COST ACTION FP1303

HYGROTHERMAL PERFORMANCE OF BUILDINGS AND THEIR MATERIALS

POZNAN, August30 th – 31 st 2016

THERMAL PERFORMANCE WOODEN WINDOWS DEMAGED BY DECAY / case study/

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Window: Functional requirements

ARCHITECTURAL: the shape, color, design, ...

DAYLIGHT

THERMAL INSULATION (EN 10077-1, EN ISO 10077-2)

* during winter. Heat transmission - U_w (heat transmission coefficients of the glass U_g and of the frame U_f) heat transmission coefficient Ψ_G/ Airtightness joint permeability coefficient a.

* during summer: solar heat gain coefficient of the pane.

SOUND INSULATION: Airborne sound insulation (ISO 140)

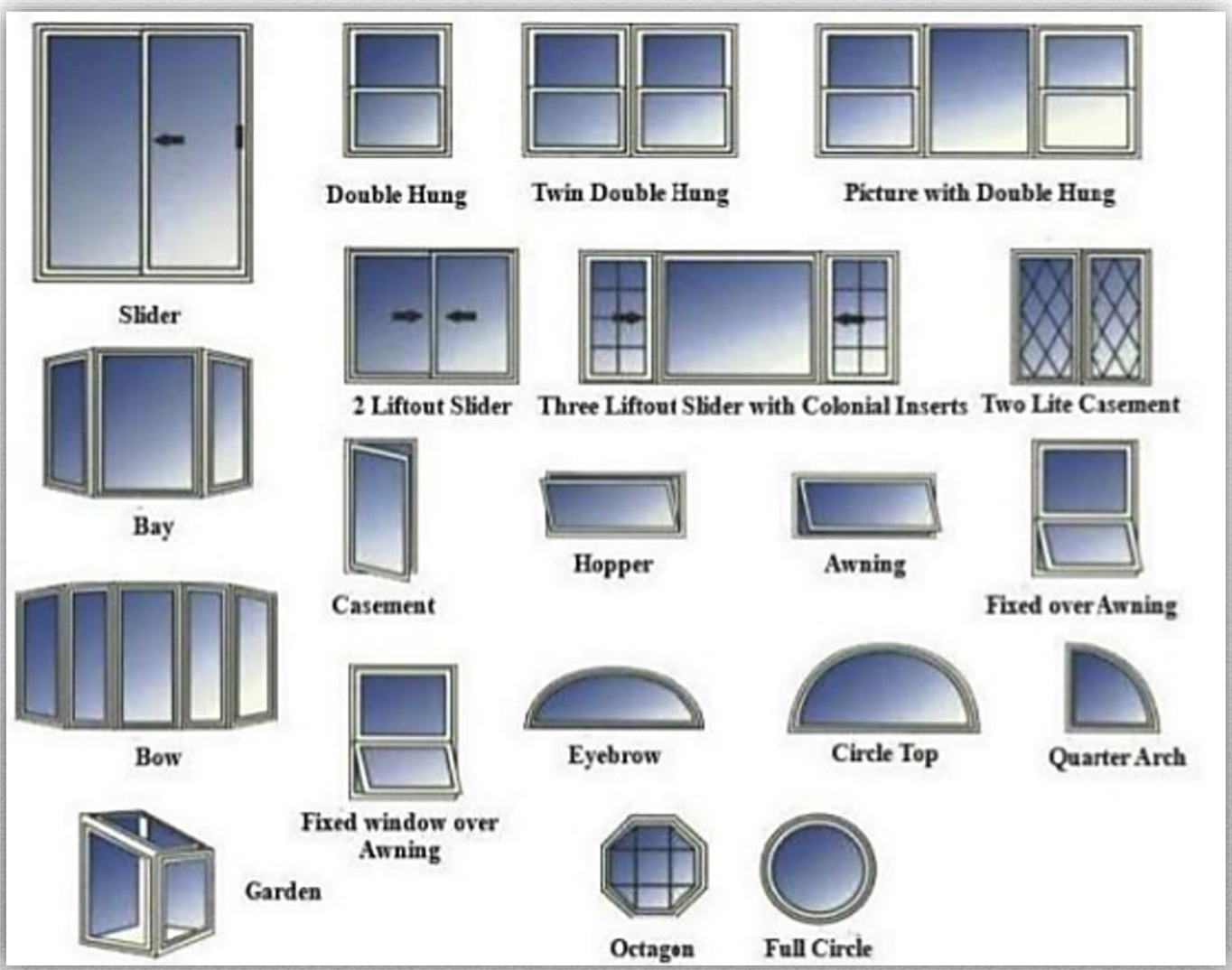
PROTECTION AGAINST THE WEATHER: Resistance to wind load (EN 12210) / Tightness against driving rain (EN 12208)

VENTILATION: Air permeability (EN 12207)

