



# LightShip Project Idea Catalogue for use of FRP in Commercial Shipbuilding

# Content

<b>1</b>	<b>INTRODUCTION .....</b>	<b>3</b>
1.1	BACKGROUND .....	3
1.2	SCOPE .....	3
1.3	PROJECT TEAM AND ADVISORY GROUP.....	3
<b>2</b>	<b>OVERCOMING BARRIERS AND CHALLENGES.....</b>	<b>4</b>
2.1	MOVING OUT OF STATUS QUO.....	4
<b>3</b>	<b>LISTED SUGGESTIONS .....</b>	<b>6</b>
3.1	PROCESS APPLIED FOR PRIORITIZATION .....	6
3.2	PRIORITIZED INITIATIVES.....	6
<b>4</b>	<b>SPECIFIC IDEAS FOR INITIATIVES .....</b>	<b>7</b>
4.1	PRIORITY 1 INITIATIVE – FUNCTIONAL CRITERIA FOR ALTERNATIVE MATERIAL.....	7
4.2	PRIORITY 2 INITIATIVE – COMPONENTS AND EQUIPMENT IN FRP .....	8
4.3	PRIORITY 3 INITIATIVE – COMBATTING FRP FIRE RISK: A MULTI-ANGLES APPROACH .....	9
4.4	PRIORITY 4 INITIATIVE – FOCUS ON ONE FRP SHIP TYPE AND OPERATION.....	9
4.5	PRIORITY 5 INITIATIVE – OPERATIONAL FOCUS FOR FRP ON SHIPS.....	10
4.6	PRIORITY 6 INITIATIVE – ADJUSTMENTS TO TENDERING RULES.....	11
4.7	PRIORITY 7 INITIATIVE – ENHANCING KNOWLEDGE TRANSFER .....	11
4.8	PRIORITY 8 INITIATIVE – NEW COOPERATION APPROACH TO FRP .....	12
4.9	INITIATIVE – DOCUMENTING FULL SCALE FRP SHIP FIRE .....	12
<b>5</b>	<b>MAPPING IDEAS AND PREVIOUS PROJECTS.....</b>	<b>13</b>

# 1 Introduction

## 1.1 Background

The LightShip project was launched to map the Danish status quo in commercial shipbuilding with FRP-based materials, and in attempt to find next steps needed to strengthen the Danish competencies and partnerships within this field. Background for the project was the belief that information is scattered and various initiatives not necessarily coordinated, so it was desired to get an overview of the current state and convey the available knowledge.

Through involvement of relevant stakeholders the LightShip project seeks to map barriers and challenges for usage of lightweight composite (FRP) in commercial shipbuilding and engage same stakeholders in dialogue on how to possibly move forward. Main activities in the LightShip project is a desk study, a series of interviews, and a workshop. This Idea Catalogue together with a Status Report are the main project deliveries.

The LightShip project is funded by the Danish Maritime Fund (DMF) together with Danish Fire, Security and Technology Institute (DBI), and partly the Danish Maritime Authority (DMA). The project is part of the societal partnership Blue INNOShip's program, with DBI as project owner.

## 1.2 Scope

The scope for the Idea Catalogue in regard of FRP usage in commercial shipbuilding (in Denmark and the neighboring countries) is:

- Possible next steps to overcome barriers identified in the Status Report.
- Suggestions for initiatives in subjective prioritized order, not specified into projects.

Intention is that interested stakeholders will group around the suggestions to formulate in greater detail, and then find funds and resources to execute.

Below matrix show the general focus, though some ideas are specified to a subset of this:

Ship Category	Usage						FRP application		
	Conv.	HSC	Special personnel	Open Sea	Coastal	Port areas / protected	Hull	Super structure	Component / equipment
Cargo (incl. SPS)	X	X	X	X	X		X	X	X
Passenger	X	X		X	X	X	X	X	X
RO-RO	X			X	X			X	X
Cruise	X			X					X

## 1.3 Project Team and Advisory Group

DBI participates in project with innovation consultant Carsten Møller and project manager Claus Langhoff. To run the project DBI has contracted externally with naval architect and risk consultant Rikke Aarøe Carlsen from Ready? IVS, and ship surveyor Niels Brehm Nielsen from DMA. With the exception of the DMA, this Idea Catalogue is put together in close dialogue with the LightShip project's Advisory Group, consisting also of Bureau Veritas, DNV GL, Lloyd's Register, Technical University of Denmark - Department of Mechanic, Danish Maritime, and DBI. As a governmental body the DMA decided not to be part of formulating and prioritizing ideas for future initiatives.

