



QUALITY MANUALS | FIRST EDITION

IAF SUSTAINABILITY AND CIRCULAR ECONOMY MANUAL

Controlled emissions reduction
and factory resource recovery

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Industrial wastewater treatment and reuse
Metal and polymer recovery with traceability

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Publication identity and use

IAF Sustainability and Circular Economy Manual

This manual defines how automotive plants reduce emissions and recover water, metal and polymers while preserving safety and product quality. Site leaders and technical teams use it to establish reliable baselines, validate recovery processes and demonstrate measured improvement.

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Reading and applying requirements

“Shall” identifies a requirement when adopted by a site, programme or agreement. “Should” identifies a recommendation. An example is illustrative; it is not a machine setting, test acceptance limit or completed operating record. Annex worksheets may be reproduced for controlled internal use.

Controlled implementation

Stable Release identifies the completed publication text. Site approval, process validation, competence authorization and equipment release are recorded when performed. A missing safety limit, test criterion or release authority prevents activation of the affected operation. Mandatory law, product requirements and validated equipment instructions remain applicable.

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Using the annexes

Enter actual values, evidence references, names and dates in the worksheets. A blank, unsigned or illustrative record is not proof of completion. Retain the record with its governing instruction and revision.

1 Purpose scope and required outcomes

1.1 This manual defines the management and operating controls for reducing automotive factory emissions and recovering water, metals and polymers. It applies to press shops, paint ovens, foundries, moulding, assembly and supporting utilities. Its purpose is to produce measurable resource improvement while maintaining worker safety, product performance and control of environmental releases.

1.2 Each site shall define the processes, buildings, utilities, waste streams and reporting period within its scope. Include outsourced activities where they materially affect the claimed result, or disclose their exclusion. A factory boundary shall not be altered simply to move an emission or waste stream out of a favourable performance indicator.

1.3 Prioritize prevention, reduced material and energy demand, reuse and controlled recovery. Recycling a rejected part does not erase the energy and material used to produce it. Process improvement shall address avoidable scrap and rework before relying only on a higher recovery percentage.

1.4 The requirements cover operational carbon accounting, heat efficiency, water treatment and reuse, scrap segregation, material release and evidence for environmental claims. They do not prescribe a universal emission factor, discharge limit, furnace setting or recycled material percentage. The site shall establish those values from its actual operating and product conditions before use.

1.5 Prompt or immediate factory recycling means timely controlled collection and processing. It does not authorize wet scrap charging into molten metal, uncontrolled polymer blending or bypass of material quarantine. Safety, contamination checks and quality release remain mandatory at every recovery stage.

2 Responsibilities and programme adoption

2.1 The site director shall appoint an accountable sustainability lead and approve the programme scope, resources and objectives. Utilities and process engineering own technical energy and water performance. Environmental specialists own discharge and waste controls. Quality and product engineering own acceptance of recovered materials and process changes affecting the finished product.

2.2 Finance or another independent data reviewer shall reconcile reported activity with bills, production records and material balances. The metrology function shall maintain measurement suitability. Procurement shall verify supplier claims and recovery routes. Operations shall execute approved instructions and report abnormal consumption, contamination and equipment condition promptly.

2.3 Adoption shall include the site boundary, obligations register, baseline, measurement plan, risk assessment, prioritized projects and emergency interfaces. Annex A records the decision and unresolved gaps. An efficiency project shall not enter service while a safety critical control, discharge acceptance criterion or product validation requirement is missing.

2.4 The programme shall involve affected workers and maintenance personnel because actual start-up, idle, cleaning and recovery practices often differ from the nominal process model. Review plans with the people who will operate the new system, including all shifts and relevant contractors. Record practical limitations and training needs before commissioning.

2.5 IAF functions may review implementation within the applicable programme and committee scope. Applying this manual does not automatically confer Corporate Recognised status, accreditation, certification or permission to use an IAF mark. Those decisions follow their own controlled evaluation and authorization arrangements.

3 Reporting boundaries and emission categories

3.1 Define organizational and physical boundaries before calculating emissions. Identify owned and operated facilities, leased assets, shared utilities and outsourced processing. Record the treatment of each activity and use the same approach between periods unless a documented change requires recalculation or clear disclosure.

3.2 Keep direct fuel combustion, process emissions and fugitive releases distinct from purchased electricity, steam, heat or cooling. Identify relevant material, transport, waste and other value chain emissions separately. Combining them into one total is permitted only where the categories and calculation basis remain visible and no activity is counted twice.

3.3 Use carbon dioxide equivalent, expressed as CO₂e, to aggregate relevant greenhouse gases through a documented factor basis. Record the gas, activity, conversion factor, units, validity period and boundary. Do not treat every air pollutant as a greenhouse gas or assume that a lower carbon result proves lower local air pollution.

3.4 For shared energy or services, use a justified allocation based on measured consumption or a documented physical driver. Where estimation is unavoidable, state the method and uncertainty and create a plan to improve data. Revenue allocation shall not replace a practical physical measure merely because it produces a preferred result.

3.5 Changes such as a new foundry, outsourced heat treatment or acquired production line shall trigger a boundary review. Preserve both the originally reported figures and any restated comparable baseline with an explanation. Annex B provides the minimum inventory fields and separates measured from estimated activity.

4 Activity data factors and calculations

4.1 Calculate emissions from consistent activity data and matching factors. For example, tonnes CO₂e = fuel energy in kWh × factor in kg CO₂e per kWh ÷ 1000. If the fuel is measured by volume, apply the documented energy conversion first and keep its reference conditions consistent with the factor basis.

4.2 Each factor record shall identify its technical basis, geography, year, covered gases, boundary and unit. Retain evidence internally even where the public report contains no external citations. Review factors when supply, technology or reporting period changes; do not mix a combustion only factor with a full supply chain factor without separating the additional scope.

