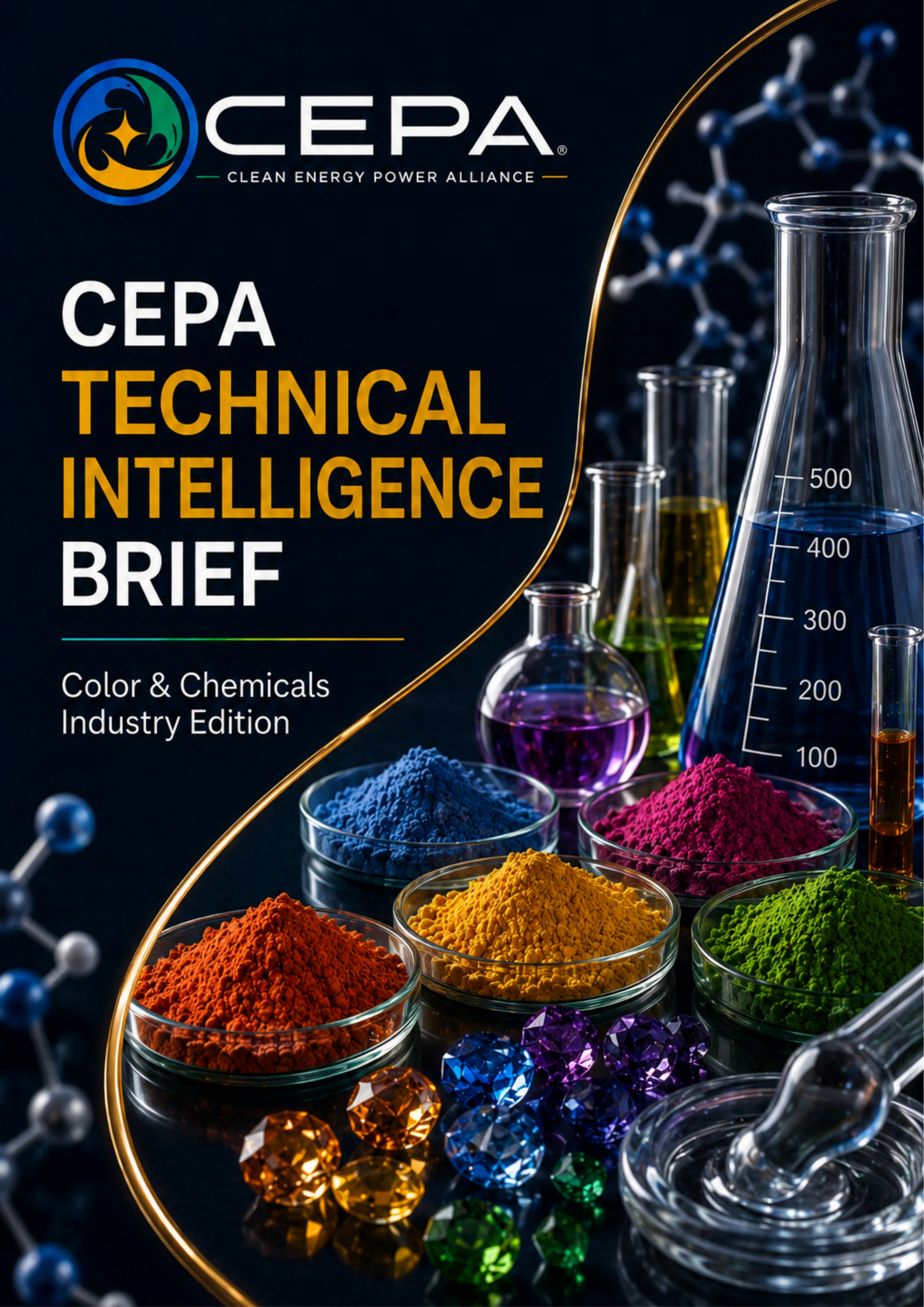




CEPA TECHNICAL INTELLIGENCE BRIEF

Color & Chemicals
Industry Edition





CEPA

CLEAN ENERGY POWER ALLIANCE

TECHNICAL INTELLIGENCE BRIEF
COLOR & CHEMICALS INDUSTRY EDITION

CHEMISTRY BEFORE WASTE

Hazard, Substitution and
Circular Formulation



FORMULATION PATHWAY



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EterSolis
Waste & Carbon Management

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Chemistry Before Waste: Hazard, Substitution and Circular Formulation


EterSolis
 Waste & Carbon
 Management

CEPA-TIB-COLCHEM-003-20260906

A decision-grade framework for ingredient hazard, functional substitution, formulation performance, regulatory uncertainty and evidence-based circular design across the color and chemicals economy.


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CONTROLLING EXECUTIVE FINDINGS

- 1 Chemical substitution must begin with required function and performance, not a blacklist alone.
- 2 Removing one hazardous ingredient does not establish improvement if the replacement creates equal or greater hazard elsewhere.
- 3 Hazard, exposure, persistence, mobility, concentration and lifecycle release are separate decision variables; do not collapse them into one label.
- 4 Missing toxicological or environmental-fate data are uncertainty, not evidence of safety.
- 5 Formulation changes must be validated against product quality, durability, process safety and customer requirements.
- 6 Circularity begins at formulation: contamination, incompatibility or hazardous constituents can eliminate downstream reuse and recycling routes.
- 7 Safer, non-toxic, PFAS-free, VOC-free and green claims need claim-specific definitions, appropriate test boundaries and substantiation for stated or implied comparisons.

DECISION-GRADE PUBLICATION SYSTEM

Evidence boundary

Source-level measurement

Normalized metric

Technical decision

Verified outcome

COL3-001 | Sources: A01, A02, A07, A09

This publication is technical intelligence, not certification or a substitute for jurisdiction-specific legal or regulatory advice.

Scope, sector boundary and evidence discipline

KEY

A decision-grade safer-formulation claim must state the chemistry, use, jurisdiction, exposure boundary, evidence class and uncertainty.

TECHNICAL BASIS

The scope covers pigments and colorants, binders and polymers, solvents, preservatives, surfactants, chelants, processing aids, plasticizers, metals, persistent chemistry, synthetic polymer microparticles, occupational hazards, environmental fate, analytical verification, circular compatibility and environmental claims. Binding legal requirements are treated separately from EPA program criteria, EU recommendations and research evidence.

DECISION INTERPRETATION

No numerical threshold, hazard designation or restriction status may be generalized beyond the source instrument. A Safer Choice threshold is a program-screening criterion; a CLP classification is a legal hazard classification; a REACH restriction is a legal use condition; and an internal supplier watch list is governance only.

CONTROL ACTION

Attach evidence class and jurisdiction to every material claim before editorial approval.

REQUIRED RECORDS

Source URL; exact locator; effective date/status; jurisdiction; use category; evidence tier; reviewer note.

AUDIT / ESCALATION TRIGGER

Escalate when a voluntary criterion is written as law, a proposal is written as final, or an analytical non-detect is written as universal absence.

COL3-002 | Sources: A01, A09, A10, A12, A16, A17 | Claim: claim_colchem003_p02_core
Recommendations require destination-market legal review and product-specific validation.

Executive substitution decision system

KEY

The substitution sequence is function -> baseline -> candidate alternatives -> hazard -> exposure -> lifecycle -> performance -> economics -> claim.

