



Synthetic turf: overview of the different infill types and associated standards



Overview

1. The different types of infills: main characteristics and criteria of choice
2. Crumb rubber debate: What do the studies say? Next steps
3. The standards/tests to be carried out in case of change of infill



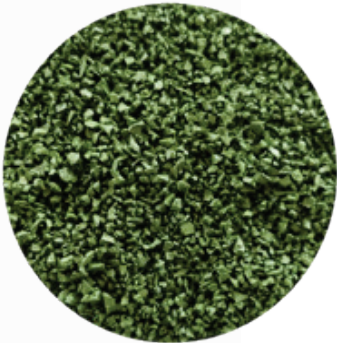
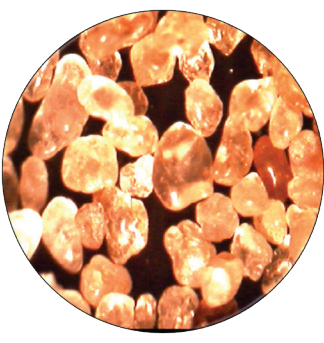
The different types of infills

Infills are key at several levels

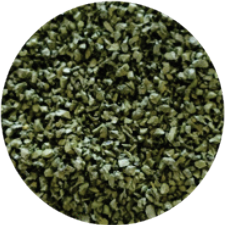
1. Maintain the fiber and stabilize the grass (weight)
2. Give the playing surface its sporting properties (flexibility, shock absorption, rotational resistance) and player comfort (friction, heat)
3. Get as close as possible to natural grass (color, odor, etc.)



- 4 large families -

THERMOSETS Irreversible polymerization: Cannot be melted	THERMO- PLASTICS Can be re-melted	VEGETAL "ORGANICS"	INORGANICS "SANDS"
			
• Tire aggregates (ELT) • New/Recycled EPDM • Recycled rubber • Thermosets Mixes	• TPE: Thermoplastic elastomers • TPO: thermoplastics olefins • PE: Polyethylene • Thermoplastic Mixes	• Coconut & Similar Fibers • Cork/Tree Bark • Organic material Mixes	• Sands (encapsulated or not) • Recycled inorganic materials (e.g. glass)

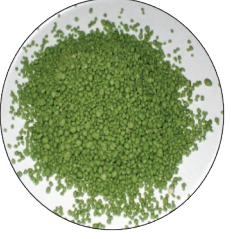
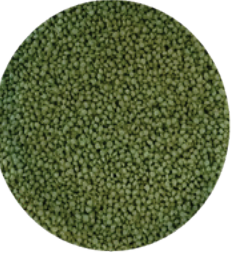
THERMOSETS: ELT

	Name	Description	Density (g/cm ³) (± 10%)	Main benefits	Main disadvantages
	ELT Ambient	Crumb rubber from tire shredding	0.4 - 0.5	• Cost (95% of fields) • Athletic Performance (excellent elasticity and durability) • High UV resistance	• Negative Perception of rubber • Rubber odor (in hot season) • Aesthetic (Black color)
	ELT Cryo	Crumb rubber cryogenics		• Like ambient ELT (except cost) • Reduction in fine particles	• Same as ambient ELT • Limited supply
	Coated ELT	Crumb rubber coated by a layer of PU or acrylic resin (brown or green)		• Same as ambient ELT • Reduction in fine particles • Aesthetics (Color)	• Different coating qualities existing on the market • Premature wear of the coating according to the quality

THERMOSETTING: EPDM

	Name	Description	Density (g/cm ³) (±10%)	Main benefits	Main disadvantages
	EPDM	Ethylene propylene diene monomer (EPDM) made from virgin or recycled synthetic rubber	0.6 - 0.7	• Athletic Performance (elasticity) • Good particle size distribution due to its angular shape • Limited fine particles	• High cost • Medium UV Resistance • Cannot be reused • Different qualities (various origin/recycling): A low polymer content can lead to premature ageing problems and agglomeration • Limited supply

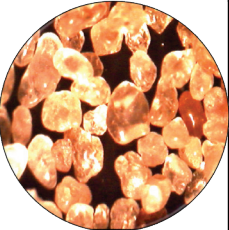
THERMO-PLASTICS

	Name	Description	Density (g/cm ³) (±10%)	Benefits	Disadvantages
	TPE – TPO	Thermoplastic based on elastomer or olefin	0.75 – 0.85	• Athletic Performance (elasticity) • Odorless • Limited fine particles • Can be recycled	• Cost • Medium UV Resistance • Different qualities (low polymer content = > Ageing, agglomeration problems) • Limited supply • mobility due to infill homometry and shape
	PE	PE aggregates from Synthetic Turf fibers	0.4	• Polymer identical to synthetic fibers • Odorless and dust free • Can be recycled	• Cost • Limited athletic Performance (hardness) • Limited supply • mobility due to infill homometry and shape

ORGANICS

	Name	Description	Density (g/cm ³) (±10%)	Benefits	Disadvantages
	Cork	100% Natural Cork	0.2 - 0.3	• Completely natural • Most durable organic matter • UV Resistant and fireproof • Heat reduction • Natural aesthetics of the soil • Low density • Odorless and rot resistant	• Cost (combined with an underlayer) • Limited Sport Performance • Displacement/loss of infill during heavy rains (low density) • Additional Maintenance • Additional filling required • Limited supply
	Mixture of organic materials	Coconut fiber or similar, tree bark...		• Heat reduction • Natural aesthetics of the soil • Low density • Odorless	• Same as cork • Additional maintenance required (moisture retention) • Degradation of materials (permeability problem-compaction)

