# D6.7 Report strategic certification/standardisation roadmap to achieve cost-effective compliance

Version N°1

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# Summary

The ZeroF project developed two families of PFAS-free coatings namely carbohydrate fatty acid ester (CFAE) based coatings for fibre-based food-contact packaging and hybrid inorganic–organic polymeric network (ORMOCER®) based coatings for textiles designed to replace fluorinated water- and oil-repellent chemistries. Both applications are targeted by upcoming European policies and regulations in the near future. At the same time, these innovations addressed directly major policy drivers under the European Green Deal, including the Packaging and Packaging Waste Regulation (PPWR; Regulation (EU) 2025/40), the forthcoming revision of the Food Contact Materials Framework Regulation (EC) 1935/2004, the universal PFAS restriction under REACH, the EU Strategy for Sustainable and Circular Textiles, and the Safe and Sustainable by Design (SSbD) framework.

The objective of this deliverable is to define the regulatory, standardisation and certification pathways that ZeroF formulations must follow to reach market readiness, which translates into an efficient process of data production and gathering so to a maximised use of data at different stages in the value chain. It is a certification/standardisation roadmap for cost-efficient compliance taking into account potential future regulatory developments.

This deliverable identifies the relevant regulatory drivers ranging from chemicals legislation (e.g. REACH, PFAS restriction) to sector-specific regulations applicable for fibre-based food-contact packaging and upholstery textiles, such as the Packaging and Packaging Waste Regulation and the EU Strategy for Sustainable Textiles, and translate them into practical requirements for ZeroF innovations. The deliverable builds on the mapping of regulatory and certification requirements (D6.2) and on the chemical safety sustainability and cost assessments carried out in D6.3, D6.4, D6.5, transforming the gaps, uncertainties and information needs identified there into a coherent set of testing, documentation, and certification actions.

## Keywords

Regulatory compliance, voluntary certification schemes, food contact materials, upholstery textiles

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# Abbreviations and acronyms

| Acronym | Description |
|---|---|
| BAT | Best available techniques |
| CEAP | Circular Economy Action Plan |
| CEPI | Confederation of European Paper Industries |
| CFAE | Carbohydrate Fatty Acid Ester |
| CLP | Classification, Labelling and Packaging |
| CSS | Chemical Strategy for Sustainability |
| CMR | Carcinogenic, Mutagenic, Reprotoxic |
| DoC | Declarations of Compliance |
| DMAc | DiMethyl Acetamide |
| DPP | Digital Product Passport |
| ECHA | European Chemical Agency |
| EEA | European Economic Area |
| EFSA | European Food Safety Authority |
| EMAS | Eco-Management and Audit Scheme |
| EPD | Environmental Product Declaration |
| EPR | Extended Producer Responsibility |
| ESPR | Ecodesign for Sustainable Products Regulation |
| FCM | Food Contact Material |
| GMP | Good Manufacturing Practices |
| KPI | Key Performance Indicator |
| MOAH | Mineral Oil Aromatic Hydrocarbons |
| MOSH | Mineral Oil Saturated Hydrocarbons |
| NIAS | Non-Intentionally Added Substances |
| OML | Overall Migration Limit |
| PCDS | Product Circularity Data Sheet |
| PFAS | Per- and polyFluoroAlkyl Substances |
| PPWR | Packaging and Packaging Waste Regulation |
| PDMS | Ethoxy terminated PolyDiMethylSiloxane |
| REACH | Registration, Evaluation, Authorisation of Chemicals |
| RSL | Restricted Substance List |

| | |
|---|---|
| SML | Specific Migration Limit |
| SVHC | Substances of Very High Concern |
| VOC | Volatile Organic Compound |


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# 1 Introduction

Polyfluoroalkylated substances (PFAS) are widely used in coatings for textile and packaging applications due to their unique performance. However, they are associated to adverse effects on human health and the environment. Some PFAS are notably classified as substances of very high concern (SVHC) by the European Union and thus restricted in certain uses or applications under the registration, evaluation, authorization, and restriction of chemicals (REACH) regulation.[1] A wider universal PFAS restriction proposal is currently under evaluation by the European chemical agency (ECHA),[2] reinforcing the need for PFAS-free alternatives such as the ones developed in the ZeroF project.

The two developed innovations in ZeroF are 1) carbohydrate fatty acid ester (CFAE)-based coatings for food packaging, including dispersion and powder coatings applied onto paperboard and moulded pulp trays, and 2) silane hybrid inorganic–organic polymeric network (ORMOCER®) based coatings for upholstery textiles. Ensuring that all coating components remain compliant with REACH, and that no PFAS or other restricted substances are introduced intentionally or unintentionally is an essential part of the regulatory compliance of ZeroF innovations. The coatings developed within the project should also aligned with the European Green Deal ambitions,[3] the chemicals strategy for sustainability (CSS)[4], and other EU initiatives (e.g. the EU plastic strategy,[5] the circular economy and zero pollution action plans[6,7] that are currently being translated into new directives[8] and regulations.[9]

This deliverable aims at identifying the current legislative, standards and certification requirements for both the new coatings and their final product applications to provide the ZeroF consortium with a strategic, actionable, and cost-effective roadmap for achieving regulatory compliance and market readiness for the PFAS-free coatings developed.

Two application-specific roadmaps are developed in this deliverable; one for fibre-based food-contact packaging and another for upholstery textiles. They are both intended to streamline data generation, improve data management, and maximise data reuse across the value chain, while reflecting the fact that each material stream follows a distinct regulatory pathway (previously described in D6.2). These roadmaps guide the planning of compliance related activities, enabling risk identification and proactive mitigation. They also strengthen the integration of sustainability considerations within both sectors, reflecting EU's ambition to shift from risk management to risk prevention.

Overall, the deliverable is designed to support ZeroF with a clear strategic direction, enabling informed decision-making and efficient planning as the project moves toward higher technology readiness levels. It provides the foundation for regulatory preparedness and supports the eventual translation of ZeroF innovations into compliant, certifiable, and market-acceptable PFAS-free coating solutions.

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[1] REACH (EC) No 1907/2006
[2] https://echa.europa.eu/hot-topics/perfluoroalkyl-chemicals-pfas
[3] Fetting, C. (2020). "The European Green Deal", ESDN Report, December 2020, ESDN Office, Vienna
[4] https://ec.europa.eu/environment/strategy-offline/chemicals-strategy_en
[5] COM(2018) 28
[6] COM(2020) 98 final
[7] COM(2021) 400
[8] Directives are defining EU binding goals and require national implementation.
[9] Regulations are defining EU laws directly applicable by EU Member States, with no national translation required.

Earlier in the project, a scoping exercise was presented in **D6.2 regarding regulation, certification and requirements on the ZeroF developed materials, anticipating future needs from the on-going action plans under the European Commission (EC) regarding plastics, food packaging and textiles**. There, several key overarching regulations relevant to the ZeroF innovations have been identified and described, as well as different sector specific regulations (for an overview see Table 1).

Table 1. Overarching and sector specific EU regulations and requirements relevant to the ZeroF innovations and foreseen applications, as identified or updated from D6.2

| **Overarching regulations** | **Sector specific regulations** | |
|---|---|---|
| | Coated fibre-based food packaging | Coated upholstery textile |
| - **Registration, Evaluation, Authorization, and Restriction of Chemicals (REACH)** (EC No 1907/2006)<br>- **Classification, Labelling, and Packaging (CLP)** (EC No 1272/2008)<br>- **Persistent Organic Pollutants (POPs) Regulation** (EU No 2019/1021)<br>- **General Product Safety Regulation (GPSR)** (EU No 2023/988)<br>- **Waste Framework Directive** as amended by directive (EU 2025/1892)<br>- **Directive on Empowering Consumers for the Green Transition** (EU No 2024/825)<br><br>**Not applicable for ZeroF innovations and foreseen applications but potentially in future ;**<br>- **Ecodesign for Sustainable Products Regulation (ESPR)** (EU No 2024/1781) and Digital Product Passport for food packaging or upholstery textiles.<br>- Extended Product Responsibility (EPR) schemes<br>- **Industrial Emissions Directive** (EU 2024/1785)<br>- **Directive on corporate sustainability due diligence** (EU No 2024/1760)<br>- **Green Claims Directive** | - **Food contact framework regulation** (EU No 1935/2004)<br>- **Good Manufacturing Practice regulation** (EU No 2023/2006)<br>- **National regulations or guidelines for paper and board food contact materials** (e.g. German BfR recommendations, Dutch Warenwet)<br>- **Packaging and Packaging Waste regulation** (EU No 2025/40)<br>- Information requirements for an European Food Safety Authority Dossier<br><br>**Not applicable for CeFAE based coatings and coated fibre based food packaging but potentially in future:**<br>- EU Strategy of Plastics in Circular Economy<br>- Packaging specific EPR schemes<br>- EU Ecolabel for packaging | - EU Strategy for Sustainable and Circular Textiles<br>- **EU Ecolabel** (Regulation (EU) No 2014/350)<br>- **Textile Labelling Regulation** (EU No 1007/2011)<br><br>**Not applicable for ORMOCER® based coatings and coated upholstery textiles but potentially in future:**<br>- Commission 2030 vision for textiles<br>- Textile specific EPR schemes |


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# 2 EU regulatory landscape for ZeroF innovations

The regulatory environment relevant to ZeroF is evolving, driven by the European Green Deal and its associated policy frameworks on chemicals, packaging, textiles and sustainable products. The coatings developed within ZeroF—bio-based C(e)FAE coatings for fibre-based food-contact packaging and ORMOCER® based coatings for textiles should ultimately comply with a combination of horizontal chemical and product legislations, sector-specific product rules, and emerging requirements related to circularity and sustainability. This section provides a high-level overview of the requirements of horizontal regulations and resulting implications for ZeroF innovations, setting the context for the more detailed, application-specific roadmaps presented in subsequent sections.

## 2.1 Chemical and process safety

The ZeroF coating formulations must comply with the horizontal EU chemical legislation established by the registration, evaluation, authorization, and restriction of chemicals (REACH) regulation (EC) No 1907/2006 and the classification, labelling, and packaging (CLP) regulation (EC) No 1272/2008, and the persistent organic pollutants (POPs) regulation (EU) No 2019/1021.

### 2.1.1 REACH

REACH looks into the manufacture, import and use of chemical substances in the EU. Coating manufacturers do not have to register the final coating formulation but must ensure that all substances that they import or manufacture above 1 tonne per year to produce the coating are registered (e.g., fatty acid esters, plasticisers, silanes, catalysts, additives and processing aids imported or manufactured above 1 t/year). Compliance requires that these substances are appropriately registered by upstream suppliers, assessed for potential restrictions under Annex XVII, and screened for their status as substances of very high concern (SVHCs), particularly with regard to carcinogenic, mutagenic, reprotoxic or sensitising properties. REACH restrictions limits or bans the manufacturing, placing on the market or use of substances listed in Annex XVII. Companies that wish to continue using substances considered SVHCs listed in Annex XIV must apply for an authorisation. Under REACH, a substance (or mixture of substances) contained in an article should be registered only if 1) the latter is expected to be released from the article under normal use and if 2) the total amount of that substance in all articles produced exceeds 1 tonne per year, which is not the case for both final product applications considered in the project. One could note that ECHA should notified via a SCIP notification (Waste Framework Directive) if an article contains SVHC above 0.1% w/w and that exposure cannot be excluded. However, polymers and polymeric network such as C(e)FAE ORMOCER® coating are exempted from REACH. Their constituent monomers may require registration if they are present in the polymer at 2% or more by weight and are not already registered by the monomer supplier. In addition, the European Commission is planning to extend REACH to certain polymers in the future.

A particularly relevant element of REACH for ZeroF is the proposed universal PFAS restriction, currently under assessment under REACH Annex XVII, following the submission of a restriction dossier by five EU Member States. This restriction is expected to severely limit the use of fluorinated chemistries across sectors, including paper and textile finishing, thereby reinforcing the need for PFAS-free alternatives such as the CFAE and ORMOCER® coatings developed in the project. Ensuring that all coating components remain compliant

with REACH, and that no PFAS or other restricted substances are introduced intentionally or unintentionally forms an essential part of the regulatory pathway for ZeroF materials.

The REACH regulation is currently being revised, and the future revision might also affect the reporting of sustainability related requirements. It is expected to enter into force in 2025 – 2027. Some potential implications are:

- Stricter requirements for intermediates,
- Electronic formats for Safety Data Sheets (SDSs),
- Registration requirements for polymers,
- Additional obligations may arise from the parallel CLP Revision and the ESPR.

### 2.1.2 CLP

The CLP sets the criteria for the hazard classification and labelling of substances and mixtures, providing the framework for identifying intrinsic hazards and ensuring safe handling during formulation, coating application and subsequent processing steps. A manufacturer of a polymer must classify, label and package the polymer (or polymeric network) in accordance with CLP. Also, if the polymer is classified as hazardous and if it is put on the market on its own or in a mixture above the concentration limits specified in the CLP Regulation, resulting in the classification of the mixtures as hazardous, the importer or manufacturer of a polymer must notify the Agency (see CLP Article 39(b)). This notification has to be done within one month after the substance is placed on the market (CLP Article 40).

The classification of the polymer should, in particular, take into account the classification of all its constituents, such as unreacted monomers. This means that the same classification methods as for mixture should be applied to polymer substances[10], which was done in D6.4. However, the use of substances or mixtures which change their properties upon processing (e.g., become no longer bioavailable, undergo chemical modification) so that the identified hazard no longer applies are exempted from the above requirements. This shall include polymers that have been modified to incorporate a function and monomers or additives which become covalently bonded with polymers.

### 2.1.3POPs

The general aim of the persistent organic pollutants (POPs) regulation (EU No 2019/1021) is "to protect human health and the environment from POPs by prohibiting, phasing out as soon as possible, or restricting the manufacturing, placing on the market and use of substances subject to the Stockholm Convention on Persistent Organic Pollutants, or the Protocol to the 1979 Convention on Long-Range Transboundary Air Pollution on Persistent Organic Pollutants, by minimising, with a view to eliminating where feasible as soon as possible, releases of such substances, and by establishing provisions regarding waste consisting of, containing or contaminated by any of those substances." Its Annex I lists substances to be eliminated, except where specific exemptions apply. One could note that several POPs were originally restricted under REACH, but deleted from Annex XVII once listed in POPs, so it is advised to check both lists separately.

[10] https://echa.europa.eu/web/guest/guidance-documents/guidance-on-clp


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### 2.1.4Implications for ZeroF innovations

While POPs, CLP and REACH regulations do not evaluate food-contact safety or consumer exposure through migration, they address chemical hazard, worker safety, environmental protection and the responsible management of chemicals throughout their life cycle. These obligations therefore apply in parallel to the product specific requirements and must be fulfilled for all ZeroF coatings before placing them on the market (Table 2).

Table 2. REACH, CLP and POPs regulation requirements for ZeroF innovations and beyond.

| Regulatory Area | Requirements | Tests / Evidence Required |
|---|---|---|
| REACH & CLP & POPs | Know hazards of used substances (including monomers and synthesis components), make sure they are registered.<br><br>No SVHCs > 0.1% (Art. 33) nor Annex XVII REACH restricted substances in final coatings nor substance listed in the Annex I POPs (i.e., Phase-out use unless justified).<br><br>CLP compliance incl. new hazard classes (ED, PBT/vPvB, PMT/vPvM), classification and labelling of polymers as done for mixtures. | Ingredient inventory & safety data (CLP classification verification, *in silico* and *in vitro* hazard screening)<br><br>Analytical screening for restricted substances<br><br>Technical dossier (IUCLID) if substances manufactured or imported ≥ 1 t/year, Exposure assessment if ≥ 10 t/year |
| Going beyond current regulation | No PFAS<br><br>Verify bioaccumulation potential of degradation products and leachates even if production remains below 1 t/year. | By design<br><br>OECD TG 301/310 (ready biodegradability) for innovations, leachate and products of degradation. |

ZeroF aimed at developing PFAS free omniphobic coatings and thus tackled the forthcoming PFAS restriction requirement by design. Moreover, by applying the safe and sustainable by design (SSbD) chemicals and materials framework[11] that was mainstreamed in the CSS and is recommended by the EC[12], ZeroF innovators prohibited or restricted the use of SVHC from the candidate list of the REACH[13] and substances listed on the Stockholm convention or protocol (or substances with a similar hazard profile) and substituted as much as possible and otherwise minimized the use of substances classified as carcinogenic, mutagenic, toxic for reproduction (CMR) as well as endocrine disruptors, respiratory sensitizers or substances presenting repeated specific target organ toxicity, or persistency,

[11] Caldeira C., Farcal R., Garmendia Aguirre, I., Mancini, L., Tosches, D., Amelio, A., Rasmussen, K., Rauscher, H., Riego Sintes J., Sala S. Safe and Sustainable by Design chemicals and materials - Framework for the definition of criteria and evaluation procedure for chemicals and materials. EUR 31100 EN, Publications Office of the European Union, Luxembourg, 2022, ISBN 978-92-76-53264-4, doi:10.2760/487955, JRC128591

[12] Commission Recommendation (EU) 2022/2510 of 8 December 2022

[13] https://echa.europa.eu/candidate-list-table

bioaccumulative and toxic (PBT) potential and/or classified as very persistent, very bioaccumulative (vPvB) under the CLP regulation.