TECHNICAL BASIS

Functional-class assessment prevents false comparisons between chemicals that do not perform the same job. Alternatives assessment then differentiates relevant human-health and environmental hazards. Exposure and lifecycle review are separate because a lower intrinsic hazard may still create a higher exposure or a burden shift if use rate, emissions, durability or disposal changes materially.

DECISION INTERPRETATION

The executive decision is not "Which chemical is least hazardous?" but "Which technically viable option provides the best evidenced risk and lifecycle profile for the defined use?" A candidate with major evidence gaps remains uncertain rather than automatically preferred.

CONTROL ACTION

Require a signed substitution record with pass/fail criteria for function, safety, manufacturing and claim integrity.

REQUIRED RECORDS

Functional specification; baseline formulation; candidate list; hazard matrix; exposure scenarios; lifecycle screen; qualification results; cost model.

AUDIT / ESCALATION TRIGGER

Escalate when a candidate advances despite failure of a critical product-performance or safety requirement.

COL3-003 | Sources: A02, A07, A08, A09 | Claim: claim_colchem003_p03_core
CEPA scoring supports decisions; it does not replace regulatory risk assessment.

Why formulation determines downstream environmental performance

KEY

Waste, wastewater, emissions and recovery constraints are partly locked in when the formulation is approved.

TECHNICAL BASIS

Ingredient identity and concentration influence volatility, aquatic hazard, persistence, residual monomers, treatment compatibility, hazardous-waste classification, worker exposure and the quality of recovered material. A downstream treatment system cannot be assumed to fully reverse an upstream design choice that makes a stream incompatible, persistent, toxic or analytically untraceable.

DECISION INTERPRETATION

Prevention should include formulation design, not only process housekeeping. The highest-value change can be an ingredient or specification change that removes a downstream treatment or segregation requirement without reducing product performance.

CONTROL ACTION

Add downstream recovery and treatment compatibility to formulation design reviews.

REQUIRED RECORDS

Formulation bill of materials; SDS plus supplemental supplier data; process emissions inventory; wastewater route; recovery specifications; waste classification.

AUDIT / ESCALATION TRIGGER

Escalate when a new ingredient is approved without identifying its likely release pathways and downstream control needs.

COL3-004 | Sources: A02, A05, A09, A16 | Claim: claim_colchem003_p04_core
 Applicability is source-, jurisdiction-, process- and evidence-boundary specific.

Functional formulation architecture

KEY

Every ingredient must have a declared function before alternatives can be compared rationally.

TECHNICAL BASIS

Color and chemical formulations commonly combine colorants or pigments, binders or polymers, carriers or solvents, dispersants and surfactants, rheology modifiers, preservatives, defoamers, chelants, catalysts, stabilizers, fillers and other performance additives. One chemical may provide more than one function, creating substitution dependencies that simple one-for-one replacement misses.

DECISION INTERPRETATION

A functional map should identify essential, supporting and incidental functions, then connect each function to measurable product and process requirements. A candidate alternative is not technically comparable until it satisfies the same required function set or the formulation is redesigned to redistribute those functions.

CONTROL ACTION

Build a function-to-ingredient matrix for every priority formulation family.

REQUIRED RECORDS

Ingredient identity; concentration range; function; critical performance test; process role; known alternatives; incompatibilities.

AUDIT / ESCALATION TRIGGER

Escalate ingredients with no documented function or formulations dependent on one ingredient for multiple uncontrolled functions.

COL3-005 | Sources: A01, A02, A06 | Claim: claim_colchem003_p05_core
 Applicability is source-, jurisdiction-, process- and evidence-boundary specific.

Hazard, exposure and risk are not synonyms

KEY

Hazard describes an intrinsic capacity to cause harm; exposure describes contact; risk depends on both and on the decision context.

TECHNICAL BASIS

Chemical-screening systems may prioritize intrinsic hazard to support substitution, while workplace and environmental risk decisions also require form, concentration, duration, frequency and route of exposure. A powder, aerosol, bound polymer and closed-system liquid can present different exposure profiles even when the underlying substance hazard is unchanged.

DECISION INTERPRETATION

CEPA should resist both errors: declaring a low-hazard ingredient "safe" without exposure context and dismissing intrinsic hazard merely because current exposure appears controlled. Design should reduce hazard where feasible while maintaining exposure controls and validated performance.

CONTROL ACTION

Record hazard and exposure as separate fields in the substitution matrix.

REQUIRED RECORDS

Hazard classifications; physical form; concentration; task and route; engineering controls; PPE assumptions; release scenario.

AUDIT / ESCALATION TRIGGER

Escalate when a risk conclusion is based only on hazard lists or only on current exposure controls.

COL3-006 | Sources: A02, A07, A16 | Claim: claim_colchem003_p06_core
Applicability is source-, jurisdiction-, process- and evidence-boundary specific.

Evidence hierarchy for chemical decisions

KEY

Chemical decisions should prefer measured and authoritative evidence but retain modeled evidence with an explicit confidence statement when measured data are incomplete.

TECHNICAL BASIS

EPA alternatives assessments can use measured studies, confidential measured data, structure-activity estimates, expert judgment and other evidence, while recording confidence and conflicting evidence. This supports a practical hierarchy rather than the false rule that no measured data means no decision can be made.

DECISION INTERPRETATION

For each hazard endpoint, record the evidence source, result, method relevance, confidence and disagreement. Where modeled evidence drives a high-consequence substitution, the uncertainty should change the decision threshold or trigger further testing.

CONTROL ACTION

Use endpoint-level evidence cards instead of one undifferentiated "hazard score."

REQUIRED RECORDS

Endpoint; source; test or model; species/system; result; confidence; conflict note; reviewer.

AUDIT / ESCALATION TRIGGER

Escalate when a modeled value is presented as measured or when conflicting high-quality studies are silently averaged.

COL3-007 | Sources: A02, A07, A08 | Claim: claim_colchem003_p07_core
Applicability is source-, jurisdiction-, process- and evidence-boundary specific.

Data gaps, uncertainty and confidence

KEY**No data is not evidence of no hazard.****TECHNICAL BASIS**

Data-poor functional classes require disciplined uncertainty treatment. EPA criteria for processing aids and certain polymer/colorant classes explicitly address common situations where traditional toxicology datasets may be incomplete. Alternatives-assessment practice can use modeling and expert judgment, but the confidence in each endpoint must remain visible.

DECISION INTERPRETATION

A data gap can lead to one of four outcomes: obtain data, use a justified surrogate/model, apply a conservative decision rule, or retain the candidate as unresolved. CEPA should not automatically classify data-poor chemistry as unsafe, but it must never classify uncertainty as safety.

CONTROL ACTION

Create an uncertainty column and a data-closure plan for every material endpoint.

REQUIRED RECORDS

Missing endpoints; surrogate rationale; model output; read-across justification; testing plan; decision owner.

AUDIT / ESCALATION TRIGGER

Escalate when a candidate receives a preferred score because unknown endpoints were treated as zero hazard.

COL3-008 | Sources: A03, A06, A08 | Claim: claim_colchem003_p08_core
Applicability is source-, jurisdiction-, process- and evidence-boundary specific.

