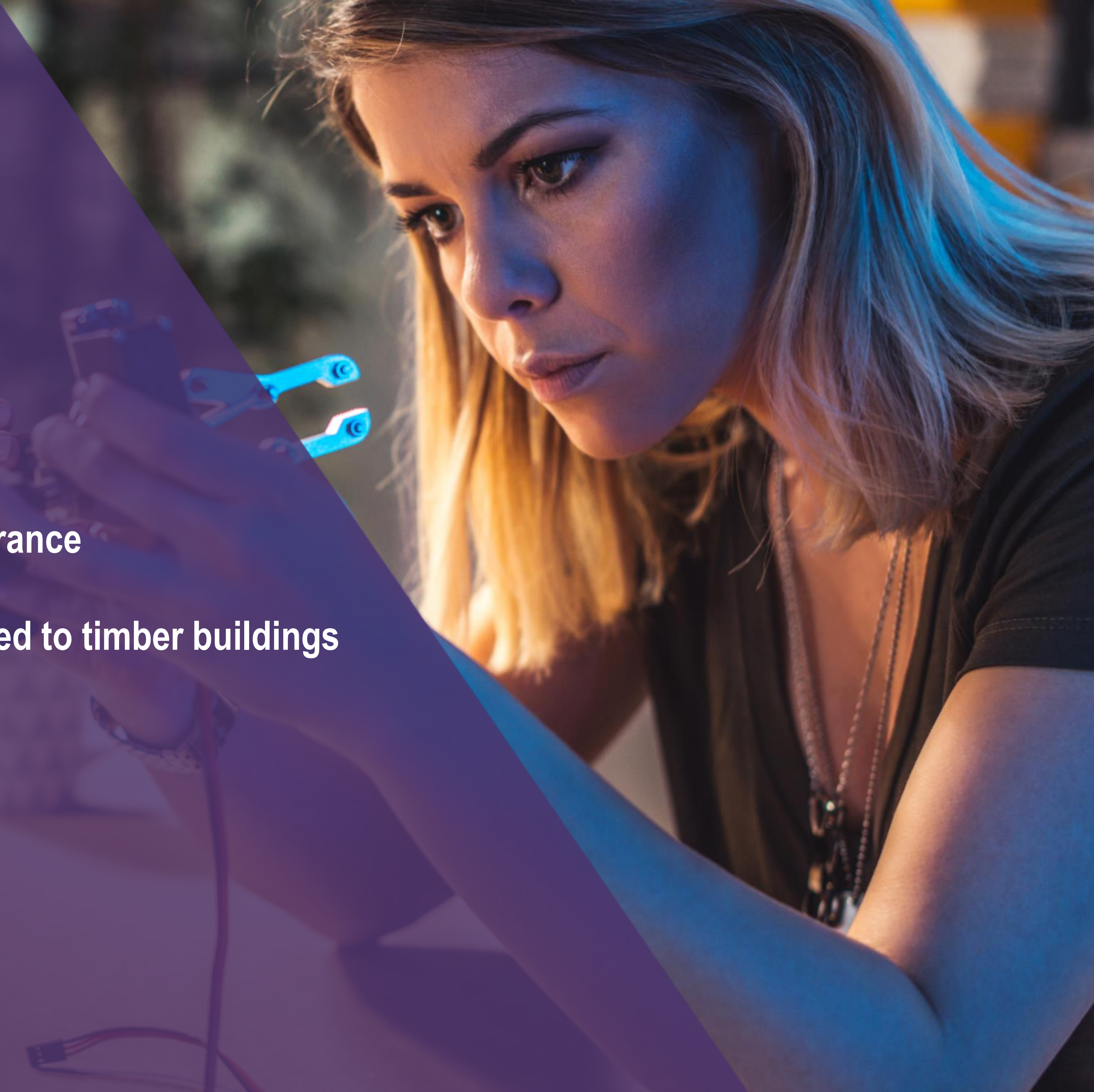
RiskCare

Maîtrisez vos risques industriels

AGENDA

1. About us
2. Overview of mass timber construction in France
3. Hazards and risk management issues related to timber buildings
4. Presentation of the tests of 25/11/2022
5. Conclusions and outlook
6. Appendix



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Who are we ?

Who are we ?

The synergy of 3 market leaders within an innovative joint-venture

RiskCare

GENERALI

apave

Comforth Easyfront MagellanPartners

Project initiator

Insurance expertise

1st client

Technical expertise and solution design

Knowledge base

Technical expertise missions

Platform design

Technical and IT support

Platform maintenance and development

**RiskCare is an independent company: Our shareholders don't have acces to our commercial data.
They ensure the company's excellent financial standing and indisputable collective experience to meet the market requirements.**

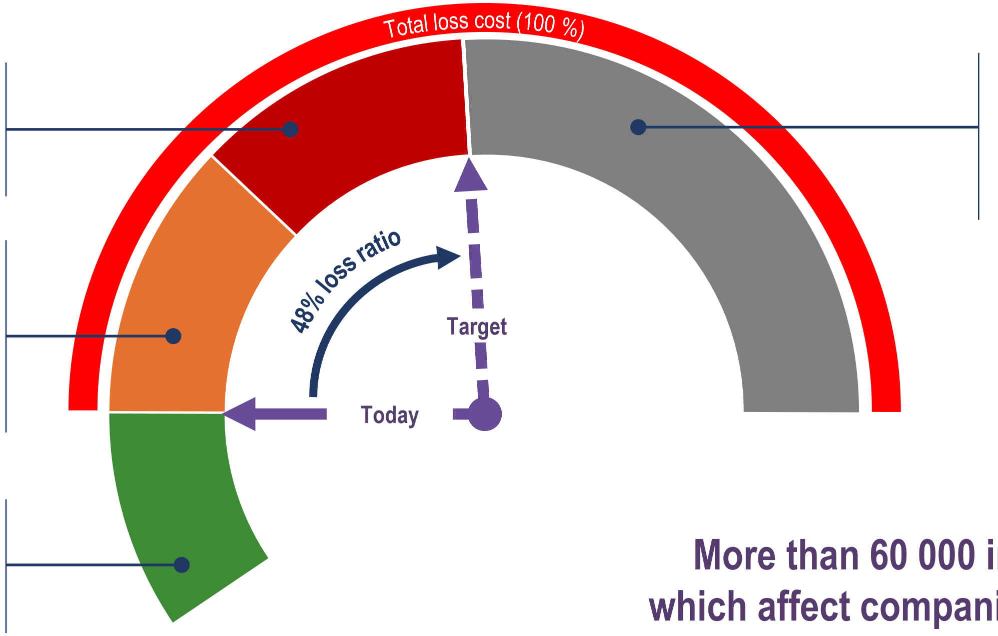
Our goal

We aspire to reduce in a concrete and measurable way the frequency and severity of claims affecting risk portfolios

Prevention missing **24%**

Insufficient prevention **24%**

Efficient prevention **19%**



52% Non-anticipated risk
The risk occurrence is beyond control…at least for now

Daily statistics in France :
More than 60 000 industrial accidents, including around 20 fire cases which affect companies preventing them from their core producing activity
(Statistics of 2020 issued by fire and rescue services)