4.3 Use actual meter and purchase data where suitable. Reconcile opening and closing fuel or material stocks when consumption differs from purchases. Identify missing intervals, estimated readings and meter failures. An estimate shall be labelled and approved, with uncertainty considered before making a precise reduction claim.

4.4 Illustrative calculation: 2,000,000 kWh of fuel at 0.200 kg CO₂e per kWh produces 400 tonnes CO₂e. Purchased electricity of 1,000,000 kWh at 0.350 kg CO₂e per kWh produces 350 tonnes. The combined result is 750 tonnes for those two categories only; the example factors are not approved reporting factors.

4.5 Preserve unrounded source values and round only the reported result at a justified precision. A reviewer shall check units, conversions, period coverage and duplicate entries. Carbon dioxide, CO₂e, kilograms and tonnes shall be labelled clearly so a spreadsheet unit error cannot silently change the reported result by a factor of one thousand.

5 Baseline normalization and performance comparison

5.1 Select a representative baseline with sufficient data to describe production volume, mix, operating hours, weather where relevant and exceptional events. Record why the period is suitable and which processes it covers. A low output shutdown period or unusually high scrap run shall not be selected solely to magnify apparent future improvement.

5.2 Report absolute emissions and an appropriate intensity measure together. For an automotive plant, the denominator may be accepted vehicles, coated area, tonnes of sound castings or another meaningful output. Define the denominator consistently and avoid using total attempted production where rejected output would make performance appear better.

5.3 Normalize project comparisons for relevant changes in production mix, throughput, ambient conditions or operating schedule using a documented model. Keep actual reported emissions separate from normalized analytical results. Explain the assumptions and uncertainty rather than replacing actual emissions with an adjusted figure without disclosure.

5.4 Illustrative comparison: a baseline of 1,000 tonnes CO₂e for 10,000 accepted units is 100 kg per unit. A later period of 900 tonnes for 8,000 units is 112.5 kg per unit. Absolute emissions fell by 10 percent while intensity rose by 12.5 percent; both observations are needed to interpret the result.

5.5 Recalculate a baseline only under a defined policy for material structural or data changes. Preserve the original and revised series, reason, approval and effect. Operational inefficiency, poor performance or an inconvenient comparison is not a valid reason to silently reset the baseline.

6 Objectives investment and project approval

6.1 Set objectives from the measured baseline and the site's significant environmental impacts. Define target, scope, owner, deadline, resources and verification method. Include absolute consumption or emissions as well as intensity where relevant. Avoid targets that reward transferring waste, pollution or energy demand to an unreported process.

6.2 Evaluate each project for safety, product quality, environmental effects, reliability and whole life cost. Consider added pumping, drying, treatment chemicals, maintenance and disposal as well as the primary energy saving. A recovery process that consumes more resources elsewhere shall be assessed as a complete system.

6.3 The business case shall state the counterfactual, expected operating range, measurement points and savings calculation. Distinguish forecast savings from measured post-implementation results. Annex C records approval, commissioning and verification; a supplier's promotional claim shall not be entered directly as the site's achieved reduction.

6.4 Prioritize avoidable idle operation, leaks, poor insulation, unnecessary rework and unstable process control before major technology changes where these offer effective improvements. Capital projects such as electrification, heat recovery and advanced water treatment require validated integration with the production and safety systems.

6.5 Management shall review progress and resolve constraints without pressuring operators to exceed approved limits. If a project fails its safety, quality or environmental acceptance test, hold deployment and correct the design. Financial payback does not authorize operation outside the approved boundary.

7 Paint oven energy and cure control

7.1 Map energy from fuel or electrical input through air handling, heated surfaces, exhaust and product heating. Separate warm-up, production, idle and shutdown consumption. Measure the relevant loads and identify losses from air leakage, excessive exhaust, damaged insulation, poor door control and unnecessary standby operation.

7.2 The paint process owner shall define the validated curing window for each coating and product family, including actual part temperature, time and relevant film properties. An oven air setpoint alone does not prove that the part has achieved the required cure. Energy reduction shall remain within the validated product and equipment envelope.

7.3 Optimize loading and scheduling to reduce repeated heat-up and underloaded running where quality and production constraints permit. Maintain airflow distribution, filters, burners or heaters and temperature measurement. Dirty heat transfer surfaces and poor balance can increase energy demand while causing uneven cure.

7.4 Any proposed lower temperature, shorter residence time or reduced airflow shall undergo controlled trials and coating performance verification. Assess solvent concentration, exhaust function and fire protection interactions before changing ventilation. Operators shall not reduce a safety related flow or disable an interlock to meet an energy target.

7.5 Track energy per accepted coated area or another justified denominator alongside rejection, rework and cure results. A nominal energy saving that increases repainting may worsen the total outcome. Record the complete process result and reject unverified savings derived only from a changed controller setpoint.

8 Paint oven efficiency improvement

The process engineer shall use a controlled project record for each material operating change. Production, quality, maintenance and HSE shall agree the trial boundary before changing the released recipe.

Step / owner	Required action and evidence
1 Establish baseline	Record energy, operating states, product mix, accepted output and cure performance. Confirm meters, temperature measurement and the comparison period are suitable.
2 Identify losses	Inspect insulation, seals, air balance, maintenance condition and idle schedules. Separate defects requiring repair from proposed changes to the validated process.
3 Assess change	Define the proposed setting or equipment change and its effect on cure, solvent management, fire protection and downstream quality. Approve a limited trial and stop criteria.
4 Conduct trial	Use representative products and loading conditions. Record part temperature history, energy and required quality tests while maintaining all protective functions.
5 Verify result	Compare normalized energy and accepted output with the baseline. Include additional rework and auxiliary loads. Hold the change if quality or safety acceptance fails.
6 Release and monitor	Approve the revised recipe and instructions, train affected shifts and define follow-up checks. Retain the original configuration and a safe rollback method.

The commissioning record shall contain actual measurements, test results and signatures. Savings remain provisional until representative sustained production confirms them. Unexpected cure defects, solvent alarms or unstable temperature require prompt return to a safe validated state.

