Formal representation of Maritime Regulations: Creation, Enforcement and Compliance

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Agenda

- e-Compliance
- Motivation
- Maritime Regulation Ontology
- Polar Code
E-Compliance: [http://www.e-compliance-project.eu/](http://www.e-compliance-project.eu/)

- E-Compliance is a three year EU research project, FP 7: From June 2013 to June 2016.
- Goal: To help reduce the administrative burden on maritime stakeholders by using semantic technology and digital models to manage regulations.
Motivation

- Maritime Regulations are extremely complex
- Practitioners are often unsure which regulation applies in a given scenario
- Terms are used inconsistently ("bulk carrier" means different things in different chapters of SOLAS)
- Long lifetimes of ships complicate things further
**Creation**
Create and maintain regulations for both int’l organizations (IMO, SOLAS, MARPOL etc), for Classes, for national and local legislators, and for ship management.

**Compliance**
What must be done by the ship to be compliant with regulations, rules, procedures.

**Enforcement**
Check compliance with regulations from both int’l organizations and Class rules, national and local regulations.
Example of ISM Code

<table>
<thead>
<tr>
<th>Stakeholder/Actor</th>
<th>Service</th>
<th>Tasks</th>
<th>Information Elements</th>
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<td>Flag state</td>
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<tr>
<td>Ship Operator/ISM Company</td>
<td>Create</td>
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<td>ISM Code</td>
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<tr>
<td></td>
<td></td>
<td>Create</td>
<td>National law to implement the code in a flag state</td>
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<tr>
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<td>Create</td>
<td>National law to implement the code in a flag state</td>
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<td>Comply</td>
<td>National law to implement the code in a flag state</td>
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<td>Enforce</td>
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<tr>
<td>Master/Crew</td>
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<td>Port state/Port authority</td>
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<td></td>
<td></td>
<td>Create</td>
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</tbody>
</table>

- **Create**: Create, amend and publish ISM Code (international regulation)
- **Comply**: Comply by ensuring that the ISM Code is implemented at the national level.
- **Enforce**: Enforcing national laws (possibly done by recognized authority), by doing inspections (RO, class)
- **Create**: Create national laws to implement the ISM Code.
- **Comply**: Comply by creating check lists and procedures.
- **Create**: Create check lists and procedures.
- **Comply**: Comply with check list and procedures by doing reporting.
- **Comply**: Comply with port specific rules and procedures.
- **Create**: Create port specific rules and procedures.
- **Enforce**: Enforcing national laws by doing port state inspections.

**Four levels of regulations/laws/bylaws which are related**

- **Guidelines Descriptions**
- **Rules (IF condition THEN action)**
- **Inspection Results Arrival Messages FAL forms**
- **Port specific Regulations Message Formats Templates**
Implementation of Use Cases

<table>
<thead>
<tr>
<th>e-Compliance Subsystems</th>
<th>Creation System</th>
<th>Port System</th>
<th>Ship System</th>
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<tr>
<td>International/National Legislator</td>
<td>1. Creation of international regulations</td>
<td>3. Publication of Port Regulations</td>
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<td>Port Authority</td>
<td>2. Creation of port bye-laws</td>
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<td>Port State Inspector</td>
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<td>4. Publish/Subscribe</td>
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<td>Ship Master and Crew</td>
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<td>5. Assisting SMS Users</td>
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<td>Ship Management</td>
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<td>7. Automatic, Rule-Based Compliance</td>
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<td>Ship Agent</td>
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<td>10. Ship Reporting through Reusing Data</td>
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<tr>
<td>User</td>
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</tr>
</tbody>
</table>

**Services**
- Creation Services
- Compliance Services
- Enforcement Services
Ontology based management of maritime rules and compliance

Maritime ontology - WHY:
- Simplify and improve creation, amendment, enforcement and compliance of regulations
- Maritime regulations fully understood by compliers and enforcers
- All users interpret the regulations in the same way
- Uniformity in regulation representation

Maritime ontology – HOW:
- Define an ontology to formally describe maritime regulations
- Define a maritime thesaurus (concepts)
- Do reasoning on formalized maritime regulations: Check draft regulations against existing ones
- Consistent use of terms
- Consistent regulation creation
**Thesaurus**

- Ensure a consistent and unambiguous use of terms (“preferred labels”) when creating regulations;
- Link terms in regulations to their definitions;
- Form the basis for semantic search and annotation of regulations.
- Linking ontology and thesaurus will create a “termino-ontological resource” to allow for annotation and indexing as well as inferring and reasoning.