FIRE SAFETY

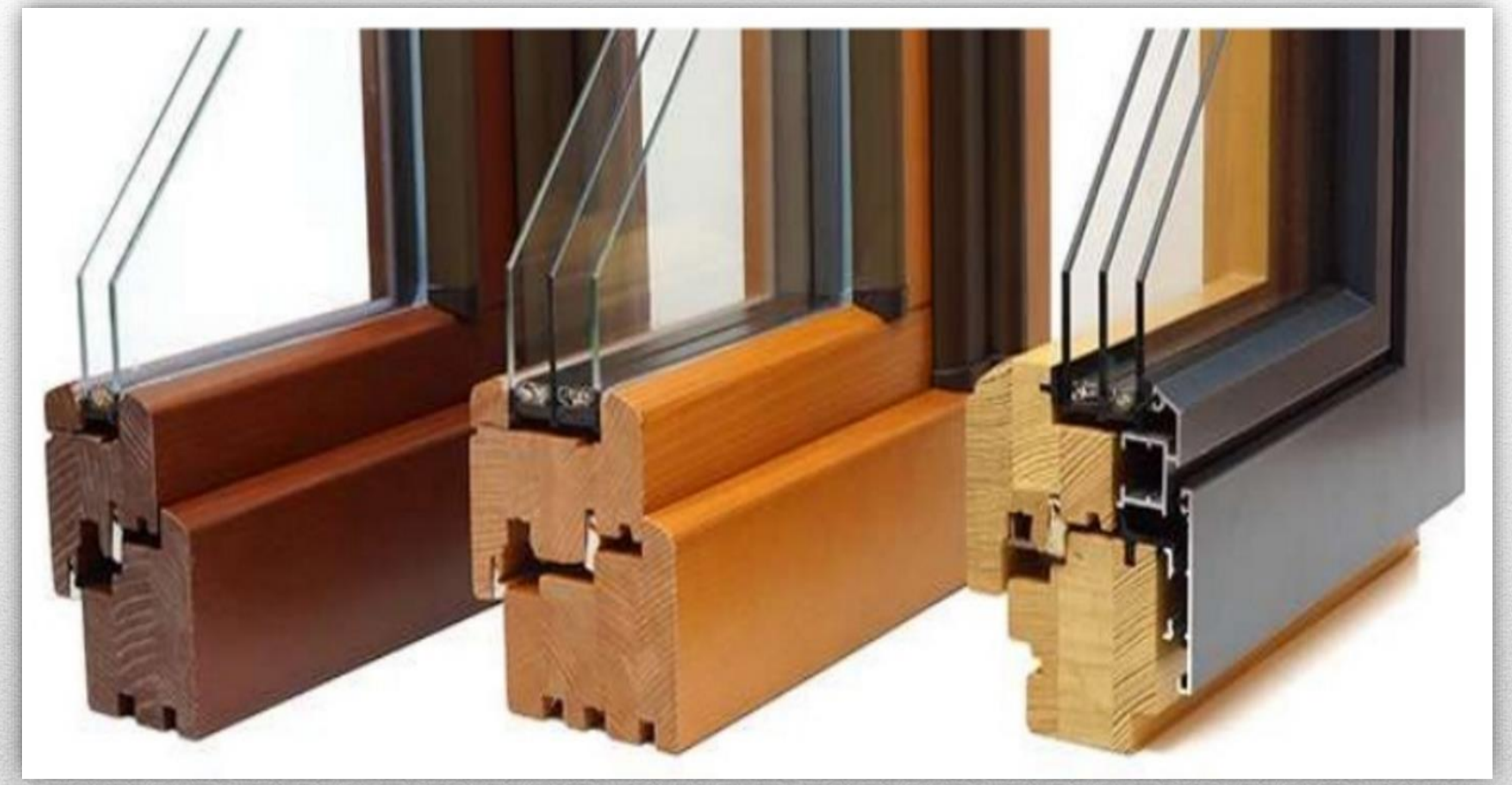
SECURITY: protection of the human being during the usage protection against theft or direct attacks.

Windows are available in a variety of shapes, sizes and materials.



Identifying Window Types

Windows are available in a variety of shapes, sizes and materials.