9 Heat recovery and emission abatement

9.1 Assess heat recovery opportunities from oven exhaust, foundry off-gas, cooling loops and compressed air systems. Match source temperature, available duty, operating schedule and contamination to a real heat demand. Heat that cannot be used at the required time shall not be counted as useful recovered energy.

9.2 Design heat exchangers and ducting for temperature, fouling, corrosion, condensation and cleaning access. Evaluate fire and explosion hazards where solvent laden or combustible streams are present. Prevent cross-contamination between process exhaust and occupied space or clean process air through a suitable engineered separation and monitoring strategy.

9.3 Emission abatement equipment shall remain effective through the operating range, including startup, shutdown and low load. Changes intended to reduce fuel use shall not compromise destruction, capture or treatment performance. Monitor the actual parameters that demonstrate control and establish a hold or shutdown response to failure.

9.4 Include fan, pump, control and treatment energy in the project balance. A heat recovery system may reduce fuel while increasing electricity; calculate the net energy and emissions outcome using consistent boundaries. Consider maintenance downtime, bypass use and degradation when assessing sustained performance.

9.5 A bypass shall have defined authorization, indication, duration limits and operating restrictions. Do not bypass abatement or protective functions to preserve production without the required technical and operational authority. Retain inspection and performance evidence and review the system after material changes in coating chemistry, exhaust flow or furnace loading.

10 Foundry energy and metal yield

10.1 Map energy through melting, holding, transfer, casting and return processing. Separate furnace input from auxiliaries and identify avoidable holding time, repeated remelting, heat loss and rejected castings. Use tonnes of accepted castings and metal yield alongside energy per tonne melted to avoid hiding excessive internal returns.

10.2 Maintain furnace lining, covers, seals, burners or induction components, temperature measurement and transfer equipment. Follow the approved operating envelope for each alloy and furnace. Excessive superheat or holding can increase energy use and affect metal quality; reductions shall be validated against casting requirements and safe operation.

10.3 Charge material shall have verified identity, cleanliness, moisture condition and compatibility. Wet or contaminated scrap can create violent reactions when exposed to molten metal. Use the engineered inspection and drying or preheating process where required; visual appearance alone shall not establish safe dryness for a hazardous charge.

10.4 Improve yield through stable moulding, gating, process control and defect prevention. Record dross, slag, spills, machining returns and rejected castings as distinct streams. Recovering internal returns is beneficial but does not erase the original process loss or justify an inflated recycled content claim.

10.5 Evaluate recovery and energy changes with metallurgy and HSE specialists. Alloy contamination, oxide formation, dust, emissions and water contact risks can change when more scrap is introduced. Do not increase recovered content or alter the charge mix without a controlled material specification and demonstrated product acceptance.

11 Foundry efficiency and charge release

Apply this procedure to a proposed change in furnace scheduling, holding practice or recovered charge use. The furnace operating instruction remains the authority for actual charging and temperature settings.

Step / owner	Required action and evidence
1 Baseline owner	Record furnace energy, charge mass, accepted casting mass, return streams, operating hours and quality losses. Reconcile material stocks and meter coverage.
2 Material controller	Verify charge identity, alloy compatibility, contamination and approved moisture control evidence. Segregate wet, unknown or suspect material and prevent charging.
3 Process engineer	Assess the proposed schedule, temperature or mix change for metal quality, equipment capability and safety. Define trial scope, samples, limits and rollback conditions.
4 Authorized operator	Execute the approved trial with the normal protective controls. Record actual charge sequence, temperatures, holding time and abnormal conditions without improvising adjustments.
5 Quality and environment	Verify casting properties, chemistry, defects, emissions and residue handling. Include remelt and rejected output in the total performance comparison.
6 Release authority	Approve only the validated operating range and material combinations. Update instructions and monitor sustained energy, yield and safety performance after implementation.

If charge condition or furnace behaviour is uncertain, stop the affected step and obtain the competent technical decision. A cost or carbon benefit does not justify introducing wet scrap, incompatible alloys or unverified feedstock into the furnace.

12 Electrification and utility optimization

12.1 Assess electrification of heat against the actual process temperature, load profile, electricity supply, equipment efficiency and grid constraints. Compare the full operating energy and emissions result with the existing system using consistent factors. Electrical heating does not inherently make a process emission free.

12.2 Separate the physical electricity consumption and location based emissions view from any contractual energy attribute claim. Retain evidence of ownership, applicable period, geography and retirement where such attributes are used. Present the methods distinctly and prevent the same attribute being claimed by more than one party or process.

12.3 For on-site generation, meter generation, self-consumption, imports, exports and storage losses separately. Exported energy shall not also be counted as electricity consumed by the factory. Battery storage changes timing and incurs losses; it does not itself create renewable energy.

12.4 Optimize compressed air, chilled water, cooling towers, ventilation and pumps through leak repair, pressure or flow control, maintenance and appropriate operating schedules. Validate the effect on tools, quality, exposure control and emergency systems before lowering utility settings. Safety related ventilation and firewater availability shall remain protected.

12.5 Review peak demand, resilience, backup operation and maintenance capability before replacing a fuel based process. Include startup, outage and degraded mode scenarios in commissioning. Record the actual performance after implementation and disclose material increases in another resource or environmental impact.

13 Water balance and fit for purpose reuse

13.1 Establish a water balance covering fresh supply, process use, recirculation, reuse, evaporation, product carryover, wastewater and other discharges. Use consistent periods and units and distinguish a repeated circulation flow from new water entering the site. Summing every pass through a cooling loop would overstate water use and recovery.

13.2 Identify quality requirements for each intended reuse point, such as pretreatment rinse, cooling makeup, cleaning or another industrial process. Define chemical, physical and microbiological criteria where relevant, together with material compatibility and product quality needs. Water suitable for one use may be unsuitable for another.