Functional-class substitution methodology

KEY

Alternatives must be screened against the same required function before comparative hazard and lifecycle analysis.

TECHNICAL BASIS

A defensible method defines the use case, essential function, operating conditions, performance threshold, current baseline, candidate universe, regulatory exclusions, hazard endpoints, exposure conditions, lifecycle considerations and qualification tests. The method can compare ingredients, technologies or redesign options rather than assuming a one-for-one molecule swap.

DECISION INTERPRETATION

The preferred candidate is the option that passes mandatory performance and legal requirements and provides the strongest evidenced improvement without creating an unacceptable new risk or burden shift. A technically superior redesign can outperform a simple chemical replacement.

CONTROL ACTION

Use a gated method: eligibility -> hazard -> exposure -> lifecycle -> performance -> implementation.

REQUIRED RECORDS

Use definition; critical-to-quality specification; candidate list; exclusion reason; endpoint matrix; trial protocol; sign-off.

AUDIT / ESCALATION TRIGGER

Escalate when candidates are compared despite different functions or when a candidate fails a critical specification but remains in the preferred set.

COL3-009 | Sources: A01, A07, A09 | Claim: claim_colchem003_p09_core
Applicability is source-, jurisdiction-, process- and evidence-boundary specific.

Avoiding regrettable substitution

KEY

A substance should not be replaced with an alternative that recreates the same problem through another hazard, exposure pathway or lifecycle stage.

TECHNICAL BASIS

Regrettable substitution can occur when a restricted or highly visible chemical is replaced with a structurally similar substance, a more persistent alternative, a higher-use-rate chemical, a more volatile carrier, or a lower-durability formulation that increases lifetime material demand. A free-of claim can also mislead if a replacement poses a similar environmental risk.

DECISION INTERPRETATION

Require a comparative record of what risk is reduced, what new risks appear and which uncertainties remain. "Free of X" is not a technical endpoint; the decision endpoint is the net profile of the complete functional solution.

CONTROL ACTION

Require explicit burden-shift and similar-risk checks before approval.

REQUIRED RECORDS

Baseline hazard profile; replacement hazard profile; use rate; exposure scenario; durability; disposal/recovery route; claim language.

AUDIT / ESCALATION TRIGGER

Escalate when the substitution rationale is primarily reputational and lacks comparative technical evidence.

COL3-010 | Sources: A07, A09, A14 | Claim: claim_colchem003_p10_core
Applicability is source-, jurisdiction-, process- and evidence-boundary specific.

Colorants and pigment selection

KEY

Pigment and colorant substitution must preserve optical performance while controlling composition, impurities, particle characteristics and lifecycle release.

TECHNICAL BASIS

Colorants vary from soluble dyes to insoluble inorganic and organic pigments. Relevant questions include identity, metal content, residual impurities, particle size and form, dusting potential, lightfastness, weathering, migration, aquatic hazard and compatibility with the binder system. EPA Safer Choice provides a hazard-oriented criterion for colorants but does not create a universal coatings specification.

DECISION INTERPRETATION

A safer option is only meaningful if tint strength, color stability, opacity, dispersion, durability and processability remain fit for purpose. Lower hazard paired with poor durability can increase lifetime material demand and repaint frequency.

CONTROL ACTION

Qualify colorant alternatives using both hazard and optical/durability performance tests.

REQUIRED RECORDS

CAS/EC identity; impurity specification; particle data; color coordinates; tint strength; weathering; migration/leach data; dust controls.

AUDIT / ESCALATION TRIGGER

Escalate when a pigment change is approved without impurity limits or long-term color/durability validation.

COL3-011 | Sources: A03, A09, A16 | Claim: claim_colchem003_p11_core
Applicability is source-, jurisdiction-, process- and evidence-boundary specific.

Binders, polymers and resin systems

KEY

Polymer safety and circularity depend on the polymer system, residual chemistry, molecular-weight distribution, additives and end-use form - not the word "polymer" alone.

TECHNICAL BASIS

EPA Safer Choice requests molecular-weight information, residual monomers and oligomers for polymer review and notes closer review in specified contexts when average molecular weight is above 10,000 Da or the fraction below 1,000 Da exceeds 5 percent. These are program-specific review criteria, not universal legal safety thresholds.

DECISION INTERPRETATION

Binder substitution should examine residual monomers, crosslinkers, cure chemistry, emissions, durability, recyclability and separation compatibility. A high-molecular-weight polymer can still carry risk through residual monomers, additives, degradation products or particle release.

CONTROL ACTION

Require polymer-system data beyond the finished resin trade name.

REQUIRED RECORDS

Average molecular weight; low-MW fraction; residual monomers; oligomers; crosslinker; cure emissions; glass transition/cure performance; recyclability.

AUDIT / ESCALATION TRIGGER

Escalate when supplier data omit residual monomer/oligomer information for a material substitution that depends on low exposure assumptions.

COL3-012 | Sources: A03, A09, A12, A17 | Claim: claim_colchem003_p12_core
The 10,000 Da and 5 percent values are Safer Choice review criteria, not general legal definitions of a safe polymer.

Solvents and carrier systems

KEY

Solvent substitution must compare toxicology, environmental fate, process function, flammability, volatility, use rate and recovery behavior together.

TECHNICAL BASIS

EPA solvent criteria evaluate multiple human-health and environmental endpoints. A lower-VOC or VOC-exempt carrier can still present occupational, aquatic, persistence or flammability concerns. Conversely, a regulated VOC is not automatically highly toxic. The carrier also affects viscosity, drying, film formation, cleaning and emissions control.

DECISION INTERPRETATION

Choose solvent systems by whole-function performance. Compare required solvency, evaporation profile, flash point, worker exposure, aquatic hazard, persistence, recoverability and the mass of solvent required per unit product.

CONTROL ACTION

Create a solvent-system balance and alternatives matrix for each major formulation family.

REQUIRED RECORDS

Identity; use rate; vapor pressure; flash point; occupational limits where applicable; hazard criteria; recovery rate; product performance.

AUDIT / ESCALATION TRIGGER

Escalate when a solvent is preferred solely because it is VOC-exempt or because it lowers one regulatory metric.

COL3-013 | Sources: A05, A13, A16 | Claim: claim_colchem003_p13_core
Applicability is source-, jurisdiction-, process- and evidence-boundary specific.

Preservatives and antimicrobial functionality

KEY

Preservative reduction is only successful if microbial stability and product safety remain controlled.

TECHNICAL BASIS

Preservatives can carry sensitization, aquatic-toxicity or regulatory concerns, yet removing them without redesign can shorten shelf life, increase spoiled product and create microbial risks. Safer Choice treats preservatives within a specialized functional class, while market-specific biocidal and product rules may impose separate legal requirements.

DECISION INTERPRETATION

The correct question is the minimum effective preservation strategy for the specific formulation, packaging, manufacturing hygiene and shelf-life target. Alternatives include chemistry changes, packaging changes, water-activity or pH control and manufacturing improvements, but each requires validation.

CONTROL ACTION

Use challenge testing or other appropriate product-specific preservation validation before reducing or changing preservative systems.

REQUIRED RECORDS

Preservative identity/concentration; microbial challenge protocol; shelf-life data; packaging; pH/water activity; manufacturing hygiene controls.

