Innovation and Risk
Regulatory Challenges and tools

Future of Ship Safety
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Dr Philippe Corrignan,
Head of Safety Energy & Environment Section
Bureau Veritas Marine & Offshore Research Department
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Drivers for changes & innovations

- **Energy sources storage & management:**
  - Alternative fuels (LNG,…), other energy sources (wind, solar, recovery from waste), combinations of multiple energy sources

- **New construction & repair materials:**
  - Composites, FRP, sandwich, FRP patch, Steel + elastomer

- **Large ships:**
  - Large fire zones, large lifeboats, hydroelastic response

- **Energy efficiency improvement measures:**
  - Ultra slow steaming, energy Saving devices, hull air lubrication…

- **Environment:**
  - Energy efficiency improvement measures:
    - EGCS, onboard waste treatment, ballast water treatment

- **New technologies:**
  - HTS,…

- **Anti-piracy measures & equipment**

- **Anti-terrorism measures & equipment**

- **Automation:**
  - Autonomous ship, eMaritime,

- **New navigation zones:**
  - Polar,…

- **Market**

- **New ship designs**

- **Security**

- **Resources**
Regulatory challenges

► An acceptable level of safety must be defined and attained to address:
  • New operational conditions & situations
  • Novel and/or unproven technologies, new technical domains
  • New (or more significant) physical phenomena & ship responses

► Traditional *prescriptive* regulatory approach, based on experience, is not adapted to breakthrough innovations

► The industry needs another approach that is:
  • Flexible and reactive enough to cope with the fast booming of innovations
  • Without compromising safety
Innovation and regulatory framework

- Prescriptive generic approach
  - Innovation falls into existing rules
  - Exemption
  - Prescriptions based on safety experts
  - Development of new regulations, codes; FSA, GBS*

- GBS-SLA*

- Alternative ship/equipment specific approach:
  - Equivalent
  - Alternative Design
  - Risk Based Approval (Safety Case)*

(*) IMO instruments under development
Existing regulatory tools

Risk based framework for IMO rule making process: Formal Safety Assessment:

FSA is a rational and systematic process for assessing the risks relating to maritime safety and the protection of the marine environment and for evaluating the costs and benefits of IMO’s options for reducing these risks. The use of FSA is consistent with, and should provide support to, the IMO decision-making process (MSC/Circ.1023, 5th April 2002).

- Structured and transparent process; method fully published (MSC/Circ.1023-MEPC/Circ.392; revised guidelines to be approved by MEPC65); studies reviewed by MSC EG/FSA.
- Generic analysis, adapted to address a category / a fleet of ships
- Not developed to address specific innovations
- Long process: FSA study > review by IMO EG/FSA > action by relevant IMO Committee/SC
Existing regulatory tools

▶ Equivalents

- Principle: design solution deviating from prescriptive regulations/rules may be approved provided it is demonstrated to be at least as effective as that required by the regulations.
- Provision in several IMO instruments (SOLAS, MARPOL Annexes I, II, VI, IGC,…) and classification society rules
- The approval of an equivalent design should be reported to IMO by the approval authority
- Approval is completely in the hands of the Flag State: no regulation on the way to demonstrate equivalency, no standardization, very limited reporting

Examples of Recent Equivalents

<table>
<thead>
<tr>
<th>Description</th>
<th>Flag</th>
<th>SLS.14 Circ No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floodable length curves for ro-ro passenger ships with long lower hold or similar spaces</td>
<td>Italy</td>
<td>446</td>
</tr>
<tr>
<td>Equivalent arrangements for the maximum rudder angle and time limit at full service speed required by regulation II-1/29.3.2</td>
<td>Sweden</td>
<td>458</td>
</tr>
<tr>
<td>Equivalent on location of the free fall life boat on a Cargo ship when not possible at stern</td>
<td>Isle of Man</td>
<td>460</td>
</tr>
<tr>
<td>Equivalent arrangements accepted under regulation I/5 Steering Magnetic Compass Requirement Fire Fighting Carriage Requirement</td>
<td>Vanuatu</td>
<td>488</td>
</tr>
</tbody>
</table>
Existing regulatory tools

► Alternative design

- Principle: refinement of the equivalents principle, with guidelines on the global methodology.
- Current applications:
  - Alternative design and arrangements for Machinery and Electrical Installations (SOLAS regulations II-1/55 + MSC.1/Circ. 1212)
  - Alternative design and arrangements for fire safety (SOLAS regulation II-2/17 + MSC/Circ. 1002)
  - Novel life-saving appliances or arrangements (SOLAS regulation III/38 + MSC.1/Circ. 1212)
Existing regulatory tools

► Alternative design

- Methodology:

Statistical / accident based approach + expert judgement

Assessment of effects of alternative features: \( \Delta R_1 > 0 \)

Assessment of effects of RCO: \( \Delta R_2 < 0 \)

Equivalence: \( \Delta R_1 + \Delta R_2 \leq 0 \)

Summary to IMO
Existing regulatory tools

- Alternative design
  - Current applications:

<table>
<thead>
<tr>
<th>Alternative Designs</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FIRE</strong></td>
<td></td>
</tr>
<tr>
<td>Movable Fire Walls</td>
<td>Norway 232;293</td>
</tr>
<tr>
<td>B15 Tunnel</td>
<td>Norway 295;353</td>
</tr>
<tr>
<td>Lifts without separate machinery room</td>
<td>Finland 226</td>
</tr>
<tr>
<td></td>
<td>Norway 235;294</td>
</tr>
<tr>
<td></td>
<td>Malta 328;382;483</td>
</tr>
<tr>
<td></td>
<td>Bahamas 407</td>
</tr>
<tr>
<td>MVZ&gt;1600m² or L&gt;48m</td>
<td>Malta 329;357;383</td>
</tr>
<tr>
<td></td>
<td>Bahamas 353;395</td>
</tr>
<tr>
<td></td>
<td>Italy 459</td>
</tr>
<tr>
<td>Particle board combustible</td>
<td>Sweden 433</td>
</tr>
<tr>
<td><strong>LSA</strong></td>
<td></td>
</tr>
<tr>
<td>Life-boat capacity 370 persons</td>
<td>Bahamas 352</td>
</tr>
<tr>
<td>Life-boat capacity 293 or 267 persons</td>
<td>Bahamas 381</td>
</tr>
<tr>
<td>Life-boat capacity 270 persons</td>
<td>Bahamas 408</td>
</tr>
<tr>
<td>Life-boat capacity 170 persons</td>
<td>Malta 482</td>
</tr>
<tr>
<td></td>
<td>Italy 437;459</td>
</tr>
<tr>
<td><strong>COMPOSITE</strong></td>
<td></td>
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<tr>
<td>FRP sandwich for superstructures</td>
<td>R&amp;D</td>
</tr>
<tr>
<td>Sandwich repair, FRP patches</td>
<td>R&amp;D</td>
</tr>
<tr>
<td>Balistic protection</td>
<td>R&amp;D</td>
</tr>
<tr>
<td>Naval</td>
<td>R&amp;D</td>
</tr>
</tbody>
</table>
Existing regulatory tools

► Equivalents & alternative design: pros and cons

- Adapted to address a specific system
- Quicker implementation (compared to FSA)
- Large effort required; need to analyze a reference (prescriptive) design, in addition to the alternative design
- A reference should be found so extent and number of deviations from regulations/rules should remain limited
- No standardization, no systematic sharing or review of alternative design studies (design casualty scenarios, risk models, acceptance criteria). A complete study must be repeated when changing approval authority and/or RO, with possible different conclusions
Existing regulatory tools

► Equivalents & alternative design: key aspects

- Development of the scenarios
- Definition of a reference design:
  - Consider same “functional unit” (ie same capacity, number of pax, cargo rate…)
  - A reference may not exist. Example: energy generating devices fuelled by shipboard waste. Reference = Incinerator? Engine?
- Definition of functional requirements and performance criteria
  - The conclusion of the study can be very sensitive to the selected criteria. Example: alternative design for fire safety; influence of burning materials, (visibility,…) thresholds, location and height of simulation sensors, timeline if ASET-RSET criteria are used
Existing regulatory tools

- Equivalents & alternative design: key aspects
  - Acceptance criteria:

Lifeboat; 150 vs 300 persons capacity; 4500 persons to evacuate
  “LSA unavailability or failure”

Slow steaming, Handymax tanker
  “Last minute avoidance too late; failed to turn in time to avoid collision”
Future regulatory tools

- Goal-Based Standards: goal-based regulatory framework for the development of regulations (IMO) and rules (classification societies, …)
  - Principle: regulations and rules should be demonstrated to comply to goals and functional requirements developed by IMO.
  - Generic guidelines for developing IMO GBS MSC.1/Circ.1394
  - Deterministic or risk-based approach (Safety Level Approach).
  - Examples of implementations:
    - New SOLAS regulation II-1/3-10 “Goal-based ship construction standards for bulk carriers and oil tankers”, application date 01/07/2016 (standards as set out in MSC.287(87)).
    - DE ongoing work on “Goal-based guidelines on framework of requirements for ships' life-saving appliances”
Future regulatory tools

Risk-Based Approval

- Origin: Safedor MSC/86-5-3; New draft MSC/92 INF.5
- Scope: Covers the approval process for Equivalents, Alternative designs and full risk-based design applied to a specific ship
- Principle:
  - development of a preliminary design
  - approval of preliminary design
  - development of final design
  - final design testing and analyses
  - approval
- Not necessarily comparison with prescriptive designs; eg using ALARP
- FSA applied on a specific ship ie QRA with ALARP concept or other risk acceptance criteria to be developed by IMO
Summary & important issues

► It is necessary to define and ensure an acceptable level of safety for the multitude of innovations proposed today.

► Suitable regulatory instruments exist and/or are under development; but important issues must be properly addressed:
  
  • Transparency, standardization and verification in the tools/process; ship data base, risk models, acceptance criteria…
  
  • Third party verification
  
  • Case by case approval and acceptance of specific studies by other ROs: eg specific equipment approved by RO A based on alternative design study, to be approved by RO B on another ship: new study starting from scratch or adaptation of existing study?
  
  • IP issues
  
  • Development of new goal-based or functional rules and prescriptive regulations for novel technologies once a sufficient number of specific studies performed
Thank you for your attention

Philippe.corrignan@bureauveritas.com

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