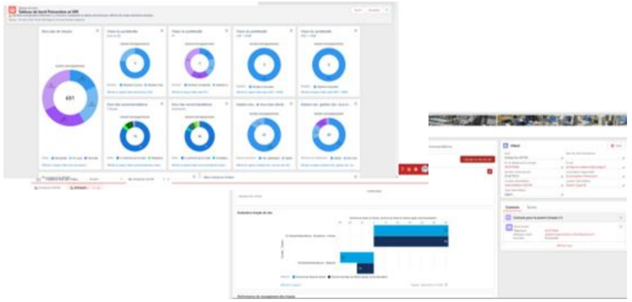
RiskCare reshapes the way we anticipate and take action when faced with the risks at the industrial sites…
… by bringing together the expert services and the digital platform for a safer and simpler economy

Our Risk Prevention Platform

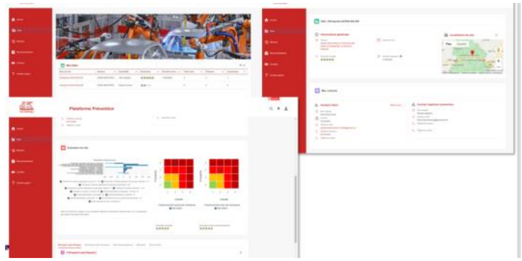
A major leap towards the future of industrial sites security thanks to a collaborative platform

3 interfaces offering **a shared view** on the same data, processes and documentation

Centralised Back Office



Client Portal



Intermediary Portal

Workflow fluidity

Interface personnalisation

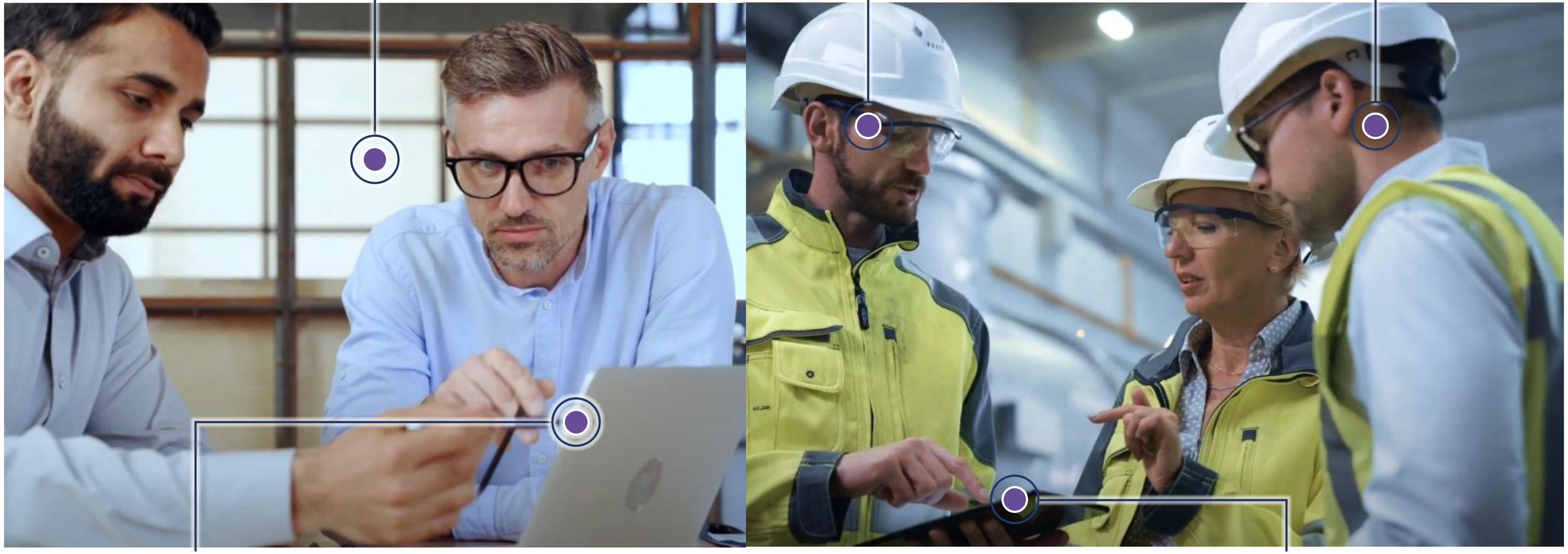
Our team of seasoned consultants

Global and multisectorial capacity to meet the market requirements

An expert team of industrial risk management
dedicated to risk prevention on your important sites and account management

On-site visits
powered byAI and digital technologies

Ecosystem of certified suppliers
to implement the measures and provide local expertise



Supervision of risk portfolios
including all-scale dashboards for managers

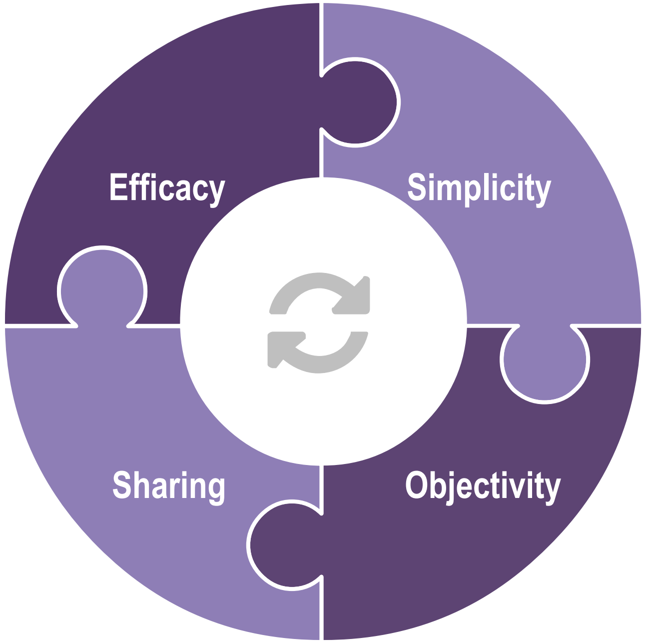
Customised recommendations
designed for the right suppliers and based on 360° monitoring

Our approach

We are developing a highly performant approach based on 4 key requirements:

A comprehensive solution which allows you to concretely measure the results of your action plans.

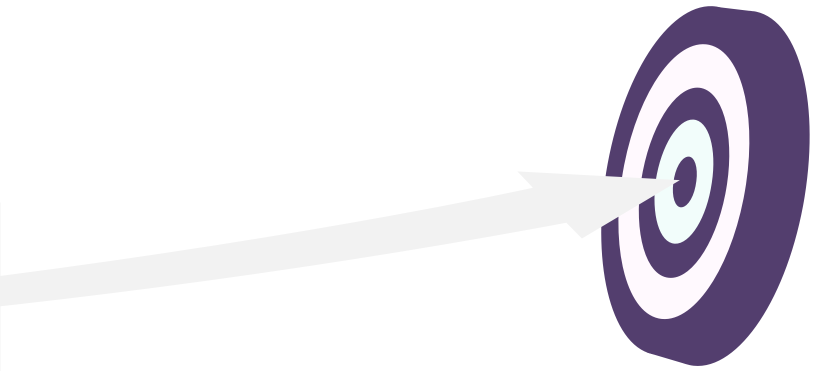
A solution developed by the experts in the field in close collaboration with intermediaries and industrial companies for a better operability and enhanced user-friendliness.



A solution designed for connecting all of the shareholders: Insurers, Intermediaries, Clients, Partners.

