Electroplating Items with Blind Holes

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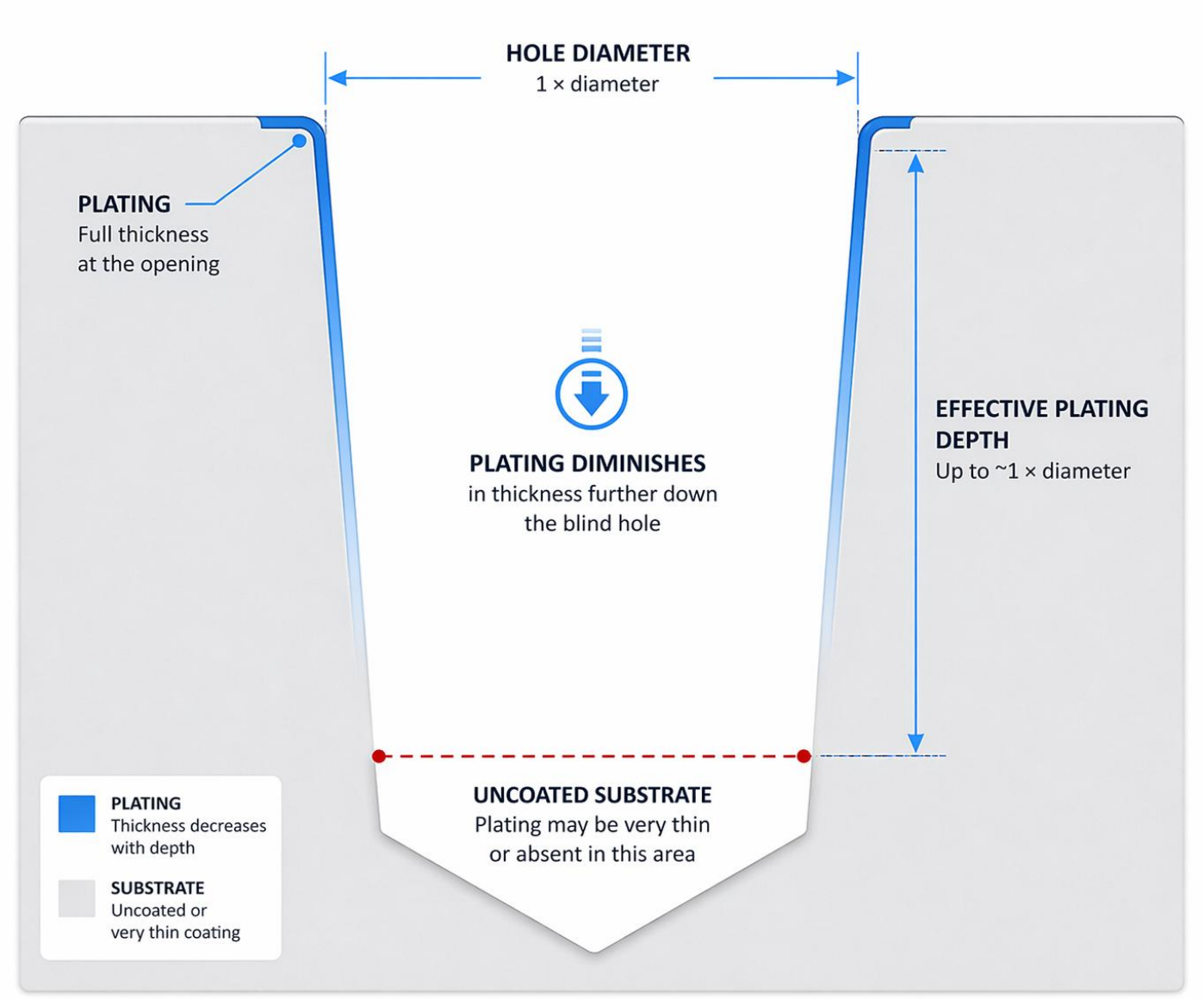
Introduction

A blind hole may be either threaded or unthreaded, but in both cases it introduces complexity when parts are electroplated. Unlike open features, blind holes restrict current flow and solution exchange, making consistent coating difficult to achieve. When components containing blind holes are chemically treated, particularly on non-corrosion-resistant steels or aluminium alloys, several important considerations must be addressed by both the design engineer and the electroplater. While this brief focuses on zinc electroplating, similar behaviours and risks apply to other surface treatments such as anodising and conversion coatings.