AUDIT / ESCALATION TRIGGER

Escalate when a "preservative-free" claim is proposed without a validated microbial-stability strategy.

COL3-014 | Sources: A03, A14, A16 | Claim: claim_colchem003_p14_core
 Applicability is source-, jurisdiction-, process- and evidence-boundary specific.

Surfactants, dispersants and wetting agents

KEY

Surfactant substitution should combine functional efficiency with aquatic toxicity and biodegradation rather than compare toxicity alone.

TECHNICAL BASIS

EPA Safer Choice uses an aquatic-toxicity/biodegradation matrix for surfactants. The ≤ 1 ppm and >1 to ≤ 10 ppm acute aquatic toxicity bands are screening bands within that program and carry different biodegradation expectations; they are not wastewater discharge limits. Dispersants and wetting agents also affect pigment stability, foam, cleaning and use rate.

DECISION INTERPRETATION

A more concentrated or functionally efficient surfactant may reduce total mass used, while a readily biodegradable option may reduce persistence concerns. Decisions should compare hazard band, biodegradation behavior, use concentration and technical performance.

CONTROL ACTION

Normalize surfactant comparison to delivered function, not kilograms purchased.

REQUIRED RECORDS

Acute aquatic endpoints; biodegradation data; use concentration; surface tension/wetting test; dispersion stability; foam profile.

AUDIT / ESCALATION TRIGGER

Escalate when program-screening toxicity bands are copied into permits or plant discharge limits.

COL3-015 | Sources: A04, A02 | Claim: claim_colchem003_p15_core
The aquatic toxicity bands are Safer Choice functional-class screening criteria.

Chelants, sequestrants and processing aids

KEY

Data-poor supporting ingredients still require a function, exposure and downstream-compatibility assessment.

TECHNICAL BASIS

Chelants and processing aids can influence hardness control, pigment dispersion, metal mobility, pH, stability, catalysis and manufacturing performance. EPA notes that many processing aids are common, multifunctional and data-poor, making a simplistic hazard-list approach unreliable. Chelation can also change how metals behave in wastewater or treatment systems.

DECISION INTERPRETATION

Characterize the actual function and dose, then assess whether the ingredient changes contaminant mobility, wastewater treatment, product durability or recovery. When data are sparse, uncertainty must be explicit and high-consequence claims should be conservative.

CONTROL ACTION

Create a supporting-ingredient register with function, use rate and evidence completeness.

REQUIRED RECORDS

Function; dose; water chemistry; metal interactions; biodegradation; treatment data; product performance; uncertainty rating.

AUDIT / ESCALATION TRIGGER

Escalate multifunctional processing aids with unknown composition or no downstream fate assessment.

COL3-016 | Sources: A01, A06, A08 | Claim: claim_colchem003_p16_core
 Applicability is source-, jurisdiction-, process- and evidence-boundary specific.

Plasticizers, modifiers and performance additives

KEY

"Phthalate-free" or similar category claims are not substitutes for a comparative performance and hazard assessment of the replacement additive.

TECHNICAL BASIS

Plasticizers and modifiers tune flexibility, low-temperature behavior, adhesion, cure, impact strength and processing. Replacement can shift volatility, migration, persistence, reproductive hazard, aquatic hazard or durability. The correct comparison is among candidates that deliver the required mechanical and processing function at the expected use rate.

DECISION INTERPRETATION

Use a functional specification and comparative endpoint matrix. If the replacement requires more mass, reduces product life or creates a new high-concern endpoint, the substitution may not be an overall improvement.

CONTROL ACTION

Validate mechanical performance and migration/exposure behavior before claim approval.

REQUIRED RECORDS

Additive identity; use rate; mechanical properties; migration data; hazard profile; durability; supplier declaration.

AUDIT / ESCALATION TRIGGER

Escalate when a free-of claim is stronger than the evidence for the substitute itself.

COL3-017 | Sources: A07, A09, A14, A16 | Claim: claim_colchem003_p17_core
Applicability is source-, jurisdiction-, process- and evidence-boundary specific.

Metals and inorganic constituents

KEY

Inorganic chemistry requires attention to identity, oxidation state, solubility, particle form, impurities and exposure route.

TECHNICAL BASIS

Metal-containing pigments, catalysts, driers and fillers can behave very differently depending on chemical form and matrix. Total metal concentration alone may not predict bioavailability, leaching or occupational exposure. Insoluble particulate materials can still create inhalation concerns during powder handling, while soluble or mobile forms can affect wastewater and environmental fate.

DECISION INTERPRETATION

Specifications should distinguish intentional metal chemistry from trace impurities and should connect total concentration to the relevant exposure or leachability question. Substitution must avoid replacing a well-characterized material with a poorly characterized inorganic mixture.

CONTROL ACTION

Set impurity and speciation requirements where they materially affect risk or compliance.

REQUIRED RECORDS

Elemental analysis; chemical form/speciation where relevant; particle size; solubility/leachability; supplier impurity limits; exposure controls.

AUDIT / ESCALATION TRIGGER

Escalate when total-metal data are used to infer exposure or environmental mobility without considering chemical form.

COL3-018 | Sources: A02, A16 | Claim: claim_colchem003_p18_core
Applicability is source-, jurisdiction-, process- and evidence-boundary specific.

Persistent and highly persistent chemistry

KEY

Persistence is a separate decision variable because a chemical that resists degradation can create long-lived exposure and remediation burdens even when acute toxicity is modest.

TECHNICAL BASIS

Environmental fate assessment should consider persistence, degradation products, mobility, bioaccumulation potential, partitioning and likely release. The EU SSbD framework and chemical hazard systems increasingly emphasize lifecycle and persistence concerns. Persistence alone does not quantify risk, but it raises the consequence of uncertainty and uncontrolled release.

DECISION INTERPRETATION

When two functionally suitable alternatives have similar performance, the more persistent or mobile option needs stronger justification, especially for uses with diffuse release. Closed-system use still requires credible end-of-life and waste handling.

CONTROL ACTION

Add persistence/mobility to substitution gates for any material with plausible environmental release.

REQUIRED RECORDS

Biodegradation; hydrolysis; photolysis; partitioning; mobility; degradation products; release scenario.

AUDIT / ESCALATION TRIGGER

Escalate when persistence is ignored because acute toxicity is low.

COL3-019 | Sources: A09, A10, A16 | Claim: claim_colchem003_p19_core
 Applicability is source-, jurisdiction-, process- and evidence-boundary specific.

PFAS: status, use and analytical boundaries

KEY

As of 1 September 2026, the broad EU PFAS restriction remains in the REACH opinion-development process and should not be described as a final universal ban.

TECHNICAL BASIS

ECHA's RAC adopted its final opinion on 2 March 2026; SEAC agreed its draft opinion on 10 March 2026 and consulted on it through 25 May. ECHA continues to show the broad proposal in opinion development, with SEAC's final opinion expected by the end of 2026. Final Annex XVII text for the broad proposal has therefore not yet been adopted.

DECISION INTERPRETATION

Formulators should inventory intentional PFAS uses, supplier declarations and plausible impurities now, while publication claims distinguish proposed restriction scope from binding law. A PFAS-free claim must define the relevant PFAS scope or analyte universe, matrix, method, sample preparation and LOD/LOQ; a non-detect under one method does not prove absence of all PFAS.