A solution based on pragmatic analyses and aggregated operational realities.

Our consulting services based on the accident scenarios simulations, as well as our platform, enable a simplified decision-making process by unifying the comprehension and language between the different counterparts of prevention.



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Overview of mass timber construction in France

Overview of mass timber construction in France

French Market Status and Outlook

- The construction sector worldwide accounts for **40% of CO_2 emissions.**
- In France, the building sector accounts for 44 % of energy consumption and nearly 25 % of CO_2 emissions.
- The carbon footprint of wood construction is 75% better than with a conventional material.

The environmental regulation RE2020 obliges to reduce the carbon impact of buildings, and to continue improving their energy performance

- It is divided into several stages and **will concern all buildings**:
  - In the 1st stage: individual houses and collective housing,
  - In the 2nd stage: offices and primary and secondary education buildings,
  - In the 3rd stage: specific tertiary buildings: hotels, shops, gymnasiums, ...

Today in France:

- On the construction market, 80 % of the construction is concrete and steel
- In 2020, 686 000 m2 of industrial and commercial buildings were built in wood, i.e. a market share of 20.3%, and **sales of €1.9 billion before tax**
- This **market share indicator is said to grow fivefold minimum by 2030**, according to Frédéric Carteret, President of the Union of Wood Manufacturers and Constructors

According to the Carbone 4 survey agency, making one cubic meter of concrete emits 471 kilos of greenhouse gases (GHG).

While manufacturing the same amount of CLT is equivalent to subtracting 460 kilos of carbon from the atmospheric balance for the entire life of the building.

Overview of mass timber construction in France

The risks stemming from the lack of proper regulation and adapted standards

- In France, 3 essential regulations provide a tsrict framing of the fire risks: the construction and housing code, the environment code and the labour code.
- Nevertheless, **the laws and the current standards do not provide for the specific cases for the wooden buildings** (fire behaviour, contribution of the structure to the fire, …)
- Professional associations are working to draw up framework documents. The latter do not have any regulatory scope, but they issue best practice recommendations, generally drafted with the opinions of the examining services (BSPP, SDIS, etc.), which enrich the existing provisions in the field of soft law.
- However, without the official approval of their application, the risk of confusion persists, and **the project owners could be tempted to take as a reference the only existing regulations, which are less restrictive and therefore less costly for their project.**
- At the same time advances in construction techniques allow us to build much higher buildings at an increasingly fast speed.
- The CLT "cross laminated timber" technique makes it possible to overcome the constraints of traditional glued laminated timber, by greatly increasing the resistance and load-bearing capacity of the wooden structure, and **to exceed 15 floors**. Its great dimensional stability, its flexibility, the speed of execution in terms of assembly and construction, combined with its aesthetic appearance, make it a material highly prized by architects.
- Finally, among the performance qualities of the CLT which are frequently put forward by engineers and architects, we obviously find these last characteristics, but also what legitimately raises questions for us: **its fire resistance!**

Overview of mass timber construction in France

Colleges, residential towers, wooden campuses: projects becoming more and more ambitious

Les bois d'Angers

- Function: free access housing or housing for the elderly (92 apartments in total) as well as a drop-in daycare center
- Height: 9 floors and up to **37 meters high**
- Surface: 6 513 m²
- Comments: cross-laminated timber (CLT) panels, openwork timber cladding facades and hanging gardens

Wood up

- Function: Residential building (52 apartments in total)
- Height: **14 floors**
- Surface: 4 374 m²
- Comments: The layout of the interior surfaces, also designed in wood, makes future housing fully modular in the distribution of rooms

Light house

- Function: Residential building
- Height: **14 floors**
- Surface: 4 374 m²
- Comments: 2 organized around a vertical and central opening defining an open and crossing distribution space

Overview of mass timber construction in France

Colleges, residential towers, wooden campuses: projects becoming more and more ambitious

Balcons en forêt

- Function: 47 modular apartments (window and balcony installations)
- Height: 8 floors
- Surface : 3 160 m²
- Comments: Entirely designed in wooden structure: stairwells and elevators, and facades. The tops are freed from carrying points, thanks to a long-span wooden box structure. The set is equipped with an innovative natural ventilation device

Cartoucherie Wood'Art

- Function: Large urban complex: apartments, shops, workspaces, hotels
- Height: 9 floors
- Surface : **13 057 m²**
- Comments: 76 % made of wood: cladding of balconies and passageways, ceilings, floors

Wood'up

- Function: 112 apartments, activities and commerce
- Height: **14 floors, up to 50m high**
- Surface: 7 636 m²
- Comments: Entirely wooden structure (glued laminated and CLT) wrapped in wood siding. A glass facade also "encapsulates" the building

Overview of mass timber construction in France

Colleges, residential towers, wooden campuses: projects becoming more and more ambitious

Des Alpes aux jardins

- Function: apartments, offices and shops
- Height: 9 floors, 30 m high
- Surface: **8 600 m²**
- Comments: high thermal insulation, renewable energy, positive biodiversity, continuous plant variety, summer comfort, green roofs

Pop up

- Function: Apartments + offices + hotel
- Height: 9 floors
- Surface : 3 586 m²
- Comments: main facade supported by two large wooden stilts. Wood that is also found in the stairwells and elevators, floors and ceilings, and on the roof terrace

La tour commune

- Function: University accommodation
- Height: **15 floors**
- Surface: 5 100 m²
- Comments: The tower is covered with a metal bark discreetly revealing its wooden structure. A visible but unexposed wooden frame

Overview of mass timber construction in France

Colleges, residential towers, wooden campuses: projects becoming more and more ambitious

The Olympic village case

- The specifications for the Olympic Village provide that “all buildings of less than eight floors will be built of wood and taller buildings will be made of mixed materials combining wood”.
- **Of the 280,000 m^2 of the Olympic Village, 200,000 m^2 will have wooden facades and 80,000 m^2 will be wooden structures.**
- The buildings will then be transformed into offices or residential apartments.
- The overall share of wood in the building represents 2/3 in terms of surfaces and ½ in terms of volumes.
- The exoskeleton is made of wood (posts, beams and floors in CLT), as well as the framework of the facades. The latter are however covered with a steel cladding.
- Concrete was chosen for the structure of the core of the building, for reasons of rigidity (bracing constraints), for the base, and for the terraces for sealing problems.
- The first two floors are also entirely made of concrete.