Wood, Vinil, Aluminium, Fibreglass and Composite

Windows Material Options

Windows Styles

Wood Windows

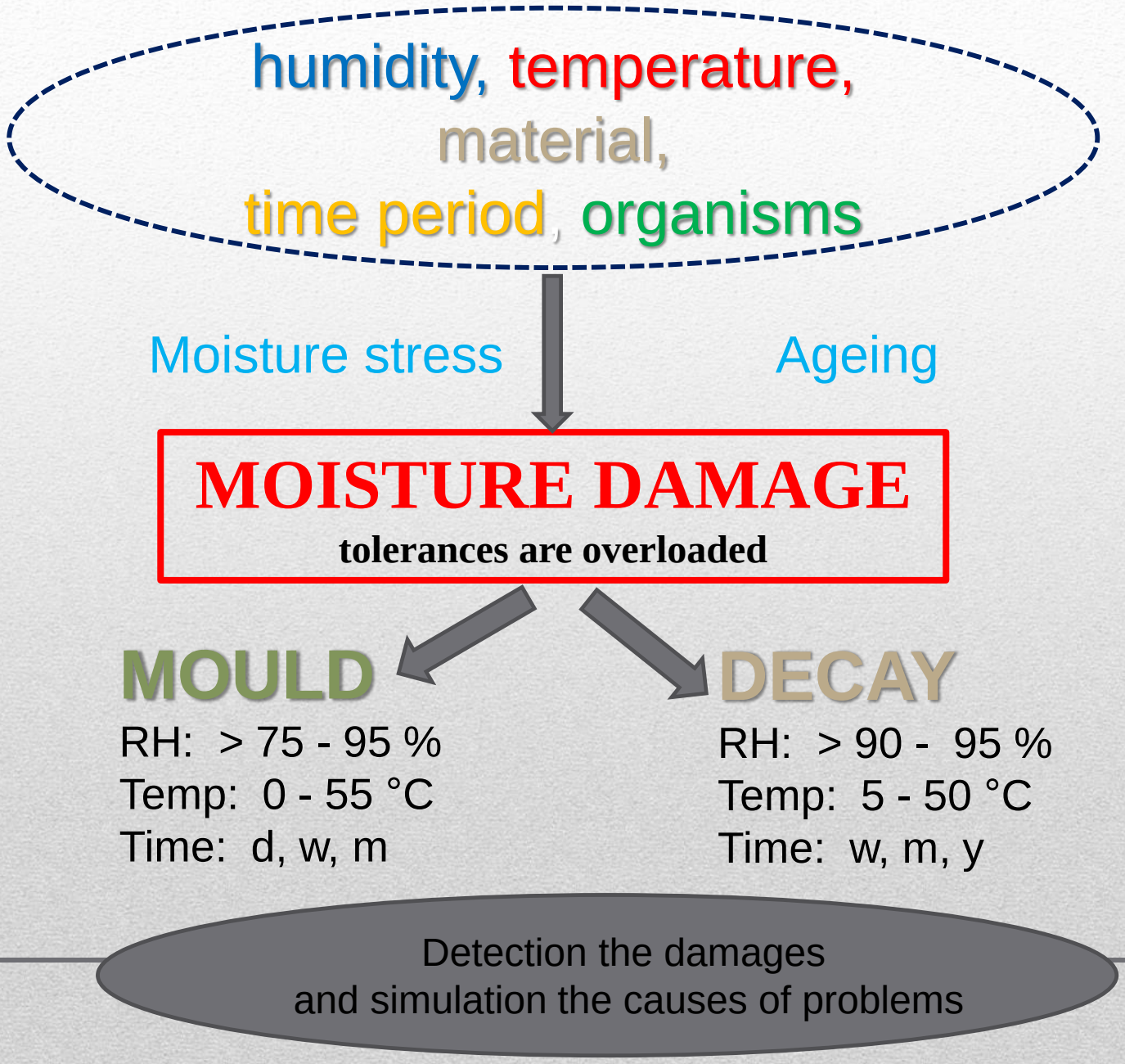
(softwood or hardwood),

Aluminium Windows

PVC Windows

Fiberglass windows

Most modern glazing is double glazing


humidity, temperature,
material,
time period, organisms
Moisture stress
Ageing
MOISTURE DAMAGE
tolerances are overloaded
MOULD
RH: > 75 - 95 %
Temp: 0 - 55 °C
Time: d, w, m
DECAY
RH: > 90 - 95 %
Temp: 5 - 50 °C
Time: w, m, y
Detection the damages
and simulation the causes of problems

WOODEN Windows – surrounding environment

INTERIOR / INDOOR CLIMATE

for standard living rooms:

Air relative humidity: 35-55%

Temperature: 18-22 °C

for bathrooms, swimming pools, wellness, saunas:

Air relative humidity: 60-99%

Temperature: 24-28 ° C

EXTERIOR / WEATHERING CLIMATE

variable, different intensive and combined factors

- Solar radiation
- Change in temperature
- Water incl. changes in humidity, rainfall, icing and hail
- Wind incl. flow of liquid and gaseous media
- Air dust
- Pollutants - gaseous and biological

WOODEN Windows – wood & EN 335

INTERIOR / INDOOR CLIMATE

Hazard Class 1

for units exposed inside no contact with ground, under a shalter

window

EXTERIOR / WEATHERING CLIMATE

Hazard Class 3

for units exposed outside above ground with out a shalter

on the exterior side

weathering of coating

on the interior side

moisture condensation

mould grow

decay

WOODEN Windows – DETERIORATION

WOODEN Windows – DURABILTY & PROTECTION

- STRUCTURAL PROTECTION

Timber quality (solid / laminated timber)

– Seasoned to a consistent MC=12 ± 2%

– Durable species – Pine, Quercus, Douglas fir, Meranti, Cedar, ... or Modified wood

Woodworking of friezes

– round and sloped

– sills include a drip, eaves and drainage groove

Aluminium (frame, wing) drip

- CHEMICAL PROTECTION

Preservative chemicals – type, its penetration and retention

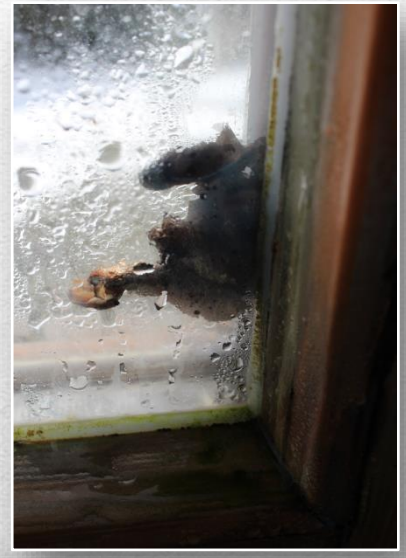
Finishing – quality of the coatings, care taken in application and ongoing maintenance regime