**Ontology**

- Allow a consistent creation of regulations by defining the structure of a well-formed regulation;
- Provide IT systems with a certain “understanding” of what a regulation demands and what it is aimed at;
- Clearly define the role of a term within a regulation;
- Allow for indexation of regulations and thus enhance the relevance of query results.
Maritime Ontology

Thesaurus, Including Lexicon

Plain Regulation Text

Knowledge Database (DB Schema = Ontology)

Regulatory Database

Ship Structure
- Hull structure
- Opening
- Propulsion system
The Basic Idea: Model of maritime regulations

Model maritime regulations as logical “Rules”: “If A then B”

Three parts for a rule:

1. **Target** (Ship, Organisation or Role): Subject of the rule.
3. **Context** (Maritime Situation, Journey, Activity, Cargo): Where the rule is applicable.

“All ships carrying 100 or more seafarers and ordinarily engaged on international voyages of more than three days' duration shall carry a medical doctor as a member of the crew”

(From ILO regulation C164 Health Protection and Medical Care (Seafarers) Convention, 1987)
What does the Thesaurus give us?

- Read and interpret new regulations
  - Bring up the definition of a concept used in a regulation;
  - Check correct use of terms
  - Point to similar, relevant regulations that address the same topic.

- Semantic Search:
  - What is the correct term to use for a vessel used for fishing?
  - What is the definition of a “bulk carrier”?
  - Which of the requirements in a regulation are mandatory, which ones are guidelines?
What does the ontology give us? – Ontological Search

➤ What types of things are allowed as target of a regulation?
➤ Which ship types are targeted in these regulations?
➤ Check draft regulations against existing ones:
  ➤ What other regulations apply to vessels longer than 100m, carrying dry bulk and having a single engine?
  ➤ Are there any regulations demanding ships to carry fire pumps?
➤ Publish relevant regulations:
  ➤ Publish only relevant regulations:, for instance: I am the ship manager of a cargo vessel carrying dry bulk between Spain and the UK. Which regulations are relevant for my business?
IMO adopts Polar Code

The International Maritime Organization (IMO) has adopted the International Code for Ships Operating in Polar Waters (Polar Code), and related amendments to the International Convention for the Safety of Life at Sea (SOLAS) to make it mandatory, marking an historic milestone in the Organization’s work to protect ships and people aboard them, both seafarers and passengers, in the harsh environment of the waters surrounding the two poles.

The Polar Code and SOLAS amendments were adopted during the 94th session of IMO’s Maritime Safety Committee (MSC), which was meeting at the Organization’s London headquarters for its 94th session, from 17 to 21 November 2014.

The Polar Code covers the full range of design, construction, equipment, operational, training, search and rescue and environmental protection matters relevant to ships operating in waters surrounding the two poles.

Ships trading in the polar regions already have to comply with all relevant international standards adopted by IMO, but the newly adopted SOLAS chapter XIV “Safety measures for ships operating in polar waters”, adds additional requirements, by making mandatory the Polar Code (Preamble, Introduction and Part IA (Safety measures)).