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Hazards and risk management issues related to timber buildings

Hazards and risk management issues related to timber buildings

The major danger of a wooden building:

The Maximum Foreseeable Loss (MFL)

Maximum Foreseeable Loss (MFL)

Collapse of the buillding

Time

Propagation to neighbouring buildings (especially due to the wind force)

Widespread fire outbreak in the building

Excessive deformations dangerous for the safety of people during their evacuation, for the safety of the emergency services during their intervention and for the protection of property when this objective is adopted

Propagation to the entire building through facades

Propagation of the smoke and hot gases through structural voids

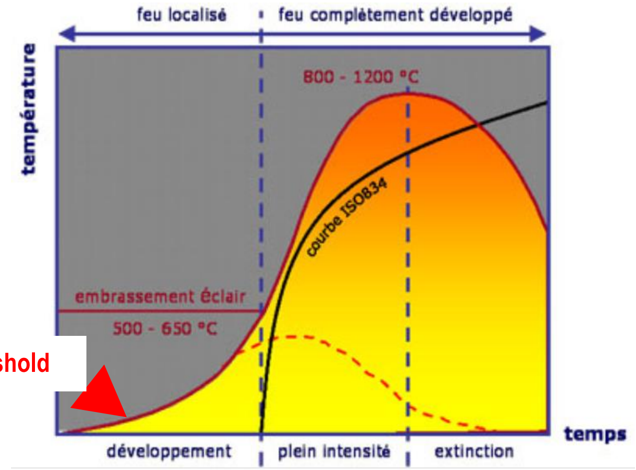
Complexity of the emergency response due to the strong thermal radiation generated by the wood itself

Participation of structural wood in fueling the fire

Fire outbreak

The T° of structural wood exceeds 250°C. That leads to wood pyrolysis

Critical threshold



Hazards and risk management issues related to timber buildings

The major danger of a wooden building:

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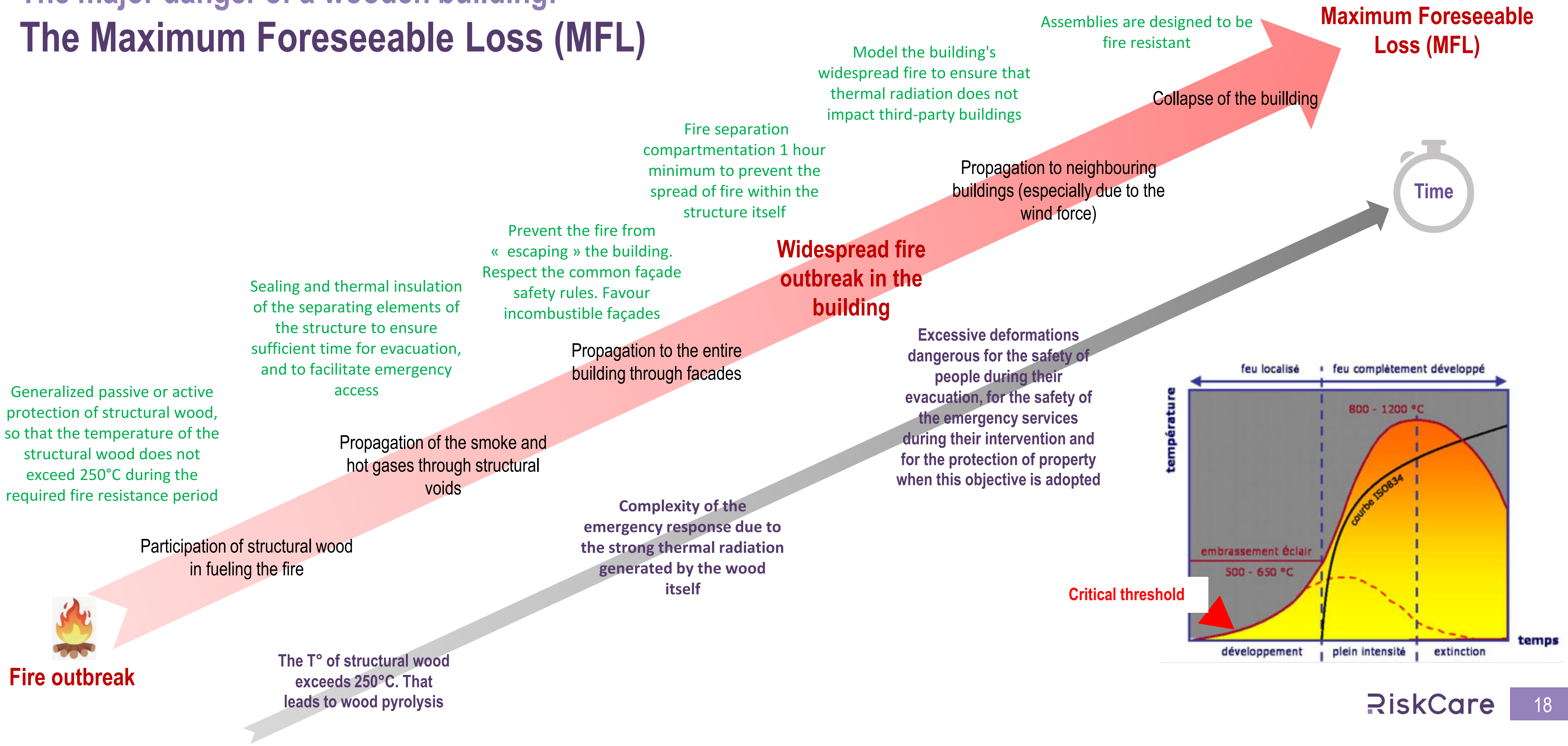
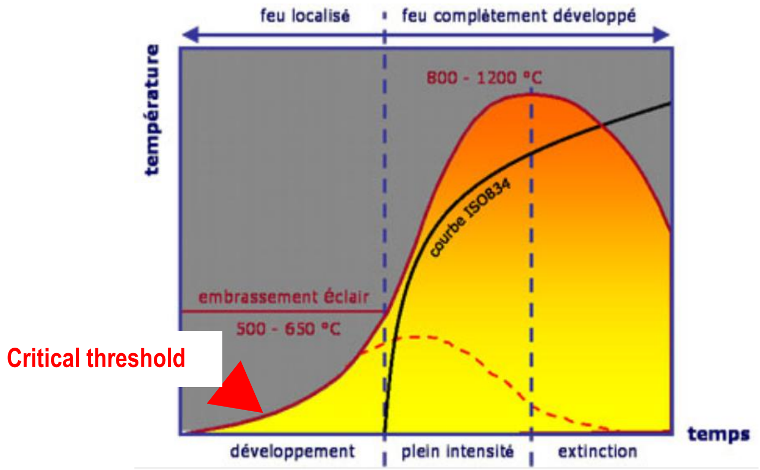


Hazards and risk management issues related to timber buildings

In order to accept the danger: reduce the risks



General protection goals: Fire stability of structures

- Master the **Temperature// Resistance ratio** mechanics to ensure structural stability of the building and to deter its collapse:
  1. Evacuate safely
  2. Facilitate rescue and extinguishing operations
  3. Limit the extent of property damage

2 risk families to master:

- **« Traditional » risks and risks common to all high-rise buildings**
  - Wind force can play an important role in the fire spreading depending on the size and position of the openings
  - Spread of fire through the façade to be controlled according to known protection criteria

- **Specific risks common to mass timber buildings**
  - Participation of structural wood in fueling the fire. This impact is predefined by a heat flux sufficient to lead to the pyrolysis of the wood and auto-ignition of the combustion gases (250°C).
    - Maintain the heat flux below the inflammation threshold values in order to stop auto-ignition: Passive protection of part or all of the wooden structural elements / Active protection of the volumes in which the structural wood is exposed.
  - Propagation of fire through the facade while it is visibly burning:
    - Prevent the fire from « escaping » the building. Active protection of the corner formed by the underside of the balcony and the exterior facade.

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Presentation of the tests of 25/11/2022

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Fire tests with automatic water extinguishing system on a full-scale model wooden structure

3 performance goals established prior to testing:

1. Control the development of a fire outbreak in the presence of exposed structural wood
2. Capacity not to spread the fire
3. Be able to justify these performances for open-space areas with surface over 1000 m².

