Paste 2025 – AB Fourie, A Copeland, V Daigle & C MacRobert (eds)

doi:10.36487/ACG_repo/2555_38

# The RhoVie™ Slack Screen Densifier: a novel primary dewatering process for fine, high-clay-containing tailings

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## Abstract

*The drive towards so-called dry stacked tailings necessitates that the mine tailings undergo two dewatering steps, i.e. primary dewatering, which typically utilises gravity sedimentation technologies such as thickeners, followed by secondary dewatering, in which a variety of dewatering technologies such as vacuum or pressure filters, centrifuges and presses can be utilised.*

*Incorporating various concepts from inline flocculation to static and dynamic screening, the RhoVie™ Slack Screen Densifier was developed to provide an alternative primary dewatering process for fine high-clay-containing tailings. The technology has several significant advantages such as low complexity, low power requirement and a low footprint, which allows for mobility depending on mining process or tailings deposition site locality.*

*The development of this technology potentially provides an opportunity for an alternative dry stacking flow sheet for high-clay-containing tailings streams to be utilised.*

**Keywords:** *clays, dewatering, dry stacking, filtration, flocculation, thickening*

## 1 Introduction

Dewatering of tailings has undergone a significant change in mindset within the minerals industry over the last 40 years. Up until the late 1990s, tailings disposal strategies selected by mine owners were generally driven by net present value incentives to achieve the most economical solution (Williams 2021). Primary dewatering technologies were limited mainly to high-rate thickeners which were used ubiquitously to treat the tailings from across the commodity spectrum.

Gradually, improvements in dewatering technology evolved and by the early 2000s high-density and paste thickeners were added to the range of primary dewatering options available (Schoenbrunn 2011; Schoenbrunn & Bach 2015). Secondary dewatering (after primary dewatering) was very rarely utilised and technologies such as filters, centrifuges and presses, although available, were restricted to niche tailings dewatering applications (Copeland et al. 2006; Williams 2021).

The tailings dam failures at Mount Polley in 2014, closely followed by the more catastrophic Fundão and Feijão tailings disasters in 2015 and 2019, respectively, fundamentally changed the industry outlook on tailings dewatering and disposal (Franks et al. 2021). With the subsequent introduction of the Global Industry Standard for Tailings Management in 2020, tailings dewatering was viewed as an essential element in the sustainability of the mining enterprise (Global Tailings Review 2020).

With this newfound realisation, secondary dewatering technologies were elevated to prominence, particularly pressure filtration due to its higher throughput capability, and a new tailings disposal strategy known as filtered dry stacked tailings became part of the mining lexicon.

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Several successful large-scale filtered dry stacked tailings disposal systems have recently been installed, treating iron ore tailings in Brazil and Australia (Gomes et al. 2016; Hogg 2010; Amoah 2024), copper tailings in Chile and Peru (Lara et al. 2013; Cacciuttolo & Atencio 2023), and gold tailings in Canada and elsewhere (Masengo et al. 2024). Based on these case studies, the industry has tended to perceive that the standard flow sheet for achieving dry stacked tailings disposal would include a thickener for primary dewatering followed by pressure filtration as a secondary dewatering technology, and that this flow sheet should be applied to all tailings types (Figure 1).

