



Final presentation

Issues associated to PUR and PIR foams



Paris, March 7th 2011

ALCIME



All experts' quotations and third persons interviewed by ALCIMED during this mission and quoted in this report, are strictly confidential and may not be diffused or extracted by SAINT-GOBAIN, without the permission of ALCIMED.

▪ Context, objectives and methodology	4
▪ Risk assessment	9
▪ Summary and recommendations	30
▪ Appendices	36



Context, objectives and methodology



Risk assessment



Summary and recommendations



Appendices



- In an environment where demand on highly performant thermic insulation solutions is increasing, SAINT-GOBAIN is willing to understand the evolution of its thermic insulation portfolio and better anticipate the issues associated to the polyisocyanurate (PIR) and polyurethane (PUR) foams:
 - Are there expected evolutions of legislations regarding the PUR/PIR insulating materials?
 - What are the different hazards associated with PUR/PIR foams (health hazards, fire hazards, other chronic hazards / "low dose")?

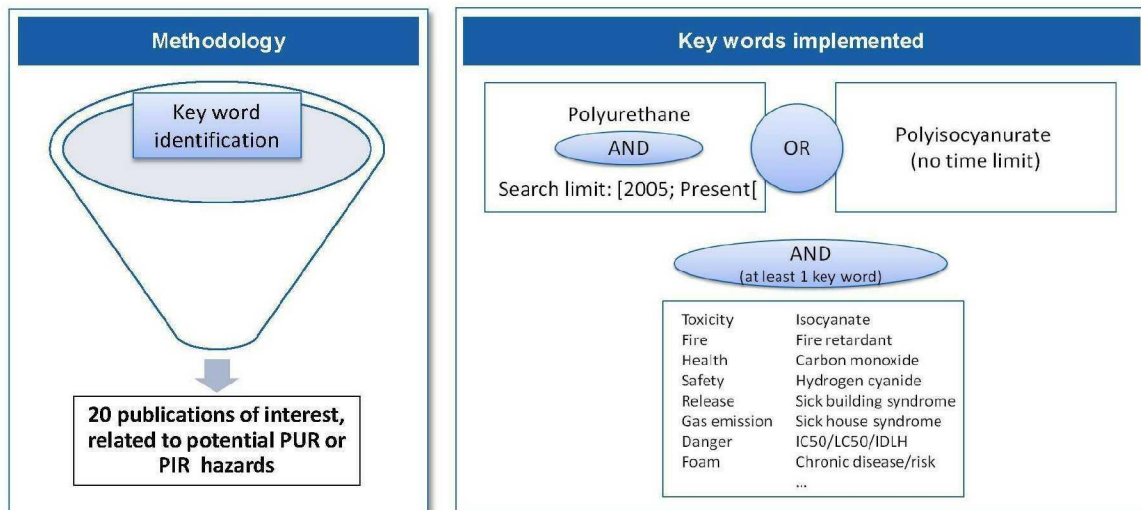


- ALCIMED is helping SAINT-GOBAIN in their approach by undergoing a 2-step study:
 - The first step will consist in analyzing the "health" hazards, as well as the "fire" risks, associated with the PUR/PIR foams.
 - The second step will consist in analyzing the possible evolutions in the legislation in the sector of PUR/PIR foams.
- Globally, the perception of the risk associated to PUR/PIR will be assessed among all the different levels of the decision-making process.

Geographical scope: France, UK ,Germany, Benelux



➤ Within the literature research, 20 publications were identified as potentially raising awareness towards PUR / PIR hazards.



Source: SCOPUS database

Please refer to Appendix 3



➤ Finally, the desk research was completed by 43 interviews with players potentially involved in every level of the regulatory decision-making process.




Institutions (25)		Academics / Publication authors (6)	
 4	 5	 2	 2
 6	 5	 1	
PU associations and industrials (5)		NGOs (1)	
 1	 1	 1	
 2	 1		
Internal- Saint-Gobain (6)			
 3	 1		
 1	 1		

Objectives

- ➡ Understand the perception of PUR/PIR foams as insulating material, at every potential level of decision.



- To evaluate the perception of the different identified risks linked to PUR/PIR foams as insulating materials, a risk register has been developed.

Description of risk	Potential impact on PUR/PIR use	Impact on PUR/PIR use	Probability to happen	Risk grade	Potential timing
<ul style="list-style-type: none"> ▪ Potential regulatory change ▪ Communication influence ▪ ... 	<ul style="list-style-type: none"> ▪ Possible induced limitations on PUR/PIR foams use as insulating materials 	 <ul style="list-style-type: none"> ▪ Importance of the impact on PUR/PIR use ▪ Perception evaluated on a 0-5 scale (0 being low, 5 being high) 	 <ul style="list-style-type: none"> ▪ Probability for the risk described to happen ▪ Assessed in percentage 	 <ul style="list-style-type: none"> ▪ Multiplication of the impact on the PUR/PIR use and the probability to happen ▪ Assessed on a 0-5 scale 	<ul style="list-style-type: none"> ▪ Time estimation for the risk to happen and affect PUR/PIR foams use

Based on the interviewees' perception and desk research



Context, objectives and methodology



Risk assessment



Summary and recommendations



Appendices



➤ The global level of risk associated to PUR/PIR use as insulating material is limited, with 2,5/5 as the highest perceived risk grade.

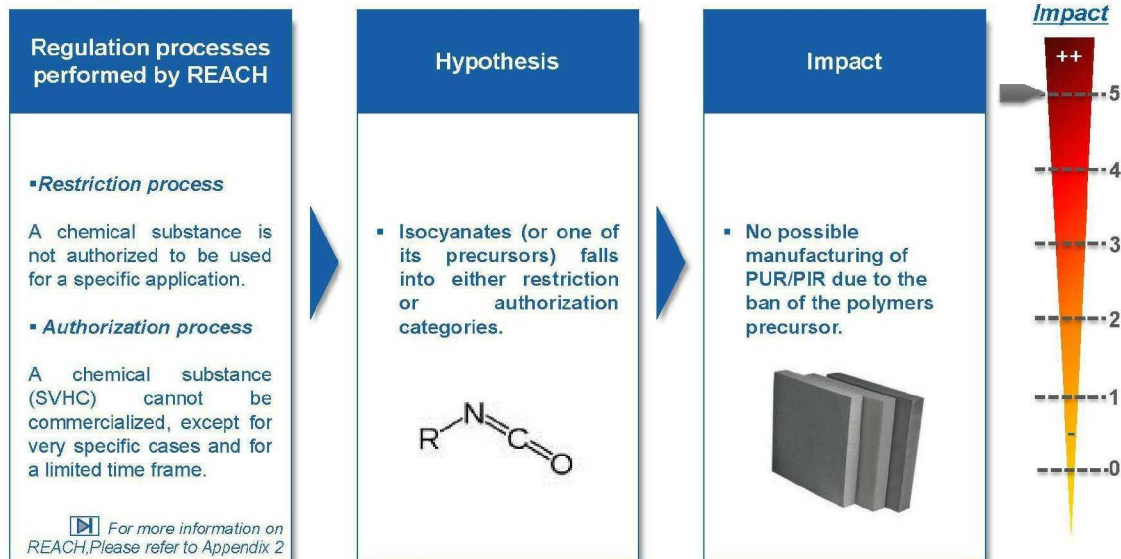
Description of risk	Potential impact on PUR/PIR use	Impact on PUR/PIR use	Probability to happen	Risk grade	Potential timing
<i>Limitation of isocyanates applications</i>	No possible manufacturing of PUR/PIR	5	50%	2.5/5	> 2014
<i>Ban of certain fire retardants included in PUR/PIR lifecycle</i>	Alternative solution for fire-retardancy to be found	1	100%	1/5	> 2014
<i>Fire disaster</i>	Stricter regulatory measures on the use of PUR/PIR foams	3	30%	0.9/5	Anytime
<i>Increased negative image of PUR/PIR due to global communication</i>	Loss of interest from end users in using PUR/PIR	4	20%	0.8/5	Anytime
<i>Mandatory smoke toxicity testing for all building types</i>	Additional limitation for a specific product's approval in particular applications	3	20%	0.6/5	> 10-15 years
<i>Mandatory VOC testing (TC 351)</i>	Additional step to reach product approval	0	100%	0/5	End 2016

Limitation of isocyanates applications Impact on PUR/PIR use

Risk assessment



➤ If isocyanates would fall under the restriction or authorization process of REACH, PUR/PIR foams manufacturing would be jeopardized.



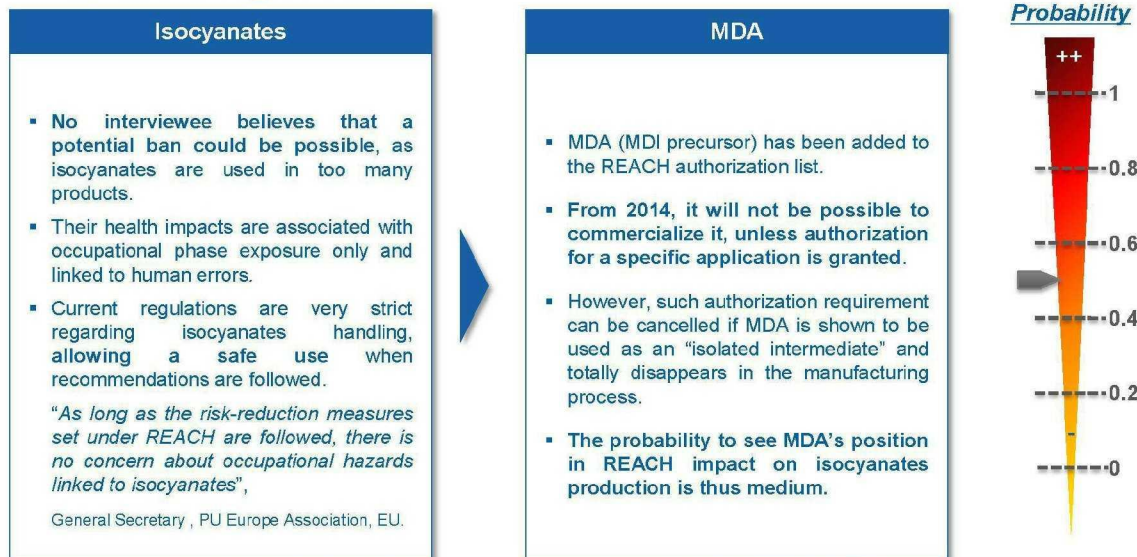
Sources: interviews, REACH and ECHA websites

Limitation of isocyanates applications Probability to happen

Risk assessment



➤ Isocyanates are not at risk, but MDI precursors are already on the REACH authorization list, what may impact isocyanates manufacturing from 2014.



Sources: interviews, REACH website, ECHA website, European Union Risk Assessment Report for MDI

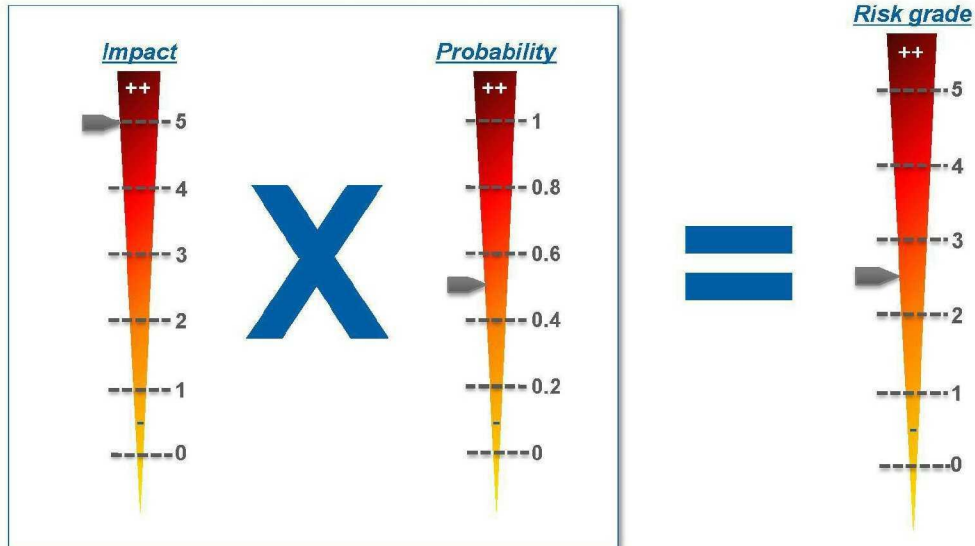
Limitation of isocyanates applications

Risk grade

Risk assessment



➤ A high potential impact and a 50% probability of seeing isocyanates use being limited in the next years represent a medium risk of 2,5/5 for the use of PUR/PIR as insulating materials.





➤ In case of currently used flame retardants interdiction, new options will be required to preserve acceptable PUR/PIR fire reaction properties, but their use will not be challenged.

Impact of certain flame retardants ban

- No risk of limited use of PUR/PIR as insulators.

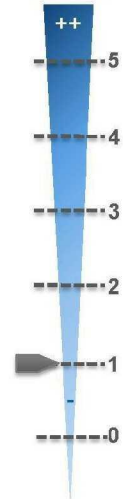
"Actually, many PUR/PIR rigid foams in construction have no fire-retardants as there have already good properties!", R&D head, LNE, FR

- However, an increased burden in the manufacturing of PUR/PIR can still be expected.

- Search for new additives with fire-retardant properties
- Testing of potential candidates
- Need to adapt PUR/PIR manufacturing process to the new molecules

"For PUR and PIR, you can have polyols with fire-retardant properties, so you do not need to have additives", R&D manager and NVPU member, Nestaan, NL

Impact



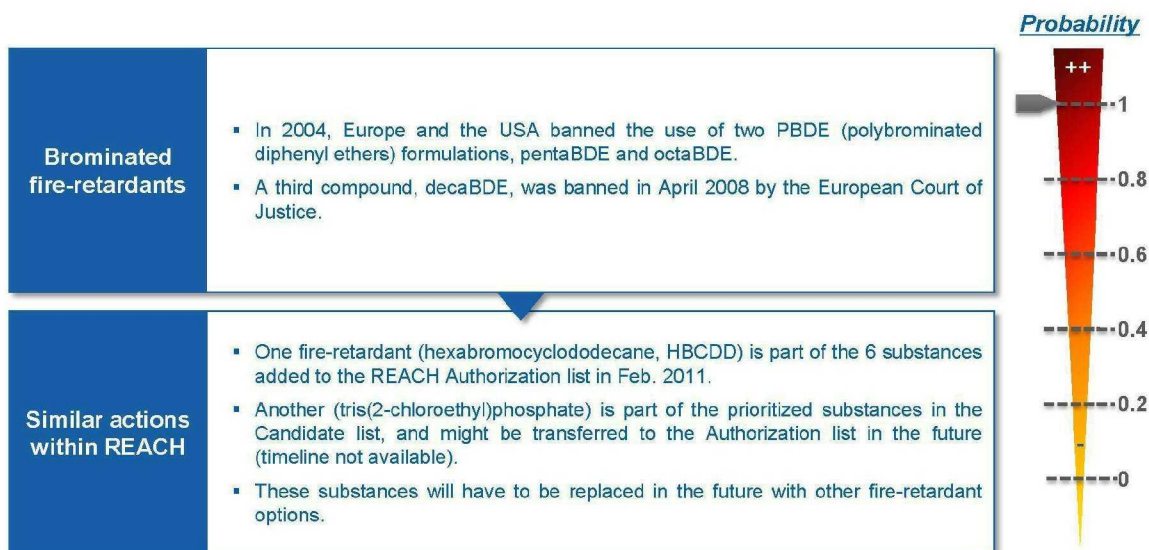
Sources: interviews.

Ban of certain flame-retardants Probability to happen

Risk assessment



➤ The HBCDD fire-retardant is already in the REACH authorization list, leading to a high probability of its interdiction from 2014.



Sources: interviews, *New Thinking on Flame Retardants*, *Environmental Health Perspectives*, 116(5), May 2008

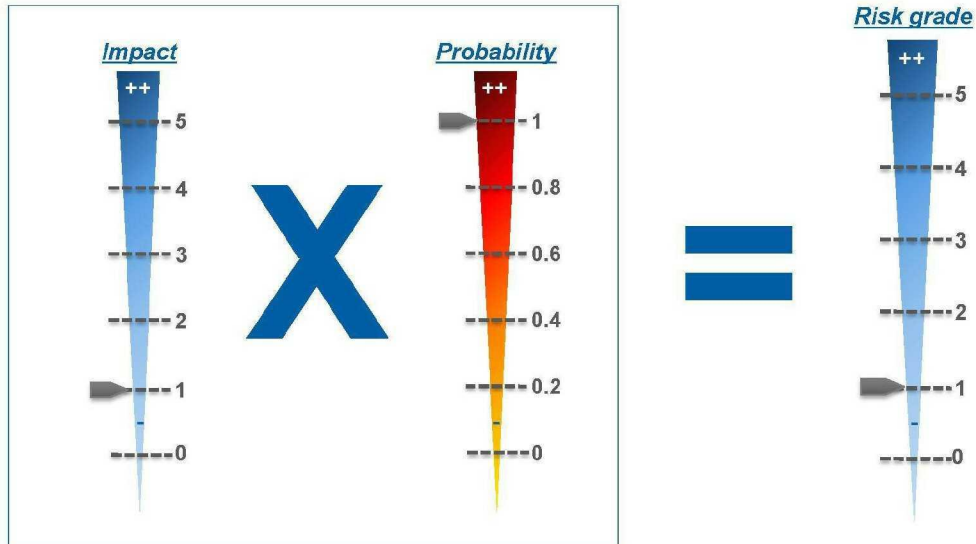
Ban of certain flame-retardants

Risk grade

Risk assessment



➤ The interdiction of certain fire-retardants will only increase the burden associated to PUR/PIR manufacturing, but with a global low risk on their future use.





- In the case of a large fire disaster with PUR/PIR identified as aggravators, stricter regulatory measures are expected.

Example: Dijon fire, Nov. 2010, 7 dead

Insulation cause

- presence of polystyrene in the exterior of facades induced fire propagation

Additional causes:

- anormal high amount of trash was present
- a chimney-like phenomenon occurred due to architectural enclave
- a lack of population education regarding behavior to adopt

"They should not have gone in the halls but should have waited in their apartments to be evacuated", R&D head, LNE, FR.