INORGANICS

	Name	Description	Density (g/cm ³) (±10%)	Benefits	Disadvantages
	Sand	Soft silica-based rounded granular sand infill	1.4 - 1.5	• Low cost • Low maintenance • Good permeability • Supply	• Hardness • Abrasiveness (Users and fibers) • Pollution (clogging)
	Coated sand	Sieved rounded sand infill based on silica coated with resin (PU or acrylic)		• Low maintenance • Good permeability • Aesthetics	• Abrasiveness (Users and fibers--> coating degradation) • Hardness • Cost (combined with an underlayer) • Pollution (clogging) • Variable coating quality: fiber pollution and filling

Comparison of Benefits & Disadvantages

	ELT Crumb rubber	EPDM New	EPDM Recycled	TPE New	Organics
Price(€/t)	5	2	3	1	2
Sustainability	5	3	1	1	1
Sports Performance	5	4	3	2	1
Maintenance	5	5	5	5	1
Perception (color, odor, T °)	2	5	4	5	5
Perception (Health/environment)	1	3	2	3	5

Market share

90%

5%

<1 %

<1 %

<5 %



Debate on crumb rubber



What risks are we talking about?

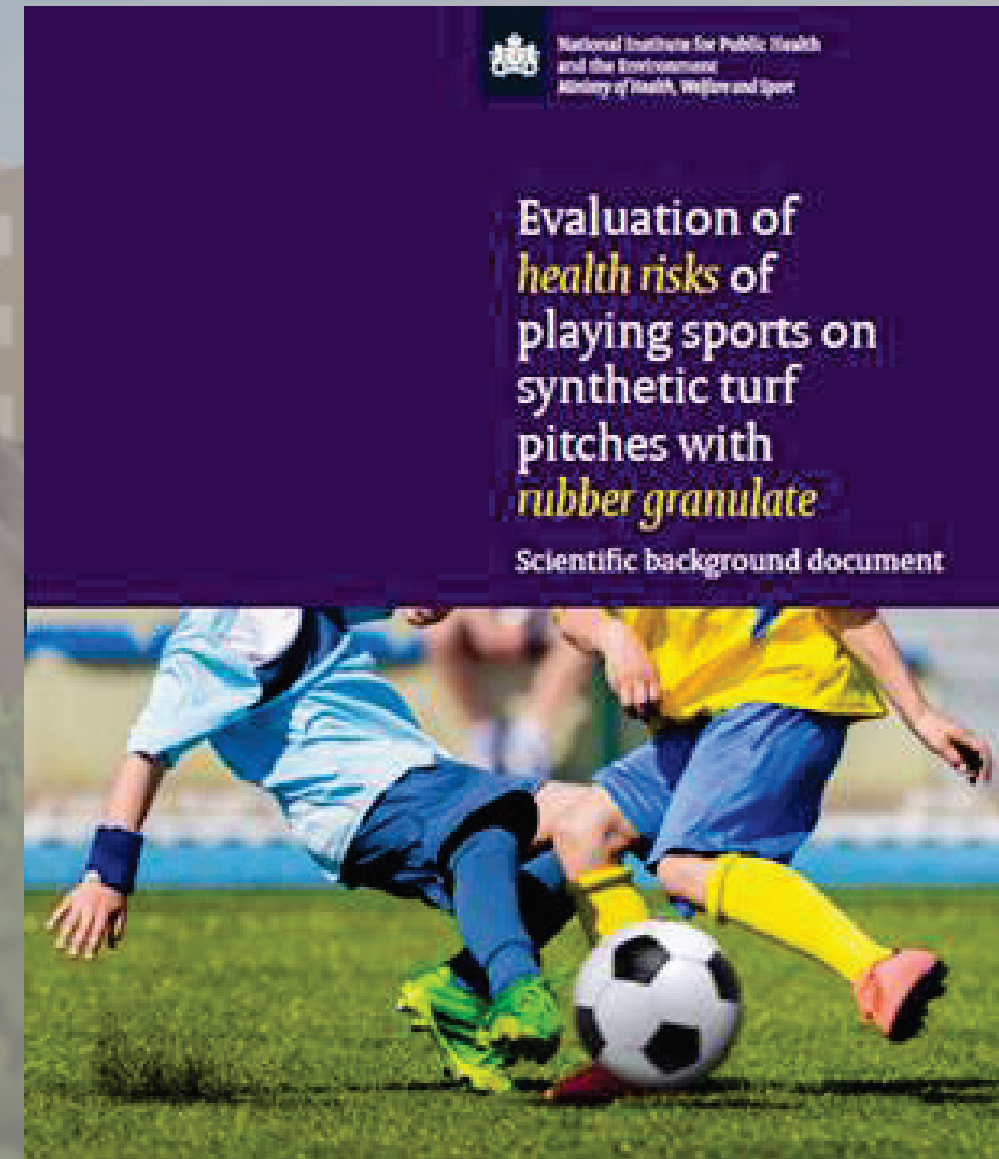


What do the studies conclude now?



Netherlands : RIVM Study

- Dutch National Institute for Public Health and the Environment (Dec. 2016)
 - According to their results, playing games on fields of synthetic turf is not dangerous to the health.
 - The rubber particles contain many substances (PAH, BPA, Plasticizers...) but are released in limited quantities.
 - Some metals can migrate to the environment
 - The additional cancer risk is much lower than the maximum allowable and slightly higher than the negligible risk (1 additional cancer cases in 1 million).
 - No link between leukemia and the increase in artificial turf field installations in recent years.
- Set more demanding PAH limits than those present in REACH (entry 50 annex XVII)
- <https://echa.europa.eu/-/lower-concentration-limit-proposed-for-pahs-found-in-granules-and-mulches>



[http://www.rivm.nl/en/About RIVM/Mission and strategy](http://www.rivm.nl/en/About_RIVM/Mission_and_strategy)

ECHA Study

- European Chemicals Agency (February 2017)
- PAH concentrations were measured in recycled rubber pellets (< 20 mg/kg), the risk of lifelong cancer for players and workers is very low
- The risk of heavy metals is negligible (levels under the standard of toys)
- No problems with other substances (other than indoor VOCs that can cause irritation to the eyes and skin).