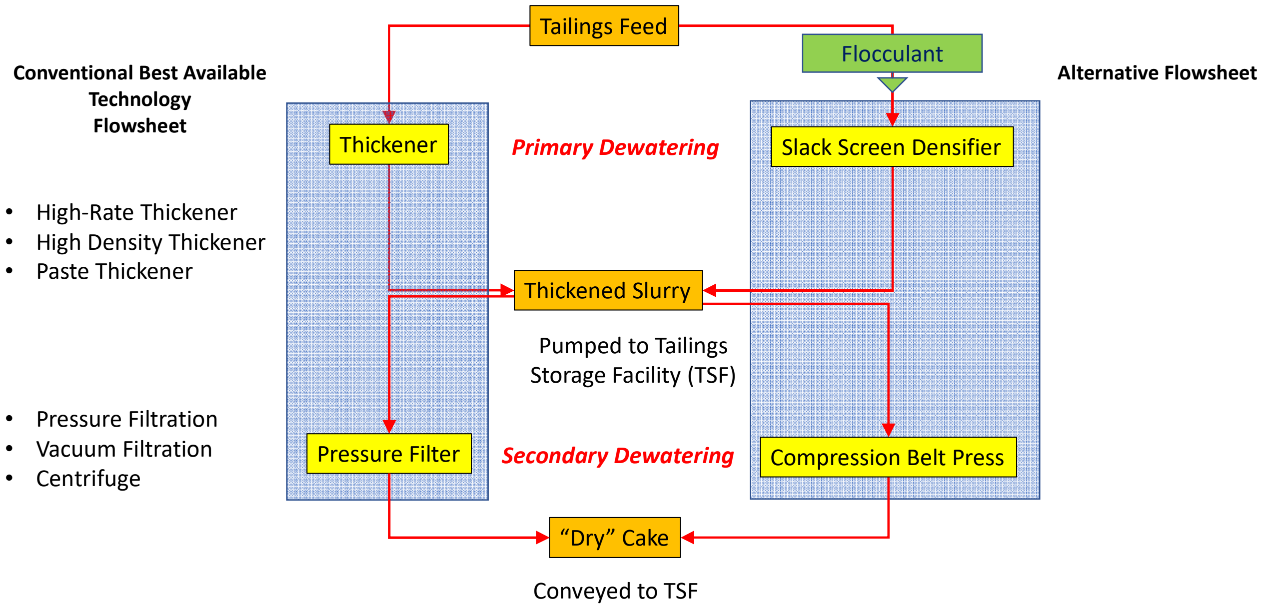



**Figure 1 Conventional and alternative dewatering flow sheets for dry stacked tailings disposal**

Technology providers, however, have understood that not all tailings are suitable for dewatering by filtration, particularly those containing clay minerals (Grosso & Kaswalder 2021), and that an alternative dewatering technology flow sheet may be required for these more difficult tailings.

This paper describes the development of an alternative dewatering flow sheet for dry disposal of those tailings containing a high fines fraction and/or a high clay content. The introduction of a novel primary dewatering technology known as the RhoVie™ Slack Screen Densifier, developed by Vietti Slurrytec Pty Ltd in South Africa, is a key component to the alternative flow sheet. The concept, principle of operation and some test results are presented in this paper.

## 2 Tailings type and dewatering technology compatibility

Tailings engineers and technology providers involved in the selection of dewatering equipment know from experience and testwork that there are groups of commodities whose tailings can be dewatered more easily than others. For instance, in a dry stacking application, iron ore tailings tend to filter easily while mineral sands slimes tailings are extremely difficult or impractical to filter. These incompatibilities are largely due to differences in the fines content within the tailings, herein defined as the percentage –20µm fraction, and the presence of active or swelling clays, herein defined by the methylene blue index number in meq/100g solids (Hang & Brindley 1970; Kaminsky 2014) within the tailings.

Using these two properties, mineral tailings from different commodity types can be classified into several groups representing degrees of dewatering difficulty (Figure 2). The groupings have been defined arbitrarily by Vietti Slurrytec Pty Ltd based on testwork experience.