Single event impact

- Current regulation review for polystyrene in France
- Addition of stone wool layers on polystyrene's sides to lower fire propagation
- No sign of polystyrene interdiction in the near future

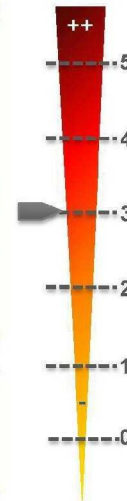
- Similar regulatory restrictions can be envisaged for PUR/PIR in case of a devastating fire including them as fire aggravators.

- However, no total ban is expected following a single event.

Note: for UK, Benelux, Germany: no single event was identified by interviewees

Sources: interviewees, <http://www.lemoniteur.fr/185-regles-et-normes/article/solutions-techniques/832200-incendie-du-foyer-adoma-a-dijon-les-experts-ont-rendu-leur-rapport>

Impact





- According to interviewees in fire safety departments, current regulations on PUR/PIR guarantee a safe use and these products are not associated to an increased risk of fire in buildings.

Probability for a fire disaster to be linked to PUR/PIR foams

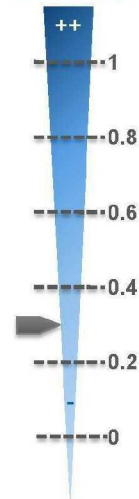
- Interviewees do not identify fire risks regarding PUR/PIR foams, since they follow strict regulatory safety requirements.
 - PUR/PIR foams are applied as sandwich panels for insulating applications.
 - No interviewee had to face an event of fire related to PUR and PIR foams.

"Even in areas where a level 0 inflammability material would be recommended, e.g. emergency exit tunnels, PUR and PIR can be used if properly covered", Fire engineering department, Greater Manchester fire service, UK.

- PUR/PIR foams are even used as firewalls in public buildings, to allow population evacuation.

"We need to be stricter on the fire requirements of the products [...] for some buildings. That does not change the fact that PUR is used and actually, also as a firewall", Prevention service manager, SDIS de l'Ain, FR.

Probability



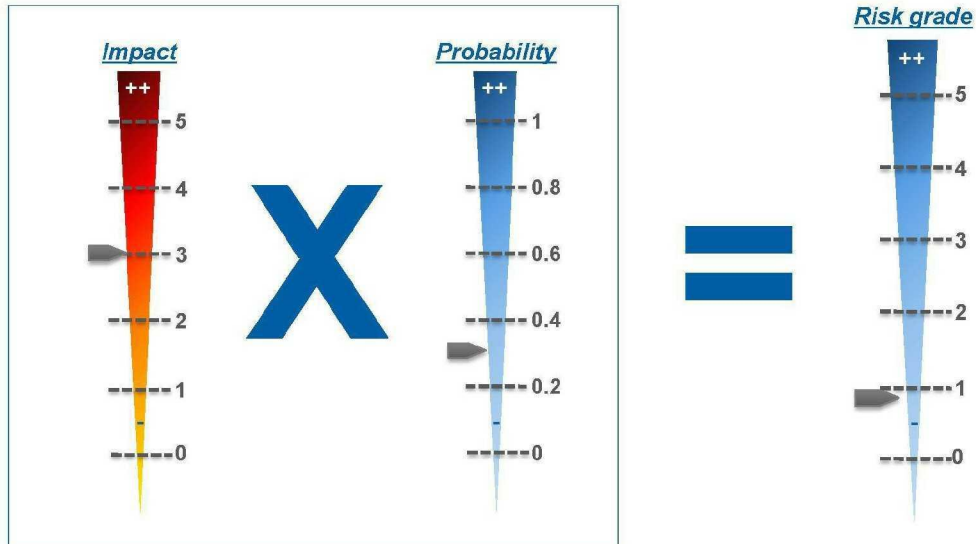
Sources: interviews.

Fire disaster Risk grade

Risk assessment



➤ The risk on PUR/PIR use associated to a single, devastating fire is relatively low due to the small probability of occurrence.



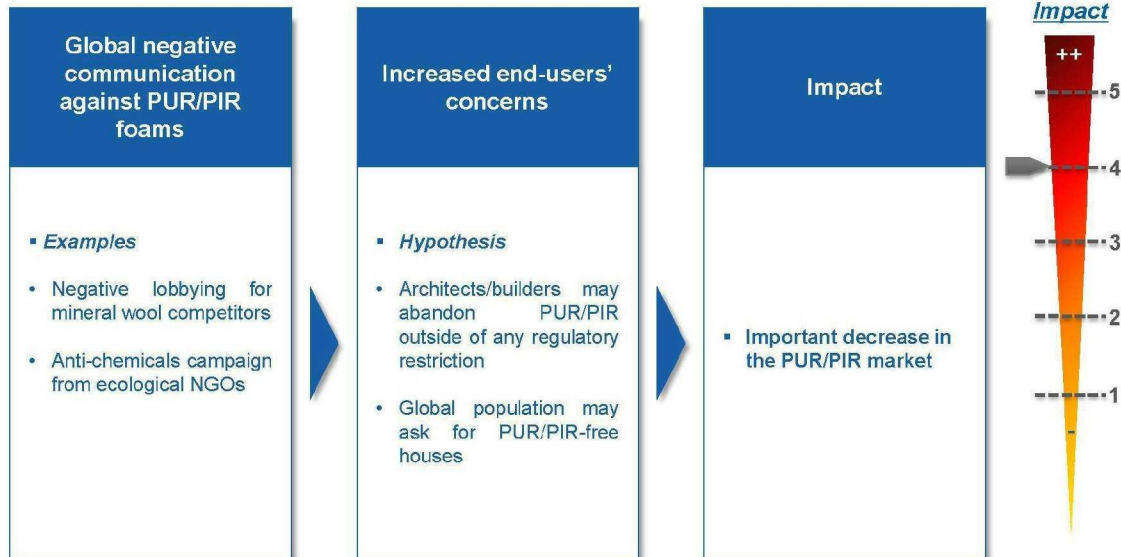
Increased negative image of PUR/PIR Impact on PUR/PIR use



Risk assessment



Like for any other product, a strong, negative communication, based on real facts or not, can strongly impact the use of PUR/PIR.



Increased negative image of PUR/PIR Probability to happen

Risk assessment



- However, no interviewee or publication highlighted any current threatening communication against the risks of PUR and PIR.

- No high threat has been identified by any interviewee at any level (PUR associations, regulatory bodies, notified organisms, ...).
- Today, PUR/PIR foams are recognized to have the highest insulating performance, thus leading to lower energy loss, which is well-aligned with the need for sustainability.

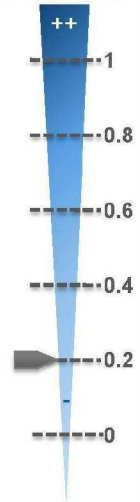
Competitors

- Mineral wool producers always tried to highlight the higher toxicity of PUR/PIR compared to their products, but with no sensible impact.
"That enters in the normal competitive environment, and went on for years: we do not feel any specific threat", R&D manager, Nestaan, NL.

NGOs

- No interviewee in Europe, at any level, ever heard of warnings from associations or NGOs.
- Moreover, NGOs do not have decision making power at regulatory level.
- The use of PUR and PIR in construction raises concern by some ecological NGOs such as ELEA (BE); though, their message is included in a global ecological trend, and not as a direct attack aiming at deteriorating PUR/PIR image. [D]

Probability



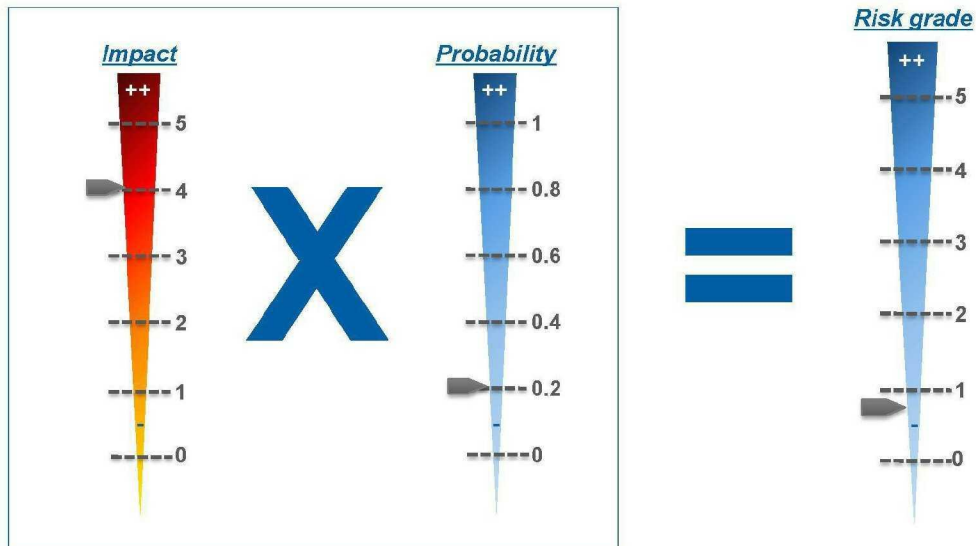
Sources: interviews, global internet search.

Increased negative image of PUR/PIR Risk grade

Risk assessment



➤ Today, the risk associated to negative communication on PUR/PIR is low, but this does not exclude a future threat.



Mandatory smoke toxicity testing Impact on PUR/PIR use



Risk assessment



➤ If smoke toxicity testing for all buildings becomes mandatory, additional testing will add a burden to the use of PUR/PIR foams.

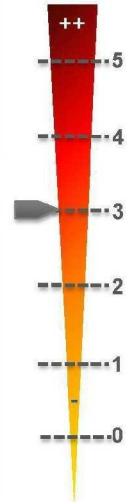
Smoke toxicity testing

- Mandatory for specific applications (transportation and enclosed spaces) due to limited evacuation issues.
- Even in such cases, PUR foams have been stated to be used: trains, boats, London underground
"PUR foams are used in London's underground but have been approved under specific conditions.", Testing officer, Exova Warrington Fire, UK.

Potential impact on all buildings use

- PUR/PIR foams will have additional requirements to meet for specific applications' approval, but no ban will be expected.
"Restrictions are linked to performance and behavior on the final assembly of a specific product, not anymore on a family of products", R&D head, LNE, FR.
- If smoke toxicity testing is required, thresholds will most likely be less strict than for transportation and enclosed spaces.
"PUR might not be impacted since they are already used in restricted areas. In all cases, the thresholds would not be as strict as in enclosed spaces", Fire safety officer, DDSC, FR.

Impact



Sources: interviews, Eric Guillaume, LNE, *Effet du feu sur les personnes, synthèse bibliographique (2006)*

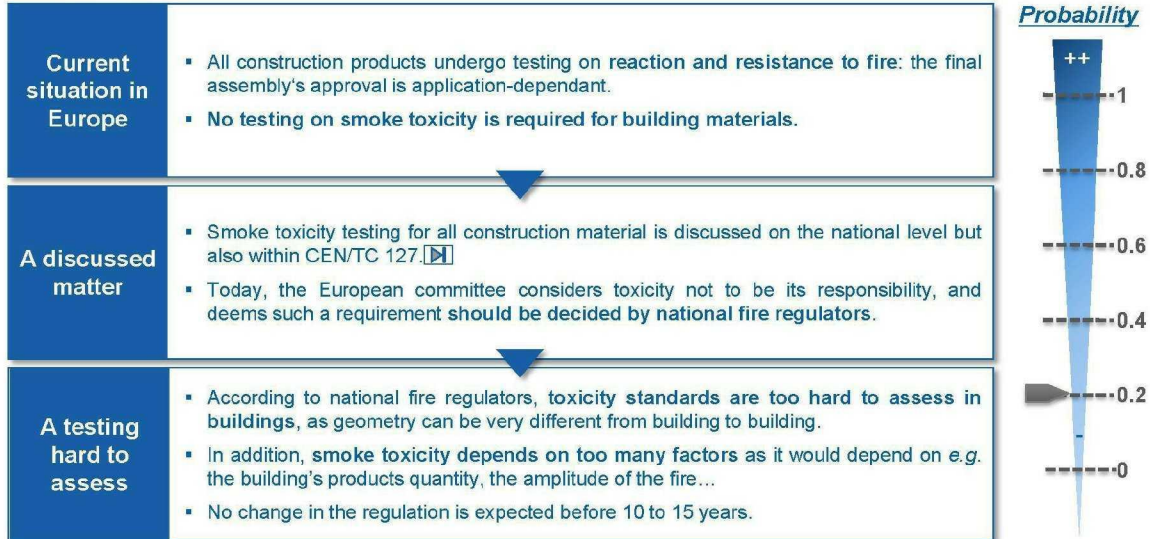
Please refer to Appendix 2 for information on transportation smoke toxicity testing

Mandatory smoke toxicity testing Probability to happen

Risk assessment



➤ However, such testing is not expected to become a requirement in Europe due to the difficulty of setting up a standardized testing method.



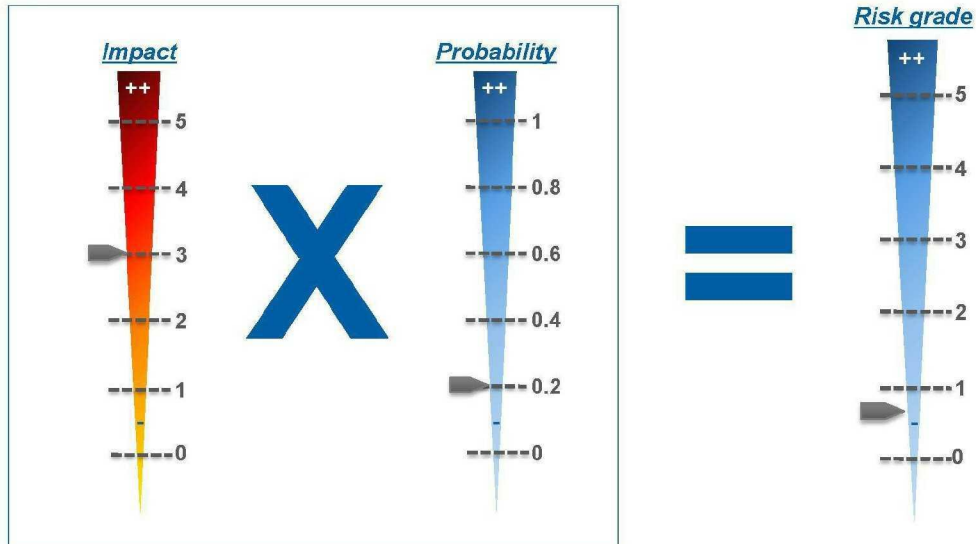
Source: interviews, CEN website.

Mandatory smoke toxicity testing Risk grade

Risk assessment

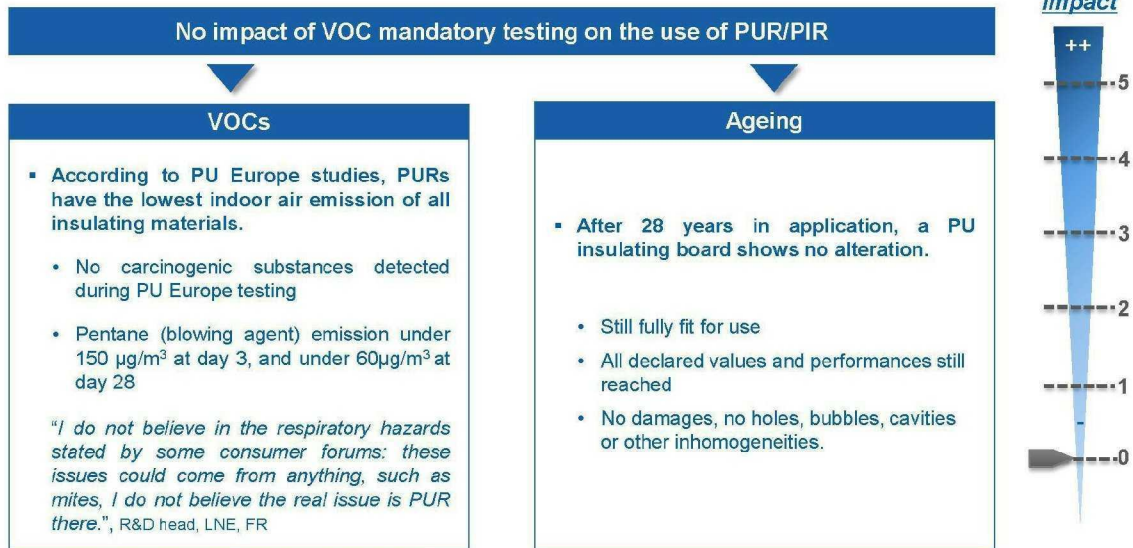


➤ The global risk associated to smoke toxicity testing is low, due a medium impact and a low probability to happen in the next 10 to 15 years.





- **VOC and ageing testing on PUR foams have already been performed, showing no potential danger in case of mandatory VOC testing.**



Sources: interviews, PU Europe documentation

Mandatory VOC testing Probability to happen

Risk assessment

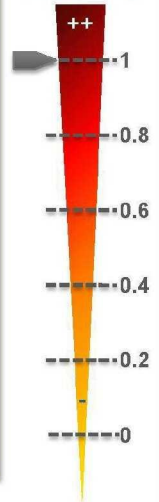


- **Mandatory VOC testing will certainly be introduced for PUR by the end 2016 .**

CEN/TC 351

- The CEN/TC 351 is in charge of the harmonized European standards assessing dangerous substances release in specific construction products.
- **All construction products under the Construction Products Directive (CPD) are targeted for these future testing.**
- **As insulating materials, PUR/PIR fall into this category and will therefore undergo VOC testing.**
- Today, these standards are still in a preparatory phase:
 - ✓ A first validation phase in the choice and validation of testing methods is expected in 2012.
 - ✓ **The final validation is expected end 2016.**

Probability



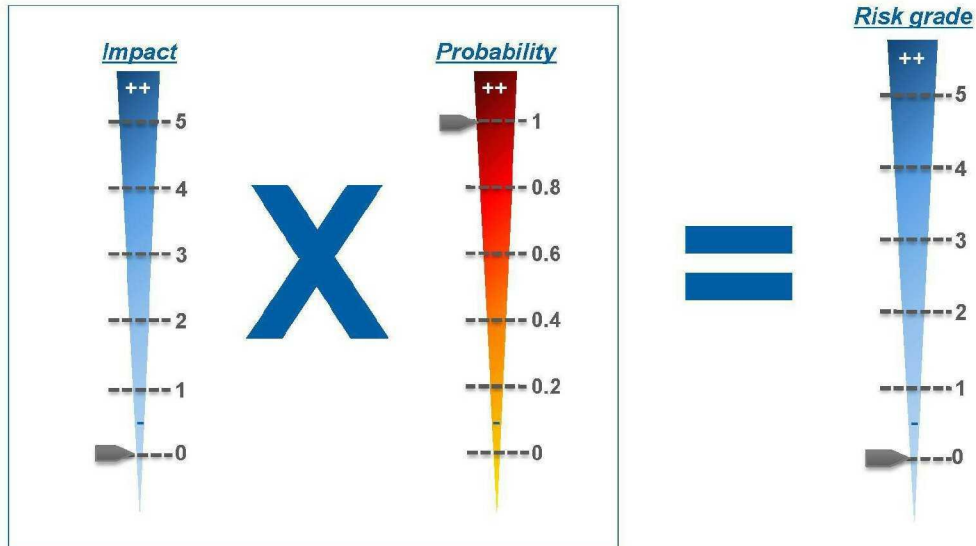
Source: interviews, CEN website.

