LASH FIRE

Legislative Assessment for Safety Hazards of Fire
and Innovations in Ro-Ro Ship Environment

Evaluation of composite materials for ro-ro space surfaces in LASH FIRE

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Content

Introduction to LASH FIRE project

Fire requirements for ro-ro space composite materials

Legislative Assessment for Safety Hazards of Fire and Innovations in Ro-Ro Ship Environment

LASH FIRE Coordinator RI.SE

Sept 2019 – Aug 2023

26 partners
13 EU countries

Budget: EUR 13.5 M
Funding: EUR 12.2 M

www.lashfire.eu

Providing a **recognized technical basis** for the revision of international **IMO regulations**, which greatly **enhances fire prevention** and **ensures independent management of fires** on ro-ro ships in current and **future** fire safety challenges

- Effective Manual Operations
- Inherently Safe Design
- Ignition Prevention
- Detection
- Extinguishment
- Containment

→ Ship Integration

→ Formal Safety Assessment

Legislative Assessment for Safety Hazards of Fire and Innovations in Ro-Ro Ship Environment

LASH FIRE

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WP06	Effective Manual Operations	Validation
6-A	Manual screening of cargo fire hazards and effective fire patrols	Onboard/Terminal
6-B	Quick manual fire confirmation and localization	Onboard
6-C	Efficient first response	Onboard
6-D	Effective and efficient manual firefighting	Onboard/Field
WP07	**Inherently Safe Design**	**Validation**
7-A	Improved fire detection system interface design	Onboard/Virtual
7-B	Efficient extinguishing system activation and inherently safe design	Onboard
7-C	Firefighting resource management centre	Onboard/Virtual
WP08	**Ignition Prevention**	**Validation**
8-A	Automatic screening and management of cargo fire hazards	Onboard/Shore
8-B	Guidelines and solutions for safe electrical connections	Onboard
8-C	Fire requirements for new ro-ro space materials	Lab
WP09	**Detection**	**Validation**
9-A	Detection on weather deck	Onboard
9-B	Detection in closed and open ro-ro spaces	Onboard
9-C	Technologies for visual fire confirmation and localization	Onboard
WP10	**Extinguishment**	**Validation**
10-A	Local application fire-extinguishing systems	Lab
10-B	Weather deck fixed fire-extinguishing systems	Onboard
10-C	Updated performance of alternative fixed fire-fighting systems	Lab
WP11	**Containment**	**Validation**
11-A	Division of ro-ro spaces	Lab/Onboard
11-B	Ensuring safe evacuation	Virtual/Shipyard
11-C	Safe design with ro-ro space openings	Virtual/Lab
11-D	Ro-ro space ventilation and smoke extraction	Lab/Onboard

20 Challenges

>50 solutions

FEASIBILITY

EFFECTIVENESS

INTEGRABILITY

OPERABILITY

Legislative Assessment for Safety Hazards of Fire and Innovations in Ro-Ro Ship Environment