To this end, two inventories of potential substances associated to production and processing steps of the ZeroF innovation-based coatings for food packaging and upholstery textile applications were created and screened for safety (See D6.4 for further details).

For food packaging, an alternative solvent system was tested at lab scale to limit the worker exposure potential to SVHC and toxic chemicals initially used during C(e)FAEs synthesis and to limit their presence as synthesis residues above 0.1% in the final coating system (See D6.4 for further details). For upholstery textile, all synthesis components are registered under REACH, except for the performance additive which is also a polymer. The identification of a SVHC co-occurring in the ethoxy terminated polydimethylsiloxane (PDMS) stock used as precursor of the ORMOCER® polymeric network led to the test of an alternative coating system without PDMS (See D6.4 for further details). Overall, **it is recommended that further analytical techniques are deployed on ZeroF innovations to characterise quantitatively their final composition and potential impurities (i.e. check against restricted substances list).**

When applying the same CLP classification methods as for mixture on polymeric substances using on harmonized classification of precursors,[14] the results led to the classification of all the ZeroF innovations, notably for suspected hazard for skin when manipulated as pure forms (See D6.4 for further details). CLP hazard endpoints for C(e)FAE and ORMOCER® innovations and performance additive developed in the project were also screened with *in silico* tools and *in vitro* assays. **The overall results obtained so far for CeFAE polymers did not support any CLP classification**, additional data (e.g., toxicokinetic, *in vivo* data) would be required to justify the low hazard potential of the C(e)FAE innovations. **Some concerns were raised regarding the hazard profile of ORMOCER® materials**, as they were predicted to have a CMR potential, to be skin sensitizer and potentially persistent and to lead to aquatic toxicity after chronic exposure (See D6.4 for further details). However, further tests are needed to confirm the ORMOCER® and performance additive hazard profiles as the *in silico* predictions were mainly deemed not reliable, and the application of mixture assessment onto polymeric networks remains questionable, even if the CLP classification of the polymer should take into account the classification of unreacted monomers.

Other *in vitro* assays are notably on-going to complete chemical safety screening of the ZeroF PFAS-alternatives for dermal and oral exposure routes, addressing skin corrosion, skin irritation, and genotoxicity CLP hazard classes (results will be reported in the final project technical report).

In addition, other tests can be performed to prove that the PFAS alternatives developed in the project won't constitute regrettable substitution, going beyond the testing criteria laid down under any regulation (if production maintained below 1t/year production). It is notably recommended to prioritise confirmation of PBT/vPvB and PMT/vPvM properties, using measured degradation and sorption data for the polymeric materials and their degradation or extractable fractions.

[14] https://echa.europa.eu/web/guest/guidance-documents/guidance-on-clp



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## 2.2 Emission and waste managements

In Europe, the EU circular economy action plan (CEAP)[15] was adopted by the Commission in March 2020. It targets how products are designed, promotes circular economy processes, encourages sustainable consumption, and aims to ensure that waste is prevented and the resources used are kept in the EU economy for as long as possible. It applies to all materials and product value chains, including food packaging and upholstery textile identified as key value chains, setting strategic goals in terms of durability, recyclability, recycled content and chemical safety.

The CEAP and strategy like the EU strategy for sustainable and circular textiles adopted in March 2022 legally translate in certain directives, like the waste framework directive (WFD)[16] and the Packaging and Packaging Waste regulation (PPWR)[17], that enforces recycling, reuse and extended producer responsibility (EPR) and product passports for end-of-life of products. Similarly, the industrial and livestock rearing emissions directive (IED 2.0) ensures production facilities minimize emissions and environmental impact.[18,19] All have been recently revised to implement stricter rules for waste prevention and recycling and stricter pollution controls for industries like.

### 2.2.1 WFD, PPWR and circular textiles

The WFD covers **all products once they become waste, and thus apply to coated food packaging and upholstery textiles when wasted**. The directive establishes the overarching EU legal framework for waste management, setting key principles such as waste hierarchy (i.e. prioritising prevention, reuse, and recycling), obligations on producers for collection, recycling, and reporting and associated fees (i.e., EPR), and requirements for separate collection, recycling, and waste prevention.

The WFD notably requires EPR fees to be modulated based on recyclability, presence of hazardous substances, durability and reparability. WFD does not impose grades or specific test methods. It leaves implementation details to sectorial legislation and Member states. Recyclability and separability of coatings are particularly relevant for the end of life management of the coated products, as non-removable or disruptive coatings may hinder fibre recycling in both applications. Hazardous substances (e.g. SVHC in coatings) may affect classification, treatment options, recycling compatibility, linking WFD obligations with REACH restrictions. The use of such substances has been avoided, replaced or minimised in the project through the application of the SSbD framework, as described in the chemical and process safety section above.

Textiles are explicitly included as a priority material stream in the WFD. From 1 January 2025, Member States must set up separate collection systems for textiles, and upholstery textile are increasingly covered by EPR schemes established under national law based on WFD principles. It is foreseen that EPR fees must be modulated based on durability,

[15] COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS A new Circular Economy Action Plan For a cleaner and more competitive Europe

[16] Waste Framework Directive (Directive 2008/98/EC, amended by Directive (EU)

[17] Regulation (EU) 2025/40 of the European Parliament and of the Council of 19 December 2024 on packaging and packaging waste, amending Regulation (EU) 2019/1020 and Directive (EU) 2019/904, and repealing Directive 94/62/EC

[18] Directive (EU) 2024/1785 of the European Parliament and of the Council of 24 April 2024 amending Directive 2010/75/EU of the European Parliament and of the Council on industrial emissions (integrated pollution prevention and control) and Council Directive 1999/31/EC on the landfill of waste

[19] Industrial and Livestock Rearing Emissions Directive (IED 2.0) - European Commission

reparability, recyclability and presence of hazardous substances under Article 8a WFD. For coated upholstery fabrics, compliance is not additive but cumulative; a fabric that fails REACH will undermine Ecodesign for Sustainable Products Regulation (ESPR)[20] goals and create WFD problems.

Further product specific regulations and directives such as the Packaging and Packaging Waste regulation (PPWR)[21] expands the general principles sets in the WFD. The commission noted that, especially in food packaging materials, they want to improve the reusability and recyclability of packaging, as well as to minimise substances of concern in packaging materials. **Under the PPWR, the recyclability is a market access condition, with the recyclability performance grades directly linked to EPR fees (i.e., non-recyclable packaging may pay the highest fees or be restricted). There is also a push for the use of paper based or biodegradable materials for replacement of plastic packaging**. The PPWR came into force on 12 February 2025, with most provisions applicable from August 12, 2026.

### 2.2.2IED

The IED notably requires that large industries use best available techniques (BAT)[22] to prevent or reduce pollution and promote resource and energy efficiency, a circular economy, and waste prevention. It applies to industrial installations that perform high impact activities listed in Annex I (e.g., chemical manufacturing, solvent-intensive surface treatment, paper and board production or waste management that exceed defined thresholds).

**None of the ZeroF alternatives synthesis or applications specific activities reach the scale of IED application** but non-IED plants can use BAT conclusions and related reference documents as voluntary guidelines. BAT conclusions are legally binding for IED installations within 4 years of their publication. Non-IED plants can use them as voluntary guidelines or in EMAS / ISO 14001 programs.

BAT available for textile producers are further described in the dedicated section below.

[20] Regulation (EU) 2024/1781 of the European Parliament and of the Council of 13 June 2024 establishing a framework for the setting of ecodesign requirements for sustainable products.
[21] Regulation (EU) 2025/40 of the European Parliament and of the Council of 19 December 2024 on packaging and packaging waste, amending Regulation (EU) 2019/1020 and Directive (EU) 2019/904, and repealing Directive 94/62/EC
[22] 'Best available techniques' means the most effective and advanced stage in the development of activities and their methods of operation which indicates the practical suitability of particular techniques for providing the basis for emission limit values and other permit conditions designed to prevent and, where that is not practicable, to reduce emissions and the impact on the environment as a whole: (a) 'techniques' includes both the technology used and the way in which the installation is designed, built, maintained, operated and decommissioned; (b) 'available techniques' means techniques developed on a scale which allows implementation in the relevant industrial sector, under economically and technically viable conditions, taking into consideration the costs and advantages, regardless of whether such techniques are used or produced in the Union, as long as they are reasonably accessible to the operator; (c) 'best' means most effective in achieving a high general level of protection of the environment as a whole, including human health and climate protection.


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### 2.2.3EMAS

Eco-management and audit scheme (EMAS)[23] is a voluntary but legally recognised EU framework based on ISO 14001 programs.[24] ISO 14001 provides a framework for organizations to design and implement an energy management system, and to continually improve their environmental performance.

EMAS requires external verification and public environmental statements. EMAS supports a structured management of emissions, waste and chemical uses, while providing evidence of regulatory compliance in regard to environmental legislation, highlighting BAT adoption when conducted voluntarily.

ISO 14001 certified applicants shall demonstrate annually the implementation of this commitment. EMAS registered applicants shall forward a copy of their annually verified environmental statement.

### 2.2.4Implications for ZeroF innovations

Switching to PFAS free alternatives may imply changes in chemical handling, waste streams or process controls, it is thus important to evaluate the implications of ZeroF innovations on processes, and associated emissions and waste management systems. For example, reporting and monitoring requirements must be adapted to the actual substances used, including potential residuals or transformation products from alternative coatings.

If optimally designed, CeFAEs biobased coatings could for example participate to the objectives of reduction of persistent substances in food packaging waste streams (i.e., partial biodegradability of 71% after 123 days measured so far) and improve the environmental performance of the food packaging coating production, as less impactful than the PFAS based coating production based on all the environmental categories (i.e., toxicity, climate change, pollution, use of resources) evaluated in the project (D6.3), despite volatile organic compounds emissions and toxic waste generation concerns raised in D6.4. As a result, **the adoption of CeFAEs could potentially be publicly advertised as part of environmental improvements set in objectives of manufacturers and producers, when adhering EMAS voluntary scheme.**

In the case of ORMOCER® materials, concerns were raised regarding their persistency, so further investigations on their degradation profile and on the toxicity of their associated products of degradation during end-of-life (i.e., mainly incineration) are required. Moreover, upscaled production data are required to re-evaluate the environmental impacts of their synthesis as the life cycle assessment conducted on available lab scale data highlighted more impacts of ORMOCER® coated textile than those associated to the manufacturing of PFAS coated ones (D6.3).

In regard to the end of life of the ZeroF based coatings, important impacts of the ZeroF innovations based coatings on recyclability can be foreseen, especially in the case of ORMOCER® based coatings as they are designed to chemically bonded to the textile fibres to ensure durability and effectiveness, and to resist degradation by liquids (water, oil, etc). This inherent resistance makes their separation and the recovery of high-quality base

[23]Regulation (EC) No 1221/2009 of the European Parliament and of the Council of 25 November 2009 on the voluntary participation by organisations in a Community eco-management and audit scheme (EMAS), repealing Regulation (EC) No 761/2001 and Commission Decisions 2001/681/EC and 2006/193/EC.
[24] https://www.iso.org/fr/standard/60857.html

materials a complex undertaking. Silicones, for example, can be problematic in PET depolymerization if they generate silica or other residues. PFAS coated moulded fibre plates are notably rejected by recyclers and classified as non-recyclable, while water based dispersion coating designed to disappear during recycling that allow fibres to be recovered efficiently are targeted.

Table 3. IED and WFD requirements for ZeroF innovations and beyond.

| Applicability | Regulatory Area | Requirements | Tests / Evidence Required |
|---|---|---|---|
| Voluntary for the current scale of ZeroF coatings and applications production. | IED | Environmental permits for installations, environmental performance indicators, implementation of BAT, accident prevention and emergency plans | Emissions monitoring reports, waste and resource consumption records, BAT compliance documentation, environmental management system |
| Voluntary | EMAS | Environmental performance indicators and public statement describing environmental impacts, environmental legislation compliance, objectives and targets for continuous improvement | Emissions monitoring reports, waste and resource consumption records, validated environmental statement, evidence of compliance with environmental legislation verified by external |
| Mandatory | WFD | Requirements for separate collection, recycling, and waste prevention, Extended Producer Responsibility (EPR) | Evaluation of coating impacts on recyclability, and emission of by-products from end-of-life management.<br><br>Registration to national registry or scheme, Reporting to national authorities on volume sold, eco-fees, evidence of waste prevention and recycling activities, information on mandated labels or consumer information, and documentation on compliance submitted to authorities. |


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| | | | |
|---|---|---|---|
| Mandatory | PPWR | Recyclability performance A/B/C, Coating thickness < 50 µm, Evidence of recycling at scale, compostabilitiy certification when applicable | Material composition disclosure, REACH and food contact materials safety rules compliance data, Report compatibility study for coatings and fibre recycling (e.g. enable delamination) and coating thickness measurements, harmonised labelling for end-of-life management. |

## 2.3 Product safety and sustainability

This section focuses on current and anticipated EU regulations and voluntary schemes applicable to both ZeroF applications, that ensure that final products are safe for consumers while promoting transparency, environmental responsibility and circularity throughout their life cycle.

### 2.3.1 GPSR

The scope of the general product safety regulation (GPSR) (EU No 2023/988)[25] is to assure that only safe products are placed on the EU market, **when not covered under product-specific EU regulations**. For example in the case of food packaging, it can apply for physical risks for consumers (e.g. choking hazard from detachable pieces) but does not apply to the food contact material safety as covered by EU harmonised legislation (See Packaging following section). GPSR applies to upholstery coated textiles as covering consumer safety beyond chemicals (e.g. flammability if no national regulation applies, indoor use risks and foreseeable misuse).

When placing their products on the market, manufacturers shall ensure that those products have been designed and manufactured in accordance with the general safety requirements, following notably European, international and national standards, voluntary certification schemes or similar third-party conformity assessment frameworks, in particular those conceived to support Union law.

GSPR mainly focuses on ensuring that products do not pose unacceptable risks to consumers and that sufficient information is provided for safe use, with information requirements on producer/importer, product identification, safety instructions and warnings, and maintenance instructions.

[25] Regulation (EU) 2023/988 of the European Parliament and of the Council of 10 May 2023 on general product safety, amending Regulation (EU) No 1025/2012 of the European Parliament and of the Council and Directive (EU) 2020/1828 of the European Parliament and the Council, and repealing Directive 2001/95/EC of the European Parliament and of the Council and Council Directive 87/357/EEC

### 2.3.2ESPR

The Ecodesign for Sustainable Products Regulation (ESPR)[26] is an example of regulation which entered into force on 18 July 2024 (i.e. after D6.2 publication). It's the cornerstone of the Commission's approach to more environmentally sustainable and circular products placed on the EU market, including imports, but with the exception of food, feed, medications, medical supplies, and certain vehicles. Ecodesign requirements are set via delegated acts for groups of similar products, and consist of specific targets for relevant product aspects among the 16 reported in article 5 of the ESPR[27]. These aspects notably cover the **product performance** (e.g. durability, reusability, and reparability), the **product environmental impacts** (e.g. carbon and environmental footprints and energy and resource efficiency), and the presence of substances that inhibit circularity.

**Nor upholstery textile nor food packaging are considered for the first working plan of ESPR (2025-2030) that will be reviewed in 2028[28].** Initial product priorities (2025-2030 working plan) were set in the regulation (Article 18) itself, including textiles and the product group '**chemicals**'[29], of relevance in the context of ZeroF. However, the regulation gives the Commission some discretion to omit some of these products or to add new products, if it provides a justification. As the 'chemicals' product group is wide and complex (i.e. overlap with other segments such as petrochemicals, polymers, specialty chemicals and plastics), a study will be launched by the end of 2025 to define more precisely the potential chemicals in scope of the first working plan of the ESPR as well as potential focus areas for product aspect improvements for (a) future ESPR delegated act(s) related to chemicals (**including polymers & plastics**). Anticipated ESPR measures for textiles are expected to align with the revised Textile Labelling Regulation, currently under review, to ensure a coordinated and effective regulatory approach. These measures are tentatively scheduled for adoption in 2027.

