Tech Note 4.4

Electrostatic Application Guidelines

Prepared from internal electrostatic material application evaluations and technical notes

Executive Summary

Electrostatic air-assisted airless applications can provide meaningful reductions in overspray, improve transfer efficiency to the targeted areas being coated, and provide better wrap around conductive steelwork when the coating, thinner, resistivity properties, viscosity, grounding, spray tip, pressure, air movement, and spray technique are all tuned as a system.

A limited product evaluation was completed recently demonstrating the electrostatic performance is product-specific rather than universal. Internal trials confirmed successful outcomes for Durepon EZP, Duremax GPE ZP, Weathermax HBR, Luxathane DTM, Metalshield HB ZP, Congard 321 & 878, Luxepoxy 4 White Primer, and Luxathane HPX under defined conditions.

The main technical messages emerging from the investigative program are: (1) use a round spray tip by default; (2) treat the megaohm meter as a guide rather than an absolute; (3) control viscosity first, resistivity second; (4) monitor wet film thickness (WFT) closely because electrostatic attraction can overbuild film with limited visual warning; and (5) do not promote broad transfer-efficiency claims without process validation.

1. Purpose and Scope

This guide expands on the electrostatic application evaluation work into a structured reference for sales personnel, fabrication shops, and field applicators. It explains not only what worked during the evaluations performed, but why the outcomes occurred and which process controls most strongly affected repeatability.

The document is intended to support technically credible conversations with customers, provide an evidence-based setup path for controlled application trials, and reduce the risk of oversimplified claims around transfer efficiency or universal applicability.

2. Principles of Electrostatic Application

Electrostatic spray application relies on charging atomised coating particles while the target workpiece is properly grounded. The charged droplets are attracted toward the conductive substrate, improving the likelihood of deposition and enabling varying degrees of wrap around edges and sections not directly in the main spray line.

Compared with conventional spraying, the process can reduce overspray and improve coating transfer when four conditions are present at the same time: adequate charging, conductive/grounded substrate, suitable paint resistivity, and a droplet size/momentum profile light enough for the electrostatic field to influence droplet movement.

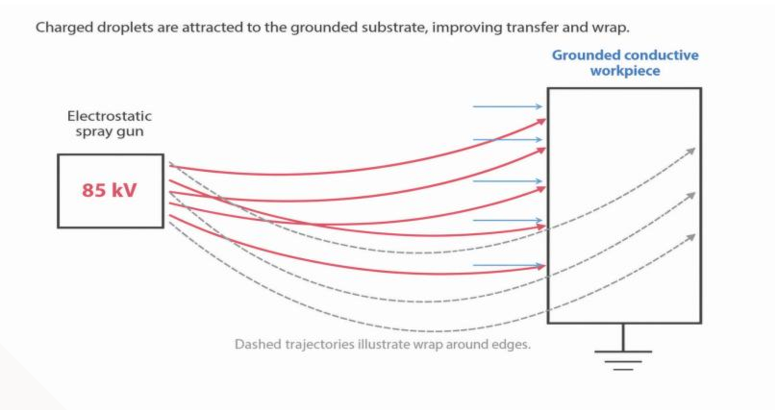


Figure 1. Schematic of charged droplet attraction and wrap around a grounded conductive workpiece.

3. Electrostatic Physics and Wrap Mechanism

Electrostatic performance is the result of a force balance. Charged droplets are drawn toward the grounded substrate by electrostatic attraction, while droplet momentum (driven by fluid pressure, atomising air, and droplet mass), airflow, and gravity act in competing directions. Wrap occurs when the electrical attraction is strong enough relative to droplet momentum for the droplet trajectory to curve around the item.

The internal evaluations performed strongly support this theory. Wrap improved when round spray tips were used, when circular spray motion was adopted, and when spray booth draw was reduced during application. All three measures directed momentum or reduced external force expression, allowing the electric field to exert greater influence over the droplet path.

This also explains why the same coating can behave differently between shops. Two operators may use the same product but achieve different outcomes if one shop has stronger booth draw, poorer grounding, or a flatter spray pattern with more directional energy.