Mandatory VOC testing
Risk grade

Risk assessment

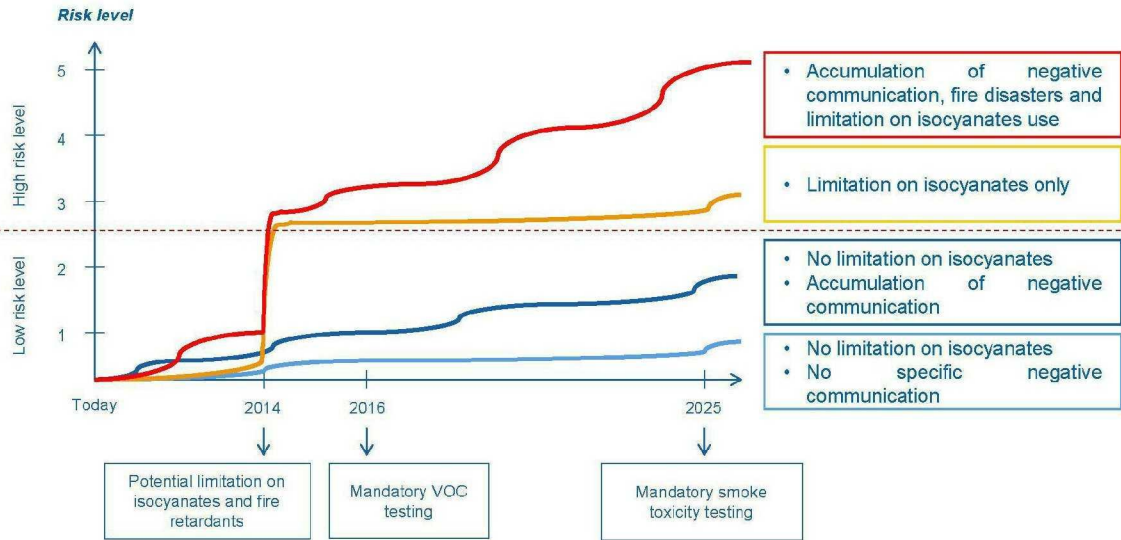


➤ The risk grade associated to VOC testing is negligible as previous studies showed no issued linked to PUR/PIR.





The main possibility of seeing the risk level increase will take place in 2014 with a potential limitation on the use of isocyanates.





Context, objectives and methodology



Risk assessment



Summary and recommendations



Appendices



- **The global perceived risk associated to the use of PUR/PIR is low, with the main identified threat being related to a potential limitation of isocyanates applications from 2014.**

- ☐ Interviewees at the different levels of the decision making chain agree: there is no major risk associated to the use of PUR/PIR as insulation material.
- ☐ According to the global perception, the low risk scenarios are more probable than high risk scenarios.
- ☐ The main risk, graded at 2,5/5 is linked to the toxicity of MDI precursor, required in the production of isocyanates.
 - This compound is already part of the REACH authorization list, what can possibly impact its commercial use by 2014 and thus impact the manufacturing of PUR/PIR.
- ☐ All risks focusing directly on health risks of PUR/PIR itself are deemed minimal by all interviewees:
 - **Risk of fire:** very low due to PUR/PIR use in the frame of already restrictive regulations.
 - **Smoke toxicity:** not considered as a factor to take into account in the product's testing in the next 10-15 years.
 - **VOC emissions:** previous studies presented PUR/PIR as the insulating material with the lowest emissions.



➤ **As no current threat as been identified, the PUR/PIR insulation market is a good opportunity for Saint-Gobain.**

Global perception

- ❑ Global image on PUR/PIR foams is positive and no interviewee highlights major threats on their use.
- ❑ Risks associated to such foams are known and safety requirements are already in place to lower these hazards, at both occupational and end-user's levels.

Saint-Gobain on the PUR/PIR market

➔ **No major hurdle identified in entering the PUR/PIR insulators' market**

➔ GO

MDI sourcing

- ❑ Saint-Gobain can overcome the potential MDI sourcing issue in the following way:
 - Demonstrate no MDA presence in the final product.



- Nonetheless, as health risks exist with PUR/PIR foams and are well known, Saint-Gobain should be proactive against potential future attacks...

Proactivity

➔ Know the potential risk by undergoing some tests on a voluntary basis on each specific PUR/PIR based product:

- Fire resistance and reaction
- Smoke toxicity testing
- VOC testing

➤ Saint-Gobain should proceed to these testing through the national testing centers in order to gather independent test results and guarantee no biases.

➤ Consider these test results as a protection against any potential attack on PUR/PIR image.



- ...and should ensure that any identified risk is communicated on a voluntary basis.

Communication transparency

- Some potential risks are already known.
- Any additional identified issue, following a specific product testing, must be taken into account and clearly communicated.

→ LEAVE NO ROOM FOR SUSPICION!



- In order to follow the situation evolution, Saint-Gobain should participate to regulatory working groups, open to industrials and PUR associations.

**Participative
activity**

Working groups

- Can be integrated on both national and European levels.
- Allow to be aware of potential regulatory changes, by being part of the regulatory and/or standardization working groups.

Professional association

- Be part of the PUR/PIR associations, as they have a strong lobbying power.
- Allow to communicate on PUR/PIR under a global name, dissociating the messages from Saint-Gobain's name.



Context, objectives and methodology



Risk assessment



Summary and recommendations



Appendices

▪ Appendix 1	
▪ Global PUR/PIR perception	38
▪ Appendix 2	
▪ Geographical specificities	46
<i>European Union</i>	47
<i>France</i>	56
<i>UK</i>	64
<i>Germany</i>	72
<i>Benelux</i>	80
▪ Appendix 3	
▪ Scientific and global bibliographic information	88
▪ Appendix 4	
▪ Contacts list – publication references	110
▪ Appendix 5	
▪ VOC testing – PU Europe	118



Global PUR/PIR perception



Geographical specificities



Scientific and global vision



Contacts list



➤ **Feedback from scientific authors do not highlight any alarming signals against the use of PUR or PIR foams.**

Only 20
publications
directly relate to
the project scope
since 2005

- Fire toxicity: publications do not raise new issues from the ones already well-known.
 - First authors interviewed feel there is no specific concern about PUR or PIR fire toxicity as their use follows the regulatory safety requirements.
 - Toxicants such as dioxins coming from flame-retardants are the ones considered as most important by firefighters, PIR foams should thus not present any concern.
- Chronic hazards:
 - The only publication on indoor air contamination, presenting a potential negative impact on PUR insulating materials, was a single event in Germany and was not prejudicial to PUR use.
 - Isocyanates exposure is of concern in occupational health; however, authors interviewed are not willing to ban them but only to sensitize population on the importance of following the right procedures and using the right equipments.
- Among all *Environmental Health Perspectives* (EHP) PUR-related publications, few were related to the project scope and mainly focus on furniture and flame retardants.
 - There was no occurrence on "polyisocyanurate" or "polyiso" in EHP, which confirms the low interest on studying PIR in the last few years.

Please find detailed slides on Appendix 3



➤ **Very disparate concerns are raised through different types of websites, but do not show strong threat against PUR/PIR foams.**

Global end users perception	<ul style="list-style-type: none">Some concerns are raised by individuals through internet discussion forums, but remain marginal and do not appear to have any impact.
Foam fumes	<ul style="list-style-type: none">Concerns about foam fumes or dust are raised on different American websites but focus on individual protection measures and do not encourage consumers to avoid PUR use.
NGO's communication	<ul style="list-style-type: none">The main concern about the use of PUR and PIR in construction is raised by an ecologist NGO (ELEA).However, their message is included in a global ecological trend and is not meant to influence regulatory authorities or consumers on potential restrictions of PUR and PIR foams' use.
American lawyers	<ul style="list-style-type: none">Some American law firms are referring to the dangers of polyurethane foams in case of fire, but none relate them to building insulation.

Please find detailed slides on Appendix 3



➤ As such, no PUR professional association representative feels any threat regarding the perception of PUR/PIR foams.

- PUR professional associations are very active both at the national and European level in regards to the regulatory and standardization working groups.
- No interviewee has heard of any specific association (consumers, ecological...) communicating against PUR and PIR foams or advocating the associated risks.
- *"The only attacks come from mineral wool producers but that enters in the normal competitive environment, and went on for years: we do not feel any specific threat", R&D manager, Nestaan, NL.*
- All interviewees are confident that no regulatory restriction is to be feared in the next years regarding insulating materials.

Smoke toxicity

Even if it becomes mandatory, this should be no burden as PUR foams are already used in transports, where smoke toxicity requirements are strict.

Isocyanates

"As long as the risk-reduction measures set under REACH are followed, there is no concern about occupational hazards",
General secretary, PU Europe, EU

Fire-retardants

Too many alternatives exist to fear any potential ban.

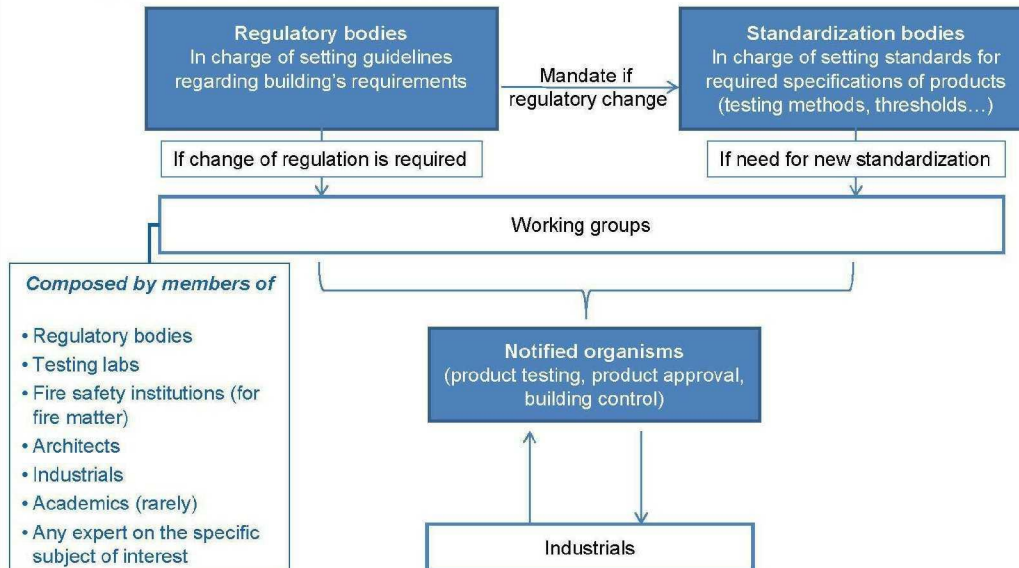
VOCs

"We have studies that prove that PUR have the lowest air emission of all insulating materials",
General secretary, PU Europe, EU

Sources: interviews.



➤ In all European countries of interest, the organization regarding construction products requirements is similar and every level of decision has been contacted.





Similarly, regulatory decision-makers do not feel that concern should be raised on PUR/PIR foams, since they follow safety regulations.

Construction material testing	<ul style="list-style-type: none"> The different levels of decision-makers set the requirements on a global level for all construction materials. <ul style="list-style-type: none"> <i>"As long as the product is following the regulatory requirements, I do not see why I should raise any concern. That also stands for PUR and PIR foams!"</i>, Prevention service, SDIS de l'Allier, FR Future mandatory VOC testing will encompass all building materials within the CPD, which does not impact the use of PUR/PIR considering their low emission levels. Interviewees believe that if smoke toxicity testing became mandatory for building materials, thresholds might certainly be less strict than for enclosed spaces or transports where this testing is already mandatory. <ul style="list-style-type: none"> PUR is already used in some of these evacuation-limited spaces
NGO's lobbying	<ul style="list-style-type: none"> No interviewee was able to name an association or NGO communicating actively against PUR/PIR foams. <ul style="list-style-type: none"> Such organisms are welcome to join the meetings even if they have no decision power within the regulatory working groups.
REACH	<ul style="list-style-type: none"> Only REACH program might impact isocyanates and some fire-retardants use, even if interviewees agree that the impact on PUR/PIR would be limited.

Source: interviews



➤ The OEHHA is currently reviewing the reference exposure levels for TDI and MDI, but that will not impact final products.

Revised reference exposure levels

- The OEHHA* has a responsibility for "protecting and enhancing public health and environment by scientific evaluation of risks caused by hazardous substances"
- In 2010, a draft has been available for public review regarding revised reference exposure levels (RELs) for TDI and MDI.
 - ✓ No specific single event was involved in that decision and such revision was mainly set as prevention for both workers and, in particular, children's potential exposure (sprays, painting...)
 - ✓ "No external expert was associated to the redaction of the document, as we base our research on public scientific literature and, when possible, toxicologic reports from industries"

Ageing and damaging

- There could be "possible presence of unreacted isocyanates as PUR ages or damages" even though there is no long-term exposure.
 - ✓ "All isocyanates are very reactive, with water vapors for instance, and have a very short half-life"
- Regarding rigid PUR foams, concerns could exist towards residual components (through cutting, degradation, ageing) but testing is not a priority.
 - ✓ "Actual levels of volatile compounds in rigid foams are minimized, but that does not mean zero; though, as for today, the time scale for sensibilization is unclear and we do not know if a single exposure could be an issue. It could be a good idea to do such testings, but this is not our goal today"

There is no will to ban the use of PUR or PIR foams, but only to get stricter on the exposure levels of isocyanates, during e.g. fabrication process or DIY activities, to avoid potential health hazards.

*OEHHA: Office of Environmental Health Hazard Assessment

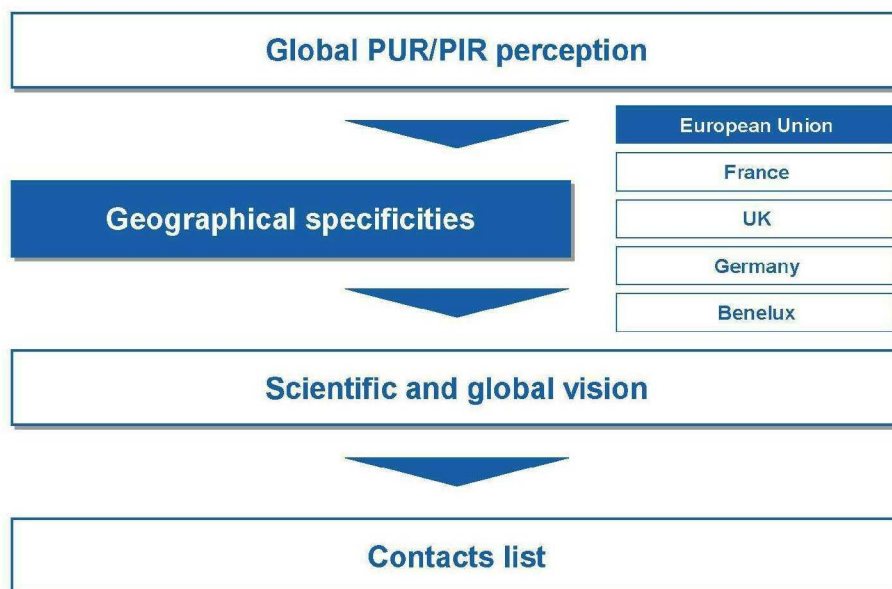
Source: interview with Dr. Salmon, http://oehha.ca.gov/air/hot_spots/061710tdimdd.html



- In South Korea, smoke toxicity testing is mandatory for specific buildings and no stricter regulatory change is expected.

Event	Regulatory consequence	Impact on PUR/PIR foams
<p>Devastating fires</p> <ul style="list-style-type: none"> ▪ Dae Yeon Gak Hotel fire, 163 deaths (1971) ▪ Sea Land Youth Camp fire, 23 deaths (1999) 	<p>Smoke toxicity testing mandatory</p> <ul style="list-style-type: none"> ▪ Only for the buildings specified in the Article 61 of the Enforcement Decree of the Building Act <p><i>"The government never decided that all insulating materials should be built with the noncombustible class", KFPA, KR</i></p>	<p>No expected interdiction of PUR/PIR foams as insulating materials</p> <ul style="list-style-type: none"> ▪ PUR/PIR foams can be used as composite materials (e.g. sandwich panels), but not as independent ones. <p>➤ No regulatory change is expected</p>

Source: interviews





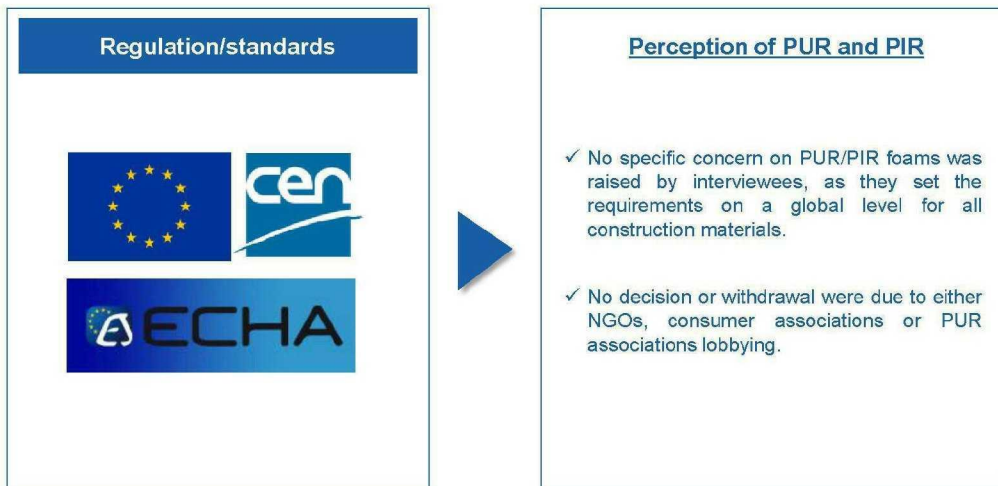
A European harmonization is being put in place in order to allow free movement of products within the Member States, including construction materials.



