

Towards Safety of Composite Ships

Date: Monday 3 February, lunchtime

Duration: 30 minutes

Presenters: Alfonso Jurado, Matthias Krause, Stéphane Paboeuf



Presentation outline

- Motivations for both projects
- FIBRESHIP
- RAMSSES
- Joint conclusions
- Q&A

Motivations Current regulatory regime

Very little number of FRP ships registered at IMO

SOLAS Ch.II-2 Regulation 2:

“The hull, superstructures, structural
bulkheads, decks and deckhouses
**shall be constructed of steel or
other equivalent material.**”

= barrier

SOLAS Ch.II-2 Regulation 17:

“Alternative design and arrangements”

On basis of Equivalent Safety = opportunity

Main issue to be addressed: **fire safety**

Motivations Current regulatory regime

Guidance available

- MSC.1/Circ.1455 Guidelines for the approval of alternatives and equivalents as provided for in various IMO instruments
 - **Uncertainty of getting approval in contract phase**
- MSC/Circ. 1002 Guidelines on alternative design and arrangement for fire safety
- MSC.1/Circ.1574 Interim guidelines for use of fibre reinforced plastic (FRP) elements within ship structures: Fire safety issues.
 - **Adopted June 2017, 4 years evaluation period**

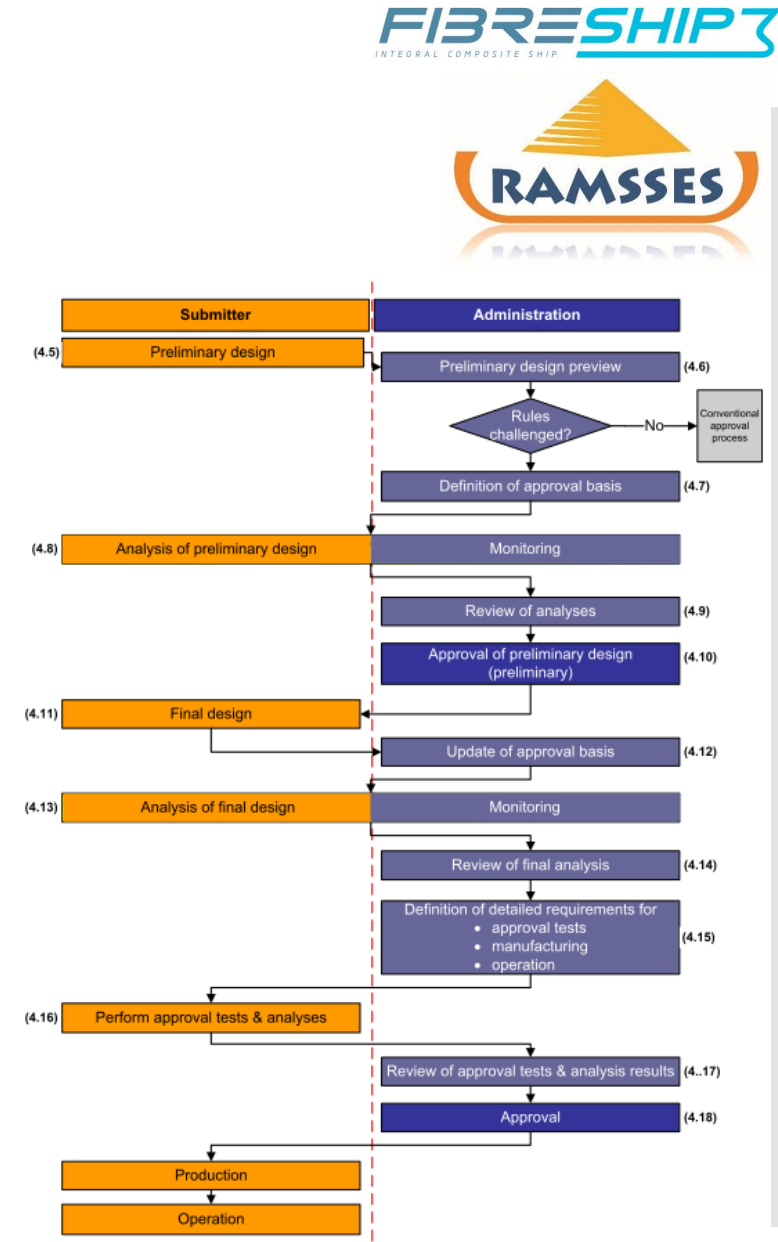


Figure 2: Design and Approval Process

Developed Approaches



Short term approach

- Based on existing rules and a **Smart Track to Approval**
 - Database of pre-approved solutions and materials test results
 - Fire risk scenarios
 - Analysis and modelling tools, including numerical or statistical models



Long term approach

- Development of **new prescriptive rules** in:
 - Structure
 - Fire
 - Production
- Validation by simulations, tests and full-scale demonstrator

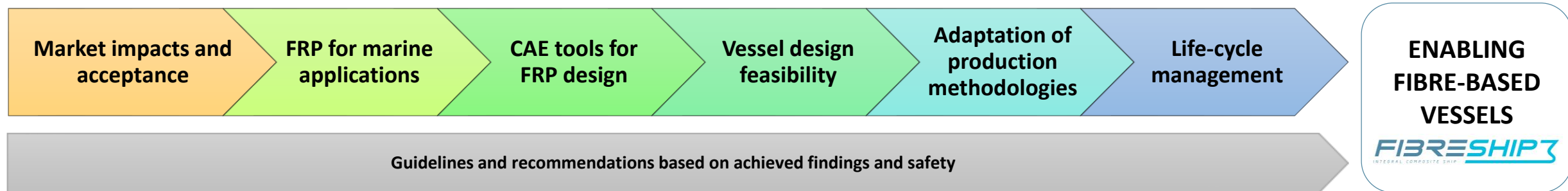


FIBRESHIP PROJECT DESCRIPTION



FIBRESHIP Project

- FIBRESHIP addresses the **feasibility** of using **FRP** technology for **large-length vessels**, trying to overcome the identified technical challenges and promote a change in the regulatory framework that enables their design, building, and operation.