Key Finding	Why It Matters	Practical Takeaway
Round spray tips materially improved wrap	Softened distribution and reduced directional throw	Use a round tip by default for electrostatic work
Viscosity often outweighed resistivity as the success variable	Resistivity level is important, however, poor atomization limits field of influence	Chase clean atomization first, then resistivity parameters
Excessive booth airflow can disrupt wrap	External airflow competes with the field	Reduce booth draw to acceptable levels during spraying only where safe and permitted
WFT control is critical	Electrostatic deposition can be overbuilt quickly if not careful, insulating the surface	Check WFT early and often, especially with larger tips
Product suitability is not universal	Different products respond differently to thinners and setup logic	Use validated setup data before making a recommendation

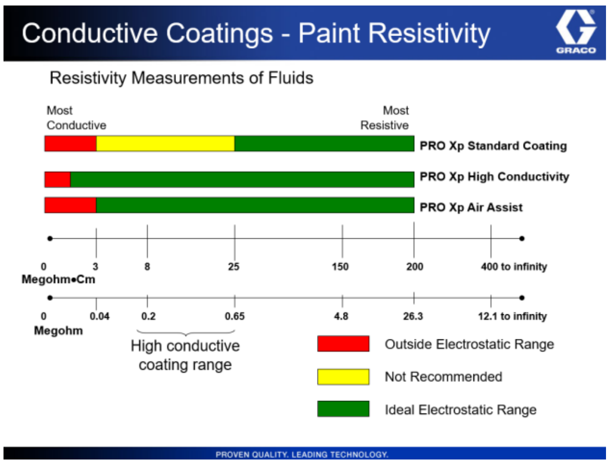
4. Paint Resistivity and Megaohm Meter Use

Paint resistivity is a practical indicator of how readily the fluid system accepts and retains charge. For the Dulux electrostatic evaluation program, an ideal value of approximately 100–200 megaohms centimeter squared (CMS) was used as the starting point for tuning, with readings within the broader “green zone” often still producing workable results.

The key lesson from the program is that the meter must be treated as a guide rather than as an absolute pass/fail tool. Some coatings delivered successful wrap outside the ideal range, while others could not be brought into a more favourable electrical space even after thinner changes. Formulation chemistry, pigment type, and solvent-polymer interaction all affect how the coating responds.

Conventional Megaohm Meter Face

Electronic Megaohm Meter



Side provided by Graco HQ Tech

4.1 Measured Thinner Resistivity Values Used During the Program

Thinner / Solvent	Approx. Resistivity Observed
CR Reducer	Approx. 500 MΩ
Dulux Urethane Thinner	Approx. 43 MΩ
Duthin 799	Approx. 80 MΩ
Dulux Epoxy Thinner	Approx. 300 MΩ
Duthin 115	Approx. 60 MΩ
Duthin 340	Approx. 700 MΩ
Duthin 511	Approx. 5 MΩ
MEK	Approx. 5 MΩ

Note: A thinner's measured resistivity does not guarantee that it will move a given coating in the expected direction. During these trials, some thinners changed a product's viscosity while barely affecting the paint resistivity value; others strongly shifted the resistivity but did not always provide the best finish or wrap.

5. Viscosity, Atomisation and Droplet Behaviour

Viscosity emerged as a very influential success variable in the entire evaluation program. High viscosity promotes large droplet size, coarse atomisation, and higher momentum, which reduced the ability of the electrostatic field to redirect droplets toward edges and reverse faces. By contrast, tuned viscosity supports finer atomisation and creates droplets that spend longer within the influence of the electrical field.

This is why several products that were electrically plausible still performed poorly when initially trialed due to excessive viscosity, and why small thinning adjustments with the right matched thinner could transform an application outcome even where resistivity barely changed. The practical field rule is simple: if the coating will not atomise cleanly, it will not wrap cleanly.