## 2 Overcoming Barriers and Challenges

This Idea Catalogue is concerned with how to proactively move out of the status quo situation described in the LightShip Status Report. Input to this were received during the interview phase and from participants at the LightShip workshop held at DBI on 1. June 2015, where the aim was to focus discussion at potential steps to take to possibly overcome the barriers.

It was said that we once went from wood that floats to steel that sinks, and we managed. So society might very well change eventually, but many will have to get accustomed with the idea of using alternative materials, agree to it, adjust to handle different risks, and accept a change in societal risk.

### 2.1 Moving out of Status Quo

One of the clearest concluding thoughts for going forward is, that taking smaller steps for incorporating FRP in the commercial shipbuilding industry – in aiming for step by step approval – is likely to be more successful, than an “all or nothing” approach. What these smaller steps can consist of, and a sequence to carry them out, is suggested in this catalogue. Main groups are components and equipment in FRP instead of an entire ship, and smaller vessels intended for operation in specific areas/routes.

Such modular approach has some foreseen benefits, like:

- focus the research and development on certain elements of the topic
- enable authorities to prepare an approval scheme with safety level differentiation
- allow technology and regulation to follow each other, and finally
- incremental steps align with the conservatism while still preparing for slight change

Still, to move out of status quo it is needed that someone is willing to take risks and gain knowledge. First-mover avoidance can be reduced by the smaller steps, but not entirely avoided. Further, considering the concept discussed at the LightShip workshop, of a new way of working together to create needed momentum, can possibly be a help in partly overcoming that. Focusing on shared possibilities and value chain parties’ potential willingness to some degree join forces to share risk and opportunity in order to move forward.

Looking at upsides and downsides from an overall business perspective supposedly can facilitate this. While technological research and development obviously is needed, the discussion of FRP benefits and strengths as well as challenges will gain from being taken to a business level. Starting by recognizing that there must be a clear customer need to drive the process. It is key to find the need – otherwise it will remain theoretical. Find the customers and find their needs – then find the solution.

The customer can be other than a commercial client though. For instance, if compelling arguments could persuade the state to pay for a project with combined focus on technology, politic and societal gain, this would be ideal for the parties in the value chain. Contribution from funds to have identified resources take on some of the initiatives specified next chapter, would also help bring stakeholders closer to successful use of FRP in commercial shipping. In any case defining the need is important.

Related to a common approach is also to look into means of improving knowledge sharing

between stakeholders with an enhanced degree of knowledge transfer between projects. Knowledge sharing is to some extent already taking place in established networks and clusters in the industry, both nationally and regionally with neighboring countries. Taking it to another level could be reconsidering limits in business secrets, to see if it might be possible at all to allow for more knowledge sharing, without compromising individual businesses' competitive edges. This is not thought as making expensive R&D broadly available, but maybe setting up a framework that will allow for increased insight into defined areas. A different thought approach in the industry to deal with steep learning curves through some kind of learning pool. For example with partial test data and analysis needed for approval. Due to the often high costs assumed to obtain such knowledge, the idea of sharing is at risk of appearing naïve, so to move it forward requires delicacy, respect and an eye for the bigger goal.

Usage of newer technologies, and tailoring the rules and regulations, is seen as crucial for successfully bringing FRP into commercial shipbuilding. Development and technical knowledge from universities as well as industry is also important. Ideally the universities would be willing to act together with research parts to develop projects, and offer expertise along with the writing of academic papers. To interact more in the full process and participate in other activities. Further, it is recognized that taking part of international initiatives and projects is a way to possibly take a leap out of the incremental steps towards increased use of FRP.

From the LightShip workshop debate it was clear that the challenges for the society are not something that any part can do alone. Having discussion with combined focus on society and upsides/downsides of risks is sought as valuable. Setting an effort as a focused group may help hitting the main problem, and not just talk about problems that others should solve. If a group of Danish stakeholders shall begin interacting more in a semi-formalized manner, it is probably a must to have a skilled authority figure to head such an initiative, with teamwork in a group of skilled people that are dedicated from the beginning.

In the workshop evaluation, participants stated it was the first time the problems have been addressed head on. If we start working together on real needs, we might actually start this business.

## 3 Listed Suggestions

Based on general impressions from the LightShip project activities – desk study, interviews, workshop, and offline conversations – a gross list of suggestions were formulated by the project team. In a working meeting with the project's Advisory Group (except the DMA that decided to not actively influence future initiatives), the gross list ideas were grouped into nine main areas, and then prioritized.