Main particulars of FIBRESHIP:

- Grant Number: 723360
- Duration: 36 months (June2017-May2020)
- Project Budget / EU Contribution: €11M / €8,7M
- TRL: 7-9
- Collaboration between 18 partners of 11 countries

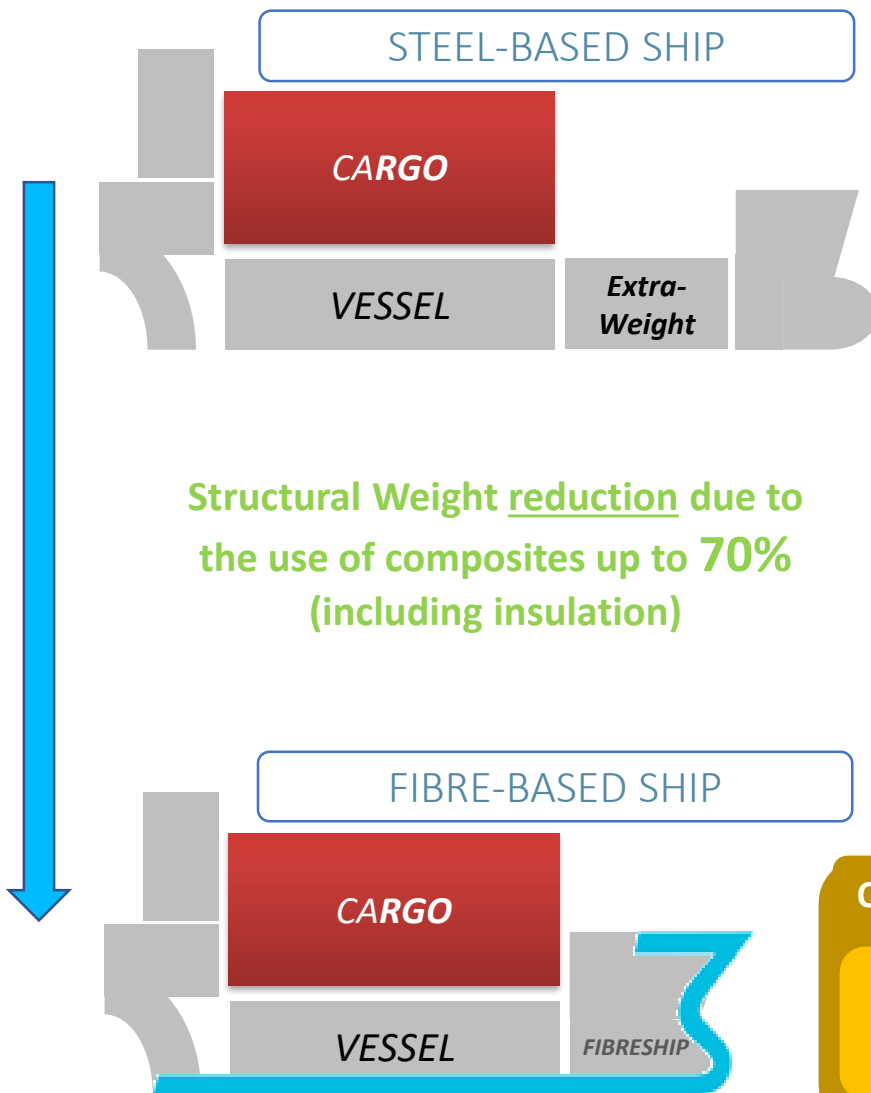
H2020 Project Management



This project has received funding from European Union's Horizon 2020 research and innovation programme under grant agreement N° 723360



POTENTIAL BENEFITS IDENTIFIED



Benefits for shipowners due to the reduction of structural weight:

Reduction of Powering Needs & Wet Surface implying:

Bunkering Consumption Reduction

Lower Greenhouse Gas Emissions

Increasing of Payload Capacity

Other potential benefits for shipowners:

Better Fairing Solutions for the Constructed Hull

Aesthetic Improvements

Corrosion Immunity

Life Cycle Costs Reduction

Other potential benefits identified in the FIBRESHIP project:

Continuous Structural Health Monitoring

Possibility of Using Wireless Sensors

Underwater Radiated Noise Reduction

MAIN OUTCOMES (1/5) – SUMMARY OF RESULTS

FRP adoption roadmap in EU shipping market considering end-users satisfaction

Cost-Benefit calculator and Global Business Plan

FRP selection methodology

Results verification with experimental tests:

- Material mechanical properties and bondings.
- Small- & medium scale fire tests of FRP panels with and without insulation.
- Influence of environmental conditions on FRP panels.
- Onboard N&V tests and URN measurements.
- Structural full-scale vessel test.
- Modal analysis and NDT of FRP panels for detection of delamination failures.
- Engineering solutions for aesthetic improvements.