The Polar Code highlights the potential hazards of operating in polar regions, including ice, remoteness and rapidly changing and severe weather conditions, and provides goals and functional requirements in relation to ship design, construction, equipment, operations, training, and search and rescue, relevant to ships operating in Arctic and Antarctic waters. As well as mandatory provisions, recommendations are also include in a Part 1.A.
Polar Code: Scenarios related to Search and Creation

• Scenarios related to querying the Polar Code
  1. Search involving content of Polar Ship Certificate
  2. Search for terms related to the Polar Code (for instance ice-covered water)
  3. Search involving ice condition data

• Scenarios related to creating references in the Polar Code text
  4. Creating reference to other regulations in the Polar Code

• Scenarios related to checking consistent use of terms in the Polar Code text
  5. Consistent use of terms: Preferred labels
1. Search involving content from Certificate and Manual

PART I-A of Polar Code:

1.1 Each chapter in this part consists of the overall goal of the chapter, functional requirements to fulfil the goal, and regulations. A ship shall be considered to meet a functional requirement set out in this part when either:

1.1.1 the ship's design and arrangements comply with all the regulations associated with that functional requirement;

or

1.1.2 part(s) or all of the ship's relevant design and arrangements have been reviewed and approved in accordance with regulation 4 of SOLAS chapter XIV, and any remaining parts of the ship comply with the relevant regulations => The alternative design and arrangements meet the intent of the goal and functional requirements

• Is it possible to know whether Regulation 1.1.1 (functional requirements) or Regulation 1.1.2 (meets the goals and intent of the regulation) is used as the requirement for ensuring compliance with the Polar Code?

Query:

• Given this ship with static information and Polar Ship Certificate, which regulations are mandatory?

• What must the Polar Ship Certificate contain, if compliance according to Regulation 1.1.2 in Part I-A are to be ensured?
1. Search involving content from Certificate and Manual

• Question: Can check the ship's compliance towards the alternative design and arrangement?

• What does "deviate from the prescriptive requirements" mean?
  
  – SOLAS XIV, reg 4 paragraph 4: also defining the technical and operational measures and conditions for the allowed deviation: What is allowed deviation: if it still meet the intent and functional requirements. ⇒ Need to know the content of the Polar ship certificate and Polar Water Operational Manual to know which operations are allowed! Need to maintain the connection between the regulation and the actual ship certificates and operational manual.

Polar Code, Part I-A, Safety Measures, Chapter 1 – GENERAL, Regulation 1.1:

• If this design and arrangements deviates from the prescriptive requirements, the ship can still be compliant with the code if it

  1. Meet the intent of the goal and functional requirements meaning: intent of the goal and intent of the functional requirements AND

  2. Provide an equivalent level of safety to the requirements in those chapters. AND

  3. An engineering analysis, evaluation and approval of the design and arrangements shall be carried out based on the guidelines approved by the Organization. Refer to the Guidelines for the approval of alternatives and equivalents as provided for in various IMO instruments (MSC.1/Circ.1455), the Guidelines on alternative design and arrangements for SOLAS chapters II-1 and III (MSC.1/Circ.1212) and the Guidelines on alternative design and arrangements for fire safety (MSC/Circ.1002), as applicable." AND

  4. Deviations must be recorded in the Polar ship certificate and the ship's Polar Water Operational Manual


2. Search for terms related to the Polar Code

- **Example Query:** What regulations are mandatory for my cargo shipping operating in **ice-covered water**?
- More general: Which regulations is relevant for my ship under this ice condition?
- What is the correct term to use for ice-covered water?

- **Ice-covered water:** Used several places in the Polar Code, but
  - not defined by WMO (World Meteorological Organization's sea-ice nomenclature).
  - Not defined in POLARIS/IACS either
  - Nor in the Polar Code.
- WMO have a definition of "Occurrence of Floating Ice":
  - **Ice cover:** The ratio of an area of ice of any *concentration* to the total area of sea surface within some large geographic local; this local may be global, hemispheric, or prescribed by a specific oceanographic entity such as Baffin Bay or the Barents Sea.
  - "**Concentration**" saying: "Concentration describing the amount of the sea surface covered by ice as a fraction of the whole area being considered."
- Examples from the Polar Code:
  - **Icebreaker** means any ship whose operational profile may include escort or ice management functions, whose powering and dimensions allow it to undertake aggressive operations in **ice-covered waters**.
  - ships shall have means to ensure safe evacuation of persons, including safe deployment of survival equipment, when operating in **ice-covered waters**, or directly onto the ice, as applicable;
  - Ships shall be designed and have plans to minimize the risk of any environmental impact from oil or oily mixtures in case of an emergency situation, in particular one that may lead to an oil spill in **ice-covered waters**.
- A lot of other regulations deal with ice-covered waters as well.
3. Search involving ice condition data

