





Mäder Coating and Composite Solutions for Mass Transit and Railway GRP Makers

1.		<p>New tough European Fire Protection Requirements (CEN TS 45545)</p>
2.		<p>Polyester Resins, Gelcoats and Coatings passing the new European Requirements</p> <p>Processing of advanced FST Systems</p>



Easy and fast process GRP resins meeting the highest requirements of the new CEN TS 45545-2



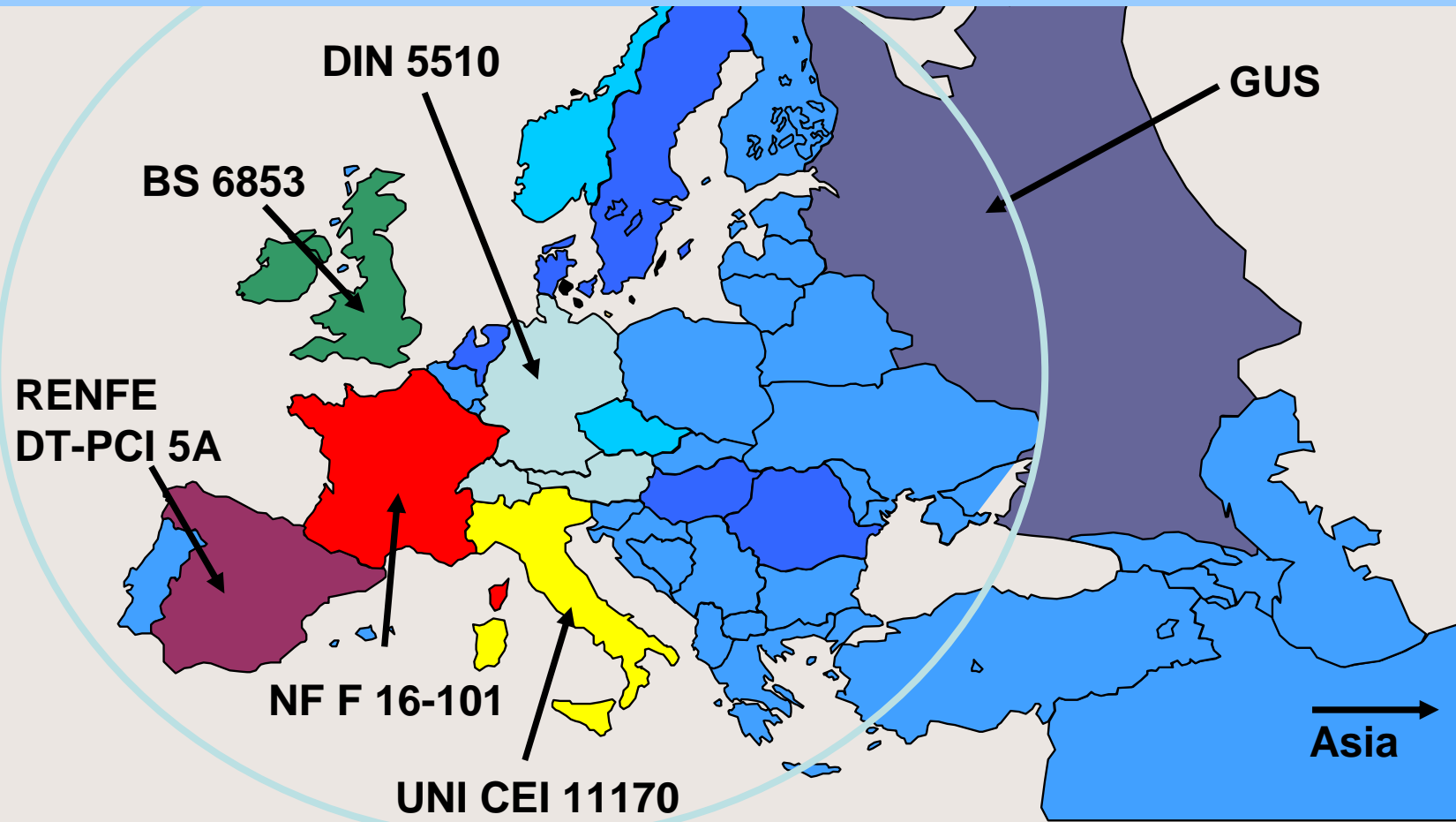


Challenges and Solutions for GRP in Mass Transit and Railways

- **Higher Fire and Smoke Safety Requirements: CEN TS 45545 from 2012**
- **Processing of highly filled resins**
- **Higher quality control costs**
- **Higher environmental protection (less styrene emission)**
- **Lower GRP weight to cut energy costs in operation**
- **Lower production costs in European countries**

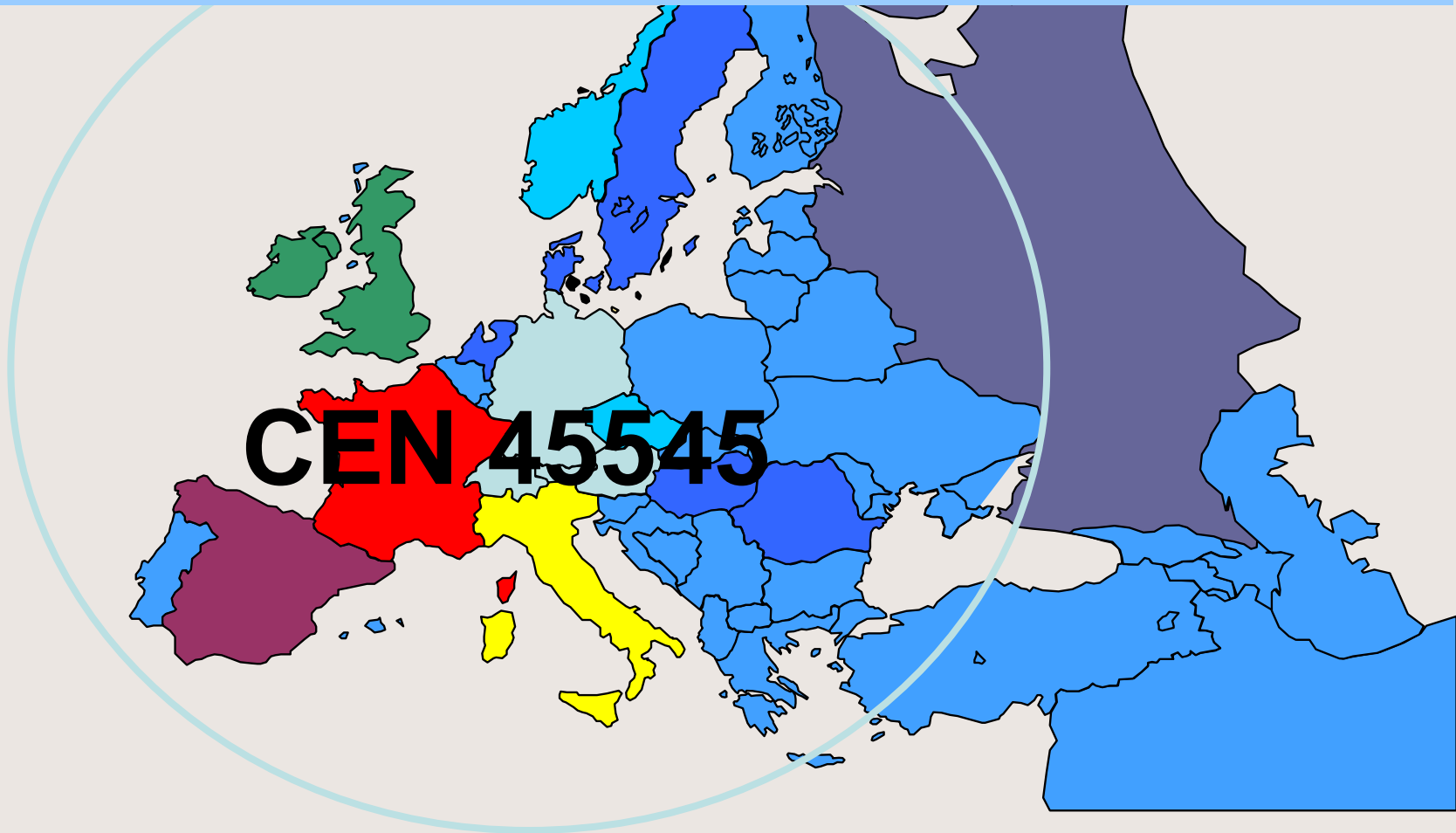


Europe today





Europe from 2012





CEN TS 45545

In the Year 2012 CEN TS 45545 shall replace:

- DIN 5510
- BS 6853
- RENFE DT-PCI 5A
- NF F 16-101
- UNI CEI 11170
- ...