CONTROL ACTION

Create a PFAS inventory and claim-support protocol before making free-from statements.

REQUIRED RECORDS

Ingredient/supplier declaration; intentional-use status; analyte list; method; matrix; LOD/LOQ; QC; legal status date.

AUDIT / ESCALATION TRIGGER

Escalate any statement that calls the proposed broad EU restriction a final universal prohibition or treats one non-detect as proof of all-PFAS absence.

COL3-020 | Sources: A10, A11, A14 | Claim: claim_colchem003_p20_core

SEAC's final opinion is expected by end-2026; Commission restriction text, final scope, derogations and transition periods remain pending.

Synthetic polymer microparticles: scope before slogan

KEY

EU REACH Entry 78 is binding law, but it is not a simple statement that all microplastics are banned.

TECHNICAL BASIS

Regulation (EU) 2023/2055 added REACH Annex XVII Entry 78. Regulation (EU) 2026/1168 amended its paragraph 4 derogations and will replace paragraph 5(c) from 22 June 2028. The 0.01% w/w condition remains subject to the legal definition, exclusions, derogations, information/reporting duties and staggered transition dates.

DECISION INTERPRETATION

For a formulation, determine whether the material is within the legal definition, whether the concentration condition is met, whether a derogation applies and what information/reporting duties remain. Do not use the word "microplastic" as a substitute for the legal applicability analysis.

CONTROL ACTION

Create an Entry 78 applicability worksheet for representative polymer-containing formulations.

REQUIRED RECORDS

Polymer identity; physical state; particle-size distribution; concentration; intended use; site use; end-use transformation; transition date.

AUDIT / ESCALATION TRIGGER

Escalate when applicability is asserted without particle-form and concentration data.

COL3-021 | Sources: A12, A17 | Claim: claim_colchem003_p21_core

The 0.01% w/w condition applies only within Entry 78's specific placing-on-market scope and subject to current exclusions/derogations; it is not a universal polymer threshold.

VOC reduction versus whole-formulation performance

KEY

Under U.S. federal air regulation, VOC status is based on participation in atmospheric photochemical reactions, with specified negligibly reactive compounds excluded; it is not a general measure of health or environmental safety.

TECHNICAL BASIS

EPA defines VOC for regulatory purposes under 40 CFR 51.100(s) and excludes certain compounds with negligible photochemical reactivity. That exemption does not establish that an exempt compound is non-toxic, non-persistent, non-flammable or lifecycle-preferable. Likewise, a regulated VOC is not automatically highly toxic.

DECISION INTERPRETATION

Low-VOC development should remain a valid air-quality objective while separately evaluating occupational hazard, solvent use rate, durability, fate and recovery. Product claims should state the VOC method/definition and avoid implying broader safety unless separately substantiated.

CONTROL ACTION

Separate VOC compliance, toxicology and lifecycle fields in formulation reviews.

REQUIRED RECORDS

VOC content/method; exempt-compound basis; solvent hazard profile; use rate; emissions estimate; durability result.

AUDIT / ESCALATION TRIGGER

Escalate claims that equate VOC-exempt with safe or low-VOC with universally low impact.

COL3-022 | Sources: A05, A13, A14 | Claim: claim_colchem003_p22_core
Applicability is source-, jurisdiction-, process- and evidence-boundary specific.

Sensitization and occupational exposure interfaces

KEY

Formulation changes can reduce one hazard while increasing inhalation, dermal or sensitization exposure during manufacturing and use.

TECHNICAL BASIS

CLP and other hazard frameworks classify respiratory and skin sensitization separately from acute toxicity, carcinogenicity and other endpoints. Physical form matters: powders, aerosols, reactive monomers and spray applications can create exposure patterns not evident from finished-film behavior. Engineering controls and PPE reduce exposure but do not erase intrinsic hazard.

DECISION INTERPRETATION

Qualification should evaluate manufacturing tasks, application method, cleaning, maintenance and foreseeable misuse. A lower-hazard finished product can still create a higher-risk production step if dusting, volatility or reactive handling increases.

CONTROL ACTION

Complete a task-based exposure review for every major substitution.

REQUIRED RECORDS

Physical form; task; route; duration/frequency; ventilation; containment; PPE; sensitizer classification; incident history.

AUDIT / ESCALATION TRIGGER

Escalate when occupational review only considers the cured or finished material.

COL3-023 | Sources: A05, A16 | Claim: claim_colchem003_p23_core
Applicability is source-, jurisdiction-, process- and evidence-boundary specific.

Acute versus chronic hazard interpretation

KEY

One favorable endpoint cannot stand in for the full hazard profile.

TECHNICAL BASIS

Acute toxicity, repeated-dose toxicity, carcinogenicity, mutagenicity, reproductive/developmental toxicity, neurotoxicity, sensitization and aquatic effects represent different outcomes and evidence bases. Alternatives-assessment frameworks compare multiple endpoints because a candidate may improve one while worsening another.

DECISION INTERPRETATION

CEPA should avoid composite scores that hide critical endpoints. A candidate with a high-consequence chronic hazard should not be averaged into acceptability by several low-concern endpoints. Use gating for critical hazards and scoring only among candidates that pass mandatory gates.

CONTROL ACTION

Use endpoint gates plus a transparent comparative matrix.

REQUIRED RECORDS

Endpoint result; classification; study quality; route; uncertainty; criticality; decision rule.

AUDIT / ESCALATION TRIGGER

Escalate when a single acute LD50/LC50 or similar endpoint is used as a claim of overall safety.

COL3-024 | Sources: A02, A07, A16 | Claim: claim_colchem003_p24_core
Applicability is source-, jurisdiction-, process- and evidence-boundary specific.

Environmental fate: persistence, mobility and bioaccumulation

KEY

Environmental impact depends on where a chemical goes, how long it remains, what it becomes and whether organisms can accumulate it.

TECHNICAL BASIS

Useful fate descriptors include biodegradation, hydrolysis, photolysis, partitioning, water solubility, soil/sediment affinity, mobility, degradation products and bioaccumulation indicators. These properties interact with release pathway: a chemical bound in a durable matrix differs from the same chemical discharged in an aqueous stream.

DECISION INTERPRETATION

Assess fate for the expected release scenario rather than as an abstract property list. A highly persistent mobile substance with diffuse release deserves a different decision threshold than a substance used in a tightly controlled, recoverable system.

CONTROL ACTION

Define the dominant release scenario before interpreting fate data.

REQUIRED RECORDS

Use/release map; fate endpoints; degradation products; partitioning; wastewater route; solid-waste route.

AUDIT / ESCALATION TRIGGER

Escalate when fate conclusions ignore the physical form and release pathway.

COL3-025 | Sources: A02, A05, A09 | Claim: claim_colchem003_p25_core
Applicability is source-, jurisdiction-, process- and evidence-boundary specific.

Aquatic toxicity and wastewater implications

KEY

Ingredient aquatic hazard and facility wastewater risk are related but not interchangeable.

TECHNICAL BASIS

Aquatic toxicity data are usually generated for defined organisms and exposure conditions, while facility effluent risk depends on concentration, mass loading, dilution, treatment, biodegradation, partitioning and mixture effects. A highly toxic ingredient at low contained use may create little discharge, whereas a moderately hazardous, high-volume and poorly biodegradable ingredient can dominate load.

