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White Paper

Environment, Health & Safety Concerns in the Post-Processing of Additively Manufactured Parts

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Environment, Health & Safety Concerns in the Post-Processing of Additively Manufactured Parts

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I. Introduction

As additive manufacturing (AM) adoption matures and shifts toward higher-volume production, post-processing remains one of the most challenging factors affecting scalability, cost, quality, workforce efficiency, and environmental, health & safety (EH&S) performance. With the growth of AM across aerospace, defense, medical, automotive, and industrial sectors, the focus has shifted beyond printing speed and material capability. Many organizations now recognize that a printed part is only partially complete until supports are removed, surfaces are finished, and the component is cleaned for downstream use.

The Additive Post-Processing Survey: Trends Report continues to identify post-processing as a major bottleneck as AM scales toward production, with growing attention on **safety, sustainability, and regulatory readiness.**

Post-Processing Survey: Trends Report 2026

Traditional post-processing workflows rely heavily on manual labor, hazardous chemicals, and open-air environments that introduce significant risks to operators and facilities. From operator exposure to volatile solvents to the generation of massive waste streams, conventional post-processing equipment presents a fundamental challenge to achieving safe and sustainable 3D printing at scale. While these methods may appear safe and low-cost initially, they often incur hidden costs due to safety incidents, labor intensity, inconsistent quality, and waste.

Conventional post-processing setups are commonly decentralized and labor-intensive. Operators may move parts among multiple stations for washing, rinsing, support removal, drying, and inspection. In many facilities, chemical tanks remain uncovered, ventilation is inconsistent, and material handling is repetitive.

Research has been conducted on the hazards of additive manufacturing, identifying inhalation exposure to volatile organic compounds (VOCs), exposure to harmful resins and solvents, fire/explosion risks with powders and flammable detergents, and ergonomic stress during loading/unloading and maintenance. Many articles and studies have been done with PMC, CDC, CDC/NIOSH, CCOHS, and Wayne Research detailing these risks.

Additive Manufacturing Technician Cleaning Resin Parts Using IPA

For companies scaling AM production, these risks become significant as higher throughput means more chemicals, more handling, more operators, and more opportunities for workplace incidents.

II. Current Dangers in Conventional Post-Processing

- **Open Tanks of Solvent:** Many conventional post-processing setups rely on open dunk tanks filled with hazardous solvents like isopropyl alcohol (IPA) or caustic detergents. These open tanks pose significant spill hazards and directly expose operators to toxic chemicals during manual part handling; they also release vapors, contribute to evaporation loss, and increase the risk of injury during loading and unloading.
- **Fumes:** The heating and agitation of chemical detergents in open environments increase their vapor pressure, leading to high emissions of volatile organic compounds (VOCs) or nuisance odors requiring engineered ventilation and industrial hygiene controls. If they are not properly ventilated, these fumes can cause dizziness, respiratory irritation, and long-term health complications.
- **Explosion & Fire Risks:** Flammable solvents like IPA are highly volatile and combustible. High concentrations of solvent vapors, combined with potential ignition sources such as electrostatic discharges, create severe fire and explosion risks. Consequently, companies are often forced to build expensive ATEX-certified rooms to house their post-processing operations safely.
- **Repetitive Motion and Ergonomic Injury:** Manual post-processing is a laborious task that relies heavily on hand tools like picks, pliers, and brushes. Frequent lifting of heavy build platforms, scrubbing parts, water blasting, and repetitive transfers between stations increase the risk of injury. Nearly two-thirds of all reported occupational injuries are caused by repetitive movement injuries, costing employers billions of dollars annually (Source: RSI-Therapy.com).
- **Exposure Risks for Employees:** The manual nature of conventional post-processing involves direct contact with uncured resins, solvents, support-removal chemistry, or contaminated liquids, potentially through skin contact or splashing. This exposure requires operators to take extreme measures to protect themselves.
- **Sustainability (Longevity of Detergents):** Traditional solvents like IPA reach saturation very quickly, requiring frequent chemical changeouts. This increases downtime, raises the risk of accidents during chemical changes, and creates a highly unsustainable cycle of consumption. Manual methods also have the tendency to increase water and solvent consumption.
- **Disposal of Chemicals:** Traditional solvent waste represents both an environmental liability and a massive cost driver. Hazardous waste must be properly contained, traced, and disposed of in accordance with strict environmental regulations like Resource Conservation and Recovery Act (RCRA) and Environmental Protection Agency (EPA) guidelines.
- **Breakage (Less Sustainable):** Manual support removal processes, such as using water blasters or hand tools, frequently lead to damaged or broken parts. Damaged parts result in scrapped prints, wasting energy, time, and materials, and ultimately leading to schedule delays and lost revenue for the company.