Source: interviews.



Decision-makers on the EU level set regulations on a global level, and thus do not target specific construction products such as PUR/PIR foams.



Source: interviews.



The TC 127 is in charge of the harmonized European standards of fire safety in buildings, which include resistance and reaction to fire.

According to members of TC 127, the following parties were involved in the committee:

- ✓ National standardization bodies
- ✓ Fire regulators
- ✓ Industrials
- ✓ Test laboratories
- ✓ Academics which are considered as high-level experts

Only national standards members have voting power.

- ✓ All others are welcome to attend and share knowledge

Resistance to fire

Indicates how well a building component – for a stated period of time – can:

- Keep its mechanical characteristics
- Hold back the fire
- Prevent it from penetrating from one room to another
- *This type of testing is not in this project's scope*

Reaction to fire

- Gauges its contribution to the propagation of flames in a fire: flammability, flame propagation, heat value, smoke and flaming droplets...
- The product is then graded following the Euroclass classification.
- *Non-devastating fire is not identified by interviewees as being a significant test.*

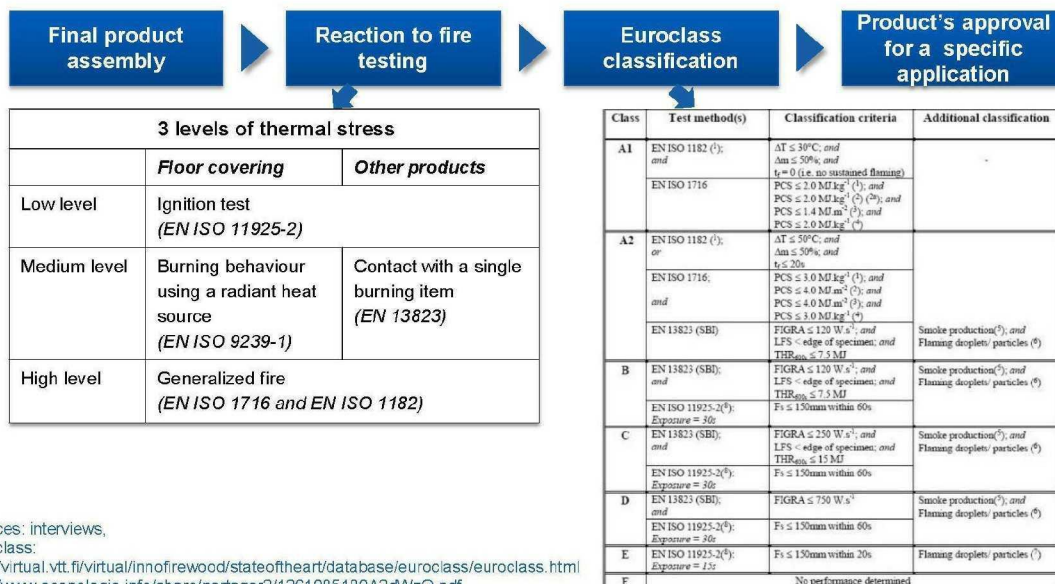
Smoke toxicity testing

- **A debated matter**, usually linked to specific cases:
"For instance, Greece is prone to impose such testing on a European level for public buildings such as hotels",
 Secretary, CEN/TC 127, EU
- The committee considers toxicity **not to be its responsibility**, and deems such a requirement should be decided by national fire regulators.

Sources: interviews, global internet search-



In particular, reaction to fire encompasses 3 types of fire testing, which gives a Euroclass classification of each building material.





The TC 351 is in charge of the harmonized European standards assessing dangerous substances release in specific construction products, which will most probably be in place end of 2016.

The parties involved in that committee are the following:

- ✓ Construction products industry
- ✓ Test laboratories
- ✓ European and national regulators
- ✓ Environmentally aware consumers

Only national standards members have voting power.

- ✓ All others are welcome to attend and share knowledge
- ✓ 1 representative of the PUR industries (O. Loebel, PU Europe) attends the working groups

Leaching
and VOC
testing

- Products targeted are all the products under the Construction Products Directive
- Insulating materials will thus also be subject to mandatory VOC and leaching testing
- No specific construction material is of main concern behind that future directive

Timeline



Source: interviews



➤ At the European level, REACH could, in the future, impact on the use and commercialization of some chemicals considered of high concern.

REACH is the Regulation on Registration, Evaluation, Authorization and Restriction of Chemicals, which entered into force on June, 1st 2007.

The European Commission is also preparing for its future tasks under REACH:

Authorization

- Substances of very high concern (SVHC) will be gradually identified in a 'Candidate list' and eventually included in Annex XIV (i.e. Authorization list) of the REACH Regulation.



Restriction

- REACH foresees a restriction process to regulate the manufacture, commercialization or use of certain substances, either on their own or in mixtures or articles if they pose an unacceptable risk to health or the environment.
- Such restrictions are application-specific.
- They are presented in Annex XVII of the REACH Regulation.

SVHC: Substance with Very High Concern

Sources: interviews, http://ec.europa.eu/enterprise/sectors/chemicals/reach/index_fr.htm



➤ In particular, REACH foresees to forbid specific SVHCs' commercialization, unless an authorization is granted for a specific application.

Candidate list	Authorization list
<ul style="list-style-type: none">▪ Substances of very high concern will be gradually identified in a Candidate list* (last updated Dec, 15th 2010)▪ 8 substances have been prioritized and should be included in the authorization process soon.▪ All State Members are allowed to propose their own candidate lists, which will be reviewed by REACH.	<ul style="list-style-type: none">▪ Substances from the Candidate list which are included in the Authorization list cannot be placed on the market or used after a date to be set.▪ In February 2011, Six SVHC have been moved from the Candidate list to the Authorization list.<ul style="list-style-type: none">✓ Timeline associated: 2014-2015▪ If a company proves that for a specific application, there is no other alternative but to use a substance present in the Authorization list:<ul style="list-style-type: none">✓ Authorization will be granted <u>only</u> for that application and that company✓ Such granting will be time-limited▪ If a company proves that such substance is used as an "isolated intermediate" and that it totally disappears within a specific process, then the substance will not fall anymore under that authorization requirement.

* http://echa.europa.eu/chem_data/authorisation_process/candidate_list_table_en.asp?sortBy=Date_inclusion&order=ascending
Sources: interviews, http://ec.europa.eu/enterprise/sectors/chemicals/reach/index_fr.htm



Overall results of the risk assessment

Environment

- There is at present no need for further information and/or testing and for risk reduction measures beyond those which are being applied already.

Human Health (toxicity)

Workers

- There is need for further information and/or testing.
- There is a need for limiting the risks; risk reduction measures which are already being applied shall be taken into account.

Consumers

- There is need for further information and/or testing.
- There is a need for limiting the risks; risk reduction measures which are already being applied shall be taken into account.

Humans exposed via the environment

- There is at present no need for further information and/or testing and for risk reduction measures beyond those which are being applied already.

Combined exposure: workers/consumers/humans exposed via the environment

- There is need for further information and/or testing.
- There is a need for limiting the risks; risk reduction measures which are already being applied shall be taken into account.

Source: EU Risk assessment, Report for MDI

Smoke thresholds in transportation



➤ Smoke toxicity testing is mandatory in transportation due to evacuation limitations, but products' assessment is different depending on the application.

Train-related regulations

- An harmonization is currently under development and is expected to be effective in 2013.
- The goal will be to take into account all potential toxic gases and give a global grade for product's final approval.

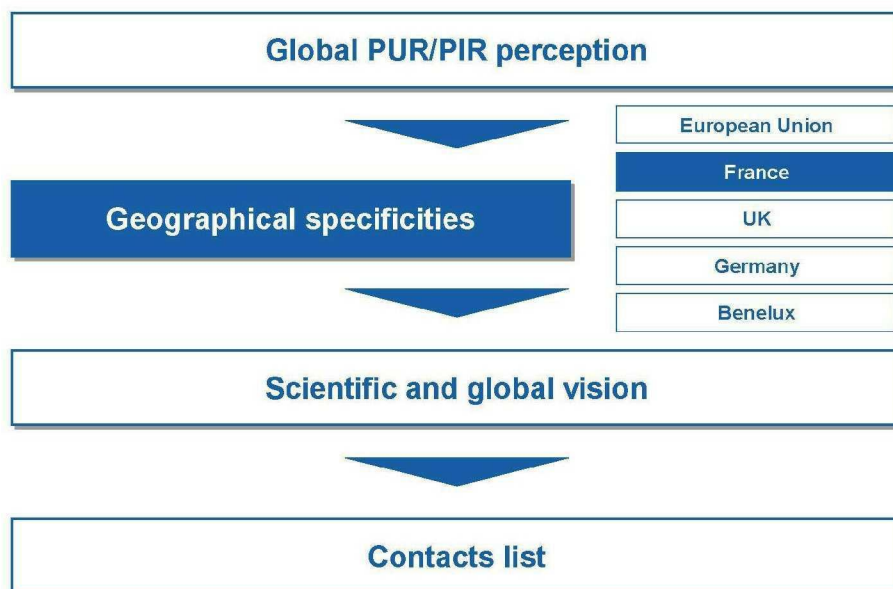
Boat-related regulations

- Thresholds have been set by the International Maritime Organization (IMO).
- As opposed to train regulations, approval is given as long as no gas is above the given thresholds.
- This implies that if a product shows a gaz release just below the thresholds for all gases, it will still be approved.

Thresholds used in maritime transportation

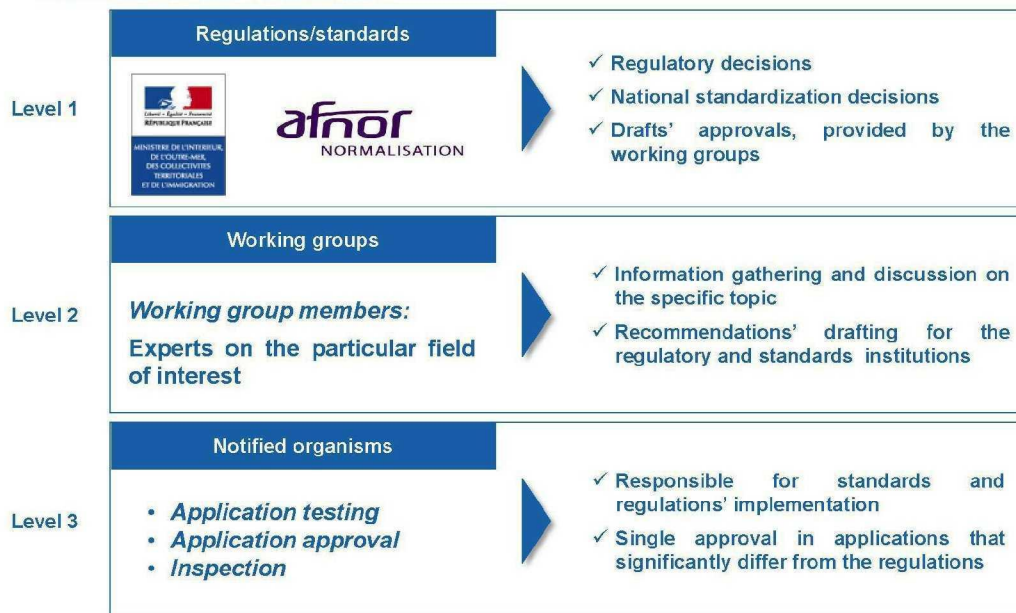
Gaz	Seuil (ppm)
Monoxyde de carbone CO	1450
Acide chlorhydrique HCl	600
Acide bromhydrique HBr	600
Acide fluorhydrique HF	600
Acide cyanhydrique HCN	140
Oxydes d'azote NO _x	350
Dioxyde de soufre SO ₂	120

Source: interviews; Eric Guillaume, LNE, *Effet du feu sur les personnes, synthèse bibliographique*, Juillet 2006





➤ The three main levels of decision-making process have been identified and contacted.





➤ The Ministère de l'Intérieur and AFNOR are the French institutions responsible for all building requirements and reference standards.

Regulatory body	Standardization body
 <ul style="list-style-type: none"> ➤ The Direction de Défense et de Sécurité Civile (DDSC), within the Ministère de l'Intérieur is in charge of the building regulations. ➤ In particular, an office is in charge of the prevention of fire risks and chronic hazards in high-rise and public buildings. ➤ The fire-fighter department (Services Départementaux d'Incendie et de Secours, SDIS) is also part of the DDSC. 	 <ul style="list-style-type: none"> ➤ AFNOR* Normalisation develops standardization strategy, coordinates and guides standardization agency efforts, and oversees that all the stakeholders to a standard get to provide their input. ➤ AFNOR Certification delivers the sector-leading NF. ➤ No working groups within AFNOR group has been identified to put efforts specifically into PUR/PIR foams as insulating materials.

*AFNOR; Association Française de NORmalisation
Source: DDSC and AFNOR websites

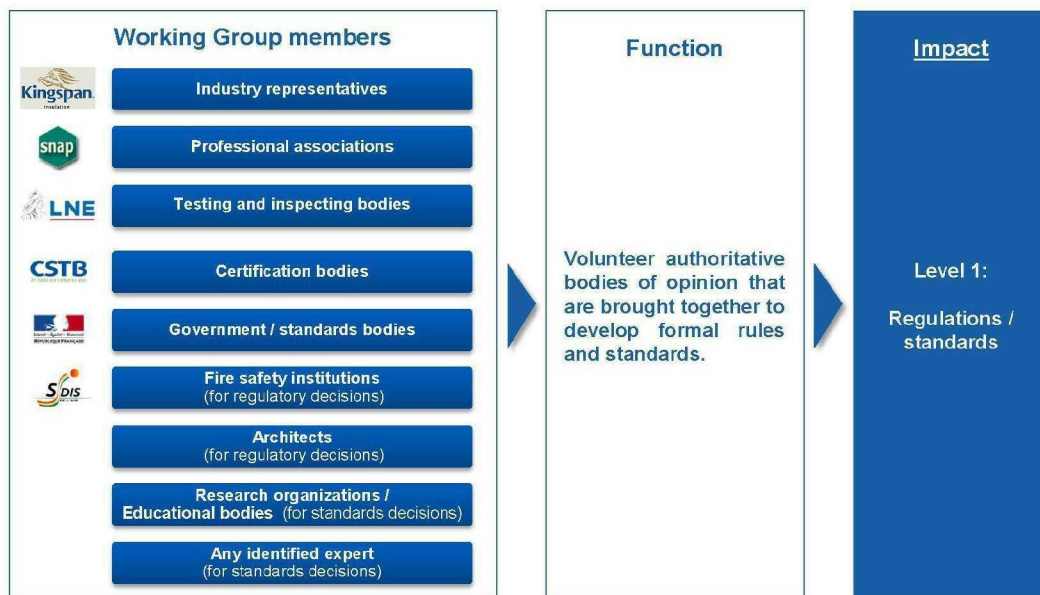


➤ Institutional bodies do not foresee any reason that would lead to major changes for PUR or PIR use, as no direct danger is identified.

Regulatory body	Field perception
 <ul style="list-style-type: none"> ➤ No major changes on the use of PUR or PIR are expected, as no concerns were raised concerning PUR/PIR foams. ➤ Changes in the regulations take more than 10 years to be put in place. <i>"For instance, the Arrêté du 24 Mai 2010 took 14 years to be finally on place!",</i> Fire safety officer, DDSC, FR ➤ The DDSC can decide to take regulatory action, following the reports of several single events where a product was presented as being a common cause. <i>"When we are changing the regulations, our goal is not to ban a product but to increase its safety, by implementing an additional protection level (e.g. stone wool layers on polystyrene or AI for PUR), or changing manufacturing procedures",</i> Fire safety officer, DDSC, FR 	 <ul style="list-style-type: none"> ➤ Smoke toxicity is not taken into account during fire intervention: evacuation is the priority. ➤ Thus, no specific concern was expressed regarding PUR/PIR foams. <i>"We have never experienced any fire disaster related these foams. As long as they are implemented in accordance with the regulatory requirements, we have no reason to raise concerns",</i> Prevention service, SDIS de l'Allier, FR ➤ Firefighters are also in charge of controlling specifications for public buildings, where requirements are stricter regarding evacuation: <i>"In public places, population is larger, not familiar with the building and panicks easily. As such, we need to be stricter to be able to have an evacuation threshold of minimum 30 min, and up to 3h for some buildings. That does not change the fact that PUR is used and actually, also as a firewall",</i> Prevention service manager, SDIS de l'Ain, FR

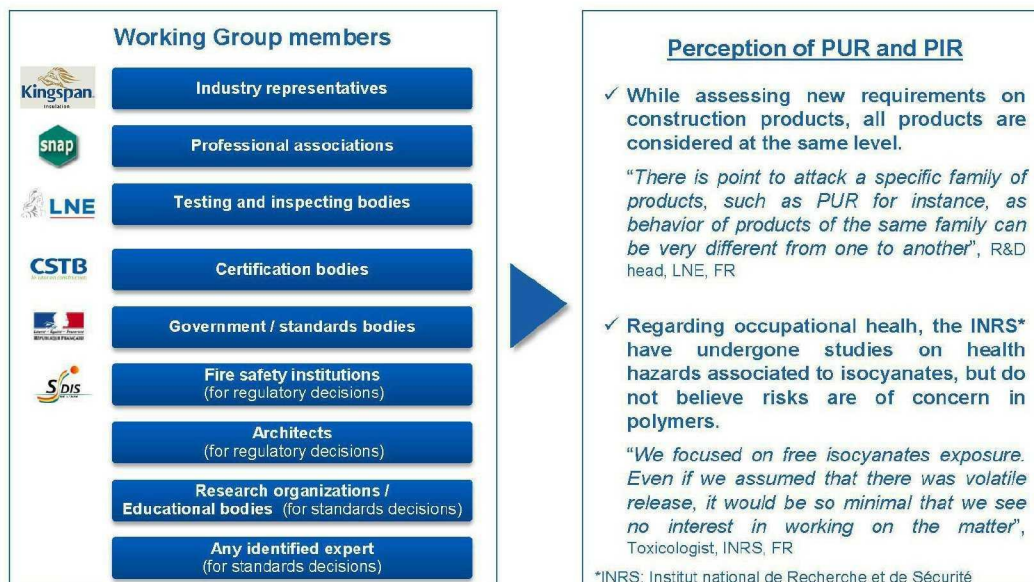


Working groups include representatives from various bodies who share their expertise to discuss PUR/PIR potential issues.





