

Single Pass printing vs Multi Pass printing 2026



Single Pass versus Multi Pass Printing

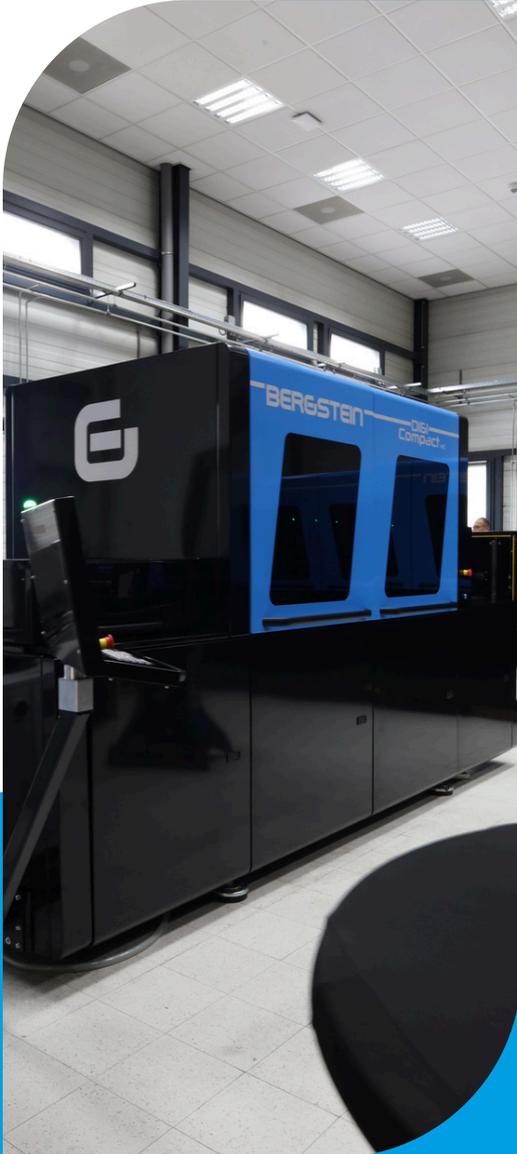


A practical perspective on efficiency, speed, and scalability

Industrial printing is evolving. Manufacturers are increasingly challenged by higher production volumes, shorter product lifecycles, and growing demands for flexibility and consistency. In this changing landscape, the choice of printing technology has become a strategic decision rather than a purely technical one.

At Bergstein Digital B.V. we have been active in industrial digital printing for over 15 years. Throughout this time, we have closely analyzed, tested, and implemented both multi pass and single pass printing solutions across a wide range of applications. The insights gained from these real-world production environments form the foundation of this whitepaper.





Different Technologies, Different Strengths

Single pass digital printing has proven to be a future-proof and time-efficient solution for direct-to-shape printing, particularly in production environments where speed, repeatability, and scalability are critical.

By printing products in one continuous movement, single pass technology enables a significant increase in output while maintaining consistent print quality and predictable costs.

That said, multi pass printing still has its place. For applications involving very small production volumes or larger product formats, multi pass printing can remain a suitable and effective choice. The goal of this whitepaper is therefore not to position one technology as universally superior, but to provide a clear and balanced comparison based on practical experience.

Why Single Pass Printing matters

In the following sections, we will outline the key differences between single pass and multi pass printing. By highlighting the operational, technical, and economic advantages of single pass technology, we aim to explain why it can be a compelling substitute for multi pass printing in many modern industrial applications.

Production time

Continuous High-Speed Production

Single pass printing enables products to move through the printer in one continuous flow. Each product is pretreated, printed, and cured in a single pass, without stopping or repositioning.

With production speeds of approximately 25 meters per minute, large numbers of products can be printed consecutively within one job. This results in a highly efficient process with predictable throughput and minimal idle time between products.