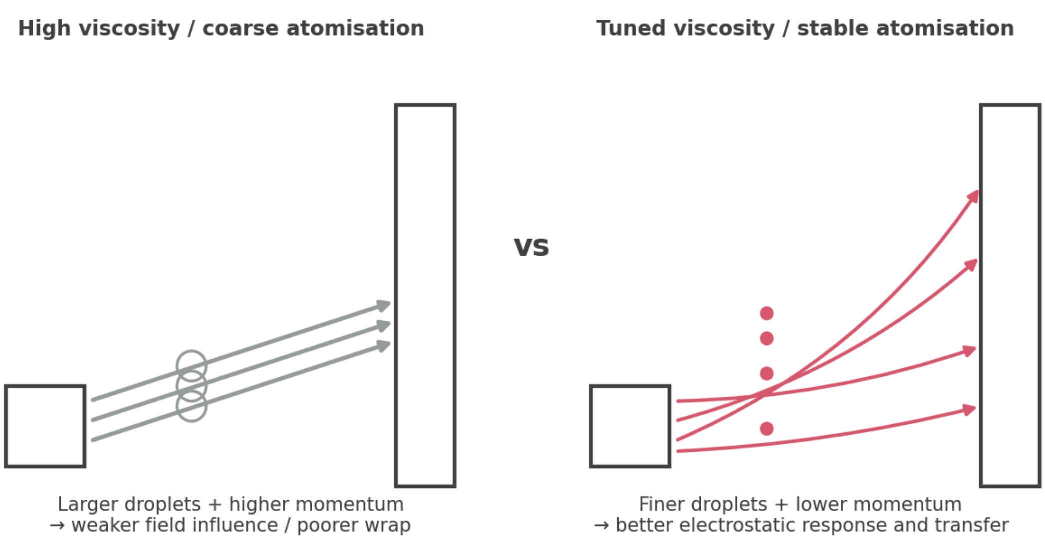


Figure 2. Conceptual link between viscosity, droplet size, momentum and electrostatic response.

Protection you can count on.

6. Faraday Cage Effect and Geometric Limitations

Recesses, internal corners, and deep geometries can exhibit Faraday cage behaviour, where the electric field concentrates on exposed edges and does not effectively penetrate into the most sheltered sections. In application terms, edges can receive excess coating while internal corners & surfaces remain thin.

This evaluation program indirectly addressed the effect through technique: circular motion, lower output, and round tips softened the spray pattern and improved deposition balance. Although electrostatics can improve wrap on complex shapes, it does not eliminate geometric limitations. Applicators will need to adjust in these areas including items such as adjusting spray gun settings (Example – lowering spray gun kV output), manage air/material pressures, build coverage in light passes, precoat these areas, and/or verify recessed zones rather than assuming the field will reach every edge equally.

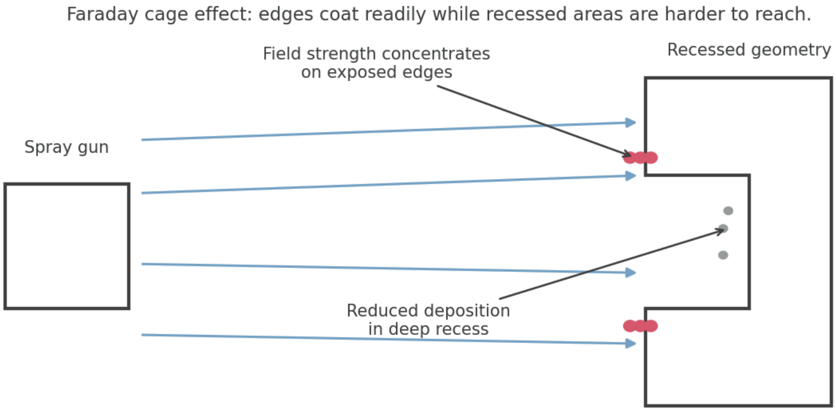


Figure 3. Faraday cage effect on recessed geometries; exposed edges attract coating more readily than deep recesses.