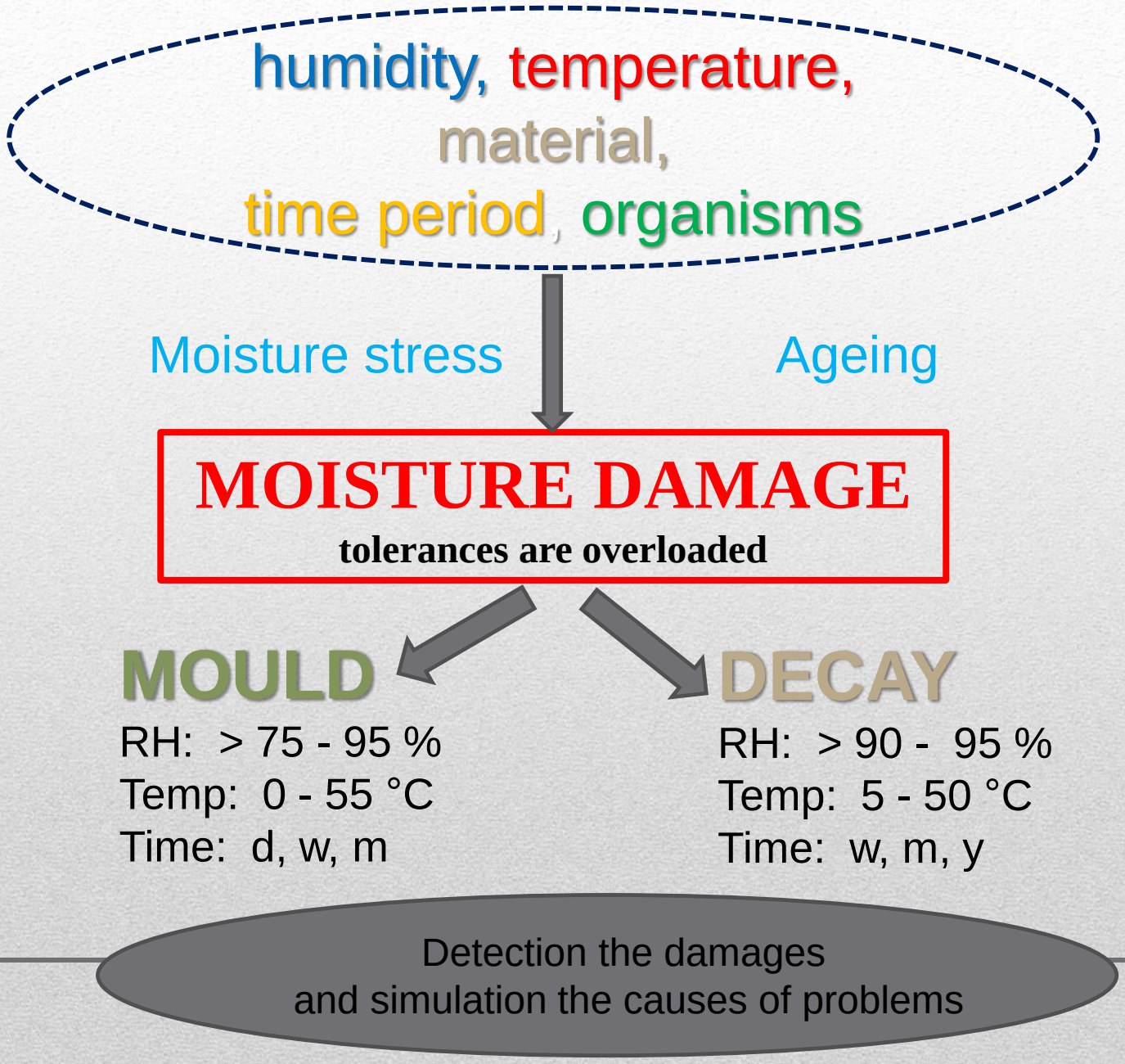
WOODEN Windows – DURABILTY & PROTECTION

Probable heartwood life expectancy (years)		
Natural durability class	**Hazard class 1 Fully protected from the weather**	**Hazard class 3 Above ground exposed to the weather**
Class 1 (highly durable)	50+	40+
Class 2 (durable)	50+	15–40
Class 3 (moderately durable)	50+	7–15
Class 4 (non-durable)	50+	0–7

9 years old wooden windows in wellness

Tatranská Polianka (Slovakia)