→ Recommendations:

- Test the infills used on site
- Suitable indoor ventilation
- Comply with basic hygiene rules
- Reflect on requirements to ensure low levels of PAH



ANNEX XV REPORT

AN EVALUATION OF THE POSSIBLE HEALTH RISKS OF RECYCLED RUBBER GRANULES USED AS INFILL IN SYNTHETIC TURF SPORTS FIELDS

Substance Names: Substances in recycled rubber granules used as infill material in synthetic turf

EC Number: Not relevant

CAS Number: Not relevant

Submitter: ECHA

Date: 28 February 2017

ECHA has found no reason to advise people against playing sports on synthetic turf containing recycled rubber granules as infill material. This advice is based on ECHA's evaluation that there is a very low level of concern from exposure to substances found in the granules. This is based on the current evidence available. However, due to the uncertainties, ECHA makes several recommendations to ensure that any remaining concerns are eliminated.

<https://echa.europa.eu/fr/about-us/who-we-are/mission>

US EPA – Washington State

- U.S. Environmental Protection Agency (December 2016)
- Study Plan for 2/3 years. Only the part concerning the exhaustive census of scientific studies on the subject was conducted. 97 studies referenced and categorized.
- One conclusion is that some areas are well studied (level of substances contained in aggregates) and others less (human exposure).
- Life-size study on the exhibition conducted in autumn 2017
- Washington State Department of Health (April 2017): The statistical number of cancer cases identified by a trainer are less than those of the average population of the relevant age group in Washington state.



*Investigation of Reported Cancer
among Soccer Players in
Washington State*

Regulations and standards: global overview

	Stage	Standard regulation	Private Labels	Comments
	Tire Production	REACH		REACH : Manufacturer's declaration. No frequency imposed, but commits its responsibility
	Granulation			Technigom : Origin traced + random tests by third-party laboratories
	Transport			FFF (NF P90-112) : Identification and environment
	Installation on site		TEST YOUR INFILL 	Testyourinfill : Toxicity (HAPs REACH & standard of toys) Manufacturer's specifications

REACH- Tires regulations

- The European REACH regulation requires all manufacturers and importers of chemical substances placed on the market ($> 1\text{t/yr}$) to register these substances with ECHA
- Companies must identify and manage the risks associated with the substances they manufacture and market in the EU (Declaration of conformity of products placed on the European market)
- Since 2010, tires produced in the countries of the European Union must comply with this Regulation

REACH Regulation – Granules from tires

The case of granules from tires used for synthetic turf has recently been clarified by the European Commission (CARACAL)

Rubber granules used as infill for synthetic turf surfaces are classified as "mixtures" for the European regulations REACH

As such, rubber granules must conform to entry 28 of annex XVII of the REACH Regulation (PAHs are part of this entry)

TECHNIGOM LABEL

- "Made in France" granules manufactured by companies member of the Aliapur network, exclusively from tires collected on the French market
- From 5 years old average tires, traceability ensured by collecting companies
- Pure and calibrated product, whose quality is controlled by independent laboratories analyzing samples randomly.

Source: Aliapur

Label Labosport : « testyourinfill.eu »



Online order of
REACH PAHs tests
& Heavy metals
(Toys Standard)



ANALYSE your INFILL within 3 WEEKS

A chemical analysis will allow to identify the material's nature, its origin and raise a flag in case its chemical composition will be considered unusual by our experts.

WHO CAN DO THIS FOR ME ?

Any laboratory equipped with Gas Chromatography and ICP can perform those analyses.

Labosport is an independent ISO-17025 laboratory dedicated to sport surfaces, we have been testing infill materials since 2005.

We can therefore compare your infill with hundreds of others and precisely interpret your test results.

HOW DOES IT WORK ?

STEP 1



Place your order, you will receive a tag from our customer service department.