DECISION INTERPRETATION

Use aquatic hazard for substitution screening, then use flow x concentration and treatment fate for facility decisions. Do not paste ingredient toxicity thresholds into wastewater permit tables.

CONTROL ACTION

Link formulation inventory to process-loss and wastewater mass balance.

REQUIRED RECORDS

Ingredient use mass; loss fraction; wastewater concentration; biodegradation/removal; effluent flow; permit/receiving-water boundary.

AUDIT / ESCALATION TRIGGER

Escalate when ingredient hazard values are represented as facility discharge standards.

COL3-026 | Sources: A04, A05, A02 | Claim: claim_colchem003_p26_core
 Applicability is source-, jurisdiction-, process- and evidence-boundary specific.

Product durability as an environmental variable

KEY

A reformulation that shortens service life can increase lifetime material, energy and maintenance burdens even if its ingredient hazard profile improves.

TECHNICAL BASIS

Durability affects repainting, recoating, maintenance frequency, replacement, transport and waste generation. The EU SSbD lifecycle approach supports examining such trade-offs rather than optimizing hazard in isolation. However, durability benefits do not justify retaining a high-concern substance without exploring alternatives.

DECISION INTERPRETATION

Use a minimum performance gate first, then compare lifecycle consequences across candidates that meet it. If a safer candidate needs more frequent application, quantify the added mass and process burden rather than assuming one result dominates.

CONTROL ACTION

Add accelerated and, where feasible, field durability validation to major formulation changes.

REQUIRED RECORDS

Service-life specification; weathering/corrosion/abrasion results; application mass; maintenance frequency; failure mode.

AUDIT / ESCALATION TRIGGER

Escalate when a safer-formulation claim relies on laboratory hazard improvement while known product life materially declines.

COL3-027 | Sources: A09, A01 | Claim: claim_colchem003_p27_core
 Applicability is source-, jurisdiction-, process- and evidence-boundary specific.

Substitution and manufacturing compatibility

KEY

A substitution candidate with an improved hazard profile can still fail if it destabilizes mixing, dispersion, cure, filtration, filling, cleaning or rework.

TECHNICAL BASIS

Formulation changes can alter viscosity, wetting, foam, reaction kinetics, temperature profile, pot life, filter loading, equipment fouling, cleaning requirement and off-specification rate. Those effects influence both resource efficiency and worker exposure. A substitution that doubles rework or cleaning can shift rather than solve the environmental burden.

DECISION INTERPRETATION

Pilot qualification must include process capability and loss metrics, not only finished-product tests. Compare first-pass yield, cycle time, cleaning mass, rework, reject rate and energy demand before full release.

CONTROL ACTION

Run controlled pilot batches with a defined baseline and acceptance limits.

REQUIRED RECORDS

Batch records; process conditions; yield; cleaning inputs; rework/rejects; downtime; emissions/waste changes.

AUDIT / ESCALATION TRIGGER

Escalate when the substitution passes product tests but creates unstable manufacturing performance.

COL3-028 | Sources: A01, A09 | Claim: claim_colchem003_p28_core
 Applicability is source-, jurisdiction-, process- and evidence-boundary specific.

Substitution and product-recovery compatibility

KEY

A formulation can make internal recovery or downstream recycling easier or harder through compatibility, contamination and identity preservation.

TECHNICAL BASIS

Recovery routes depend on chemistry and specification. A pigment, additive, crosslinker or contaminant can prevent rework, downgrade recovered material or make mixed-stream recycling impractical. Conversely, compatible formulation families and controlled ingredient sets can expand rework windows and simplify segregation.

DECISION INTERPRETATION

Recovery compatibility should be a design input. Evaluate whether off-spec product, first flushes, returns or end-of-life material can re-enter a defined process without creating quality, safety or legal problems.

CONTROL ACTION

Add recovery-route compatibility to formulation change control.

REQUIRED RECORDS

Rework specification; contamination limits; compatibility tests; receiving specification; segregation plan; downstream acceptance evidence.

AUDIT / ESCALATION TRIGGER

Escalate changes that eliminate a functioning recovery route without a quantified benefit or replacement route.

COL3-029 | Sources: A09, A01 | Claim: claim_colchem003_p29_core
 Applicability is source-, jurisdiction-, process- and evidence-boundary specific.

Formulation design for recycling and reuse

KEY

Circularity claims require both design compatibility and an actual route capable of accepting the material.

TECHNICAL BASIS

Design choices can influence separability, contamination, hazardous constituents, cure reversibility, compatibility with recycled feedstock and the quality of recovered output. But design-for-recycling is not the same as recycling in practice. A technically recyclable product may still lack collection, sorting, processing or market infrastructure.

DECISION INTERPRETATION

Distinguish three claims: designed for a route, technically demonstrated on a route, and actually recovered at scale. Each needs different evidence. Avoid counting theoretical recyclability as a realized circular outcome.

CONTROL ACTION

Define the target recovery route before assigning circular-design requirements.

REQUIRED RECORDS

Material composition; disassembly/separation need; recycler specification; trial result; collection route; accepted mass; end-product evidence.

AUDIT / ESCALATION TRIGGER

Escalate when "recyclable" is claimed solely from material composition without route availability or qualification.

COL3-030 | Sources: A09, A14 | Claim: claim_colchem003_p30_core
 Applicability is source-, jurisdiction-, process- and evidence-boundary specific.

Supplier data and formulation transparency

KEY

SDS information alone may be insufficient for decision-grade substitution and circularity analysis.

TECHNICAL BASIS

Safety data sheets are essential hazard-communication documents but may not disclose full formulation composition, residual monomers, impurities, particle-size distributions, use-specific fate data or confidential constituents below disclosure thresholds. Decision-grade work may require confidential supplier declarations, third-party verification or controlled data exchange.

DECISION INTERPRETATION

Specify the minimum data needed for each ingredient class and separate "not disclosed" from "not present." Supplier confidentiality can be protected while still verifying critical claims through attestations or third parties.

CONTROL ACTION

Issue a technical data requirement schedule to strategic suppliers.

REQUIRED RECORDS

Identity range; concentration; impurities; residuals; polymer data; hazard classifications; analytical method; regulatory declarations; change notification.

AUDIT / ESCALATION TRIGGER

Escalate when a critical free-from, low-hazard or recycling claim rests only on an SDS absence.

COL3-031 | Sources: A03, A08, A14 | Claim: claim_colchem003_p31_core
 Applicability is source-, jurisdiction-, process- and evidence-boundary specific.

Restricted-substance and watch-list governance

KEY

Binding restrictions, candidate lists, customer standards and internal watch lists must be visibly separated.

TECHNICAL BASIS

A substance can be prohibited for a specific use, subject to authorization, classified as hazardous, proposed for restriction, listed by a customer or merely flagged internally. These statuses create different obligations. Combining them in one red list without status metadata can cause both over-compliance and missed legal duties.

DECISION INTERPRETATION

Governance should record jurisdiction, legal instrument, scope, threshold, effective date, exemption/derogation, customer requirement and internal policy status. Substitution priority can then reflect both legal urgency and technical risk.

CONTROL ACTION

Create a controlled restricted-substance register with status fields.