Already today the industry asks for these materials



CEN 45545

CEN TS 45545 requires advanced materials to:

- 1) pass the more stringent test
- 2) to be processable

GRPs according to CEN TS 45545 will be more expensive:

- 1) new gelcoat technology
- 2) processing
- 3) coating even more important



CEN TS 45545

**Resin + Gelcoat + Primer + Top Coat
= Total System**
must pass the Fire and Smoke Tests





Definition of Railway Vehicles

Railway vehicles in this standard are:

- Locomotives
- Multiple units
- Coaches
- Light rail vehicles
- Underground vehicles
- Trams
- Trolley buses (only in relation to the electrical equipment);
- Magnetic levitation vehicles



Evaluation of Material Reaction to Fire

The 5 parameters for evaluation of reaction to fire are :

- Spread of flame
- Ignitability
- Heat release
- Smoke
- Toxicity

The fire behaviour is evaluated on materials and components, in end-use condition as far as it is possible.



CEN TS 45545 Test Methodes (Material Classes)

Ref.	Standard	
T01	EN ISO 4589-2	Oxygen index
T02	ISO 5658-2	Spread of flame
T03	ISO 5660-1	Cone calorimeter
T04	EN ISO 9239-1	Flame spread of floorings
T05	EN ISO 11925-2	Ignitability
T06	ISO/TR 9705-2	Furniture calorimeter
T07	EN ISO 12952 -3/4	Ignitability of bedding items
T08	IEC/TS 60695-1-40	Guidance - Insulating liquids
T09	EN 50266-2-4	Vertical flame spread of cables
T10	EN ISO 5659-2	Smoke Generation
T11	CEN/TS 45545-2, C	Gas analysis - FTIR
T12	NF-X70-100-1	Gas analysis
T13	EN 61034-2	Smoke density of cables



Hazard Levels

Categories and Fire Hazard Levels (=HL)

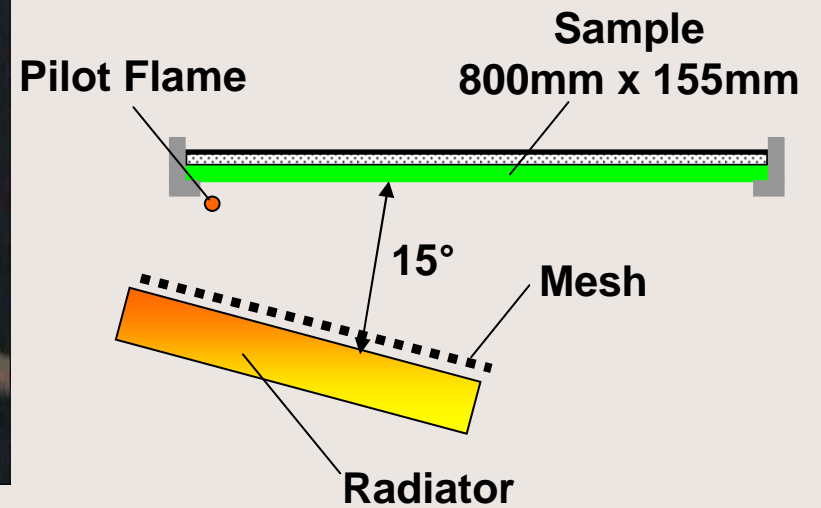
Design Categories Operation Categories	N Standard Vehicles	A Automatic Vehicles, having no emergency exit	D Double decked Vehicles	S Sleeping and Couchette
1	HL 1	HL 1	HL 1	HL 2
2	HL 2	HL 2	HL 2	HL 2
3	HL 2	HL 2	HL 2	HL 3
4	HL 3	HL 3	HL 3	HL 3



T02 - ISO 5658-2 Spread of Flame

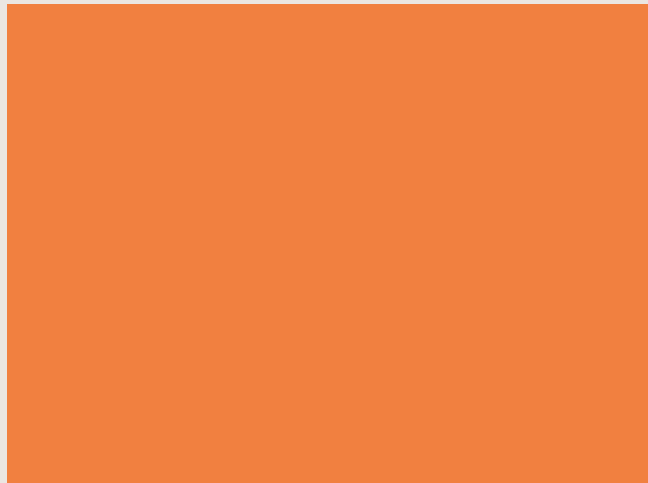


CFE [kW/m²] - Critical Heat Flux at Extinguishment (Intensity at max Flame Spread)