Up to 5–10× higher throughput compared to multi pass printing
Continuous production without interruptions

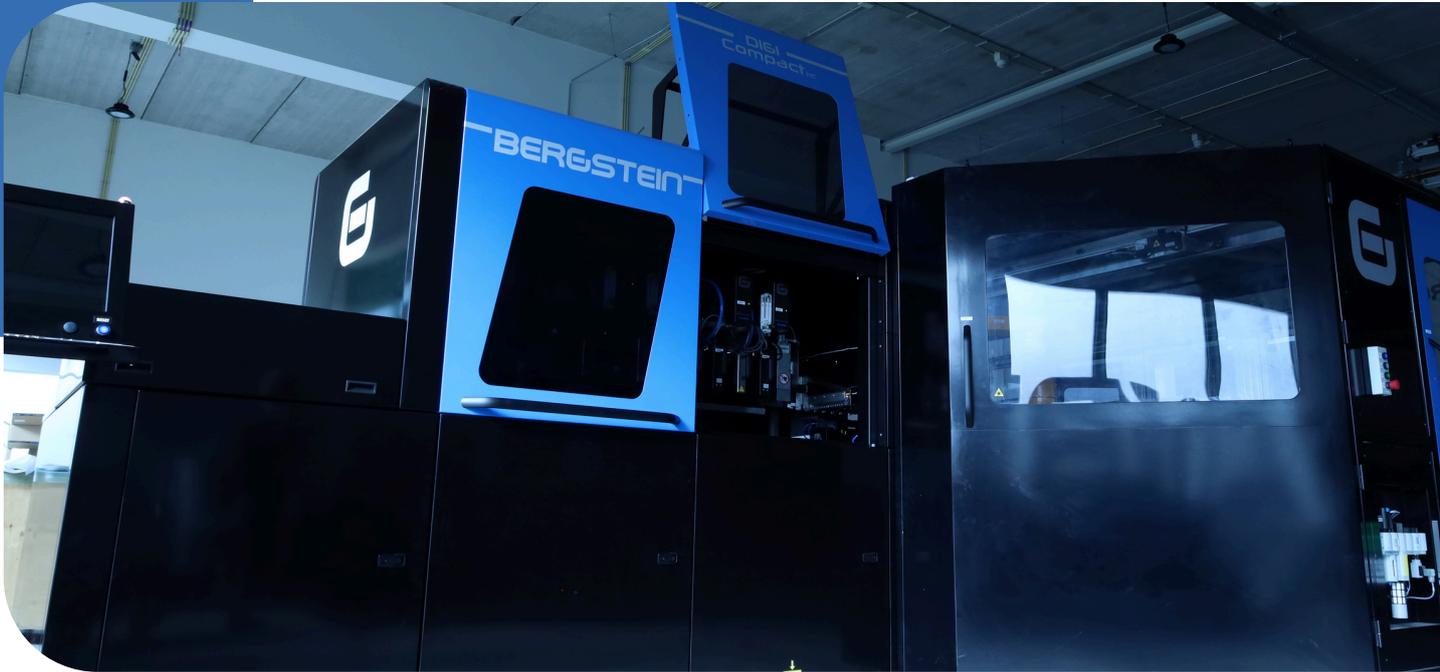
Sequential and Time-Intensive

In multi pass printing, the product remains stationary while the printhead moves back and forth to build up the image. This sequential process means that each product must be completed individually before the next one can be printed.

As a result, the production time per product is significantly longer compared to single pass printing, especially when higher print resolutions or multiple layers are required.

**Longer cycle time per product due
to repeated print passes**





Ready to Print, In One Flow

Single pass printing

Thanks to its modular design, single pass printing allows different pre-treatment units to be integrated directly into the printer. Depending on the application, technologies such as flame, flame with Pyrosil, plasma, or Corona treatment can be selected and installed inline.

Immediately after pre-treatment, the product surface is ready for printing without any interruption. Pre-treatment, printing, and curing take place in one continuous process, eliminating additional handling steps and ensuring stable, repeatable surface activation.

Multi pass printing

With multi pass printing, pre-treatment is performed outside the printer as a separate process step. After pre-treatment, the product must be transported and manually placed onto the printer before printing can begin.

This external handling increases cycle time and introduces variability in surface condition. Each product is handled at least twice, which negatively impacts production speed, process flow, and overall efficiency.



Led Curing: Controlled Energy, Consistent Results

Instant Job Changes, Stable Curing

In single pass printing, changing print jobs or colors is a fast and purely digital action. By selecting a new file in the software, the printer is immediately ready to continue production.

This digital workflow enables rapid job changes without mechanical adjustments or downtime. The curing process remains stable and controlled, independent of job or color changes, supporting a continuous and efficient production flow.