In any case, ESPR will facilitate **end-to-end product life cycle management** by compiling a **digital product passport (DPP)** which contains information on **material composition** including any **substances of concern** in the product, together with information on how it can be **safely used, recycled and disposed of**. Some products may also carry an ESPR label and/or other labels governed by specific EU legislation, such as the Textile Labelling Regulation, currently under review[30].

### 2.3.3Directive on Empowering consumers for the green transition

Another legally binding act of interest for ZeroF and the foreseen certification of the innovations developed in the project, is the Directive on Empowering Consumers for the Green Transition[31]. It requires EU Member States to implement criteria for environmental

[26] Regulation (EU) 2024/1781 of the European Parliament and of the Council of 13 June 2024 establishing a framework for the setting of ecodesign requirements for sustainable products.
[27] Durability, reliability, reusability, upgradability, repairability, the possibility of maintenance and refurbishment, the presence of substances of concern, energy use and energy efficiency, water use and water efficiency, resource use and resource efficiency, recycled content, the possibility of remanufacturing, **recyclability,** the possibility of recovery of materials, environmental impacts, including carbon footprint and environmental footprint, expected generation of waste.
[28] COM(2025) 187 final
[29] Iron and steel; aluminium; textiles, in particular garments and footwear; furniture, including mattresses; tyres; detergents; paints; lubricants; **chemicals**; energy-related products and information and communication technologies products and other electronics
[30] Revision of textile labelling Regulation | EESC (consulted in April 2025)
[31] Directive (EU) 2024/825 of the European Parliament and of the Council of 28 February 2024 amending Directives 2005/29/EC and 2011/83/EU as regards empowering consumers for the green transition through better protection against unfair practices and through better information (Text with EEA relevance).


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claims and labels into national laws. The directive entered into force February 28, 2024 and will protect consumers from greenwashing from 2026 onwards. It mandates clearer product information by prohibiting the display (on the product, at the point of sale or across all media channels) of **sustainability labels** which are not based on a certification scheme, or which have not been established by public authorities (i.e. **ISO Type I and Type I -like labels** - Table 4). It also prohibits misleading commercial practices regarding generic **environmental claims** (e.g. 'biodegradable', 'biobased' or implicit claims such as colours or images) without recognised excellent environmental performance.

**Recognised excellent environmental performance** can be demonstrated by compliance with Ecolabel EU Regulation (EC) No 66/2010[32] or with other officially recognized ISO Type I ecolabelling schemes in the Member States (EN ISO 14024), or by corresponding to top environmental performance for a specific environmental characteristic in accordance with other applicable Union laws (e.g. Energy labelling of energy-related products). For example, a generic environmental claim such as 'biodegradable' could not be made based on recognised excellent environmental performance in accordance with Ecolabel EU Regulation, insofar as there are no requirements for biodegradability in the specific EU Ecolabel criteria related to the product in question. Similarly, a trader should not make a generic claim such as 'sustainable' based exclusively on recognised excellent environmental performance, because such claims relate to other characteristics in addition to environmental characteristics, such as social characteristics.

Table 4 - Types of environmental labelling classified by the International Organisation for Standardisation (EN ISO 14024[33]; ISO DIS 14021[34]; ISO 14025[35]).

| Type | Content | Establishment | Example |
|---|---|---|---|
| ISO Type I labels | Multi-criteria and multi-sectorial identifying the environmental preference of a product within a product category based upon life cycle considerations. | Awarded by an impartial third party (Public or Private agencies), with national, regional, or international recognition | Eu Ecolabel<br>Nordic Swan<br>Blue Angel |
| ISO Type I-like labels | Focus on specific impacts and applied on specific sector | | Energy labelling of energy-related products |
| ISO Type II | Self-declared environmental label, single attribute | Company's own environmental logo with no mean of verification required | 'PFAS-free' and other examples in |
| ISO Type III | Environmental Product Declaration (EPD) based on quantified LCA data | Verified by third party like | An EPD for a food-grade paperboard tray showing carbon footprint, energy demand, water use. |

[32] Regulation (EC) No 66/2010 of the European Parliament and of the Council of 25 November 2009 on the EU Ecolabel

[33] ISO 14024:2018 - Environmental labels and declarations – Type I environmental labelling – Principles and procedures

[34] ISO 14021:2016/Amd 1:2021 - Environmental labels and declarations – Self-declared environmental claims (Type II environmental labelling) – Amendment 1: Carbon footprint, carbon neutral

[35] ISO 14025:2006 - Environmental labels and declarations – Type III environmental declarations – Principles and procedures

### 2.3.4EU Ecolabel

The EU Ecolabel (Regulation (EC) No 66/2010)[36], established in 1992, is the **EU official voluntary certification scheme[37]** for environmental excellence (i.e. Ecolabel Type I - Table 4). The EU Ecolabel helps consumers, retailers and business make truly sustainable choices. The European Commission sets EU Ecolabel multicriteria for different categories of products[38] to minimise their environmental impacts over their entire lifecycle, while guaranteeing their high quality. Because each product category is different, the criteria are tailored to address their unique characteristics. All criteria are developed in consultation with key stakeholders[39], including consumer associations and experts in the relevant field. They are periodically revised by the EU Ecolabelling Board (EUEB), which takes into account technical innovations or market changes to ensure they are up to date, robust, and trustworthy. EU Ecolabel criteria are based on the best products available on the European Economic Area (EEA) market in terms of environmental performance throughout the life cycle and correspond indicatively to the best 10-20 % of the products available on the EEA market in terms of environmental performance at the moment of their adoption.

There is a specific EU Ecolabel category for 'Textile products' which includes upholstery fabrics, last updated in Commission Decision (EU) 2014/350. It focuses on reduced environmental impact during production, limited use of hazardous chemicals (e.g., dyes, flame retardants) and requirements on fibre sourcing (e.g., organic cotton, recycled polyester) (Further details in Textile dedicated sections below). The EU Ecolabel itself does not directly cover food packaging as a standalone product, but it could in the future extend to packaging products, specifically if discussed under broader European Green Deal and Circular Economy Action Plan updates. It is notably foreseen that the EU Ecolabel could successfully be integrated in relevant EU policies, such as the Ecodesign for Sustainable Products Regulation and the Empowering Consumers for the Green Transition Directive[40].

Additional sustainability standards listed in the recently published Deutsch circularity roadmap[41] can be applied are to both ZeroF innovations:

- ISO 14040/44 on the principles and procedures for conducting LCAs,
- ISO 14025 on environmental labels and declarations,

[36] Regulation (EC) No 66/2010 of the European Parliament and of the Council of 25 November 2009 on the EU Ecolabel

[37] A 'certification scheme' means a third-party verification scheme that certifies that a product, process or business complies with certain requirements, that allows for the use of a corresponding sustainability label, and the terms of which, including its requirements, are publicly available and meet the following criteria: i) the scheme is open under transparent, fair, and non-discriminatory terms to all traders willing and able to comply with the scheme's requirements, ii) the scheme's requirements are developed by the scheme owner in consultation with relevant experts and stakeholders, iii) the scheme sets out procedures for dealing with non-compliance with the scheme's requirements and provides for the withdrawal or suspension of the use of the sustainability label by the trader in case of non-compliance with the scheme's requirements, iv) the monitoring of a trader's compliance with the scheme's requirements is subject to an objective procedure and is carried out by a third party whose competence and independence from both the scheme owner and the trader are based on international, Union or national standards and procedures.

[38] Eu ecolabel products catalogue divided in product groups; cleaning, clothing and textiles, coverings, do it yourself, electronic equipment, furniture and mattresses, gardening, tourist accommodation, lubricants, paper, personal and animal care products. https://environment.ec.europa.eu/topics/circular-economy/eu-ecolabel_en (consulted in August 2024)

[39] competent bodies, producers, manufacturers, importers, service providers, wholesalers, retailers, notably SMEs, and environmental protection groups and consumer organisations

[40] BEUC-X-2024-078_EU_Ecolabel_work_plan_2025-2029.pdf

[41] DIN e. V., DKE German Commission for Electrical, Electronic & Information Technologies, VDI – The Association of German Engineers. (2023). Standardization roadmap, deutsche normungs roadmap circular economy.


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- ISO 14067 on principles, requirements and guidelines for the quantification and reporting of the carbon footprint of a product,
- GHG Protocol, which is a global standard for companies and organizations to measure and manage their GHG emissions,
- ISO 50001 on ways to improve energy use, through the development of an energy management system.

### 2.3.5 Implications for ZeroF innovations

Given the EU's trend toward adopting binding sustainability measures, food packaging and textile producers should not only ensure compliance with horizontal regulations and product-specific EU legislations (D6.2 for further details) but also conduct standardised and verified safety and sustainability assessments to limit the impacts of their products on human health and the environment, and enhance market uptake and stakeholder acceptance of PFAS alternatives.

Such assessments are partly covered under the SSbD framework. However, as ZeroF innovations were compared to PFAS benchmark references, the focus was not on the final product production. Therefore, even if the information collected during the iterative SSbD assessments can help prepare the sustainability assessment and claims, further requirements from product specific regulations and relevant (voluntary) certification schemes must be fulfilled for coated fibre-based food packaging and coated upholstery textiles to reach market. These requirements are described in more detail in the dedicated sections below.

# 3 Food contact materials

The CFAE coatings developed in ZeroF are intended for use as PFAS-free barriers in fibre-based food-contact packaging, including coated 2D paperboard substrates and 3D-molded fibre trays. Bringing these materials to regulatory and market readiness requires a structured, staged approach that addresses horizontal regulations requirements described in the above section, performance requirements, food-contact safety, and packaging recyclability under the evolving EU framework. This section presents a strategic roadmap applicable for CeFAEs innovations and their foreseen applications onto paper and moulded fibre food packaging,[42] outlining the mandatory tests, documentation steps, standardisation needs, and prioritised actions required to achieve cost-effective compliance for food contact materials (FCMs)[43] and packaging.

## 3.1 Coating performance

The standards typically referenced for assessing barrier performance and food-contact suitability of fibre-based materials such as the Cobb water absorption test (ISO 535), KIT grease resistance test (TAPPI T559), and various CEN/TS specifications were originally developed for flat, homogeneous paper and board substrates. In the project, minimum key barrier targets were thus defined when considering coated flat substrates (Table 5). These methods assume a planar geometry, relatively uniform porosity, and consistent coating thickness, conditions that differ substantially from those of 3D-molded or thermoformed fibre structures such as trays, cups, and containers. Moulded fibre products present distinct material characteristics that influence both testing and compliance pathways:

- Variable thickness and density across the geometry
- Deep internal porosity and fibre entanglement
- Surface roughness and local defects not typical of planar board
- Irregular coating distribution, especially when using powder-coating or dip-coating methods
- Differential heat transfer during hot-press fusion, affecting film formation locally.

As a result, standards developed for flat substrates do not always accurately represent the performance of moulded fibre items, and in some cases cannot be applied without modifications. Similarly, CeFAE based coatings on paper or moulded fibre are not formally plastic under EU regulation No 10/2011, but principles are commonly used by analogy for migration testing and compliance demonstration with food contact materials framework regulation (EU N0 1935/2004).

[42] Not classified as plastics because they are primarily cellulose-based not polymer based, and thus not cover by single use plastics directive (SUPD, 2019/904/EU)

[43] **Food contact material (FCM):** refer to materials and articles intended to be in contact with food, such as packaging and containers, kitchen equipment, cutlery, and dishes.



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Table 5. Key performance indicators (KPIs), their descriptions and specific test guidelines that can be followed to test them.

| KPI | Description | Test guideline | Project targets |
|---|---|---|---|
| Type of food | Compatibility and resistance to different food types (aqueous, acidic, alcoholic, fatty, dry) | Migration testing (see paragraph on FCM safety regulatory compliance)<br><br>EU Food Simulant Testing according to plastics regulation (EU) No 10/2011:<br>- Simulant A: Ethanol 10% (aqueous foods)<br>- Simulant B: Acetic acid 3% (acidic foods)<br>- Simulant C: Ethanol 20% (alcoholic foods)<br>- Simulant D1: Ethanol 50% (high-fat foods)<br>- Simulant D2: Vegetable oil (fatty foods)<br>- Simulant E: Poly(2,6-diphenyl-p-phenylene oxide) (Tenax®) for dry foods. | Test overall migration in simulant A and water < 10 mg/dm$^2$ |
| Type of contact | Resistance according to type of contact: direct contact, indirect contact, repeated use, long-term or short-term, high or low temperature | Repeated use testing: Three sequential migration tests using fresh simulant each time.<br><br>Time and temperature conditions simulating worst-case scenarios, such as 10 days/40°C (OM2) or 2 hours/100°C (OM4).<br><br>Tests adjusted surface area-to-volume ratios to simulate real use. | |
| Oil repellency | Ability to prevent penetration or staining from oily/fatty foods | - Kit Test (TAPPI T 559 cm-12): Measures oil resistance using a series of standard liquids of increasing aggressiveness.<br>- Grease Resistance Test (EN 1186-13): Contact with olive oil under defined conditions to check for staining or migration.<br>- Cobb Test Modified (for greasy substances instead of water).<br>- ISO 16532-1:2008 Paper and board – Determination of grease resistance – Part 1:<br>- Permeability test | Oil/grease resistance for 6 h for fast food and food service items;<br><br>KIT value of 12 and grease resistance of 5 days for longer shelf-life packaging.<br><br>Oil repellency grade > 4-6 (ISO 14419, AATCC 118). |
| Water repellency | Ability to resist water absorption and maintain mechanical integrity | Cobb Test (ISO 535): Measures the amount of water absorbed by paper or board over a set period (usually 60 or 120 seconds).<br><br>Contact Angle Measurement (EN 828): Water droplet contact angle >90° indicates good water repellency (hydrophobic surface).<br><br>Water Vapor Transmission Rate (WVTR) (ISO 2528 / ASTM E96): Measures water vapor permeability, critical for shelf-life performance. | Minimum key barrier targets for coated flat substrates: Cobb 1800 s of < 30 g/m$^2$ for water Absorption.<br>Ultimate barrier targets for coated flat substrates: Cobb 1800 s of ≤ 10 g/m$^2$ for water absorption.<br>Water repellency grade > 4 (ISO 4920, AATCC 22) |
| Organoleptic Testing | Inability to transfer smell or flavour from FCM to food | Sensory Testing (EN 1230-1 and EN 1230-2): Ensures no off-odours or off-flavours are imparted to food. | |

### 3.1.1 Remaining Gaps for moulded fibres

To ensure reliable and meaningful evaluation of ZeroF's CFAE-coated moulded pulp trays, the following considerations apply:

**Water absorption: COBB vs. moulded fibre water uptake**

ISO 535 (Cobb test) assumes a flat sheet with fully sealed edges and uniform thickness. However, for moulded fibre trays water absorption occurs through sidewalls, corners, and varying densities, not just a flat plane. The Cobb apparatus cannot maintain uniform pressure on a curved or angled surface. Therefore, in the case of ZeroF the Cobb test may be initially applicable on 2D sheets to understand intrinsic coating performance, however for 3D trays, the test may be complemented with immersion tests, leakage tests, or customised Cobb rings adapted to flat regions of the tray. A prototyped/adaptation of the Cobb method being "localized" may be developed for coated moulded fibre areas.

**Grease resistance: KIT test limitation**

The KIT test (TAPPI T559) is calibrated for planar samples and uniform liquid spreading. In the case of moulded fibres, the surface roughness leads to inconsistent reagent contact, and powder-coating produces local thickness gradients, affecting local KIT values. A recommended approach would use KIT testing for screening and 2D benchmarking purposes only, as well as long-term oil diffusion tests (as already done in ZeroF work with dyed olive oil) for moulded trays. These tests are more representable for end-use conditions. Finally, the ASTM F119-82 oil absorption may be considered for moulded shapes.

**Migration testing**

Overall and specific migration tests using standard EU simulants (e.g., ethanol, acetic acid, vegetable oil) that match the intended food type and thus reflect realistic use conditions (e.g., room temperature, microwave heating) should be conducted with coated packaging materials.

Migration tests under EN 1186 assume flat materials submerged or filled with the simulant. Regarding moulded fibre trays, liquid contact areas differ between base, corners and sidewalls. In addition, coating penetration into fibre matrices can alter simulant access, and migration may be higher at thin/porous regions than at thick ones. Therefore, the approach in ZeroF was to conduct simulant contact (Table 5) using cut-out representative zones (base, walls, corners) treated as repeatable samples, besides testing should focus on worst-case geometry areas.