- **Example Query:**
  - Where in the Polar Waters can my Category A ship operate?
  - => Need to have Ice Condition Data

- 2.1 *Category A ship* means a ship designed for operation in polar waters in at least medium first-year ice, which may include old ice inclusions.
- 2.2 *Category B ship* means a ship not included in category A, designed for operation in polar waters in at least thin first-year ice, which may include old ice inclusions.
- 2.3 *Category C ship* means a ship designed to operate in open water or in ice conditions less severe than those included in categories A and B.

- Another query: What regulations are mandatory for by category B ship?
4. Creating reference to other regulations in the Polar Code

Example Regulation: Use this as an example of reference to other regulations:

4.3.2 Stability in damaged conditions

4.3.2.1 In order to comply with the functional requirements of paragraph 4.2.1.2, ships of categories A and B constructed on or after 1 January 2017 shall be able to withstand flooding resulting from hull penetration due to ice impact. The residual stability following ice damage shall be such that the factor $s_i$, as defined in SOLAS regulations II-1/7-2.2 and II-1/7-2.3, is equal to one for all loading conditions used to calculate the attained subdivision index in SOLAS regulation II-1/7. However, for cargo ships that comply with subdivision and damage stability regulations in another instrument developed by the Organization, as provided by SOLAS regulation II-1/4.1, the residual stability criteria of that instrument shall be met for each loading condition.

Footnote in Chapter 3, regulation 3.3 in Polar Code: Refer to IACS UR S6 Use of Steel Grades for Various Hull Members – Ships of 90 m in Length and Above (latest version) or IACS URI Requirements concerning Polar Class (latest version), as applicable.
5. Consistent use of terms: Preferred labels

- Example: **Ice accretion**: Already in thesaurus. In polar code: **accretion of ice**: add this as an alternative label (the Polar Code uses both ice accretion and accretion of ice).

- **Ice class or Polar Class**: In practice the same terms?
  - Regulation 1.2 in chapter 1 in Part I-A in Polar Codes defines Ice Class and Polar Class (same): requirements to hull and propeller.

- Definitions: Regulation 2 in Introduction chapter in Polar code defines
  - **Category A ship**, 
  - **Category B ship**, and
  - **Category C ship**.

- Pluss: In Regulation 3.3, in chapter 3 in Part I-A in the Polar Code, the concept of
  - **Ice strengthened category C ship** appears. And also that all category C ships does not need to be ice strengthened.
  - From Polar Code chapter 6, regulation 6.2.1.3: **ships ice strengthened in accordance with chapter 3** .. Is this really the same term?

- Polar code talks about "Category C cargo ships", meaning that the polar class is a possible property for all ship types. => This means that Category A, B or C ship must be a grouping in addition to the ship type (cargo ship, passenger ship etc)

- PWOM: Not defined before used. (Polar Water Operation Manual)
Purpose of Creation Tool for Maritime Regulations

• Check consistency in terms:
  – All terms defined? Eg. Polar Code: ice-covered water used several times, but not defined.
• Ensure usage of only one term for the same thing, eg:
  – in the thesaurus: watertight door
  – In the polar code: doors relevant to watertight integrity  But: Are they really synonyms?
  – Ice class vs polar class: Synonyms?
• Ensure that all terms are defined in the same way in all regulations:
  – From SOLAS: Bulk carrier is defined in two different ways in to different SOLAS chapters
• Check consistency in references:
  – Are all references meaningful: Eg Polar code: refers to paragraph 4.4.2, but this does not exist! (4.3 is the last one in chapter 4)
• Easy access to related regulatibs:
  – IMO Vega: not easy to find the version that is valid: Lot of postponed regulations.
• Propose preferred term (label): eg
  – closing appliances vs closing devices  The Polar Code uses both!
Questions:

1. Do you know of any conflict internally in the POLAR CODE?
2. Do you know of any conflicts between the POLAR CODE and SOLAS/MARPOL?
3. Do you know of any conflicts with other regulations?