Limited Power, Limited Flexibility

In multi pass printing, products pass the LED curing unit multiple times. To prevent over-curing or damage to the product, the LED lamp operates at a relatively low power level typically between 4 and 8 Watt.

This low wattage causes the ink to dry slowly and, in some cases, not fully cure for optimal adhesion. As a result, specially formulated inks are required that are compatible with low-power LED curing. This restricts ink choice and limits flexibility for different applications.

Quality & adhesion

- Improved adhesion through controlled curing
- Reduced risk of under- or over-curing
- Consistent curing conditions per product

Complete Curing, Inline

Optimized Curing from Top to Bottom

In single pass printing, a UV-curing lamp is installed directly after the LED lamp inside the printer. By combining both curing technologies, the ink is cured effectively on the surface as well as in depth.

Different UV wavelengths can be applied to achieve optimal ink adhesion and durability, tailored to the specific material and application. Because curing is fully integrated inline, products leave the printer completely cured and ready for further handling or packaging.



External Curing, Additional Handling

In multi pass printing, UV curing is not integrated into the printer. When additional UV curing is required, products must be transferred to a separate conveyor belt equipped with UV lamps.

This extra process step increases handling, extends production time, and introduces additional logistics and space requirements. As a result, curing becomes a separate operation rather than a seamless part of the printing process.

The Right Ink for Every Substrate

The wide range of ink types available in single pass printing is closely linked to inline pre-treatment and integrated curing. Because the surface is activated immediately before printing and the ink is fully cured inline using controlled LED and UV technologies, ink performance can be optimized for each application.

Wide Ink Compatibility, Maximum Flexibility

Single pass printing offers a broad choice of ink types, enabling printing on a wide variety of materials. In combination with inline pre-treatment, post-treatment, and different jettable primers, this flexibility allows manufacturers to optimize adhesion for each specific application.

More robust inks can be used, as well as inks with specialized formulations such as different photo-initiators or enhanced flexibility for demanding substrates. This makes it possible to achieve reliable adhesion and durability across numerous materials without compromising production speed or process stability.

Limited by Curing Constraints

In multi pass printing, the choice of ink types is strongly restricted by the curing process. Limited curing power directly affects which inks can be used and how well they adhere to different substrates.

As a result, adhesion performance can vary significantly, and both ink and jettable primer options are limited. This reduces application flexibility and makes it more challenging to achieve consistent results across different materials.

▲ **70%** Up to 77% wider application range

▲ **60%** Up to 60% improvement in adhesion consistency

Future-Proof Printhead Configuration

Configured to match the application

Single pass printing allows different types of printheads to be selected and mounted, depending on the product geometry, required print quality, and ink formulation. This makes it possible to tailor the printing system precisely to the application.

Multiple printheads can also be integrated within a single system to increase print width, improve resolution, or enhance ink laydown. This modular approach ensures consistent quality while enabling scalability and future upgrades.

Fixed configuration, limited options

In multi pass printing, the printer is typically designed around a single type of printhead. If a specific product, ink, or quality requirement demands a different printhead technology, adaptation is not possible.

This fixed configuration limits flexibility and restricts the range of applications that can be printed efficiently or at the desired quality level.