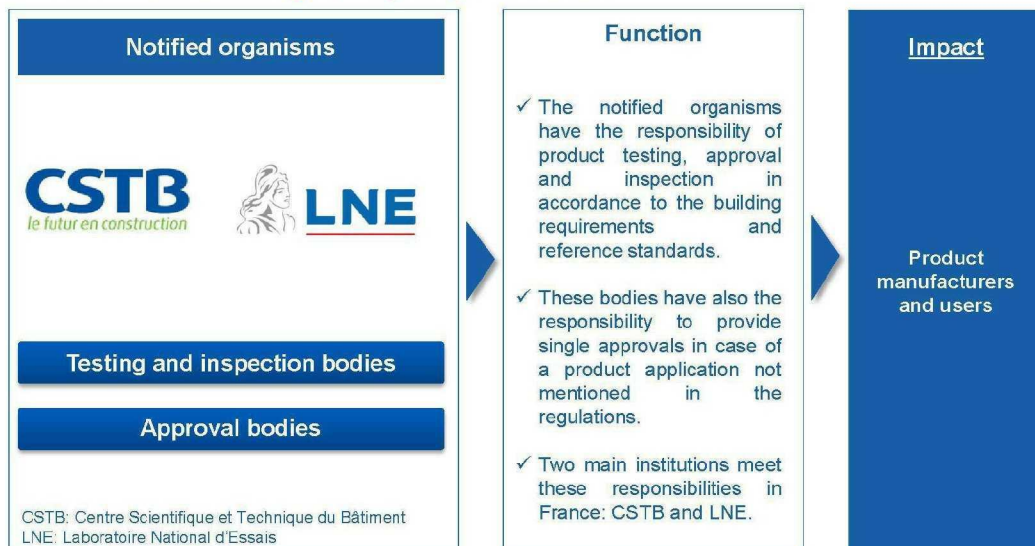
The working group members did not present concerns with regard to the use of PUR and PIR as insulators in buildings.



Source: interviews



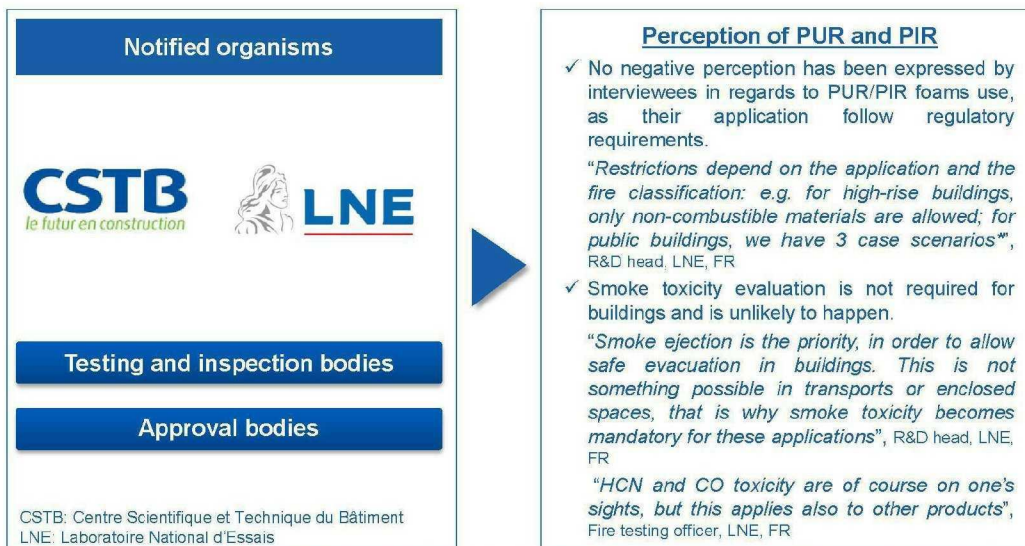
Notified organisms have the responsibility to test, approve and inspect for a specific application of a product's assembly in accordance to regulatory requirements.



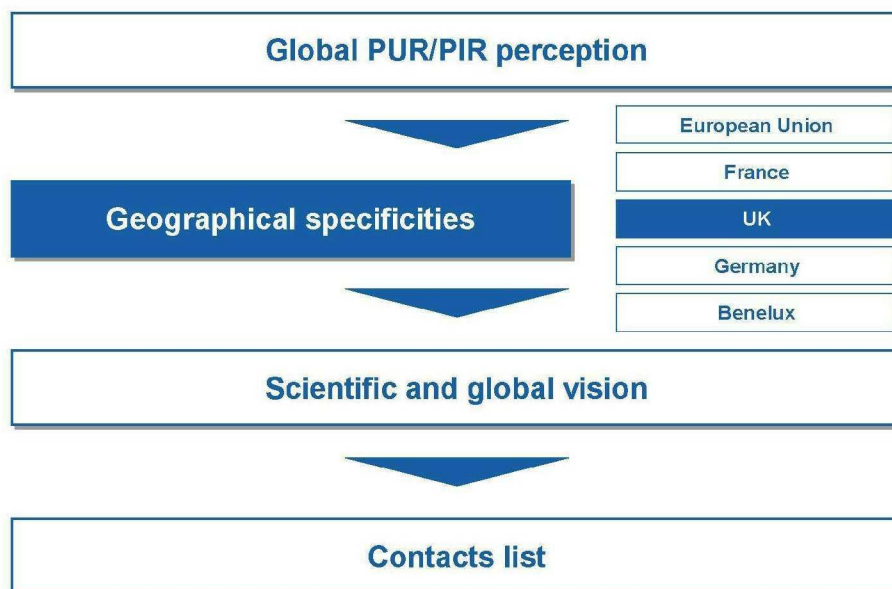
Source: Interviews, CSTB and LNE websites



➤ PUR and PIR foams do not suffer specific restrictions for application's approval, as long as they follow building regulations.



*Thermal insulators have to be either non-combustible, or have a heat shield, otherwise a complete risk assessment is required.
Source: interviews.






➤ Three main decision making levels have been identified and contacted.

Level 1	<p>Regulations/ Guidelines/ standards</p>	<ul style="list-style-type: none"> ✓ Regulatory decisions ✓ Approval of the drafts provided by the working groups ✓ Issuing of legal and semi-legal documents
Level 2	<p>Working groups</p> <p>Working group members: Experts on the particular field of interest</p>	<ul style="list-style-type: none"> ✓ Information gathering and discussion on the specific topic ✓ Recommendations' drafting for the regulatory, guidelines and standards institutions
Level 3	<p>Notified organisms</p> <ul style="list-style-type: none"> • <i>Application testing</i> • <i>Application approval</i> • <i>Inspection</i> 	<ul style="list-style-type: none"> ✓ Responsible for the implementation of the rules and guidelines approved by the regulatory and standard bodies ✓ Single approval in applications that are significantly different from the guidelines



➤ **BIS, CLG and BSI are the British institutions responsible for all building requirements, guidelines and reference standards.**

Regulations/Guidelines	Standards
<p>BIS Department for Business Innovation & Skills</p> <p>➤ BIS publishes the Building regulations</p> <p></p> <p>➤ CLG publishes practical guidance with respect to the requirements of the Building Regulations for example:</p> <ul style="list-style-type: none"> • Approved document B – Fire safety • Approved document D – Toxic Substances • Approved document L – Conservation of fuel and power (linked to energy saving and insulation) 	<p>BSI</p> <p>➤ Set how the tests for a certain application should be performed</p> <ul style="list-style-type: none"> ✓ BS ISO 15064:2010 Aromatic isocyanates for use in the production of polyurethanes. ✓ BS 4841-1:1993 Rigid PUR and PIR foam for building applications - Specification for laminated board for general purposes. ✓ BS 4841-4:2006 PUR and PIR products for building end-use applications - Specification for roofboard thermal insulation under non-bituminous single-ply roofing membranes.

Source: Interviews, BIS, CLG and BSI websites, Approved document B



➤ Regulation and standard bodies do not foresee any reason that would lead to major changes of PUR or PIR use in the next 3-5 years.

Regulations/Guidelines	Standards
<div data-bbox="268 448 331 510">BIS</div> <div data-bbox="338 452 497 506">Department for Business Innovation & Skills</div> <div data-bbox="584 448 737 519"> </div> <ul style="list-style-type: none"> ➤ In the Approved document B, CLG recommends PUR and PIR panel cores in the following situations: chill stores, cold stores, blast freezers, food factories, clean rooms... ➤ Changes in the regulations take several years to take place. ➤ No major changes on the use of PUR or PIR are expected in the next 3-5 years. <p><i>"It is hard to imagine a situation where we would ban the use of PIR or PUR for fire safety reasons but there is always the possibility that we might vary our guidance on where combustible materials can be used. We have no plans to revise this guidance in the near future",</i> Principal Construction Professional Department of Communities and Local Government, UK</p>	<div data-bbox="970 448 1136 510">BSI</div> <ul style="list-style-type: none"> ➤ Lead times for standards vary from a matter of months to several years. British standards are usually developed within 12–15 months, whilst international standards take around 3 years. ➤ Currently no new standards are in discussion that would have a major impact in the use of PUR or PIR rigid insulating panels.

Source: Interviews.

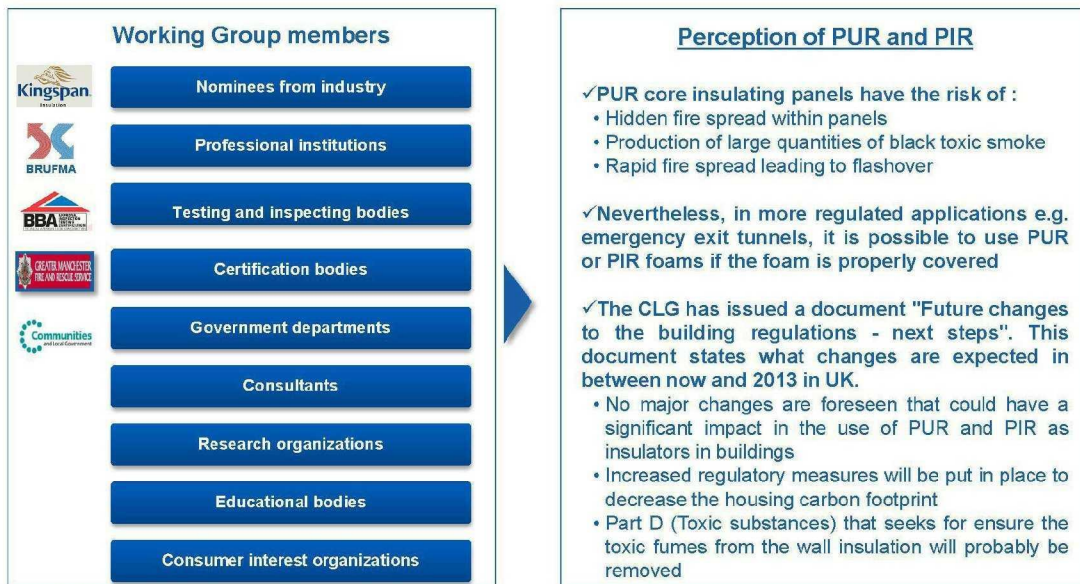


Working groups include representatives from various bodies who will bring their expertise to discuss PUR/PIR potential issues.





The working group members did not present major concerns with regard to the use of PUR and PIR as insulators in buildings.





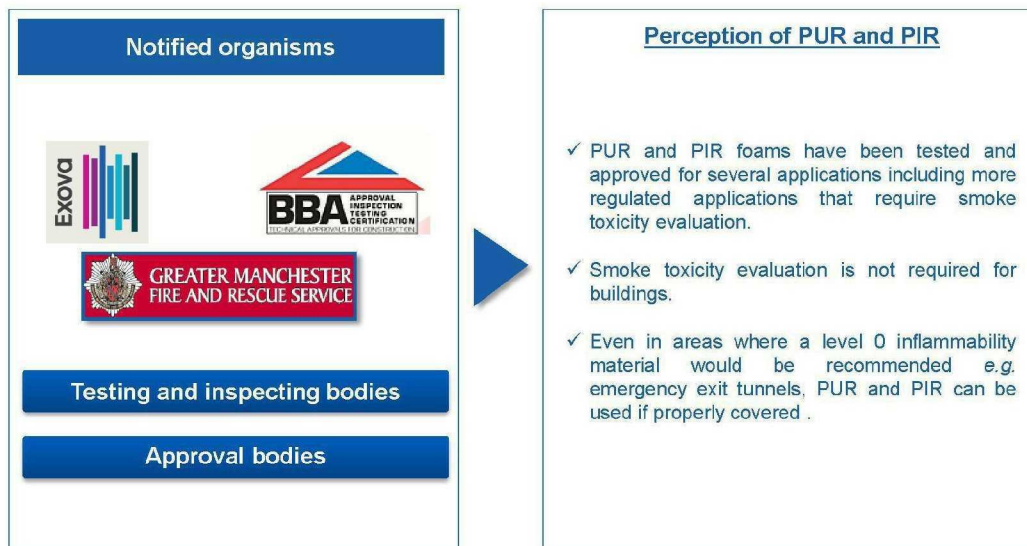
Notified organisms have the responsibility to test, approve and inspect the specific application of a product in accordance to the rules and standards of Level 1.



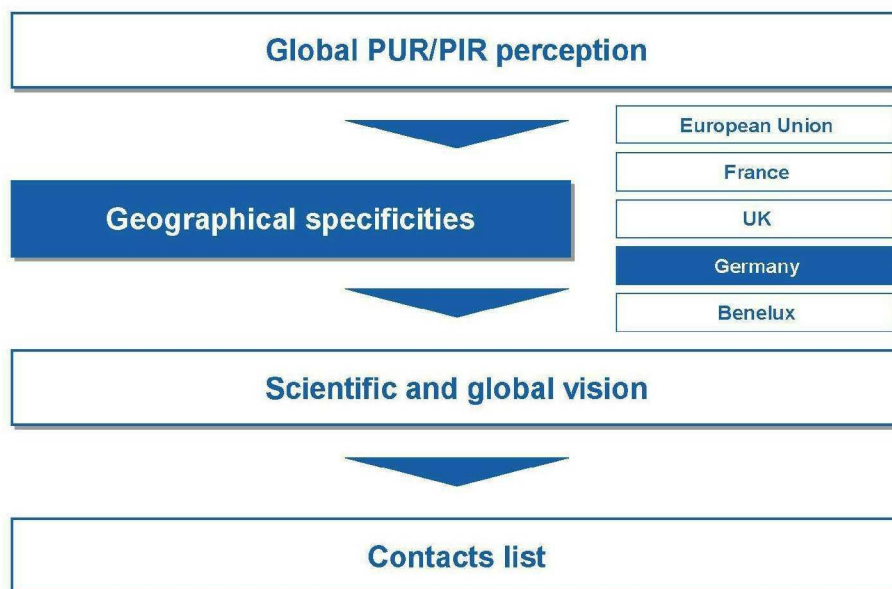
Source: Interviews, Exova, BBA and Greater Manchester fire and rescue service websites



PUR and PIR foams have been approved for several applications including in presently more extensively regulated applications.

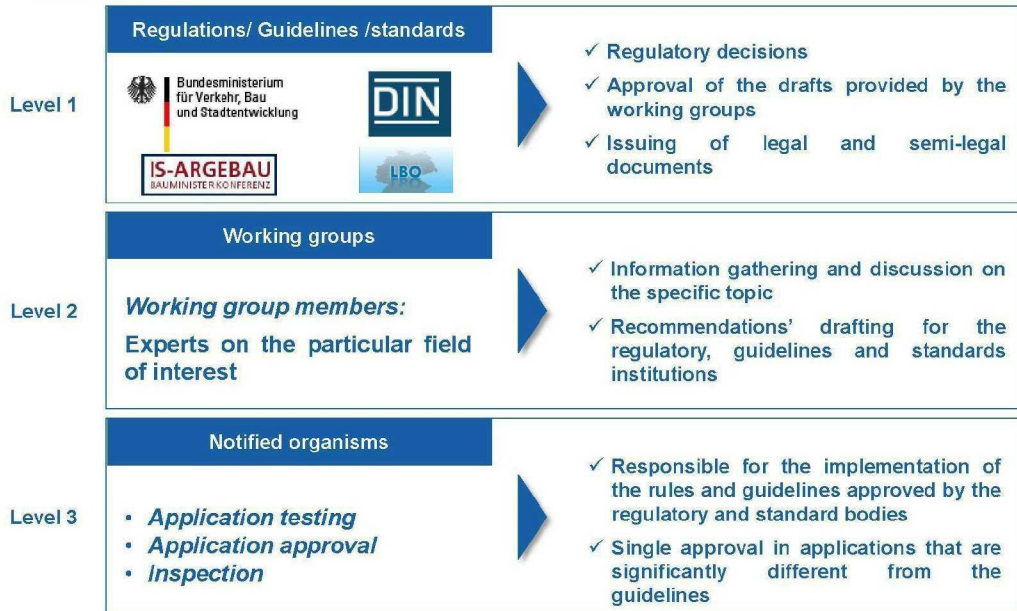


Source: Interviews.





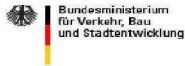
➤ Three main decision making levels have been identified and contacted.





➤ Construction products' approval follow also the requirements of both regulatory and standardization bodies in Germany.

Regulations / guidelines



- Federal Ministry of Transport, Building and Urban Development publishes the Building Regulations



Landesbauordnung (LBO)

- All 16 states publish their practical guidance at a local level, with respect to the requirements of the Building Regulations.



Bauministerkonferenz (ARGEBAU)

- ARGEBAU publishes at a federal level the practical guidance with respect to the requirements of the Building Regulations.

Standards



Deutsches Institut für Normung e. V

- Sets how the tests for a certain application should be performed.

✓CEN/TC 88/WG 6 Rigid cellular polyurethane and polyisocyanurate National mirror committee: NA 005-56-60 AA

Source: Interviews, DIN, LBO, Argebau and Federal Ministry of Transport, Building and Urban Development websites



➤ Regulation and standard bodies do not foresee any reason that would lead to major changes of PUR or PIR use.

Regulations/ guidelines



Bundesministerium
für Verkehr, Bau
und Stadtentwicklung



IS-ARGEBAU
BAUMINISTERKONFERENZ

➤ No feedback was obtained from these bodies.

