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Environmental Qualification Protocol — PAHs in Sentinel Leaves

Working technical sheet • Version 1.0 • 9 November 2026 • Proposed thresholds requiring field validation

1. Purpose and methodological principle

Use leaves of locally widespread tree species, with exploratory priority given to Robinia pseudoacacia, as bioindicators of deposition and environmental occurrence of polycyclic aromatic hydrocarbons (PAHs). The purpose is not to certify the leaves as food-compliant but to identify significant anthropogenic pressures and compare areas reproducibly.

TDE thresholds are voluntary, conventional environmental qualification criteria; they are not statutory limits for black locust leaves or validated toxicological values. Territorial assessment integrates the different matrices and local setting.

2. Proposed provisional thresholds — leaves on a dry-weight basis

Indicator	Direct TDE qualification	Integrated assessment	TDE exclusion
Benzo[a]pyrene (BaP)	X < 2 µg/kg dw	2 ≤ X ≤ 4 µg/kg dw	X > 4 µg/kg dw
Sum of PAH4	X < 10 µg/kg dw	10 ≤ X ≤ 40 µg/kg dw	X > 40 µg/kg dw

The final classification is determined by the most restrictive indicator. Exceeding either exclusion threshold results in a negative outcome for the foliar PAH criterion; an intermediate value calls for comparison with other available matrices and bioindicators. Results exactly equal to 2, 4, 10 or 40 fall within the integrated assessment category.

PAH4 = benzo[a]pyrene + benz[a]anthracene + benzo[b]fluoranthene + chrysene. The sum uses the lower-bound convention: values below the limit of quantification (LOQ) count as zero. The laboratory must state LOQs and recoveries for each substance in the dry-leaf matrix.

3. Comparison with EU food legislation

Food category (EU Reg. 2023/915, Annex I, §5.1)	BaP (µg/kg)	PAH4 (µg/kg)
Banana chips	2	20
Powdered plant-based foods for preparing beverages	10	50
Dried herbs (product placed on the market)	10	50
Oils and fats (subject to exceptions)	2	10

The TDE direct-qualification thresholds equal 20% of the EU limits for dried herbs for both indicators. The exclusion thresholds equal 40% (BaP) and 80% (PAH4), respectively. This is a purely conventional comparison: dried food herbs and leaves sampled for biomonitoring differ in exposure and processing.

4. Published evidence on vegetation

Study / matrix	Published result	Basis and comparison limits
Capozzi et al. (2017), black locust leaves and moss, Campania	20 PAHs investigated; black locust captures light and heavy PAHs	Numerical tables for individual PAHs in black locust were not verified; no figures are invented
Yang et al. (2024), black locust leaves beside an urban road, Beijing	Σ31 PAHs = 65.9 µg/kg (65.9 ng/g)	Sum of 31 compounds is not PAH4; weight basis needs verification before comparison
Portuguese study (2011), Pinus pinaster needles	Σ16 PAHs = 96 ± 30 µg/kg at remote sites; 866 ± 304 at industrial sites	Dry weight; needles exposed for 1–3 years and not directly comparable with annual leaves
2024 scientific review of plant biomonitoring	Reports ranges of BaP in bioindicators and strong differences among species and settings	Heterogeneous secondary data: useful for orders of magnitude, not direct black locust calibration

The Beijing black locust example shows that a substantial sum of many PAHs does not automatically establish exceedance of PAH4. Pine-needle data show a remote-to-industrial gradient, but tissue age and accumulation differences call for caution.

5. Experimental monitoring guidance

• Preferred matrix: unwashed Robinia pseudoacacia leaves, identified botanically and sampled consistently for height, exposure, leaf age and season.

• Report results in µg/kg dry weight; use drying and conditioning procedures that minimise contamination and loss of more volatile PAHs; determine moisture.

• Quantify at least all four PAH4 compounds individually; an EPA16 profile can help identify sources, but no exclusion threshold is currently assigned to EPA16.

• Include procedural blanks, replicate samples and a low-pressure reference site; record recent fires, traffic, combustion facilities and weather.

• In the intermediate category consider available soil, moss, bee, water and source-mapping evidence, without automatically requiring every matrix.

• Review thresholds following a pilot campaign across sites with different anthropogenic pressures, before final adoption.

6. Bibliography and sources

European Union (2023). Commission Regulation (EU) 2023/915 of 25 April 2023, Annex I, Section 5.1, PAHs. Official Italian text. https://eur-lex.europa.eu/eli/reg/2023/915/oj/ita

Capozzi F.; Di Palma A.; Adamo P.; Spagnuolo V.; Giordano S. (2017). Monitoring chronic and acute PAH atmospheric pollution using transplants of the moss Hypnum cupressiforme and Robinia pseudoacacia leaves. Atmospheric Environment 150, 45–54. DOI: 10.1016/j.atmosenv.2016.11.046. https://iris.unicampania.it/handle/11591/463070

Yang M.; Liu Q.; Tian S.; Yang Z.; Yang Y.; Shao P.; Liu Y. (2024). Occurrences of Deposited Polycyclic Aromatic Hydrocarbons in Wax of Plant Leaves Using Laser Scanning Microscopy and Gas Chromatography–Mass Spectrometry. Atmosphere 15(10), 1165. DOI: 10.3390/atmos15101165. Supplementary Table S1 on publisher's page.

Study of geographical trends of polycyclic aromatic hydrocarbons using pine needles (2011). Atmospheric Environment 45(33), 5988–5996. DOI: 10.1016/j.atmosenv.2011.07.058. https://www.sciencedirect.com/science/article/abs/pii/S1352231011008028

Environmental contamination with polycyclic aromatic hydrocarbons and contribution from biomonitoring studies to the surveillance of global health (2024). Environmental Science and Pollution Research. https://doi.org/10.1007/s11356-024-34727-3

7. Status of the decision

BaP thresholds <2 / 2–4 / >4 and PAH4 thresholds <10 / 10–40 / >40 µg/kg dry weight constitute the provisional operational criterion for leaves. They require comparative field testing and reasoned review. They do not imply absolute absence of PAHs or, by themselves, certification of the TDE territory.