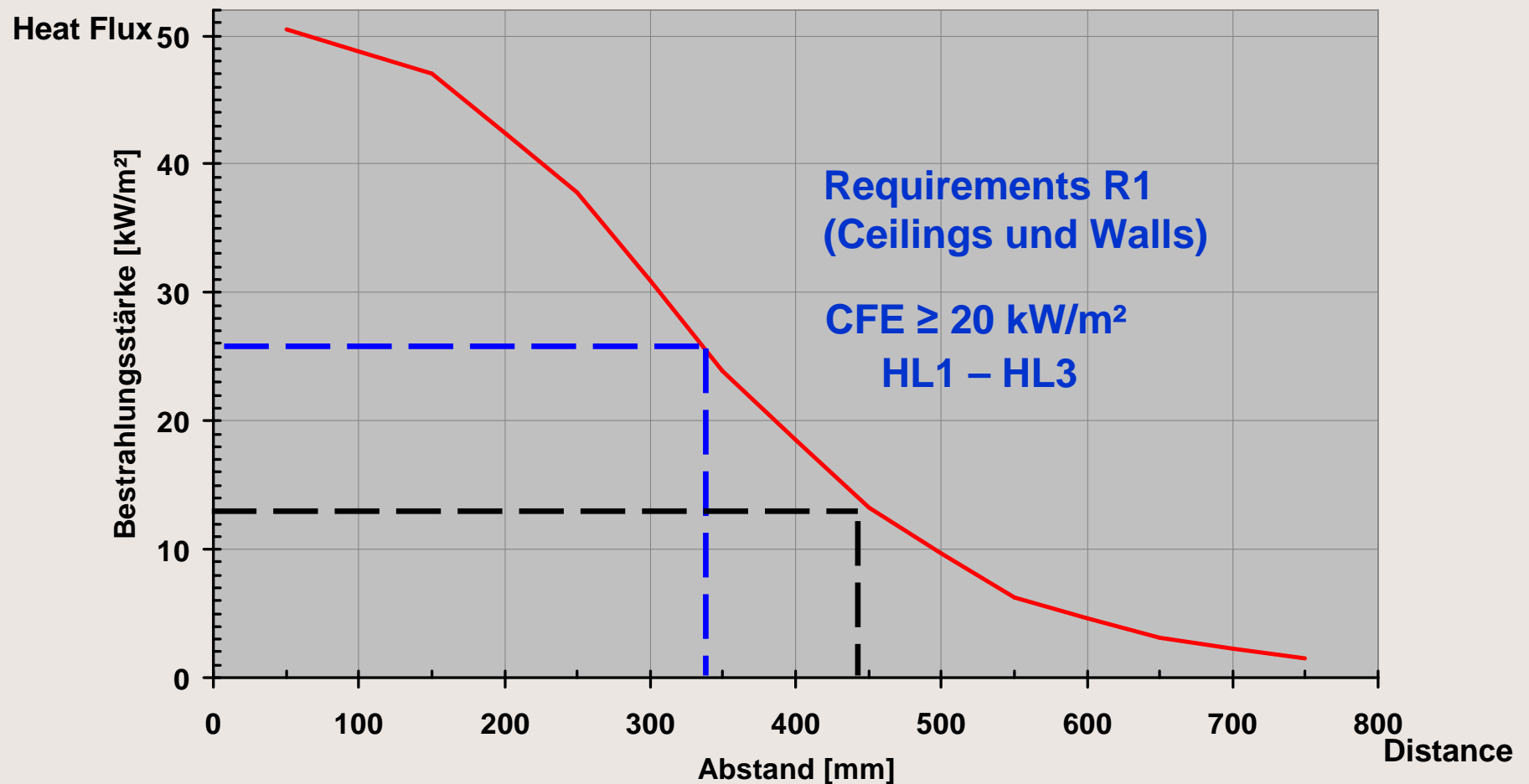
T02 - ISO 5658-2 Spread of Flame



CURRENTA 



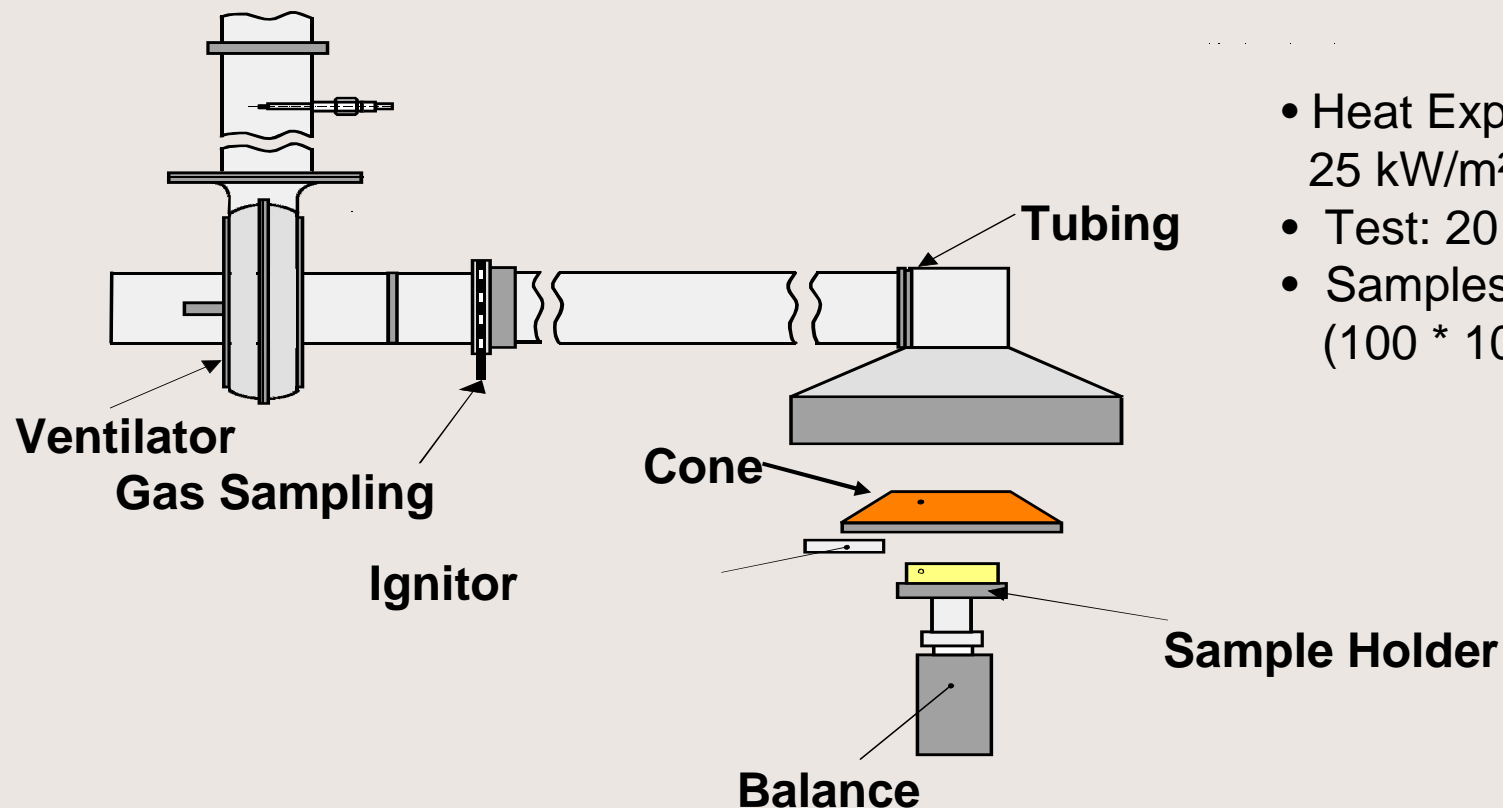
T02 - ISO 5658-2 Spread of Flame





ISO 5660-1 Cone Calorimeter (Rate of Heat Release)

MARHE: Maximum average rate of heat emission



- Heat Exposure:
25 kW/m² or 50 kW/m²
- Test: 20 min
- Samples
(100 * 100 * ≤ 50) mm



ISO 5660-1 Cone Calorimeter (Rate of Heat Release)

MARHE: Maximum average rate of heat emission (kw/m²)

The maximum value of ARHE during the time period $t=0$ to $t=tend$
(Oxygen Methode)





T02 - DIN EN ISO 5659-2 Smoke Generation

Determination of optical density by a single-chamber test



- 25 kW/m² mit Pilot Flame or 50 kW/m².
- Samples: (75 * 75 * ≤ 25) mm
- Smoke sampling for Toxicity Det. after 4. und 8. Minutes
- Max. Value from the 2 Samples



T02 - DIN EN ISO 5659-2 Smoke Toxicity

8 Gas Components are measured (CO₂, CO, HF, HCl, HBr, HCN, NO_x, SO₂)

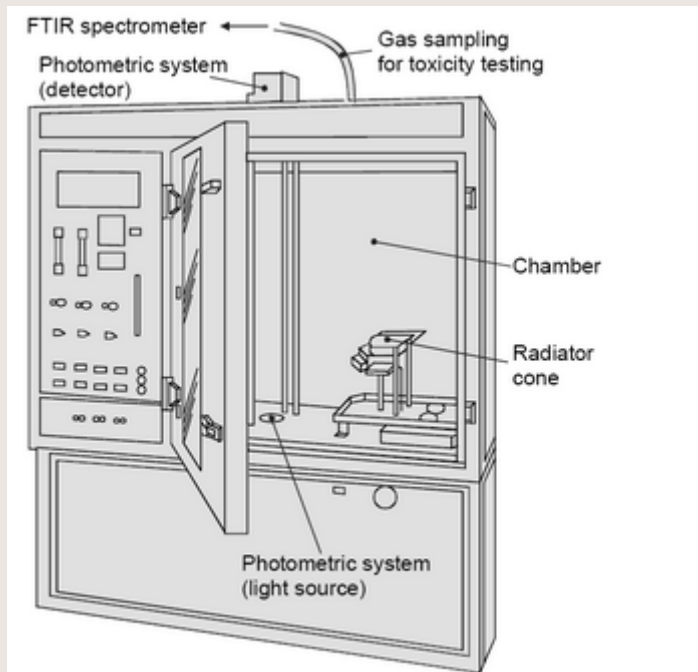
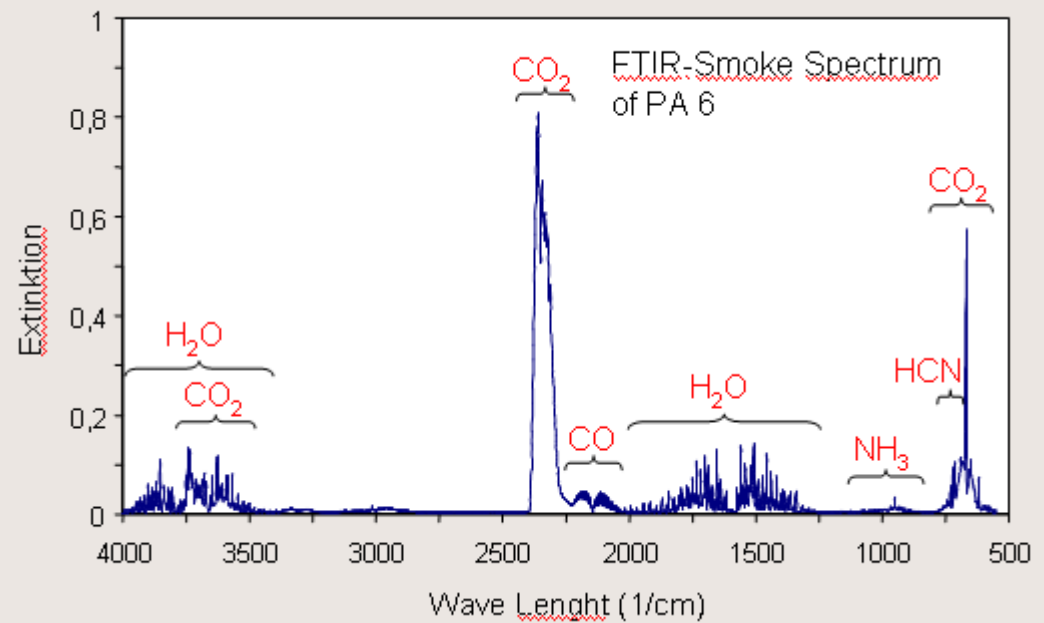