Clear Coat: Protection without delay

Inline Clear Coat, Perfectly Timed

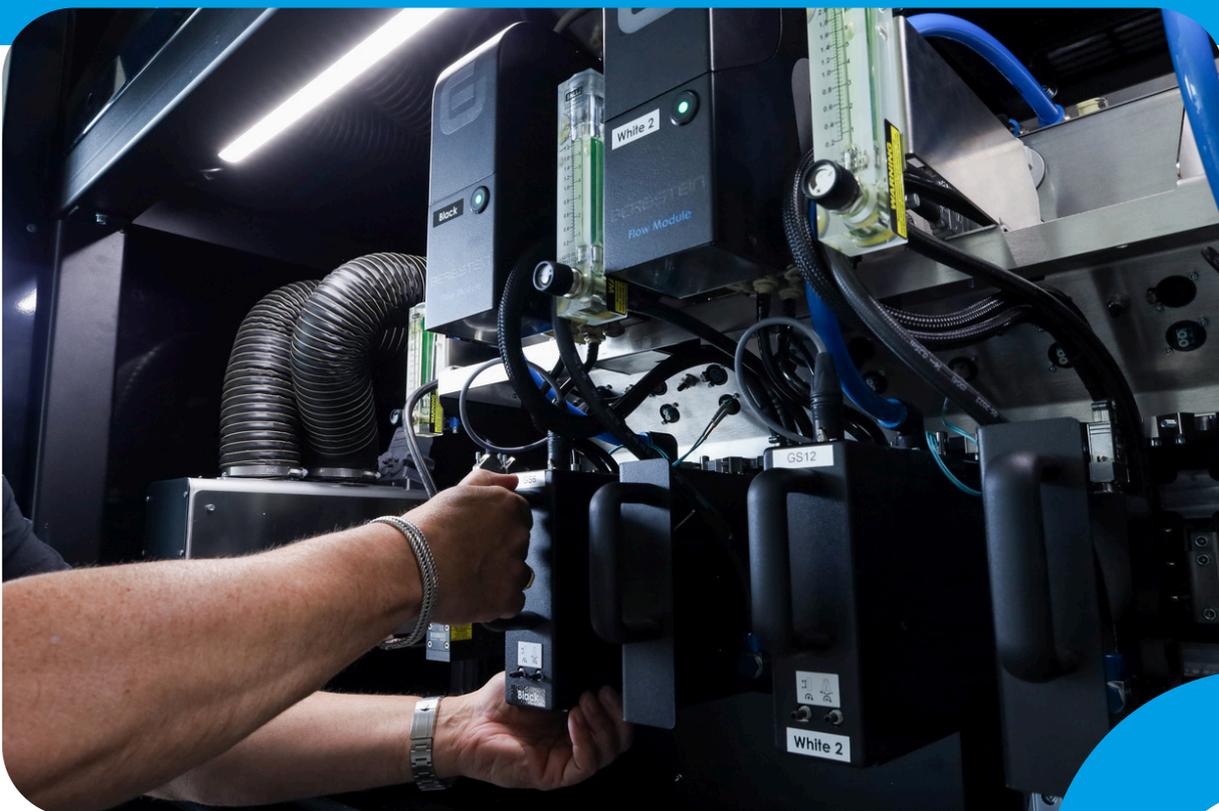
In **single pass printing**, a dedicated clear coat module can be integrated directly after the color layers. The clear coat is applied inline and cured immediately afterwards as part of the same continuous process.

By adjusting the transport speed of each carrier, the clear coat is given sufficient time to flow and level before curing. This results in a smooth, durable protective layer without affecting production speed or requiring additional process steps.

Additional Pass, Additional Time

In **multi pass printing**, the clear coat can only be applied after all color layers have been printed and pre-cured. This requires the product to be printed again in a separate step.

As a result, the total print time is effectively doubled, increasing production time and reducing throughput. The clear coat becomes an additional operation rather than an integrated part of the printing process.