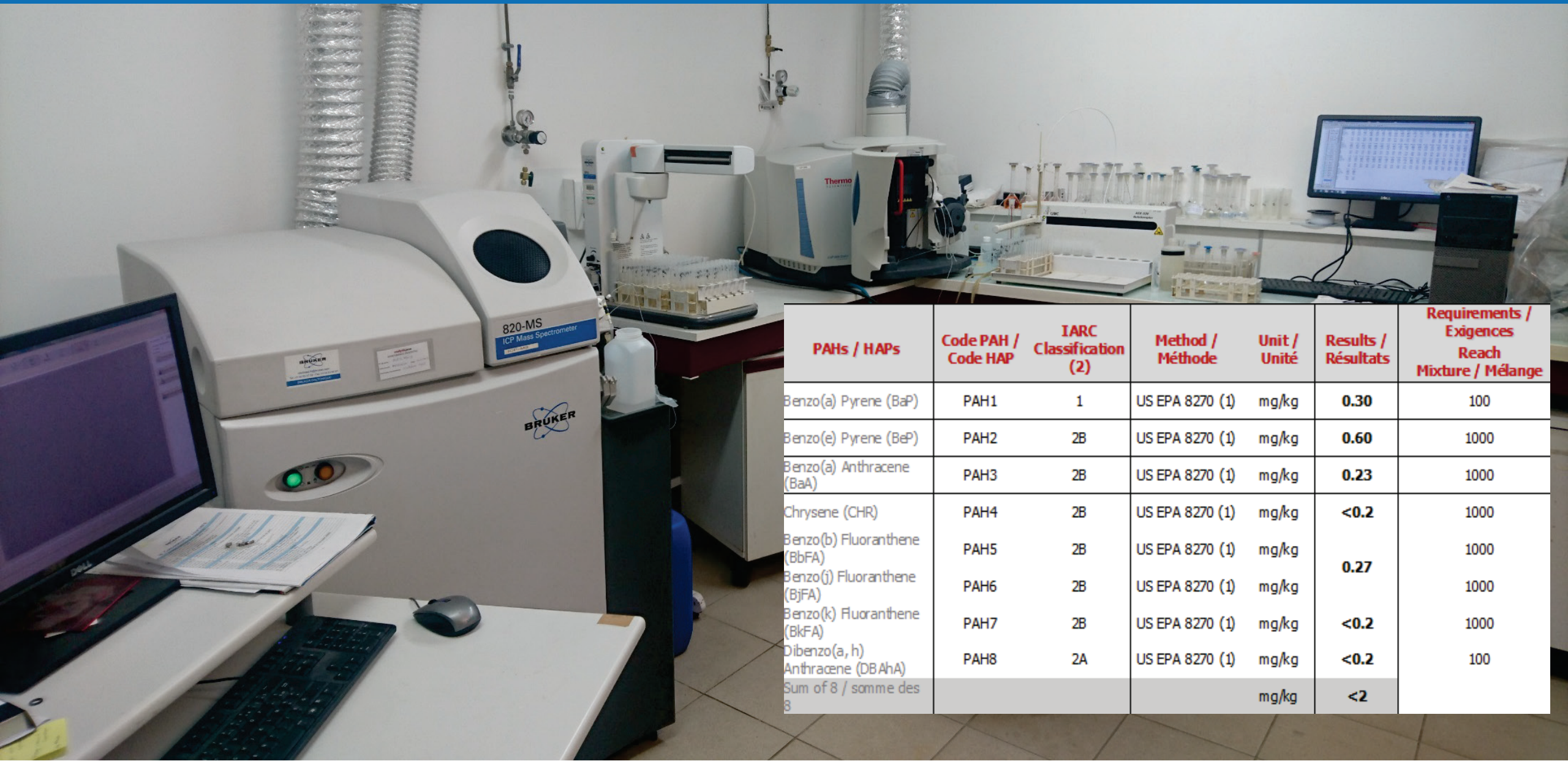
STEP 2



Sample the infill material from you field, following the indications on the [sampling instructions notice](#). Receive your order confirmation.

Service that will
adapt according to
the evolution of
the Regulations

Analysis related to REACH-PAHs



PAHs / HAPs	Code PAH / Code HAP	IARC Classification (2)	Method / Méthode	Unit / Unité	Results / Résultats	Requirements / Exigences Reach Mixture / Mélange
Benzo(a) Pyrene (BaP)	PAH1	1	US EPA 8270 (1)	mg/kg	0.30	100
Benzo(e) Pyrene (BeP)	PAH2	2B	US EPA 8270 (1)	mg/kg	0.60	1000
Benzo(a) Anthracene (BaA)	PAH3	2B	US EPA 8270 (1)	mg/kg	0.23	1000
Chrysene (CHR)	PAH4	2B	US EPA 8270 (1)	mg/kg	<0.2	1000
Benzo(b) Fluoranthene (BbFA)	PAH5	2B	US EPA 8270 (1)	mg/kg	0.27	1000
Benzo(j) Fluoranthene (BjFA)	PAH6	2B	US EPA 8270 (1)	mg/kg		1000
Benzo(k) Fluoranthene (BkFA)	PAH7	2B	US EPA 8270 (1)	mg/kg	<0.2	1000
Dibenzo(a, h) Anthracene (DBA _h A)	PAH8	2A	US EPA 8270 (1)	mg/kg	<0.2	100
Sum of 8 / somme des 8				mg/kg	<2	

Toys Standard

Analysis of heavy metals according to EN 71-3 (standard for toys):

Parameter Élément Elemento	Unit Unité Unidad	Test method Méthode d'essai El método de ensayo	Result Résultat Resultado	NF EN 71-3
Aluminium	mg/kg MS	NF EN ISO 17294-1 et 2	3.5	< 70 000
Antimony	mg/kg MS	NF EN ISO 17294-1 et 2	< 0.5	< 560
Arsenic	mg/kg MS	NF EN ISO 17294-1 et 2	< 0.25	< 47
Barium	mg/kg MS	NF EN ISO 17294-1 et 2	1	< 18 750
Boron	mg/kg MS	NF EN ISO 17294-1 et 2	< 0.5	< 15 000
Cadmium	mg/kg MS	ICP	< 0.5	< 17
Chromium total	mg/kg MS	NF EN ISO 17294-1 et 2	< 1	-
Chromium III	mg/kg MS	NF EN ISO 11885	< 1	< 460
Chromium VI	mg/kg MS	NF T 90-043	< 0.2	< 0.2
Cobalt	mg/kg MS	NF EN ISO 17294-1 et 2	< 0.5	< 130
Copper	mg/kg MS	NF EN ISO 11885	18	< 7 700
Lead	mg/kg MS	NF EN ISO 17294-1 et 2	< 0.5	< 160
Maganese	mg/kg MS	NF EN ISO 17294-1 et 2	1	< 15 000
Mercury	mg/kg MS	NF EN ISO 17852	< 0.005	< 94
Nickel	mg/kg MS	NF EN ISO 17294-1 et 2	< 0.5	< 930
Selenium	mg/kg MS	NF EN ISO 17294-1 et 2	< 0.25	< 460
Strontium	mg/kg MS	NF EN ISO 17294-1 et 2	< 0.5	< 56 000
Tin	mg/kg MS	NF EN ISO 17294-1 et 2	< 0.5	< 180 000
Zinc	mg/kg MS	NF EN ISO 11885	120	< 46 000

Note:

Originally, this standard is not intended to be applied to synthetic turf or other sports floors

Nevertheless it allows to simulate the migration of metals **by ingestion** and to compare against the thresholds of the toy standard.