Building a FRV block fully in composites as a demonstrator

Designing of three fibre-based vessel structures

Sub-task 4.1.1: CATEGORY I
Light Commercial Vessels

CONTAINER VESSEL



Containership
250m LOA

Sub-task 4.1.2: CATEGORY II
Passengers transportation & Leisure Vessels

ROPAX



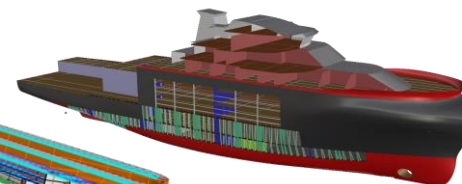
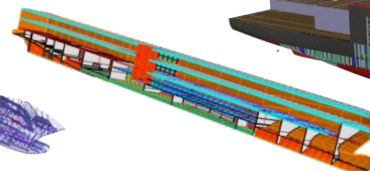
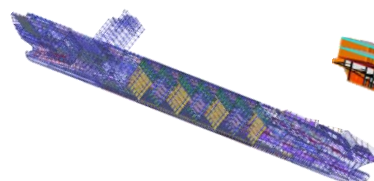
ROPAX
204m LOA

Sub-task 4.1.3: CATEGORY III
Special Services Vessels

FISHING RESEARCH VESSEL



FRV
85m LOA



Coupled software capable to assess the vessel structural and fire performance

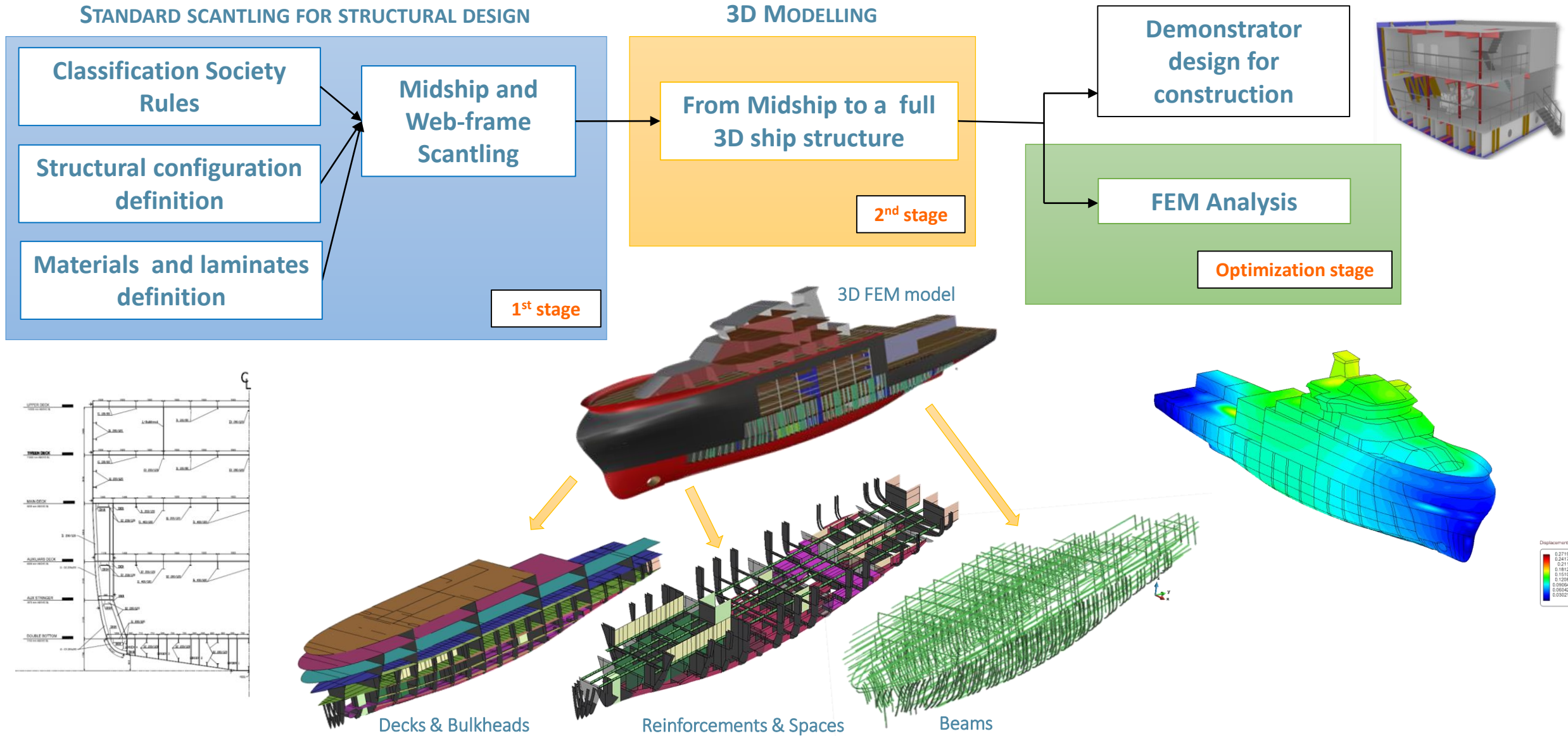
Definition of vessel inspection and SHM strategy

Guidance notes and recommendations:

- Applicable materials and joining techniques.
- Structural design based on structural and fire criteria.
- Adoption of new production strategies and building techniques.