consistent print
quality throughout
production



First-pass yield
quality-related
rejects



Higher OEE
Uninterrupted carrier-
based production

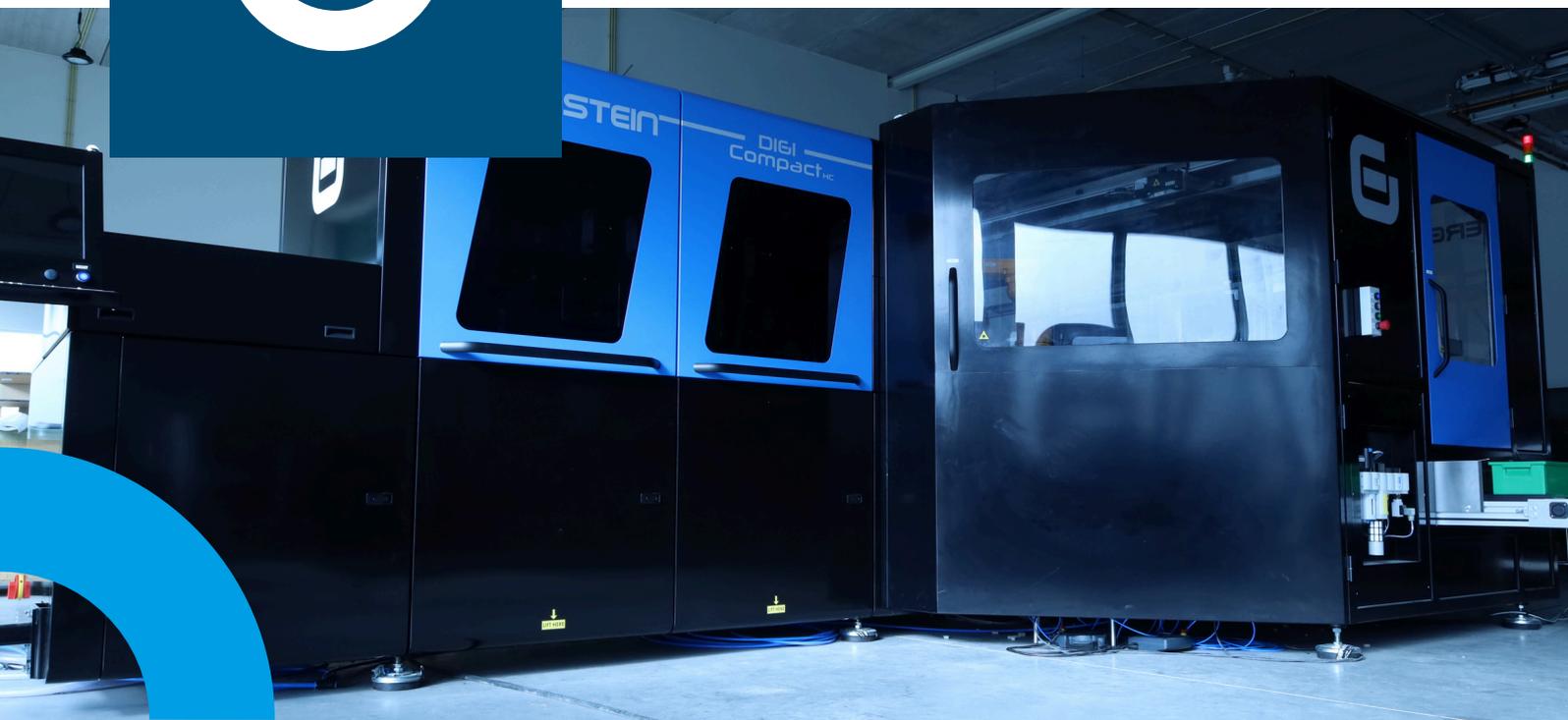


Quality Through Continuous Flow

The design of a **single pass** printer is built around continuous flow. Products are loaded and unloaded on carriers outside the printer, while other carriers are printed inside the system at the same time.

This creates a constant, uninterrupted stream of carriers moving along a conveyor belt being loaded, printed, cured, and unloaded simultaneously. Because the process never stops or resets between products, printing conditions remain stable, resulting in consistent print quality from the first product to the last.

In **multi pass printing**, each product must be placed inside the printer individually either manually or by automation before printing can begin. Once the product is printed, the printer returns to its start position before the product can be removed.