Presentation of the tests of 25/11/2022

Performance goals achievement criteria (1)

Capacity to control the fire:

➢ Control the development of a fire outbreak in the presence of exposed structural wood

- Qualitative criteria
  1. During the test: extent of combustion area and flame height no longer increase (steady state) during the spraying of the fire-suppression systems
  2. After the test: a part of the stake didn't burn

- Quantitative criteria
  1. During the test: constant ceiling temperatures above the fire less than or equal to the temperature measured just before activation of the fire-suppression system
  2. During the test: heat release rate (mass loss rate) constant or reduced
  3. During the test: ceiling temperatures away from the seat of the fire (3m) constant and less than or equal to the temperature measured just before activation of the AFSS

Presentation of the tests of 25/11/2022

Performance goals achievement criteria (2)

Capacity not to spread the fire:

➢ Ensure limited participation of structural wood with char layer thicknesses no greater than under ISO fire without fire-suppression systems

- Qualitative criteria:
  1. During the test: absence of propagation to targets (cellulose, plastic) located within 1 metre of the fire area during spraying

- Quantitative criteria:
  1. During the test: gas temperatures lower than 200°C within 1,5 m of the fire area during spraying

Presentation of the tests of 25/11/2022

Performance goals achievement criteria (3)

Capacity to limit the contribution of structural wood:

➢ Be able to justify these performances for open-space areas with surface over 1000 m².

- Qualitative criteria:
  1. Charred ceiling surface limited to area above the fire
  2. Charred post surface limited to the post next to the fire

- Qualitative criteria:
  1. Temperatures under the ceiling lower than 250°C outside the fire area
  2. Char layer thickness values below the level expected from the fire under ISO dimensioning at the same point of time

Presentation of the tests of 25/11/2022

Arboretum: the tests fitting in the context with high stakes

- 125 000 m² of offices and services, the largest mass timber campus in Europe
- 5 multi-storey office buildings with a floor surface area of 1000 m².
- Load-bearing structure essentially composed of wooden frame walls, front and interior posts in glued laminated wood and CLT floors.
- 2.7 m centre distance between facade posts, and 5.4 m indoors.
- CLT floors consisting of panels from 180 to 240 mm thick (5 ply).
- Largely glazed facades without lintel of 2 types: Either curtain wall without sill on the gable facade (width 18 m); or wood frame façade on the long sides, with a spandrel of 0.60 m and an opening rate of 60%.

Presentation of the tests of 25/11/2022

Entry data: Penalizing and security conditions

HEATING LOAD AND FIREPLACE:

- Power of around 500MJ/m² (value greater than the load representative of the office risk according to the protocol in appendix A of standard NF EN 14972, as well as the average fire load in offices set by the Eurocodes)
- Surface of 10m² to assess the responsiveness and the ability to control a fire starting with a high surface power
- Rapid development kinetics to quickly solicit the wooden structural elements adjacent to the hearth in order to make them contribute
- 9 MW peak expected after 3-4 minutes
- Duration of the focus without sprinklers = 20 min

LOCALISATION OF THE TEST ZONES:

- Successive positioning at the foot of the post, and between the posts
- Successive ignition in the corner or on the front side

VENTILATION CONDITIONS:

- Openings of the bays at the start of the fire to take into account this real situation, which is unfavorable to the activation of the sprinkler heads
- Closing after activation of the AFSS to foster the confinement of hot gases and the ignition of the wood
- Forced ventilation: installation of 2 diffusers injecting air at 1 m/s under the plenum towards the facade with bay windows, in order to recreate real and unfavorable conditions for the activation of the spray heads/nozzles

Presentation of the tests of 25/11/2022

Model and instruments

- **Monitoring of the fire**
  - Continuous weighing of the fire package
  - Temperature above the fire
  - Propagation
  - Targets (wood/plastic)
  - Room temperature

- **Limitation of fire contribution**
  - Ceiling temperature
  - Thickness of carbonisation

- **Extinguishing system**
  - Temperature of nozzles/sprinkler heads
  - Mains water flow (L/min et m3)
  - Incoming water metre (m3)
  - Mains pressure