III. Open-Air Dunk Tank Ban

The severe risks associated with traditional open-air dunk tanks in additive manufacturing are driving major operational shifts across the industry. Handling and emptying saturated tanks filled with caustic chemicals, such as sodium hydroxide (NaOH), presents significant spill and operator-exposure hazards.

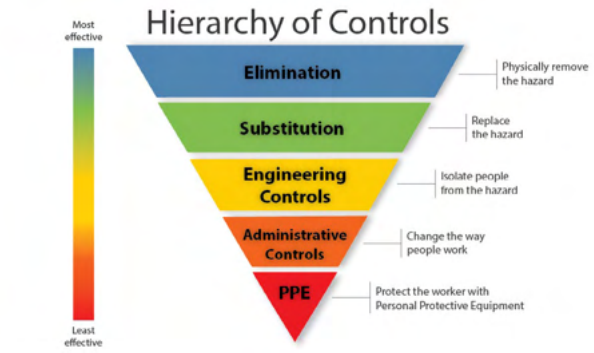


Figure 1: OSHA Hierarchy of Controls. Source: NIOSH

Because of these manual system setups, the only exposure mitigation typically available to operators is **Personal Protective Equipment (PPE)**. As a result, many part manufacturers' EH&S departments are determining that open-air tanks are inherently unsafe under the OSHA Hierarchy of Controls (see Figure 1), a framework that aligns with the hierarchy of prevention measures promoted by EU-OSHA.

Consequently, companies are officially banning the use of open-air dunk tanks across their additive manufacturing labs. To ensure workplace safety, these organizations are now mandating the replacement of open tanks with equipment that is "inherently safe," such as fully enclosed, automated systems designed to remove operators from hazardous chemical exposure.

IV. Increasing Restrictions on IPA Use in Additive Manufacturing Labs

Across industrial, academic, and government additive manufacturing environments, there is a growing trend toward restricting, or in some cases fully banning, the use of isopropyl alcohol (IPA). In cases where IPA is not completely banned, there are severe restrictions on the amount of IPA that can be stored in an area, creating challenges for high-use customers. While IPA has historically been the default solution for cleaning photopolymer resin parts due to its effectiveness and low upfront cost, organizations are reassessing its use through a modern EH&S lens. Safety authorities highlight that solvents used in 3D printing workflows are often flammable, generate hazardous vapors, and can pose respiratory and skin exposure risks to workers.

The primary drivers behind these restrictions are fire and explosion risks. IPA produces highly flammable vapors that can accumulate in poorly ventilated areas, requiring costly mitigation strategies such as explosion-proof (ATEX-rated) rooms, specialized storage cabinets, and strict handling protocols. Additionally, open-tank usage common in legacy workflows increases vapor release, operator exposure, and spill potential. Beyond safety, companies are also responding to sustainability and operational concerns. IPA degrades quickly as it becomes saturated with resin, leading to frequent disposal, increased hazardous waste streams, and higher lifecycle costs. These combined factors are prompting many organizations to transition toward less-flammable, engineered detergents and enclosed processing systems that align more closely with modern EH&S standards and corporate sustainability goals.