## 3.2 Safety of FCM

Several additional test with regards to those conducted during the innovation process for SSbD need to be conducted in order to conform to regulatory compliance of food contact materials. These mainly include migration tests to show safety of the FCM (coating and packaging) and used additives. With regards to REACH and CLP, SSbD can help to prepare for registration and classification of the materials used to produce the coating system and packaging. It is important to note that REACH and CLP are undergoing revision, and polymers might need to be registered once the REACH revision is published (See Chemical and process safety section above).


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### 3.2.1 EU food contact materials legislation

The safety of food packaging coatings should be evaluated on their intended substrate, under realistic use conditions to be compliant with food contact materials relevant regulations, because the substrate can affect migration behaviour, barrier properties, and overall performance.

In Table 6, an overview is presented of the relevant EU regulations that apply when registering a new coating (Material[44]) and/or new container (Article[45]) used as a FCM.

Table 6. Overview of the relevant requirements and standards for FCMs.

| Area | Relevant requirements and standards |
|---|---|
| Food contact material regulations | - Materials and articles intended to come into contact with food (Framework Regulation EC No 1935/2004)[46]<br>- Good manufacturing practice for materials and articles intended to come into contact with food (Regulation (EU) No 2023/2006GMP in FCM)[47]<br>- European food safety authority transparency regulation (Regulation (EU) 2019/1381) |
| Specifically regulated (group) of substances in Framework Regulation EC No 1935/2004 | - Nitrosamines and nitrosatable substances<br>- BADGE/ BFDGE/NODGE<br>- Polyamide and melamine plastic kitchenware<br>- BPA<br>- Vinyl chloride monomer<br>- Glymo (announced) |
| Material specific regulations | - Regenerated cellulose film 2007/42/EC<br>- Ceramics 84/500/EEC<br>- Plastic materials EU 10/2011<br>- Recycled plastics EU 2022/1616<br>- Active & Intelligent Materials EC/450/2009 |
| No harmonized regulation | - Glass<br>- Metals<br>- Inks<br>- Adhesives<br>- Paper and Board<br>- …<br>In these cases, the FCM compliance in Article 3(1)(a) can be demonstrated by adhering to national regulation or guidelines. |

The EU regulation EC No 1935/2004 provides a harmonized legal framework for all food contact materials. It sets out general principles to ensure that materials and articles intended to come into contact with food are safe.

The Framework Regulation (EC) No 1935/2004 requires that materials and articles do not:

- Release their constituents into food at levels harmful to human health
- Change food composition, taste and odour in an unacceptable way

[44] Material following the FCM Framework Regulation EC No 1935/2004 and Commission Regulation (EU) No 10/2011 are substances or combinations of substances that are intended to come into contact with food at any stage and are characterized according to their chemical and physical properties. They can be raw material or semi-finished (e.g., plastic film, paper sheet, coatings).

[45] Article is the finished product made from one or more materials, designed for final use in food contact. It has a specific shape, function, and design.

[46] Framework Regulation (EC) No 1935/2004, amended by Regulation (EU) 2019/1381 on the transparency and sustainability of the EU risk assessment in the food chain.

[47] Regulation (EU) No 2023/2006

In Article 3 of the framework regulation, it is stipulated that these materials and articles shall be manufactured under good manufacturing practice (GMP) in accordance with EU Regulation 2023/2006. As per this regulation, GMP means "*those aspects of quality assurance which ensure that materials and articles are consistently produced and controlled to ensure conformity with the rules applicable to them and with the quality standards appropriate to their intended use by not endangering human health or causing an unacceptable change in the composition of the food or causing a deterioration in the organoleptic characteristics thereof*".[48]

The EU regulation for Transparency and sustainability of the EU risk assessment in the food chain[49] requires greater transparency and availability of data used in food safety risk assessments—including those concerning FCMs, where non-intentionally added substances (NIAS)[50] are a key concern. It notably mandates the European food safety authority (EFSA) to make all submitted scientific studies and supporting data publicly accessible as soon as an application is validated. This includes any additional information provided by applicants and EFSA's scientific opinions.

Specific EU regulations have been established on few FCMs such as plastic[51], ceramics, regenerated cellulose film and intelligent packaging materials (Table 6). The plastics regulation EU No 10/2011 contains for example a list of substances authorized for use in the manufacture of plastic FCM. Further details can be found in D6.2.

**In the absence of specific regulation on EU level, article 6 of Framework regulation allows Member States to maintain or adopt national provisions. This applies for example on paper and paperboard FCM which lack EU-wide regulation.** Similarly, in the case of a novel FCM material used in fibre based food packaging, which includes chemical modifications not previously assessed for food contact, as in the case of CeFAE based coating formulations, approval falls under national authority guidelines, as there is no EU harmonized regulation or guidance document for coatings.

### 3.2.2 National regulations or guidelines for fibre based food packaging

Currently, nine Member States (Belgium, the Czech Republic, Germany, France, Greece, Croatia, Italy, the Netherlands and Slovakia) have established national regulations or instructions for paper and board FCMs (including Moulded pulp packaging with BIOWAX of ZeroF). Additionally, the Council of Europe has published two resolutions addressing paper and board, as well as tissue paper[52]. Paper and board industry often refers to German

[48] EC. (2006). Commission Regulation (EC) No 2023/2006 of 22 December 2006 on good manufacturing practice for materials and articles intended to come into contact with food. *Off J Eur Union.*, *50*, 75-78.
[49] Regulation (EU) 2019/1381 of the European Parliament and of the Council of 20 June 2019 on the transparency and sustainability of the EU risk assessment in the food chain and amending Regulations (EC) No 178/2002, (EC) No 1829/2003, (EC) No 1831/2003, (EC) No 2065/2003, (EC) No 1935/2004, (EC) No 1331/2008, (EC) No 1107/2009, (EU) 2015/2283 and Directive 2001/18/EC
[50] Non-Intentionally Added Substance (NIAS) are chemical substances present in a food-contact material that were not deliberately added during its manufacture. They may arise from impurities, reaction or degradation products, or contaminants introduced during processing. NIAS must be identified and assessed to ensure they do not pose a risk to human health, as required under Regulation (EC) 1935/2004.
[51] Plastic means polymer to which additives or other substances may have been added, which is capable of functioning as a main structural component of final materials and articles.
[52] European Commission. (2016). *Non-harmonised food contact materials in the EU: Regulatory and market situation – Baseline Study*. Brussels: Directorate-General for Health and Food Safety (DG SANTE).


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BfR XXXVI[53] recommendations as it is the most widely accepted national guideline for paper FCMs. While these recommendations are not legally binding standards, they represent the current state of science and technology regarding the conditions under which paper-based food contact materials meet the safety requirements of Article 3(1)(a) of the Framework Regulation. Limits are specified for migration testing of different substances (phthalates, benzophenone, beno-a-pyrene, benzo-s-pyrene, di-isopropylnaphthaline and 4,4'-bis(dimethylamino)benzophenone). Moreover, raw materials that may be used are specified, including natural and synthetic cellulose fibres, bleached or unbleached, and different other ingredients such as colourants and preservatives that are allowed are listed. An overview of the evaluation of components under BFR XXXVI is shown in Figure 1.

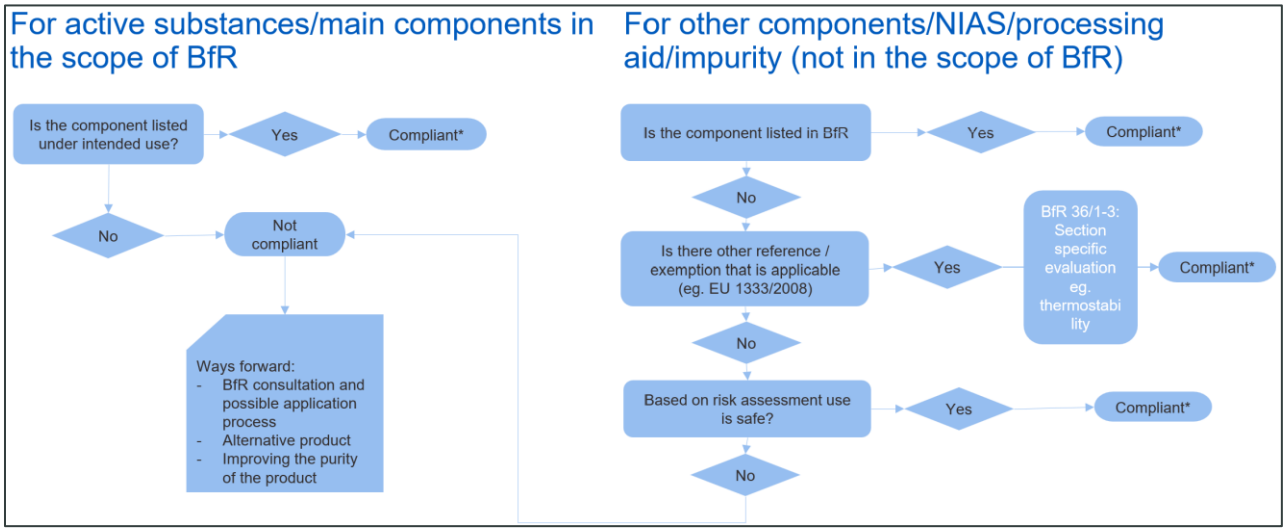


Figure 1. Evaluating FCMs under BFR XXXVI (source: personal communication with Kemira). *Limitations for compliance need to be evaluated and communicated as well.

### 3.2.3 Regulatory compliance

The safety of FCMs for consumers is tested by the business operators producing them and placing them on the market according to the general (e.g. Framework Regulation EC No 1935/2004) and specific regulations mentioned in the above section. Producers have notably the responsibility to follow good manufacturing practices (GMP, EU Regulation 2023/2006) to limit the potential for food pollution to harmful substances from NIAS. For raw materials, which are outside the scope of GMP, constant quality should be ensured by the manufacturer, in order to allow the risk assessment/risk management to be valid for every batch as in the requested in the EU regulation for transparency and sustainability of the EU risk assessment in the food chain (Figure 1). The responsibility for compliance with GMP lies with the manufacturer, but GMP checks are performed on the national level by the competent authorities of the Member States during official controls. Scientific knowledge and technical competence on testing methods is being maintained by the European Reference Laboratory for FCMs. This reference laboratory sets standards and provide scientific and technical assistance to the EU and the Member States and organises inter-laboratory comparison exercises.

[53] BfR. (2023). XXXVI. Papiere, Kartons und Pappen für den Lebensmittelkontakt . Berlin; Germany.

Methods to test paper based FCM following the BfR XXXVI[54] are summarised here (https://www.bfr.bund.de/de/methodensammlung_papier__karton_und_pappe-32620.html). In brief, tests exist that cover:

- General aspects (including migration tests, testing for taste/smell transfer, etc.)
- Studies to test the paper quality
- Identify any unwanted presence of metals
- Identify any unwanted presence of fluor
- Identify any unwanted presence of by the BfR restricted substances
- Specific tests for recycled paper (if applicable)
- Multimethods to identify specific substance groups

New substances are included in the BfR Recommendations on FCMs upon application by the manufacturer to BfR. The application must be submitted on the basis of the EFSA Note for Guidance[55]. In addition to the full identity of the substance, physico-chemical data and intended application of the substance, several tests need to be conducted, as summarized in Table 7.

As ZeroF aims to validate its CFAE-coated fibre-based packaging materials, accredited external laboratories will play a critical role in generating the analytical evidence required for demonstrating compliance with food-contact legislation, chemical safety obligations and recyclability-related criteria. Migration testing, NIAS assessment, analysis of mineral oil saturated hydrocarbons (MOSH) such as paraffins, cycloparaffins, and mineral oil aromatic hydrocarbons (MOAH), and paper-specific purity evaluations must be performed by laboratories with recognised expertise in EU food-contact materials and the analytical methods relevant to coated paper and molded-fibre substrates.

Several European laboratories are widely relied upon by industry for compliance testing of paper and board FCMs. ISEGA (Germany) is one of the most established institutions for paper-based materials and provides comprehensive migration testing, NIAS screening, BfR XXXVI conformity assessment and other FCM-related services. SQTS (Switzerland) offers advanced analytical capabilities, particularly for non-targeted NIAS profiling and mineral oil hydrocarbon (MOSH/MOAH) analysis, while EUROLAB members in various Member States provide accredited testing for overall migration, specific migration and chemical purity analyses. These laboratories are equipped to conduct EN 1186 migration tests, analytical methods for MOSH/MOAH detection or quantification[56], and other relevant assessments such as photoinitiator screening and contaminant profiling.

As there is no single centralised EU certification body issuing an 'EU Food contact approved certificate' there is a self-declaration system in placed which is based on compliance testing, technical documentation. While not always mandatory for paper (due to lack of harmonization), issuing a voluntary declarations of compliance (DoC) is recommended and often requested by customers and authorities. The DoC can be created based on the information obtained from the testing mentioned above, but should at least include:

- Identity of the paper material
- List of substances with migration limits

[54] BfR. (2023). XXXVI. Papiere, Kartons und Pappen für den Lebensmittelkontakt . Berlin; Germany
[55] https://www.efsa.europa.eu/en/efsajournal/pub/rn-21
[56] LC–GC-FID or GC×GC methods


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- Confirmation of compliance with relevant Eu regulations and relevant national rules.

Selecting appropriate laboratories early in the roadmap enables ZeroF partners to plan testing timelines, ensure the use of validated analytical methods, and secure test slots aligned with material development iterations. Engaging with specialised FCM laboratories also supports the preparation of the DoC by providing robust, traceable datasets that meet regulatory expectations and facilitate market acceptance of ZeroF's PFAS-free packaging solutions.

Table 7. Core type of tests required. Identification and quantification of migrating substances, chemical characterization and degradation products, oligomers, additives in FCM under EU 10/2011.[57]

| Test Type | Detailed Description |
|---|---|
| Migration Testing | • Overall Migration Test: Amount of total substances migrating into food simulants.<br>• Specific Migration Test: Amount of particular substances migrating.<br>• Use standard EU food simulants (ethanol, acetic acid, vegetable oil, etc.).<br>• Reflect intended use conditions (temperature, time, type of food). |
| Chemical Characterisation | • Identification and quantification of migrating substances.<br>• Identification of degradation products, additives[58], and oligomers.<br>• Structural and physico-chemical analysis (MOSH/MOAH, molecular weight, solubility, etc.). |
| Toxicological Studies with leachate | • If migration < 0.05 mg/kg: Basic data<br>- Bacterial reverse mutation test (Ames test)<br>- In vitro mammalian cell gene mutation test<br>- In vitro mammalian chromosomal aberration test<br>• If migration 0.05 – 5 mg/kg: Reduced data<br>- All basic data + 90-day oral toxicity study in rodents<br>- Additional genotoxicity studies<br>• If migration > 5 mg/kg: Full data<br>- All reduced data + carcinogenicity studies<br>- Reproductive and developmental toxicity studies<br>- ADME studies (Absorption, Distribution, Metabolism, Excretion)<br>- Endocrine disruption assessment if necessary. |
| Degradation and Stability Testing | • Test stability of the material during intended uses (e.g., cooking, freezing).<br>• Identify and assess breakdown products.<br>• Ensure material integrity and predict behavior over shelf-life. |
| Nanomaterial-specific Testing | • Nano-specific migration testing: Evaluate particle release.<br>• Physico-chemical characterisation at nanoscale (size, shape, surface area).<br>• *In vitro* and *in vivo* genotoxicity and toxicity tests tailored for nanoparticles.<br>• Risk assessment according to EFSA 2021 Nano Guidance. |

For the paper based FCM, there is no harmonized EU regulation. Therefore, FCM needs to comply with national laws, of which the most widely accepted national guideline is the BfR

[57] EFSA Journal: Volume 19, Issue 8, August 2021/Reference Number: EFSA-Q-2018-00569 DOI: 10.2903/j.efsa.2021.6768

[58] **Additive:** means a substance which is intentionally added to plastics to achieve a physical or chemical effect during processing of the plastic or in the final material or article; it is intended to be present in the final material or article.

XXXVI. This recommendation is valid for single/multi-layered commodities (articles, materials) made of paper or –board as well as fiber casting.

## 3.3 Recyclability of food packaging

Paper composite packaging, which is currently often used as a substitute for plastic packaging, presents recycling challenges. In this area, there are various efforts to create uniform rules to develop a uniform assessment of the recyclability of paper composite packaging but none of these are adopted yet[59]. Methods from the Confederation of European Paper Industries (CEPI) are developed to support the EPR and PPWR implementation in the case of paper-based packaging. It focuses on repulpability and fibre recovery to affect a recyclability grade (from A - 'fully recyclable' to D – 'not recyclable'), that can then be used to affect PPWR grades, the latter taking into account further aspects, notably associated to the collection and the sorting of the packaging waste.