Standards



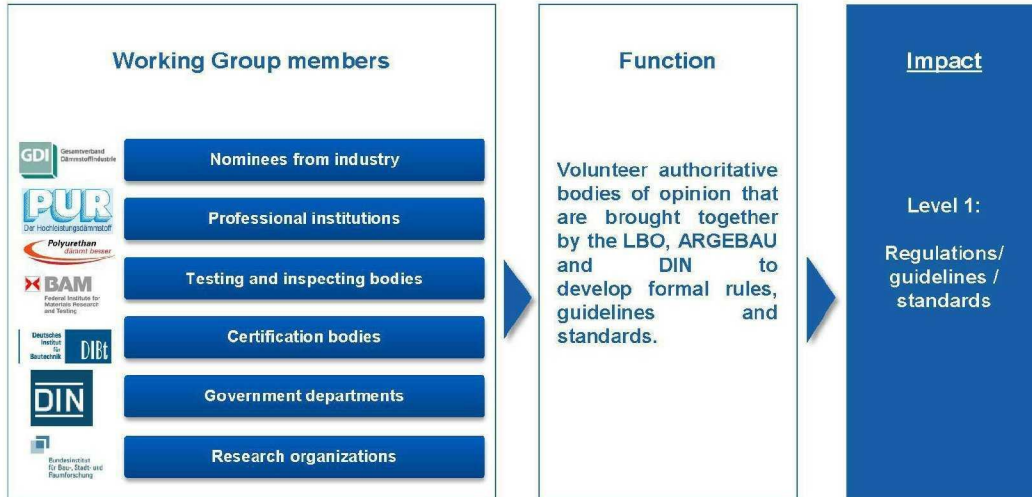
Deutsches Institut für Normung e. V

- No information regarding the PUR or PIR foams has been released by the CEN/TC 351 "Assessment of release of dangerous substances".
- Thermal insulation products for buildings - Factory made rigid polyurethane foam (PUR) products - Specification; German version EN 13165:2008

Source: Interviews.



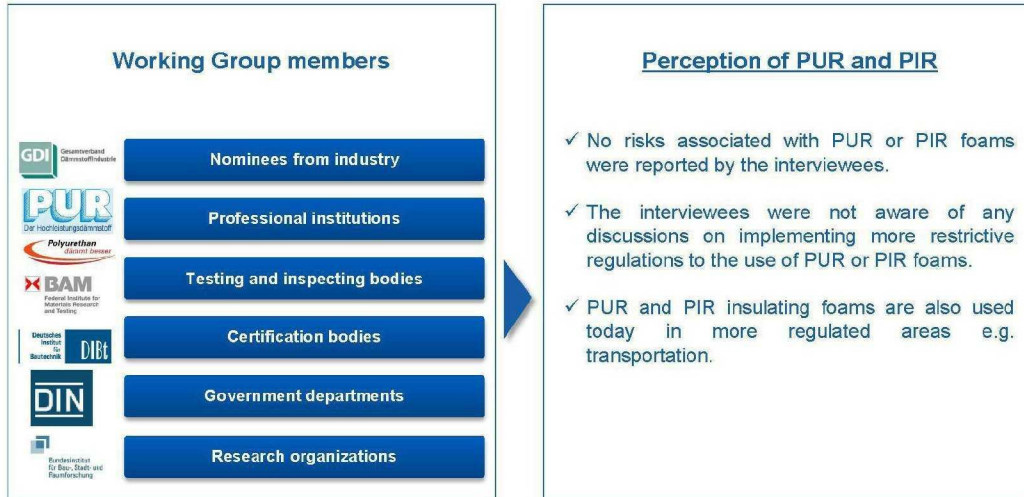
Working groups include representatives from various bodies who will bring their expertise to discuss PUR/PIR potential issues.



Source: Interviews.



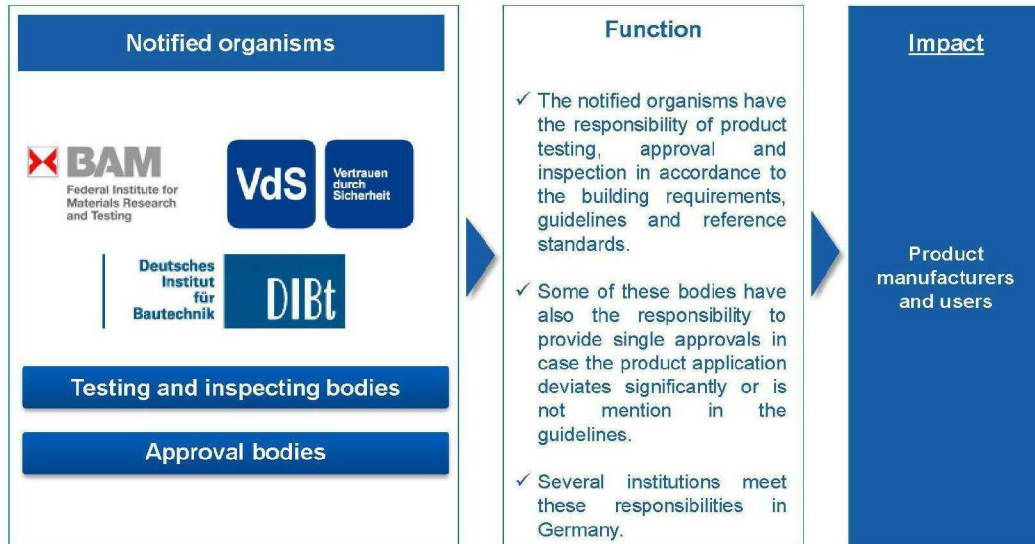
The working group members did not present major concerns with regard to the use of PUR and PIR as insulators in buildings.



Source: Interviews.



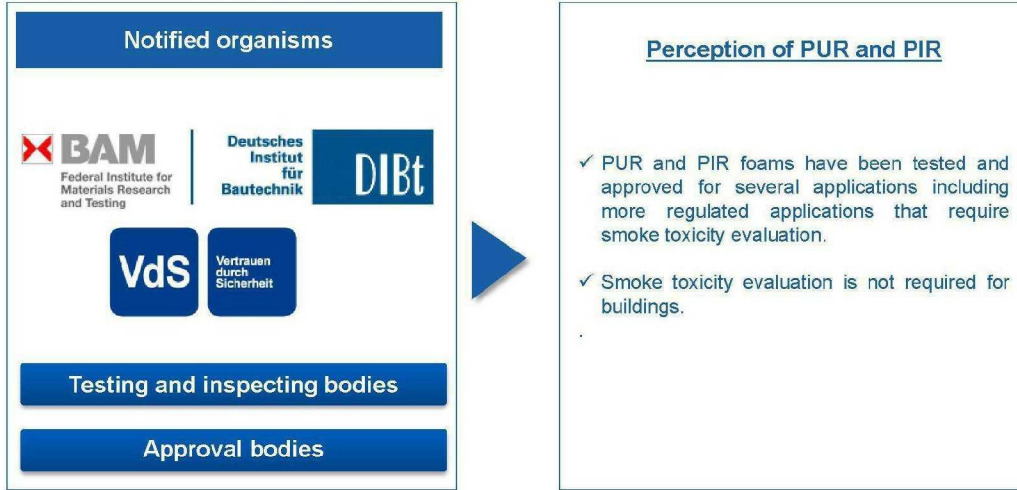
Notified organisms have the responsibility to test, approve and inspect the specific application of a product in accordance to the rules and standards of Level 1.



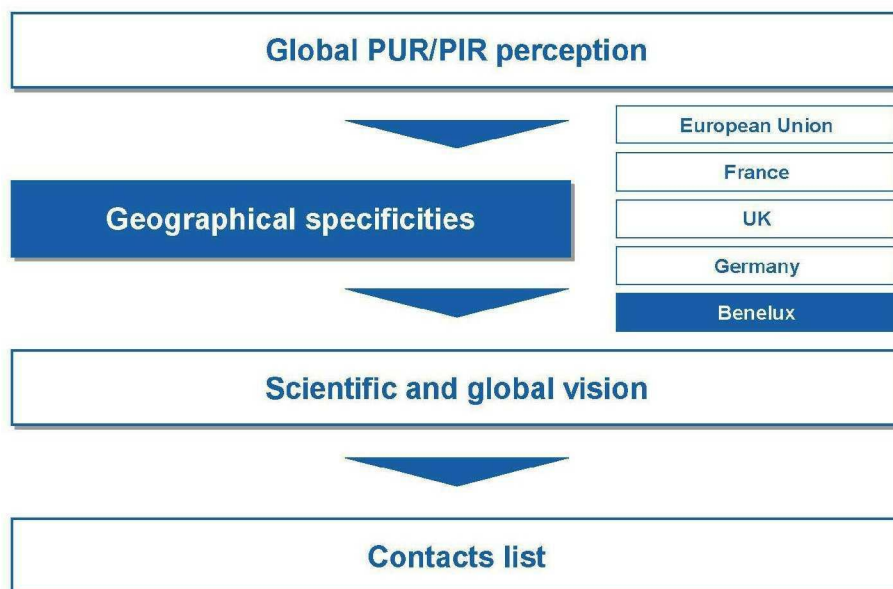
Source: Interviews, BAM, VDS and DIBt websites.



PUR and PIR foams have been approved for several applications, including in applications with stricter regulations.

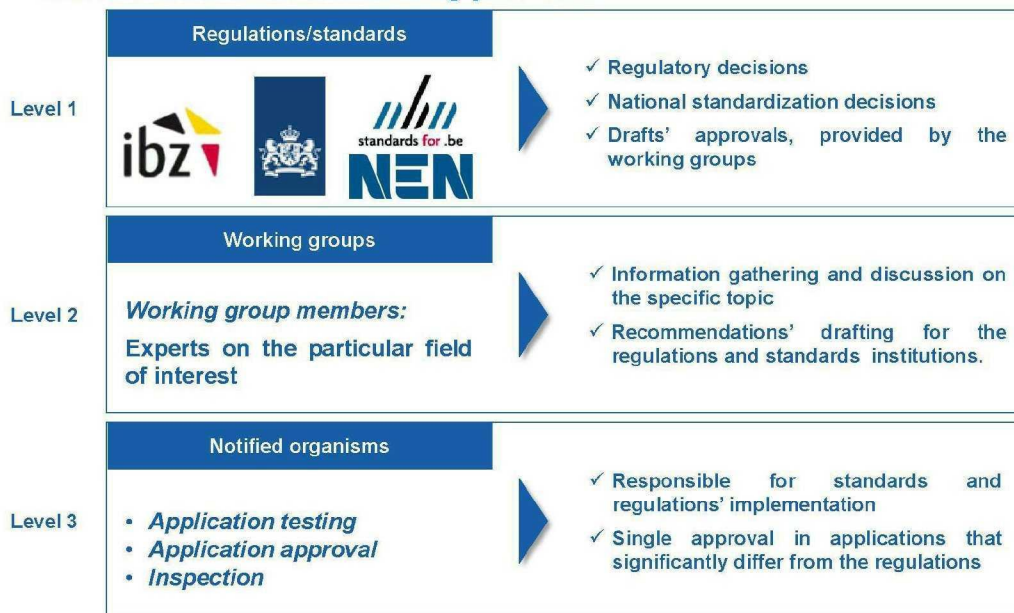


Source: Interviews.









➤ Similarly to other European countries, Benelux countries follow the same 3-level decision making process.








➤ **Construction products' approval follow also the requirements of both regulatory and standardization bodies in Benelux.**

Regulatory body	Standardization body
<div>   </div> <ul style="list-style-type: none"> ➤ In Belgium, IBZ is in charge of building regulations and fire safety. <ul style="list-style-type: none"> ✓ the Arrêté Royal for building security (December 19th 1997) states the requirements of materials depending of the building characteristics (height, public building, hotel, malls, schools....) ➤ In the Netherlands, it is under the responsibility of the Ministry of the Interior and Kingdom Relations. 	<div>   </div> <ul style="list-style-type: none"> ➤ NBN is the national standardization body in Belgium, while NEN is its equivalent in the Netherlands. ➤ No working group within both NEN and NBN has been identified as working specifically on standards related to potential PUR/PIR foams stricter testing.

Source: Interviews, NEN, IBZ and NBN websites



Interviewees from standardization bodies did not heard any negative communication on PUR/PIR, thus did not expressed any concern.

Regulatory body	Standardization body
  <p>➤ No feedback was obtained from these bodies.</p>	 <p>➤ No specific concern was expressed regarding PUR/PIR foams.</p> <p><i>"i have not heard anything negative on PUR or PIR foams. But of course, this could be linked to the fact that no single event was associated to these foams. Once there is an incident, maybe people will start talking but how can we know how they will react or if they will react at all?", Head of the cluster building materials, NEN, NL</i></p>

Source: Interviews.

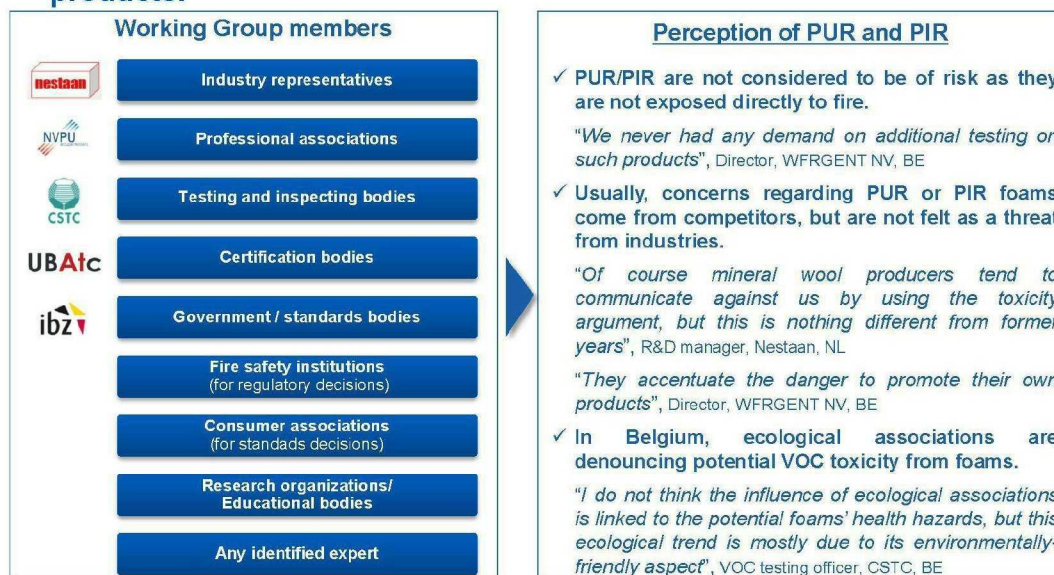


Working groups include representatives from various bodies who share their expertise to discuss PUR/PIR potential issues.





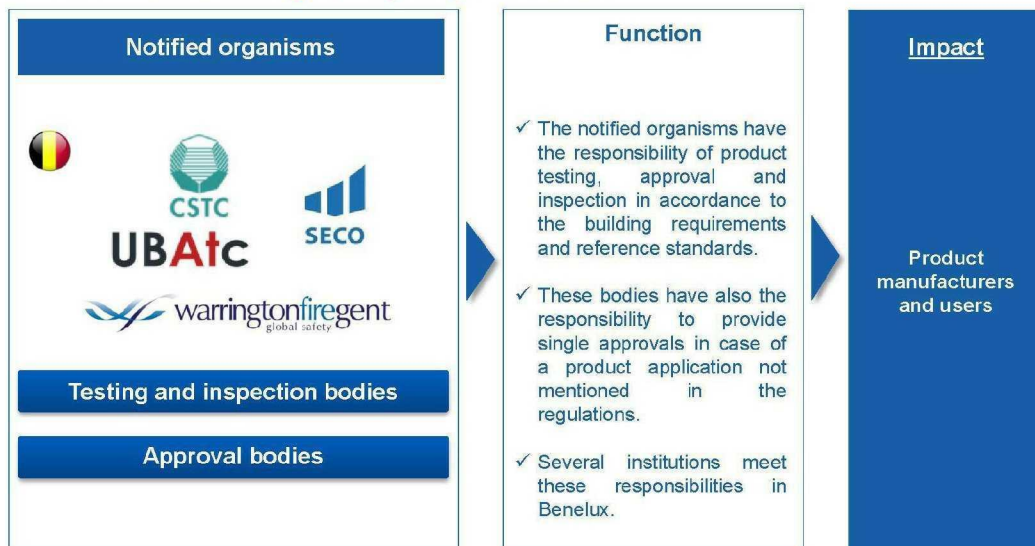
➤ There is no negative opinion specific to PUR/PIR use, apart from competitors and ecological bodies who want to promote their own products.



Source: Interviews.



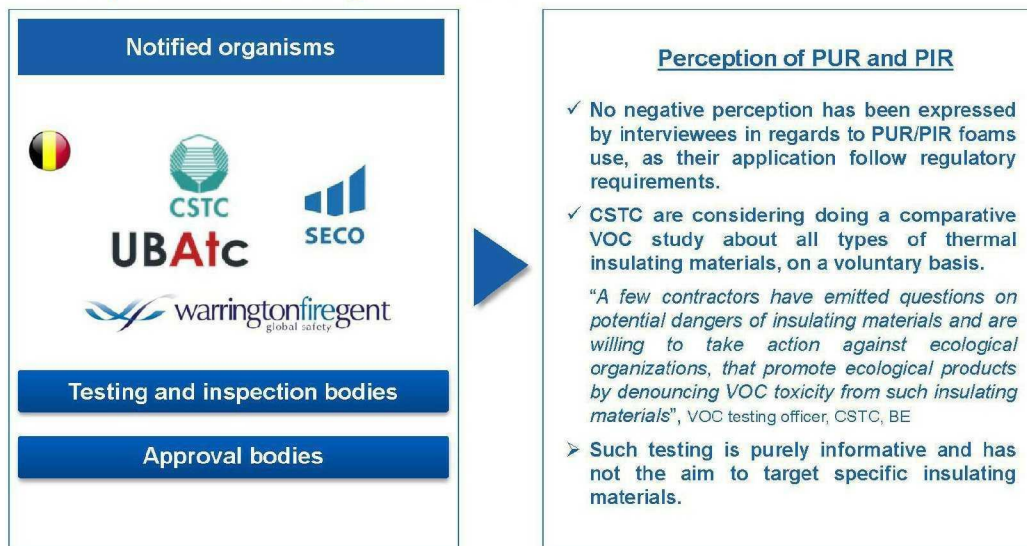
Notified organisms have the responsibility to test, approve and inspect for a specific application of a product's assembly in accordance to regulatory requirements.



Source: Interviews, notified organisms websites for Belgium and the Netherlands.



PUR and PIR foams do not suffer regulatory restrictions, but belgian notified organisms are under discussion to assess a VOC study to compare all insulating materials.