7. Equipment Platform, Spray Tips and Pressure Windows

The evaluations performed used the following set up - Graco Merkur 30:1 air-assisted airless electrostatic package with the Pro Xp85 kV air spray electrostatic spray gun, electrostatic lines, suitable grounding cables, hopper kit, a 100-mesh fluid filter, and a round spray conversion kit. The biggest single equipment lesson from these evaluations is that round tips should be treated as standard for electrostatic work. In practical terms, the round tip increases field residence time, reduces directional "throw," and helps build a more uniform envelope around the target item. The structure will many times however dictate if a round tip or a flat tip is the better set up. Example where a flat tip may make more sense is on flat plate.

Product	Preferred Graco Tip(s)	Technical Comment
Metalshield HB ZP	236840	Full range is workable; 236840 preferred on balance due to better control and wrap.
Congard 878 / 321	236840 or 236842	Both tips provided strong wrap; Duthin 511 gave the best finish.
Luxepoxy 4 White Primer	236838, 236839, 236840	236842 delivered excessive output and increased sag resistance risk.
Luxathane HPX	236842	236840 usable if needed; 236838 was found to be too small a size.
Luxathane DTM	236839	This round tip size was found key to film control within PDS range.
Durepon EZP	236842	Provided the most favourable spray pattern.
Duremax GPE ZP	236842	Needed output and atomisation suitable for thicker product.
Weathermax HBR	236842	Best combination of atomisation and transfer in final method.

8. Process Control and Environmental Factors

The electrostatic setup should be viewed as part of a carefully balanced holistic system for a successful outcome. Material pressure controls flow and momentum. Atomising air controls droplet break-up. Voltage establishes the charging field.
Together, these variables must be balanced. Excess pressure can overpower the electrical attraction and reduce wrap; insufficient pressure can cause poor atomization and rough finish.

Air movement where spraying also matters. During successful trials, booth draw was reduced or turned off during application and then restored during cure/flash-off. This significantly improved wrap by reducing external airflow forces that would otherwise distort the charged droplet path. Any deviation from normal booth operation must, however, remain aligned with site-specific health, safety, & environmental requirements.

Another essential control is wet film thickness. Because electrostatic attraction can continue depositing material efficiently even on edges with no visible initial tendency to sag, overbuild can occur quickly. Applicators must therefore check WFT early and often, particularly with products capable of high film build or with larger-output tips. If not checked, the end result could be loss of sag resistance and/or insulation to attraction of a finish coat.

9. Product-Specific Engineering Recommendations

Product	Starting MΩ	Recommended Thinner / %	Pressure Window (Material / Air)	Application Notes	Status
Metalshield HB ZP	270	Duthin 511 @ 15%	600–800 PSI / 60–70 PSI	Uniform four-sided wrap. Viscosity suitable across tested range.	Validated
Congard 878 (old)	450	Duthin 511 @ 15% (or Urethane Thinner @ 15%)	600–800 / 60–70	Both worked; Duthin 511 gave better finish and wrap.	Validated
Congard 321 (current)	600	Duthin 511 @ 10–15% or Urethane Thinner @ 10%	1000–1300 / 50–60	Both worked; Duthin 511 gave better finish and wrap	Validated
Luxepoxy 4 White Primer	25	CR Reducer @ 10% (practical option tested)	1000–1300 / 55–65	Apply in two back-to-back light coats to avoid runs.	Validated
Luxathane HPX	35	CR Reducer @ 3%	1500–1800 / 50–60	Small thinning change materially improved finish and wrap.	Validated
Luxathane DTM	25 to 40	CR Reducer @ 10%	1200–1500 / 60–70	Critical product for WFT control; smaller tip resolves overbuild risk.	Validated
Durepon EZP	200	MEK @ 5%	1200–1450 / 55–65	Re-evaluation converted earlier negative result to positive outcome.	Validated
Durepon GP ZP	200	CR Reducer @ 15%	2000–2500 / 60–70	Viscosity was the key gating issue; not resistivity alone.	Validated
Weathermax HBR	500	Duthin 511 @ up to 15%; Part C critical to final mix response	1600–2000 / 55–65	Initial failure overcome during October re-evaluation.	Validated
Durebild STE	30	Multiple thinners tried at various %	N/A	Not ideal for this application method.	Not validated

Note: Several products only became consistently viable after the initial evaluations moved away from a “find the ideal megaohm value” mindset and instead tuned viscosity, tip geometry, and spray technique as the priority controls.