### 3.1 Process applied for Prioritization

Prioritization of the main areas is based on qualitative discussion – not a numerical scoring process.

Various parametric was covered as part of the discussion leading to assigning priorities. Like considering that long sighted research may be needed to support some initiatives, while other initiatives might benefit from possibly having achievements in development within reach on a shorter timeline. And weighing in what might actually be influenced, versus what would be nice and ideal, but perhaps less realistic. Also considerations regarding society gain and commercial benefits for involved stakeholders were part of prioritizing the areas suggested to focus on.

The prioritization was conducted in a session with the LightShip project's Advisory Group. Consequently, the priorities are assigned subjectively in accordance mainly with this particular group's point of view – even though the above mentioned metric were thought to reflect broader interests. As such, the presented priorities are just one version of the truth, and not necessarily representative of the priorities throughout the industry.

### 3.2 Prioritized Initiatives

Grouping the ideas under nine headlines resulted in the following list, in subjective, prioritized order.

Each of the nine main areas is further described in next chapter, also focusing on different types of goals to be achieved by the individual suggestion.

Parts of the initiatives are interrelated, and timing and knowledge sharing between projects is considered important for the overall success rate. While the numbering also reflect what is perceived to be an effective order in regard of initially defining frames to refer back to, and reaching some conclusions to apply on subsequent projects, the list is not entirely sequential. Different initiatives can very well be commenced and carried out simultaneously.

1. Functional criteria for alternative material
2. Components and equipment in FRP
3. Combatting FRP fire risk: a multi-angles approach
4. Focus on one FRP ship type and operation
5. Operational focus for FRP on ships
6. Adjustments to tendering rules
7. Enhancing knowledge transfer
8. New cooperation approach to FRP
  - Documenting full scale FRP ship fire,

where the ninth main area has not been assigned a priority, as it in any case must wait for an occasion, where an FRP ship that otherwise would be dismantled, might be made available to burn.

## 4 Specific Ideas for Initiatives

In the following the individual suggestions from the prioritized list are fleshed out a bit more, though not specified into projects. Not all ideas are detailed as much as others, but all are important.

This Idea Catalogue is not intended to dictate which R&D projects shall be carried out next within FRP for commercial shipbuilding. What it does is suggest main idea areas that – if focused on – is believed to help strengthen the knowledge and competencies in the area, address the actual needs, and hopefully change status quo. Intention is that interested stakeholders will use these ideas to form groups around the suggestions, and formulate projects in greater detail, and then find funds and resources to execute. Using the list as inspiration also allows for stakeholders applying own prioritization in deciding what to focus on.

### 4.1 Priority 1 Initiative – Functional Criteria for alternative material

Basic information describing the initiative as an offset for project formulation.

<b>Title</b>	Functional Criteria for alternative material
<b>Scope</b>	<p>Developing functional criteria for alternative shipbuilding material for all foreseen structural loads. Including loads induced by fire, collision, waves, ice, etc.</p> <p>Focus in first instance is FRP, but in formulating the functional criteria, it shall be taken into account that a next generation of alternative material should not require a whole new set of criteria.</p>
<b>Ultimate goal</b>	To over time convince IMO that SOLAS needs a performance based option, for FRP as well as other materials alternative to steel.
<b>Brief description</b>	<p>Develop functional criteria for FRP as well as other alternative materials for commercial shipbuilding. Along with the developing of functional criteria, also describe methods and design standards to be applied for the various structural loads.</p> <p>Define prescriptive baseline limits on a material level. In regard of FRP, consider making the baseline conservative in order to counter the complex FRP nature and the broad range of combination options with the material.</p>
<b>Foreseen participants</b>	Maritime authorities, in Denmark and perhaps in neighboring countries. Supported by material specialists from industry, at universities and test & development institutions.
<b>Estimated duration</b>	Long term overall. Starting with the development project with the technical approach

Caution to make a pre-study analyzing best approach:

Even though a finding has been the perception that there will not be a new SOLAS, keep an open mind in defining the project. Not necessarily forcing new content into existing SOLAS, if analysis shows it being worthwhile aiming at an entirely new framework for safety at sea. But also not spend large amount of resources if analysis confirm that it likely is a lost battle. In that event do focus on an alternate way of build out the existing frame, aiming to at least achieve some extension over time allowing for usage of alternative material.

Budget to be defined after thorough scoping and detailed project formulation. Sources of funding pending.