Source: Interviews.



Global PUR/PIR perception



Geographical specificities



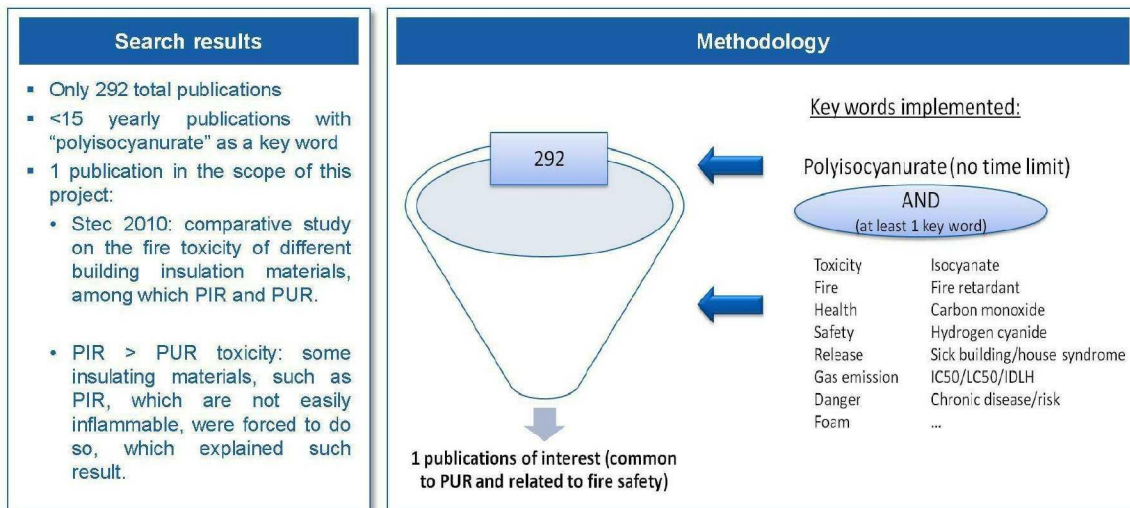
Scientific and global vision



Contacts list



PIR does not appear as a “hot topic”, with less than 15 publications per year and only one related to this project’s scope.



Source: SCOPUS database



Authors of the single PIR-related scientific publication are not willing to raise concerns about insulating materials and do not feel that PUR or PIR use is subject to controversy in the UK.

Feedback from authors

- No will to sensitize authorities or consumers about fire toxicity in building insulating materials.
- Fire fighters do not emit specific concerns about any type of insulating materials.
- Fire retardants are subject to debate as they can both be live-saving (e.g. a cigarette on the foam) or induce higher toxicity with higher CO concentration in the air (e.g. everything is burning around).

"This study was undergone on a purely academic matter"

Dr Stec, Centre for Fire and Hazard Science University of Central Lancashire, UK.

"Toxicity in a fire can not be focused on a single product such as PUR or PIR foams: toxicity is a combination of everything."

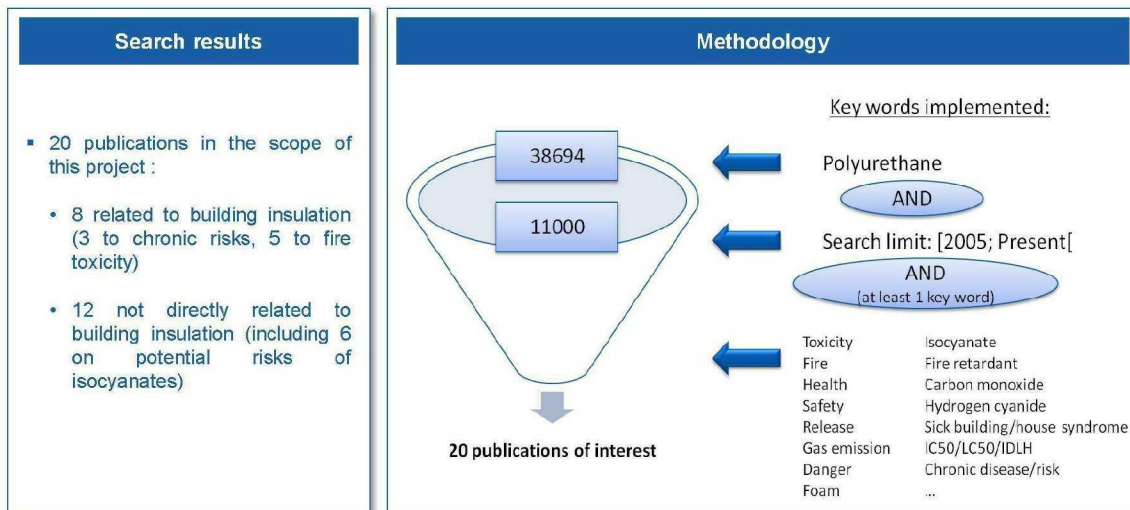
"For PUR and PIR foams, the main toxicants are HCN and CO, but they are a punctual hazard. Stable chemicals, such as dioxins or polycyclic aromatic hydrocarbons, are the compound that raise concerns."

Pr. Hull, Centre for Fire and Hazard Science University of Central Lancashire, UK.

Source: interviews with Dr. Stec and Pr. Hull



Polyurethane appears to be a product of higher scientific interest, but, since 2005, only 20 publications which studied health hazards are relevant in this project's scope.



Source: SCOPUS database



Among three publications related to chronic hazards of PUR foams, one focuses specifically on the use of PUR floor components...

Interest in project's scope



Heinzow 2009: case study on indoor air contamination

- *Context:* newly-renovated primary school building, 6-months complains from children (6-10 yo) and teachers about chemical odors and health effects (respiratory track, nasal irritation, cough, headache)
- *Results:* elevated indoor air concentrations of dibasic esters [$1-2 \text{ mg/m}^3$] originating from PUR floor component
- *Recommendation:* Using a benchmark value of 5 mg/m^3 for nasal irritation from animal experiments, an indoor air guidance value of 0.5 mg/m^3 was proposed

Lesage 2007

- Most of the airborne MDI sampling results collected in the breathing zones of the spray foam applicators exceeded the OSHA PEL*.

Lithner 2009

- Screening for leachates toxicity with *Daphnia magna*: plasticised PVC and PUR were the only plastic types of the 15 tested that displayed toxicity

* OSHA PEL: Occupational Safety and Health Administration Permissible Exposure Limit



.. but according to its first author, PUR is not considered to represent a risk for its use in construction.

1st case of complaints with PUR

- Toxicity was due to dibasic esters (solvent & softener for better flexibility/ elasticity), not to PUR itself.
- The interviewee never heard of any other single event neither for PUR or PIR.
- Results of the study were transferred to authorities: committee adopted their recommendation on dibasic esters (indoor air guidance value of 0.5 mg/m³).
- But such health risk is not of concern anymore as dibasic esters use has been banned by the EU.

"There is nothing to be worried about, we use such foams a lot, in furniture or cars for instance! I have never heard about negative "background noise" from any association or organization"

"In Germany PUR is principally used for floor insulation certainly because of fire hazards"

"Of course cyanide poisoning is of concern, but the first concern is to avoid having a fire on the first place, as it will not be the only toxic product in your house!"

Dr Heinzow, National Office for Social Services, State Agency for Nature and Environment, DE.

Source: interview with Dr. Heinzow



The most recent publications focusing on PUR fire issues confirm its toxicity while minimizing the risks that it really represents and focusing exclusively on devastating fires.

Interest in project's scope



Singh 2009

- Review on ignition, combustion, smoke, toxicity and fire-retardant performance of flexible and rigid PUR foams.
- *Conclusion:* Toxicity of PUR combustion products is much higher than that of many other manmade polymers because of high concentrations of HCN and CO. No commercial solution to the fire retardancy of polyurethane foams without some loss of physical and mechanical properties is available.

Hirschler 2008 (GHB International, USA)

- Polyurethane foam can be used safely for applications that require adequate fire safety, only if it is appropriately fire-retarded or if the correct type of fire barriers (or alternate product design) is used.

Stec 2010

- Cf. previous slides

Liang 2007 (National United Uni. & Architecture and Building Research Institute, Ministry of Interior)

- Polyethylene foam and polyurethane foam did not meet the requirements of the low fire hazard material, with a toxicity index higher than 10 ($TI < 10$), in comparison to rock wool or fiberglass

Konecki 2009

- For different types of polymers tested, of which 2 types of PUR foams, the critical state of toxicity (CO) is obtained quicker than the critical state of visibility (at least twice longer).



Issues raised about PUR toxicity in case of devastating fires are not directed towards a potential ban of these types of products.

Singh 2009

All toxicity issues mentioned are the ones that are globally raised:

- a) HCN and CO are the principal toxicants for PUR.
- b) The gases that evolve from the non-flaming combustion of urethane foams are more toxic than those from flaming combustion.
- c) Under similar conditions, the toxicity of combustion products of fire-retarded PUR foams is higher than that of conventional urethane foams because of the formation of bicyclic phosphate esters in the smoke.

- Non-building oriented
- No open communication against PUR is expressed and, as the author states, they "*have great commercial importance*"

Hirschler 2008

According to the author, banning of PUR foams is not warranted for 3 reasons:

- a) There are abundant uses for polyurethane foam where fire safety is not an issue,
- b) PUR foam can be adequately fire-retarded,
- c) It is possible to use other techniques, such as barriers, co-extrusion or general adequate design of products so that the foam is not easily reachable by the relevant ignition sources.

- The author wants to lower the impact of non evidence-supported alarming calls against PUR use
- Solutions exist against fast PUR fire ignition and should be considered



Concerns about isocyanates in occupational health may have an impact on the use of finished products such as PUR and PIR.

Interest in project's scope



Bello 2006 & 2007 (supported by the NIOSH* and CDC)

- In spite of substantial research needs, sufficient evidence already exists to justify greater emphasis on the potential risks of isocyanate skin exposure and the importance of preventing such exposures at work and during consumer use of certain isocyanate products.

Robert 2006

- From 19 factories, 4,4-methylenedianiline (MDA), a metabolite of MDI, was used to assess MDI occupational exposure. MDA was detectable in 73% of workers' urine samples.

Mirmohammadi 2009

- There was a significant relationship in exposure levels between workers' health surveillance factors (weight and appearance of disease symptoms) and concentration of absorbed isocyanates metabolites.

Booth 2009

- There are operations where airborne concentrations above exposure limits have been measured, e.g. with diisocyanate-containing aerosol where MDI or MDI-containing mixtures are applied by spraying.

Hoffmann 2010 (BASF, manufacturer of PUR)

- Following dermal uptake of TDI and MDI in male rats, systemic exposures and resulting toxicity (other than sensitization) can be expected to be very low.

*NIOSH: National Institute for Occupational Safety and Health; CDC: Centers for Disease Control and prevention



➤ Through his work, Dr. Bello is not willing to ban isocyanates but only to increase awareness on the the dangers linked to workers' exposure.

Feedback from author

- Dr. Bello's paper, dated 2007, is *"the most comprehensive review in isocyanates as for today"* and focuses on the reasons for concern regarding skin exposure to isocyanates.
- Similarly to the previously contacted academicians, the purpose of such publication was not to communicate towards regulatory authorities.
- Through his work, Dr. Bello is not willing to ban isocyanates, and has no intention to impact directly in PUR foams, as he focuses on occupational health.

"The goal of this paper was to raise awareness towards the scientific community and the consumers"

"Our funding from NIOSH and CDC came as a global funding for the whole Public Health Department. I have no idea whether they have read my work or not"

"My goal is not to advocate for isocyanates banning, but only to point out that workers should be aware of the issue and use the right equipment, follow the right procedures..."

Dr. Bello, Harvard School of Public Health, Exposure Epidemiology and Risk Program, USA (position at the time of his paper's publication).

Source: interview with Dr. Bello



➤ The Swedish government imposed stricter regulations on isocyanates exposure levels, but had no will to impact final products such as PUR or PIR foams.

Stricter maximum exposure levels

- The levels found to promote health hazards made the government drop their maximum exposure levels from 5 p.p.b. to 2 p.p.b. in Sweden.
- All workers from PUR factories were found to be exposed to isocyanates in the range 0.004–5.2 p.p.b.
 - ✓ Companies having levels superior to 2 p.p.b. adapted their factories to meet these new requirements.
- Currently, the American Conference of Governmental Industrial Hygienists (ACGIH) recommends that governments drop their maximum exposure levels to 1 p.p.b.

No intention to target PUR/PIR foams

- Such recommendations have no intention to impact on PUR or PIR foams commercialization.
- Companies need to adapt to follow the required isocyanates' exposure levels, but this should not impact the final product.

Source: interview with Dr. Tinenberg

ACGIH is a US-government organization that establishes and recommends occupational exposure limits for chemical substances



➤ According to Dr. Sagunski, isocyanates might be considered as potentially dangerous in occupational health, but show no concern in the chronic use of PUR/PIR foams.

Occupational vs. public health

- In public health, isocyanates are not of concern since they are combined with other components.
- On the contrary, in occupational health, the potential health risks of isocyanates are studied.
- In the German example, a strong separation between public health and occupational health exists: there is no influence between one another.

"I have never heard of any topic of concern from any association/ organization for PUR or PIR use."

"Occupational health raise the biggest concerns about isocyanates and I guess maybe PUR."

"Even if there were some isocyanates released in the houses, the concentration would be so small that there would be no way to measure it."

"10 years ago, there were a very few publications on people complaints living near factories using isocyanates and having health issues, but I have never heard about something similar since then."

Dr Sagunski, Public Office for Science and Health of the City of Hamburg, DE.

Source: interview with Dr. Sagunski (co-author of Heinzow 2009)



3 publications non-related to building materials were further investigated, and a single event of asthma death after PUR spraying was identified as potentially harmful for the PUR industry.

Interest in project's scope



Chester 2005

- Asthma death happened after spraying PUR truck bedliner and was partly due to the volatile isocyanates emitted by the spray

Hoffman* 2009

- PUR containing up to 24 ppm extractable MDI do not pose a critical toxicological risk to consumers. Whether higher contents are acceptable depends on the result of migration and evaporation tests.

Hillier 2009**

- Study of odours coming out from PUR foam mattresses do not show any concerns.

* BASF SE, Experimental Toxicology and Ecology, Germany

** Member of the European Association of Flexible Polyurethane Foam Block Manufacturers (EUROPUR)



Higher fire-resistance for upholstered furniture were found life-saving, but ignition control might not be enough as, in ¾ cases, furniture is still the item first ignited.

Interest in project's scope



Graham 2009

- UK fire statistics has confirmed the cost-effectiveness and life-saving value of the Furniture and Furnishings (Fire) (Safety) Regulations 1988 - which set levels of fire resistance for domestic upholstered furniture and furnishings, with several thousand lives saved and injuries prevented.
- Standard polyurethane foam was considered too dangerous for use in domestic furniture and was banned.
- The statistics also suggest that ignition controls alone would not be sufficient since, in 25% of fires, the furniture is not the item first ignited. It becomes involved by fire spread from another item, which almost certainly would be a larger source than cigarette or match flame.

Miyahara 2009*

- Regarding PUR toxicity during combustion, CO and HCN etc. of isocyanate group origin are particularly viewed as problematic. These emissions were not great even when compared to other polymeric materials often used in daily life.
- However, the risk increases when it is in the state of foam because the combustion speed is faster.

Kotresh 2009

- A comprehensive characterization of the heat release rate and burning behaviour of foam and foam/Basofil fabric combination was carried out at different levels of heat flux from 10 to 70 kW/m²: smoke toxicity and gas emission were found to be lower for the foam/fabric combination.

* As the publication is in Japanese, only the abstract has been reviewed.



➤ There was no occurrence on “polyisocyanurate” or “polyiso” in EHP, which confirms the low interest on studying PIR in the last few years.

- Environmental Health Perspectives (EHP) is a peer-reviewed open access journal published by the U.S. National Institute of Environmental Health Sciences, National Institutes of Health, Department of Health and Human Services.
- EHP deals with many scientific disciplines encompassing basic research; epidemiologic studies; risk assessment; relevant ethical, legal, social, environmental justice, and policy topic,...



Source: <http://ehp03.niehs.nih.gov/home.action>



➤ Among all EHP PUR-related publications, few were related to the project scope and mainly focus on furniture and flame retardants.



More than 100 articles on PUR exist,
Very few appear to be relevant to our scope and are mostly related to furniture and flame retardants

Imm 2009 [1] assess the current PBDE (banned in EU) body burdens and identify residential source of exposure, the highest being vehicle seat cushions.

Although bromine- and chlorine-containing flame retardants are still used in some products, the need for new alternatives is being driven by a confluence of policy, standards, and pressure from environmental groups (Betts 2008 [2])

"Instead of adding new fire retardant chemicals that ultimately may be shown to cause health problems, we should be asking whether we need to use these chemicals or if there are other ways to achieve equivalent fire safety," Arlene Blum, founder of Green Science Policy Institute [2]

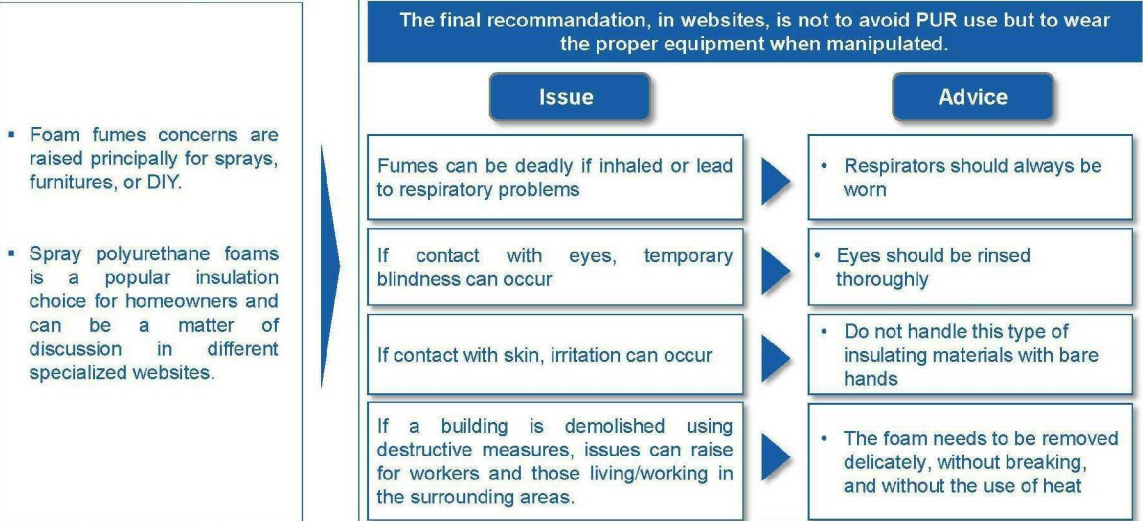


- No publication refers to any PUR building insulating materials-related health hazards.