13.3 Recovered industrial water shall remain segregated from potable systems through a verified design with suitable backflow and cross-connection protection. Label pipelines, tanks and outlets clearly. A colour or label alone is not a physical barrier, and a clear appearance does not demonstrate safe drinking quality.

13.4 Evaluate local water availability and discharge constraints when prioritizing projects. A high percentage recovery may still leave excessive absolute consumption or a difficult concentrated waste stream. Report fresh water withdrawal, total discharge and relevant quality outcomes alongside recovery measures.

13.5 Set measurement points and reconcile unexplained imbalance. For example, 100 cubic metres of treatment feed split into 70 cubic metres of reuse water, 25 cubic metres of concentrate and 5 cubic metres of measured losses gives 70 percent recovery at that treatment boundary. It does not prove a 70 percent reduction in site withdrawal.

14 Wastewater characterization and segregation

14.1 Characterize wastewater by source, variability and hazardous properties before selecting treatment. Include paint pretreatment, metal finishing, oily cleaning, cooling blowdown, foundry contact water and sanitary streams where applicable. Record flow peaks, batch discharges, cleaning chemicals and foreseeable upset conditions, not only a single average sample.

14.2 Segregate incompatible or unusually concentrated streams to prevent reactions and protect downstream treatment. Identify metals, oils, suspended solids, salts, solvents, acidity or alkalinity and other process specific contaminants. Mixing streams to dilute a pollutant is not treatment and shall not replace control of the source.

14.3 The sampling plan shall define representative locations, frequency, containers, preservation, holding time and chain of custody appropriate to each analysis. Use competent sampling and testing personnel. Field instruments shall be maintained and verified; a conductivity reading alone cannot establish removal of all contaminants.

14.4 Provide controlled collection, equalization and containment where variation could overload the treatment system. Define tank compatibility, level protection, secondary containment and abnormal discharge isolation. Consider confined space, chemical handling and gas generation hazards in operation and maintenance.

14.5 Recharacterize when raw materials, coatings, cleaners, production rate or cleaning practices change. Unknown discharges shall be held and assessed before entering a sensitive reuse system. Annex D records the approved stream and reuse criteria, while the actual analytical reports remain controlled supporting evidence.

15 Treatment technology selection and validation

15.1 Select the treatment train from the characterized feed and intended reuse or discharge quality. Screening, settling, oil separation, coagulation or precipitation can address particular suspended or dissolved contaminants; biological treatment can address suitable biodegradable loads. Each stage shall have a defined purpose and an identified residual stream.

15.2 Membrane filtration and reverse osmosis can provide further separation where appropriate, but their performance depends on feed quality, operating conditions and integrity. Pretreatment shall control fouling, scaling and incompatible chemicals. A membrane process generally transfers rejected substances into concentrate rather than destroying them.

15.3 Assess polishing such as adsorption, ion exchange, disinfection or other treatment only against a defined contaminant and required endpoint. Include spent media, regenerant, by-products and energy. No technology name by itself proves that the complete water is suitable for the intended use.

15.4 Pilot or otherwise validate the proposed train across representative feed variability and credible upset conditions. Confirm product water quality, recovery, residual handling, maintenance needs and monitoring response. Record the operating envelope and the consequences of exceeding it before routine operation.

15.5 The design shall include off-specification diversion, safe storage, monitoring failure response and a controlled fallback supply where production requires continuity. Reuse shall not continue merely because the factory needs water when treatment performance is uncertain. Annex E supports commissioning and batch or interval release records.

16 Water recovery commissioning and release

Commission the complete system, including controls, sampling, residual handling and the receiving process. Water reuse remains on hold until the defined technical and quality criteria have been demonstrated.

Step / owner	Required action and evidence
1 Design verification	Confirm feed characterization, intended use, treatment stages, capacity, materials and approved acceptance limits. Resolve missing criteria before introducing process water.
2 Physical inspection	Check tanks, pipe identity, cross-connection protection, containment, pumps, instruments and safe maintenance access. Verify the installed configuration against the approved design.
3 Functional testing	Test alarms, diversion valves, level protection, loss of power and instrument failure response. Confirm off-specification water cannot reach the approved reuse point unnoticed.
4 Performance trial	Operate within the planned envelope and sample representative feed, product water and residuals. Record flow, quality, chemical use, energy and system stability.
5 Receiving validation	Confirm the recovered water does not impair coating, cooling, material compatibility or other intended process performance. Assess microbial and aerosol risks where relevant.
6 Authorization	Approve the operating limits, sampling schedule, release authority and fallback method. Train all shifts and retain actual results, open restrictions and signed release.

A successful single sample shall not replace the required demonstration of sustained control. Failed performance or a bypass during the trial requires investigation and repeated verification of the affected function before release.

17 Water system operation and contamination response

17.1 Operators shall monitor the parameters specified for the treatment train and intended use, including flow, pressure, level, differential pressure and selected quality indicators. Record instrument status and trends, not only isolated readings. Define alert and action levels with enough response time to divert off-specification water before it reaches the receiving process.

17.2 Release water by the approved continuous or batch method. The method shall state which online values are sufficient for routine control, which laboratory results are required and what happens while results are pending. A missing or failed instrument shall trigger the defined restricted or hold condition rather than an assumed pass.

17.3 When a quality limit is exceeded, isolate the affected supply, divert or hold water safely and assess material already exposed. Notify production, quality and environment functions. Trace the affected interval and receiving batches; flushing a pipe does not automatically release products made with suspect water.

17.4 Control biofilm, stagnation and aerosol exposure through the validated maintenance and hygiene plan where applicable. Manage treatment chemicals, cleaning solutions and membrane preservation safely. Do not increase chemical dosing outside the approved range to compensate for a poorly understood process upset.

17.5 Restart after contamination, maintenance or prolonged shutdown shall follow defined inspection, cleaning and performance verification. Record the cause, corrective action and acceptance evidence. Keep recovered water and fresh water labels, valves and connection controls current after any piping modification.