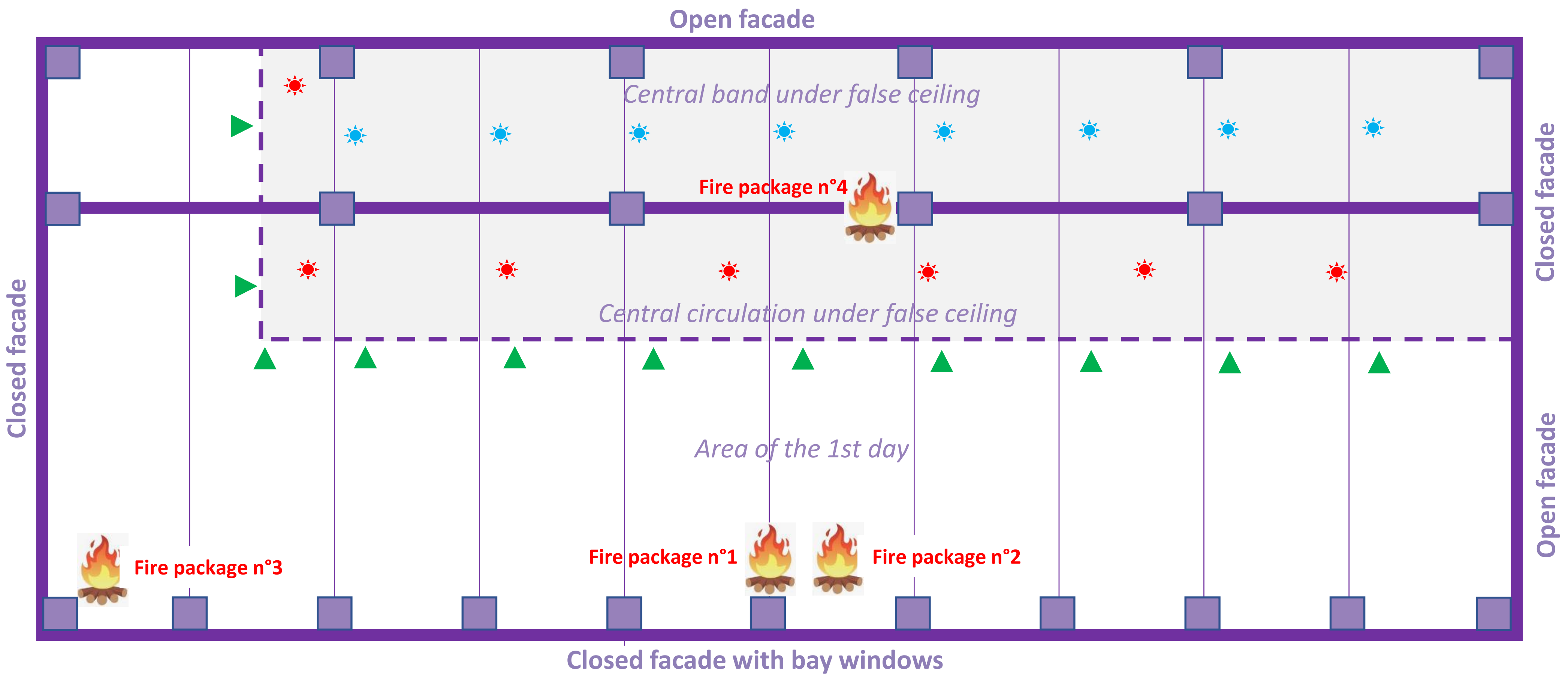
Presentation of the tests of 25/11/2022

Model blueprint and the fire package characteristics

Layout
- Surface area from 4 to 9m²
- 10 beds of 13 to 20 wooden cleats

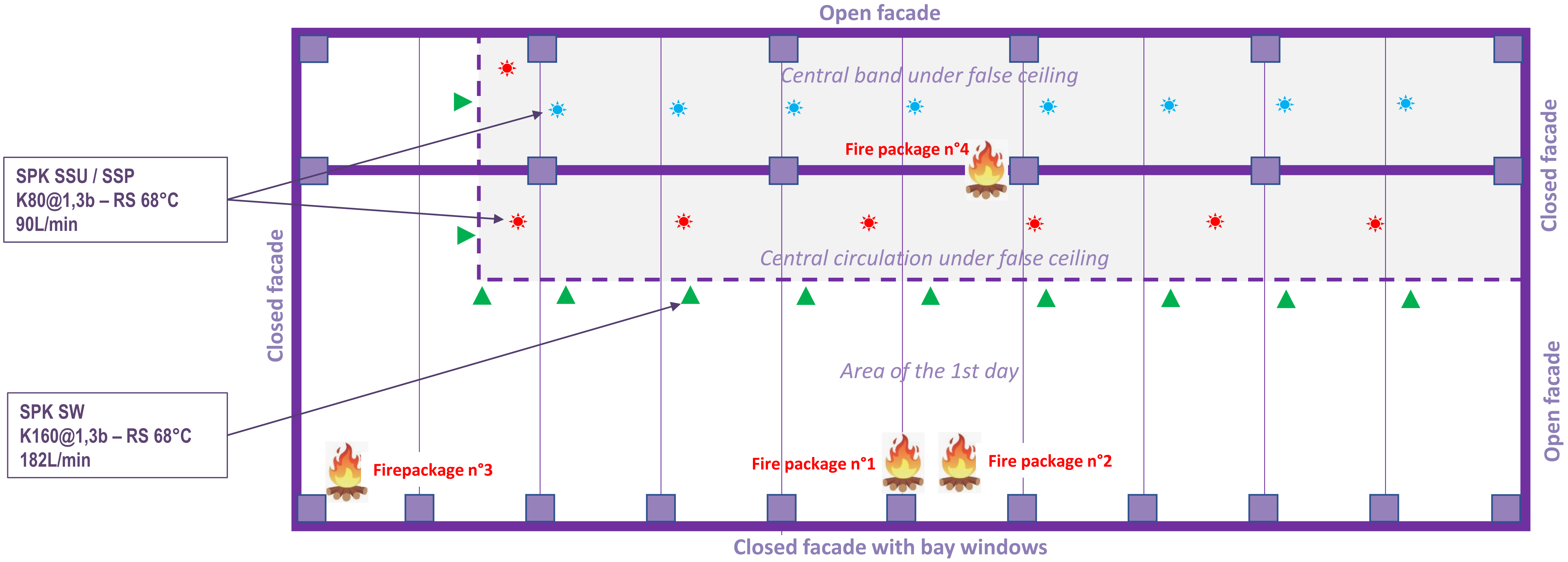
Heating load
- 130 to 270kg of wood
- 450 to 550MJ/m²

Ignition
- 3 bowls of 50cl of heptane
- 1 bed of wood fiber panels soaked in white spirit
- 20cl diesel spray