V. PostProcess Technologies Solutions: High-Level Overview

To address these critical EH&S gaps, PostProcess Technologies provides software-driven, automated post-processing solutions designed to eliminate hazardous manual workflows. By moving from traditional open dunk tanks to fully enclosed systems, PostProcess reduces chemical exposure, lowers energy consumption, minimizes waste streams, and creates a cleaner production environment. Our proprietary detergents also last up to ten times longer than traditional solvents, generating up to 80% less waste.

PostProcess Technologies Product Overview

VI. PostProcess Technologies Solutions by Process

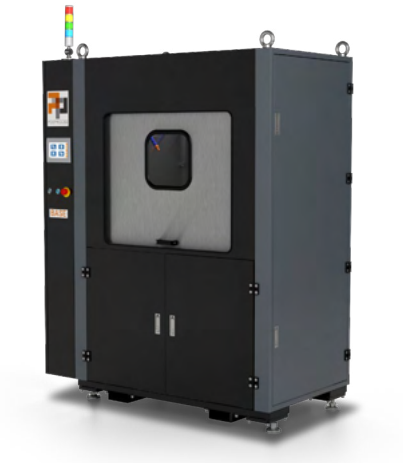
FDM Support Removal

Conventional Method & Risks: Traditional FDM support removal methods typically rely on immersing printed parts into large, open-air tanks containing hundreds of gallons of caustic chemistry such as sodium hydroxide (NaOH). This process introduces significant EH&S risks.

- ***Fumes and Air Quality:*** Open caustic tanks continuously release hazardous fumes and airborne contaminants into the workspace, increasing operator exposure and placing greater demands on facility ventilation and air-handling systems.
- ***Operator Exposure & Fall Risk:*** Technicians must routinely work around large, exposed chemical vats during loading, unloading, and maintenance activities. Wet floors, splashing, and direct contact with caustic solutions increase the risk of slips, falls, and chemical burns.
- ***Heavy Lifting and Ergonomic Strain***: Operators are often required to manually lift heavy baskets or liquid-saturated parts from the tanks, creating substantial ergonomic stress and increasing the risk of injury.
- ***Spill Potential:*** Because conventional processes involve large tanks holding hundreds of gallons of hazardous chemicals, leaks or accidental spills can pose serious environmental contamination risks and necessitate costly cleanup.
- ***Part Breakage and Scrap:*** Delicate or thin-walled geometries can be weakened by prolonged submersion and chemical saturation, leading to excessive part breakage and unnecessary material waste.

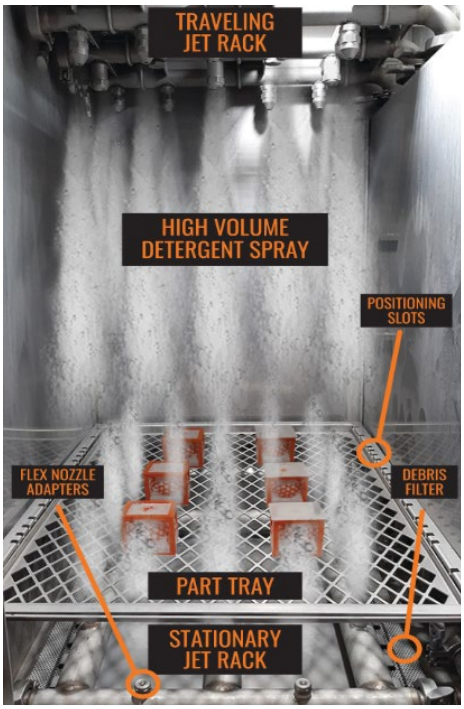
PostProcess BASE Solution for FDM Support Removal uses patented spray technology to automate support removal for large-format FDM parts ranging from delicate to robust. Combined with proprietary software and custom-formulated detergents, the BASE delivers a consistent, enclosed, and hands-free operation that significantly reduces operator interaction and reduces EH&S exposure.

