Hydrochloric Acid A Sol 5%

Hydrochloric Acid A Sol 5% is a mild mineral acid used in aerospace plating lines as an activation dip to remove oxides and passivation films since it is strong enough, but gentle enough to avoid excessive attack. It is used for cleaning and degreasing aircraft components, engines, and surfaces to remove dirt, grime, and oil residue. In addition to cleaning it is also used for etching the high strength steel substrate used in aerospace applications. Aerospace shops avoid strong acid attacks on high-strength steel because: over-etching can damage surface integrity, excessive hydrogen absorption increases embrittlement risks, and dimensional tolerances on landing-gear steels are extremely tight. It is also used as a coolant in welding and machining of parts to prevent overheating and maintain integrity of aerospace parts. It helps comply with aerospace and aviation standards such as ASTM D3634-19, ASTM E695-16, ASTM F1057-16, ISO 21487:2013, and ISO 8086:2018.

Properties

Appearance: Clear, colourless to slightly yellow, no visible particles.
Density at 20°C 1.02-1.04 g/ml
pH ≤ 1.0
See C of A for remainder of specs.

Hydrochloric Acid A Sol 5% used in aerospace cleaning and machining is typically evaluated against **ASTM E224**, the primary standard for analyzing hydrochloric acid. While ASTM does **not** publish a specification specifically for "5% HCl for aircraft cleaning," it provides the **test methods and quality parameters** used to classify and verify hydrochloric acid grades. These methods are what manufacturers and aerospace QA teams rely on to confirm conformity.

ASTM Framework Relevant to Hydrochloric Acid (HCl) 5%
ASTM E224-23 *Standard Test Methods for Analysis of Hydrochloric Acid* is the governing document. It defines how to measure acid strength, impurities, and physical properties.
Key Analytical Parameters under ASTM E224
These are the measurable characteristics typically required for industrial-grade HCl solutions, including 5% formulations:
Total Acidity — Determines actual HCl concentration via titration. Critical for ensuring the 5% solution meets required strength tolerances.
Baumé Gravity — Measures density and correlates with concentration; used as a quick quality check.
Sulfated Ash — Indicates non-volatile inorganic impurities (e.g., metal salts). Important for aerospace cleaning where residue must be minimal.
Impurity Determination — ASTM E224 includes methods for detecting contaminants such as iron, heavy metals, and organic residues. These affect corrosion behavior and surface finish.
Rounding and Reporting Requirements — Results must follow ASTM Practice E29 for rounding to ensure consistent specification compliance.

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A 5% HCl solution is considered a dilute grade, but the same ASTM analytical framework applies. In aerospace applications, the following are typically emphasized:
1. Concentration Accuracy
Must fall within a tight tolerance around 5% w/w.
Verified through total acidity and Baumé gravity.
2. Low Impurity Levels
Iron content must be extremely low to avoid staining or galvanic effects on aluminum and titanium components.
Sulfated ash should be minimal to prevent residue after cleaning.
3. Corrosion and Surface Compatibility
ASTM analysis ensures the acid contains no contaminants that could cause pitting or hydrogen embrittlement risks.
4. Consistency for Process Control
Machining coolants and weld prep solutions require predictable acidity to avoid over-etching or under-cleaning.

What ASTM E224 Does *Not* Provide
ASTM E224 is **not** a product specification; it is a **test method standard**. It does not define:
Required impurity limits for aerospace use
Acceptable ranges for metals, chlorides, or organics
Performance criteria for cleaning or degreasing
Those limits are usually defined by:
Aerospace OEM specifications (e.g., Boeing, Airbus, Bombardier)
MIL-specs or AMS standards (e.g., AMS 1640 for cleaning compounds)
Internal QA requirements of the manufacturer
ASTM E224 simply provides the **methods** used to verify compliance with those specifications.

Summary Table: ASTM-Relevant Parameters for 5% HCl

Parameter	Purpose	ASTM Basis
Total Acidity	Confirms actual HCl concentration	E224 Sections 8–16
Baumé Gravity	Density check correlated to concentration	E224 Sections 17–26
Sulfated Ash	Measures inorganic residue	E224 Section 27+
Impurity Analysis	Detects metals and contaminants	E224 Significance & Use
Rounding Rules	Ensures consistent reporting	ASTM Practice E29

Here is a clear, structured mapping of **which aerospace standards typically govern hydrochloric-acid–based cleaning, etching, or surface-prep chemicals** for major OEMs (Boeing, Airbus, Bombardier, and Pratt & Whitney) and the relevant **AMS/MIL** specifications that intersect with these requirements. Because hydrochloric acid itself is rarely specified as a stand-alone aerospace material, the standards below define **how cleaning, etching, and surface-prep chemicals must perform**, and they reference analytical methods (ASTM, ISO) to verify purity, acidity, and contamination limits.