Fig. 2: Decomposition apparatus according to EN ISO 5659





Hazard Levels

Relations between Categories and Fire Hazard Levels (=HL)

Design Categories Operation Categories	N Standard Vehicles	A Automatic Vehicles, having no emergency exit	D Double decked Vehicles	S Sleeping and Couchette
1	HL 1	HL 1	HL 1	HL 2
2	HL 2	HL 2	HL 2	HL 2
3	HL 2	HL 2	HL 2	HL 3
4	HL 3	HL 3	HL 3	HL 3



CEN TS 45545 Hazard Level Requirements

R1: Walls and Ceilings

Test Method	Parameter	Requirement	HL 1	HL 2	HL 3
Spread of Flame	CFE kW/m ²	Minimum	20	20	20
Rate of Heat Release	MARHE kW/m ²	Maximum		90	60
Smoke	Ds (4) dimensionless	Maximum	600	300	150
Smoke	VOF4 Minutes	Maximum	1200	600	300
Smoke Toxicity	CIT _G Dimension less after 8 Minutes	Maximum	1.2	0,9	0,75





More Informations

- **Currenta, Germany**
http://www.currenta.com/index.php?page_id=3606
- **Crepim, France:** www.crepim.fr



Mäder Coating and Composite Solutions for Mass Transit and Railway GRP Makers

1.		<p>New tough European Fire Protection Requirements (CEN TS 45545)</p>
2.		<p>Polyester Resins, Gelcoats and Coatings passing the new European Requirements</p> <p>Processing of advanced FST Systems</p>



Mäder Coating and Composite Solutions for Mass Transit and Railway

Resin + Gelcoat (+ Primer + Top Coat) = System Package
→ must pass the Fire and Smoke Tests



Mäder develops and produces full Systems

- Coatings
- Resins
- Gelcoats
- Primers
- ...