18 Concentrate sludge and residual management

18.1 Account for every residual from treatment and resource recovery, including membrane concentrate, metal bearing sludge, oily solids, spent media, filter cake, dross and contaminated packaging. Determine the relevant hazards and authorized handling route from actual composition. A reduced wastewater volume does not necessarily mean a reduced pollutant load.

18.2 Design tanks and storage areas for compatibility, containment, weather protection and access control. Prevent incompatible wastes from mixing and protect against overflow or accidental discharge. Inspect storage condition and maintain clear identity, quantity, origin and status for each container or batch.

18.3 Assess the destination of recovered water treatment residuals before increasing recovery. Higher recovery can increase salt or contaminant concentration and create scaling, corrosion or disposal constraints. “Zero liquid discharge” shall not be claimed unless the defined boundary and all liquid pathways support that statement; solid residues still require management.

18.4 Use authorized competent service providers and retain transfer, weight and acceptance evidence. Reconcile dispatched quantities with receipt and final treatment information appropriate to the claim. A collection receipt alone does not prove recycling or environmentally acceptable final treatment.

18.5 Investigate leaks, unexplained mass loss, rejected waste loads and repeated storage overflow. Apply the emergency plan where a release threatens people or the environment. Correct the generating process as well as the disposal route so an operational problem is not simply transferred off site.

19 Metal scrap identification and collection

19.1 Define metal scrap streams by alloy or grade, coating, process origin and contamination risk. Separate steel, aluminium and other metals and preserve distinctions needed by the intended recovery process. Mixed or unidentified material shall be held for characterization or sent through a suitable separately approved route.

19.2 Collect press offcuts and other returns at source using guarded equipment and containers suited to sharp edges and mass. Prevent access to conveyors, chutes, shredders and compactors during operation. Jam clearing and maintenance require the applicable energy isolation procedure; prompt recycling does not justify reaching into moving equipment.

19.3 Keep scrap free from batteries, aerosol containers, sealed vessels, tools, incompatible metals and other hazardous inclusions. Control oil, coolant, water and debris according to the receiving process specification. A bin identified for a grade shall not be used for convenient disposal of unrelated material.

19.4 Trace each collected lot to its source material and production period where the recovery route or product claim requires it. Use weighing equipment suitable for the range and record tare consistently. Account for packaging, moisture and nonmetal content when calculating usable recovered mass.

19.5 Set inspection and acceptance criteria for transfer to internal remelting or external recovery. Wet scrap destined for a molten process requires a validated moisture control route; uncovered storage and a visual check are insufficient where hidden water can remain. Annex F records identity, checks, movement and release.

20 Controlled internal metal recycling

Use this process for eligible metal returns routed back into factory production. Product engineering and metallurgy shall approve the allowed grades and destinations before routine recycling begins.

Step / owner	Required action and evidence
1 Collect and identify	Capture scrap at the defined source and label grade, origin, period and status. Prevent mixing and record gross, tare and net mass through the approved weighing method.
2 Inspect and hold	Check foreign objects, incompatible metals, oils and moisture risks. Segregate uncertain material and record the reason; do not blend it into an accepted lot to dilute the problem.
3 Prepare safely	Perform approved sorting, cleaning, cutting, compaction or drying with guarded equipment and controlled energy. Verify that preparation achieves the receiving process requirements.
4 Release feedstock	Confirm material identity, chemistry where required, contamination and moisture controls. Record the authorized destination and allowable charge use; quality release precedes charging.
5 Process and verify	Use the approved charge recipe and operating instruction. Test the resulting metal or product for the specified properties and trace the recovered lot into its production batch.
6 Reconcile and improve	Record accepted output, residues, rejected material and stock changes. Investigate unexplained loss or contamination and update source segregation controls before recurrence.

A material accepted for one alloy or product family shall not be used in another without approval. Retain quarantine status until the required checks pass. The furnace operator shall still verify the immediate charge condition under the furnace safety instruction.

21 Controlled polymer scrap recycling

Only eligible identified polymer streams may enter an internal regrind loop. The approved material specification shall define resin, grade, additives, source, preparation and permitted end use.

Step / owner	Required action and evidence
1 Source segregation	Separate scrap by resin, grade, colour and additive or reinforcement system as required. Identify process origin and exclude unknown, mixed, contaminated or degraded material.
2 Preparation	Use approved guarded granulation and collection equipment. Control dust, noise, ignition sources, static and foreign metal; use the established isolation method for jam clearing.
3 Condition material	Apply the validated drying, storage and handling method for the resin. Record moisture or other required condition checks and prevent recontamination after preparation.
4 Blend authorization	Weigh virgin and recovered components to the approved recipe. Record lot identities and actual percentages; do not select a recycled fraction from this manual or from visual appearance.
5 Process validation	Run within the approved process window and verify relevant mechanical, thermal, dimensional and appearance properties. Trace the blend into product batches and retain required samples.
6 Release and reconcile	Quality authorizes the defined end use after results pass. Record residues, rejects and stock changes; hold off-specification output and investigate the cause before further use.

Repeated processing can alter material properties. The approved loop shall control thermal history or maximum reprocessing conditions where relevant. Safety critical products require explicit engineering authorization and customer approval where required; recovered material is not an automatic equivalent substitute.

22 Polymer quality and product restrictions

22.1 The recovered polymer specification shall address composition, contamination, moisture, degradation, particle condition and the properties required by the final product. Select tests appropriate to the resin and application, such as flow behaviour, strength, impact, heat resistance, dimensions or appearance. A passing single property does not establish complete equivalence.

22.2 Control incompatible polymers, flame retardants, fillers, fibres, pigments and coatings that can affect the recovered blend. Identify the consequences of mixed source streams and define which are prohibited. Material that cannot be traced or characterized adequately shall not enter a demanding product application on the assumption that processing will make it acceptable.