In the absence of a specific standard, it is the one that is used as reference today.

Next steps

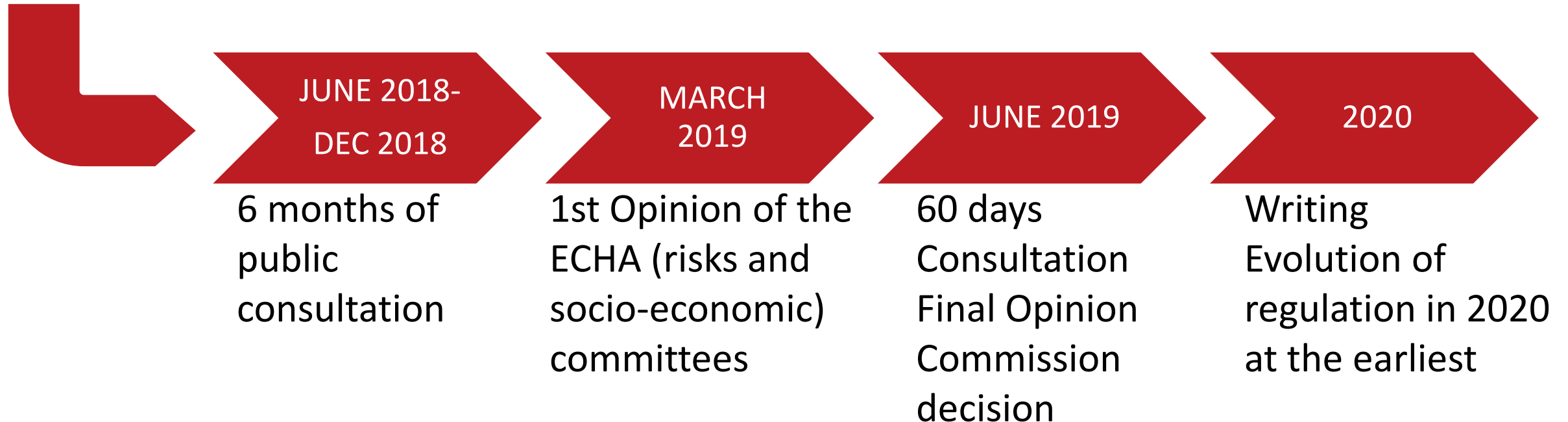
Large-scale studies (1-2 years) are underway (EPA, ETRMA)

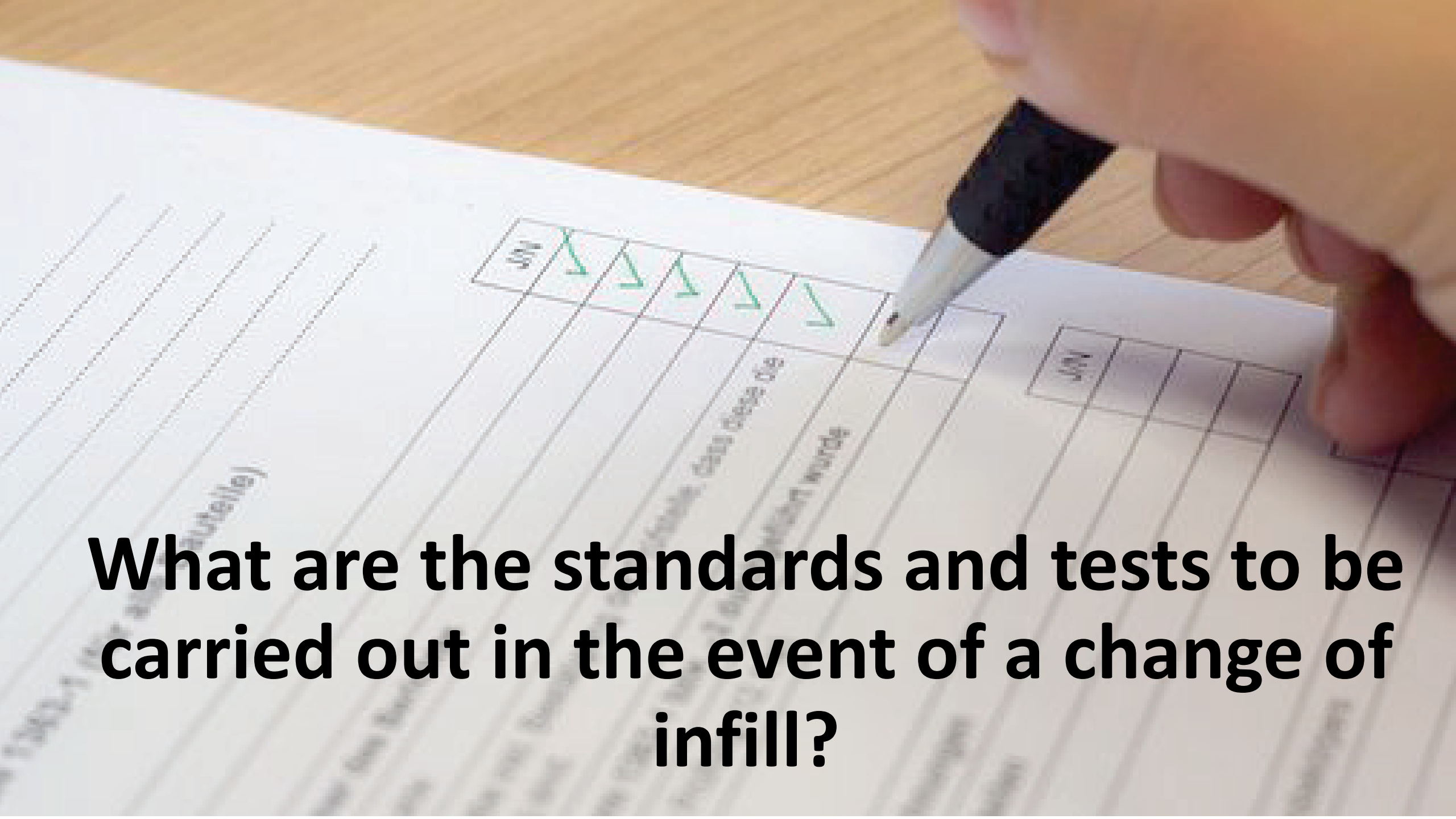
Netherlands has already notified a proposal to ECHA to evolve the REACH regulation for reused tire granules.

