Lodestone

belt weigher guide

March 2007

To measure
is to know

Introduction

The object of this document is to provide information on belt weigher applications, and naturally attempt to sell LodeMaster Belt Weighers. The principles stated here however apply to all belt weighing applications. If you have a belt weigher and are experiencing problems, please call +44(0)1306 884197 and our engineering staff would be pleased to help you solve your weighing difficulties.

Belt weighers are designed to measure the mass flow of a product on a conveyor system. It can measure both the rate (tph) that the material is being conveyed at and also integrate the total number of tonnes conveyed over a given time.

The engineers at Lodestone have been involved in process weighing for many years and have pooled their experience to produce a belt weigher that is not only rugged, but will satisfy the requirements of most process control and weighing applications.

The LodeMaster belt weigher is intended to be used as a process weigher and load indicator. (See later discussion).

It does not matter how "smart" the weigher electronics are, or how many fancy gadgets are attached to it, the fundamentals of weighing remain the same. Good engineering, and a deep understanding of how to apply this engineering. A sound mechanical installation is the real secret. That is, putting the weigher in the right place in the conveyor and ensuring it is installed correctly. Application engineering comes with experience, and at Lodestone we have some of the most experienced application engineers in this sector of industry.

Once you are sure the mechanical installation is correct, the next major consideration is the interface electronics. Lodestone has used high specification units. It is by using this approach that we have been able to supply a weigher that is suitable for its intended market place, good value for money and reliable.

This document explores all aspects of good weighing practice to enable you to get the very best performance from your weighers.

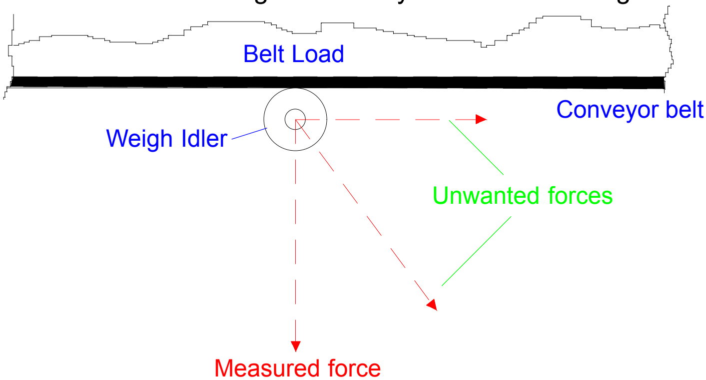
Theory of operation.

Lodestone has designed their belt weigher with the process control end user in mind.

Force collection method

One idler set from the conveyor is selected and with special mounting feet is

mounted onto the weigh carriage assembly. This then acts as a force measuring device. The material passing over the idler set generates the forces of interest. The information from the tachometer and the load cell are then combined electronically by the weigher electronics to calculate rate and totalised tonnes.
The major conflict in any dynamic conveyor weighing system is between the belt tension and the down force generated by the material being conveyed.



The problem arises from the fact that the lateral tensions in the belt are effectively in opposition to the downward weight of the material resting on the belt. So the greater the tension in the belt, the more difficult the weighing application. Some conveyors in the UK can actually achieve tensions in excess of 45 tonnes. This is when good application engineering is vital. And in some cases, Lodestone will advise you that it is not possible to weigh on certain conveyors.

One crucial factor in assessing the suitability of a weighing application is the weigh span requirements. The process involves an assessment of the following:

Belt speed
Material throughput (tonnes per hour)
Motor size
Gravity Take Up (GTU)
Belt lift (work done)
Idler troughing angle
Conveyor angle
Belt tension Friction

and other “belt effect” factors. All the above need to be considered in order to fully evaluate each conveyor system.

Once this engineering assessment has been done, then the required minimum weigh length can be calculated.

The following factors also have to be considered during the application engineering phase:

Conveyor rigidity.
Torsional Stability
Lateral force assessment
Belt mis-tracking
Conveyor squareness
Idler alignment
Belt loading
Volumetric utilisation
Material build-up in weigher area
Material overloading.
Load sensing arrangements

A major factor in belt weighing is the belt displacement required on the force sensor between no load and full load. A true force collection device has zero movement. Load cell weighers with a well designed force collection system require a movement of less than 0.08mm. The LodeMaster belt weigher is designed to this exacting standard and also meets all the standards for high temperature stability over a wide range of temperatures. The design ensures that the stability at zero factor (difficult to achieve) and long term calibration is achieved and maintained to within the specified tolerances.