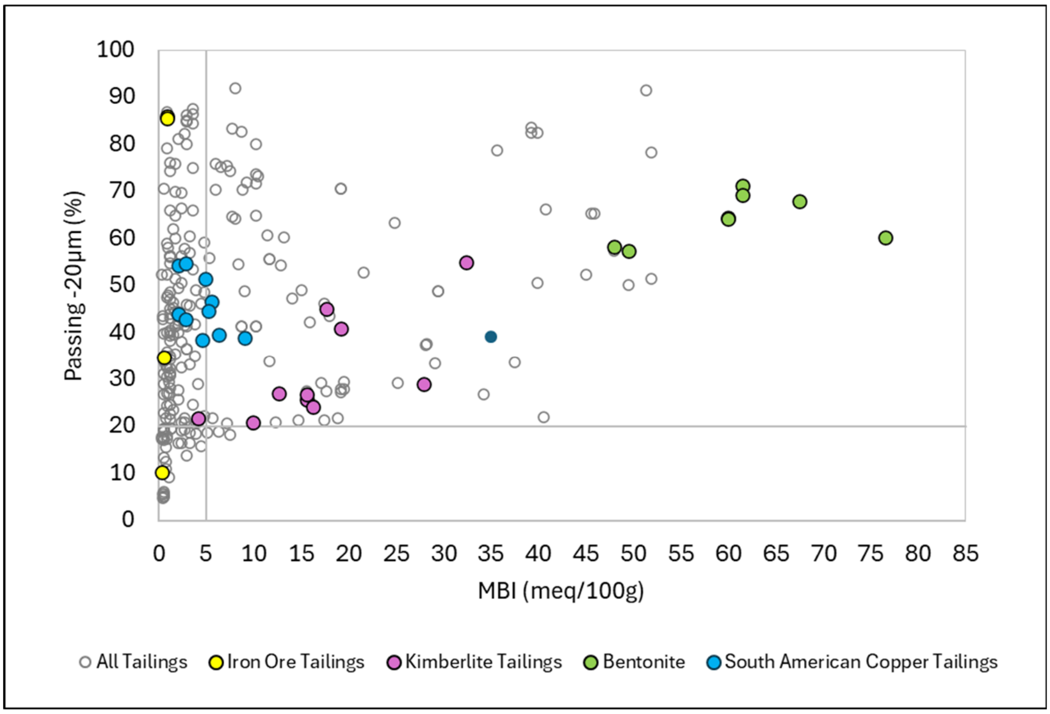



**Figure 2 Tailings dewatering behaviour classification based on fines content and clay properties**

From Figure 2 it is evident that the existing filtered dry stacked disposal projects treating iron ore and copper tailings, appear to be treating tailings which are compatible with filtration dewatering technology. These tailings tend to have a relatively low fines content (< 20%) and, more importantly, have almost no active clay content (< 5 meq/100g). These properties may explain why dry stacked tailings disposal projects are absent in commodities with more difficult tailings.

Does this mean that dry stacked disposal is technically and economically not feasible for these tailings? No, but it does point to the fact that an alternative, more compatible dewatering technology breakthrough needs to be found and that an alternative dry stacking flow sheet needs to be developed for the more difficult class of tailings.

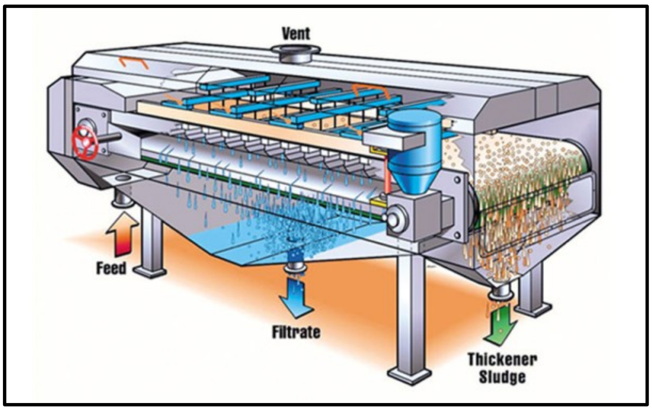
# 3 The RhoVie Slack Screen Densifier concept

All tailings dewatering processes rely to some extent on the addition of a polymer reagent to initiate aggregation or flocculation of the suspended solids so that solid/liquid separation within the slurry can take place.

In a basic dewatering process used to re-treat oil sands fluid fines tailings, the recovered tailings are pumped via a pipeline and a polymer flocculant is injected inline. By adjusting the flocculant dosage and the mixing conditions, a distinct flocculated solids texture, referred to colloquially as 'cottage cheese', is obtained when the tailings are discharged into the tailings storage facility. This characteristic texture is required for rapid gravity consolidation and the release of entrained water when the tailings are deposited (Sadighian et al. 2018).

Belt/sludge thickeners used in the sewage treatment industry are operated in a similar manner, whereby the flocculated sewage sludge with the same cottage cheese texture is introduced onto a horizontally moving belt (City of Beloit Public Works 2022). Gravity-assisted dewatering takes place on the belt, and vertical static 'ploughs' mechanically shear the solids as they pass so that further consolidation and water release can be achieved. Likewise, in the dairy industry, ricotta cheese is made by discharging milk curds onto a static screen so that gravity-assisted dewatering of the whey can take place. In this process, however, the curds are further consolidated and dewatered by a mechanical rolling action when the flexible screen is pulled back and forth by workers (Figures 3a and 3b).