Limitations of Electroplating in Blind Holes

Electroplating is governed by current density distribution and the throwing power of the electrolyte. In recessed features such as blind holes, both are significantly reduced.



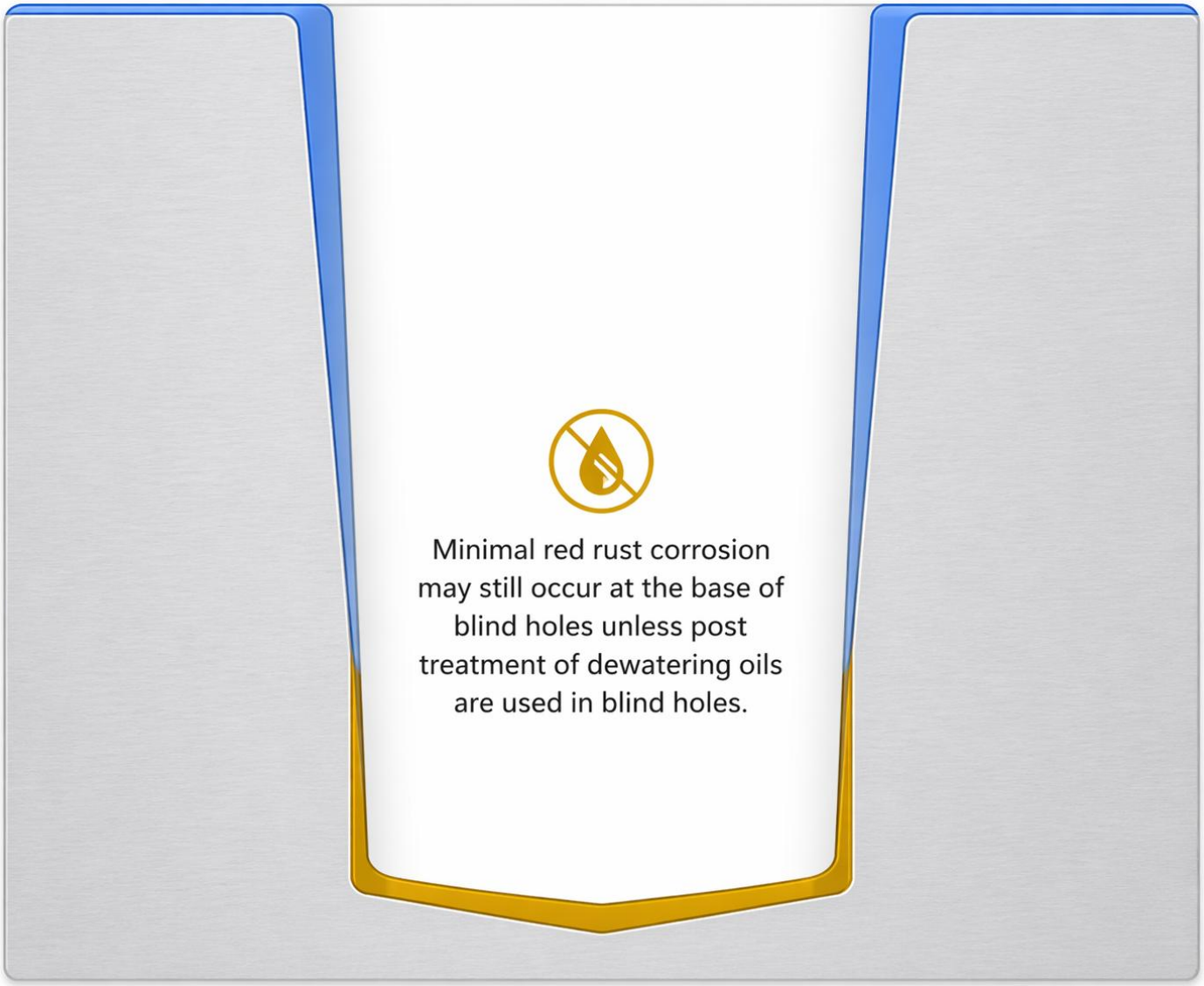
As a general rule, effective plating coverage within a blind hole is limited to a depth approximately equal to the hole diameter. Beyond this depth, coating thickness reduces rapidly and may become negligible.