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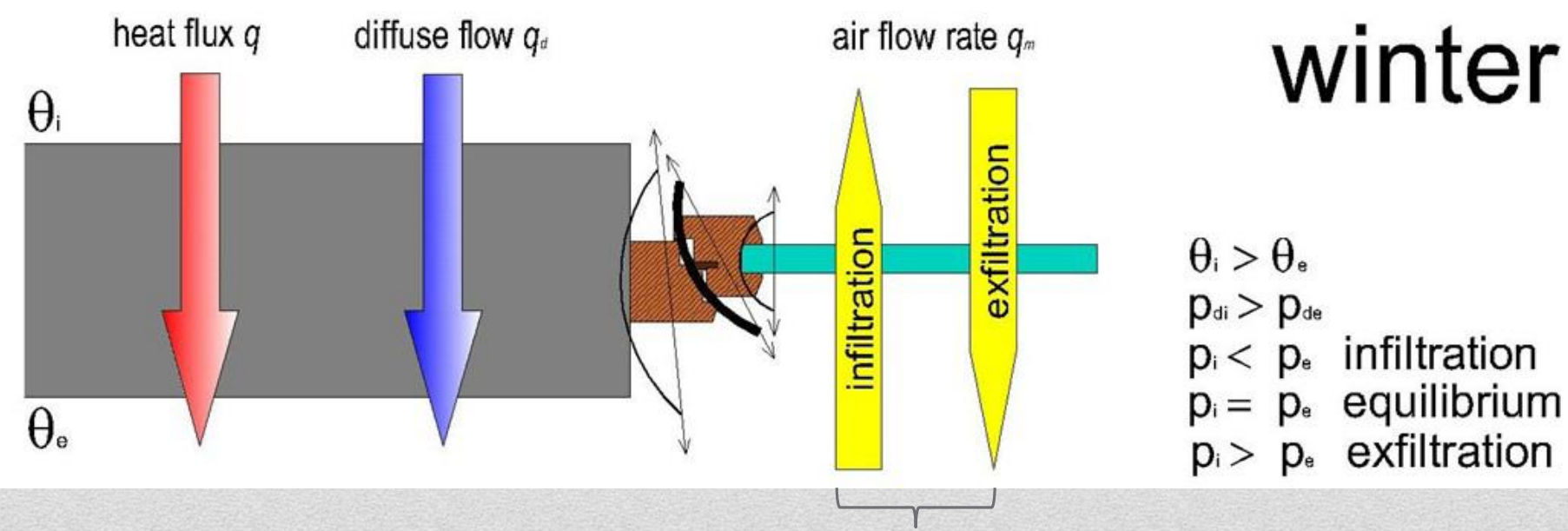
and simulation the causes of problems

A) MOISTURE TRANSPORT ↔ condensation

Through gap between casement and frame at condensation temperature



Air pressure differences

taking water vapour

A)MOISTURE TRANSPORT ↔ condensation

Diffusion of water vapour – different saturation of water vapour in exterior and interior

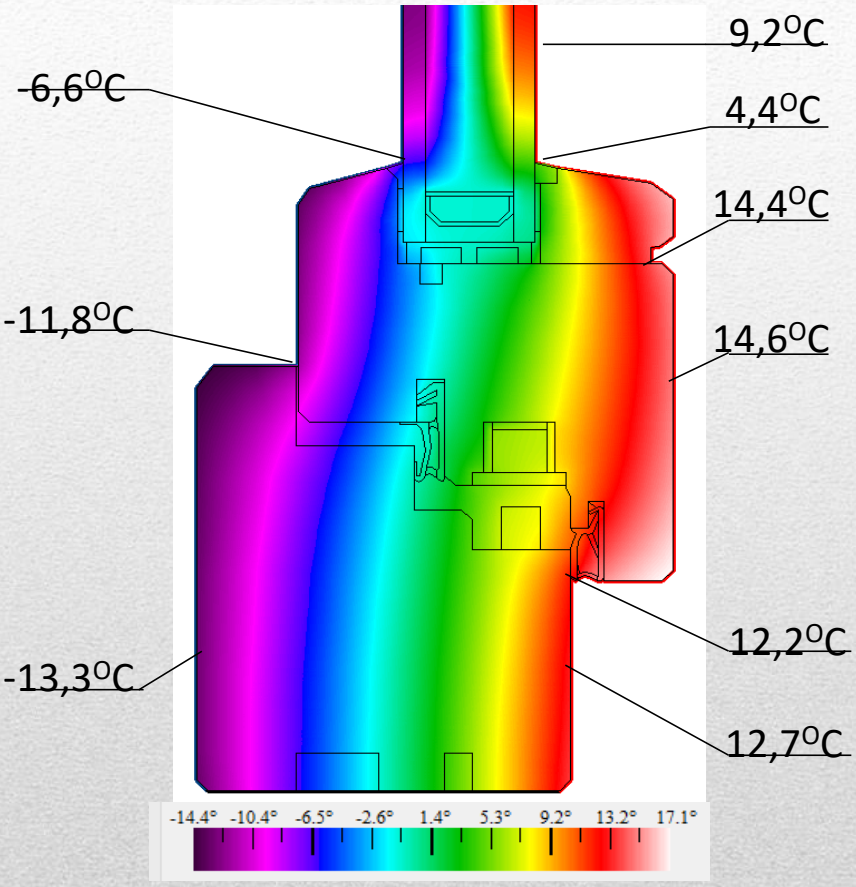
Contain of water vapour

20 °C ⇒ 17.25 $g.m^{-3}$

-15°C ⇒ 1.99 $g.m^{-3}$

Interactive accumulation
of infiltration or exfiltration and diffusion of
water vapour leads to **condensate**
or ice coating
in winter period.