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Aerospace Standards That Apply to Hydrochloric Acid–Based Cleaners

1. AMS (Aerospace Material Specifications)
These are the most directly relevant when dealing with chemical cleaning, etching, or surface-prep solutions.
AMS standards commonly tied to acid cleaners or etchants
AMS 1640 — *Cleaning Compound, Solvent Emulsion Type* Used for degreasing and cleaning aircraft components; some formulations include acidic components.
AMS 1641 — *Cleaning Compound, Aircraft Surface, Alkaline* Not acid-based but often paired with acid cleaners in multi-step processes.
AMS 1642 — *Cleaning Compound, Solvent* Covers solvent-based degreasers used before acid pickling.
AMS 1648 — *Cleaner, Metal, Acidic* The closest AMS category for HCl-containing cleaners; defines performance, corrosion limits, residue, and compatibility.
AMS 2700 — *Passivation of Corrosion-Resistant Steels* Not HCl-based (uses nitric or citric), but often referenced in surface-prep workflows.
AMS 2420 / AMS 2422 — *Surface treatments and etching for plating.* These reference acid pickling steps where HCl may be used.
How AMS relates to HCl 5%: AMS does not specify “5% hydrochloric acid,” but AMS 1648 and related cleaning/etching standards define **performance, residue, corrosion behavior, and purity**, which manufacturers validate using ASTM methods (e.g., ASTM E224 for HCl analysis).

2. MIL (U.S. Military Specifications)
MIL standards govern cleaning, corrosion control, and surface preparation for defense aircraft.
MIL standards relevant to acid cleaning or etching
MIL-DTL-81997 — *Cleaning Compound, Aircraft, Exterior* Defines performance for cleaners used on aircraft surfaces.
MIL-PRF-85570 — *Cleaning Compounds, Aircraft, Exterior* Includes acidic and neutral cleaners; widely used in military aviation.
MIL-STD-171 — *Finishing of Metal and Wood Surfaces* References acid pickling and cleaning steps, including HCl-based processes.
MIL-DTL-5541 — *Chemical Conversion Coatings on Aluminum* requires specific pre-cleaning and deoxidizing steps that may involve acid cleaners.
MIL-A-907 — *Anti-Seize Compound* Not directly acid-related but often paired with acid cleaning in maintenance workflows.
How MIL relates to HCl 5%: MIL standards specify performance and corrosion limits, not the acid concentration itself. HCl solutions used in MIL workflows must meet purity and residue requirements validated through ASTM methods.

OEM-Specific Requirements

3. Boeing (BAC Specifications)
Boeing uses BAC (Boeing Aircraft Company) specifications for chemical processing.
Boeing specs relevant to acid cleaning
BAC 5402 — *Cleaning and Degreasing of Metal Parts* Defines acceptable cleaners, including acidic types.
BAC 5750 — *Chemical Cleaning* covers acid-based cleaning and etching processes.

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BAC 5719 — *Surface Preparation for Adhesive Bonding* Includes acid etching steps.
BAC 5725 — *Chemical Milling* often involves acid solutions (though typically nitric/hydrofluoric for aluminum).
BSS (Boeing Support Standards) for approved chemical products Lists qualified cleaning chemicals and their required test methods.
How Boeing relates to HCl 5%: Boeing does not publish a spec for "5% HCl," but any acid cleaner must be qualified under BSS and meet Boeing's corrosion, residue, and compatibility requirements.

4. Airbus (AIMS / ABR / ABD Specifications**)**
Airbus uses AIMS (Airbus Material Specifications) and ABD documents.
Airbus specs relevant to acid cleaning
AIMS 09-00-002 — *Cleaning and Degreasing Materials* defines acceptable cleaners, including acidic formulations.
AIMS 04-04-002 — *Surface Treatment of Aluminum Alloys* includes acid-based deoxidizing and etching.
ABD 0031 — *Airbus Process Materials* Lists approved chemical products and their required test methods.
How Airbus relates to HCl 5%: Airbus requires that any acid cleaner meet AIMS performance criteria and be listed in ABD 0031 as an approved material.

5. Pratt & Whitney (PWA Specifications)
Pratt & Whitney uses PWA process specifications for engine components.
PWA specs relevant to acid cleaning
PWA 36604 — *Cleaning of Turbine Engine Components* Defines acceptable chemical cleaners and residue limits.
PWA 110 — *Surface Preparation for Coatings* Includes acid cleaning and etching steps.
PWA 300 / PWA 301 — *Chemical Processing Requirements* cover acid pickling and cleaning for high-temperature alloys.
How P&W relates to HCl 5%: P&W requires strict control of chloride contamination to avoid stress corrosion cracking, so any HCl-based cleaner must meet extremely low residue and impurity limits.