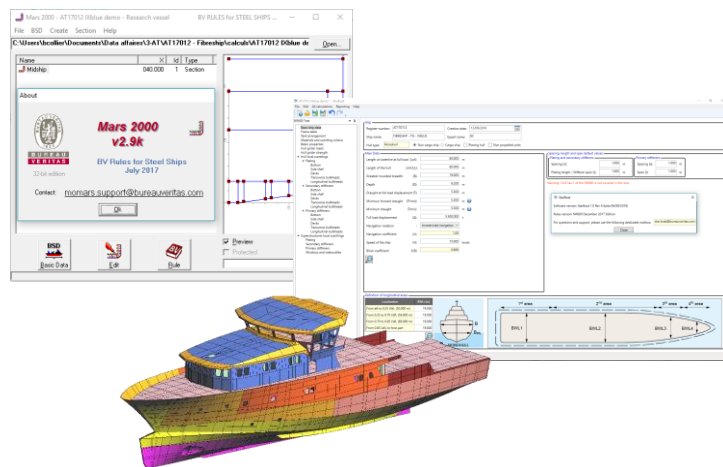
Decision Support Tool on life-cycle assessment (LCA)

MAIN OUTCOMES (2/5) – FRV Structural design process



• Structure Performance Criteria

- ✓ **Calculation Approach:** Loads - Rules Based / Numerical (FE) approach
- ✓ **Loads combination:** Local / Global
- ✓ **Fatigue assessment:** S-N Curves, cumulative damage
- ✓ **Joining:** Adhesive bonding of composites and hybrid materials
- ✓ **Structural continuity:** Between primary hull girder and structure / primary and secondary stiffener



• Fire Performance Criteria: two complementary approaches

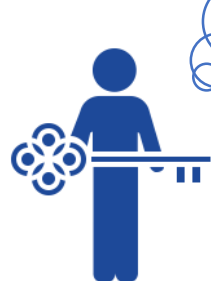
- ✓ **Local equivalence approach for composites:**
 - Based on **SOLAS** expectations for steel structures and deck/bulkheads fire ratings.
 - Proposal of **new fire division rating and spaces: REI**
 - a. Resistance (R), Integrity (E), Insulation (I) (to avoid misunderstanding with A & B class fire divisions)
 - Proposal of **new fire tests and performance criteria** for FRP structures
- ✓ **Global equivalence approach for composites:**
 - Based on **generic risk models** to be developed.
 - Considers fire risk in a **global approach** and all possible **fire safety systems**
 - Identification of **specific nodes** (from **local equivalence approach**) to reach an **equivalent safety level**

Adjacent space →	A	B	C	D	E	F	G	H	I	J	K	L	M	N
Space on fire ↓														
A	60	60	60	60	30	30	30	30	30	60	60	60	60	60
B	60	60	60	60	30	30	30	30	30	60	60	60	60	60
C	60	60	60	60	30	30	30	30	30	60	60	60	60	60
D	60	60	60	60	30	30	30	30	30	60	60	60	60	60
E	60	60	60	FRM	FRM	FRM	30	30	30	60	60	60	60	60
F	60	60	60	30	30	30	30	30	30	60	60	60	60	60
G	60	60	60	FRM	FRM	FRM	30	30	30	60	60	60	60	60
H	60	60	60	FRM	FRM	FRM	30	30	30	60	60	60	60	60
I	60	60	60	FRM	FRM	FRM	30	30	30	60	60	60	60	60
J	60	60	60	30	30	30	30	30	30	60	60	60	60	60
K	60	60	60	30	30	30	30	30	30	60	60	60	60	60
L	60	60	60	30	30	30	30	30	30	60	60	60	60	60
M	60	60	60	30	30	30	30	30	30	60	60	60	60	60
N	60	60	60	30	30	30	30	30	30	60	60	60	60	60

Space classification	Description	Space classification	Description
A	Control stations	K	Areas of minor fire risk
B	Stairways	L	Areas of moderate fire risk
C	Corridors	M	Areas of high fire risk
D	Evaluation stations and external escape routes	N	Machinery spaces
E	Open decks	O	Auxiliary machinery spaces
F	Sanitary and similar spaces	P	Special category and re-ro spaces
G	Tanks, voids with no or little fire risk	Q	Cargo

ACHIEVABLE IMPACTS FOR SHIPOWNERS

- O&M cost savings
- Emissions reduction
- Economies of scale achievement by increasing cargo capacity



Larger ships in FRP looks as a good idea to owners!

Smooth
Scale
Increasing

Vessel segments closest to market:

Inland Waterway Vessels / Superyachts / Small Feeders
Research Vessels / Small Offshore Supply Vessels



Good starting point for fully fibre-based vessels

FACTORS OF MARKET READINESS

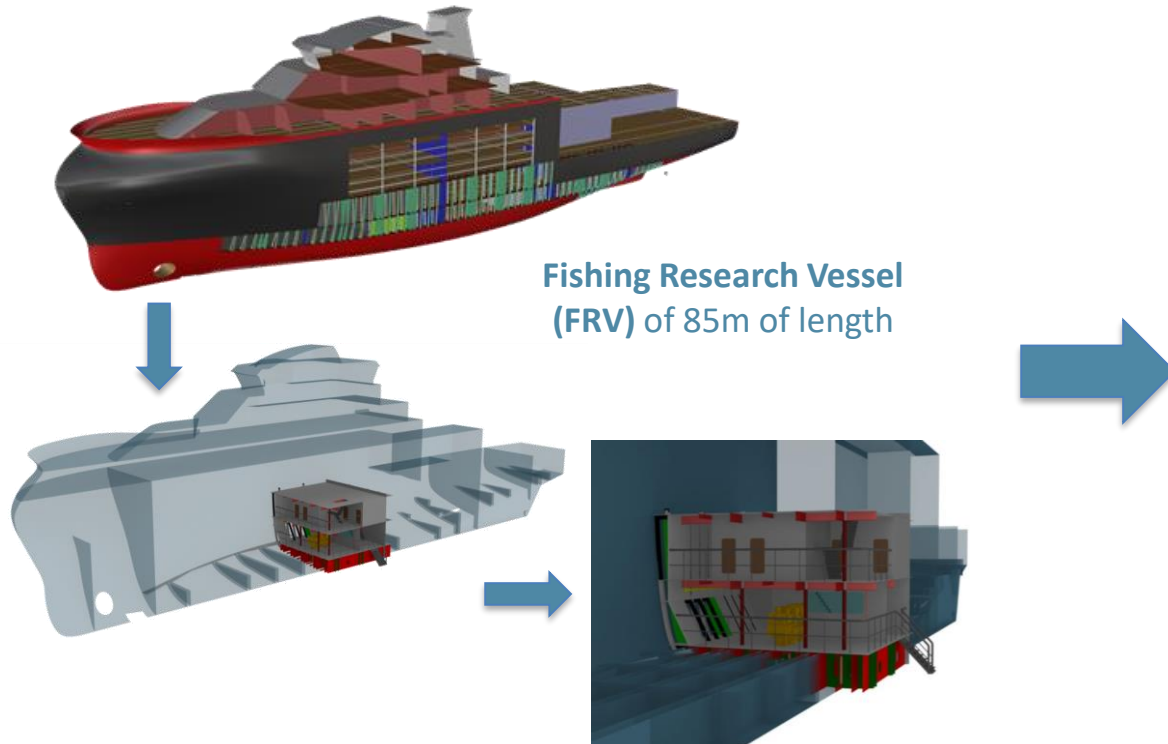
✓
Incentives to
Short Sea Shipping
market