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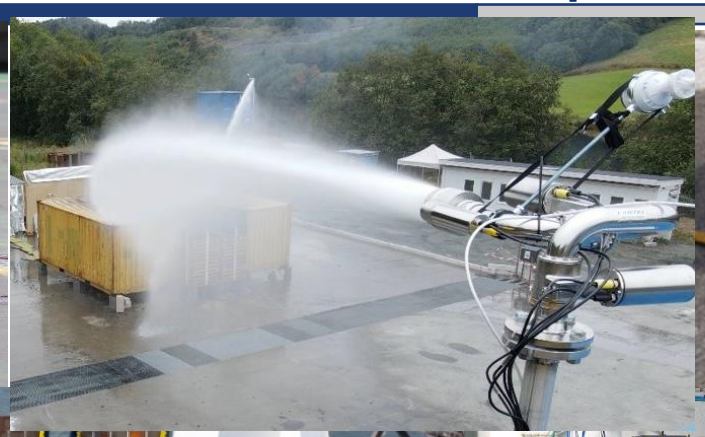
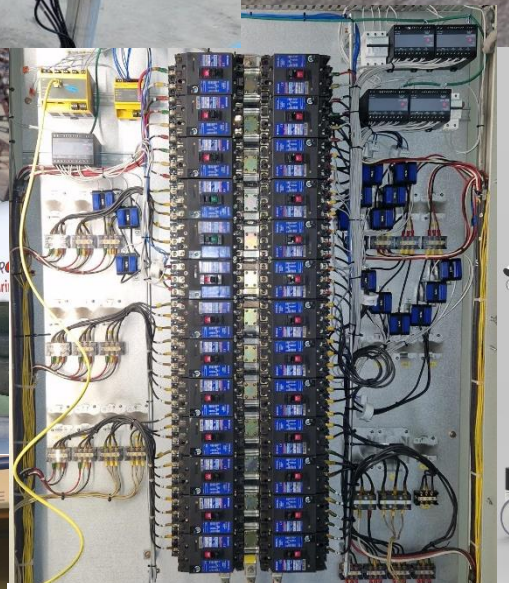
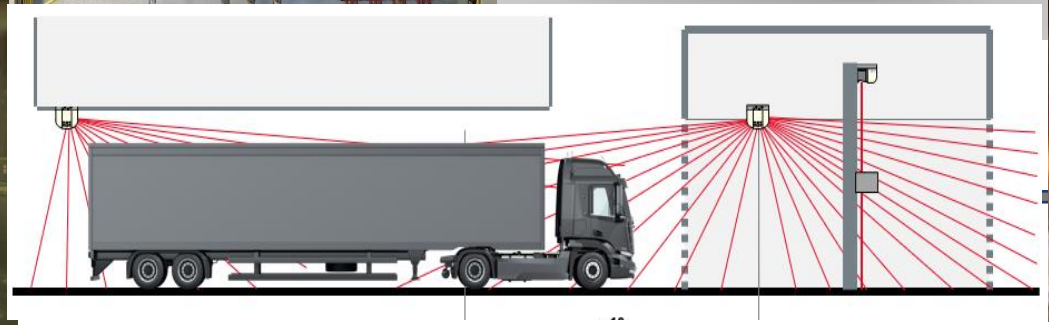









Ignition Prevention

8-C

Fire requirements for new ro-ro space materials

Background and Objective

The usage of combustible materials, e.g., composite materials, increase in maritime applications.

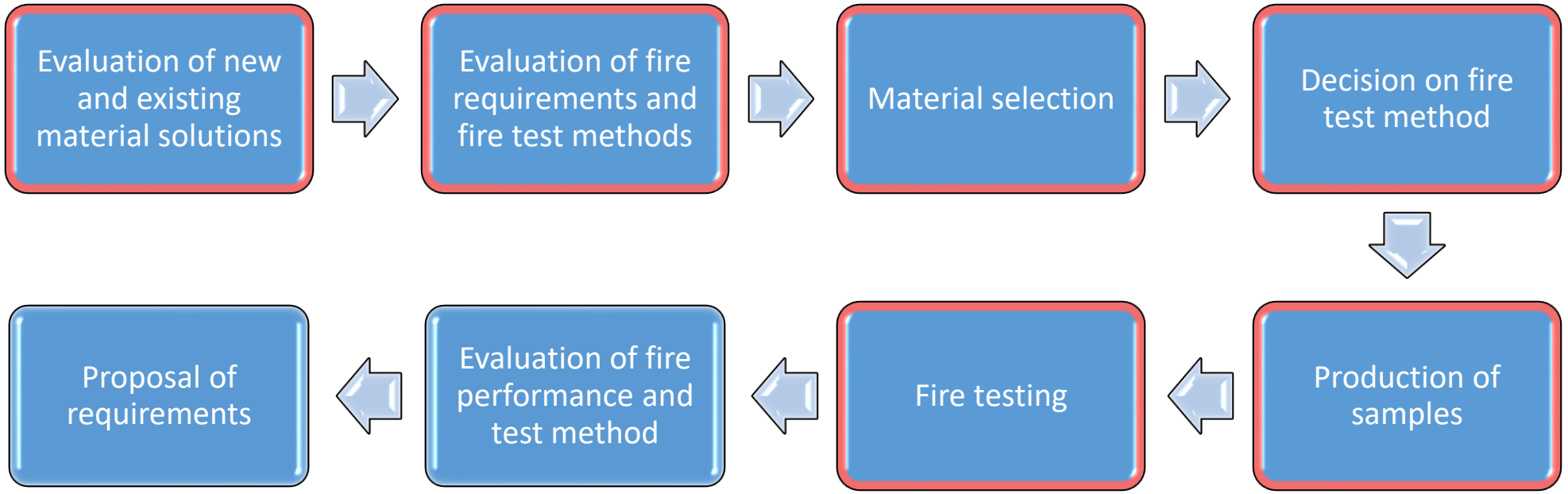
These materials is increasing in the design of ro-ro spaces, both newly developed and materials from other sectors.