- **Fully Enclosed Chamber:** All chemical processing occurs behind closed doors, within a sealed process environment, substantially reducing operator contact with active chemistry and limiting airborne exposure within the workplace.
- **Integrated Safety Hardware:** The BASE incorporates locking doors, emergency stop functionality, and safety interlocks to ensure safe operation and prevent access during active process cycles.
- **Reduced Spill Potential:** Unlike conventional dunk tanks that may contain hundreds of gallons of caustic chemistry, the BASE operates with a vastly reduced fluid volume (45 gallons), mitigating mass spill hazards.



PostProcess BASE Solution

- **Ergonomic Part Handling:** The system is designed with operator ergonomics in mind, allowing for safer loading and unloading at an optimized working height while minimizing awkward lifting and repetitive strain.
- **Reduced Part Weight:** Because the BASE utilizes targeted spray technology rather than a full-part immersion, components absorb substantially less chemistry during the process. This significantly reduces saturated part weight and lowers the risk of heavy-lifting injuries.
- **Reduced Part Breakage and Scrap:** The proprietary spray process minimizes excessive chemical saturation on delicate geometries and thin-walled features, improving process consistency while significantly reducing part breakage and waste.
- **Energy Savings:** Using the patented spray technology, the BASE system will use 2-4x less energy compared to conventional open tank systems. Faster processing cycles and lower heated fluid volumes contribute to the reduced energy consumption.
- **Detergent Longevity:** Proprietary PLM-201-SUB and PLM-202-SUB detergents were specifically formulated for FDM support removal and offer significantly longer usable life compared to traditional sodium hydroxide (NaOH)-based solutions. Extended detergent longevity reduces the frequency of chemistry change-outs, lowers chemical consumption, and minimizes hazardous waste generation.



BASE Targeted Spray Technology

- **Automated Detergent Change Process:** The BASE system features an automated drain and refill process that eliminates direct operator interaction with chemicals during detergent replacement. During the refill process, the detergent is automatically mixed and distributed into the system, removing the need for manual chemical handling.

Resin Removal

Conventional Method & Risks: Traditional resin cleaning workflows commonly rely on large open tanks of IPA distributed across multiple manual workstations. These processes introduce significant EH&S concerns related to chemical exposure, flammability, air quality, and facility safety.

- ***Fumes and Air Quality:*** Open IPA tanks continuously release hazardous fumes directly into the workspace, negatively impacting air quality and increasing operator exposure to toxic VOCs.
- ***Operator Exposure:*** Frequent manual interaction with open solvent tanks increases the risk of skin contact, splashing incidents, and spills in the workspace, significantly increasing the risk of operator exposure to chemicals.
- ***Explosion and Fire Risks:*** Large volumes of flammable IPA present extreme fire and explosion hazards, requiring facilities to invest heavily in building specialized ATEX-rated explosion-proof rooms.

PostProcess DEMI X 5000 for Large Format Resin Removal combines a fully enclosed processing environment with proprietary non-flammable chemistry to create a safer and more sustainable resin removal workflow for large-format AM applications. By replacing traditional IPA-based cleaning methods, the system helps reduce operator exposure, facility hazards, and hazardous waste generation while improving operational efficiency.

PostProcess DEMI X 5000 Solution

- **Fully Enclosed Chamber:** All chemical processing is contained safely behind closed doors within the machine, minimizing solvent exposure and reducing airborne contaminants in the workplace.
- **Automated Lift System:** The integrated automated lift lowers and raises the build platform without requiring direct operator interaction, reducing ergonomic strain and minimizing operator exposure to hazardous materials.
- **Integrated Safety Hardware:** The system features locking doors, emergency stop functionality, and safety interlocks that prevent operation while the chamber is accessible, supporting safe and compliant operation.
- **Non-Flammable PLM-403-SUB Chemistry:** The use of proprietary PLM-403-SUB chemistry eliminates the flammability concerns associated with IPA, eliminating the need for expensive ATEX facilities and improving overall workplace safety. Key performance, safety, and handling characteristics are compared in **Table 2.**
- **Reduced Waste Generation and Disposal Costs:** PLM-403-SUB provides approximately five to seven times the usable life of traditional IPA, significantly reducing chemistry replacement frequency. This extended detergent longevity lowers waste generation, reduces disposal costs, and lowers operator exposure by reducing the frequency of change-outs.