Mäder Total Solutions: Resins, Gelcoats, Primers, Topcoats



outside



Mäder Total Solutions: Resins, Gelcoats, Primers, Topcoats

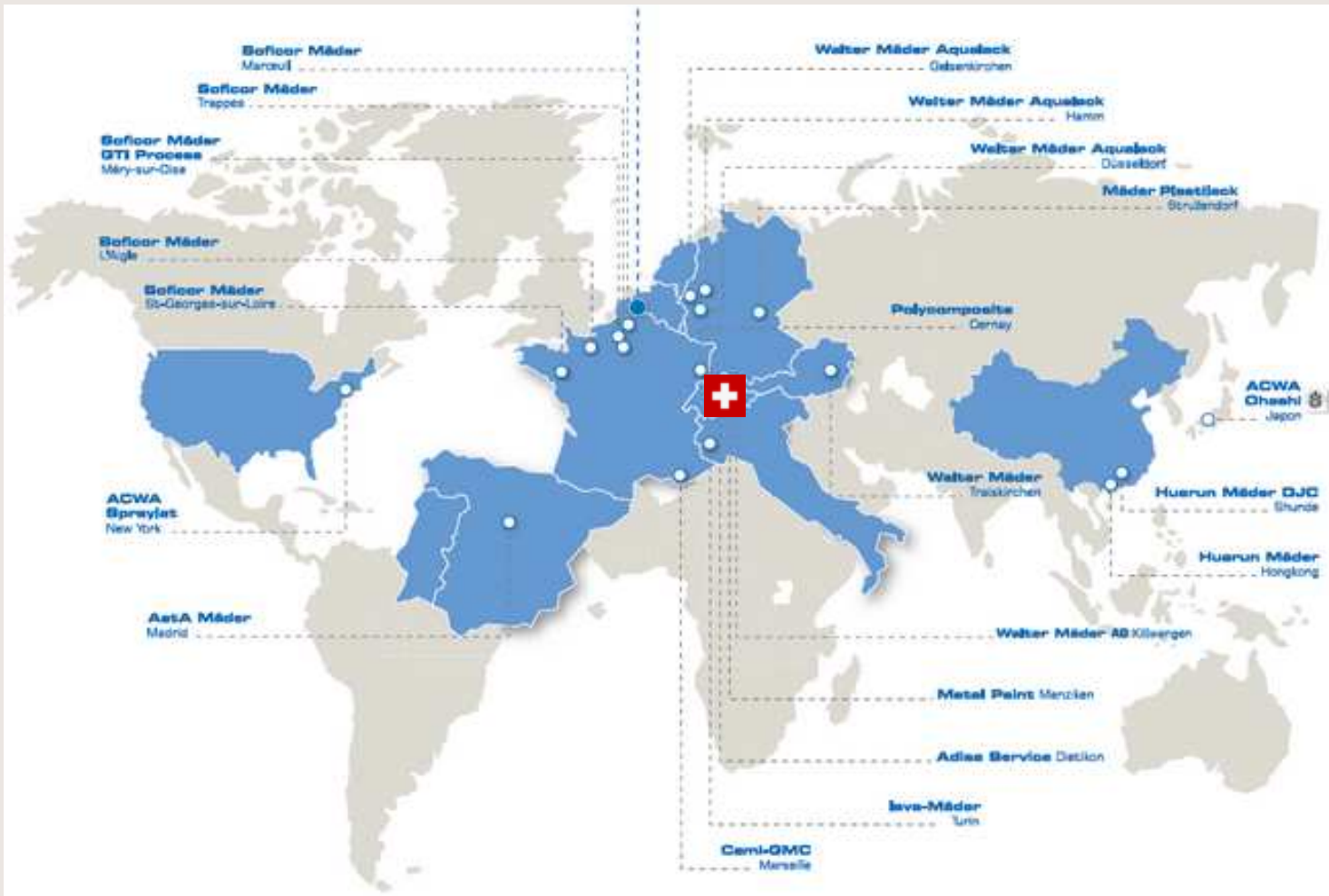
inside



TGV Duplex



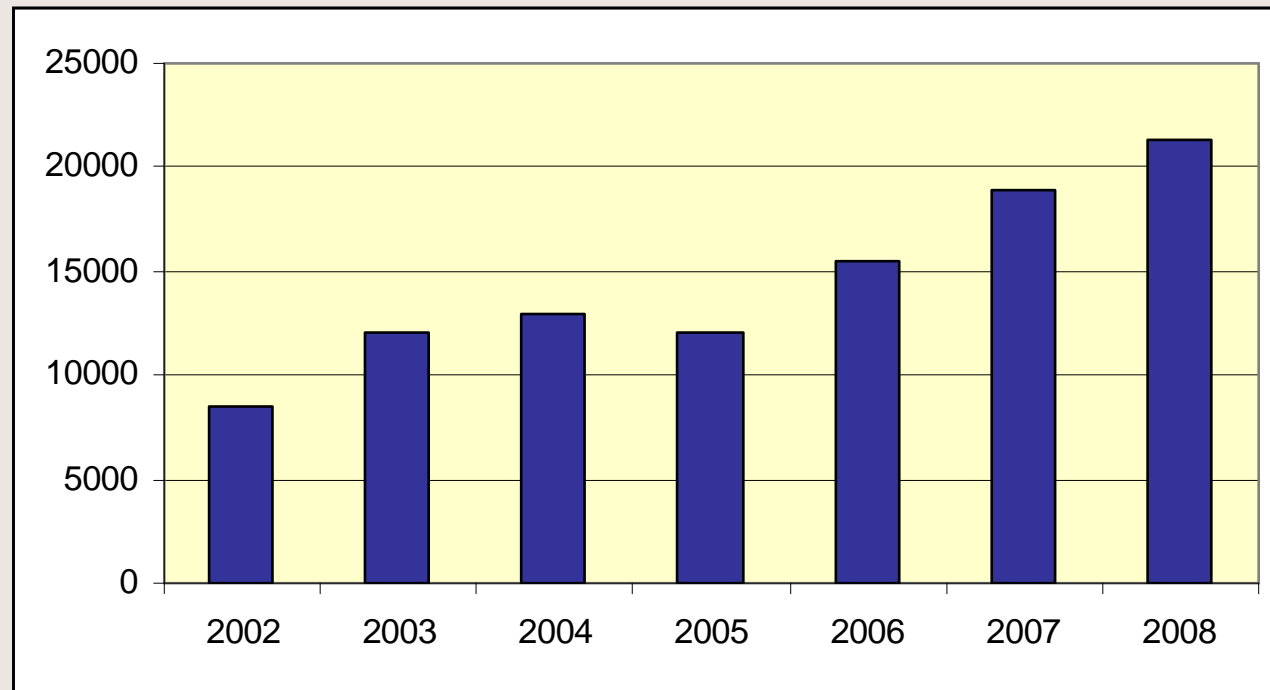
Mäder Coating and Composite Solutions (EUR 185 Mio.)





Mäder Growth (kEUR)

Market Leader in Europe in Railway / Mass Transit Coatings





Mäder Railway Services for...



Passenger Trains Ext.



Passenger Trains Int.



Bogies and Axel Trees



Antigraffiti Solutions



Resins & Gelcoats for GRP



Goods Wagons



Technical Products for Car Bodies



Cleaning and Surface Preparation



Services



Urban Equipment & Services





Mäder Solutions

TGV Speed Record



574,8 km/h



Mäder Solutions

High speed trains

CRH 5	China	Alstom / CRC	2006
TGV Duplex	France	Alstom	2001
TGK	Korea	Alstom / Rotem	< 2000
ICN	Switzerland	Bombardier	< 2000
ICE III	Germany	Bombardier	< 2000
ICE II	Germany	Bombardier	< 2000



Tilting trains



Helsinki - Saint Petersburg	Finland / Russia	Alstom	2008
Cisalpino	Switzerland / Italy	Alstom	2005
New Pendolino	Italy	Alstom	2005
SM3 Finlandia II	Finland	Alstom	2003
Virgin WCML	England	Alstom	2002
Pendolino Slovenia	Slovenia	Alstom	2001
SM3 Finlandia I	Finland	Alstom	2001
CP Portugallo II	Portugal	Alstom	< 2000
ETR 500	Italy	Alstom	< 2000
ETR 480	Italy	Alstom	< 2000
CP Portugallo I	Portugal	Alstom	< 2000
ETR 470 Cisalpino	Switzerland	Alstom	< 2000
ETR 460	Italy	Alstom	< 2000



Mäder Solutions



Metros

Istanbul II	Turkey	Alstom	2008
Caracas Los Teques	Venezuela	Alstom	2007
VAL 208 Rennes	France	Siemens	2007
Caracas IV	Venezuela	Alstom	2006
Paris MF 2000	France	Bombardier	2006
VAL 208 Roissy	France	Siemens	2006
VAL 208 Toulouse B	France	Siemens	2005
VAL Torino	Italy	Siemens	2005
Caracas III	Venezuela	Alstom	2000
Istanbul I	Turkey	Alstom	< 2000
Metro Kaohsiung	China	Siemens	< 2000
Metro Roma	Italy	Alstom	< 2000

Regional & suburban trains

NAT	France	Bombardier	2008
Bari Nord II	Italy	Alstom	2007
S-Bahn Zurich	Switzerland	Siemens	2005
BAF Minuetto	Italy	Alstom	2003
Desiro Southwest	England	Siemens	2002
AGC	France	Bombardier	2001
TER 2N NG	France	Alstom & Bombardier	2001
BLS Nina	Switzerland	Bombardier	2000
Bari Barletta	Italy	Alstom	< 2000
Bari Nord II	Italy	Alstom	< 2000
X TER	France	Alstom	< 2000
Hillside	Australia	Alstom	< 2000
Mi2N	France	Alstom & Bombardier	< 2000
Z2N	France	Alstom	< 2000





Mäder Solutions

Tramways

Antalya	Turkey	CAF	2008
Vitoria	Spain	CAF	2008
Citadis Angers	France	Alstom	2007
Citadis Tunis	Tunisia	Alstom	2007
Citadis Bordeaux II	France	Alstom	2006
Citadis Valenciennes	France	Alstom	2005
Flexcity Bremen	Germany	Bombardier	2003
Flexcity New Jersey	USA	Bombardier	2003
Tram Torino	Italy	Alstom	2002
Citadis Bordeaux I	France	Alstom	2002
Flexcity Munchen	Germany	Bombardier	2002
Citadis RATP I	France	Alstom	2001
TVR Nancy	France	Bombardier	2001
TVR Caen	France	Bombardier	2001
Citadis Melbourne	Australia	Alstom	2000
Citiway Roma	Italy	Alstom	2000
Tram Nuremberg	Germany	Bombardier	< 2000
Tram Messina	Italy	Alstom	< 2000
Tram Zurich	Switzerland	Bombardier	< 2000
Tram Frankfurt	Germany	Bombardier	< 2000





Mäder Certificates

HL 3 System: UP Resin + colored Gelcoat

HL 2 System: UP Resin + colored Gelcoat

HL 2+ System: UP Resin + Gelcoat + Primer + Top Coat
(R1 for Walls, Ceilings) and R16 for Front Cup)

M1 F1 System: UP Resin + colored Gelcoat

M1 F1+ System: UP Resin + Gelcoat + Primer + Top Coat

DIN System: UP Resin + colored Gelcoat

DIN+ System: UP Resin + Gelcoat + Primer + Top Coat

HL 3, HL 2: pr CEN TS 45545

M1 F1: French Norm

DIN: 5510-2: German Norm



Mäder Coating and Composite Solutions passing CEN TS 45545

Test Methode	Parameter	Requirement	HL 1	HL 2	HL 3	HL 2
TO 2 ISO 5658-2	CFE kWm2	Minimum	20 22,6	20 22,6	20 24	20 22,8
T03.01 ISO 5660-1 50 kWm2	MARHE kWm2	Maximum	- -	90 70,9	60 57,5	90 75
T10.01 EN ISO 5659-2 50 kWm2	Ds (4) dimensionless	Maximum	600 196	300 196	150 106	300 175
T10.02 EN ISO 5659-2 50 kWm2	VOF4 Minutes	Maximum	1200 363	600 363	300 194	600 322
T11.01 EN ISO 5659-2 50 kWm2	CIT ₆ Dimensionless After 8 Minutes	Maximum	1,2 0,1	0,9 0,1	0,75 <0,5	0,9 0,2