In case of fire, the combustible materials will burn and contribute to fire development on board. However, there are no defined fire requirements for these materials.

Evaluating the fire performance of these materials and define requirements and guidelines will keep the fire safety at a high level **and facilitate implementation**.

Work flow

Proposal for requirements of surface materials in ro-ro spaces, with reference to suitable test method and material property performance criteria



Investigation of material solutions

Material systems for a wide range application in ro-ro spaces are investigated:

- Surface protection
  - Fire retardant systems
  - Intumescent coating systems
  - Anti-skid coatings
- Insulation
  - Ceramic fibre
  - Spray-on insulation
- Structural material
  - Composite materials

Composite material and **intumescent systems** selected for further assessments

Evaluation of fire regulations

Classification of materials used for:

- **Marine application**, IMO FTP Code 2010
  - Heat release, smoke production, flame spread, smoke toxicity
- **Railway vehicles**, EN 45545-2
  - Heat release, smoke production, flame spread, smoke toxicity, ignitability
- **Aircrafts**, FAR 25
  - ignitability
- **Buses**, UN ECE Regulation 118
  - Ignitability, burning rate, melting behavior
- **Trucks and automotive**, FMVSS 302
  - Ignitability, burning rate

IMO FTP Code 2010 found to be appropriate

Evaluation of fire test methods

Fire test methods relevant for ro-ro space surface material:

- Surface flame spread, IMO Part 5, ISO 5658-2, ISO 9239-1
- Smoke density and smoke gas toxicity, IMO Part 2, ISO 5659-2
- Heat release, IMO Part 10, ISO 5660-1
- Burning rate, FMVSS 302, Far 25
- Ignitability, several single flame tests

IMO 2010 FTP Code, part 2 & part 5 selected for LASH FIRE assessments

Development of samples

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Specimens in **composite materials** including **intumescent systems** developed for small scale fire tests:

- Type: monolithic, sandwich
- Fibres: glass & basalt
- Cores: balsa, PVC, PET, PIR, PU
- Resins: polyester, vinilester, epoxy, PFA
- Production technology: vacuum, pre-preg
- Intumescent system: Integrated in fibres, gelcoat, applied on laminate