It should be emphasised that the primary dewatered solids in all the above examples do not undergo any subsequent shear, and they retain their unsheared texture. This is important as it allows the solids to be supported on a belt when being presented to a secondary dewatering process such as a belt press. This is not the case when tailings are dewatered by a thickener where the thickened solids in the underflow undergo shear via the thickener underflow pump and are therefore presented to the secondary dewatering process (such as a pressure filter) as a sheared slurry.

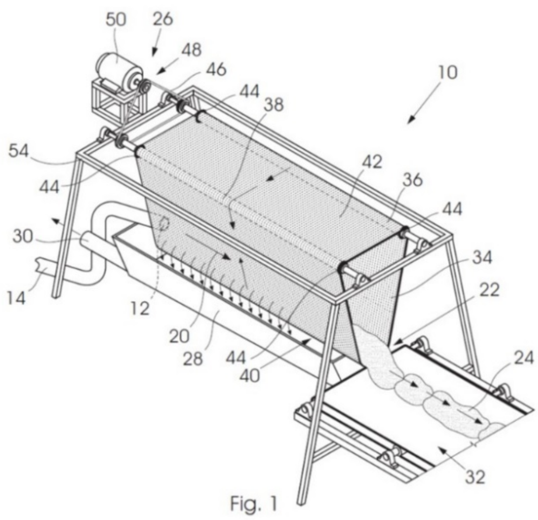



(a) (b)

**Figure 3 (a) Principle of operation of a belt thickener (Filmedia n.d.); (b) Ricotta cheese production (Milk Innovation Group 2014)**

The RhoVie Slack Screen Densifier was designed and patented based on these observations, for treating mineral tailings with high fines and clay content (Figure 4a).

In concept, tailings are flocculated inline and are presented to the inner surface of an endless slack belt. The flocculated solids collect in the apex of the belt and are dewatered by gravity while the flexible belt provides a mechanical rotational motion to the solids so that they can be compacted into a ‘sausage’. The compacted solids are then discharged from the end of the belt and filtrate is returned to the process. A pilot-scale Slack Screen prototype unit was built with a 1.3m-wide belt on which concept improvement tests were conducted. A final twin-loop version was settled on and equipped with separate dewatering and consolidation loops plus a scroll for assisting with the mechanical discharge of the dewatered solids (Figure 4b).




(a) (b)

**Figure 4 (a) RhoVie Slack Screen Densifier concept; (b) Final patented pilot-scale prototype**

# 4 Pilot-scale test

A pilot-scale test was conducted to determine the dewatering performance of the RhoVie Slack Screen when treating a high fines and high active clay content mineral sands tailings sample from Southern Africa (Table 1).

**Table 1 Test slurry sample properties**

| Parameter | Unit | Value |
|---|---|---|
| Particle $P_{80}$ | µm | 21.5 |
| Particle $P_{50}$ | µm | 7.0 |
| Particle $P_{20}$ | µm | 3.4 |
| –20 µm | % | 79 |
| Solids density | g/cm$^3$ | 2.650 |
| Methylene Blue Index | meq/100 g | 35.7 |

The operational set-up and conditions under which the RhoVie Slack Screen was operated is detailed in Figure 5 and Table 2.

The tailings were mixed continuously in a 1 m$^3$ agitated tank. Feed from the tank was delivered to the RhoVie Slack Screen by an AFX positive displacement hose pump via a 0.025 m-diameter by 29 m-length flexible hose. The slurry volumetric flow was limited to 3.5 m$^3$/h due to the size of the feed pump.

Flocculant (poly-ethylene oxide at 0.05% m strength) was pumped from a 50-L flocculant make-up tank via an APEX 15 positive displacement hose pump and two flocculant dosing points were allowed for. The first dose (80% of the total flocculant dosing volume) was dosed inline 5 m ahead of the feed pump and prior to a high-shear static mixer located in the feed pipe. The second dose (20% of the total flocculant dose volume) was dosed inline 3 m before discharge to the RhoVie Slack Screen and prior to a low-shear static mixer.