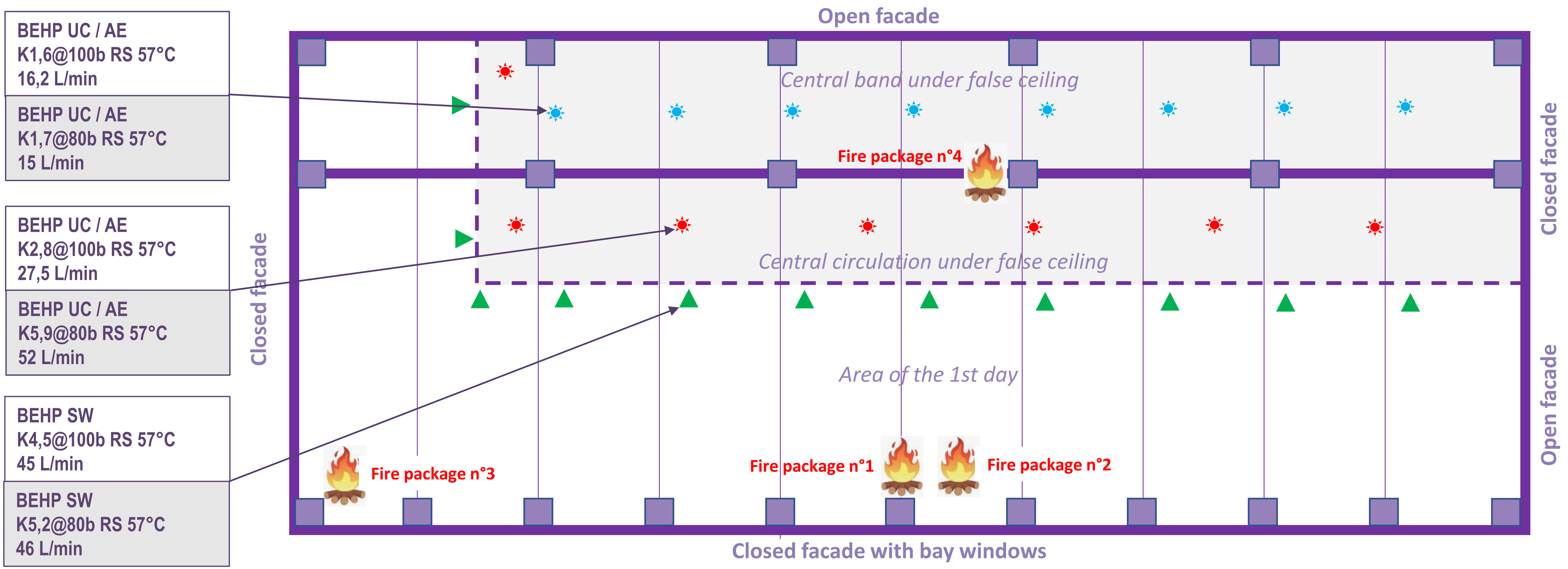
Presentation of the tests of 25/11/2022

Model blueprint and sprinkler heads characteristics: sprinkler option



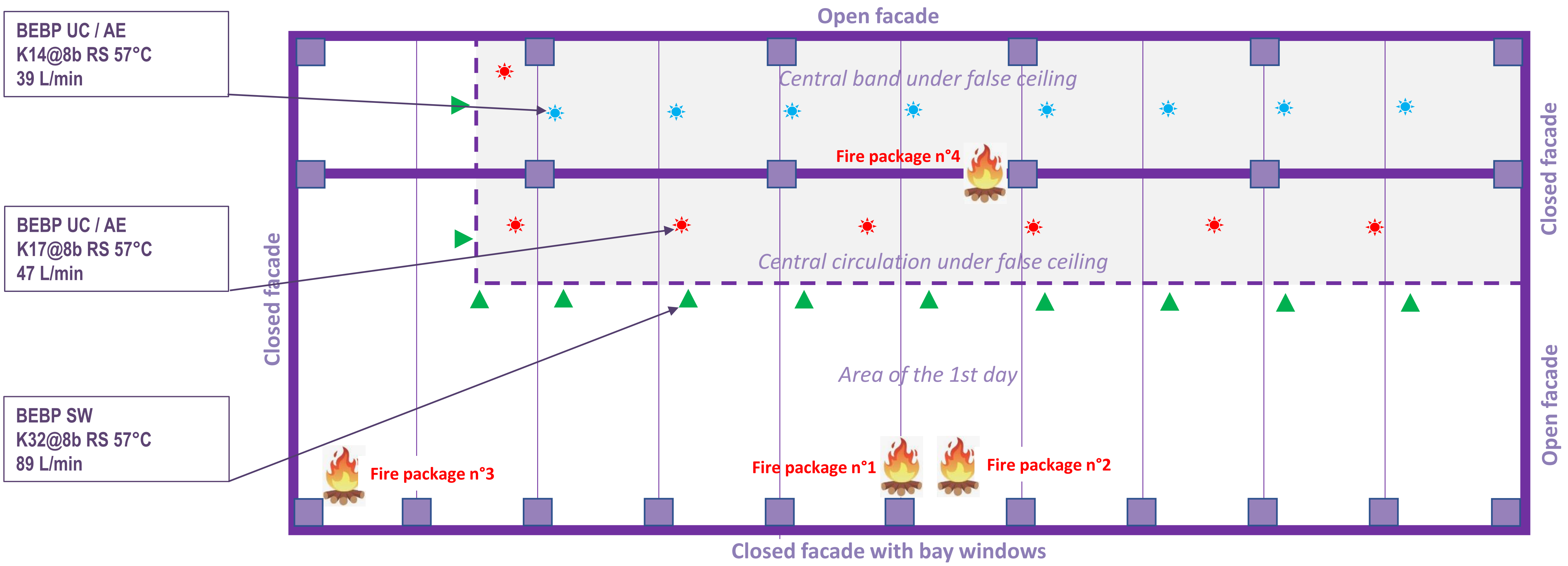
Presentation of the tests of 25/11/2022

Model blueprint and Hi-Fog nozzles characteristics: the 2 options of High Pressure Water Mist system



Presentation of the tests of 25/11/2022

Model blueprint and Low-Fog nozzles characteristics: Low Pressure Water Mist system option



Presentation of the tests of 25/11/2022

Tested systems demonstrating extremely promising results

Number of activated sprinkler heads:

- Between 2 *(HPWM, SPK) and* 8 *(BEHP)*

Covered surface area:

- Between 40 *(HPWM) and* 160m² *(HPWM)*

Activation time:

- Between 22 sec *(LPWM) and*114 sec *(SPK)*

Surface flow:

- Between 1,5 mm/min *(HPWM) and* 9,2mm/min *(SPK)*

SEAE	Taux d'applicatoin [L/min/m²]				Essai	Nombre de têtes déclenchées			Surface de couverture [m²]	Temps de déclenchement de la première tête [sec]	Débit surfacique [L/min/m²]
	Circulation	Bande centrale	1er jour 2,7m	1er jour 5,4m		SideWall	Pendante	Up			
Danfoss - Brouillard d'eau Haute Pression	3.4	2.5	3.0	1.5	1er jour - Entraxe 2,7m	4	0	0	66.6	91	2.7
					1er jour - Entraxe 5,4m	4	1	3	157.86	60	1.6
					Extrémité de plateau	2	0	0	48.1	81	1.9
					Bande centrale	2	5	0	90.4	39	2.5
Axima - Sprinkler	13.0	8.3	12.2	6.1	1er jour - Entraxe 2,7m	4	0	0	96.3	67	7.6
					1er jour - Entraxe 5,4m	2	0	0	51.7	86	7.0
					Extrémité de plateau	2	0	2	67.2	114	8.1
					Bande centrale	2	5	0	88.1	55	9.2
VID Firekill - Brouillard d'eau Basse Pression	7.0	4.4	7.4	3.7	1er jour - Entraxe 2,7m	5	0	1	97.4	94	5.0
					1er jour - Entraxe 5,4m	4	0	1	127.1	71	3.1
					Extrémité de plateau	4	2	0	83.7	22	5.4
					Bande centrale	1	5	0	74.1	31	4.4
Marioff - Brouillard d'eau Haute Pression	6.5	4.9	3.1	1.6	1er jour - Entraxe 2,7m	3	0	0	51.7	68	2.7
					1er jour - Entraxe 5,4m	4	0	2	143.1	42	1.5
					Extrémité de plateau	2	0	0	40.6	39	2.3
					Bande centrale	0	3	0	43.4	37	3.6

Ref.:
HPWM – High Pressure Water Mist
SPK – Sprinkler
LPWM – Low Pressure Water Mist

Presentation of the tests of 25/11/2022

Summary of the goals achieved

Goal	Achievement criteria	Axima Sprinkler	Danfoss Brouillard d'eau Haute Pression	Marioff Brouillard d'eau Haute Pression	VID Firekill Brouillard d'eau Basse Pression
Capacity to control fire outbreaks:	Extent of fire and flame height no longer increase (steady state) during the spraying of the AFSS	✔	✔	✔	✔
	The fire package does not burn completely	✔	✔	✔	✔
	Constant ceiling temperature above the fire less than or equal to the temperature measured just before activation of the AFSS Likewise for ceiling temperatures away from the fireplace (3m)	✔	✔	✔	✔
	Heat release rate (mass loss rate) constant or reduced	✔	✔	✔	✔
Capacity not to spread the fire:	Absence of propagation to targets (cellulose, plastic) located within 1 metre of the fire area during spraying	✔	✔	✔	✔
	Gas temperatures lower than 200°C within 1,5 m of the fire area during spraying	✔	✔	✔	✔
Capacity to limit the contribution of structural wood:	Charred ceiling surface limited to fire area	✔	✔	✔	✔
	Charred posts surface limited solely to the post next to the fire	✔	✔	✔	✔
	Temperatures under the ceiling lower than 250°C outside the fire area	✔	✔	✔	✔
	Char layer thickness values below the level expected from the fire under ISO dimensioning at the same point of time	✔	✔	✔	✔

Conclusions and outlook

Conclusions and outlook

Scenario-based approach to challenge the tests

Fire kinetics

Fire spreading	Obstacles that will slow down the heat spreading	Combustible load of the facades	Combustible load of goods and storage areas	Combustible load distribution
Hypothesis of an electrical fire outbreak => Traces of beading on the office electrical conductors causing an ignition point on the electrical installations Fire spread to other combustible materials in the room (chairs, tables, etc.).	The office floors are compartmentalized CF 1h. Action of the AFSS which makes it possible to prevent the ignition of walls, high and low interior floors. Construction CLT = 5 plies of which the 1st has a thickness of 40mm. Fire penetration tests excluding AFSS action = 0.7mm/min => to reach the second layer: 57 minutes.	Low since the steel is galvanized. Insulation: rock wool (euroclass A1); lighter in CLT.	Interior materials and office furniture can assist propoagation of the fire. Anticipated action of AFSS has shown that the target samples were not impacted by the thermal radiation of the initial fire seat.	The combustible load is equally distributed over the entirety of the compartment. No effective fuel cut is possible.