### 3.3.1 Remaining Gaps for moulded fibres

The CEPI harmonised recyclability test is applicable to moulded fibre, but rejects may appear artificially high due to collapsed geometry during disintegration. Coating penetration interacts with fibre orientation in 3D structures. Moulded fibre coatings must be tested as whole items, not cut-out sheets, to simulate real mill behaviour. Therefore, even if CEPI is still the correct method for regulatory alignment under PPWR, interpretation of results must take into account the moulded fibre structure. The negative CEPI results in ZeroF (−100 / −86) already reflect this.

While numerous standards exist for planar paper and board (e.g. EN 643 – Paper recycling quality EN 13430 – Packaging recyclability), there are currently no dedicated international standards for many key performance tests relevant to 3D moulded fibre packaging, such as leakage testing, surface energy mapping, dimensional stability after soaking, edge wicking, and coating penetration depth. In industry practice, manufacturers rely on a combination of adapted ASTM/ISO methods and internal quality control protocols. This highlights a standardisation gap for moulded fibre products, which may be covered through future engagement with CEN/TC 6 and CEPI.

## 3.4 Biodegradability of food packaging

Persistent materials and chemicals accumulate in the environment, where they can negatively affect human health and the environment. To tackle this, chemicals and materials can be designed in such a way that they degrade. Generally, two terms are being use: 1) biodegradation and 2) compostability. Compostable materials break down completely into their basic parts (water, carbon dioxide, and biomass). If something is biodegradable it can be broken down by naturally occurring microorganisms such as bacteria and fungi. Thus, both terms describe a natural process for recycling organic waste. All compostable products are biodegradable, but biodegradable products are not always compostable. The main difference is that compostable products have undergone strict testing to ensure that they break down within a specific time frame and do not release any harmful degradation

[59] DIN e. V., DKE German Commission for Electrical, Electronic & Information Technologies, VDI – The Association of German Engineers. (2023). Standardization roadmap deutsche normungsroadmap circular economy


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products into the environment. Biodegradable products have no such requirements, meaning that they may not be as beneficial as they first appear.

There are two types of compostability certifications: 1) Industrial compost associated to a faster breakdown due to high heat, controlled environment, and 2) Home compost which is slower, natural backyard-like environment.

Biodegradability of CeFAE coated tray in the industrial compost environment was evaluated according to EN14046 :2003, which is part of the testing scheme for compostability EN 13432:2000 (and ISO 18606:2013) defining requirements for industrial compostability. Partial biodegradability was observed when microcellulose crystalline was used as reference materials (i.e., 71% after 123 days), highlighting the need for further optimization targeting the 90% biodegradability threshold target in several certification schemes (See Annex I).

## 3.5 Certification schemes

With regards to safety and sustainability, multiple (voluntarily) certification systems exist, mainly focussing on the compostability of the FCM and its substrate, which is currently not taken into account in the SSbD assessment, meaning additional tests need to be performed.

Other aspects that need to be addressed for cellulose based and moulded pulp innovations under SSbD, are the effects of the use of raw material on biodiversity, land use, and social impacts. For these aspects however no legal requirements for FCMs currently exist. The safety and cost considerations linked to the transport of (biobased) starting materials should also be taken into account under the SSbD framework.

Specific guidelines exist that are relevant for the paper based FCM in order to classify the product as compostable or biobased (See Annex I). These include the European EN13432 and the American ASTM D6400 standards.

For any other sustainability and/or safety claims (e.g. PFAS-free), there seems to be a lack of internationally recognised standards, and many different certification programs exist (see Annex I). However, the European Commission is working on the Green Claims Directive to 'stop companies from making misleading claims about environmental merits of their products and services', by establishing clear standards and requirements for companies. It mandates that businesses support their green claims with scientific evidence and transparency while introducing regulations on labelling schemes to prevent greenwashing.

This directive will have huge implications for current certification practices, as it essentially would prohibit self-classification. The directive is expected to be adopted around early 2026. Moreover, the EU's policy framework on the sourcing, labelling and use of biobased plastics, and the use of biodegradable and compostable plastics could affect the labelling of the coating as biobased or biodegradable.

## 3.6 Roadmap to market

The roadmap for ZeroF's fibre-based food-contact packaging provides a structured sequence of actions that enables the CFAE-coated paperboard and moulded-fibre substrates to progress from laboratory prototypes to fully compliant and market-ready materials. Its purpose is to connect the regulatory requirements described in the previous sections with the technical developments achieved so far, and to define the steps necessary to demonstrate safety and recyclability in line with EU legislation and future policy targets.

Initially, the food-contact compliance status of all raw materials used in the CFAE coating formulations (including fatty acid esters, plasticisers, catalysts, silanes) and any processing aids need to be systematically verified. This step requires gathering supplier declarations, checking the substances against relevant positive lists where applicable, and confirming that no prohibited or restricted chemicals are intentionally introduced. Building on this, the roadmap foresees the analytical characterisation of the coating materials, covering both qualitative and quantitative assessment of their chemical composition. This includes confirmation of the polymeric structure, determination of oligomeric fractions, identification of impurities and residuals, and the establishment of a baseline impurity profile prior to migration testing. Compositional data support the evaluation of the food-contact compliance status of the individual components, considering not only FCM framework requirements but also national and international reference lists relevant for paper and board. Where substances fall outside these references, the roadmap foresees the generation or collection of toxicological information in accordance with EFSA requirements, enabling the determination of safe exposure limits through approaches such as the threshold of toxicological concern. This toxicological step is particularly important for assessing NIAS, oligomers or any impurities identified during analytical characterisation. Based on the results of the compositional and toxicological assessments, the roadmap includes a decision step to identify any issues that may require product improvement, for example through reduction of impurity levels, substitution of problematic additives or optimisation of synthesis or coating processes to limit degradation products. Once these improvements are implemented, the materials can proceed to comprehensive migration testing in accordance with the EN 1186 series using relevant food simulants, ensuring that both overall and, where applicable, specific migration remain within acceptable limits. Where needed, the roadmap also foresees contact with BfR for clarification or confirmation regarding the interpretation of BfR XXXVI requirements for paper and board, especially where specific substances, impurities or NIAS fall into categories requiring expert judgement or national-level guidance. This interaction is common practice in the absence of harmonised EU rules for paper FCM and supports the preparation of the Declaration of Compliance. Further steps of the roadmap include MOSH/MOAH analysis, NIAS screening, recyclability verification under the PPWR through CEPI testing, and the gradual development of GMP documentation. Together, these actions outline the path for ZeroF's packaging solutions to achieve a verified safety and compliance profile aligned with EU regulatory and market expectations (Table 8).


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Table 8. Overview of a step by step approach to achieve regulatory compliance of Zerof FCM

| Roadmap Step | Description of Actions | Purpose / Output |
|---|---|---|
| Raw material compliance verification | Collect supplier documentation; confirm food-contact status of all raw materials; check against relevant positive and restriction lists. | Ensure no prohibited substances enter the formulation and establish regulatory basis for downstream testing. |
| Chemical characterisation of coating | Perform qualitative and quantitative analysis: polymer structure confirmation, oligomer profiling, impurity identification, residual solvent analysis. | Establish chemical identity, impurity profile and analytical baseline needed for NIAS and migration assessments. |
| Component-level food-contact compliance assessment | Evaluate all intentionally added substances against FCM guidelines (e.g., BfR XXXVI), national lists, and relevant international references. | Confirm that the composition aligns with accepted FCM raw materials and permitted additives for paper and board. |
| Toxicological assessment (EFSA-aligned) | Gather or generate toxicological data; apply TTC approach where applicable; assess safety of NIAS, oligomers and impurities. | Determine safe exposure limits and support risk assessment for both intentionally added substances and NIAS. |
| Identification of issues and product optimisation | Evaluate impurity profile and migration behaviour; implement reformulation if needed (e.g., reduce impurities, substitute additives, improve thermal stability). | Improve material safety, reduce NIAS burden, and enhance compliance readiness. |
| Migration testing (EN 1186) | Conduct overall migration and, where relevant, specific migration testing using appropriate simulants and conditions (OM2/OM4). | Demonstrate compliance with Regulation (EC) 1935/2004 for intended food-contact applications. |
| NIAS assessment | Perform targeted and non-targeted screening (GC–MS, LC–MS); identify unknowns; conduct toxicological evaluation for relevant substances. | Provide required safety evidence for non-intentionally added substances and degradation products. |
| MOSH/MOAH analysis | Perform LC–GC-FID or GC×GC analysis to assess mineral oil hydrocarbons and potential migration from fibres or coatings. | Ensure compliance with national expectations and demonstrate low or no risk from MOAH and MOSH. |
| Consultation with BfR (if needed) | Seek clarification on borderline substances, NIAS interpretation or impurity limits in relation to BfR XXXVI. | Support regulatory alignment for paper-based FCM in absence of EU harmonised rules. |
| Recyclability assessment (PPWR) | Conduct CEPI recyclability testing; evaluate reject rates and fibre recovery; improve coating formulation and application as needed. | Achieve PPWR recyclability performance grades A–C and support circularity compliance. |
| GMP compliance (EC 2023/2006) | Establish process documentation, traceability, control of raw materials, fusion | |

# 4 Upholstery textile coatings

ZeroF has developed water-based ORMOCER® hybrid coatings for textiles that reach high water and oil contact angles on representative upholstery fabrics, with a clear performance target framed by standardised textile tests and basic human safety endpoints. For upholstery textiles, ZeroF worked mainly with PES 2D, PES 3D, cotton and some blends. Water based coatings developed in the project target PFAS-free water and oil repellency, designed for durable finishing on synthetic and blended fabrics.

## 4.1 Coating performance

Manufacturers can assess the impact of coating on textile quality to ensure coated products retain their functionality for as long as possible. To this end, different performance criteria exist. In 2017, technical and ecological criteria for EU Ecolabel furniture were presented as part of the EU Ecolabel criteria[60]. The physical criteria are presented in Table 9.

Following this certification scheme, textile products should be tested for domestic wash cycles (ISO 6330) or industrial laundry cycles (ISO 15797) in combination with water repellents (ISO 4920), oil repellents (ISO 14419) and stain repellents (ISO 22958) standards. ZeroF KPI in terms of water repellency (i.e., grade > 4) and oil repellency (i.e., grade > 4) are compatible with EU Ecolabel certification scheme requirements (Table 9 and further details in Annex II), while seems under the EU Ecolabel resistance to abrasion target (i.e, 20.000 and ≥ 50.000 Martindale cycles for household and contracting applications, respectively following ISO 12947-2 versus ≥ 75,000 cycles in EU Ecolabel).

Such water and oil repellency properties have not yet been achieved with ZeroF innovative coatings and the consortium advocate a change in mentality and requirements from standards and certification schemes to balance the product performance expectations when considering upholstery textiles with the real consumer needs and the environmental and health concerns associated to unique omniphobic coatings.

Table 9. Physical and performance requirements for textile fabric covering materials in furniture upholstery (as taken from Appendix II to EUR 28443, EN 14465 and the EU Ecolabel regulation).

| Source of criteria | Test factor | Guideline | Removable and washable coverings | Non-removable and washable coverings |
|---|---|---|---|---|
| EUR 28443 EN (textiles used as upholstery covering material) | Dimensional changes during washing and drying | Domestic washing: ISO 6330 + EN ISO 5077 (three washes at temperatures as indicated in the product with tumble drying after each washing cycle) Commercial washing: ISO 15797 + EN ISO 5077 (at minimum of 75 °C) | +/- 3.0% for woven fabrics +/- 6.0% for non-woven fabrics | NA |
| | Colour fastness to washing | Domestic washing: ISO 105-C06 Commercial washing: | ≥ level 3-4 for colour change ≥ | NA |

[60] Donatello S; Moons H; Wolf O. Revision of EU Ecolabel criteria for furniture products. Final Technical Report. EUR 28443 EN. Luxembourg (Luxembourg): Publications Office of the European Union; 2017. JRC105558


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| | | | | |
|---|---|---|---|---|
| | | ISO 15797 + ISO 105-C06 (at minimum of 75 °C) | level 3-4 for staining | |
| | Colour fastness to wet rubbing* | ISO 105 X12 | ≥ level 2-3 | ≥ level 2-3 |
| | Colour fastness to dry rubbing* | ISO 105 X12 | ≥ level 4 | ≥ level 4 |
| | Colour fastness to light | ISO 105 B02 | ≥ level 5** | ≥ level 5** |
| | Fabric resistance to pilling | Knitted and non-woven products: ISO 12945-1 Woven fabrics: ISO 12945-2 | ISO 12945-1 result >3 ISO 12945-2 result >3 | ISO 12945-1 result >3 ISO 12945-2 result >3 |
| EUR 28443 EN (Any coated fabrics used as upholstery covering material) | Tensile strength | ISO 1421 | CH ≥ 35daN and TR ≥ 20daN | |
| | Tear resistance of coated fabrics by the trouser tear method | ISO 13937/2 | CH ≥ 2,5daN and TR ≥2daN | |
| | Colour fastness to artificial weathering – Xenon arc fading lamp test | EN ISO 105-B02 | Indoor use ≥ 6; Outdoor use ≥ 7 | |
| | Textiles – abrasion resistance by the Martindale method | ISO 5470/2 | ≥ 75,000 cycles | |
| | Determination of coating adhesion | EN 2411 | CH ≥ 1,5daN and TR ≥ 1,5daN | |
| EU ecolabel | Water repellency | ISO 4920, AATCC 22 | Water repellents shall retain a functionality of 80 out of 90 after 20 domestic wash and tumble dry cycles at 40 °C, or after 10 industrial washing and drying cycles at a minimum of 75 °C | |
| | Oil repellency | ISO 14419, AATCC 118 | Oil repellents shall retain a functionality of 3,5 out of 4,0 after 20 domestic wash and tumble dry cycles at 40 °C, or after 10 industrial washing and drying cycles at a minimum of 75 °C. | |
| | Stain repellency | ISO 22958 | Stain repellents shall retain a functionality of 3,0 out of 5,0 after 20 domestic wash and tumble dry cycles at 40 °C, or after 10 industrial washing and drying cycles at a minimum of 75 °C. | |

* does not apply to white products or products that are neither dyed nor printed

** A level of 4 is nevertheless allowed when furniture covering fabrics are both light coloured (standard depth ≤ 1/12) and made of more than 20 % wool or other keratin fibres, or more than 20 % linen or other bast fibres.

## 4.2 Safety of upholstery textile coatings

The safety of the ZeroF coatings developed for upholstery textile relies on chemical, process and product horizontal regulations described in the EU regulatory landscape section above. Under the GPSR, upholstery textile coatings must be safe under normal use, meaning not associated to skin irritation (OECD TG 439), skin sensitisation (OECD 442C/442D/442E), nor cytotoxicity (ISO 10993-5), or volatile organic compound (VOC) emissions (ISO 16000-6 series for total VOC and individual VOCs) and replying to mechanical and safety testing of textile products (e.g. EN 16889), when tested using international recognised safety

standards or national standards such as DIN B1 (Germany) and CSR RF 1/75 A (Italy) for fire safety.

Additional chemical testing restrictions and requirements are foreseen in the context of ESPR even if not yet defined for upholstery textiles. Indeed, DPP requirements are expected to align with existing criteria in the EU Ecolabel applicable for upholstery textile products (EU No. 2014/350/EU). Most of these criteria refer to the REACH and CLP regulations, and are aligned with the SSbD framework with regard to the **avoidance of SVHC (<0.1% w/w) and substitutions of hazardous substances and mixtures used in dyeing, printing and finishing** if classified following CLP (not only cat .1 but also cat. 2 of carcinogenicity, mutagenicity or reproductive toxicity), with some exception notably for water repellents (H413 exempt if repellent and degradation products readily biodegradable or non-bioaccumulative in aquatic environment) and for auxiliaries including dispersing agents and surfactants (H301, H311, H331, H371, H373, H317, H334, H411, H412, H413, H070, with <1% w/w final product concentrations for H311, H331 and H317).

The EU Ecolabel guarantees the consumer that the use of such substances has been limited to the extent technically possible without prejudice to the fitness for use. For substances that have not been registered under Regulation (EC) No 1907/2006, or which do not yet have a harmonised CLP classification, information meeting the requirements listed in Annex VII of that regulation should be gathered when substances are produced in more than 1 tonne per year.

Other restricted substances list exists in different certification frameworks dedicated to textiles, such as the ZDHC Manufacturing Restricted Substance List[61] or the AFIRM restricted Substance Lists.[62]

By complying to (most) of these criteria the coated textile can be eligible for the EU Ecolabel, as well as other classification schemes such as Blue Angel and the Nordic Swan Ecolabel (which are further described in section 4.5 of this deliverable).