This limitation occurs due to several factors:

- Reduced current density deeper into the hole due to shielding effects
- Restricted electrolyte movement, limiting ion replenishment
- Gas entrapment, such as hydrogen evolution, which blocks active surfaces

- Inadequate rinsing between process stages, particularly between alkaline cleaning and acid treatment causing precipitation reaction leading to obstruction

As a result, uncoated or very thinly coated substrate is often present at the base of deeper blind holes.



Without appropriate post-treatment, such as the application of a dewatering oil, there is a high likelihood of red rust forming on steel, (or other corrosion reactions occurring on different metal substrates) within these unprotected internal surfaces.

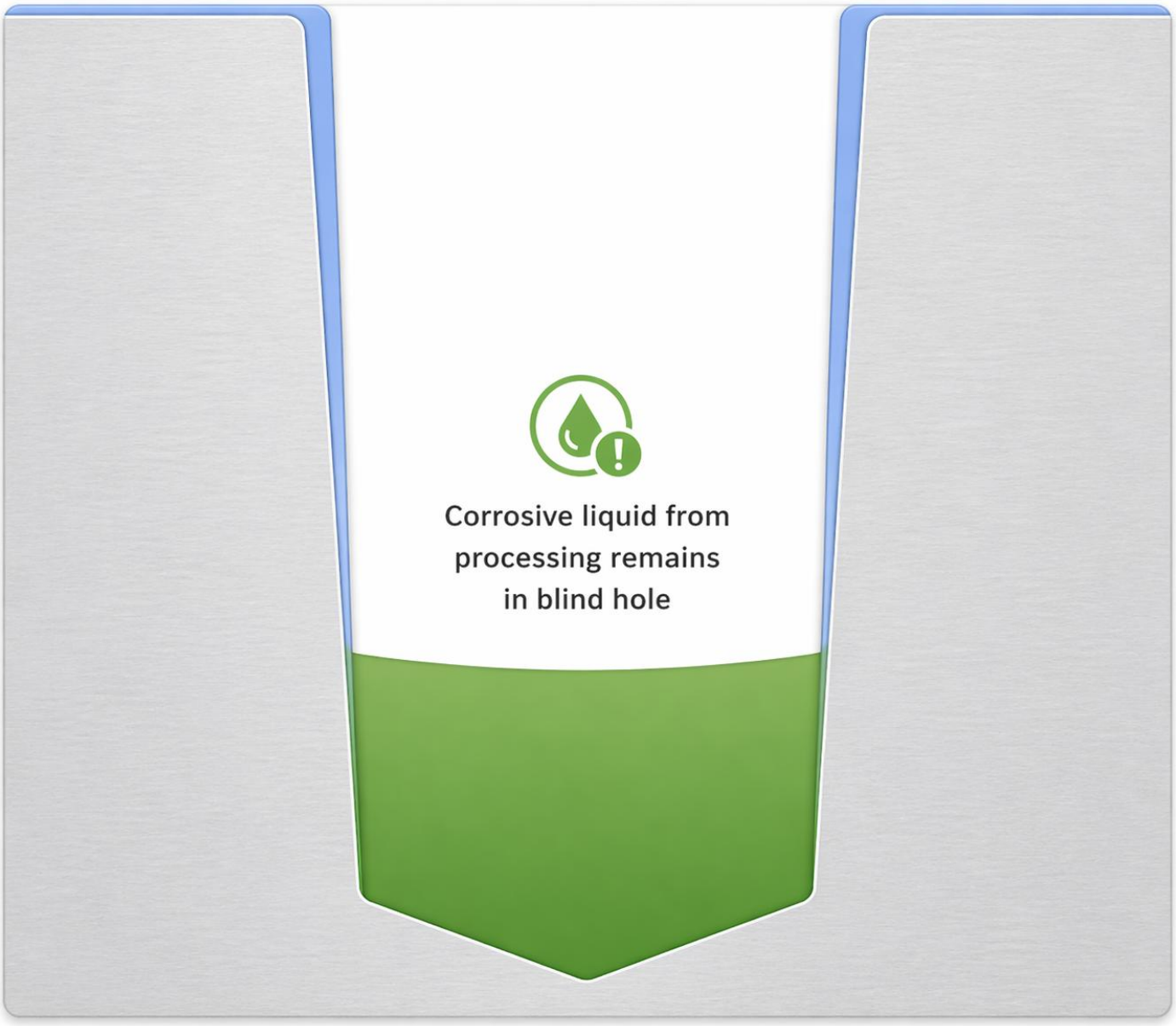
Frequent Problems with Electroplating Blind Holes