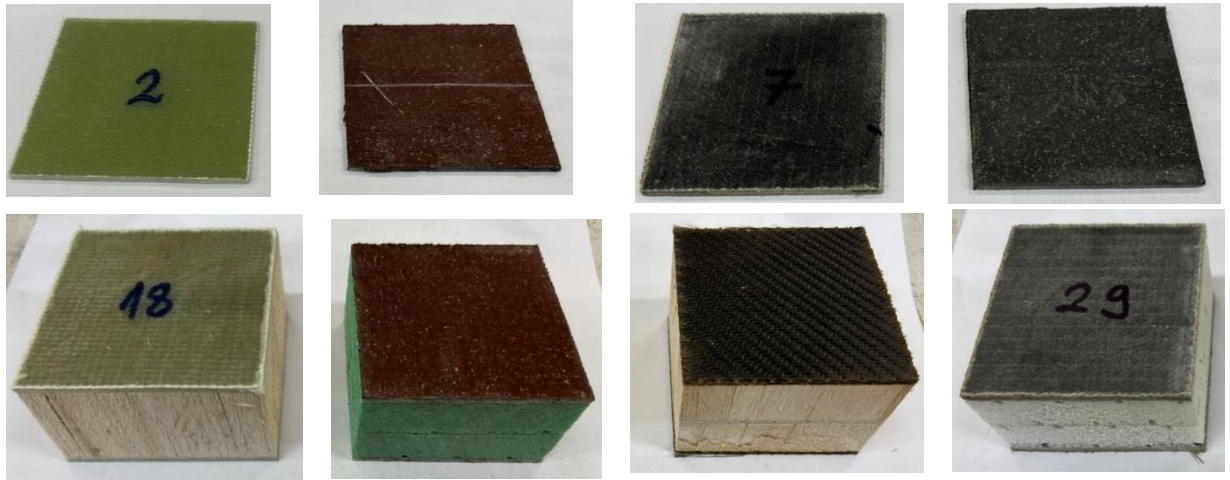
>30 material layouts to be tested

Material layout based on real case implementation

RAMSSES

(2017-2021)

www.ramsses-project.eu/



SAERTEX BASALTEX The thread of stone POD COMP brzoglas TEKNOS

Fire tests

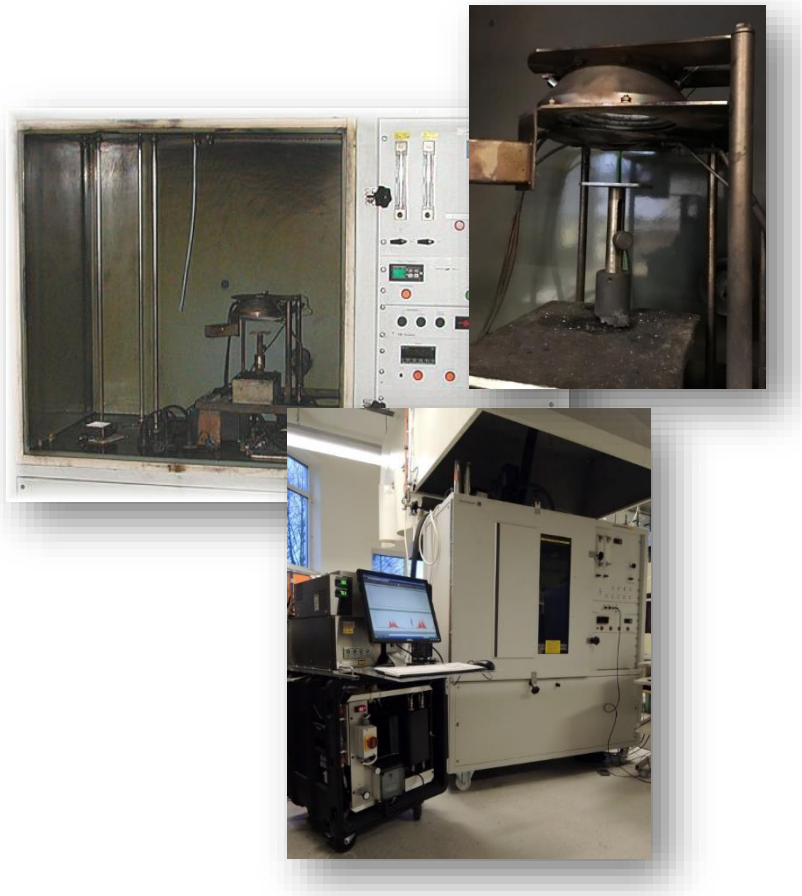
IMO FTP Code Part 2 – Smoke density and toxicity

Determination of optical density by a single-chamber test.

The test sample is placed horizontally and subjected to thermal radiance. The specimen starts to emit smoke which is collected in the chamber. The smokes specific optical density (transparency) is measured with a light source and a photocell.

The smoke toxicity analysis is done with FTIR.