22.3 Product engineering shall define the permitted recovered fraction and process window from validation. Use representative worst case conditions, including material age and repeated thermal exposure where relevant. Maintain separate limits for different parts or grades; there is no universal safe recycled content percentage for all automotive components.

22.4 Maintain a traceability chain from source scrap through preparation, blend and moulding batch to finished product. Record recipe changes, test results and disposition. Retained samples and records shall support investigation if a later dimensional, durability or appearance issue arises.

22.5 Where a recovered batch fails, segregate it and assess a controlled alternative use, further treatment or disposal. Repeated blending to dilute a defect requires an explicitly approved technical basis and traceability; it shall not be an informal route around a failed acceptance criterion.

23 Mass balance and circularity accounting

23.1 For each defined recovery boundary, reconcile opening stock plus receipts with production use, dispatched output, residues, measured losses and closing stock. Use consistent units and distinguish wet mass from dry material where relevant. Investigate imbalance beyond the site's justified tolerance rather than assigning it automatically to an unexplained loss category.

23.2 Report collection rate, process yield and actual reuse separately. Material collected for recycling is not necessarily material successfully recycled. Define the denominator and destination of each measure, and distinguish internal production returns from recovered material sourced after product use when making a content claim.

23.3 Illustrative balance: 10 tonnes opening scrap stock plus 90 tonnes collected equals 100 tonnes available. If 80 tonnes are released to production, 12 tonnes become classified residues and 8 tonnes remain in stock, the balance closes. Released material is 80 percent of available mass; this is not automatically the recycled content of the final product.

23.4 For a controlled polymer blend containing 750 kg virgin resin and 250 kg eligible recovered resin, the input recovered fraction is 25 percent by mass. A finished product content claim still requires a consistent boundary, loss treatment and eligibility definition. Do not count the same internal material repeatedly each time it circulates through the process.

23.5 Keep avoided virgin material, actual purchased material reduction and avoided emissions as distinct analytical results. If avoided emissions are estimated, disclose the comparison scenario and keep them separate from the site's actual emission inventory. Offsets shall not be subtracted from operational emissions to conceal continued consumption.

24 Resource prevention and circular design

24.1 Use process capability, material nesting, design simplification and defect prevention to reduce scrap at source. Evaluate material utilization alongside quality and safety. A tighter nesting pattern or thinner section requires the appropriate manufacturing and product validation; material savings shall not weaken structural or functional performance.

24.2 Extend asset and packaging life through maintainable design, repairable components and controlled reuse where suitable. Coordinate with the IAF Industrial Packaging and Circularity Manual for reusable containers, return logistics and packaging material policy. Ensure that cleaning, transport and replacement burdens are included in the assessment.

24.3 Control consumables such as oils, solvents, abrasives and filters through appropriate selection, storage and maintenance. Recover or reuse them only within validated quality and safety limits. A reused fluid can accumulate contaminants even where its appearance remains acceptable, and uncontrolled reuse can increase product defects or exposure.

24.4 Evaluate the compatibility of circularity choices with disassembly, repair and end of life processing. Document material identity and relevant additives where needed for future recovery. Avoid unsupported claims that a composite, coating or mixed assembly is readily recyclable merely because one constituent can be recycled separately.

24.5 Review trade-offs across water, energy, emissions, waste and product life. A change that saves one resource may increase another; report the material trade-off and the decision basis. The objective is a demonstrated improvement within the declared scope, not a favourable isolated percentage.

25 Procurement suppliers and environmental claims

25.1 Procurement specifications shall define the required material, recycled content basis, energy or water performance and supporting evidence. Evaluate supplier capability, traceability and the actual delivery scope. Generic corporate claims shall not be assumed to apply to a particular batch, factory or service.

25.2 Verify recovery providers and downstream routes through risk based evidence review and, where necessary, site assessment. Confirm identity, competence, accepted waste types and final treatment information. A memorandum or membership record alone is not evidence that a particular waste stream was processed as claimed.

25.3 Public statements shall be precise about boundary, period, method and measured result. Avoid unqualified terms such as zero emission, zero waste, fully circular or carbon neutral unless the evidence supports the complete stated scope and relevant conditions are disclosed. Marketing shall obtain technical review before publication.

25.4 Differentiate renewable energy attributes, physical energy use, operational emission reduction and offset related claims. Prevent double counting between sites, suppliers and customers. Keep forecast, modelled, avoided and measured results visibly distinct in internal approvals and external communication.

25.5 IAF marks and recognition statements shall follow the IAF Mark Usage Policy and the recorded authorized scope. Do not imply that this manual independently verifies a product claim. Complaints, suspected misstatement and conflicts of interest shall be handled through the corresponding IAF policies and corrective action arrangements.

26 Measurement assurance and performance review

26.1 Maintain a register of meters, balances, analytical instruments and data systems that support material decisions or reported results. Define range, accuracy needs, calibration or verification, maintenance and data owner. Assess the effect of an out of tolerance instrument on previously reported periods and released materials.

26.2 Data controls shall preserve original readings, corrections, calculation versions and approvals. Restrict access to factors and formulas and review material changes independently. Reconcile monthly totals with utility bills, production output, purchasing and waste transfer records; investigate unexplained differences rather than selecting whichever source gives a lower result.

26.3 Monitor absolute fuel, electricity, CO₂e, fresh water withdrawal, discharge, accepted output, scrap generation and actual recovery. Include quality losses, environmental incidents and treatment reliability so savings cannot conceal degraded performance. Define alert thresholds from the site baseline and operating envelope.

26.4 Audits shall trace reported results to physical processes and records. Sample an oven project, a foundry charge, a reuse water interval and a recovered material lot. Check the installed configuration, actual operator practice and destination evidence, including rejected material and abnormal operating periods.

26.5 Management shall review results, uncertainty, open risks and project effectiveness at planned intervals. Annex H records decisions and resources. Repeated unexplained imbalance, unsupported claims or bypassed treatment controls shall trigger corrective action even where the headline target appears to have been achieved.