A)HEAT TRANSPORT ↔ condensation



	Window A	Window B
Material	Spruce – laminated wood	
Thick of wooden frame [mm]	68	78
Glazing	double	triple
Heat transmission coefficients of the glass U_G [W/(m².K)]	1.3	0.9
Leak under beading	no	yes

CONDITIONS:

bathrooms, swimming pools, wellness, saunas

Interior: Temperature - T_{IN} = 24 - 28 °C,

Air relative humidity - RH = 30 - 60 -99 %

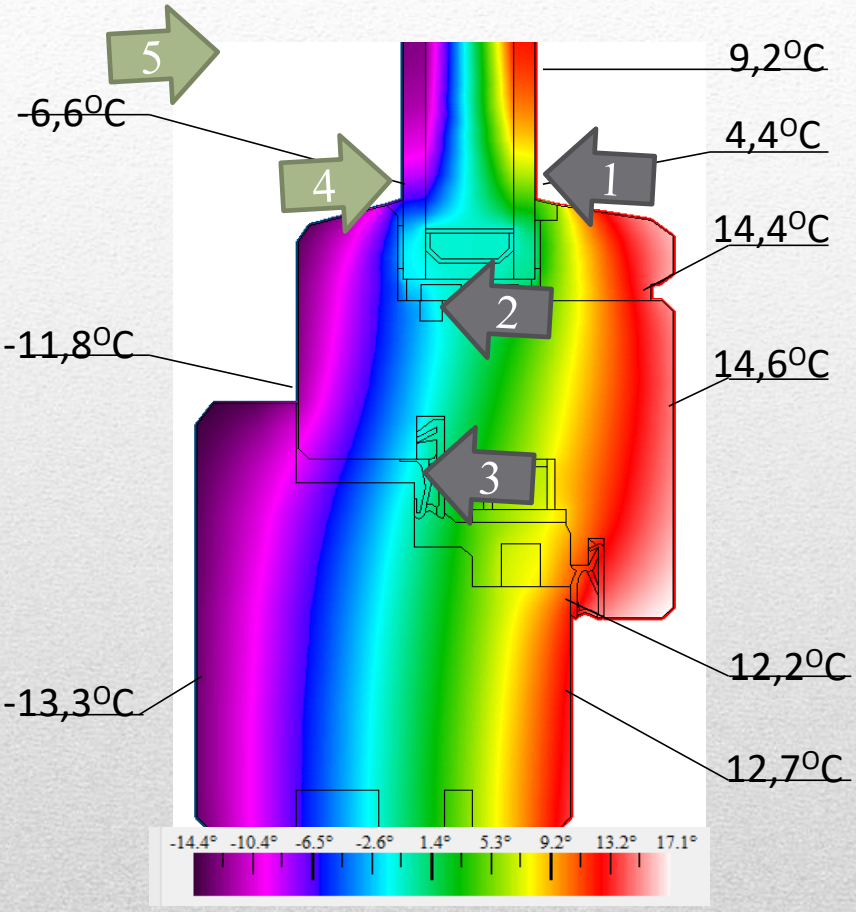
constant and repeated high RH !!!

Exterior: Temperature - T_{EX} = -15 °C

Illustration of the heat flow and surface temperature / software THERM 7.2.7, EN ISO 10077/

Boundary conditions: *Interior:* T_i *= 20 °C Exterior: T = -15 °C*

Window A – *used in welness*



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Condensation occurring in:

1. **indoor glazing condensation**
2. **glazing joint condensation**
3. **functional gap condensation**
4. **external glazing condensation**
5. **supplementary elements condensation (shutters)**

Illustration of the heat flow and surface temperature / software THERM 7.2.7, EN ISO 10077/