[1] <http://ehp03.niehs.nih.gov/article/fechArticle.action?articleURI=info%3Adoi%2F10.1289%2Fehp.0900839>
[2] <http://ehp03.niehs.nih.gov/article/info:doi%2F10.1289%2Fehp.116-a210>



Concerns about foam fumes or dust are raised on different American websites but do not seem to have a negative impact as they do not encourage consumers to avoid PUR use.



http://www.ehow.com/about_5418626_danger-spray-polyurethane-foam.html; <http://www.suite101.com/content/the-dangers-and-drawbacks-of-polyurethane-foam-insulations-a290893>; <http://www.thomasnet.com/articles/plastics-rubber/foam-insulation-danger>; <http://www.doityourself.com/stry/polyurethane-foam-insulation-dangers-to-avoid>; http://www.ehow.com/facts_5845942_illness-polyurethane-foam-odor.html



➤ In several European countries, isocyanates in spray have been banned, avoiding any recent concerns on this matter.

Risk linked to isocyanates exposure

- Isocyanates are classified as being potentially carcinogen.
- According to Soudal, an ISOPA survey realized with 12000 professional users concluded that no real risk was to be of concern about PUR sprays.

Use of MDI-based isocyanates spray banned



L'Europe met fin aux aérosols avec isocyanates

Soudal lance Soudafoam SMX®,
une mousse expansive sans isocyanates,
respectueuse de l'environnement et de la santé.

- In 2008, some European countries, of which France and Germany, banned the use of MDI-based isocyanates in spray. Situation in UK and Benelux will be validated.
- Soudal, a global leader in sealants, foams and adhesives, operating in over 100 countries, launched a new expansive PUR foam without isocyanate in 2008.

<http://www.soudal.com/upload/DossierPresse72dpid.pdf>



Globally, some concerns are raised by individuals through discussion forums, but remain marginal and do not appear to have any impact.

Public questioning

- Questions either related to PUR mattresses or insulating materials
- Hazards stated include dizziness, headaches, coughing, asthma...
- Reactions towards such concerns are very low, implying a very limited impact on consumers
- Statements on PUR health risks are too inhomogeneous to be convincing, as implied in the french forum

<p>Could Polyurethane in mattress make me sick? by #0004 8 years ago 701 Ticks</p> <p>I purchased a "Temourpedic" mattress that was promoted as completely "hypoallergenic". After my wife and I both became ill (dizziness, headaches) shortly after beginning to sleep on the mattress, which is 100% polyurethane, we conducted a series of experiments that eliminated other sources of toxins, such as carbon monoxide, mold in the air, etc.</p> <p>I am told by the manufacturer that there has never been an adverse reaction to their beds. I have also learned that the off-gassing of polyurethane (VOCs) can in fact be very detrimental to health. Anyone have any experience with this type of problem or have scientific evidence that polyurethane in mattresses could cause dizziness or headaches?</p> <p>Thanks!</p> <p>8 years ago 8 answers</p>	<p>What is causing my wife's skin to feel sticky and why is she coughing up a clear substance?</p> <p>Four years ago my wife coated a floor with polyurethane. Shortly afterwards she began to cough and then she began to cough up and spit out a clear substance that her skin felt sticky and then she began to cough up and spit out a clear substance. I was probably an allergic reaction to the polyurethane. Well, four years later she is no better, if she has a cup to spit in and has to get up during the night she else had experience with these symptoms?</p> <p>Date unavailable No answer</p>	<p>Dec. 2010 1 answer</p>
<p>Isolation en panneau de polyuréthane cancerigène?</p> <p>Bonjour,</p> <p>J'ai isolé une partie de ma maison en fibre de bois mais je viens d'avoir un très bon plan (financièrement) pour avoir des panneaux en polyuréthane déclassé (Knauf Thane 24) avez vous déjà entendu parler de risque pour la santé avec ce type de matériaux (cancer/allergie)? J'ai pas mal regardé sur google mais on lit tout et son contraire...</p> <p>http://www.curezone.org/forums/am.asp?f=427994; http://www.blurtit.com/q1508093.html; http://answers.yahoo.com/question/index?qid=20101211195120AA8MCpi; http://forums.futura-sciences.com/habitat-bioclimatique-isolation-chauffage/299396-isolation-panneau-de-polyurethane-cancerigene.html</p> <p>March 2009 41 answers</p>		



Some american law firms are refering to the dangers of polyurethane foams in case of fire, but none relate them to building insulation.

- One law firm makes calls for people who qualify for lawsuit damages due to a highly flammable product that caused a fire accident, death, burns, or smoke inhalation. [1]
 - Polyurethane foam from furnitures is presented as one of the cause of such accidents.
 - To increase their potential client awareness and illustrate the dangers of PUR, they even consider stating that HCN was used in Nazi death camps during World War II.



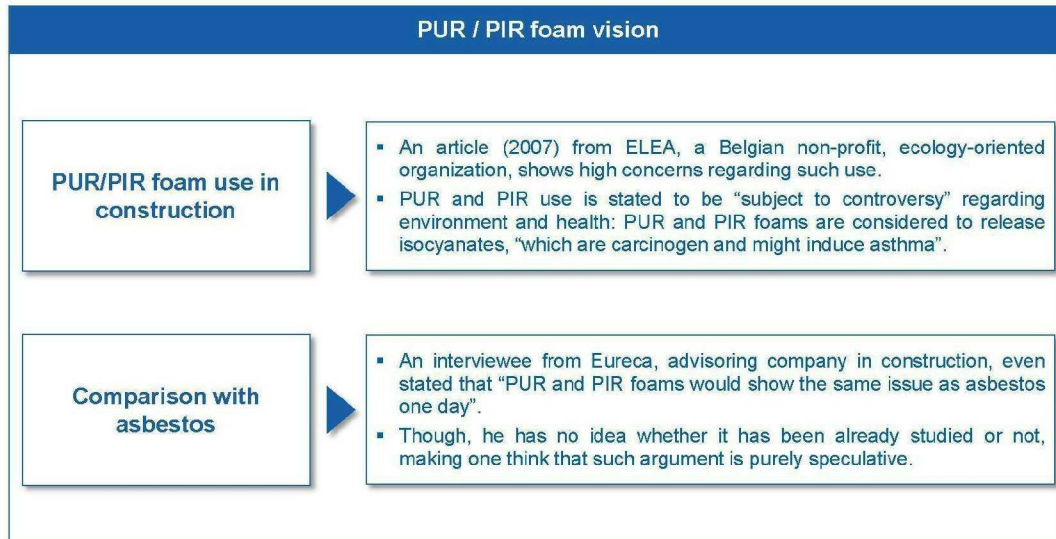
- LegalView.info is sponsored by different law firms in the US and presents several interviews about flammable PUR home furnishings. [2]



[1] <http://www.anapolschwartz.com/practices/flammable-products/polyurethane.asp>
[2] <http://flammable.legalview.info/video-library/305205/>



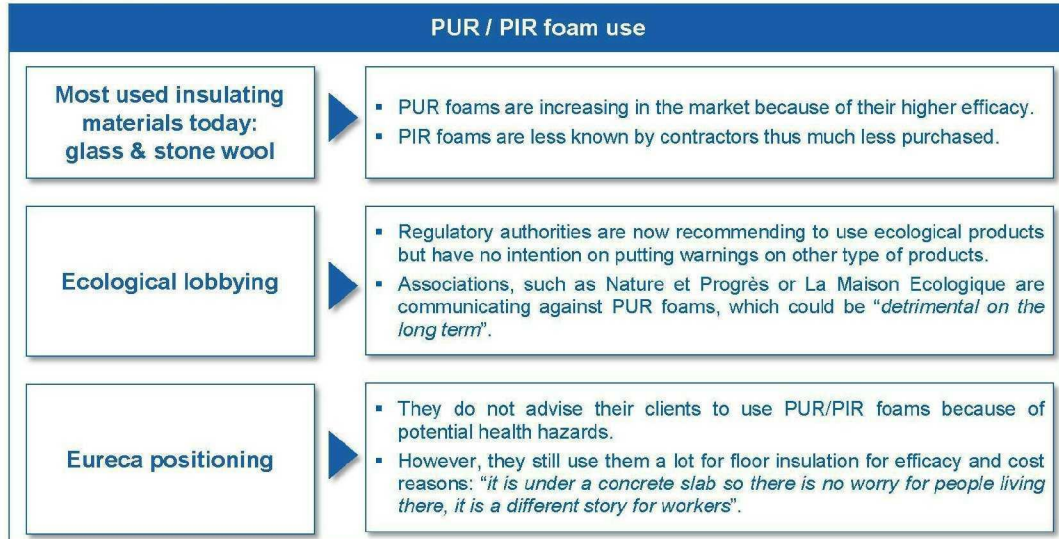
➤ The main concern about the use of PUR and PIR in construction is raised by ecologists NGOs such as ELEA...



Sources: interview with Matthieu Bourgeois, Eureka; <http://www.lanaturemamaison.be/fiches/fiche29b.pdf>



... however, their message is included in a global ecological trend and is not expected to impact regulatory authorities on the use of PUR and PIR.



Sources: interview with Matthieu Bourgeois, Eureca.



Global PUR/PIR perception










Geographical specificities



Scientific and global vision



Contacts list – publication references







	Affiliation	Name	Position
	CEN/TC 127	Amilcar Da Costa	Program Manager CEN Management Centre
	CEN/TC 127, BSI (UK)	Danny Peacock	CEN/TC 127 Secretary, Programme manager
	CEN/TC 351, NEN (NL)	Annemieke Venemans	CEN/TC 351 Secretary, Standardization consultant
	CEN/TC 351, NEN (NL)	Jody de Brouwer	Head of NEN cluster For Building materials
	SDIS de l'Ain	Cdt Yannick Vernier	Prevention service manager
	SDIS de l'Allier	NA	Prevention service
	Ministère de l'intérieur- DDSC- bureau de la réglementation incendie	NA	Fire safety officer
	LNE	Lise Rodier	Fire testing officer



	Affiliation	Name	Position
	LNE	Eric Guillaume	R&D head
	INRS, Département études et assistance médicales	Dr Nadia Nikolova-Pavageau	Toxicologist (chemical risks, pulmonary hazards)
	Greater Manchester fire service, Fire engineering department	Michael James Kelly	NA
	EXOVA Warrington fire	Dave Owen	Fire testing officer (Department of reaction and sub-department of smoke toxicity)
	EXOVA Warrington fire	Adam Brougham	Smoke toxicity testing officer (Department of reaction and sub-department of smoke toxicity)
	CLG	Brian Martin	Principal construction professional
	Health and Safety Executive	Peter Runaway	Toxicologist
	VdS, Schadenverhütung	Dr Claudia Raxsurt	NA

	Affiliation	Name	Position
	BAM	NA	NA
	Stichting BowKwaliteit (SBK), NL	Harm Verster	Senior Policy Consultant
	UBAtc, BE	NA	NA
	CSTC, BE	Kevin Vause	VOC testing officer
	Warringtonfiregent (WFRGENT NV), Gent University, BE	Pr Paul Vandeveld	Director
	SECO, BE	Mr Mehaudens	Control officer
	OEHHA	Dr. Andrew G. Salmon	Chief, Air Toxicology and Risk Assessment Unit
	KSA	Ms Raffi	NA
	KFPA	Kang Youngeun	NA






Affiliation	Name	Position
 University of Central Lancashire, Centre for Fire and Hazard Science	Pr. Richard Hull	Research Co-ordinator and Professor of Chemistry & Fire Science
 University of Central Lancashire, Centre for Fire and Hazard Science	Dr. Anna Stec	Lecturer in Chemistry and Fire Science
 Public Office for Science and Health of the City of Hamburg	Dr. Helmut Sagunski	Toxicologist
 National Office for Social Services, State Agency for Nature and Environment	Dr. Birger Heinzow	Member of the Subcommittee on Toxicology and Risk Assessment
 Harvard School of Public Health, Exposure Epidemiology and Risk program	Dr. Dhimiter Bello	Post-doctoral fellow (at the time of publications on isocyanates) <i>[Current: Assistant Professor at Umass Lowell University]</i>
 University of Lund, Occupational & Environmental Hygiene Department	Dr. Tinnerberg	Head of section



	Affiliation	Name	Position
	PU Europe (PUR association)	Oliver Loebel	General secretary
	BRUFMA (PUR association)	John Roberts	CEO
	GDI (PUR association)	Peter Seelig	Managing director
	Bauder (PUR industry)	Arisles Shineller	Marketing department
	NVPU (PUR association), Nestaan (PUR industry), NL	Yvo Trembos	NVPU Member, R&D manager
	Eureca absi, BE	Mathieu Bourgeois	Technical advisor, specialized in thermal insulation and low energy buildings



	Affiliation	Name	Position
	Saint-Gobain	Hélène Gascon	Chef de projet, REACH
	Saint-Gobain, Gypsum	Ingrid Haraldsson	Building Systems Advisor
	Saint-Gobain ISOVER	Christian Ehm	Isover TE-Laborleiter (head of laboratory)
	Saint-Gobain ISOVER	Nicolas Legendre	Fire Team Manager
	Saint-Gobain	Hans-Dieter Middendorf	Research & Development manager, EPS
	Saint-Gobain, CertainTeed Corporation	Stanley D. Gatland	Manager of Building Science Technology



- **Bello 2006.** *An FTIR investigation of isocyanates skin absorption using in vitro guinea pig skin.* J. Environ. Monit., 8, 523–529
- **Bello 2007.** *Skin Exposure to Isocyanates: Reasons for Concern.* Environ Health Perspect 115:328–335
- **Booth 2009.** *Measurements of airborne methylene diphenyl diisocyanate (MDI) concentration in the US workplace.* Journal of Occupational and Environmental Hygiene, 6: 4, 228-238
- **Chester 2005.** *Asthma death after spraying polyurethane truck bedliner.* American Journal of Industrial Medicine, 48 (1), pp. 78-84
- **Graham 2009.** *Furniture thoughts.* Fire Risk Management, (SEPTEMBER), pp. 28-31
- **Heinzow 2009.** *Dibasic esters as new and relevant indoor air contaminants [Raumlufbelastung mit Dicarbonsäuredimethylestern] Gefahrstoffe Reinhaltung der Luft, 69 (4), pp. 159-164*
- **Hillier 2009.** *Study of odours coming out of polyurethane flexible foam mattresses.* Cellular Polymers, 28 (2), pp. 113-144
- **Hirschler 2008.** *Polyurethane foam and fire safety.* Polymers for Advanced Technologies, 19 (6), pp. 521-529
- **Hoffmann 2009.** *Evaluation of consumer risk resulting from exposure against diphenylmethane-4,4'-diisocyanate (MDI) from polyurethane foam.* EXCLI Journal, 8, pp. 58-65
- **Hoffmann 2010.** *Dermal uptake and excretion of 14C-toluene diisocyanate (TDI) and 14C-methylene diphenyl diisocyanate (MDI) in male rats. Clinical signs and histopathology following dermal exposure of male rats to TDI.* Toxicology Letters Volume 199, Issue 3, Pages 364-371
- **Konecki 2009.** *Simple fire model for comparative studies of critical conditions during combustion of chosen polymer materials.* Journal of Civil Engineering and Management, 15 (3), pp. 247-257
- **Kotresh 2009.** *Heat release and burning behaviour of foam and foam/Basofil fabric combination.* Polymer Testing, 28 (5), pp. 511-520
- **Lesage 2007.** *Airborne methylene diphenyl diisocyanate (MDI) concentrations associated with the application of polyurethane spray foam in residential construction.* Journal of occupational and environmental hygiene 4: 2, 145 -155
- **Liang 2007.** *Toxicity characteristics of commercially manufactured insulation materials for building applications in Taiwan.* Construction and Building Materials, 21 (6), pp. 1254-1261
- **Lithner 2009.** *Leachates from plastic consumer products - Screening for toxicity with Daphnia magna.* Chemosphere, 74 (9), pp. 1195-1200
- **Mirmohammadi 2009.** *Risk assessment of hexamethylen diisocyanate and hexamethylene diamine in the polyurethane factories.* Pak J Med Sci, Vol. 25 No. 4 613-618
- **Miyahara 2009.** *Study of the combustion product gases of polyurethane and other polymers and their safety.* Zairyo/Journal of the Society of Materials Science, Japan, 58 (9), pp. 747-752
- **Robert 2006.** *Biological monitoring of workers exposed to 4,4-methylenediphenyl diisocyanate (MDI) in 19 French polyurethane industries.* Int Arch Occup Environ Health . 80:412–422
- **Singh 2009.** *Ignition, combustion, toxicity, and fire retardancy of polyurethane foams: A comprehensive review.* Journal of Applied Polymer Science, 111 (2), pp. 1115-1143
- **Stec 2010.** *Assessment of the fire toxicity of building insulation materials.* Energy and Buildings, Article in Press



- PU associations have already performed VOC and ageing testing, which showed no issue regarding chronic hazards.

Evaluation in accordance with the AgBB diagram (28 days):

VOC testing

Sample name: PUR insulation panel	
Overview of results 28 days	Measured values [µg/m³]
TVOC ($C_6 - C_{16}$)	0
Σ VOC excl. NIK ($C_6 - C_{16}$)	0
Σ SVOC ($C_{18} - C_{22}$)	0.000
Σ cancerogens	0
Σ R _i [-]	0

Ageing

Property	Initially declared characteristics	Measured value after 28 years
Facing: Aluminium multilayer facing on both sides, one side perforated		
Thickness	100 mm	101.08 mm
Moisture content	Not declared	0.05 Vol.%
Compressive strength	150 kPa	208 kPa
Thermal conductivity	0.030 W/(m·K)	0.0292 W/(m·K) (10°C mean temperature)
Reaction to fire	Class B2 (normally ignitable) in accordance with DIN 4102-1 No flaming droplets / particles	Class B2 (normally ignitable)* in accordance with DIN 4102-1 No flaming droplets / particles

Source: http://www.pu-europe.eu/site/fileadmin/Factsheets_public/Factsheet_16_Durability_of_polyurethane_insulation_products.pdf,
http://www.excellence-in-insulation.eu/download/EPD-IVPU-2010112-E_2010-09-09_TS_Tradox.pdf