27 Abnormal events and management of change

27.1 The site shall define immediate response to solvent or chemical releases, water contamination, treatment failure, overheating, dust events and hazardous scrap discoveries. Protect people, stop or isolate the affected process where safe and activate the emergency plan. Do not send unknown material or water into another process to clear an alarm or free storage capacity.

27.2 For an environmental release, identify the substance, amount, pathway, affected area and containment status using safe observation. Notify the designated response and environmental leads and follow applicable reporting duties. Preserve samples and records where safe, and control contaminated cleanup materials through an approved waste route.

27.3 Any change in coating, alloy, resin, cleaner, throughput, furnace, treatment chemistry or reuse destination shall undergo review before implementation. Evaluate emissions, wastewater character, material compatibility, exposure, fire risk, product performance and monitoring needs. A supplier substitution can be a significant process change even when the trade name appears similar.

27.4 A temporary operating arrangement shall state scope, duration, technical basis, monitoring and exit conditions. It shall not authorize a prohibited discharge, unsafe charge or unvalidated product substitution. If the necessary controls cannot be maintained, suspend the affected operation and use the approved fallback.

27.5 After an incident or change, verify the affected systems before restart and assess the accuracy of any performance claims covering the event. Correct data transparently and retain the original record. Root cause actions shall address the generating condition and confirm sustained effectiveness rather than ending at cleanup.

28 Records internal interfaces and revision

28.1 Manage inventories, project files, water analyses, material records and claims approvals under the IAF Documents and Records Guide. Assign owner, revision, access, retention and disposal controls. Preserve records needed to interpret past calculations, product batches or environmental investigations and apply legal or investigation holds where required.

28.2 This manual interfaces with IAF-QM-001, IAF-MAN-LMS-001, IAF-MAN-GAA-001, IAF-MAN-SCL-001 and IAF-MAN-IPC-001 for quality, production, advanced assembly, logistics and packaging. Use IAF-MAN-IHE-001 for industrial task safety and IAF-MAN-IRB-001 for emergencies, battery hazards and contaminated incident runoff.

28.3 The site implementation plan shall identify where local work instructions supply specific limits and authority. Retain the actual technical basis internally without adding external standard or organization citations to this publication. The absence of named external references does not remove applicable legal, product or equipment requirements.

28.4 Revision proposals shall state the affected clause, reason, evidence, implementation impact and transition needs. The competent IAF authority controls publication under the Constitution and document management arrangements. Sites shall assess each issued change and update affected instructions, training and records before use.

28.5 Annexes A to H are practical templates for real operating evidence. Enter actual values and approvals, attach supporting results and distinguish examples from completed records. Stable Release identifies publication status; it does not assert that a particular factory, treatment plant or recycled material recipe has already been validated.

Annex A Site programme and adoption record

Complete for the declared site and reporting boundary. Attach the obligations register, process inventory and implementation plan. Record actual decisions and responsible persons.

Field	Entry to complete
Identity and scope	Site / processes / utilities / reporting period: _____
Accountability	Director / sustainability lead / technical owners: _____
Boundary	Included assets and outsourced activities / exclusions with reasons: _____
Baseline	Energy, CO2e, water, scrap and accepted output records: _____
Critical controls	Oven and furnace safety / treatment diversion / material release: _____
Measurement	Meter register / sampling plan / factor register / data reviewer: _____
Projects	Priority actions / expected benefit / resources / owners / deadlines: _____
Open gaps	Operating restriction / interim control / corrective action / due date: _____
Adoption	Decision / actual approval reference / signatures / effective date: _____

Review trigger: significant process or material change, new reporting boundary, incident, unreliable data or planned management review. Record the next review date and the evidence needed to close each gap. A sustainability target shall never substitute for a missing safety or product acceptance criterion.

Annex B Carbon inventory and factor worksheet

Use a separate line for each activity, period and factor basis. Preserve source evidence internally and distinguish measured, estimated and corrected data.

Inventory field	Entry to complete
Category and source	Direct fuel / process / fugitive / purchased energy / value chain: _____
Activity data	Quantity / unit / period / meter or purchase record: _____
Factor basis	Value / unit / year / geography / gases / boundary / evidence ID: _____
Conversions	Volume to energy or other conversion / basis / calculation: _____
Result	Unrounded kg CO ₂ e / reported tonnes CO ₂ e / calculation version: _____
Data quality	Measured or estimated / uncertainty / missing interval treatment: _____
Review	Reconciliation / duplicate check / reviewer / approval date: _____

Illustrative calculation

Fuel: $2,000,000 \text{ kWh} \times 0.200 \text{ kg CO}_2\text{e/kWh} \div 1000 = 400 \text{ t CO}_2\text{e}$. Electricity: $1,000,000 \text{ kWh} \times 0.350 \text{ kg CO}_2\text{e/kWh} \div 1000 = 350 \text{ t CO}_2\text{e}$. Combined total for these categories = 750 t CO₂e. Factors are illustrative and shall not be adopted for actual reporting.

Record the physical electricity result separately from any contractual attribute result. Do not add the two methods together as though they represent different electricity consumption. Keep offsets and avoided emissions outside the operational inventory total.

Annex C Energy project validation record

Use for oven, foundry, heat recovery, electrification or utility projects. Forecast benefits become achieved results only after the defined measurement and validation are complete.

Project field	Entry to complete
Identity	Project / process / equipment / owner / proposed change: _____
Baseline	Period / energy / output / mix / operating states / quality losses: _____
Risk review	Safety / product / emissions / water / maintenance impacts: _____
Trial plan	Operating range / samples / acceptance limits / stop and rollback: _____
Measurements	Meters / instrument status / actual trial data / auxiliary loads: _____
Comparison	Normalization method / actual savings / uncertainty / exclusions: _____
Acceptance	Safety evidence / quality results / environmental control results: _____
Release	Approved configuration / instructions / training / signatures: _____
Follow-up	Review period / measured sustained result / corrective actions: _____

Illustrative interpretation: if a project saves 100,000 kWh of fuel but adds 30,000 kWh of electricity, assess both changes with their matching factors and include relevant auxiliary loads. Do not report the gross fuel saving as the net energy or carbon benefit. Attach calculations and the actual factor basis.