## 4.3 Sustainability of coated upholstery textile

European textile consumption is the fourth largest cause of **environmental pollution** and climate change after food production, housing and mobility[63]. European textile consumption is among the top three pressures on water and land resources and among the top five pressures in terms of raw material use and greenhouse gas emissions. To address these impacts, the EU Green Public Procurement (GPP) framework encourages public authorities to purchase sustainable textiles, reducing environmental footprints across the product lifecycle, while the Corporate Sustainability Due Diligence Directive (CSDDD) requires companies to identify and mitigate environmental and human rights risks throughout the textile supply chains.

[61] https://mrsl.roadmaptozero.com/
[62] https://afirm-group.com/wp-content/uploads/2025/11/2025_AFIRM_RSL_2025_1019.pdf
[63] https://ec.europa.eu/commission/presscorner/detail/en/FS_22_2017


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Moreover, under the IED, the following activities relevant for textiles and coating of textiles are covered:

- the pre-treatment (operations such as washing, bleaching, mercerisation), dyeing or finishing of textile fibres or textiles[64] where the treatment capacity exceeds 10 tonnes per day;
- surface treatment of substances, objects or products using organic solvents, in particular for dressing, printing, coating, degreasing, water proofing, sizing, painting, cleaning or impregnating, with an organic solvent consumption capacity of more than 150 kg per hour or more than 200 tonnes per year.

Both scenarios are currently not applicable to the ZeroF innovations, however, when production volumes increase it might be in the future. In addition, the IED can be applicable for waste regulation if the production processes exceed defined thresholds.[65]

The BAT for textile production[66] defines emission levels to air (mass of emitted substances per volume of waste gas, expressed in mg/Nm$^3$) and to water (mass of emitted substances per volume of water, expressed in mg/L) for some substances. Thresholds for others environmental performance levels in terms of water and energy consumption are set and compared to an inventory of inputs and outputs, developed as part of an environmental management system.

In order to improve the overall environmental performance, especially to prevent or reduce emissions to the environment and waste, of oil-, water- and soil-repellence finishing, BAT is to use oil-, water- and soil-repellents with improved environmental performance, selected considering the risks associated with them, in particular in terms of persistence and toxicity, including the potential for substitution (e.g. PFAS, see BAT 14 point I.(d)), the composition and form of the textile materials to be treated, the product specifications (e.g. combined oil-, water-, soil-repellence and flame retardance).

## 4.4 Circularity of coated upholstery textiles

Textiles are explicitly included as a priority material stream in the WFD. From 1 January 2025, Member States must set up separate collection systems for textiles, and upholstery textile are increasingly covered by EPR schemes established under national law based on WFD principles. It is foreseen that EPR fees must be modulated based on durability, reparability, recyclability and presence of hazardous substances under Article 8a WFD. These obligations are reinforced by the EU Strategy for Sustainable and Circular Textiles adopted March 30, 2022.[67]

Moreover, it is foreseen that the future update of the EU Textile Labelling Requirements (Regulation (EU) No 1007/2011) most likely will include information on durability and

[64] Finishing is the physical and/or chemical treatment aiming at giving the textile materials end-use properties such as visual effects, handle characteristics, waterproofness or non-flammability.
[65] Industrial and Livestock Rearing Emissions Directive (IED 2.0) - European Commission
[66] Commission Implementing Decision (EU) 2022/2508 of 9 December 2022 establishing the best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council on industrial emissions, for the textiles industry (notified under document C(2022) 8984)
[67] March 30, 2022 - Communication - EU Strategy for Sustainable and Circular Textiles - 74126c90-5cbf-46d0-ab6b-60878644b395_en

reparability, recycled content and fibre origin to align with the coming digital product passport.

#### 4.4.1.1 Relevant national regulations

As EU-wide regulation is still evolving in the field of upholstery textiles, national legislation and policy initiatives play an important complementary role and need to be taken into account. Several Member States have already introduced or announced measures that directly affect textile producers, importers, and distributors, particularly with regard to circularity, extended producer responsibility (EPR), and transparency requirements. These include:

- In **France**, the Anti-Waste Law for a Circular Economy (AGEC, Law n°2020-105, 10 February 2020) establishes a framework to prevent waste and promote circularity across product value chains, including textiles. Under the Environmental Code (Articles L.541-10-27 and R.543-214 to R.543-219), France has introduced EPR obligations and is developing an Eco-Score system. This Eco-Score aims to provide consumers with harmonised information on the environmental performance and circularity of products, which may also influence the upholstery textile sector through requirements on durability, recyclability, and end-of-life management.
- In **the Netherlands**, the Decree on EPR for Textiles introduces mandatory obligations for companies placing textiles on the Dutch market. Producers are required to take responsibility for the collection, reuse, and recycling of textile products, as well as to report on volumes placed on the market and waste management outcomes. Although not specific to upholstery textiles, the decree applies broadly to textile products and therefore has implications for furniture and interior textiles placed on the Dutch market.
- **Italy** has announced the establishment of an extended producer responsibility scheme for textiles, moving towards mandatory producer obligations similar to those already in place in other Member States. While the detailed implementation is still under development, the announcement indicates future requirements related to financing of waste management, data reporting, and circular design considerations that may affect upholstery textile producers operating in the Italian market.
- In **Luxembourg**, the Ministry of the Economy has developed the Product Circularity Data Sheet (PCDS), a voluntary but structured framework to communicate product-level circularity information. The PCDS aims to improve transparency on aspects such as material composition, durability, reparability, and end-of-life options, and can be used across different product groups, including textiles. Although not a regulatory requirement yet, it reflects increasing expectations for standardised circularity data.


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## 4.5 Certification schemes

Voluntary schemes developed by the Commission, such as the EU Ecolabel criteria for Textile Products and the EU GPP criteria for textiles products and services will include requirements related to environmental aspects of textiles products. While not yet considering upholstery textiles, they encompass, detailed criteria for good quality and durable products, restrictions of hazardous chemicals, as well as requirements on environmentally sustainable sourcing of textile fibres[68] that could be also applicable to such application.

Labelling products as sustainable under the ESPR means using less energy, no or fewer substances of concern, present a lower carbon and environmental footprint over their lifecycle with a longer usage period, easily repairable, containing parts which may be disassembled and put to further use, easily recyclable and/or containing more recycled content, and having improved availability of information on their sustainability.

Two types of marketing are considered: one regarding the ZeroF ORMOCER® coating developed as alternative to PFAS coatings, and one regarding the final upholstery textile to which the coating is applied.

### 4.5.1 Certification schemes for the ORMOCER® coating

In the table below some relevant certification schemes are listed for the ORMOCER® coating, that are further described in the sections below.

Table 10. Some identified relevant certifications for the ORMOCER® coating.

| Certification | Description | Certification steps |
|---|---|---|
| GreenScreen® | An US based, but globally recognized, certification scheme for safer chemicals. The method is hazard based. A specific section (Section II – Assessing Polymers[69] ) is available that can be applied to the ORMOCER® coating. | A licensed GreenScreen® profiler needs to be hired to perform a new Assessment for the ORMOCER® coating |
| TÜV AUSTRIA OK biodegradable WATER | Test biodegradation in water of the coating | Provide description of the ORMOCER® coating, and conduct testing by a certified laboratory on the degradation of the polymer, supported by a clear product description and a valid laboratory report |
| OEKO-TEX® ECO PASSPORT | ECO PASSPORT certification is designed for manufacturers and distributors of chemicals used in the textile, leather and footwear industries. | The ORMOCER® coating must pass CAS number screening for restricted substances, be analytically verified in an OEKO-TEX® laboratory, and undergo a manufacturer self-assessment of product stewardship (with optional on-site verification) |

#### 4.5.1.1 GreenScreen®

GreenScreen® was launched in the US in 2007 as a comprehensive hazard assessment tool for the design and use of safer chemicals via informed substitution. It translates the toxicity

[68] March 30, 2022 - Communication - EU Strategy for Sustainable and Circular Textiles - 74126c90-5cbf-46d0-ab6b-60878644b395_en

[69] GreenScreen® v1.4 (January 2018). Section II – Assessing Polymers. https://www.greenscreenchemicals.org/images/ee_images/uploads/resources/GreeScreen1.4-SectionII-1.18.pdf

principles of green chemistry into a method for identifying and taking pragmatic action away from chemicals of high concern to safer alternatives. The method exists of three steps:

- Step 1: classify the hazard (this is already done within the ZeroF project by applying SSbD);
- Step 2: Assign a GreenScreen® Benchmarks™ Score;
- Step 3: Make informed decisions about the use of chemicals in products and processes.

Different method documents exist to assess 1) single chemicals, 2) polymers and 3) products. For the ORMOCER® coating section II for the assessment of polymers[70] is the relevant method document. Here, it is detailed how one should:

- Collect formulation and structural and physical property information for the polymer substance or polymer mixture;
- Classify the hazard of the polymer by using test data and how bridging principles for similar polymers, hazard criteria and expert judgement should be applied;
- Classify hazard for fate & physical hazard endpoints;
- Determine polymer benchmark to identify polymers of potential concern, how to deal with data gaps and how to consider transformation products.

#### 4.5.1.2 TÜV AUSTRIA OK biodegradable

Products certified for OK Biodegradable WATER guarantee biodegradation in a natural, freshwater environment, and thus make a substantial contribution to the reduction of waste in rivers, lakes or any natural freshwater. In order to qualify for this certification, a test on biodegradation (chemical break down of the polymer), in addition to a clear and detailed product description, is required.

Accepted biodegradation standards are:

- Adapted for degradation in fresh water based on European standard EN 14995
- European standard EN 29408: "Water quality. Evaluation in an aqueous medium of the "ultimate" aerobic biodegradability of organic compounds: method by determining the oxygen demand in a closed respirometer"
- European standard EN 29439: "Water quality. Evaluation in an aqueous medium of the "ultimate" aerobic biodegradability of organic compounds: method by analysis of released carbon dioxide"
- International standard ISO 9408: "Water quality - Evaluation in aqueous medium of the "ultimate" aerobic biodegradability of organic compounds - Method by determining of the oxygen demand in a closed respirometer"
- International standard ISO 9439: "Water quality - Evaluation in aqueous medium of the "ultimate" aerobic biodegradability of organic compounds - Method by analysis of released carbon dioxide"
- Document with reference OECD 301 C: "Aquatic respirometric biodegradation test (MITI)"

[70] GreenScreen® v1.4 (January 2018). Section II – Assessing Polymers. https://www.greenscreenchemicals.org/images/ee_images/uploads/resources/GreeScreen1.4-SectionII-1.18.pdf


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- Document with reference OECD 301 B: "CO2 Evolution (Modified Sturm Test)"

These tests are written down in a report. Accepted reports for classification are:

- Reports from laboratories that are officially approved by TÜV AUSTRIA are accepted.
- Reports from independent laboratories that are not officially approved by TÜV AUSTRIA, but are either accredited according to ISO 17025, recognized for Good Laboratory Practices (GLP) or recognized by a similar certification body, can be accepted after a positive evaluation in detail of all requirements of the relevant test standard.
- In case the test report comes from a laboratory that is not officially approved by TÜV AUSTRIA, is older than 3 years, the report can only be accepted for evaluation on the following two conditions: - a sample from the archives of the laboratory has to be sent and FTIR analysis demonstrates that this sample fully corresponds to the sample submitted in the framework of the certification - the applicant has to provide a statement that the tested sample fully corresponds to the sample submitted in the framework of the certification

#### 4.5.1.3 OEKO-TEX® Standard 100

OEKO-TEX® Standard 100[71] is a certification scheme applicable to chemicals used in the textile sector. In brief, a first screening of CAS numbers is mandatory for ingredients in order to assure that restricted substances are not used. Then, analytical verification needs to be performed in an OEKO-TEX® laboratory to ensure that the certified chemical/coating/product follow the procedures and requirements for the OEKO-TEX® Standard 100. Then, a self-assessment step needs to be carried out (with an optional on-site visit) by the chemical manufacturer to evaluate measures of good product stewardship.

### 4.5.2 Certification schemes relevant for textiles

Below, certification schemes are listed for the textile the ORMOCER® coating is applied to. Many certification schemes focus solely the textile, such sourcing of the raw materials. These certifications are not considered in this report. The certification schemes listed in Table 11 and further described below include considerations of chemicals and/or coating materials.

Table 11. Certification schemes relevant for the ORMOCER® coated upholstery textiles.

| Certification | Description | Certification steps |
|---|---|---|
| EU Ecolabel | Voluntary certification scheme that sets environmental performance criteria across the textile life cycle, with a strong focus on chemical safety and production processes | Generation of a dossier, that contains information on the products ecological performance (assessed against the applicable ecological criteria in 2014/350/EU), covering chemical restrictions, process requirements, energy efficiency, and emissions to air and water. |

[71] https://www.oeko-tex.com/en/our-standards/oeko-tex-standard-100/

| | | |
|---|---|---|
| | | The dossier is submitted to a competent body that will evaluate and verify the assessment |
| NF Furniture Environment Label | A French eco-label that certifies products and services with a limited environmental impact while maintaining quality and performance. It guarantees that products meet strict criteria related to their entire life cycle, from manufacturing and use to disposal and recycling. | To source textiles that comply with the ecological criteria defined in the community ecological label for textiles or with another national or regional ecological label of the ISO type 1 type or with the OEKOTEX 100 (Class III product) label. |
| OEKO-TEX® Standard 100 | Ensures textile products are tested for, and do not contain, harmful substances. | Certification is done by an OEKO-TEX® institute |
| Blue Angel | Environmentally Friendly Upholstered Furniture (DE-UZ 117). The environmental label for upholstered furniture identifies furniture that – above and beyond the legal regulations:<br>- are manufactured in an environmentally friendly manner – this especially applies to leather, textiles and upholstery materials<br>- are manufactured using materials that place less burden on the environment<br>- do not contain any harmful substances that have a detrimental impact during the recycling process | Certification is done through their own organisation |
| Nordic Swan Ecolabel | The requirements include:<br>- Use of fibres that are either organic, recycled or based on renewable resources and meet specific environmental requirements.<br>- Environmental and health properties of all chemicals used in the textile production.<br>- Implementation of a minimum of BAT water and energy efficiency techniques or local production of solar energy in textile production.<br>- Test of the quality of the textile, e.g., dimensional change, colour fastness and abrasion resistance.<br>- Compliance with UN's International Labour Organization conventions on workers' rights. | Administered and managed by Nordic Ecolabelling, a Nordic joint organisation |

#### 4.5.2.1 EU Ecolabel

For now, the ecological criteria for the award of the EU Ecolabel for textile products (2014/350/EU) is still in place and has a list of restricted substances, and promotes the substitution of hazardous substances in dyeing, printing and finishing. The EU Ecolabel guarantees the consumer that the use of such substances has been limited to the extent technically possible without prejudice to the fitness for use.


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In order to show compliance with the criteria the applicant is required to declare the information about the product(s) and their supply chain as shown in Table 12. Specifically, with regards to chemicals and processes, the following criteria apply:

- Criterion 13. Restricted Substance List (RSL)
- Criterion 14. Substitution of hazardous substances and mixtures used in dyeing, printing and finishing
- Criterion 15. Washing, drying and curing energy efficiency
- Criterion 16. Treatment of emissions to air and water

Table 12. Overview of assessment and verification requirements (adapted from Ecolabel EU regulation (2014/350)).

| **Criteria set** | **Verification method** |
|---|---|
| Textile fibre criteria: The complete material composition of the product(s), identifying and showing compliance for textile fibres, components and accessories | Fibre and component manufacturers, their raw material and chemical suppliers and testing laboratories working in accordance with the specified test methods |
| Chemicals and processes: The substances, production recipes and technologies used to manufacture and impart specific qualities and functions to the product at the spinning, pre-treatment, dyeing, printing and finishing stages and to treat emissions; | Production suppliers sites, and their testing chemical laboratories working in accordance with the specified test methods. Where required product analytical testing shall be carried out annually during the license period and submitted to the appropriate competent body for verification |
| Fitness for use: The performance of the product(s) as defined by specific testing procedures which address colour under specific conditions, resistance to pilling and abrasion, and the durability of repellency, easycare and flame retardancy functions | Testing laboratories working in accordance with specified test methods |
| Corporate Social Responsibility: Compliance of the applicants' selected cut/make/trim suppliers with defined international labour standards. | Independent verifiers or documentary evidence based on the auditing of cut/ make/trim production sites. |

#### 4.5.2.2 Blue Angel

The Blue Angel is an independent German ecolabel for environmentally friendly products and services, awarded by the German federal government since 1978. The Blue Angel was the first ecolabel worldwide and since then it has been viewed as a credible label. The certification relevant for ZeroF is the Low-Emission Upholstered Furniture (DE-UZ 117). In this certification, a set of requirements are set out in order to obtain the label.[72]

#### 4.5.2.3 Nordic Swan Ecolabel

In 1989, the Nordic Council of Ministers launched a Nordic environmental label – the Nordic Swan Ecolabel. The label is administered and managed by Nordic Ecolabelling, a Nordic joint organisation. Upholstery textiles fall under the 'Nordic Ecolabelling for Textiles, hides/skins, and leather' classification.[73] The requirements cover a range of aspects, including the assessment of environmental and health properties of all chemicals used in the textile production. Among other things, Nordic Ecolabelling sets strict requirements to substances that are classified carcinogenic, toxic to reproduction or can damage genetic material. Identified and potential endocrine disruptors on up-to-date lists from EU and

[72] https://www.blauer-engel.de/en/productworld/upholstered-furniture
[73] https://www.nordic-swan-ecolabel.org/criteria/manufacturing-of-textiles-hides-skins-and-leather-039/

national authorities, flame retardants and fluorinated substances, and antibacterial additives incl. nanoparticles are forbidden to be used.