10. Sales and Application Decision Rules

1. Sell electrostatic application as a controlled process solution, not as a blanket efficiency promise.
2. Confirm that the substrate is conductive and can be properly grounded before discussing wrap or transfer gains.
3. For validated products, start with the proven thinner, thinner level, round tip, and pressure window rather than developing a new method from scratch.
4. Treat the megaohm meter as a setup aid. If the meter is favourable but spray quality is poor, correct viscosity and atomization first. However, to be clear – Do not overthin the product to be sprayed as other film defect issues may arise.
5. Where geometry includes deep recesses or internal corners, build in light passes and verify coverage because the Faraday effect can still limit deposition.
6. Escalate unvalidated products, non-standard thinner combinations, or unusual site conditions to Technical Services for review and verification before commitment.

11. Troubleshooting and Corrective Actions

Most field problems encountered with electrostatic application can be traced back to one of five issues:

- Ineffective grounding
- Incorrect tip or pressure setup
- Excessive airflow
- Unrealistic expectations for geometric wrap.

The flowchart and tables on the pages that follow provides a practical sequence for diagnosis and corrective actions.

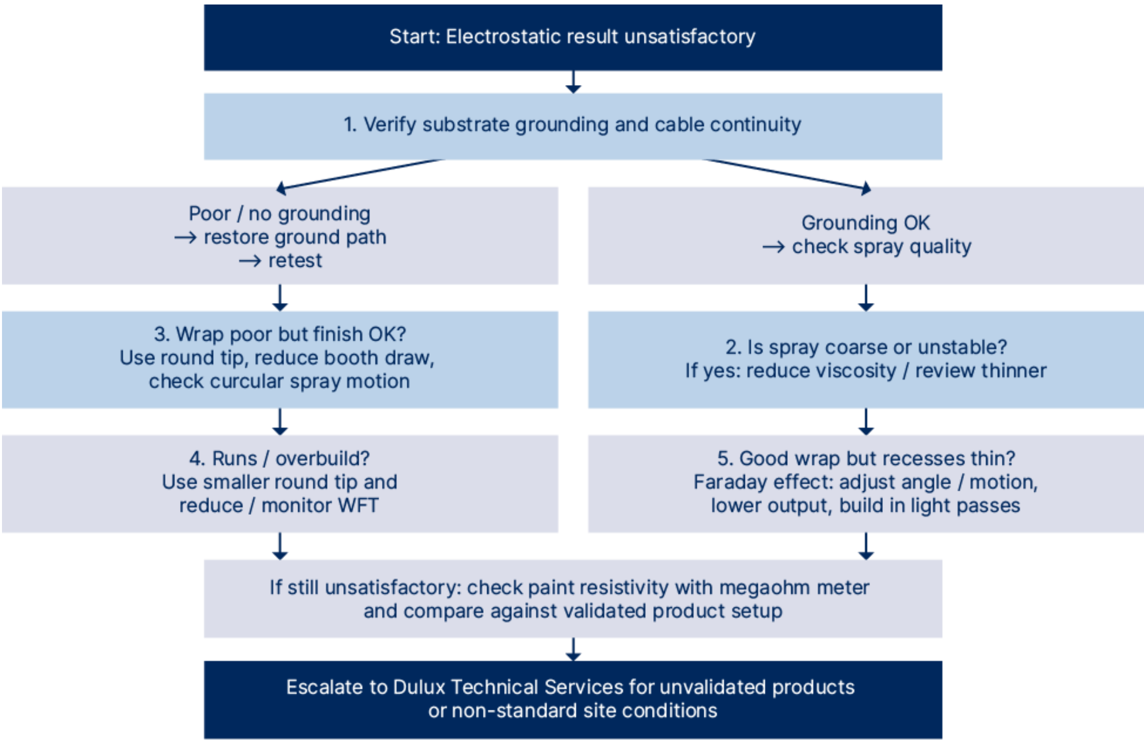


Figure 4. Troubleshooting flowchart for poor wrap, coarse finish, overbuild, and geometry-related shortfalls

Flow Chart Steps Explained

Step 1 – Is the metal grounded?