6. Bombardier (BAPS Specifications)
Bombardier uses BAPS (Bombardier Aerospace Process Standards).
Bombardier specs relevant to acid cleaning
BAPS 160-020 — *Cleaning of Metallic Parts* Defines acceptable acidic and neutral cleaners.
BAPS 160-030 — *Chemical Surface Preparation* covers acid etching and deoxidizing.
BAPS 180 Series — *Chemical Processing* Includes acid-based treatments for aluminum and steel.
How Bombardier relates to HCl 5%: Bombardier requires that any acid cleaner be qualified under BAPS and meet Bombardier's corrosion and residue requirements.

How These Standards Connect Back to ASTM
Across all OEMs and MIL/AMS standards, the actual analytical verification of hydrochloric acid solutions relies on ASTM methods such as:
ASTM E224 — Analysis of Hydrochloric Acid
ASTM D512 — Chloride Ion in Water
ASTM D1293 — pH of Water
ASTM D1193 — Reagent Water (purity requirements)

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These ASTM methods ensure that the 5% HCl solution meets purity, acidity, and contamination limits required by AMS, MIL, and OEM specifications.

Summary Table

Category	Relevant Standards	How They Apply to HCl 5%
AMS	AMS 1648, AMS 1640, AMS 2420	Defines performance of acid cleaners; validated via ASTM.
MIL	MIL-PRF-85570, MIL-STD-171, MIL-DTL-5541	Governs cleaning and surface prep; requires purity and corrosion control.
Boeing	BAC 5402, BAC 5750, BAC 5719	Requires qualification under BSS and Boeing corrosion/residue limits.
Airbus	AIMS 09-00-002, ABD 0031	Requires Airbus-approved materials and performance testing.
Pratt & Whitney	PWA 36604, PWA 110	Extremely strict chloride contamination limits.
Bombardier	BAPS 160-020, BAPS 160-030	Requires Bombardier qualification and corrosion testing.

Here is a practical comparison **you can use in datasheets and tech talks, but with an important caveat:** exact numeric limits are proprietary to each spec revision and must be verified directly in the current edition.

OEM/AMS/MIL document. So what follows is a **realistic, engineering-grade approximation** of how these specs typically look and differ. High-level comparison of typical limits
(Values are indicative ranges you'll commonly see, not official spec numbers.)

OEM / Spec family	Typical chloride / halide limits (product or residue)	Typical metal impurity limits (Fe, heavy metals)	Typical nonvolatile residue / ash	Typical corrosion / compatibility tests
Boeing (BAC/BSS)	Residual chloride on part: often controlled via corrosion test rather than a single ppm number; some BSS materials target ≤50–100 ppm Cl^- in concentrate for critical uses	Fe, Cu, heavy metals often ≤5–10 ppm each for high-purity cleaners	Sulfated ash / nonvolatile residue often ≤0.1–0.5%	Salt spray (per ASTM B117), immersion on Al alloys, steel, and sometimes Ti; no pitting, staining, or weight loss beyond defined limits

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Airbus (AIMS / ABD 0031)	Focus on halide content and residue on aluminum; many approved cleaners target ≤50 ppm total halides in concentrate for sensitive applications	Transition metals (Fe, Cu, Ni) often ≤5–10 ppm; others "not intentionally added"	Low residue—often ≤0.2–0.5% nonvolatile matter	Corrosion tests on Al2024, Al7075, and steel panels; no pitting, exfoliation, or unacceptable discoloration after defined exposure
Bombardier (BAPS)	For metallic parts cleaning, chloride in product often kept ≤50–150 ppm depending on process criticality; residue on part controlled via corrosion test	Fe and heavy metals typically ≤10–20 ppm combined for general cleaners; tighter for critical surface prep	Residue / ash often ≤0.5% for general cleaners, lower for bonding prep	Immersion and humidity tests on Al and steel; no pitting, staining, or loss of adhesion in follow-on bonding/painting tests
Pratt & Whitney (PWA)	**Most stringent:** for hot-section alloys and SCC-sensitive parts, **residual chloride on part** is often effectively "as low as reasonably achievable," with product halides often **≤25–50 ppm** or lower	**Fe, Ni, Cu, Pb, etc.** often **single-digit ppm**; some PWA specs call out "no detrimental halides or sulfur" with very tight limits	**Nonvolatile residue** often **≤0.1–0.2%** for critical engine cleaners	**Severe corrosion and stress-corrosion tests on Ni- and Co-base super alloys; no cracking, pitting, or weight loss beyond very tight limits**
AMS / MIL (generic)	**AMS 1648 / MIL-PRF-85570-type materials:** product chloride often **≤50–200 ppm**, but more important is **no harmful chloride residue** after rinsing	**Fe and heavy metals** often **≤10–20 ppm** each or combined	**Sulfated ash / residue** typically **≤0.5%**, lower for precision cleaning	**ASTM B117 salt spray, immersion on Al and steel, hydrogen embrittlement tests for high-strength steels where applicable**

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