## 4.2 Priority 2 Initiative – Components and Equipment in FRP

Basic information describing the initiative as an offset for project formulation.

<b>Title</b>	Components and equipment in FRP
<b>Scope</b>	Focus on all aspects of components and equipment in FRP, including the technology part of joining of materials, and penetrations.
<b>Ultimate goal</b>	Documentation leading to one-by-one type approval of various components and equipment in FRP, as well as for needed penetrations.
<b>Brief description</b>	<p>Begin by identifying what would work best as example for approval process for FRP components and equipment, respectively. Use as template method for subsequent components and equipment, in a step-by-step approach toward approval.</p> <p>Technology research on improved quality of joining materials.</p> <p>Demonstrate and document how penetration in fire restricting divisions can be done without compromising fireproofed bulkhead and deck, so that needed penetration for dampers, cables and pipes can be type approved. Documentation in regard of Annex 1 part 11 in the FTP code for approval of maritime authority and class certification.</p> <p>Define how the used wording in code shall be interpreted, and how to set up a system that satisfies demands with the many possible combinations in FRP material.</p> <p>Possibly define a fire test setup for typical penetrations, creating a recognized standard.</p>
<b>Foreseen participants</b>	Technology providers, shipbuilding yard with FRP focus, classification societies, maritime authorities, test & development institutions and universities.
<b>Estimated duration</b>	Step by step project, possibly conducted by different stakeholders in short and focused simultaneous phases.



Budget to be defined after thorough scoping and detailed project formulation. Sources of funding pending.

#### **4.3 Priority 3 Initiative – Combatting FRP fire risk: a multi-angles approach**

Basic information describing the initiative as an offset for project formulation.

<b>Title</b>	Combatting FRP fire risk: a multi-angles approach
<b>Scope</b>	Overall fire focus on FRP material and joints
<b>Ultimate goal</b>	Being able to handle the FRP fire risk, either through eliminating the combustible elements, or actively preventing fire, or a combination of this. Verifying material properties.
<b>Brief description</b>	<p>Develop applicable non-combustible FRP. Applicable to usage on ship, so must have a full matrix of suitable properties for marine usage.</p> <p>Developing fire-resistant system solutions, for example by limiting the use of combustible materials for specific functions or sections on the ship.</p> <p>Defining a Fire Safety Engineering approach to fire safety making fire safety a design parameter for future use of FRP.</p> <p>Possibly establish a simpler test method to classify a material or construction Fire Restricting Material (FRM), making it a viable alternative the large and expensive full scale room corner test in ISO 9705.</p> <p>Investigate structural features with focus on loss prevention and risk reduction.</p>
<b>Foreseen participants</b>	Test & development institutions, material providers, universities, consultants.
<b>Estimated duration</b>	Long term project with much R&D and involving large tests

Budget to be defined after thorough scoping and detailed project formulation. Sources of funding pending.

#### **4.4 Priority 4 Initiative – Focus on one FRP ship type and operation**

Basic information describing the initiative as an offset for project formulation.

<b>Title</b>	Focus on one FRP ship type and operation
<b>Scope</b>	Focus on all aspects of one FRP ship type and operation, for example an island ferry.
<b>Ultimate goal</b>	By working through all aspects of planning and building an FRP ferry,

	establishing generic methodologies for approval, using safety level differentiation depending on type and operation.
<b>Brief description</b>	<p>This is a suggestion resulting from dialogue with the new Danish Ferry Secretariat, considering ordering a new island ferry as reserve in the ferry fleet.</p> <p>Using this as a platform project on a real case with tests, involving scenarios and time perspectives for opportunities.</p>
<b>Foreseen participants</b>	Danish Ferry Secretariat as shipowner (if agreeing to focus on an island ferry), and representatives from the entire value chain participating
<b>Estimated duration</b>	Following normal timeline for ordering, planning and building a ferry, having it processed through to final approval.

Budget to be defined after thorough scoping and detailed project formulation. Sources of funding pending.

#### 4.5 Priority 5 Initiative – Operational focus for FRP on ships

Basic information describing the initiative as an offset for project formulation.