<https://echa.europa.eu/-/lower-concentration-limit-proposed-for-pahs-found-in-granules-and-mulches>

The proposal suggests a combined concentration limit for the eight PAHs of 17 mg/kg (0.0017 % by weight). The French health authority has aligned on this proposal.

The current concentration limits applicable for supply to the general public are set at 100 mg/kg for two of the PAHs and 1 000 mg/kg for the other six.



A close-up photograph of a hand holding a black pen, pointing at a table on a document. The document has a header row with the word 'May' and five columns. The first four columns contain green checkmarks, and the fifth column contains a green checkmark. The table is part of a larger document with other tables and text visible in the background.

May					

Synthetic Turf Standards

- The French Football Federation requires compliance with the NF P90-112 standard (French declination of EN 15330) and ensures this during checks on synthetic fields.
- The standard includes an accurate identification of infill:

Identification	Requirements NF P90-112
TGA and elastomer content	$\geq 20\%$ (for elastomer-type material)
Shape (EN 14955)	Identification
Particle size (EN 933-1): Particle size distribution	$d \geq 0.5 \text{ mm}$ and $D \leq 3.15$ Requirement NF EN15330-1: Same D and d as statement (Lab) – site tolerance $\pm 20\%$ declaration
Dry Density (NF EN 1097-3) (g/cm^3)	Requirement NF EN15330-1: $\leq 15\%$ change

Synthetic Turf Standards

- NF/EN standards include performance requirements for granules:

Qualities/Performance	Requirement NF P 90-112
Ageing hot water/hot air (EN 13744 and EN 13817) ☐ Color Change and agglomeration	Requirement NF P 90-112: no change in appearance
UVB Ageing (EN14836): ☐ Color Change and agglomeration	No change in appearance and no color change greater than 3 on the grey scale
Infiltration speed: infill capacity to allow water to circulate by gravity.	> 36 cm/h.

Synthetic Turf Standards

- Ecotoxicology (environmental impact) – analysis of heavy metals after leaching
- Lead
- Cadmium
- Chrome
- Etains
- Zinc
- Dissolved organic carbon
- Mercury
- EOX

Paramètre	Unité	Méthode d'essai	Analyse par lixiviation : Éluat 24 h sans extraction d'eau	Analyse par lixiviation : Éluat 48 h sans extraction d'eau
Plomb (Pb)	mg/l	NF EN ISO 11885	≤ 0,025	-
Cadmium (Cd)	mg/l		≤ 0,005	-
Chrome total (Cr)	mg/l		≤ 0,050	-
Etain (Sn)	mg/l		≤ 0,040	-
Zinc (Zn)	mg/l		≤ 0,5 ^a	≤ 0,5
Carbone organique dissous (COD)	mg/l	NF EN 1484	≤ 50 ^b	≤ 50
Chrome hexavalent (Cr)	mg/l	DIN 38405-24 NF T 90 043	≤ 0,008	-
Mercuré (Hg)	mg/l	NF EN ISO 12846 NF EN ISO 17852	≤ 0,0010	-
EOX	mg/kg	DIN 38414-17	≤ 100	
Chloroparaffine			(à titre indicatif : pas d'exigence)	
Phtalate			(à titre indicatif : pas d'exigence)	
a Si l'éluat 24 h est > 0.5 mg / l et ≤ 1 mg / l alors analyser l'éluat 48 h				
b Si l'éluat 24 h est > 50 mg / l et ≤ 100 mg / l alors analyser l'éluat 48 h.				