> *"As far as safety from a flammability standpoint, the DEMI cleaning fluid has a much higher flash point, so the risk of fire is greatly reduced. In addition, the automated process avoids extended exposure to cleaning solvent vapors, a common issue with hand cleaning."*
>
> ***— Sean Schoonmaker***
> Director of Operations at Stratasys Direct in Tucson, Arizona.

- **Reduced Chemical Evaporation:** PLM-403-SUB has a substantially lower vapor pressure than IPA, allowing the chemistry to remain liquid rather than evaporate into the workspace. This reduces VOC emissions and lowers overall solvent consumption.
- **AUX-400-RINSE:** The proprietary AUX-400-RINSE solution eliminates the need for a secondary IPA rinse step, further reducing operator exposure and solvent handling requirements. According to OSHA Hazard Communication Standard, 29 CFR 1910.1200, AUX-400-RINSE is classified as a flammable liquid, category 3.
- **Maintenance and Operator Safety:** During detergent change-outs and service procedures, the DEMI X 5000 utilizes an external ventilation connection to draw vapors away from the operator, improving air quality and reducing chemical exposure during maintenance activities.

COMPARISON OF RINSE SOLVENTS

Solvents	Vapor Pressure	Flashpoint	Health/Safety
Acetone	184 mm Hg @ 20°C	- 17°F (- 27°C)	Highly Flammable, Health Hazard
IPA	33 mm Hg @ 20°C	53°F (12°C)	Flammable, Irritant, Dizziness
Water	30 mm Hg @ 20°C	NA	Non-Flammable
AUX-400-RINSE	26 mm Hg @ 20°C	102°F (39°C)	Flammable, Irritant

Table 1: Comparison of Rinse Solvents for Resin Cleaning

Table 1 compares common solvents used to rinse resin parts, ranked by vapor pressure from highest to lowest. The data highlights that PostProcess AUX-400-RINSE has the lowest vapor pressure among the solvents evaluated, resulting in reduced vapor emissions and a safer operating environment. From a flammability perspective, AUX-400-RINSE also offers a significant advantage, with a flashpoint nearly twice that of IPA.

PostProcess DEMI X 520 for Resin Removal provides the same enclosed, automated, and non-flammable resin removal workflow as the DEMI X 5000, but in a platform that is optimized for smaller-format resin applications. The system is designed to improve workplace safety, reduce chemical exposure, and support environmentally responsible operations.

PostProcess DEMI X 520 Solution

- **Fully Enclosed Chamber:** All chemistry and processing operations remain safely contained within the machine, reducing solvent exposure and improving workplace cleanliness.
- **Automated Lift:** The automatic lift system lowers and raises the build platform, minimizes manual handling, and removes the operator from direct interaction with hazardous chemistry during processing.
- **Integrated Safety Hardware:** Integrated safety interlocks and an emergency stop ensure safe machine operation and help prevent accidental exposure during active processing cycles.
- **Non-Flammable PLM-403-SUB Chemistry:** Proprietary PLM-403-SUB chemistry eliminates the volatility and fire risks associated with IPA, negating the need for expensive ATEX facilities.

- **Reduced Waste Generation and Disposal Costs:** PLM-403-SUB provides approximately five to seven times the usable life of traditional IPA, significantly reducing chemistry replacement frequency. This extended detergent longevity lowers waste generation, reduces disposal costs, and lowers operator exposure by reducing the frequency of change-outs.
- **Reduced Chemical Evaporation:** PLM-403-SUB has a substantially lower vapor pressure than IPA, allowing the chemistry to remain in liquid form rather than evaporate into the workspace. This reduces VOC emissions and lowers overall solvent consumption.
- **AUX-400-RINSE:** The proprietary AUX-400-RINSE solution eliminates the need for a secondary IPA rinse step, further reducing operator exposure and solvent handling requirements. According to OSHA Hazard Communication Standard, 29 CFR 1910.1200, AUX-400-RINSE is classified as a flammable liquid, category 3.
- **Maintenance and Operator Safety:** During detergent change-outs and service procedures, the DEMI X 520 utilizes an external ventilation connection to draw vapors away from the operator, improving air quality and reducing chemical exposure during maintenance activities.