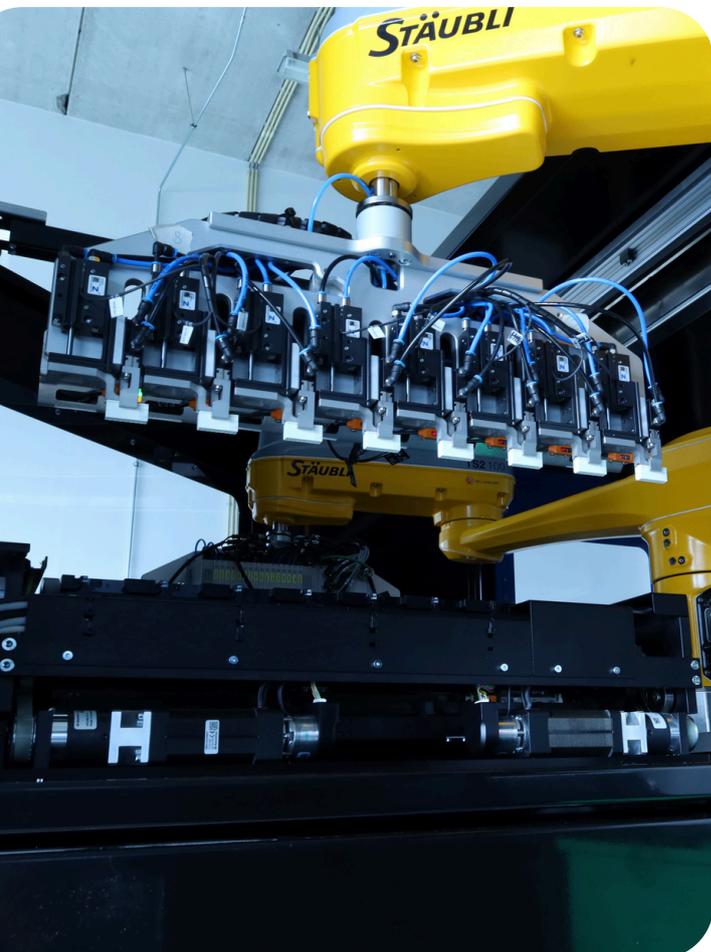


Machine Quality: Built for Industrial Reality

Engineered for Continuous Production

Single pass digital printers are specifically designed for industrial environments where production capacity, accuracy, and reliability are critical. Their robust construction, high-speed performance, and modular configuration options make them ideally suited for mass production applications.

High-quality materials and industrial-grade components allow these printers to operate for long production hours, even in demanding conditions. When combined with pick-and-place automation or robotic handling, single pass printers can run continuously up to fully unattended production without compromising performance or print quality.



Designed for General-Purpose Use

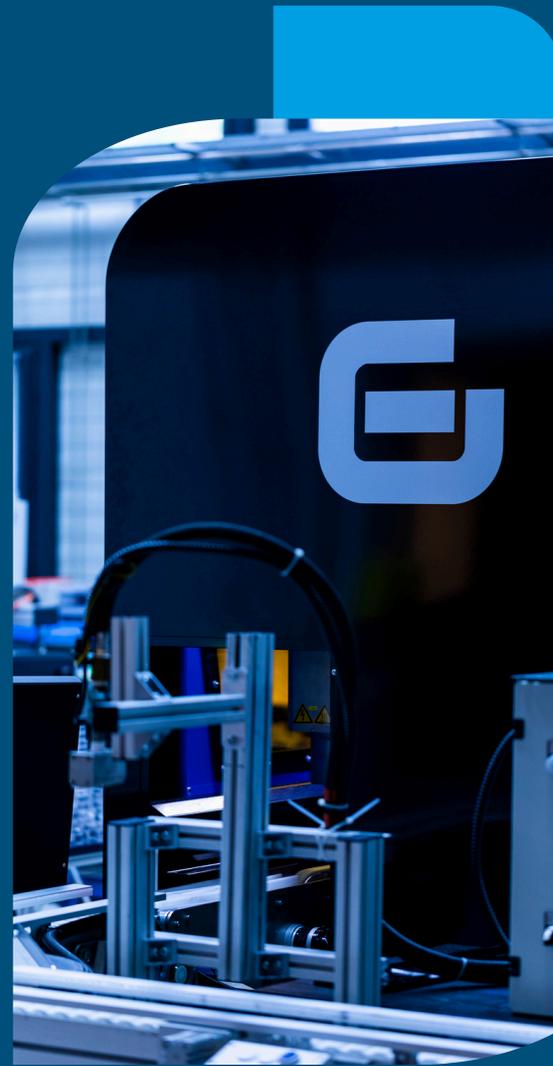
Multi pass printers are typically produced in higher volumes for use across a wide range of markets and applications. They are generally intended for lower daily production volumes and intermittent operation.

Because these systems are not designed for sustained high-output environments, material quality and mechanical construction are less suited to intensive, long-duration production. As a result, they struggle to maintain reliability under continuous industrial workloads.

From Insight to Implementation

Throughout this whitepaper, we have compared single pass and multi pass printing from an operational, technical, and economic perspective. The findings clearly show that single pass digital printing offers significant advantages in terms of speed, consistency, flexibility, and scalability particularly for industrial environments with high production demands.

At the same time, the choice of printing technology is never one-size-fits-all. Each product, material, and production environment has its own requirements. Understanding where single pass technology adds the most value is therefore a crucial step in making the right long-term decision.



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