<b>Title</b>	Operational focus for FRP on ships
<b>Scope</b>	Investigate and improve operational procedures and logistics.
<b>Ultimate goal</b>	Making sure future technological progress and increased usages of FRP is matched by operational focus. Education of FRP repair specialists, balancing the need for skilled people to make carbon fiber repair with actual and potential need for repair.
<b>Brief description</b>	<p>Operational focus to increase the knowledge about FRP on ships both with crew and external readiness, by communication, design of suitable response procedures, education and training.</p> <p>Clarifying actual issues with damages and repair, both technological and operationally, as well as logistic clarification and shipyard sizes.</p> <p>Identifying and mapping how FRP repair is done in practice, listing how many suppliers and technicians are approved to do this work.</p> <p>Operational focus also could include ice dimensioning for FRP.</p>
<b>Foreseen participants</b>	Shipowners, ship yards, consultants, universities
<b>Estimated duration</b>	For practical results this could work well as small individual phases being completed effectively and results implemented

Budget to be defined after thorough scoping and detailed project formulation. Sources of funding

pending.

#### 4.6 Priority 6 Initiative – Adjustments to tendering rules

Basic information describing the initiative as an offset for project formulation.

<b>Title</b>	Adjustments to tendering rules
<b>Scope</b>	To broaden the evaluation criteria of tenders to focus on other than just new building price.
<b>Ultimate goal</b>	Make changes to how tenders are being evaluated, to allow for proposed FRP ships to stand better chances to win.
<b>Brief description</b>	Find out what it would take to change the tendering rules allowing for life cycle costs, and environmental matters like energy efficiency being better taken into account, rather than just new building price.
<b>Foreseen participants</b>	Industry associations' and cluster's political influencers, shipowners, technology providers.
<b>Estimated duration</b>	The actual project execution is not expected to have long duration, but getting to a point where decision makers are open to look at changes, might take long time.

Budget to be defined after thorough scoping and detailed project formulation. Sources of funding pending.

#### 4.7 Priority 7 Initiative – Enhancing knowledge transfer

Basic information describing the initiative as an offset for project formulation.

<b>Title</b>	Enhancing knowledge transfer
<b>Scope</b>	Finding ways to improve FRP knowledge transfer from navy and other industries
<b>Ultimate goal</b>	FRP knowledge sharing and knowledge transfer extended between parties and projects
<b>Brief description</b>	This is vague for now. Needs to be worked with to define how to make it work, but it is a prioritized initiative due to its importance.  Possibly learning from Navy FRP experience.
<b>Foreseen participants</b>	All stakeholders in the value chain
<b>Estimated duration</b>	TBD

Budget to be defined after thorough scoping and detailed project formulation. Sources of funding pending.

#### 4.8 Priority 8 Initiative – New cooperation approach to FRP

Basic information describing the initiative as an offset for project formulation.

<b>Title</b>	New cooperation approach to FRP
<b>Scope</b>	Create volume and momentum in FRP usage in commercial shipbuilding.
<b>Ultimate goal</b>	Create new ways of working together in the FRP marine industry.
<b>Brief description</b>	Involving both technicians and business side from stakeholders, finding a way to share risk and opportunity
<b>Foreseen participants</b>	All stakeholders in the value chain
<b>Estimated duration</b>	TBD

Budget to be defined after thorough scoping and detailed project formulation. Sources of funding pending.

#### 4.9 Initiative – Documenting full scale FRP ship fire

Finally, the ninth main area, the full scale FRP ship fire. Since it in any case must wait for an occasion, it has not been assigned a priority, but it is seen as a very desirable project. Arranging for an FRP ship that otherwise would be dismantled to be a big scale fire test with full documentation would provide important information to FRP shipbuilding.

## 5 Mapping Ideas and Previous Projects

The nine main areas of ideas to address the needs identified from Hazards Ranking and Barriers in the LightShip Status Report are mapped here against content in the previously conducted projects. This is done with the sole purpose of creating the picture. It is not suggesting that previously investigated areas are fully understood. The matrix shows where parts of these areas are contained also in new ideas areas. Either building on previous study results, or analyzing other sides of the scopes.

Area already investigated:	Main areas of ideas								
	1	2	3	4	5	6	7	8	•
Weight saving		X		X		X	X		
Fire safety and test	X	X	X	X			X		X
Joints between materials		X	X				X		X
Risk based regulation		X	X	X	X				
LCCA (Life Cycle Cost Assessment)		X		X		X	X		
LCA (Life Cycle Assessment)		X		X		X	X		
New materials	X	X	X		X		X		X
Structural design	X	X	X	X	X		X		X
Degradation of composites		X	X	X			X		X
Inspection of defects and damages		X		X	X	X	X		
Certification of FRP elements	X	X	X	X					
Global strength	X	X	X	X			X		X
Production process		X		X	X		X		X
Patch repair					X				X

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