Annex D Water stream and reuse acceptance schedule

Prepare a controlled schedule for every feed stream and intended reuse point. Technical owners shall enter actual approved limits and analytical methods before commissioning.

Schedule field	Entry to complete
Stream and use	Origin / collection point / receiving process / flow range: _____
Feed character	Metals / oils / solids / salts / organics / pH / variability: _____
Required quality	Parameter / unit / alert level / action limit / basis: _____
Sampling	Location / frequency / container / preservation / laboratory: _____
Online monitoring	Instrument / range / verification / alarm and failure response: _____
Cross connections	Pipe identity / separation / backflow controls / inspection evidence: _____
Off-specification	Diversion location / storage capacity / authority / receiving product hold: _____
Residual route	Concentrate / sludge / cleaning waste / approved destination: _____
Approval	Environmental / process / quality owners / revision / date: _____

Add parameter rows on a controlled continuation sheet where needed. “Clear”, “clean” or “acceptable” without a measurable or otherwise defined criterion is insufficient. A limit for one reuse destination shall not be assumed suitable for another. Missing acceptance values prevent release to the affected use.

Annex E Water recovery operation and release record

Use for commissioning, batch release or defined continuous operating intervals. Link the record to the approved schedule in Annex D and the installed treatment configuration.

Operating field	Entry to complete
Identity	System / date and interval / operator / instruction revision: _____
Feed and output	Feed volume / reuse volume / concentrate / other measured outputs: _____
Operating conditions	Flows / pressures / levels / chemical doses / equipment state: _____
Quality evidence	Online results / sample IDs / laboratory results / pending tests: _____
Function checks	Diversion / alarms / instrument status / cross-connection controls: _____
Deviation	Limit exceeded / affected interval / diverted water / product hold: _____
Disposition	Release / hold / approved alternate route / authority and time: _____
Closeout	Corrective action / restart verification / residual transfer records: _____

Illustrative balance

100 m³ feed = 70 m³ reuse + 25 m³ concentrate + 5 m³ measured losses. Treatment recovery = $70 \div 100 \times 100 = 70$ percent. Compare site fresh water withdrawal separately; repeated recirculation shall not be added as new recovery. Investigate any unaccounted difference beyond the approved measurement tolerance.

Annex F Metal scrap recovery and release record

Record source identity and each status change. The final feedstock release does not replace the furnace operator's immediate safety checks before charging.

Material field	Entry to complete
Source	Scrap lot / source coil or batch / grade / coating / process: _____
Quantity	Gross / tare / net mass / scale ID / measurement date: _____
Inspection	Foreign objects / alloy mixing / oil / coolant / moisture risk: _____
Preparation	Sorting / cleaning / drying or other approved process / evidence: _____
Acceptance	Chemistry or identity tests / contamination and moisture criteria: _____
Destination	Approved furnace or recovery route / allowed charge use: _____
Traceability	Receiving production batch / transfer date / responsible person: _____
Disposition	Released / held / rejected / reason / quality authorization: _____
Reconciliation	Used mass / residues / stock remaining / unexplained variance: _____

Stop and segregate material containing batteries, sealed vessels, unknown metal or unverified moisture condition. Do not use dilution as an informal acceptance method. Record external recovery receipt and destination evidence where the material leaves the site, and retain any rejected load decision.

Annex G Polymer regrind and blend record

Use one record per controlled blend. The approved product and material specification shall define eligibility and the permitted recovered fraction.

Blend field	Entry to complete
Identity	Resin / grade / colour / additives / source scrap lots: _____
Preparation	Granulator / contamination checks / drying / moisture result: _____
Recipe	Virgin lot and mass / recovered lot and mass / approved percentage: _____
History	Known processing history / permitted loop condition / storage: _____
Production	Machine / recipe revision / date / moulding batch / product: _____
Testing	Required properties / samples / actual results / acceptance limits: _____
Release	Quality decision / engineering restrictions / authorized end use: _____
Mass balance	Input / accepted output / residues / rejects / closing stock: _____

Illustrative recipe calculation

750 kg virgin resin + 250 kg eligible recovered resin = 1,000 kg input. Recovered input fraction = $250 \div 1,000 \times 100 = 25$ percent. This is an arithmetic example, not a permitted recipe. Product content claims require the defined eligibility, loss treatment and traceability basis.

Unidentified resin, incompatible additives, contamination or failed properties require a hold. Any alternative use shall have its own documented technical acceptance; changing a label does not make the batch suitable.

Annex H Performance review and claims approval

Use the same reporting period and scope across the review. Record absolute results, intensity, data quality and adverse effects so a favourable single metric cannot conceal deterioration elsewhere.

Review area	Result and evidence to complete
Energy and carbon	Fuel / electricity / CO ₂ e / accepted output / intensity / factor basis: _____
Water	Fresh withdrawal / discharge / reuse / quality failures / residuals: _____
Materials	Scrap generated / collected / actually recovered / residues / balance: _____
Project outcomes	Measured savings / quality effects / auxiliary loads / uncertainty: _____
Control failures	Bypasses / incidents / instrument gaps / unsupported data: _____
Claims review	Exact proposed wording / boundary / evidence / technical approval: _____
Actions	Priority / owner / resources / due date / effectiveness check: _____

Illustrative comparison: 1,000 t CO₂e for 10,000 units gives 100 kg per unit. A later 900 t for 8,000 units gives 112.5 kg per unit. The absolute reduction is 10 percent, while intensity increases 12.5 percent. Report both results and explain the operational cause.

Review chair / signatures / date: _____. Retain the approved public wording with the evidence and calculation version. Reassess or withdraw a claim when its basis changes or a material error is found.