NUVOPOL Gelcoat 37-03 int.
on
GIRALITHE DITRA 2109-11XP

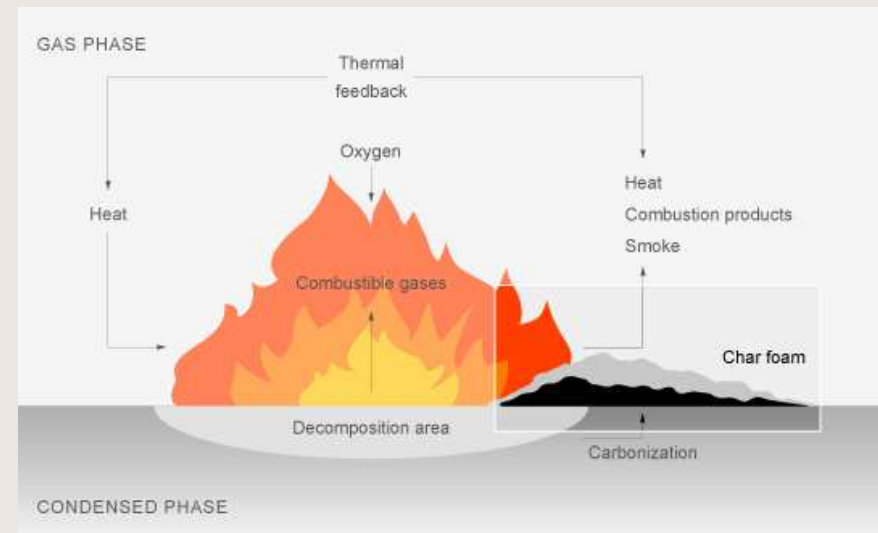
NUVOVERN AQUA
Filler + varnish
NUVOPOL Gelcoat 37-03 int.
on
GIRALITHE DITRA 2109-10XP



HL 3, HL 2 Intumescent Gelcoat Nuvopol 37-03

High fire protection trough intumescent effect:

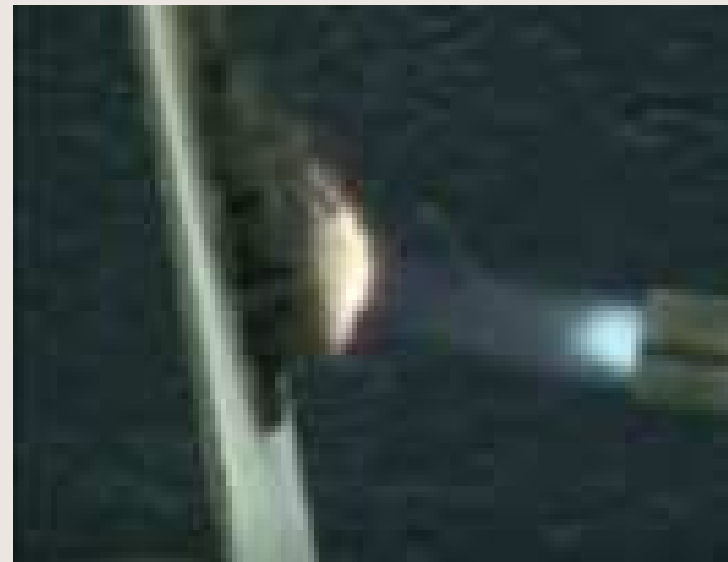
- Intumescence = swelling, foaming of a carbon rich foam layer
- has a heat insulating effect
- reduces further oxygen access
- reduces fuel transport into the flame
- prevents dripping





HL 3, HL 2 Intumescent Gelcoat Nuvopol 37-03

High fire protection trough intumescent effect:





Challenges for GRP in Mass Transit and Railways

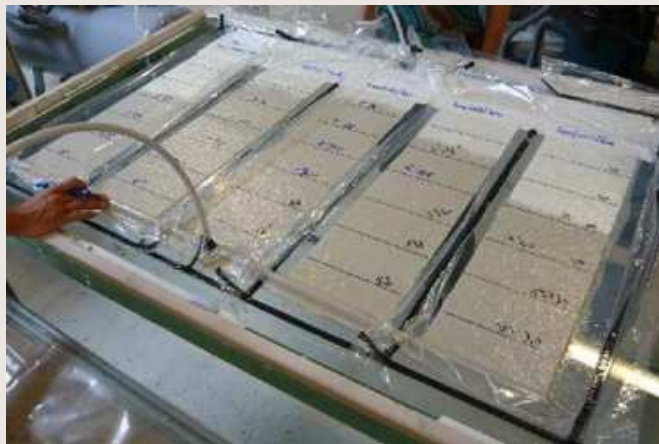
- Higher Fire and Smoke Safety Requirements: CEN 45545 from 2012
- **Processing of highly filled resins**
- Higher quality control costs
- Higher environmental protection (less styrene emission)
- Lower GRP weight to cut energy costs in operation
- Lower production costs in European countries



Easy Processing Flame Retardant UP Resins

Challenge: Normally problems with highly filled halogen-free UP resins:

- Separation / Settlement of mineral flame additive
- High viscosity, poor penetration of glass mats
- Mostly only hand lay-up possible (Separation of fillers by injection)



Test equipment for evaluating improvements:

Comparison of different resins or glass mats



Easy Processing Flame Retardant UP Resins

**GIRALITHE DITRA 2109-11XP (passes CEN TS 45545 HL 2)
is different:**

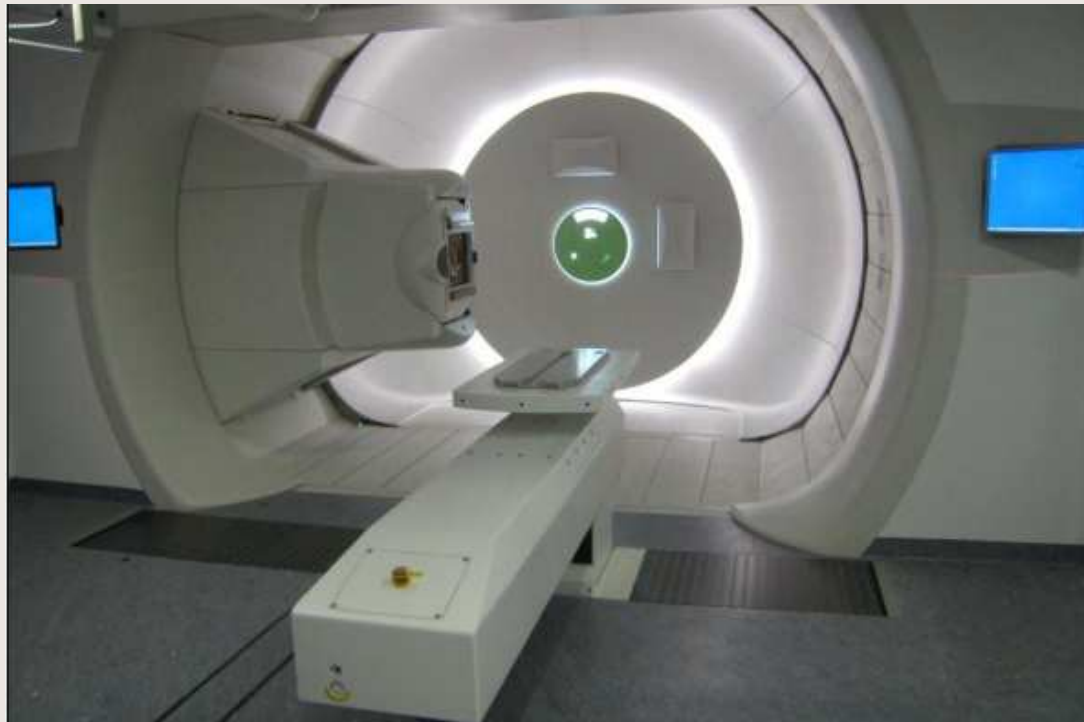
- Low viscosity
- Fast wetting of glass mats
- Easy to process by
 - Hand lay-up
 - Spraying
 - Vacuum Infusion (no/little separation of flame additive)
 - RTM light
 - RTM

GIRALITHE is not a development product, its in use already



Easy Processing Flame Retardant UP Resins

GIRALITHE DITRA 2109-11XP (passes CEN TS 45545 HL 2)
is different:



Vacuum Infusion
(Vacuum Bag Technology)
6 m², 20 Min. infusion time

Customer: unbelievable
performant solution in
comparison to RTM process
(cheaper, faster, easier)



Easy Processing Flame Retardant UP Resins

**GIRALITHE DITRA 2109-11XP (passes CEN TS 45545 HL 2)
is different:**





Infusion Tests (VI, RTM light)