REQUIRED RECORDS

Substance identity; legal/customer/internal basis; scope; threshold; date; derogation; owner; last verification.

AUDIT / ESCALATION TRIGGER

Escalate when a proposed restriction is labeled as current law or when a customer requirement is presented as a regulatory prohibition.

COL3-032 | Sources: A10, A11, A12, A15, A16, A17 | Claim: claim_colchem003_p32_core
Applicability is source-, jurisdiction-, process- and evidence-boundary specific.

Analytical verification, LOD and LOQ

KEY

A laboratory result only supports the claim defined by the method, analyte set, matrix, sampling plan and detection capability.

TECHNICAL BASIS

Non-detection is not zero. LOD and LOQ, recovery, matrix interference, blanks, sample preparation and target-analyte list determine what can be inferred. Broad chemical classes such as PFAS intensify this problem because no single targeted method necessarily captures every member or precursor.

DECISION INTERPRETATION

Every free-from claim should have a written analytical claim boundary. If a supplier declaration rather than testing supports the claim, say so. If screening methods are used, distinguish screening from compound-specific quantification.

CONTROL ACTION

Require analytical method review before publishing high-consequence absence claims.

REQUIRED RECORDS

Sampling plan; matrix; analyte list; method; accreditation; LOD/LOQ; QC; blank/recovery; result interpretation.

AUDIT / ESCALATION TRIGGER

Escalate when "not detected" is converted to "absent" or when an analyte list is hidden behind a broad class claim.

COL3-033 | Sources: A10, A14 | Claim: claim_colchem003_p33_core
Applicability is source-, jurisdiction-, process- and evidence-boundary specific.

Claims architecture: safer, free-from and low-impact

KEY

Environmental and safety claims must state or support what is being claimed, the relevant comparator where stated or implied, the applicable boundary and the evidence.

TECHNICAL BASIS

FTC guidance cautions against broad unqualified environmental claims and requires substantiation for free-of and non-toxic representations. It also warns that a free-of claim can be deceptive if a replacement poses a similar environmental risk. Directive (EU) 2024/825 required Member States to adopt and publish transposition measures by 27 March 2026; those national measures apply from 27 September 2026, after this brief's publication date.

DECISION INTERPRETATION

Prefer bounded claims such as "reduced X by Y percent under method Z" or "no intentionally added X based on supplier declarations" over vague "green," "safe" or "non-toxic" language. For PFAS-free and similar claims, pair compositional and analytical boundaries.

CONTROL ACTION

Create a claim substantiation record linked to every environmental marketing statement.

REQUIRED RECORDS

Exact claim; comparator; evidence; method; boundary; date; jurisdiction; approval; limitations.

AUDIT / ESCALATION TRIGGER

Escalate any broad environmental benefit claim without a specific substantiated benefit.

COL3-034 | Sources: A14, A15, A10 | Claim: claim_colchem003_p34_core

Directive (EU) 2024/825 is in force; Member-State transposition measures apply from 27 September 2026, after this brief's 6 September publication date.

Substitution scoring and decision matrix

KEY

A useful scorecard supports comparison but must not hide critical hazards, failed performance or major uncertainty behind arithmetic.

TECHNICAL BASIS

CEPA recommends a gated matrix: legal eligibility and critical product performance are pass/fail; high-consequence hazard endpoints are explicit gates or penalties; exposure, fate, circular compatibility, supply resilience and cost are scored with transparent weights; uncertainty is separately visible. This avoids false precision while allowing structured comparison.

DECISION INTERPRETATION

Use scoring to rank candidates that already meet mandatory gates. Do not average away a carcinogenicity, sensitization, critical product failure or legal prohibition. Sensitivity-test the weights to see whether the ranking is robust.

CONTROL ACTION

Adopt a standardized substitution scorecard with documented weights and gate logic.

REQUIRED RECORDS

Gate definitions; endpoint scores; weights; uncertainty; sensitivity result; approver rationale.

AUDIT / ESCALATION TRIGGER

Escalate when a preferred candidate wins only because of arbitrary weighting or when a failed mandatory gate is offset by other points.

COL3-035 | Sources: A07, A09 | Claim: claim_colchem003_p35_core
Applicability is source-, jurisdiction-, process- and evidence-boundary specific.

Total-cost model for formulation change

KEY

The economic case for substitution must include qualification and lifecycle operating effects, not raw-material price alone.

TECHNICAL BASIS

Cost elements can include ingredient price, dose, scrap/rework, cleaning, energy, cycle time, maintenance, PPE/controls, monitoring, waste classification, treatment, permitting, product claims, supplier qualification, customer reapproval, inventory obsolescence and potential service-life change. Avoided cost is real only if the baseline cost is measured or defensibly calculated.

DECISION INTERPRETATION

Use a parameterized model rather than a universal payback claim. Separate recurring operating value from one-time conversion cost and from risk-reduction benefits that cannot be monetized credibly.

CONTROL ACTION

Build a baseline/candidate cost ledger using site data.

REQUIRED RECORDS

Price/dose; yield; cycle time; utility use; waste/treatment; qualification cost; inventory impact; service-life effect; uncertainty.

AUDIT / ESCALATION TRIGGER

Escalate when a business case reports savings without including qualification cost or known changes in yield, cleaning or service life.

COL3-036 | Sources: A09, A01 | Claim: claim_colchem003_p36_core
 Applicability is source-, jurisdiction-, process- and evidence-boundary specific.

Failure modes and substitution risk register

KEY

Substitution projects can fail when teams optimize one dimension and discover a transferred burden after scale-up.

TECHNICAL BASIS

Common failure modes include unacceptable performance, new worker exposure, higher use rate, persistent replacement chemistry, new wastewater inhibition, loss of rework/recycling route, supplier instability, analytical ambiguity, customer rejection and misleading claims. Each failure has a detectable precursor that can be built into qualification.

DECISION INTERPRETATION

Use an FMEA-style register with severity, likelihood, detectability, control and evidence owner. Keep high-severity unknowns open until evidence closes them rather than lowering risk by assumption.

CONTROL ACTION

Run a cross-functional risk review before production release.

REQUIRED RECORDS

Failure mode; cause; consequence; current control; evidence; owner; action; closure criterion.

AUDIT / ESCALATION TRIGGER

Escalate any high-severity risk that remains open at production release without an explicit executive acceptance.

COL3-037 | Sources: A07, A08, A09 | Claim: claim_colchem003_p37_core
Applicability is source-, jurisdiction-, process- and evidence-boundary specific.

30/60/90-day safer-formulation program

KEY

Safer formulation becomes operational when data, governance and pilot qualification are sequenced into a repeatable program.

TECHNICAL BASIS

Days 1-30: inventory priority formulations, map functions, identify legal/customer drivers, define evidence gaps and establish claim controls. Days 31-60: screen functionally viable alternatives, complete endpoint matrices, obtain supplier data, run laboratory/pilot qualification and evaluate manufacturing/recovery effects. Days 61-90: validate performance, finalize cost/risk records, approve claims, release controlled specifications and track post-change performance.

DECISION INTERPRETATION

The program should prioritize high-volume, high-hazard, high-release or high-regulatory-change ingredients rather than attempt whole-portfolio reformulation at once. Each approved change becomes a reusable evidence package.