Gas specie	Requirement
Carbon monoxide, CO	1450 ppm
Hydrochloric acid, HCl	600 ppm
Hydrogen bromide, HBr	600 ppm
Hydrogen flouirde, HF	600 ppm
Hydrogen cyanide , HCN	140 ppm
Nitrogen oxides, NO_X	350 ppm
Sulphur dioxide, SO_2	120 ppm

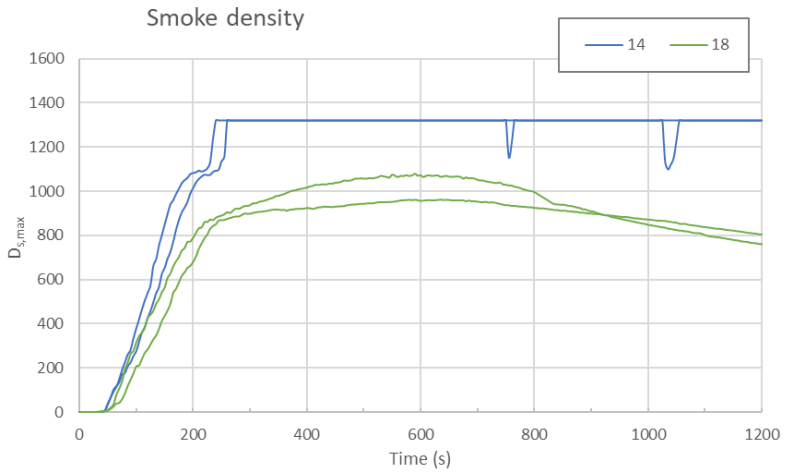


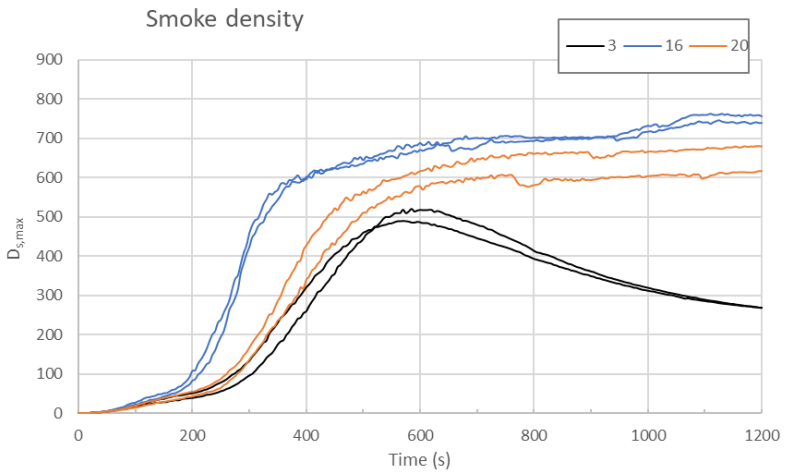
Fire tests

IMO FTP Code Part 2 – Smoke density and toxicity

Product		t_{ign}/t_{ext} (s)	$D_{s,max}$	Time to $D_{s,max}$	Detected gas specie (ppm)
Polyester/Glass/PVC	14	43/1172	1320	250	CO(1368); HCN(29); HCl(1207); NO_x(60)
Polyester/Glass/Balsa	18	66/1158	1021	613	CO(1147); HCN(6)
Epoxy/Glass/ Int.Fab	3	NI/-	505	578	CO(1423); HCN(107); HCl(16)
Epoxy/Glass/Int.Fab/PVC	16	NI/-	754	1118	CO(3628); HCN(216); HCl(1592); SO_2(19)
Epoxy/Glass/Int.Fab/Balsa	20	NI/-	649	1195	CO(4756); HCN(204); HCl(11)