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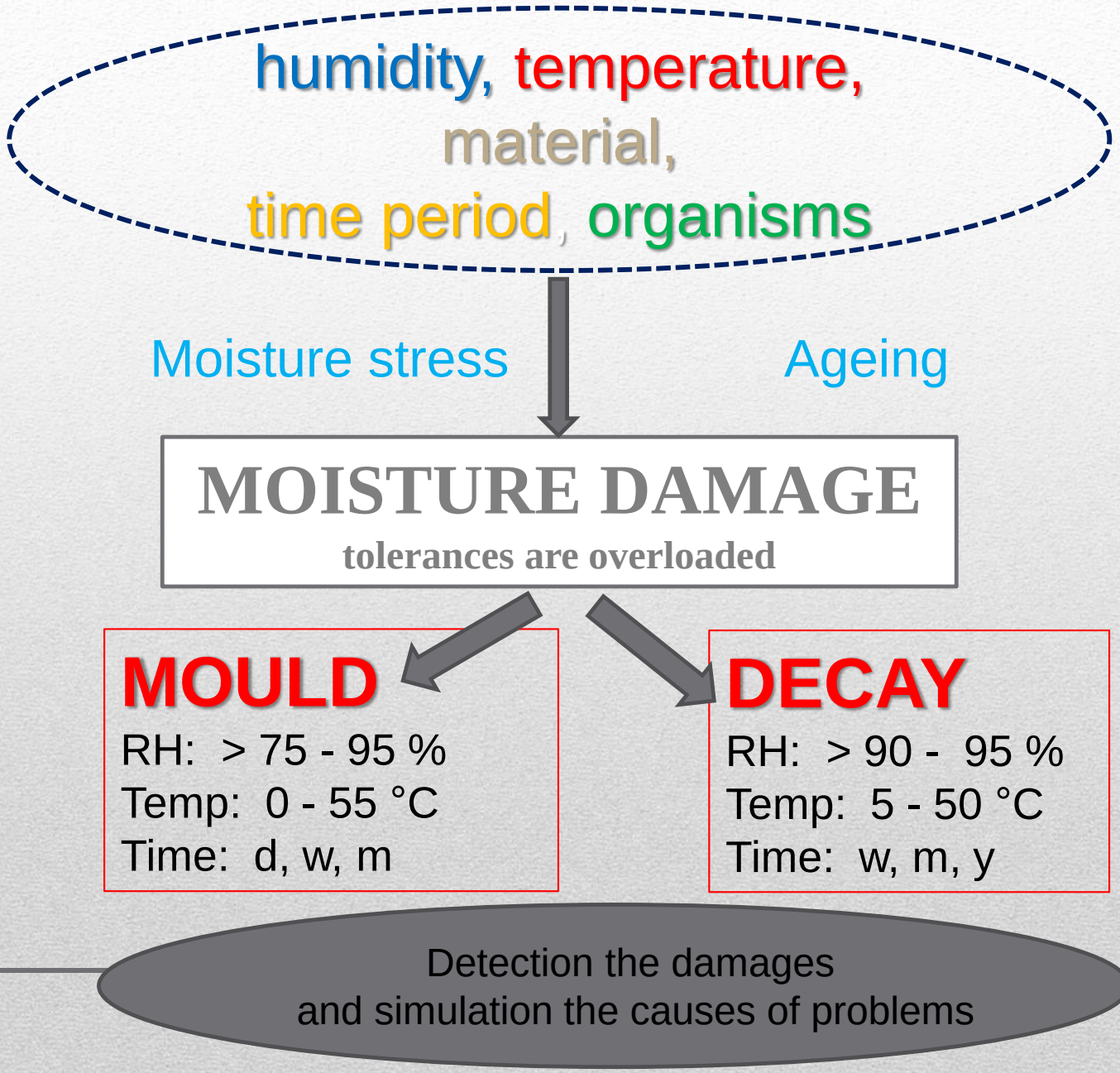
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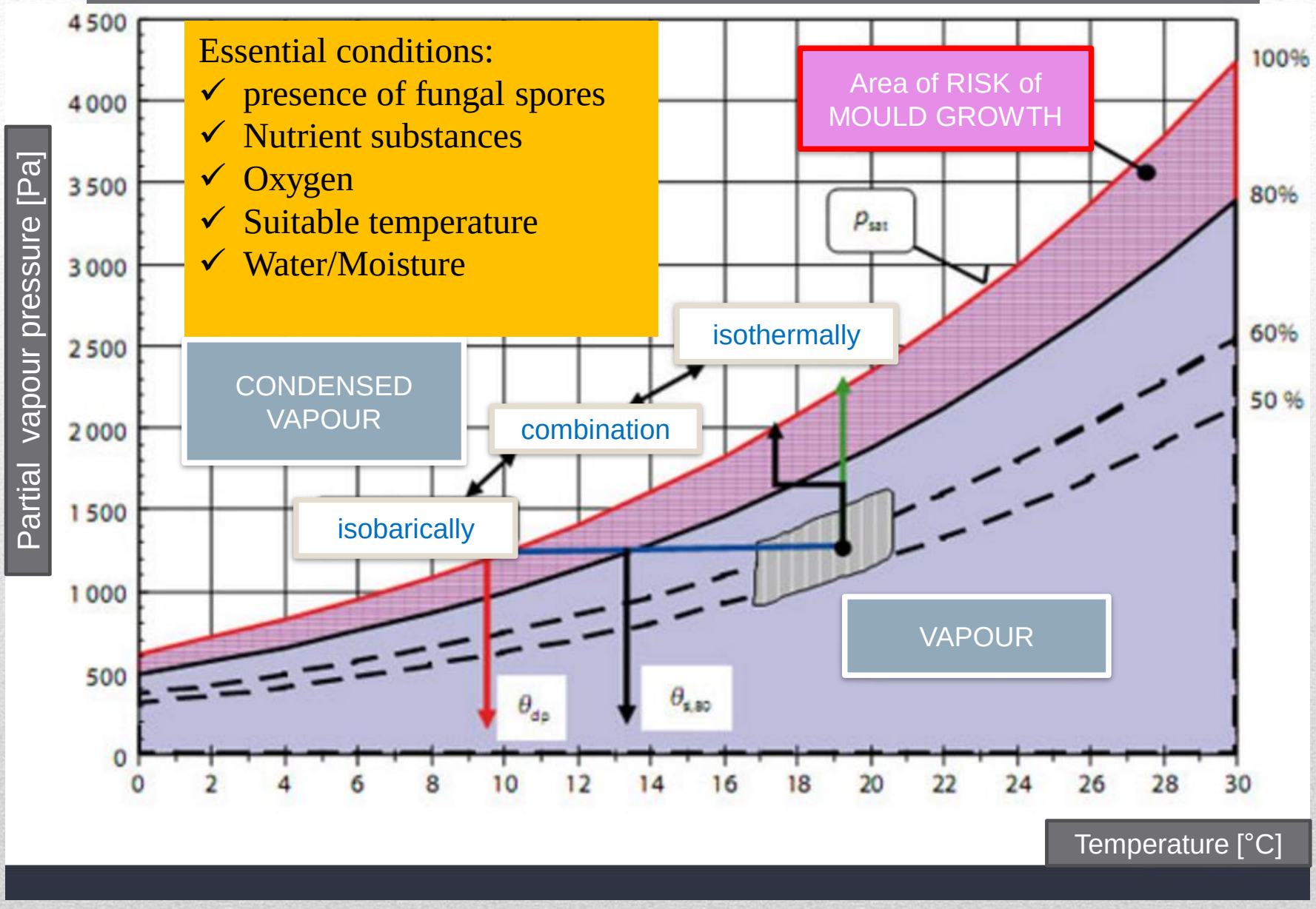