Synthetic Turf Standards

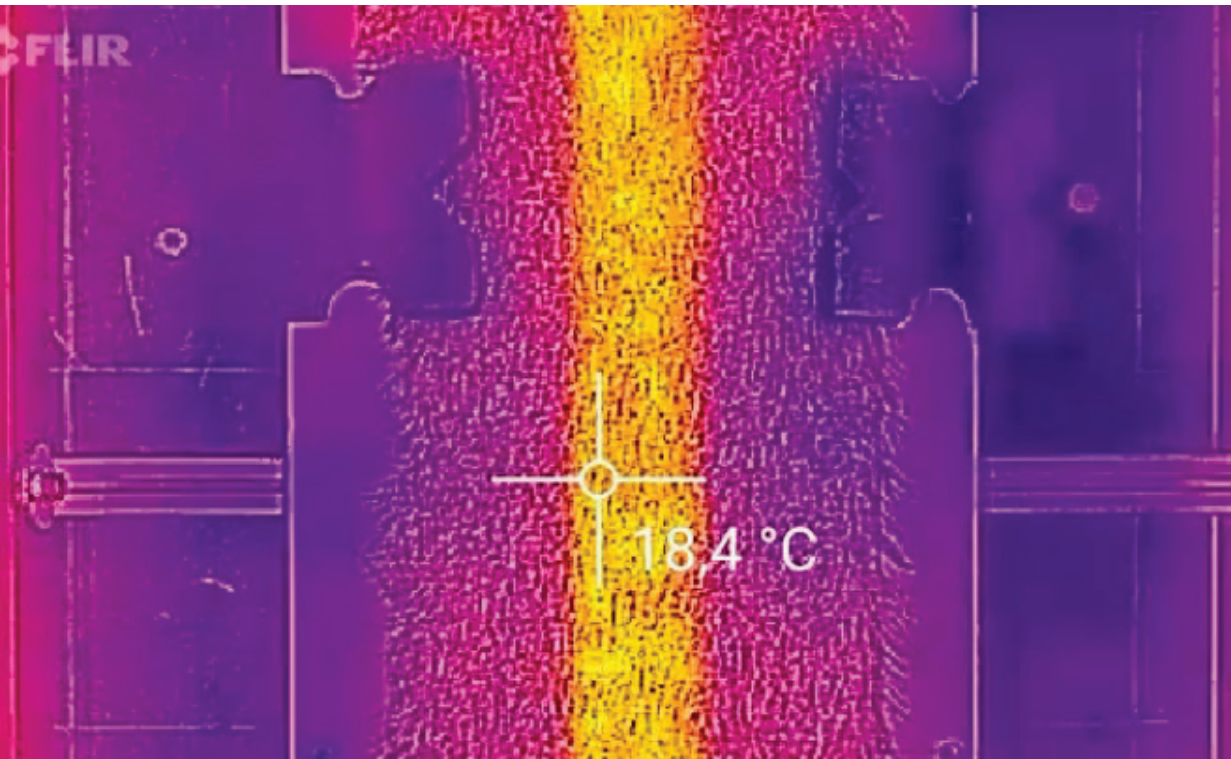
- The NF/EN/FIFA/WR standards include performance requirements on the entire system, which are influenced by the performance infill.
- Therefore it has to be done through a certification. Some short pile systems without a shock absorbing underlayment do not allow the change

Property	Influence of the filling on the property
Shock Absorption	The most sensitive point: alternative infills have a generally lower elasticity than SBR. It is often necessary to compensate by a higher filling quantity (the cost increases) or a shock absorbing underlayment.
Rotational resistance	If the infill level is low, the studs will anchor in the sand, which will result in a potentially too high rotational resistance.
Friction	Some granules have very high abrasive properties (inorganic, but also some organic and elastomers),
Deformation	The inverse of shock absorption: a moving granule will increase the movement of the system under the player.
Vertical Ball Bounce/roll	A flowing performance infill dissipates energy at impact and will potentially reduce the ball bounce height. Less infill will result in a shorter ball roll