Int.Fab = Integrated fabric



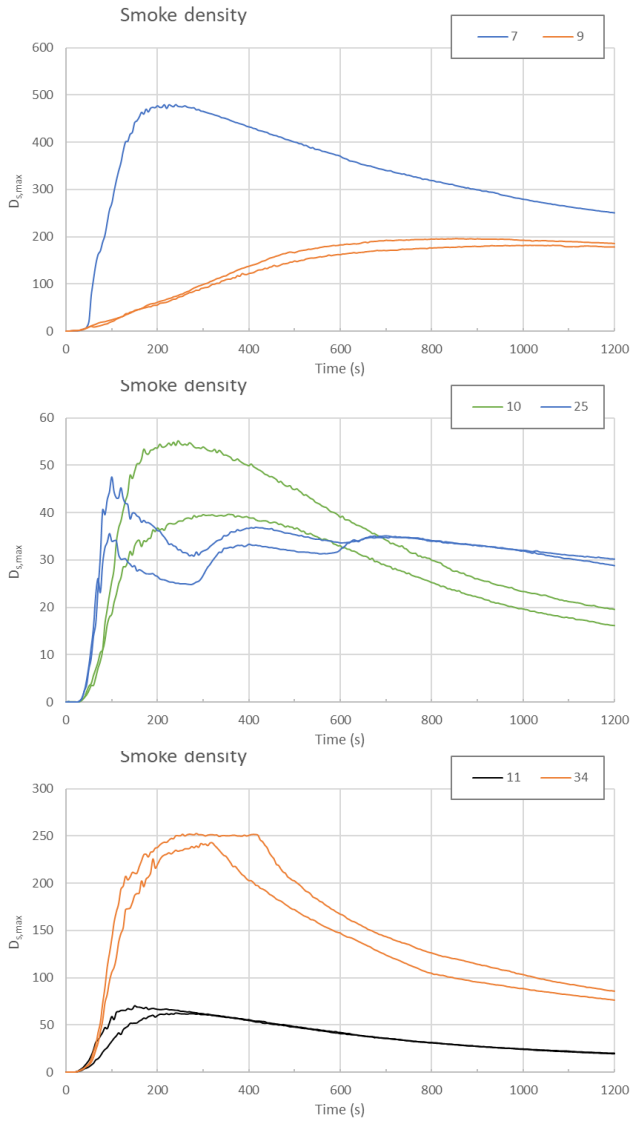


Fire tests

IMO FTP Code Part 2 – Smoke density and toxicity

Product		t_{ign}/t_{ext} (s)	$D_{s,max}$	Time to $D_{s,max}$	Detected gas specie (ppm)
Polyester/Basalt	7	47/394	480	240	CO(385
Polyester/Basalt/Int.Fab	9	29/217	960	960	CO(1838); HCN(63); SO_2(59)
PFA/Glass	10	NI/-	47	300	CO(742); HCN(6)
PFA/Glass/Balsa	25	71/613	42	98	CO(140)
PFA/Basalt	11	NI/-	67	195	CO(336); HCN(9); SO_2(60)
PFA/Basalt/Balsa	34	369/811	248	303	CO(1193)HCN(14); SO_2(22)

Int.Fab = Integrated fabric

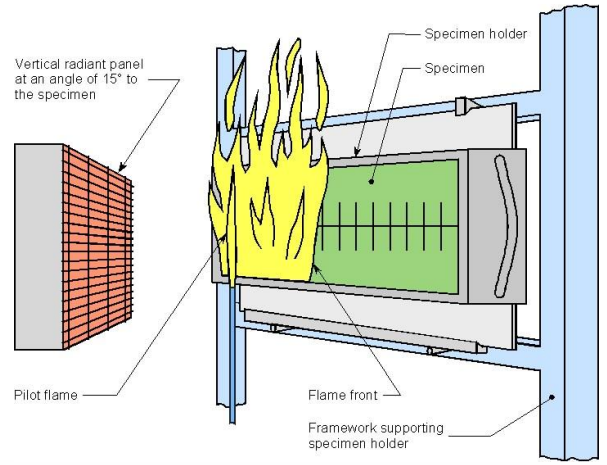


Fire tests

IMO FTP Code Part 5 – Surface flammability

The specimen is vertically positioned during test and exposed to heat radiation from a radiation panel and a pilot flame.

The time when the specimen is ignited and the time when the flame reaches every 50 mm mark along the specimen is noted. Time to flame out of the flame front on the center line, burnt length and any occurrence of burning droplets are noted.