- If yes, go to Step 2.
- If no, fix grounding before moving forward.

Step 2 – How does the atomization look?

- If fine/even spray, go to Step 3.
- If coarse/spitting/unstable – thin slightly w/ appropriate thinner to reduce viscosity.

Step 3 – Are you getting good wrap (around edges)

- If yes, go to Step 4
- If no, check tip size/type, reduce fluid output, ensure airflow is correct, and/or use stead circular motion w/ spray gun.

Step 4 – Is the WFT going on too heavy?

- If yes, (lost sag resistance, insulation of substrate) – reduce fluid flow and increase speed of movement across the surfaces to be painted.
- If no, go to Step 5

Step 5 – Faraday cage issues? (Low film build in recessed areas)

- Apply light coats in multiple passes in the specific area to achieve WFT. This may require a non-electrostatic application in these areas.
- Adjust spray angle and distance to targeted area

Observed Issue	Most Likely Cause(s)	Corrective Action
Poor or no wrap	Poor grounding; flat tip; excessive booth draw; spray momentum too high	Restore ground path; change to round tip; reduce airflow where safe; reduce output and refine technique
Coarse finish	Viscosity too high; poor atomisation; undersized tip	Reduce viscosity with validated thinner and re-check air/material balance
Runs or silent overbuild	Tip output too high; WFT not monitored; electrostatic attraction increasing local deposition	Use smaller round tip; reduce flow; measure WFT early and often
Recesses remain thin	Faraday effect; incorrect gun angle; too much output in a single pass	Use circular motion, lighter passes, and verify recess coverage
Meter value seems acceptable but result is still poor	Spray quality/viscosity issue outweighing electrical advantage	Treat resistivity as secondary to atomisation; correct spray quality first
Earlier "not suitable" result on a product	Initial trial used non-optimised thinner/tip/technique	Re-evaluate using proven setup logic before ruling out product

12. Quick Reference Matrices

12.1 Quick Go / Caution / Escalate Matrix

Question	Yes	No	Action
Is the substrate conductive and groundable?	Proceed	Stop	No ground path = no credible electrostatic case
Is the product internally validated?	Proceed using proven setup	Escalate	Seek Technical Services input for non-validated products
Is a round tip available?	Preferred	Caution	Convert to round spray tip where needed.
Can airflow be managed safely?	Proceed	Caution	Strong airflow may compromise wrap
Can WFT be monitored during application?	Proceed	Stop	Electrostatic overbuild risk must be controlled

12.1 Quick Go / Caution / Escalate Matrix

Control Priority	Variable	Why It Matters
1	Grounding	Without effective grounding (pump, spray gun, and painter) there is no useful electrostatic field at the target.
2	Viscosity / atomisation	If the coating atomises coarsely, electrostatic attraction cannot compensate.
3	Round spray tip	Strongest equipment-related improvement in wrap and deposition uniformity.
4	Pressure balance	Excess momentum reduces field influence; poor atomisation reduces finish quality.
5	Paint resistivity	Useful tuning tool, but not the sole predictor of success.
6	Booth airflow / technique	Affects whether droplets remain within the field long enough to wrap.

Final Thoughts

The material application evaluation work performed showed that electrostatic application should be understood as a collectively tuned system rather than a single equipment feature. Product chemistry, thinner type, thinner percentage, tip geometry, pressure settings, booth airflow, and operator motion must all align to achieve strong, repeatable results. With this in mind, it is advisable to have systems vetted out by Technical Services before proceeding, especially if the job is a sizeable one.