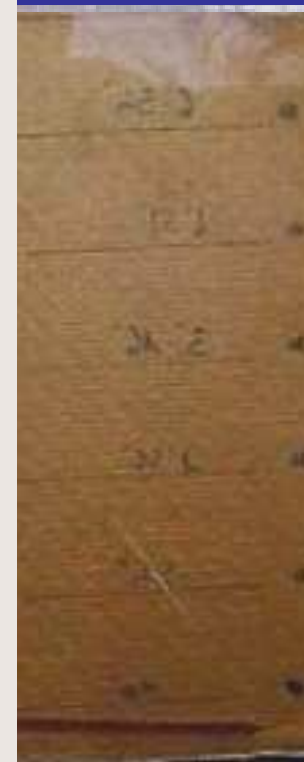
Without Net



External Flow



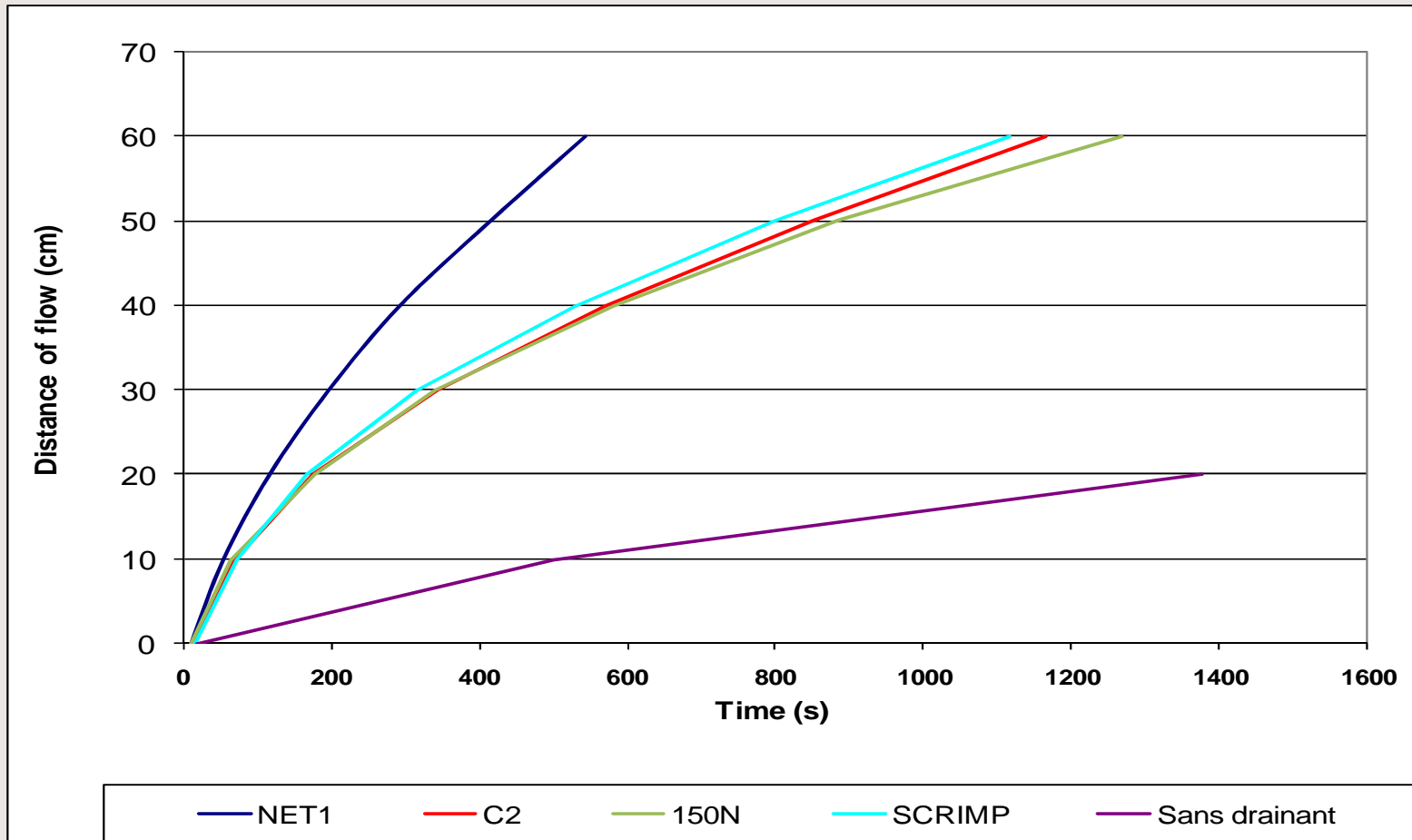
ROVIFLOW



Source:Chomarat



Influence of Glass Mats on Infusion Time





Easy Processing Flame Retardant UP Resins

GIRALITHE DITRA 2109-11XP is different:

RTM Light Production of Front Cups for years



Stadler





Easy Processing Flame Retardant UP Resins

**GIRALITHE DITRA 2109-11XP with Gelcoat Nuvopol 37- 03
for Flirt NSP (CEN TS 45545 HL 2 Requirement)**

Toilet Cabins



Stadler



Easy Processing Flame Retardant UP Resins

**GIRALITHE DITRA 2109-11XP with Gelcoat Nuvopol 80-50 TGP and Mäder Coating for DOSTO 2010
RTM Light Production of Front Cups**



Stadler



Easy Processing Flame Retardant UP Resins

GIRALITHE DITRA 2109-11XP (passes CEN TS 45545 HL 2)

is different:

RTM Production of Belgium Passenger Wagon Window Frames





Easy Processing Flame Retardant UP Resins

GIRALITHE DITRA 2109-11XP (passes CEN TS 45545 HL 2)

is different:

RTM Production of Belgium Passenger Wagon Window Frames



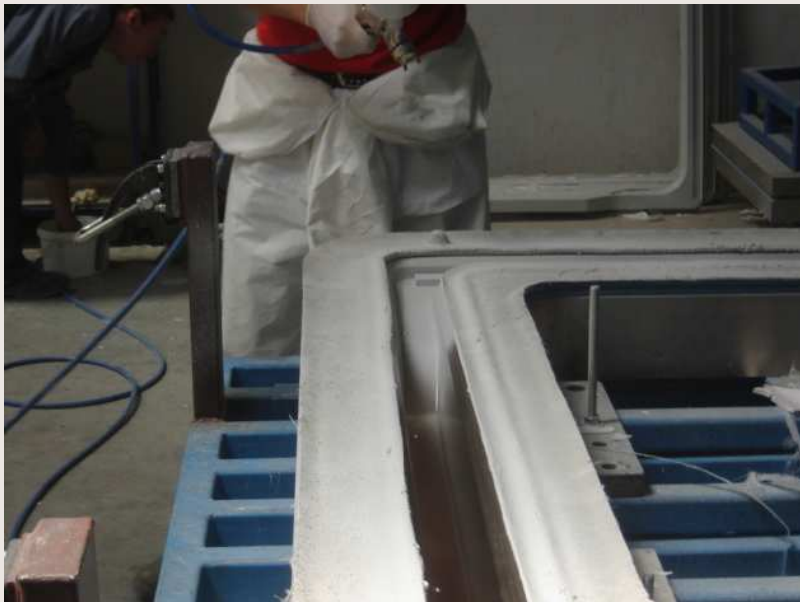


Easy Processing Flame Retardant UP Resins

GIRALITHE DITRA 2109-11XP (passes CEN TS 45545 HL 2)

is different:

RTM Production of Belgium Passenger Wagon Window Frames

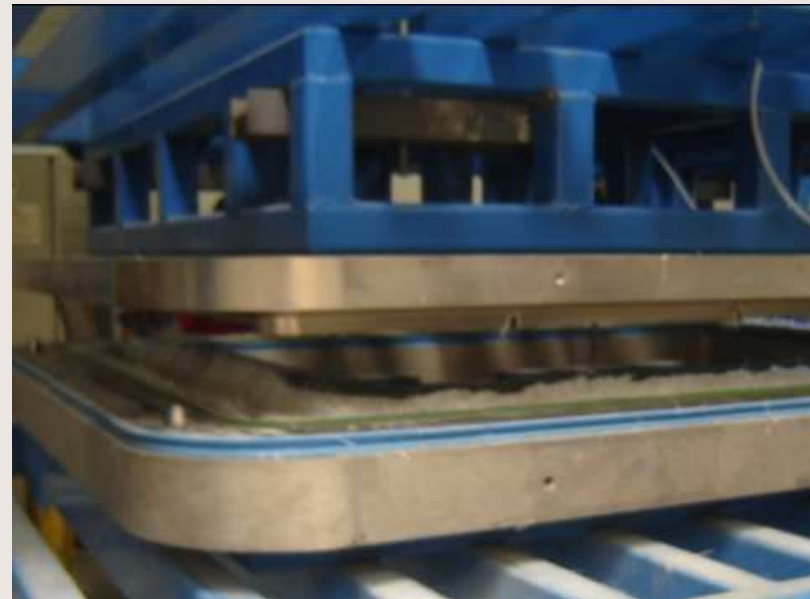




Easy Processing Flame Retardant UP Resins

**GIRALITHE DITRA 2109-11XP (passes CEN TS 45545 HL 2)
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RTM Production of Belgium Passenger Wagon Window Frames