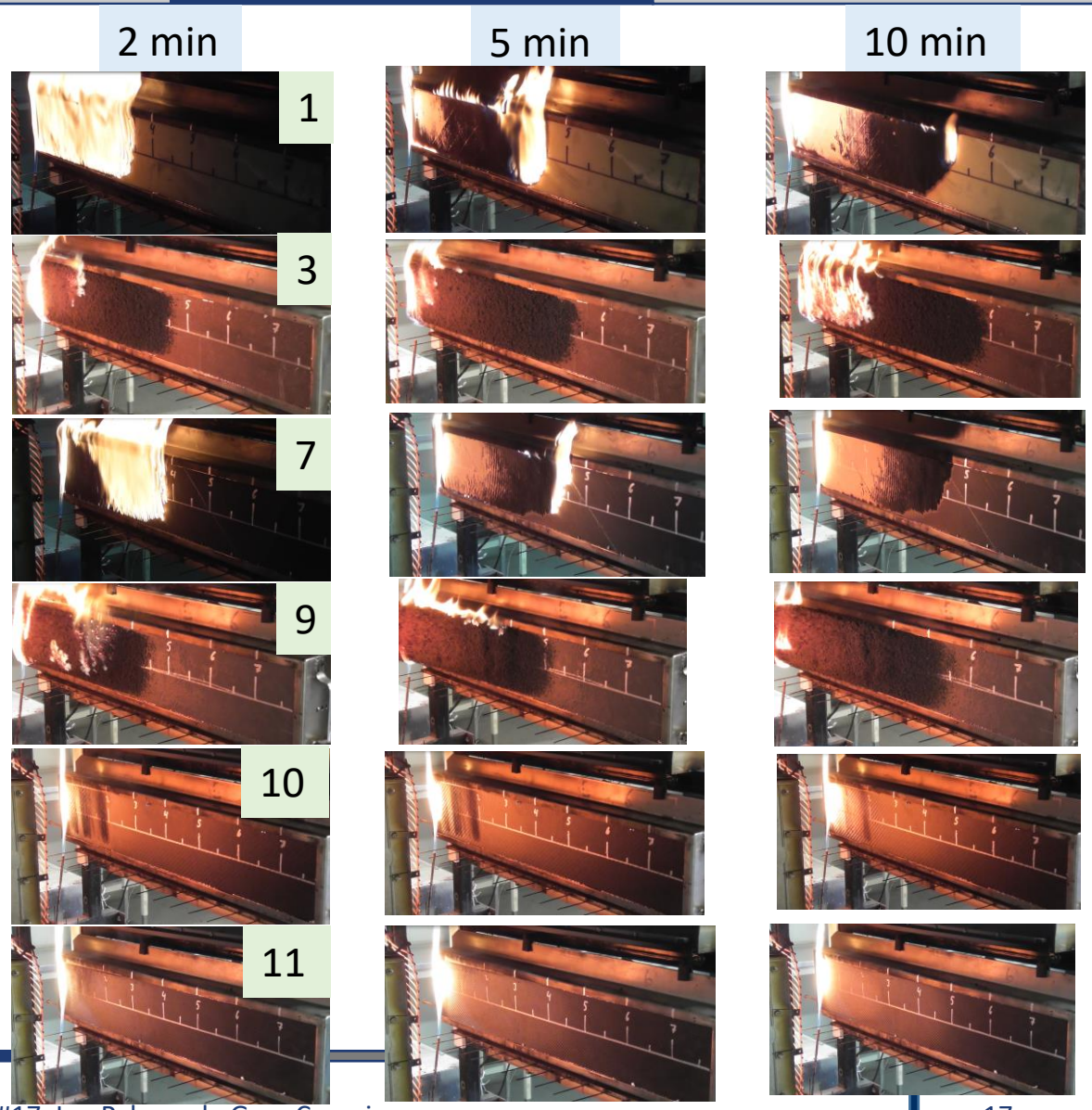
Test parameter		Bulkhead, wall and ceiling linings	Floor coverings	Primary deck coverings
Critical Flux at Extinguishment	CFE (kW/m^2)	≥ 20.0	≥ 7.0	≥ 7.0
Average heat for sustained flaming	Q_{sb} (MJ/m^2)	≥ 1.5	≥ 0.25	≥ 0.25
Total heat release	Q_t (MJ)	≤ 0.7	≤ 2.0	≤ 2.0
Peak heat release	Q_p (kW)	≤ 4.0	≤ 10.0	≤ 10.0
Burning droplets		Not produced	No more than 10 burning drops	Not produced