#### 4.5.2.4 NF Furniture Environment Label

The NF Environnement ecolabel is awarded following a certification audit carried out by a third-party organization (AFNOR Certification or one of the 12 specialized organizations it has appointed). In order to obtain this certification, organizations commit to complying with precise specifications or standards, which the auditor verifies in the field. The standards have been drawn up in partnership with manufacturers, associations, distributors and public authorities. Criteria are reviewed regularly, and certification is granted for three years.

A specific certification is in place for furniture, which is based on 20 criteria. One of the criteria concerns the textiles used for the furniture. To source textiles that comply with the ecological criteria defined in the community ecological label for textiles or with another national or regional ecological label of the ISO type 1 type or with the OEKOTEX 100 (Class III product) label.

#### 4.5.2.5 OEKO-TEX® STANDARD 100

OEKO-TEX® STANDARD 100 is a label for textiles tested for harmful substances. It sets the benchmark for textile safety, from yarn to finished product. Every item bearing the STANDARD 100 label is certified as having passed safety tests for the presence of harmful substances. A certificate is issued for one year.

## 4.6 Roadmap to market

ZeroF has achieved strong progress, developing functional PFAS-free coatings with high water repellency, initial oil repellency testing, and basic hazard screening, With the application of the SSbD framework and a good understanding of EU ecolabel requirements for upholstery textiles, project partners completed key durability and mechanical tests such as ISO 6330, ASTM D1388, ISO 13938-2 and ISO 12947-2.

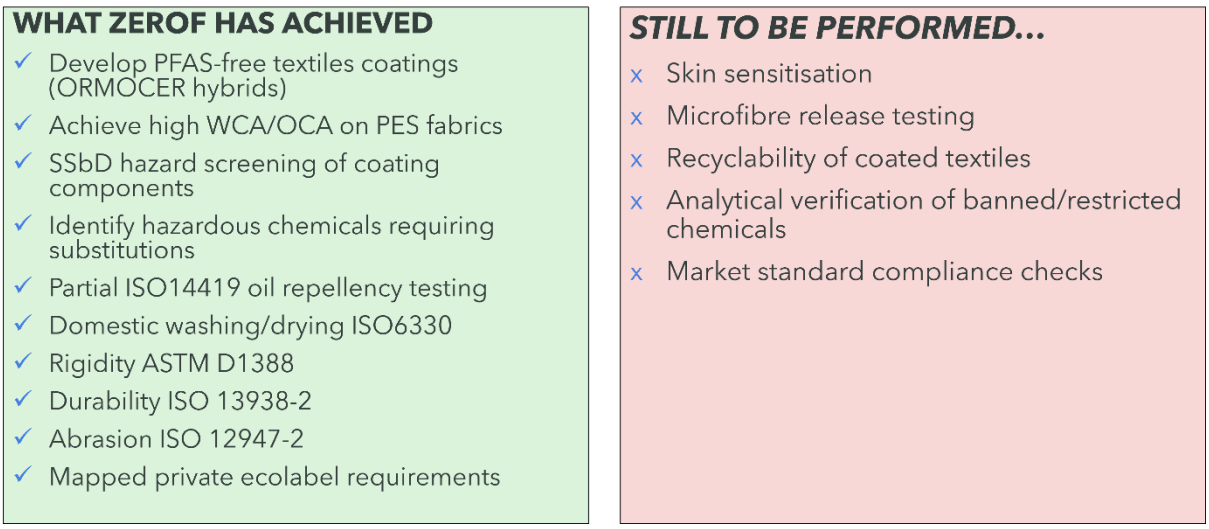


Figure 2. Pathway to regulatory compliance for coated upholstery textiles. WCA= water contact angle indicator of hydrophobicity and OCA= oil contact angle indicator of oleophobicity.


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# 5 Considerations on Costs and Performance

The transition towards PFAS-free coatings in packaging and textiles requires careful consideration of both performance and cost, as these aspects are closely interlinked. For ZeroF materials to become viable alternatives to fluorinated systems, they must demonstrate functional performance that meets end-use requirements while maintaining a cost structure compatible with industrial adoption and large-scale market deployment. Cost and performance therefore form a central component of the overall sustainability assessment of the coatings developed in the project.

From a performance perspective, C(e)FAE-based coatings for fibre packaging must achieve effective water and oil repellence, ensure controlled migration behaviour under food-contact conditions and demonstrate compatibility with circularity requirements, particularly recyclability under the PPWR. Similarly, the ORMOCER® hybrid coatings developed for textiles must offer durable repellence, resistance to abrasion and washing, and compliance with applicable chemical and product-safety requirements. Achieving these performance attributes typically requires optimisation of formulation, coating thickness, processing conditions and substrate compatibility, each of which can influence material costs and the feasibility of scaling up production.

The cost dimension is shaped by both development-related and compliance-related factors. Development costs include raw-material sourcing, synthesis or coating formulation adjustments, and the process modifications necessary to achieve stable, high-performing films on paper, moulded fibre or textile substrates. Compliance costs stem from the analytical testing required for market entry—such as migration testing, NIAS evaluation, MOSH/MOAH analysis, recyclability testing, durability testing for textiles and the preparation of GMP documentation—as well as the potential need for iterative reformulation if results fall outside accepted safety or performance limits. These activities represent significant investments but are essential to ensure that PFAS-free alternatives meet the regulatory standards that govern food-contact materials and consumer products.

In practice, cost and performance must be balanced through an iterative optimisation strategy. For example, reducing coating thickness improves recyclability and reduces material consumption, but may require adjustments in formulation to maintain repellence performance. Similarly, investing early in thorough chemical characterisation and NIAS screening reduces the risk of costly redesigns later in development. For textiles, enhancing durability and wash resistance can reduce lifetime environmental impacts and improve consumer acceptance but may require additional crosslinking components or processing steps.

Overall, the cost and performance considerations embedded in this section highlight the need for an integrated approach to the development of ZeroF coatings, where technical optimisation, regulatory compliance and long-term economic feasibility are addressed in parallel. This ensures that the materials developed in the project can deliver both functional and commercial value while aligning with European policy objectives for safe, sustainable and circular products.

# 6 Conclusions

The majority of the analysed certification schemes cover information aspects about consumer or safety requirements, but also information on social standards or sustainable sourcing[74]. The schemes reviewed appear to cover chemicals well in terms of level of hazard. However very few criteria were found to cover other chemical sustainability aspects, for example related to the production stage or the way they are treated at the end-of-life stage. Production is practically only covered in terms of the raw materials used in furniture, textiles and paper products, where a criterion on sustainable sourcing is often used.

For FCM, the regulatory pathway is very structured. If a new substance is introduced, EFSA must evaluate it before it reaches the market. Once a material is on the market, national competent authorities may request the Declaration of Compliance, migration data and NIAS risk assessments.

For upholstery textiles, compliance works differently. There is no EU-monitored authorisation. The manufacturer prepares the technical file, places the product on the market, and then national authorities verify compliance under REACH, the General Product Safety Regulation and other relevant regulations.

It is recommended that further analytical testing is conducted with the ZeroF innovations to characterise and quantify their final composition and potential impurities (i.e. check against restricted substances list). This will facilitate the use of ZeroF innovations and their publicly advertisement as part of environmental improvements (e.g., EMAS voluntary) or certification schemes.

Under forthcoming EU regulations, the recyclability may be a condition for market access; notably for the food packaging, it is expected that non-recyclable packaging and textile may pay high fees or be restricted, thus ZeroF improvements in such aspect should be targeted.

[74] DG RTD report ; 2021-DGRTD-mapping study for the development of sustainable-by-design-KI0221408ENN Copy.pdf



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# 7 Annex I – Certification schemes of relevance for ZeroF innovations

To obtain eco-labels or certifications based on specific environmental or product performance standards, food packaging and upholstery textile producers can use accredited labs to conduct certification audits. Such certifiers review technical documents and inspect production process to verify the conformity of food packaging and textiles specific claims such as compostability, recyclability.

### PFAS free certification scheme

If you manufacture or sell coatings for food contact (liners, barriers, treated paper, etc.) and upholstery textiles, several schemes might be applied. These include, but are not limited to, GreenScreen® and OEKO-TEX, which are the best fits (Table 13).

Table 13. PFAS free certification schemes that could be used for coatings (surface treatments, barriers, etc.)

| Certification | Notes |
|---|---|
| GreenScreen® Certified™ for Food Packaging | Specifically assesses all layers, including coatings/barriers; ideal if you're certifying a PFAS-free coating. |
| OEKO-TEX® ECO PASSPORT | Targets chemical inputs including coatings used on papers/textiles; relevant for fiber-based food wraps and coated packaging. |

| Certification Scheme | Scope | Certifier | PFAS Detection or Requirement | App. Price (€) | Third-Party Verifier | Source |
|---|---|---|---|---|---|---|
| GreenScreen® Certified™ for Food Packaging | Coatings & barriers for food packaging | Clean Production Action (CPA) | No intentionally added PFAS; hazard assessment for all chemicals | 6,000 – 20,000 | Licensed GreenScreen® Profiler + CPA reviewer | https://www.greenscreenchemicals.org/certified/food-service-ware |
| OEKO-TEX® ECO PASSPORT | Chemicals, coatings for textiles, paper | OEKO-TEX® Association | Prohibits PFAS in chemical classes | 3,000 – 8,000 | OEKO-TEX approved laboratories (like Hohenstein, Testex) | https://www.oeko-tex.com/en/our-standards/oeko-tex-eco-passport |

GreenScreen® is an US based certification scheme, whereas the OEKO-TEX is developed in Europe. However, GreenScreen® Certified™ is globally deployable. It is especially valuable as an add-on for safer chemical claims, but does not replace EU FCM regulatory testing.

If you're offering a final packaging product (e.g., a compostable wrapper or takeout box) or an upholstery textiles, BPI, Nordic Swan, or Cradle to Cradle might be better (Table 14).

Table 14. PFAS-Free Certification schemes that cover broader packaging (whole material, including the coating)

| **Certification Scheme** | **Scope** | **Certifier** | **PFAS Detection or Requirement** | **App. Price (€)** | **Third-Party Verifier** | **Source** |
|---|---|---|---|---|---|---|
| BPI Compostable Certification (Updated) | Compostable food packaging (full product) | Biodegradable Products Institute (BPI) | Total fluorine < 100 ppm; no intentional PFAS | 7,000 – 12,000 + annual fees | Approved independent labs (e.g., Beta Analytic, NSF) | https://bpiworld.org/commercial-compostability-certification-scheme |
| MADE SAFE® Certification | Consumer food contact products and upholstery textiles | Nontoxic Certified | Prohibits toxicants including PFAS | 5,000 – 10,000 | MADE SAFE technical team and third-party chemists | https://madesafe.org/pages/certification-process |
| Nordic Swan Ecolabel | Packaging, paper and textiles products | Nordic Ecolabelling | Bans PFAS use across full product | 5,000 – 15,000 + licensing | Independent consultants approved by Nordic Ecolabelling | https://www.nordic-swan-ecolabel.org/ |
| Cradle to Cradle Certified® (v4.0) | Product/material health certification | Cradle to Cradle Products Innovation Institute | Avoids all "forever chemicals" including PFAS | 15,000 – 50,000 | Accredited Assessment Bodies (e.g., MBDC, Anthesis Group) | https://c2ccertified.org/the-standard |

## Degradability certification scheme

Table 15. Compostability certification schemes that focus strongly on coatings (surface treatments, barriers, etc.)

| Certification Scheme | Scope | Certifier | Degradability Requirement | App. Pri | Third-Party Verifier | Source |
|---|---|---|---|---|---|---|


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| | | | | ce (€) | | |
|---|---|---|---|---|---|---|
| OK compost INDUSTRIAL (TÜV AUSTRIA) | Compostable coatings under industrial conditions | TÜV AUSTRIA Group | 90% biodegradation in 6 months under industrial composting | 5,000 – 15,000 | TÜV AUSTRIA accredited labs | https://okcert.tuvaustria.com/ok-compost-industrial-en/ |
| OK compost HOME (TÜV AUSTRIA) | Compostable coatings at home conditions (lower temp) | TÜV AUSTRIA Group | 90% biodegradation in 12 months at lower temperatures | 5,000 – 20,000 | TÜV AUSTRIA accredited labs | https://okcert.tuvaustria.com/ok-compost-home-en/ |
| BPI Compostable Certification (for coatings) | Coatings and treated materials for composting | Biodegradable Products Institute (BPI) | ASTM D6400 or D6868 compostability standards | 7,000 – 12,000 | Approved labs (e.g., NSF, Beta Analytic) | https://bpiworld.org/commercial-compostability-certification-scheme |
| DIN-Geprüft Industrial Compostable | Coatings and surfaces | DIN CERTCO (Germany) | Follows EN 13432 or ASTM D6400 biodegradability | 6,000 – 15,000 | DIN CERTCO authorized labs | https://www.dincertco.de/din-certco/en/main-navigation/products-and-services/certification-of-products/environmental-field/industrial-compostable-products/ |

Table 16. Compostability certification schemes that cover broader packaging (whole material, including the coating)

| Certification Scheme | Scope | Certifier | Degradability Requirement | App. Price (€) | Third-Party Verifier | Source |
|---|---|---|---|---|---|---|

| | | | | | | |
|---|---|---|---|---|---|---|
| BPI Compostable Certification | Entire foodservice packaging products | Biodegradable Products Institute (BPI) | ASTM D6400 / D6868 / EN 13432 compostability | 7,000 – 12,000 + annual fee | Approved independent labs (e.g., NSF, Beta Analytic) | https://bpiworld.org/commercial-compostability-certification-scheme |
| Seedling Certification (European Bioplastics) | Compostable full packaging | DIN CERTCO or TÜV AUSTRIA | EN 13432 compostability under industrial conditions | 6,000 – 14,000 | DIN CERTCO, TÜV AUSTRIA labs | https://www.european-bioplastics.org/bioplastics/standards/certification/ |
| OK compost INDUSTRIAL (TÜV AUSTRIA) | Full packaging industrial compostable | TÜV AUSTRIA Group | 90% biodegradation in 6 months | 5,000 – 15,000 | TÜV AUSTRIA accredited labs | https://okcert.tuvaustria.com/ok-compost-industrial-en/ |
| OK compost HOME (TÜV AUSTRIA) | Full packaging compostable at home | TÜV AUSTRIA Group | 90% biodegradation in 12 months | 5,000 – 20,000 | TÜV AUSTRIA accredited labs | https://okcert.tuvaustria.com/ok-compost-home-en/ |
| DIN-Geprüft HOME Compostable | Home compostable packaging products | DIN CERTCO (Germany) | Follows EN 13432 plus home compost standards | 6,000 – 16,000 | DIN CERTCO authorized labs | https://www.dincertco.de/din-certco/en/main-navigation/products-and-services/certification-of-products/environmental-field/products-made-of-compostable-materials-for-home-and-garden-composting/ |
| TÜV AUSTRIA OK biodegradable SOIL / WATER | Packaging degrading in natural environments | TÜV AUSTRIA Group | 90% biodegradation in soil/water | 7,000 – 18,000 | TÜV AUSTRIA accredited labs | https://okcert.tuvaustria.com/ok-biodegradable-en/ |

Seedling and OK compost are the most recognized in Europe, while BPI is dominant in North America.

### Biobased quantification

EN 16785-1 and EN 16640 are the main European methods for biobased content quantification. They use C14 radiocarbon analysis to determine the ratio of renewable (modern) carbon to total carbon. One should note that extraction for testing (radiocarbon (C14) dating) can be difficult for very thin coatings, especially if they are bound to other materials. If the coating is part of a multi-layer article, certification often requires testing the entire structure or proving each layer's content.