Easy Processing Flame Retardant UP Resins

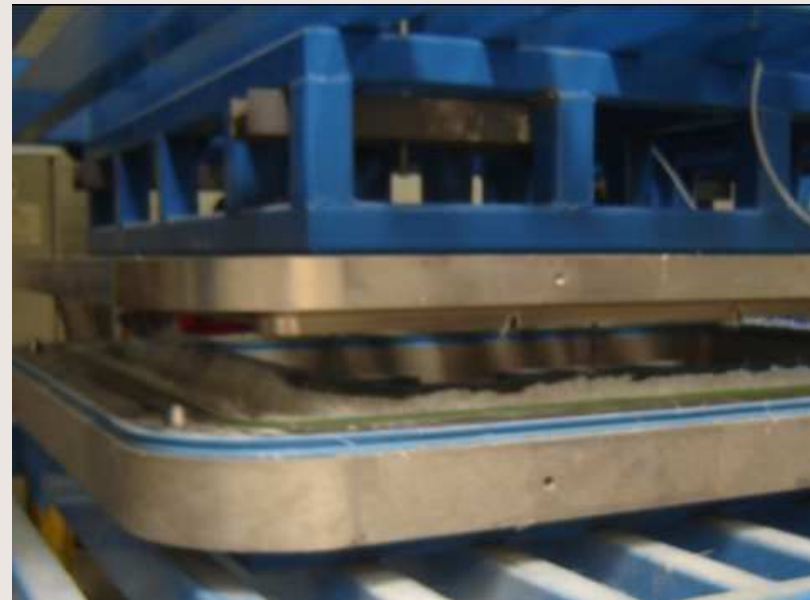
**GIRALITHE DITRA 2109-11XP (passes CEN TS 45545 HL 2)
is different:**

RTM Production of Belgium Passenger Wagon Window Frames

Process

- Cleaning / Release Agent 10 Min.
- Gelcoat Application, drying
up to 5 Layers 580g/m² 20 Min.
- Injection time: 5 Min.
- Curing 50 DC: 25 Min.
- Demolding 5 Min.

Total: about 1h





Easy Processing Flame Retardant UP Resins

**GIRALITHE DITRA 2109-11XP (passes CEN TS 45545 HL 2)
is different:**



RTM Production of Belgium Passenger Wagon Window Frames

- Glass content > 40%
(5 Layers 580g/m², 3 mm)
- lower labor costs
- exacter dimensions
- lower styrene emission



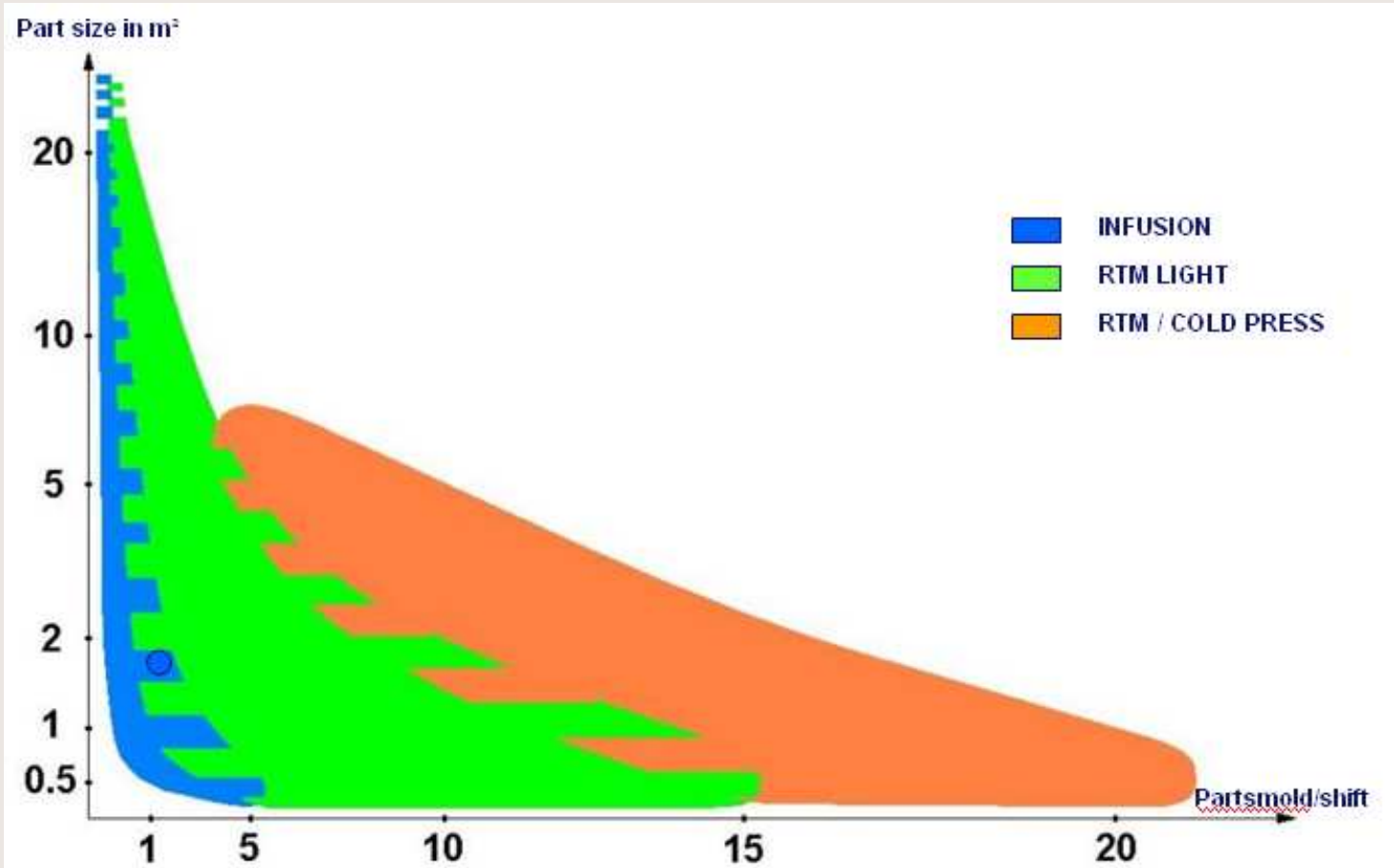
Best Manufacturing Practice (esp. Hand Lay-Up)

To achieve best possible results with GRP parts please consider the following rules:

- Workshop temperature : between 18 – 24°C
- Never add solvents or diluents (Styrene)
- Respect the prescribed quantities of accelerator and hardener
- Respect gelcoat – film thickness as indicated in the techn. data sheets
- Use emulsion bound mats only
- Work carefully, avoid air bubbles and resin – enrichments
- GRP parts have to be planned as symmetric as possible (Shrinkage)
- Follow carefully all Instruction for post curing
(To achieve flame resistance heat treatment is mandatory)



Which Process for which Part ?





Summary and Solutions Challenges for GRP in Mass Transit and Railways

- Higher Fire and Smoke Safety Requirements: CEN TS 45545 from 2012

- Processing of highly filled resins

**Mäder Total Solutions
Resin, Gelcoat
Topcoat**

- Higher environmental protection (less styrene emission)

- Lower GRP weight to cut energy costs in operation

- Lower production costs in European countries

**Prepregs
Vacuum Infusion
RTM light
RTM**



More Informations

Paul Wartenweiler
Marketing & Sales Manager

Walter Mäder AG
Industriestrasse 1
8956 Killwangen
Switzerland

p.wartenweiler@mader-group.com
www.madercomposites.com



Thank You !



We create



We protect



We respect