• **SPECIFIC QUESTIONS:**

• Ice class or Polar Class: The same?
• Ice-covered waters?

• **Problems:**

• 4.3.2.3 Damage as defined in paragraph 4.4.2 is to be assumed at any position along the side shell.
• There is no paragraph 4.4.2 in the Polar Code as is!!
Thank you!
Regulation 2.3 - Hours of work and hours of rest

**Purpose:** To ensure that seafarers have regulated hours of work or hours of rest

1. Each Member shall ensure that the hours of work or hours of rest for seafarers are regulated.
2. Each Member shall establish maximum hours of work or minimum hours of rest over given periods that are consistent with the provisions in the Code.

**Standard**

Standard A2.3 - Hours of work and hours of rest

4. In determining the national standards, each Member shall take account of the danger posed by the fatigue of seafarers, especially those whose duties involve navigational safety and the safe and secure operation of the ship.

5. **The limits on hours of work or rest shall be as follows:**
   - (a) **maximum hours of work shall not exceed:**
     - (i) 14 hours in any 24-hour period; and
     - (ii) 72 hours in any seven-day period;
   - or
   - (b) **minimum hours of rest shall not be less than:**
     - (i) ten hours in any 24-hour period; and
     - (ii) 77 hours in any seven-day period.

6. Hours of rest may be divided into no more than two periods, one of which shall be at least six hours in length, and the interval between consecutive periods of rest shall not exceed 14 hours.

7. Musters, fire-fighting and lifeboat drills, and drills prescribed by national laws and regulations and by international instruments, shall be conducted in a manner that minimizes the disturbance of rest periods and does not induce fatigue.

Minimum rest: 77 hours in 7 days means working: 7*24-77= 91 hours work.
PART A: Mandatory standards regarding provisions of the annex to the STCW Convention
CHAPTER VIII: Standards regarding watchkeeping
Section A-VIII/1: Fitness for duty: Applicable from 2012-01-01:

1. Administrations shall take account of the danger posed by fatigue of seafarers, especially those whose duties involve the safe and secure operation of a ship.

2. All persons who are assigned duty as officer in charge of a watch or as a rating forming part of a watch and those whose duties involve designated safety, prevention of pollution and security duties shall be provided with a rest period of not less than:
   .1 a minimum of 10 hours of rest in any 24-hour period; and
   .2 77 hours in any 7-day period.

3. The hours of rest may be divided into no more than two periods, one of which shall be at least 6 hours in length, and the intervals between consecutive periods of rest shall not exceed 14 hours.

4. The requirements for rest periods laid down in paragraphs 2 and 3 need not be maintained in the case of an emergency or in other overriding operational conditions. Musters, fire-fighting and lifeboat drills, and drills prescribed by national laws and regulations and by international instruments, shall be conducted in a manner that minimizes the disturbance of rest periods and does not induce fatigue.

5. Administrations shall require that watch schedules be posted where they are easily accessible. The schedules shall be established in a standardized format in the working language or languages of the ship and in English.
Work:
26: 14 hours
27: 14 hours
28: 14 hours
29: 14 hours
30: 14 hours = 70 hours
31: 13 hours
01: 8 hours
= 91 hours work in 7 days
= 24*7-91=**77 rest hours**.

➤ 77 hours rest in 7 days means 24*7-77=91 hours work, which exceeds 72 hours as defined in the first part of the regulation!!