CONTROL ACTION

Launch a ranked portfolio with named technical, EHS, regulatory and commercial owners.

REQUIRED RECORDS

Priority list; evidence matrix; pilot plan; qualification results; cost case; claim record; specification revision; post-launch KPI.

AUDIT / ESCALATION TRIGGER

Escalate programs that count substitutions completed without verifying performance, burden shifts or claim accuracy.

COL3-038 | Sources: A01, A07, A09 | Claim: claim_colchem003_p38_core
Applicability is source-, jurisdiction-, process- and evidence-boundary specific.

Source-register control and evidence discipline

KEY

Primary sources must be traceable to current official text and a precise use in the manuscript.

TECHNICAL BASIS

The controlled source register on the following page combines the principal U.S. EPA safer-chemistry and alternatives-assessment sources with the EU and U.S. regulatory and claims authorities used across this issue.

DECISION INTERPRETATION

Use each source only within its stated scope and legal or program status. Official program criteria, guidance and recommendations do not create universal chemical-law obligations.

CONTROL ACTION

Freeze source title, URL, locator and current-status date before technical review.

REQUIRED RECORDS

Source archive or URL; locator; access date; page owner; claim IDs supported.

AUDIT / ESCALATION TRIGGER

Escalate any source that cannot be opened, is superseded, or is cited for a proposition outside its scope.

COL3-039 | Sources: A01, A02, A03, A04, A05, A06, A07, A08 | Claim: claim_colchem003_p39_source_control
Applicability is source-, jurisdiction-, process- and evidence-boundary specific.

Controlled source register and methodological notes

STATUS SWEEP | 3 SEPTEMBER 2026

Regulatory status refreshed through T-3 remediation. Entry 78 was checked against Regulation (EU) 2026/1168; repeat the legal/status sweep immediately before authorization and publication.

A01 | EPA Safer Choice Standard and Criteria

S0 - official agency program standard. Use: Functional-class ingredient review; product performance; safer-ingredient program context.
<https://www.epa.gov/saferchoice/standard>

A02 | EPA Safer Choice Master Criteria for Safer Chemical Ingredients

S0 - official agency criteria. Use: Human-health and environmental hazard endpoints; functional-class logic.
<https://www.epa.gov/saferchoice/safer-choice-master-criteria-safer-chemical-ingredients>

A03 | EPA Safer Choice Criteria for Colorants, Polymers, Preservatives and Related Chemicals

S0 - official agency criteria. Use: Polymer, colorant and preservative review; molecular-weight and data-quality criteria.
<https://www.epa.gov/saferchoice/safer-choice-criteria-colorants-polymers-preservatives-and-related-chemicals>

A04 | EPA Safer Choice Criteria for Surfactants

S0 - official agency criteria. Use: Aquatic-toxicity and biodegradation screening for surfactants.
<https://www.epa.gov/saferchoice/safer-choice-criteria-surfactants>

A05 | EPA Safer Choice Criteria for Solvents

S0 - official agency criteria. Use: Solvent toxicology, environmental fate and aquatic-hazard criteria.
<https://www.epa.gov/saferchoice/safer-choice-criteria-solvents>

A06 | EPA Safer Choice Criteria for Processing Aids and Additives

S0 - official agency criteria. Use: Data-poor processing aids, multifunctional ingredients and subclass-specific review.
<https://www.epa.gov/saferchoice/safer-choice-criteria-processing-aids-and-additives>

A07 | EPA Alternatives Assessment Criteria for Hazard Evaluation

S0 - official agency methodology. Use: Comparative hazard assessment across alternatives.
<https://www.epa.gov/saferchoice/alternatives-assessment-criteria-hazard-evaluation>

A08 | EPA Design for the Environment Alternatives Assessments

S1 - official agency assessments. Use: Measured data, SAR estimates, expert judgment and confidence statements when data are incomplete.
<https://www.epa.gov/saferchoice/design-environment-alternatives-assessments>

A09 | European Commission Recommendation (EU) 2026/510 - Safe and Sustainable by Design

S0 - official EU recommendation (non-binding). Use: Voluntary lifecycle framework integrating safety, sustainability, function and innovation.
<https://eur-lex.europa.eu/eli/reco/2026/510/oj/eng>

A10 | ECHA PFAS restriction process status

S0 - official regulatory-process notice. Use: RAC final opinion; SEAC draft opinion and consultation outcome; broad proposal remains in opinion development.
<https://echa.europa.eu/-/echa-supports-pfas-restriction-with-targeted-derogations>

A11 | ECHA REACH restriction procedure steps

S0 - official procedure. Use: Distinguishes committee opinions from final Commission restriction adoption.
<https://echa.europa.eu/regulations/reach/restrictions/restriction-procedure/restrictions-process/steps>

A12 | Commission Regulation (EU) 2023/2055 - Synthetic polymer microparticles

S0 - binding EU regulation. Use: original Entry 78 definitions, 0.01% w/w condition and transition framework; apply with A17 for current derogations/effective dates.
<https://eur-lex.europa.eu/eli/reg/2023/2055/oj/eng>

A13 | EPA definition of VOC under 40 CFR 51.100(s)

S0 - official federal regulatory definition. Use: U.S. photochemical-reactivity basis of VOC regulatory treatment.
<https://www.epa.gov/air-emissions-inventories/what-definition-voc>

A14 | FTC Environmental Claims: Summary of the Green Guides

S0 - official federal guidance. Use: General environmental-benefit, free-of and non-toxic claim substantiation.
<https://www.ftc.gov/business-guidance/resources/environmental-claims-summary-green-guides>

A15 | Directive (EU) 2024/825 - Empowering consumers for the green transition

S0 - EU directive in force. Use: EU consumer-law environmental-claim changes; transposition measures apply from 27 September 2026.
<https://eur-lex.europa.eu/eli/dir/2024/825/oj/eng>

A16 | Regulation (EC) No 1272/2008 - CLP Regulation

S0 - binding EU regulation. Use: EU hazard-classification framework, including CMR, sensitization and aquatic-hazard classes.
<https://eur-lex.europa.eu/eli/reg/2008/1272/oj/eng>

A17 | Commission Regulation (EU) 2026/1168 - Entry 78 amendment

S0 - binding EU regulation. Use: paragraph 4 derogation amendments; paragraph 5(c) replacement applies from 22 June 2028; effective-date control.

<https://eur-lex.europa.eu/eli/reg/2026/1168/oj/eng>

METHODOLOGICAL NOTES

1. No universal safety declaration

The manuscript compares evidence for defined functions and uses; it does not certify any chemical or formulation as universally safe.

2. Program criteria are not law

EPA Safer Choice criteria are authoritative screening criteria within a voluntary program and are labelled accordingly.

3. PFAS status is time-sensitive

On 1 September 2026 the broad proposal remains in REACH opinion development. Recheck immediately before technical review and publication.

4. Entry 78 is fact-specific

Applicability depends on polymer identity, physical form, particle size, concentration, intended use and relevant exclusions/derogations/transitions.

5. Analytical claims are method-bounded

A non-detect is not converted into universal absence without a defined analyte scope, matrix, method and LOD/LOQ.

6. Claim evidence remains controlled

Each material claim remains linked to source IDs and requires reviewer, locator and evidence-closure checks before release.