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Table 17. Biobased content certification schemes that cover broader packaging (whole material, including the coating)

| Certification scheme | Notes on applicability for coating only |
|---|---|
| TÜV AUSTRIA OK biobased | Coatings can be certified independently if they are in solid form or extracted as testable materials. Must meet minimum content for 1–4 star label. |
| DIN CERTCO Biobased | Can certify intermediate materials like coatings, adhesives, and films. Material must be isolatable for C14 analysis. |
| USDA Biobased | Primarily for final commercial products. Coatings may be certified if they are sold as independent products (e.g., barrier coatings). |
| BPI / OK compost | These focus on compostability, not biobased content. They apply more to final articles, but underlying materials like coatings may be reviewed as part of the composite system. |

| Certification Scheme | Scope | Certifier | Biobased content requirements | App. Price (€) | Third-Party Verifier | Source |
|---|---|---|---|---|---|---|
| TÜV AUSTRIA OK biobased | Biobased content in products (1–4 star label) | TÜV AUSTRIA | Minimum 20% for 1-star; 40–60% for 2-star; up to 100% for 4-star / C14 Radiocarbon (ASTM D6866 or EN 16640) | 2,000–5,000 (initial), lower for renewals | TÜV AUSTRIA | https://www.tuv.at/ok-biobased/ |
| DIN CERTCO Biobased | Biobased products and packaging | DIN CERTCO / TÜV Rheinland | No fixed minimum; declared % based on testing/C14 Radiocarbon (EN 16640, EN 16785-1) | 2,000–4,000 | DIN CERTCO, ISO/IEC 17065 accredited bodies | https://www.dincertco.de/din-certco/en/main-navigation/products-and-services/certification-of-products/packaging/biobased-products/ |
| USDA Certified Biobased Product | Biobased commercial/industrial products | USDA BioPreferred Program | Minimum varies by product category (typically ≥25%)/C14 | 3,000–5,000 incl. testing | Approved independent labs (Beta Analytic, etc.) | https://www.biopreferred.gov/BioPreferred/faces/Welcome.xhtml |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | Radiocarbon (ASTM D6866) | | | |

Pricing includes testing and certification; lower for renewals or bundled assessments. Some schemes (e.g., USDA, TÜV AUSTRIA) offer online product registries for visibility.

All listed schemes are relevant to finished food packaging articles, particularly when:

- The product is sold as packaging to consumers or food manufacturers.
- The entire article's biobased content is tested (can include coatings, films, and structure).

If focusing on bio-based coatings for food packaging, and interest to market the biobased aspect, go with: DIN CERTCO or TÜV AUSTRIA OK biobased for coating material certification which are using EN 16785-1 or EN 16640 to back the claims analytically. If the coating is used in a final product, consider certifying the entire packaging.

Other certification scheme of relevance;

When primary biomass is used as feedstocks, it is important to ensure that it is environmentally sustainable and does not harm biodiversity or ecosystem health. Biomass used to produce biobased plastics must meet the EU sustainability criteria for bioenergy [75].

**Better biomass (NTA 8080 certified)**[76], which is an international certification system for solid, liquid and gaseous biomass. The Better Biomass certificate is used to demonstrate the sustainability of the biomass used for energy, fuels or bio-based products. These voluntary standards are widely used by the market and their application is recommended by the European Commission in their Communication for an EU policy framework on biobased, biodegradable and compostable plastics, as it ensures a consistent approach.

In summary, BPI, OK compost, Seedling are suitable options if both a *compostable and PFAS-free* label for food packaging is desired. Certification schemes differ in the way to verify the claims, Nordic Swan Ecolabel and EU Ecolabel used national verification bodies which is especially good in Europe as very strict, recognized globally (Ecolabel Type I - Table 4), other use licensed assessors, i.e., third-party but pre-approved (e.g. GreenScreen® and Cradle to Cradle use), or depend on a network of certified external labs (e.g. BPI).

[75] European Commission. (2022, November 11). COM(2022) 682 final. COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS. EU policy framework on biobased, biodegradable and compostable plastics

[76] https://betterbiomass.nl/nl/certificaat/ (consulted in April 2025)



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# 8 Annex II - EU ecolabel for textile product groups

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| Website | https://environment.ec.europa.eu/topics/circular-economy/eu-ecolabel_en |
| Structure | The EUEB is composed of representatives of the Competent Bodies of all the Member States of EU, Iceland, Liechtenstein and Norway and other interested parties (The European Consumer Organisation (BEUC), the European Environmental Bureau (EEB), EuroCommerce, Eurochambres, Collaborating Centre on Sustainable Consumption and Production (CSCP), Plastic recyclers Europe, European chemical Industry Council (CEFIC), World Wide Fund for Nature (WWF), Better Finance – the European Federation of investors and Financial Services Users, European Fund and Asset Management Association (EFAMA), European Savings and Retail Banking Group (ESBG), Insurance Europe, European Banking Federation (EBF) + European Chemical Agency (ECHA), European Investment Bank (EIB), International Labour Organization (ILO))[77]. Each Member State shall designate the body or bodies, within government ministries or outside, responsible for carrying out the tasks provided for in this Regulation ('the competent body' or 'the competent bodies') and ensure that they are operational. The composition of the competent bodies shall be such as to guarantee their independence and neutrality and their rules of procedure shall be such as to ensure transparency in the conduct of their activities as well as the involvement of all interested parties. The 'Competent Body' is an independent third party that ensures that products fully comply with the relevant EU Ecolabel criteria. Find your Competent Body.[78]<br>Register of Commission expert groups and other similar entities (europa.eu) |
| Criteria | **For textile products**; Decision - 2014/350 - EN - EUR-Lex (europa.eu) - **1. TEXTILE FIBRE CRITERIA** defined for 3 categories of fibres (natural, synthetic or man-made cellulose fibres) if above 95% of the total weight of the product or if it constitutes a padding or lining, except for polyester and polyamide if 70% weight of fibres of the products is recycled. Recycled content shall meet the criterion 13. on restricted substance list (annual randomized analytical testing) provided by fibre manufacturers and feedstock suppliers that should be traceable.<br>**-For cotton**; minimum of 10% organic cotton (organically grown cotton and transitional organic cotton) or of 20 % of integrated pest management (IPM) cotton, except for some clothes for which higher |

[77] Bigger list can be found on the expert group website ; Register of Commission expert groups and other similar entities (europa.eu)

[78] In France, ADEME (Agence de la Transition ecologique) for policies and regulation; Affichez votre engagement avec l'Écolabel européen | Entreprises | Agir pour la transition écologique | ADEME, AFNOR certification for detergents and cleaning services, paint and varnishes, lubricants, paper, growing media, personal and animal care products and tourist accomodation, ECOCERT Greenlife for detergents, cosmetic products and animal care products and bureau Veritas certification for detergents, cosmetic products and animal care products.

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| | percentage required + list of pesticides restricted (sum<0.5 ppm) ➔ verification annual + pesticides tests (US EPA standards) if not certified by a third party + traceability criteria from point of verification to at least greige fabric production. – **For flax and other bast fibres:** retted under ambient conditions and without thermal energy inputs + if water retting used then retting ponds treated to reduce the COD or TOC by 75% to 95% (ISO 6060) depending on the fibres. – **For Wool and other keratin fibres:** limit for list of ectoparasiticide with sum total limit value + COD limits for effluent with monthly verifications + measures to recover value from oxidized grease, fibre, suint or sludge arising from scouring site. **– For acrylic**: emission to air limit for acrylonitrile (< 1,0 g/kg of fibre produced + N,N-dimethylacetamide (127-19-5) below 10 ppm (IOELV) ➔ measurement campaign and monitoring report. **–For elastane:** organotin compounds shall not be used to manufacture the fibres + indicative occupational exposure limit values (IOELV) for emissions to air for aromatic diisocyanates and DMAc. - **for polyamide or Nylon**: minimum content of 20% recycled content (traceable) + N2O emissions from monomer production below 9.0 g N2O/Kg of caprolactam (nylon 6) or adipic acid (for nylon 6.6). – **For polyester**; level of antimony <260 ppm, except if recycled from PET bottles + staple fibers and filament fibres shall contain a minimum content of 50% and 20% recycled PET + emissions of VOCs (point source and fugitive emissions)< 1.2 g/kg for PET chips and 10.3 g/kg for filament fibre (EN 12619) ➔ monthly average for total emissions for a minimum of 6 months. **For polypropylene**: no use of lead based pigments➔ declaration of not use. **– For Man-made cellulose fibres**: *pulp production* 25% of pulp fibres from wood grown accordingly to UN FAO sustainable forestry management + all from legal forestry and plantation ➔ certification schemes (FSC or equivalent, and EU FLEGT or UN CITIES) + pulp produced from Cotton linters meet cotton associated criterion (organic or IPM and pesticides) + bleaching of pulp without chlorine (limit in finished fibres <150 ppm (ISO 11480), in waste water< 0.170 kg/ADt pulp (ISO 9562)) + 50% pulp purchase from pulp mills that recover value from their spent process liquors ➔ docu to be provided on manufacturing system installed. *Fibre production* annual average limit value for sulphur emissions to air for staple fibre or filament fibre (from 30 g/kg to 170g/kg)➔ demonstration of compliance. **2. COMPONENT AND ACCESSORIES CRITERIA – For filling materials:** comply if textile fibres, RSL for biocides and formaldehyde, and for detergents and other chemicals used for the washing of fillings –For coatings, laminates and membranes; if polyurethane then same criteria than for elastane, if polyester then same antimony and VOC limits + polymers shall comply with restriction g(v) of the RSL. –**For accessories** should comply with RSL for accessories. **3. CHEMICALS AND PROCESS CRITERIA –** Restricted substance list for spinning, dyeing, printing and finishing ➔ annual testing for verification + Safety data sheets (SDS) for production recipes and declarations from chemical suppliers; Avoidance of SVHC (<0.1% w/w) and substitutions of hazardous substances and mixtures used in dyeing, printing and finishing if |


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| | classified following CLP (not only cat 1 but also cat 2) + some exception notably for water repellents (H413 exempt if repellent and degradation products readily biodegradable or non-bioaccumulative in aquatic environment) and for auxiliaries including dispersing agents and surfactants (H301, H311, H331, H371, H373, H317, H334, H411, H412, H413, EUH070, with <1% w/w final product concentrations for H311, H331 and H317); For substances that have not been registered under Regulation (EC) No 1907/2006 or which do not yet have a harmonised CLP classification: Information meeting the requirements listed in Annex VII of that regulation, dedicated to substances that are produced in more than 1 tonne per year. Washing, drying, curing energy efficiency associated to dyeing, printing and finishing steps ; energy used is measured and benchmarked against an energy or carbon dioxide emissions management system (ISO 50001) + demonstration of **best available techniques implementation**. Treatment of emissions to air and water: wastewater should not exceed 20 g COD/kg textiles proceed, pH between 6 and 9 and temperature less than 35 degrees C + spectral absorption coefficients at 7 m-1 for 436 nm, 5 m-1 for 525 nm and 3 m- for 620 nm (ISO 6060 and ISO 7887). Emission to air <100 mgC/Nm3 for printing and finishing[79], and coating and drying allow for the recovery and reuse of solvents with emissions limits of 150,0 C/Nm3➔ compliance with EN 12619 standards, monthly average for 6 months before applications, if reuse and recovery, demonstration of operational system. **4. FITNESS FOR USE CRITERIA** Dimensional changes during washing and drying at domestic (EN ISO 6330 and EN ISO 5077; 3 washes at temperature indicated in the product with tumble drying) or industrial (ISO 15797 and EN ISO 5077 at 75 °C + drying as in the product label) washing temperatures and conditions (e.g. for furniture fabric 2 % tolerance if woven fabrics or 6% if non-woven fabrics, except if furniture fabric not removable and washable or indication on dry clean only). Colour fastness to washing ISO 105 C06 for domestic and ISO 15797 and ISO 105C06 for industrial, colour fastness to perspiration (acid, alkaline) ISO 105 E04 (level allowed depending on the colour of the textile, not applicable for furniture fabrics for in terior decoration). Colour fastness to wet or dry rubbing ISO 105 X12 (not applicable if not dyed or printed). Colour fatness to light ISO 105 B02 Wash resistance and absorbency of textile cleaning products EN ISO 6630 test reference with relevant procedure depending on type of textile cleaning product + liquid absorbency time < 10s. Fabric resistance to pilling and abrasion Knitted and non-woven products: ISO 12945-1 Pill box method or Woven fabrics: ISO 12945-2 Martindale method. Durability of function test report demonstrating improved or comparable performance compared to alternatives; **Water repellents shall retain a functionality of 80 out of 90 after 20 domestic wash and tumble** |

[79] Finishing processes include the thermosetting, thermosoling, coating and impregnating of textiles including their respective drying facilities.

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| | **dry cycles at 40 °C, or after 10 industrial washing and drying cycles at a minimum of 75 °C. Oil repellents shall retain a functionality of 3,5 out of 4,0 after 20 domestic wash and tumble dry cycles at 40 °C, or after 10 industrial washing and drying cycles at a minimum of 75 °C.** Stain repellents shall retain a functionality of 3,0 out of 5,0 after 20 domestic wash and tumble dry cycles at 40 °C, or after 10 industrial washing and drying cycles at a minimum of 75 °C. **For all products domestic wash cycles ISO 6330 or industrial laundry cycles ISO 15797 in combination with:**<br>– water repellents: ISO 4920<br>– oil repellents: ISO 14419<br>– stain repellents: ISO 22958<br>Flame retardant functions, For domestic wash cycles ISO 6330 or commercial laundry cycles EN ISO 10528 both in combination with EN ISO 12138. Where the textile is non-removable BS 5651 or equivalent. Easy-care (also referred to as non-crease or permanent press); ISO 7768. **5. CORPORATE SOCIAL RESPONSIBILITY CRITERIA:** freedom of association and protection of the right to organize, right to organize and collective bargaining, equal remuneration, abolition of forced labor, discrimination, occupational safety, minimum age convention elimination of the worst forms of child labor ➔ independent verification at production sites of the supply chain. Restriction on the sandblasting of denim no manual or mechanical allowed. Information appearing on ecolabel: most sustainable fiber production, less polluting production processes, restrictions on hazardous substances and tested for durability. |
| Validity period for criteria | Up-to-december 2025 for textile products; on-going revision of criteria |
| Expected cost for certification and potential for funding | Application fee: competent body to which an application is made shall charge a fee according to the real administrative costs of processing the application between 200 euros and 1200 euros with a maximum application fee of 600 euros for small and medium enterprise or 350 euros if micro-enterprise.<br>20% reduction for applicants registered under the Community eco-management and audit scheme (EMAS) and/or certified under standard ISO 14001.<br>Annual fee: The competent body may require each applicant who has been awarded an EU Ecolabel to pay an annual fee of up to EUR 1 500, with a maximum annual fee of 750 euros for small and medium enterprise or 350 euros if micro-enterprise, for the use of the label.<br>Financial support information can be found in competent body website e.g. ADEME in France: |


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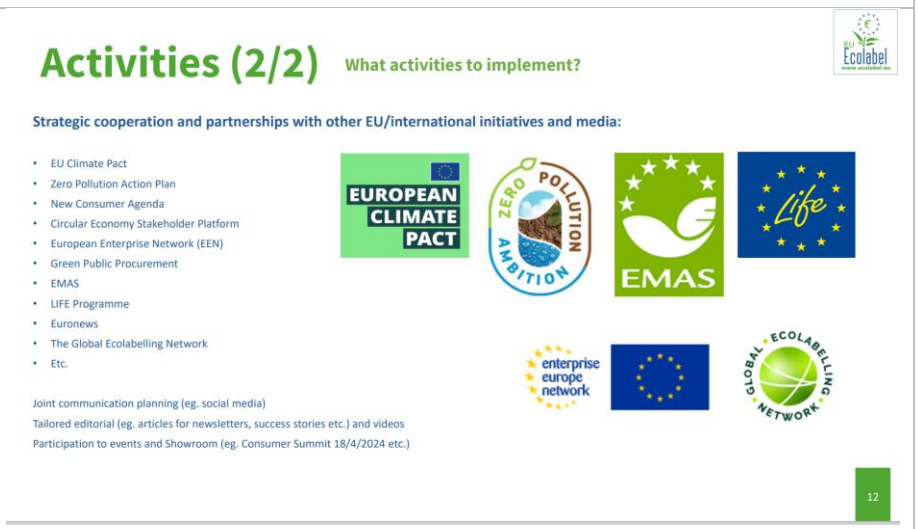

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<tr><td>Future engagement with regulation</td><td>Ecodesign for Sustainable Products Regulation (ESPR), Eu Strategy for Sustainable and Circular Textiles, EU Green Public Procurement (GPP)</td></tr>
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