✓
Construction
Readiness

✓
Potential positive
ROI

MAIN OUTCOMES (5/5) – FIBRESHIP Demonstrator

Full-scale demonstrator of a Fishing Research Vessel (FRV) module was built at iXblue facilities in La Ciotat (France):



Fishing Research Vessel (FRV) of 85m of length

Ship block that considers two different spaces on board.

Approx.: 11m x 11m x 8.6m; 20 tons



The ship block considers:

- Bottom deck with a part of an engine room.
- Upper deck with a set of accommodation spaces.

Realisation and Demonstration of Advanced Material Solutions for Sustainable and Efficient Ships



01.06.2017
31.05.2021



Budget: €13.5 M
Funding: €10.8 M



36 partners
12 countries



www.ramsses-project.eu

Call Topic: MG-2.2-2016 Development and Use of High Performance and Lightweight Materials ... (IA)

Coordinator: CETENA (Italy) – Financial and Administrative
CMT (Germany) – Technical and Dissemination



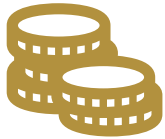
The project RAMSSES has received funding under the European Union's Horizon 2020 research and innovation programme under the grant agreement No 723246.

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Innovative Materials for Ships:



less fuel and emissions



efficient and competitive

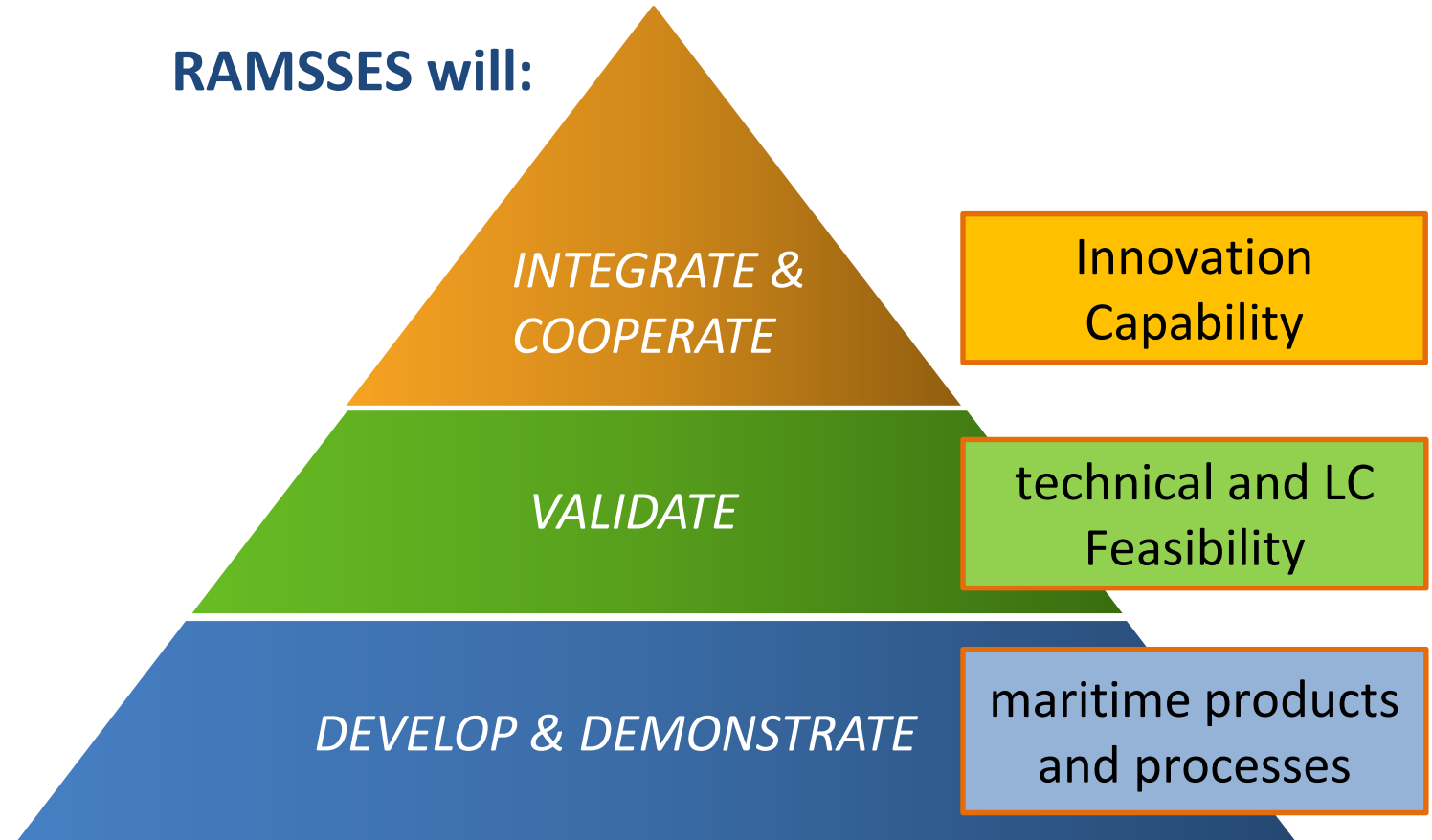


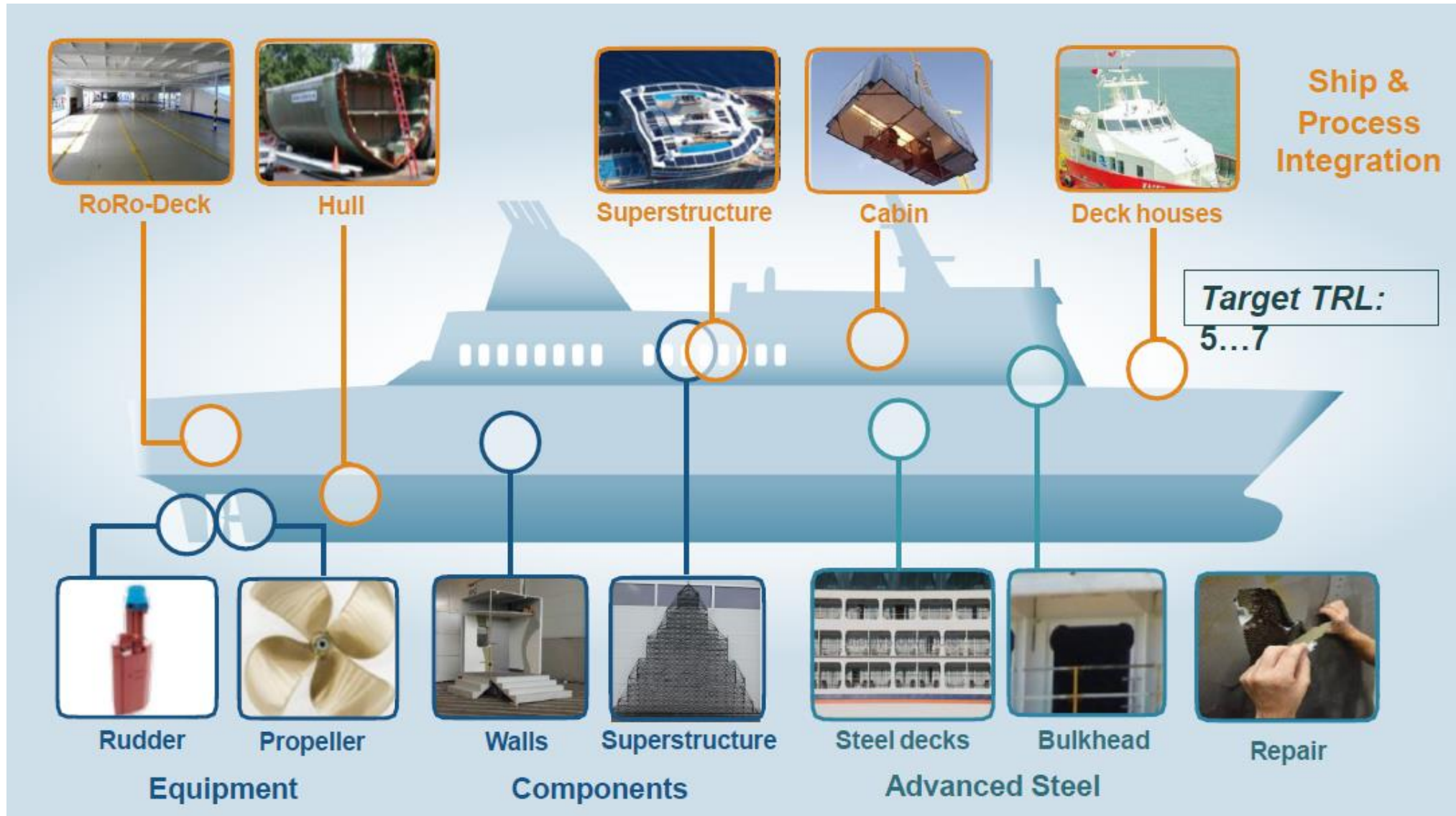
safe and comfortable

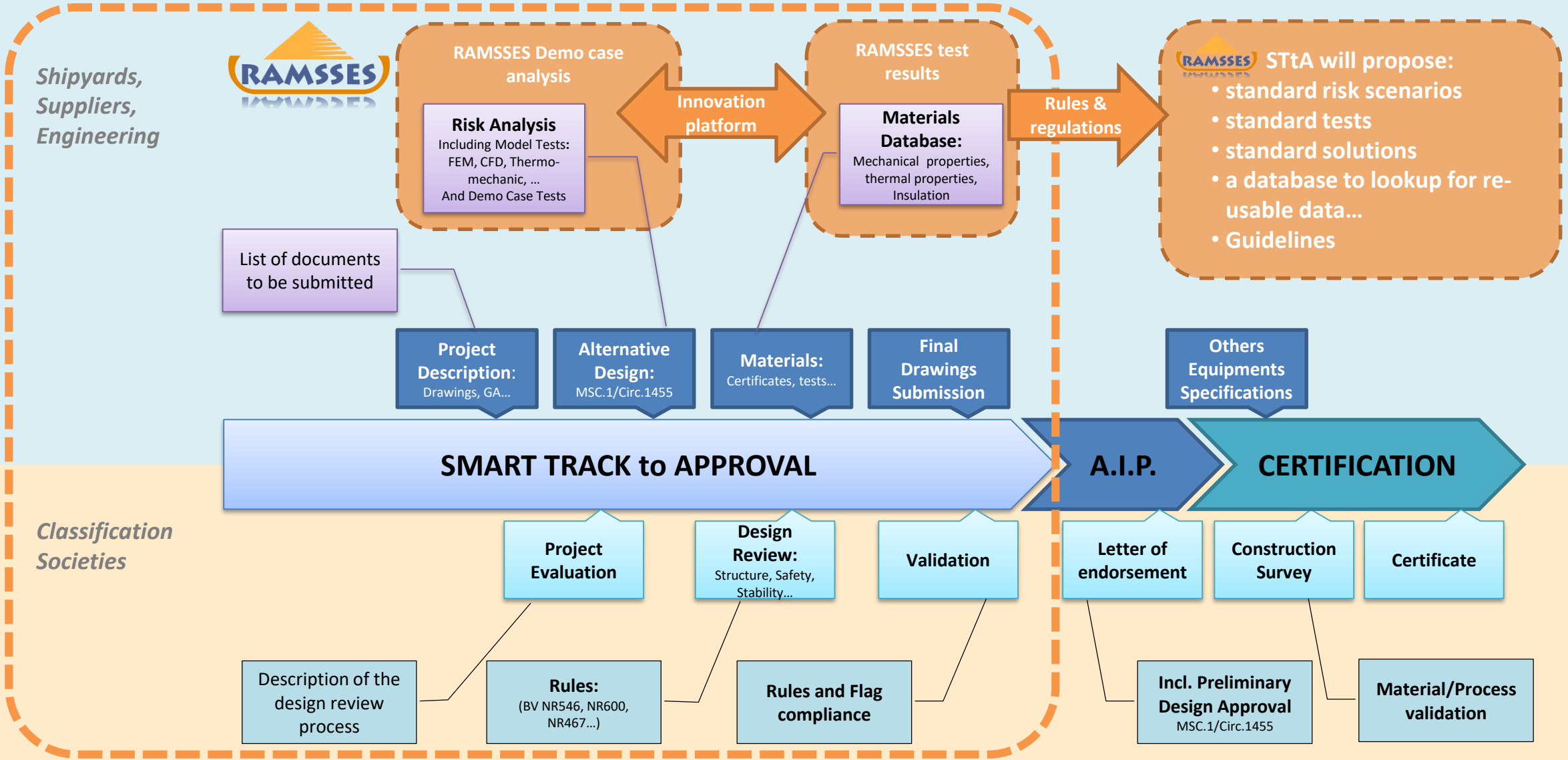


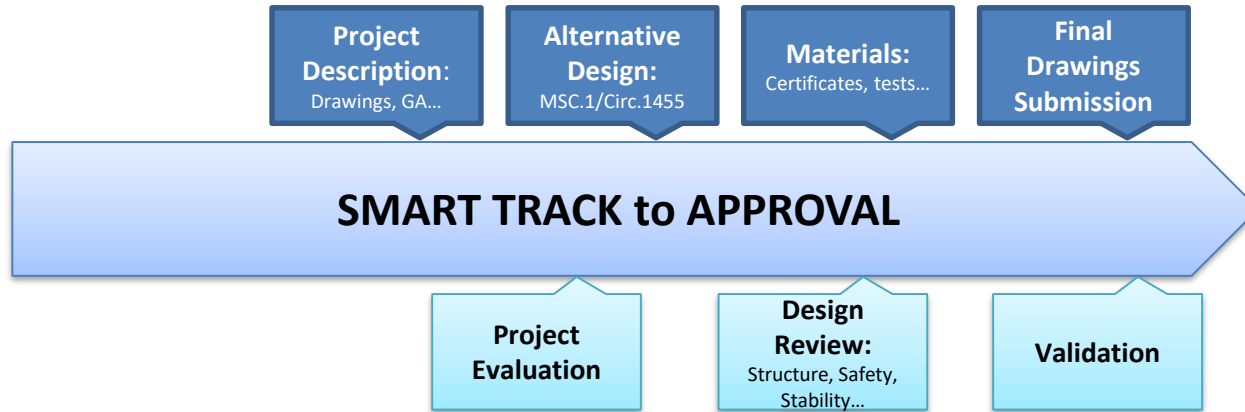
smart and functional

RAMSSES will:





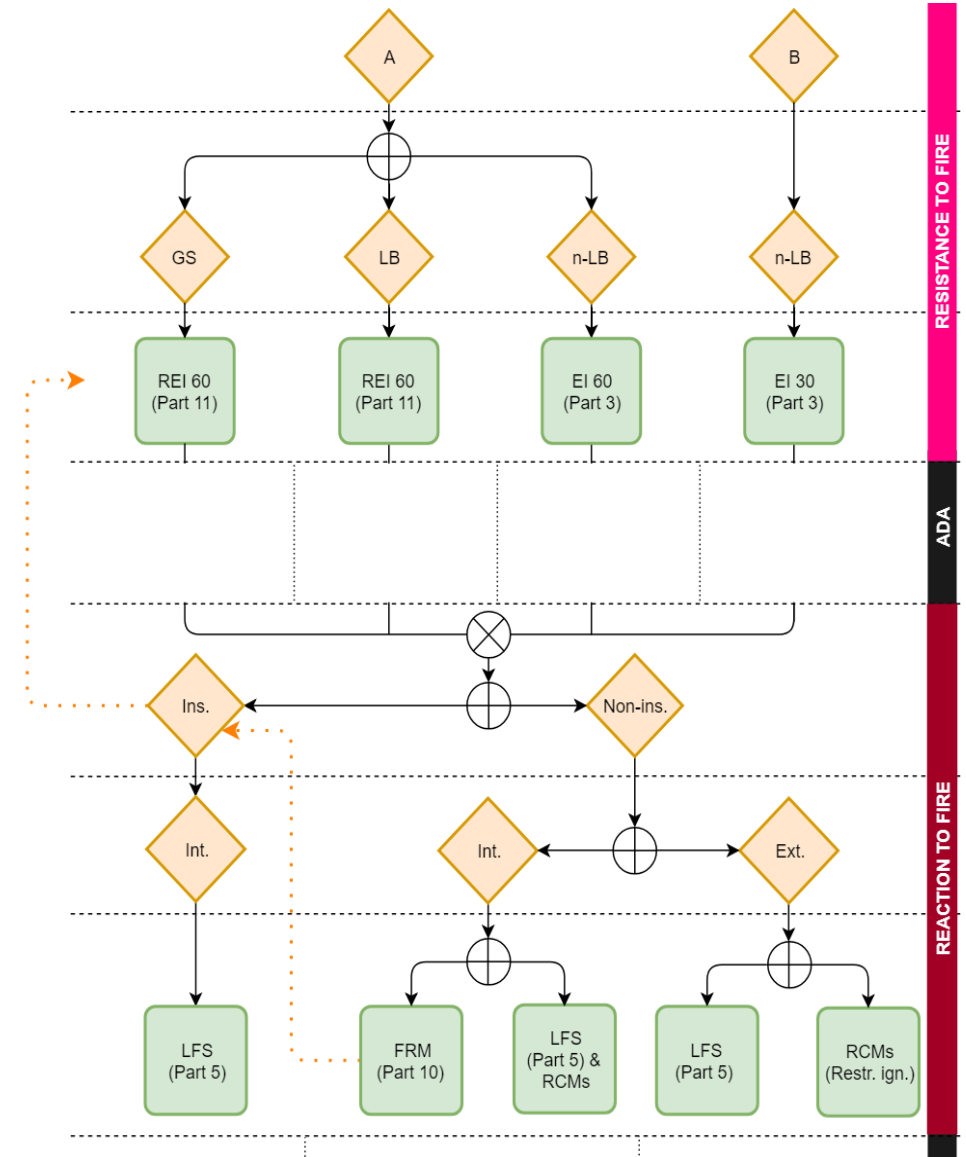




Fire

- A and B Class Division
- Resistance Class Definition
 - REI or EI
- Insulation / No insulation
 - Fire-Restricting Materials (FRM)
 - Low Flame-Spread (LFS)
 - Restricting ignitability







In accordance with FTP Code





SMART TRACK to APPROVAL





/ Materials

Materials information

Materials tree

Adhesive

Cellular

Fibre-Reinforced Polymer

- Modified Acrylic Matrix
- Polyester Matrix
- Vinylester Matrix
- Epoxy Matrix
 - Carbon Fibre Reinforced
 - Intermediate Modulus Carbon Fibre
 - High Strength Carbon Fibre
 - Unidirectional Fibres, vf = 0.6
 - 0/90 Woven Fabric, vf = 0.6

General data







Properties

Long name
Unidirectional high strength carbon fibre reinforced epoxy, vf = 0.6

Specification
High strength carbon fibres, epoxy resin, fibre volume fraction = 0.6, material form = prepreg laminate

Material type
Facing

Notes
Manufacturers data (Hexcel). Typical properties of epoxy prepreg laminates.



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More options

113 Publications










Materials information




Create new document

My own documents

General data		Properties		
Property	Value	Unit	Value type	Reference
Compressive Stiffness 1	115.0	GPa	Typical	Hexcel (2005)
Compressive Stiffness 2	10.0	GPa	Typical	Hexcel (2005)
Compressive Strength 1	1300.0	MPa	Typical	Hexcel (2005)
Compressive Strength 2	250.0	MPa	Typical	Hexcel (2005)
Poisson's Ratio 12	0.25	no unit	Typical	Hexcel (2005)
Shear Stiffness 12	4.4	GPa	Typical	Hexcel (2005)
Shear Strength 12	95.0	MPa	Typical	Hexcel (2005)
Tensile Strength 1	2000.0	MPa	Typical	Hexcel (2005)
Tensile Strength 2	80.0	MPa	Typical	Hexcel (2005)
Young's Modulus 1	130.0	GPa	Typical	Hexcel (2005)
Young's Modulus 2	9.0	GPa	Typical	Hexcel (2005)
Thermal Conductivity	1.0	W/m.K	Typical	Hexcel (2005)
Thermal Expansion Coefficient	-0.1	µstrain/K	Typical	Hexcel (2005)

- Suggestion to use selection tables to find existing solutions

		Test Compliance			
		Test A	Test B	Test C	Test D
Material selection	Material 1				
	Material 2				
	Material 3				
	Material 4				

		Standard fire risk scenarios			
		Scenario A	Scenario B	Scenario C	Scenario D
Pre-approved solutions	Solution 1				
	Solution 2				
	Solution 3				
	Solution 4				

- Quickly known what is already possible, and what is not
- More time available to assess safety of new elements

Conclusion

FIBRESHIP & RAMSSES:

- Demonstrated **advantages** of composite materials in shipbuilding,
- Proved the **ability** to build large structure in composite,
- Proposed **new approach** for fire division rating,
- Ask Member States to:
 - **support using our results in evaluation of MSC.1/Circ.1574** and,
 - **encourage to submit your own experiences to IMO**

Q&A