Fire tests

IMO FTP Code Part 5 – Flame spread

Product		CFE (kW/m²)	Q_{sb} (MJ/m²)	Q_t (MJ)	Q_p (kW)	Burning droplets
Glass/Polyester	1	9	2.5	1.1	3.3	No
Glass/Epoxy/Int.Fab	3	31	16	1.0	1.9	No
Basalt/Epoxy	7	14	2.0	0.9	3.4	No
Basalt/Polyester/Int.Fab	9	48	-*	0.8	0.9	No
Glass/PFA	10	44	3.6	0.2	0.7	No
Basalt/PFA	11	48	-*	0.1	0.6	No

Int.Fab = Integrated fabric
* Not measured since the flame front did not reach the 175 mm mark



Conclusion

- Status fire testing:
  - Half of the samples has been tested acc. to Part 2
  - One third of the samples has been tested acc. to Part 5
  - After testing has been completed, requirement levels can be developed.

- IMO MSC.1/Circ.1574 "INTERIM GUIDELINES FOR USE OF FIBRE REINFORCED PLASTIC (FRP) ELEMENTS WITHIN SHIP STRUCTURES: FIRE SAFETY ISSUES" Updates including material properties and recommendations on requirements according to LASH FIRE results

- Results/knowledge to be used as input for ship design: use of composite materials for structural application and intumescent systems

YOU CAN CONTRIBUTE !!

Open for suggestions on material systems

to be further considered within the project

Further information and contact info

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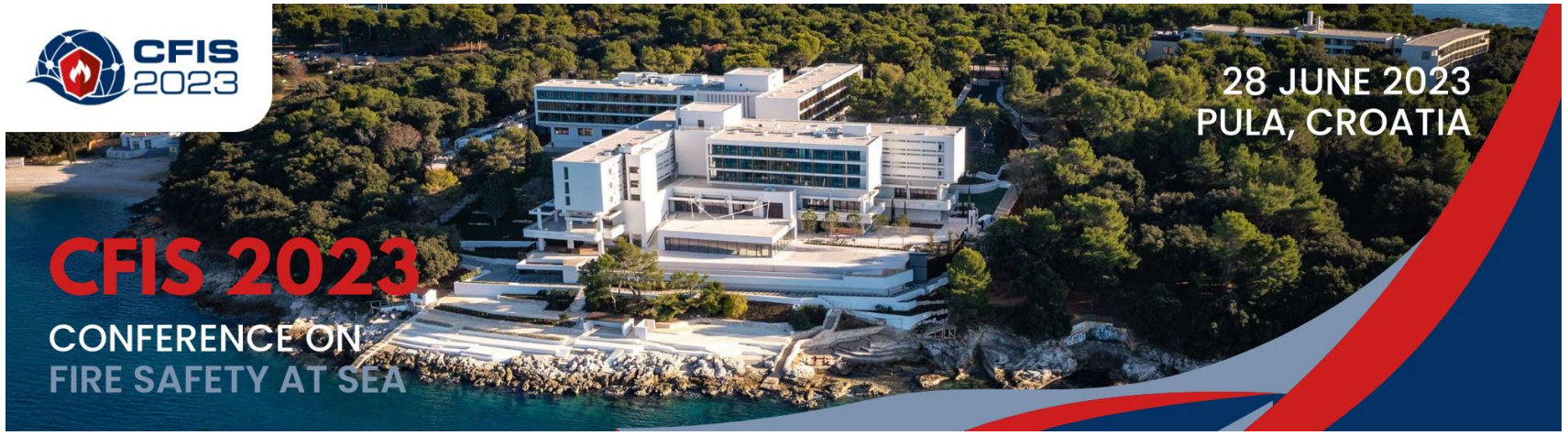
Thank you for your attention!



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