A common issue arises when blind holes are processed without sufficient attention to rinsing and solution exchange.

During processing, components are exposed to multiple chemical stages, including:

- Alkaline cleaning
- Acid pickling or activation
- Electroplating solutions
- Passivation treatments

Blind holes can trap these process solutions if rinsing is inadequate. When incompatible chemistries, such as acids and alkalis, become trapped together, they can react to form precipitates. This can create a thick residue within the hole that may not be visible during inspection.

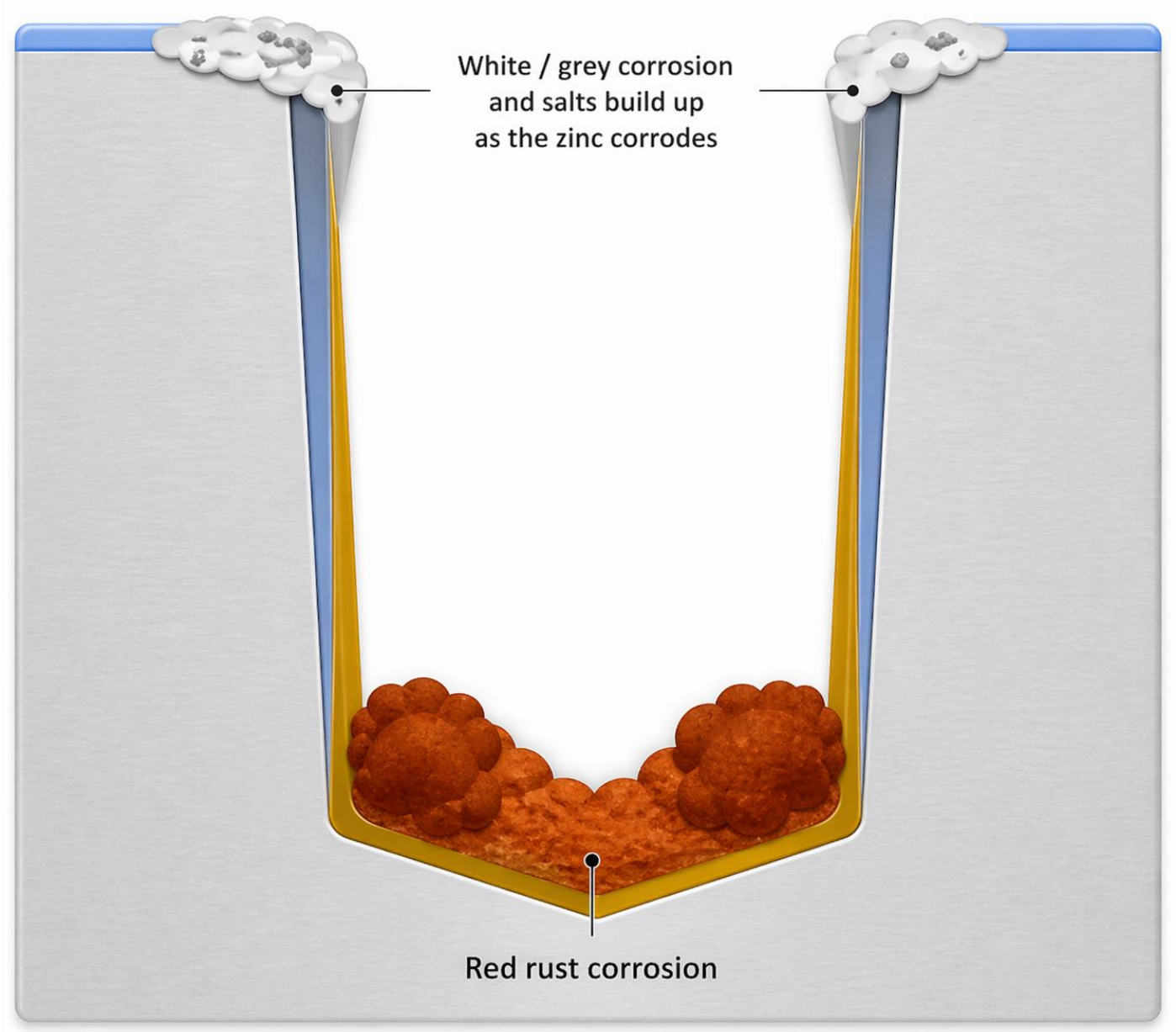


Over time, this trapped residue can:

- Continue reacting chemically and remain corrosive
- Expand or migrate out of the hole
- Damage the zinc coating

This often results in:

- White rust, appearing as white or grey powder
- Dark staining or discolouration
- Blackened or stained threads (trapped chemistry)
- Fluffy or powdery deposits
- Rust bleeding out of holes



