirements for stability curve characteristics
    - additional requirements for container vessels (secured/non secured):
      - Wind effects, centrifugal forces
    - $\text{IN}(x)$ ➔ wind pressure = $f(x)$

Economic Commission for Europe
- UN-ECE recommendations
  - Standardisation of technical requirements for inland vessels
  - No substitute for national laws/regulations
- Originally not for sea-river navigation
- For vessels in European inland waterways
  - Zone 1: $\text{H}(1/10) < 2.0 \, \text{m}; \text{H}(1/3) < 1.57 \, \text{m}$
  - Zone 2: $\text{H}(1/10) < 1.2 \, \text{m}; \text{H}(1/3) < 0.94 \, \text{m}$
  - Zone 3: $\text{H}(1/10) < 0.6 \, \text{m}; \text{H}(1/3) < 0.47 \, \text{m}$
- Freeboard and stability requirements – zone dependent
Other Regulations

Economic Commission for Europe

- Special provisions for river-sea navigation:
  - Amendments 2011 ➔ new chapter
  - “river-sea navigation vessel” is defined as a vessel intended for navigation on inland waterways and suitable for restricted navigation at sea
  - “international voyage” ➔ “coastal voyage”
    - International: SOLAS, ICLL, MARPOL, ...
    - Coastal: national certificates + selected IMO conventions

Zones and conditions of sea navigation:

- Restricted zone between ports – inland vessels allowed with season & wave height restrictions + vessel requirements
- ZONES RS 2,0 – RS 3,0 – RS 3,5: sea areas within specific borders where river-sea vessels are allowed with season restrictions
- ZONES RS 4,5 – RS 6,0: of same country
closed/open seas with distance to shelter < 100/50 nm

(definition of wave height??)
Other Regulations

- Economic Commission for Europe
  - Special provisions for river-sea navigation:
    Amendments 2011 ➔ new chapter
  - Strength requirements ➔ class
  - Minimum bow draft:
    - for RS 2,0: 0.9 m
    - for RS 3,0: 1.4 m
    - for RS 3,5: 1.7 m
    - for RS 4,5: 2.2 m
    - for RS 6,0: 2.9 m.

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**Seakeeping criteria**

- **Belgian legislation:**
  - 1 year of wave measurements (48*365 directional spectra)
  - Calculate vessel response to each spectrum
  - Order by significant wave height
  - Determine cut-off value for $H_s$ $\Rightarrow$ 1 event per lifetime/year

- **French legislation**
  - Arbitrary combinations of wave directions and ship speeds
  - Long-crested irregular waves with “marginal” $H_s$, $T_p$ range
  - Determine most critical ship response

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Discussion

Stability criteria

Belgian legislation:
- very/too strict (= sea-going vessels)
- practically impossible to meet → exemption

French legislation:
- Northern access: adapted stability requirements
- Southern access: less clear

ECE:
- Mostly reference to national administrations or IMO
- Zones 1/2/3: not directly applicable (Hs range, no bilge keels, …)

Minimum draft

Belgian legislation:
- Typical: Tmin = 2.0 – 2.5 m for Hs = 1.6 – 1.9 m

French legislation:
- Not mentioned

ECE (for sea-river navigation)
- Tmin = 0.9 – 1.7 m for RS 2.0 – 3.5
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Closing Remarks - Recommendations

- Sea-river traffic has proved to be a reliable link
- Clear regulations are very important for all parties
  - Most regulations are based on local conditions
  - Additionally inspired by international regulations
  - Sometimes contradictory
- Local character ➔ local conditions are important
- Requirements to be based on general principles (e.g. probability of undesired events, stability)
  ➔ general framework + local conditions