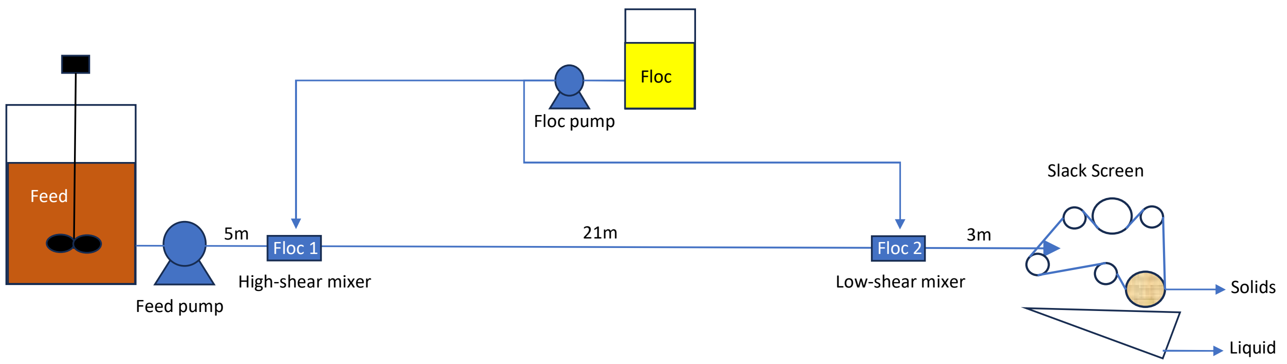
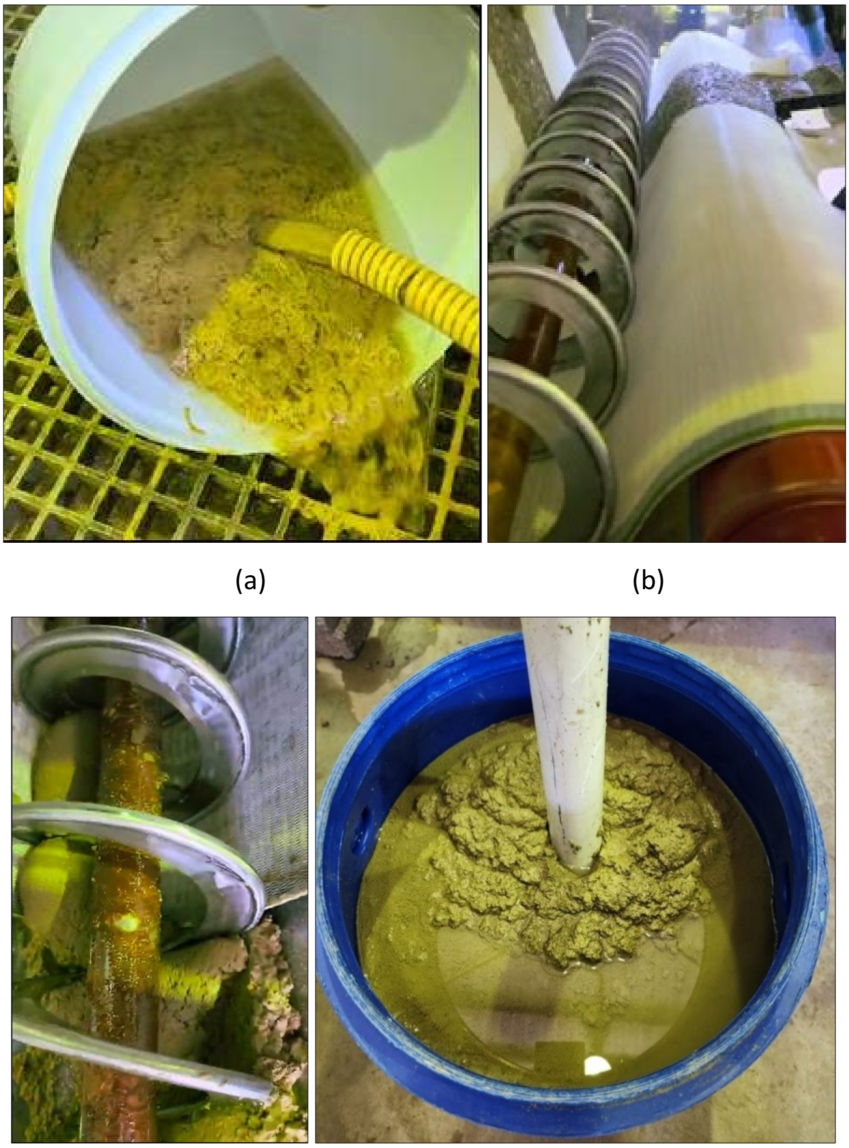