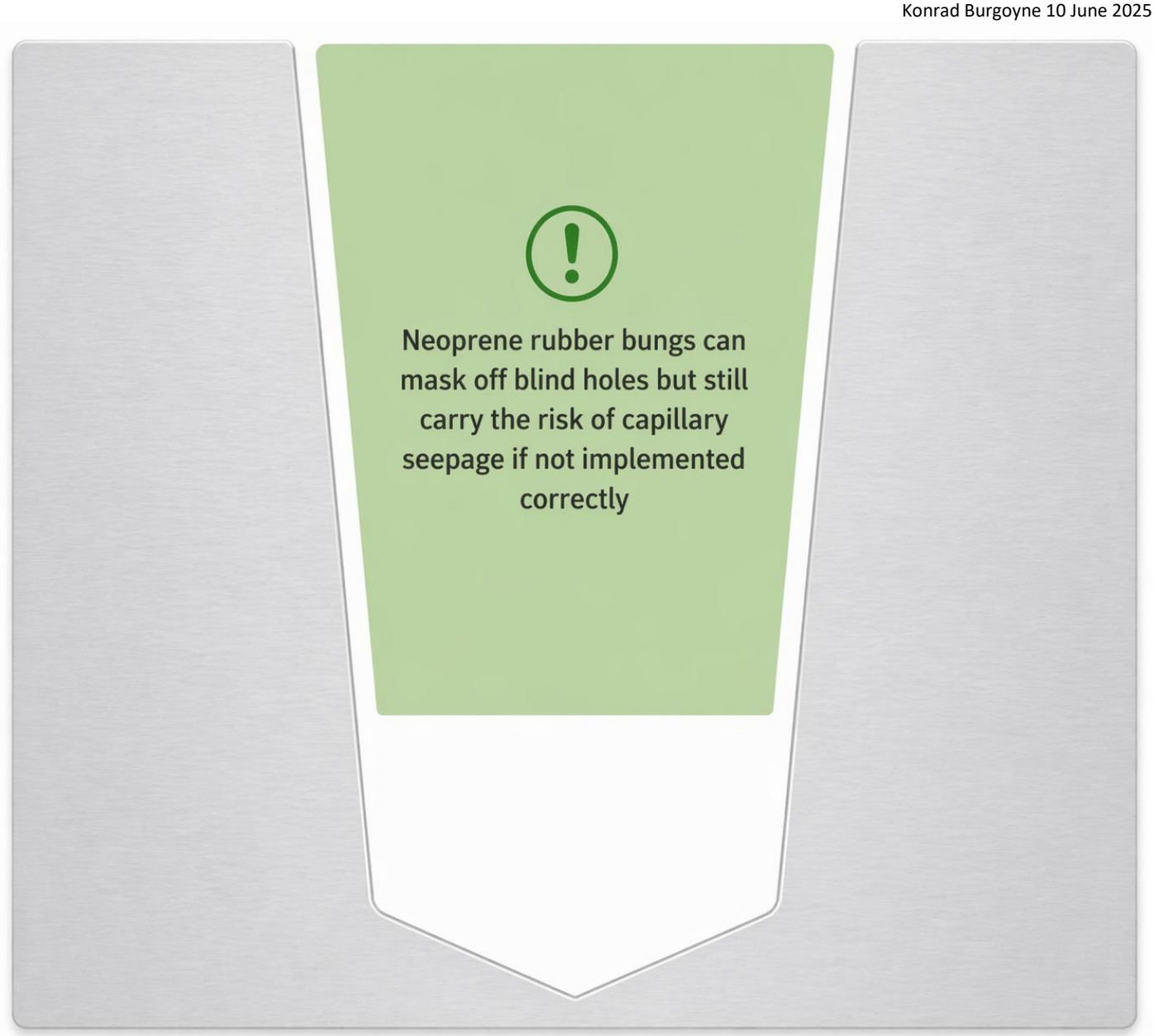
This condition is unacceptable, particularly for functional components such as fasteners, where corrosion can compromise performance and service life.

Preventive Actions

Design Considerations

The most effective control starts at the design stage. Design engineers should be aware of coating limitations and associated risks, and take these into account by considering:

- Avoiding blind holes where possible
- Increasing the hole diameter relative to depth if possible
- Specifying blind hole shall be free from corrosion and other foreign objects.
- Specifying post-treatment requirements such as dewatering oil
- Considering masking solutions such as neoprene plugs where appropriate