The risk of mould growth

The risk of decay

Essential conditions:

- ✓ presence of fungal spores
- ✓ Nutrient substances
- ✓ Oxygen
- ✓ Suitable temperature
- ✓ Water/Moisture

RH: > 90 - 95 %
Temp: 5 - 50 °C
Time: w, m, y

Permanent MC in wood above 20%

Defect in finishing

BETTER: Window B

	Window A	Window B
Material	Spruce – laminated wood	
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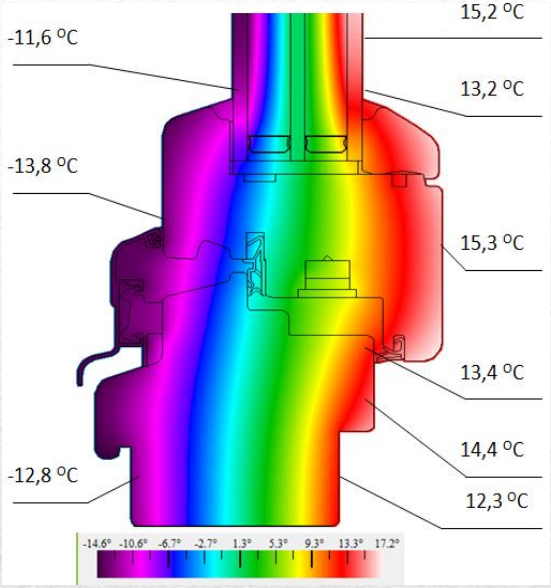


Conditions:

Interior: Temperature: $\theta_i = 20\ °C$

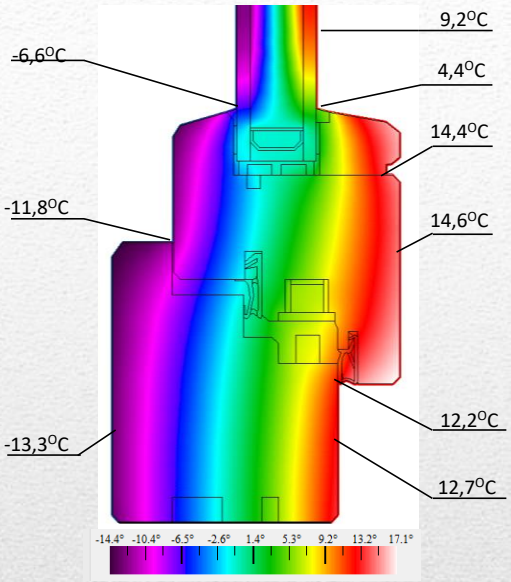
Exterior: Temperature: $\theta_e = -15\ °C$

Coeficient of heat flow

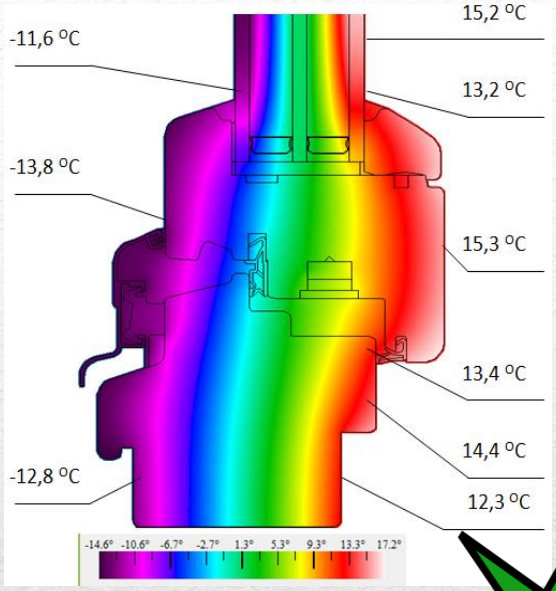
hsi = 8 W.m^{-2}.K^{-1}

hsi = 25 W.m^{-2}.K^{-1}

Window A



Window B



Conditions:

Interior: Temperature: $\theta_i = 20\ °C$

Exterior: Temperature: $\theta_e = -15\ °C$

Coeficient of heat flow

hsi = 8 W.m^{-2}.K^{-1}

hsi = 25 W.m^{-2}.K^{-1}

Coeficient of heat flow through glazing

U_g = 1.3 W.m^{-2}.K^{-1} **U_g = 0.9 W.m^{-2}.K^{-1}**

Conclusion:

In situations of high RH and temperature is necessary:

condensation of water vapour

creating defect in finishing

high moisture content in wood

risk of mould and decay damage

Design for moisture control

Ventilation – RH ≤ 55%

Window design

thick of wooden frame - 78 mm and more

triple-glazing

the leak under beading

Design of maintenance

Cleaning. disinfecing

Finishes and coatings

Desing for exchanging of glass

In the end of expected life of insulation glass

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Thank you for attention

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