> *"When IPA was banned from the lab, moving to the DEMI system from PostProcess gave us a safer solution while improving our workflow."*
>
> ***— Dallas Martin***
> Additive Manufacturing Senior Engineer, Toyota Production Engineering

COMPARISON OF RESIN CLEANING CHEMISTRIES

	PLM-403-SUB	IPA	TPM
Speed	Removes resin in under 5 min at 20% saturation	Removes resin in over 15 min at 5-7% saturation	Removes resin in over 15 min at 5-7% saturation
Longevity	36.5% by weight at 10 min 1906 g per gallon at 10 min 2344 g per gallon at 20 min	6.5% by weight at 10 min 245 g per gallon at 10 min 332 g per gallon at 20 min	4.0% by weight at 10 min 76 g per gallon at 10 min 198 g per gallon at 20 min
Flashpoint	220°F (104°C)	53°F (12°C)	250°F (121°C)
Vapor Presure	0.2 mm Hg @ 20°C	33 mm Hg @ 20°C	0.01 mm Hg @ 20°C
VOC	Not a VOC	~787 gm/l of VOCs	Not a VOC
Hazard Classification	Non-Flammable	Flammable Liquid, Category 2	Non-Flammable

Table 2: Comparison of Resin Cleaning Chemistries: Performance, Longevity, and EH&S Characteristics

Chemistry longevity remains a key consideration in resin cleaning workflows because shorter chemistry life requires more frequent changeouts, increased operator handling, and greater waste generation. However, longevity is only one factor influencing operational efficiency and EH&S performance. As shown in **Table 2**, PLM-403-SUB detergent demonstrates significantly higher resin-loading capacity than traditional solvents while also maintaining a high flashpoint, low vapor pressure, and a non-flammable classification.

Wax Support Removal

Conventional Method & Risks: 3D printed wax parts are often highly fragile, and the conventional method relies on open-air IPA tanks, which involve multiple manual handling steps throughout the cleaning process. This workflow increases the likelihood of part damage while simultaneously introducing significant EH&S concerns related to chemical exposure, fumes, and flammability hazards.

- ***Fumes and Air Quality:*** Open IPA tanks continuously release hazardous fumes directly into the workspace, negatively impacting air quality and increasing operator exposure to potentially harmful VOCs.
- ***Operator Exposure:*** Frequent manual interaction with open solvent tanks elevates the risk of skin contact, splashing incidents, and prolonged exposure to chemical solvents during loading, agitation, transfer, and rinsing operations.
- ***Explosion and Fire Risks:*** Large volumes of flammable IPA create substantial fire and explosion hazards, often requiring manufacturers to invest in specialized ATEX-rated or explosion-proof rooms, ventilation systems, and additional safety infrastructure to maintain compliance.
- ***Part Breakage and Build Loss:*** Wax printed parts tend to be delicate; repeated handling and immersion steps commonly result in cracked, distorted, or broken components. These failures contribute to unnecessary waste of material, time, and money.

PostProcess DEMI X 520 for Wax Support Removal features a fully enclosed chamber, safety interlocks, an automatic lift, and proprietary chemistry. This eliminates the excessive manual handling steps, significantly reducing part breakage while maintaining a safe, explosion-free environment.