**Figure 5 RhoVie Slack Screen pilot plant test set-up**

**Table 2 RhoVie Slack Screen operating conditions**

| Parameter | Unit | Value |
|---|---|---|
| Feed slurry flow rate | m$^3$/h | 3.5 (maximum lab pump setting) |
| Feed slurry solids conc. | %m | 8.2 |
| Flocculant dosage | g/t | 715 (maximum lab pump setting) |
| Feed presentation width | m | 0.28 |
| Drainage length | m | 1.0 |
| Discharge slurry solids conc. | %m | 33 |
| Solids flux rate | t/m$^2$.h | 1.1 |

Flocculated slurry having the distinctive cottage cheese texture (Figure 6a) was discharged into the RhoVie Slack Screen feed box, from which it overflowed onto the moving belt (Figure 6b). Gravity dewatering occurs in the primary loop before the watered solids are presented to the consolidation loop where mechanically assisted dewatering takes place. The dewatered solids are continuously removed from the unit by a rotating scroll (Figure 6c). Filtrate water gravitates to an underpan from which it is discharged.



(a) (b)

(c) (d)

**Figure 6 (a) Flocculated feed; (b) Feed discharging onto a dewatering loop; (c) Densified 'sausages' in the consolidation loop being discharged off the belt; (d) Unsheared product**

The total run time for the pilot plant test was restricted due to the limited volume of test slurry and the limited range of the laboratory feed and flocculant dosing pumps used. However, even under these limited feed rate conditions, the RhoVie Slack Screen achieved a throughput of 1.1 $t/m^2.h$ while dewatering the product to 33% m and operated flawlessly until the slurry sample was depleted (Figure 6d).

Field trials are required to determine the true throughput limits of the RhoVie Slack Screen, however, the comparable performance of alternative dewatering technologies treating a similar fine feed indicate that the throughput for both a thickener or a horizontal vacuum belt filter would be in the order of 0.1 $t/m^2.h$ or less, but at a significantly lower flocculant dosage (Figure 7).

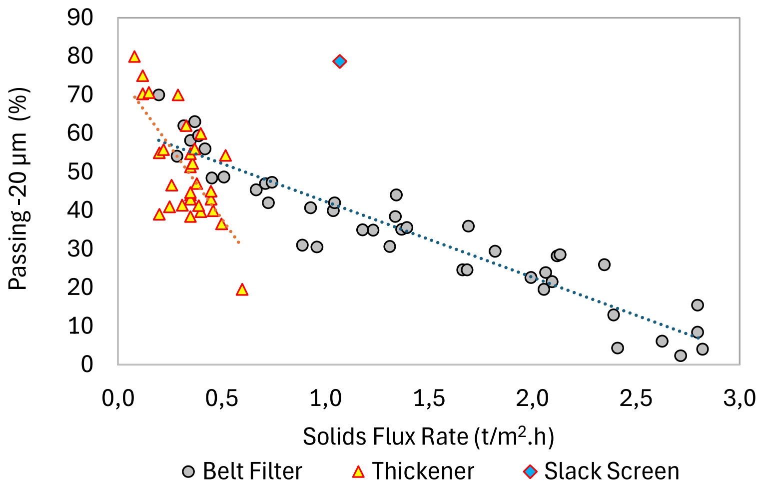



**Figure 7 Comparative tonnage throughput for dewatering technologies treating fine high clay tailings**

# 5 Conclusion

Vietti Slurrytec has developed the RhoVie Slack Screen Densifier for primary dewatering of fine high-clay-containing mineral tailings. The technology allows for the flocculated tailings to retain their unsheared textural state for subsequent presentation to a suitable secondary dewatering technology. This combination opens the possibility of using an alternative flow sheet design for treating difficult tailings needing to be fully dewatered to a conveyable state, as described in Figure 1.

Furthermore, the technology has low complexity, a low footprint, low power consumption and high capacity, which allows for mobility and site placement where necessary. It is envisaged that the technology has applications in both the dewatering and placement of tailings derived from current and re-mined applications.

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