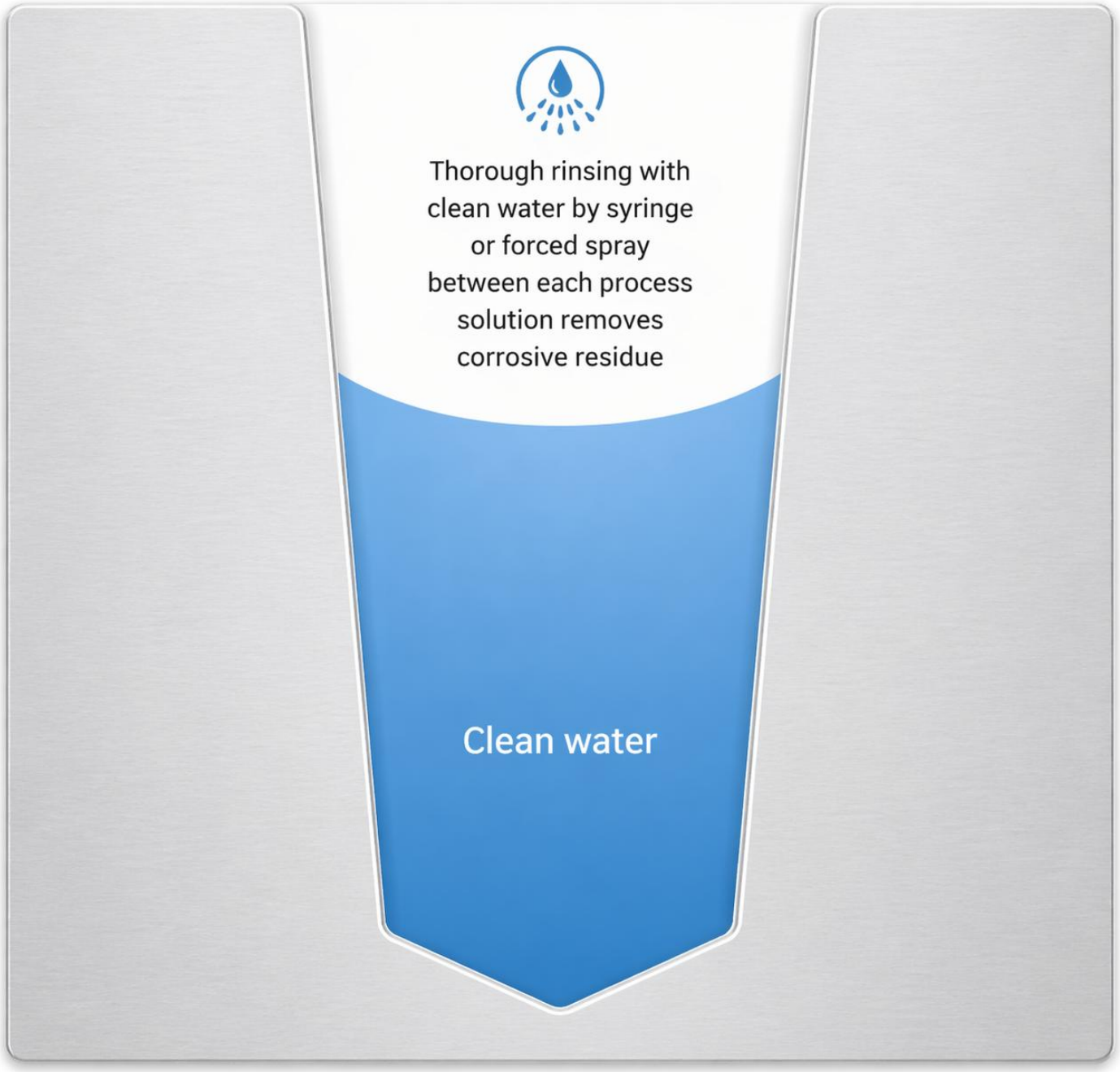
Masking can be effective in some cases but carries a risk of failure if not properly controlled.

Electroplater Responsibilities

The electroplater should identify blind holes during contract review and ensure appropriate process controls are in place. This includes:

- Orientating parts to promote drainage
- Using targeted rinsing techniques such as spray rinsing or pressure flushing
- Manually clearing holes where required
- Ensuring sufficient rinse times between all process stages (1 minute rinse rule)
- Applying post-treatment where specified
- Repair of Problematic Blind Holes

Where issues are identified after processing, repair options must be considered carefully.



Stripping and replating may:

- Reintroduce the same issue if geometry remains unchanged
- Introduce additional risks, particularly for high-strength steels

Localised repair may be possible in less severe cases. This can include:

- Removing residue from the hole
- Thorough drying
- Application of dewatering oil or a corrosion inhibitor

The success of this approach depends on accessibility and the extent of the issue.

Best Practice Recommendations

A proactive approach is essential. Key recommendations include:

- Clearly identifying blind holes on drawings and specifications
- Specifying any required post-treatment such as dewatering oil
- Ensuring process control documentation includes adequate rinsing at each stage
- Promoting collaboration between design and processing teams

If further finishing operations such as painting are applied, the sequence must be defined so that any required internal corrosion protection is applied at the correct stage.