- **Fully Enclosed Chamber:** All processing occurs within a sealed chamber, minimizing chemical exposure and improving workplace cleanliness.
- **Automated Lift:** The automated lift lowers and raises the build platform without direct operator interaction, reducing ergonomic strain and limiting exposure to hazardous chemicals.
- **Integrated Safety Hardware:** Equipped with emergency stops and safety interlocks to help ensure safe operation and prevent access during active processing cycles.
- **Non-Flammable PLM-601-SUB Chemistry:** The proprietary PLM-601-SUB chemistry eliminates the volatility associated with IPA-based cleaning methods, reducing fire risk and minimizing the need for costly ATEX infrastructure.
- **Reduced Chemical Evaporation:** PLM-601-SUB has a substantially lower vapor pressure than IPA, allowing the chemistry to remain liquid rather than evaporate into the workspace. This reduces VOC emissions and lowers overall solvent consumption.
- **AUX-400-RINSE:** The proprietary AUX-400-RINSE process eliminates secondary IPA handling steps, further reducing operator exposure and fire hazards. According to the OSHA Hazard Communication Standard, 29 CFR 1910.1200, AUX-400-RINSE is classified as a flammable liquid, category 3.
- **Maintenance and Operator Safety:** During detergent change-outs and service procedures, the DEMI X 520 utilizes an external ventilation connection to draw vapors away from the operator, improving air quality and reducing chemical exposure during maintenance activities.

Figure 3: IPA Ignited next to AUX-400-RINSE which will not ignite

PolyJet Support Removal

Conventional Method & Risks: The standard, conventional method to remove PolyJet support is a highly manual and labor-intensive process where operators use handheld water jetting systems to clean one part at a time. This workflow creates significant ergonomic challenges, limits throughput and often results in excessive part breakage.

- ***Operator Ergonomic Strain:*** Manual water blasting requires repetitive motions and prolonged operator involvement, increasing the risk of fatigue and operator injury.
- ***Manual Single-Part Process:*** This conventional workflow process allows for a single part to be cleaned at a time, creating an operational bottleneck and increased labor costs.
- ***Part Breakage and Scrap:*** Inconsistent manual support removal methods frequently result in damaged parts, higher scrap rates, and unnecessary reprints.

PostProcess DEMI X 520 for PolyJet Support Removal replaces manual water blasting with a fully enclosed, software-driven automated process utilizing proprietary detergents and intelligent process control. The system enables scalable batch processing while significantly improving workplace safety and reducing part breakage by up to 50%.

- **Automated Process:** By replacing repetitive manual cleaning operations with an automated workflow, the system helps reduce operator fatigue, repetitive-motion injuries, and variability across builds.
- **High-Volume Batch Processing:** The DEMI X 520 enables simultaneous processing of multiple parts, replacing the highly manual single process of the conventional waterjet method.
- **Reduced Part Breakage:** The controlled automated process significantly improves consistency and reduces excessive mechanical stress on delicate geometries, helping lower part breakage and scrap rates.

> *"When I calculate my ROI at the end of the year, I have increased my productivity and saved money. And, I reduced my ecological impact while improving my employees' working conditions!*
>
> ***— Oliver Mangot***
> Co-Director Ident'M Laboratory, Ninety!

VII. Conclusion

Post-processing is no longer a secondary consideration in additive manufacturing. It is a critical step in both production and high volume prototyping with direct implications for worker safety, environmental performance, operating cost, and final part quality.

Conventional methods built around open tanks, flammable solvents, repetitive labor, and fragmented workstations expose companies and their employees to avoidable EH&S risk, operational inefficiencies, and increased regulatory pressure. As additive manufacturing adoption continues to scale, these risks scale with it.

The transition to automated, enclosed post-processing is no longer driven solely by production efficiency; it is a critical mandate for corporate sustainability and workplace safety. Industry leaders are increasingly seeking alternatives to open-air dunk tanks, highly volatile solvents, and labor intensive manual processes in order to reduce injury risks and organizational liability.

Automated enclosed systems such as the PostProcess BASE, DEMI X 5000, and DEMI X 520 provide a practical path toward safer, cleaner, and more sustainable additive manufacturing operations. For organizations seeking industrialized AM workflows, EH&S-centered post-processing should be viewed as a strategic investment rather than an afterthought.

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