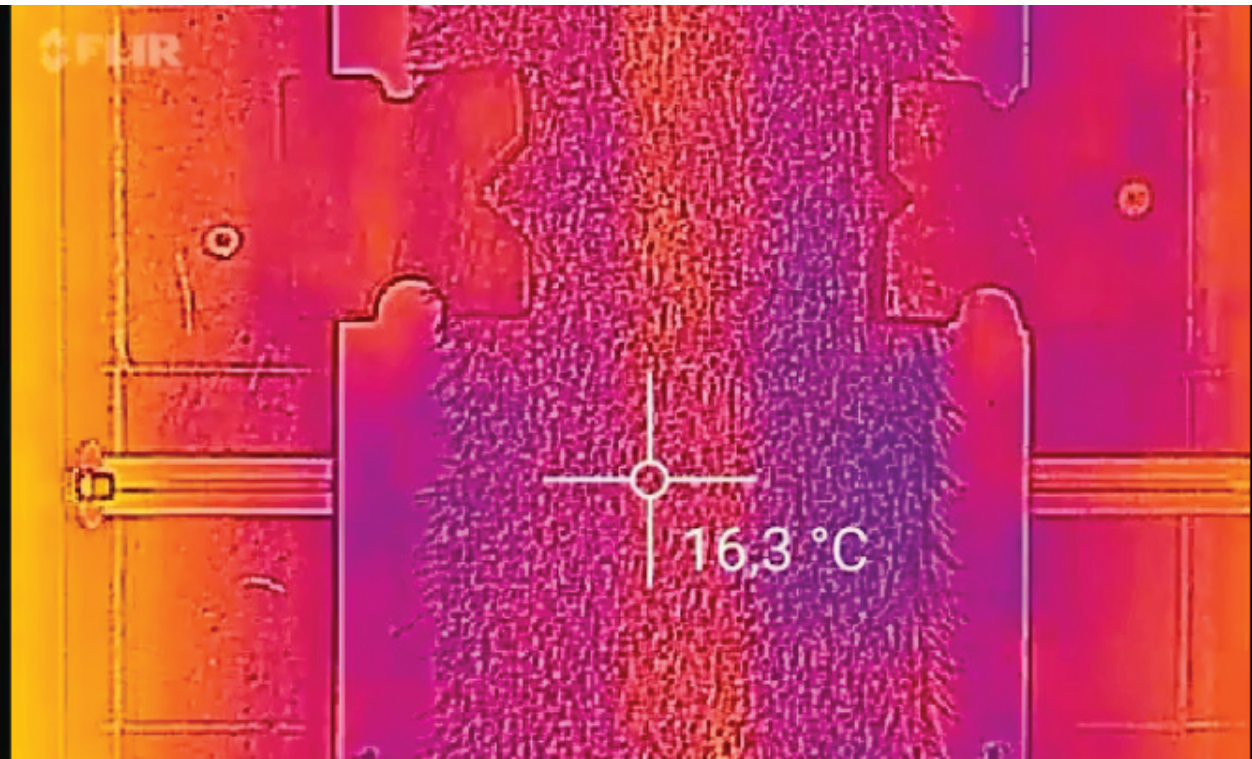
Other standards/feasible tests

- In 2017, Labosport has developed a unique tool for better measuring the friction effect
- Infills have a significant influence on this parameter

Friction Tests on dry turf



Friction Tests on wet turf



Other standards/possible tests

Permanent agglomeration temperature (internal method)

- Exposure to increasing temperatures
- Followed by compression
- Measure of the mass of agglomerated infill



70°C



100°C



125°C

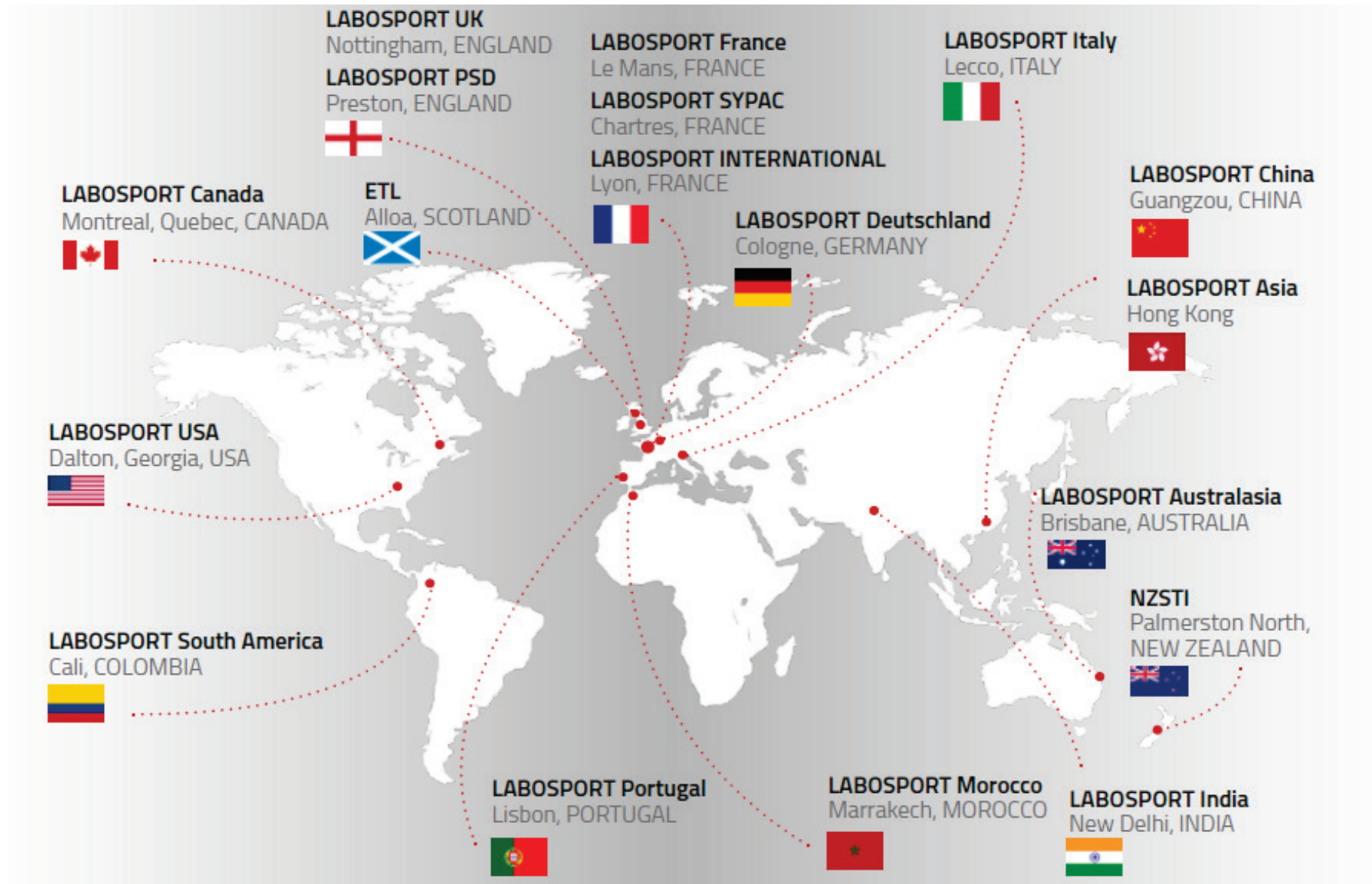


Other standards/feasible tests



- Characterization and "cleanliness" of granules
- CEN TS 14243
- Quantification of impurities (metallic and textile fibers...)
- Dust generation
- EN 15051-2
- Bulk Measurement by rotating drum
- Inhalable dust
- Chest/thorax dust
- Breathable dust

Labosport: A global player in sports surfaces quality control and certification





Thank you!

LABOSPORT
GROUP

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LABORATORY
FOR SPORT
SURFACES AND EQUIPMENT