Time: T+22 to114 seconds → T+4 minutes → T+13 to 15 minutes → T+23 to 30 minutes

Applied technics

Time to identify the fire outbreak	Alert transmission / Alert processing	Emergency services arrival / Scenario assessment and emergency services introduction	Beginning of intervention / Fire extinguishing operations
Detection made possible thanks to the automatic extinguishing system.	Fire alarm is transmitted to the telemonitor which calls the on-call manager, with a subsequent call for help.	The nearest fire station is 2 km away. Its journey time is 9 minutes.	The environment of the compartment being cooled by the AFSS, the emergency services are not hampered in their recognition and the setting up of their intervention. The hoses are put in place to avoid spreading to adjoining compartments. Rescuers are finalizing the extinguishing of the fire.

Conclusions and outlook

Some of the full-scale tests: referenced in scientific literature

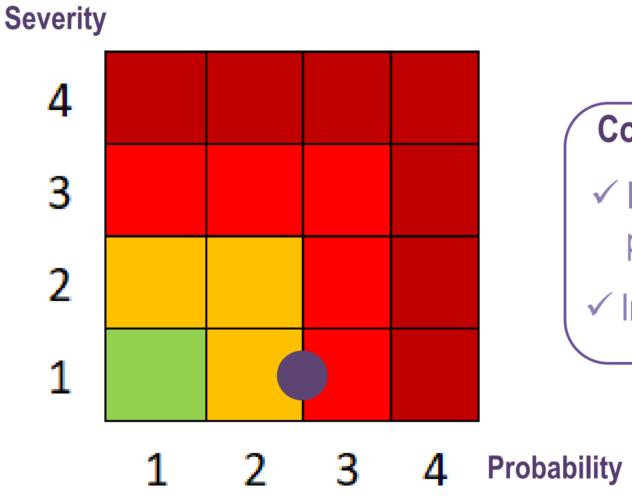
Efficacy of water mist and sprinkler in the event of a vehicle fire in the underground parking lot (2015)	Exposure to fire smoke by firefighters (2021)	Tests and modeling of several sprinkler activation systems in corridors (2015)
If the 2 systems proved to be efficient to contain the fire, the extinction of the fire was obtained only by the water mist at the highest flow rate. It is explained by a greater penetration of hot gases allowing to reach hot surfaces and to cool the flames.	According to the study, the use of traditional means of fire extinguishing results in a significantly higher risk of cancer with an occurrence rate of 13 / 1 000 000 cases. The protective effect of the water mist helps to reduce the excessive risk of cancer to under 2,6 /1 000 000 cases.	The sprinkler and the high-pressure water mist both generated mixed and thermally fairly homogeneous media for respective spray flow rates of 91 L/min and 27.5 L/min. Sprinkler cooling caused a drop in temperature to 28 ◦C under 1.5 m upstream of the head and in the entire corridor downstream, whereas the temperature before spraying was on average above 70 ◦C. The temperature dropped below 40 ◦C for the high pressure water mist. In addition, the radiation attenuation study showed the effectiveness of fog in reducing radiative transmission from a source to a target.
Full-Scale Experiments of Fire Control and Suppression in Enclosed Car Parks: A Comparison Between Sprinkler and Water-Mist Systems, Paolo E. Santangelo and Paolo Tartarini, Dipartimento di Ingegneria "Enzo Ferrari", Universita` degli Studi di Modena e Reggio Emilia, Via P. Vivarelli 10, 41125 Modena, Italy, Paolo E. Santangelo, Department of Fire Protection Engineering, University of Maryland, 3106 J.M. Patterson Building, College Park, MD 20742, USA, 26 May 2015*	*Dirand, F. Rieunier, F. Testa, L. Temime. Évaluation des bénéfices potentiels liés à l'utilisation d'un brouillard d'eau basse pression dans la lutte contre les incendies chez les sapeurs-pompiers de Paris, à partir d'une évaluation quantitative des risques. Archives des Maladies Professionnelles et de L'Environnement, Elsevier Masson, 2021, 82 (6), pp.601-613. ⟨10.1016/j.admp.2021.07.007⟩. ⟨hal-03615121⟩*	*Romain Morlon. Stratification thermique et optique d'un environnement enfumé et interactions eau/fumée sous aspersion. Autre. Université de Lorraine, 2015. Français. ⟨NNT : 2015LORR0138⟩. ⟨tel-01751966⟩*

These 3 tests support the performance approach evaluated on 25/11/2022

Conclusions and outlook

Objective criteria to qualify risk exposure on the defined objectives

Probability	Comments
1	Presence of hazards. Organizational and technical barriers are put in place. These barriers are regularly tested
2	Presence of hazards. Organizational and technical barriers are put in place. These barriers are not tested
3	Presence of hazards. The barriers put in place against these dangers are partial
4	Presence of hazards. No barriers against these dangers are put in place



Conclusion

- ✓ In terms of probability control, the uncertainty regarding the probable hazard fluctuates between levels 2 and 3
- ✓ In terms of severity control, the objectives are achieved

Severity	Human safety	Emergency services safety	Property damage level
1	No injuries or deaths	Emergency services can protect people, the environment and property	Claim cost < 5M€
2	A few minor injuries	Emergency services can only protect people and the environment	5M€ < Claim cost < 10M€
3	Several serious injuries	Emergency services can only protect people	10M€ < Claim cost < 50M€
4	Death of 1 or more people	Emergency services can't protect anything	50M€ < Claim cost

Conclusions and outlook

Results meeting the required expectations

Option	Human and social consequences	Environmental consequences	Economic consequences	Goal
Axima Sprinkler	□□□□□□	■□□□□□	■□□□□□	Achieved
Danfoss High Pressure Water Mist	□□□□□□	■□□□□□	■□□□□□	Achieved
Marioff High Pressure Water Mist	□□□□□□	■□□□□□	■□□□□□	Achieved
VID Firekill Low Pressure Water Mist	□□□□□□	■□□□□□	■□□□□□	Achieved

Selon l'échelle européenne simplifiée des accidents potentiellement majeurs :

https://www.aria.developpement-durable.gouv.fr/wp-content/uploads/2022/07/Echelle_europeenne_simplifiee.pdf

Conclusions and outlook

Some further ideas to consider

1. **The primary objective is the cooling of the atmosphere in order to avoid wood contribution:**
   - What minimum water density is required to meet this objective?
   - Is it relevant to consider a hydraulic dimensioning on a real compartment surface, rather than on a theoretical involved surface?
   - Is it possible to view the sprinkler in the context of a volumetric approach in addition to the surface approach?

2. **Which subsequent evolutions should be referenced in technical systems?**
   - To date, none of the references or standards regarding the automatic protection of wooden structural elements are applied

3. **Control over severity and, thus, financial engagements are entirely based on the early detection and spraying:**
   - How to ensure the right availability rate of installations?
   - What are the connected tools that should be used to better anticipate system maintenance and to minimise breakdowns?

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Appendix

Sources and photo credits

- Bois.com
- Boismag.com
- Leboisinternational.com
- Les échos
- AB Engineering
- Ecologie.gouv.fr
- Bâtiments bois de moyenne et grande hauteur > 28 m _ Préconisations pour la sécurité en cas d'incendie pour les immeubles bois prévus dans le cadre des prochains JOP de Paris en 2024
- Doctrine pour la construction des immeubles en matériaux biosourcés et combustibles

Thank you for your attention!

For any further information, please contact : marc.espieux@riskcare.eu

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