Belt speed (displacement) Transducers

Belt weighers calculate belt loading by measuring the movement of the belt, and multiply this value with the information from the force transducer. In order to ensure that the measurement is as accurate as possible, the belt displacement needs to be measured.
The speed sensor should always be located on a non-driven drum on the clean side (non-material side) of the belt. This can be the tail drum, a drum specially provided for the speed sensor or a snubbing roller for the GTU or a jockey wheel arrangement.

Weighing accuracy.

Accuracy definition

When defining the accuracy of a belt weigher the user should be careful of the wording used. If it states 1% f.s.d, this means that an accuracy of one percent can be obtained at 100% of designed flow rate only. At 50% of maximum flow rate, the accuracy is likely to be closer to two percent and so on. Accuracy should be stated for a flow range such as “plus or minus 1% over the flow range 20 to 100%”. This means that the results from the weigher will be accurate to within the specified tolerances over the specified range.

Repeatability definition

The term accuracy is meaningless without the length of time that the weigher will remain calibrated. If a commissioning technician performs a calibration and achieves a 1% accuracy and then the next day the weigher is 3% then its “accuracy” is only repeatable for that period of time (or less). The customer should state how long the calibration should be held for. This term then specifies the REPEATABILITY of the system. This is something fundamental to a belt weigher but which customers often ignore.

Horses for courses.

Before purchasing a belt weigher, your requirements should be carefully considered. Typically for process control a single idler 2% weigher will be sufficient. If higher accuracies are to be achieved then multi-idler scales will be required.

Belt effects

The major source of inaccuracies in any belt weighing system is grouped into a category known as belt effects this includes:

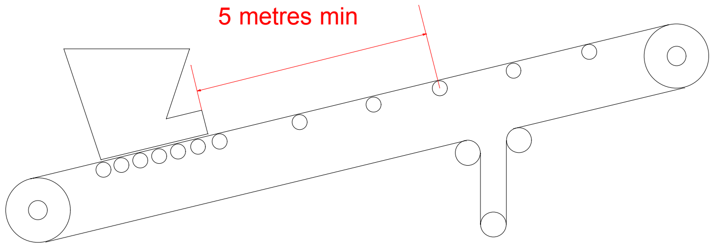
Changes in belt tension
Belt misalignment
Belt mis-tracking
Uneven or offset loading.

All of these effects can be reduced if attention is paid to the mechanical installation of the belt weigher.

Calibration

Several calibration techniques can be used for belt weigher applications. The only reliable one is material testing. This involves running a known amount of material over the weigher and recording the result. Once this process is complete, then any changes can be made as required to the calibration of the electronics. If it is not possible to use material tests then calibration weights can be used.

Scale location



The belt weigher should be located in an area where there are least belt tension variations. It is a common misconception that a conveyor belt moves at the same speed along its entire length. A conveyor belt is like a large rubber band, and behaves in a similar way. If the conveyor has its drive mounted at the head end of the conveyor, then the belt tension change here will be at its greatest. And the belt, similar to a rubber band, will be stretched more at this point than at the tail end. It is for this reason that the belt weigher should be located as close to the tail drum as possible.

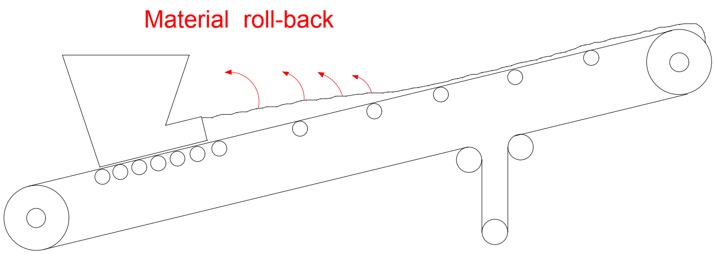
Conveyor Skirts

If the conveyor is fully skirted, then these should be removed or raised above the belt line in the weigh area. This is due to the fact that material can catch between the skirt and the belt, thus causing down loads into the weighing section, which cause weighing inaccuracies. Usually the conveyor is only partly skirted at the tail end of the conveyor to allow the material to settle. In these cases, the weigher should be located at least 5 idler spacings above the end of the skirts.

Material settling.

When material is fed onto a conveying system from a chute it is “live”. That is it is bouncing on the conveyor. Before attempting to weigh this material, the product should have time to settle. Depending on belt speed, material type and particle size distribution, at least 5 idler spans should be allowed for before the siting of the weigher.

Conveyor angle.



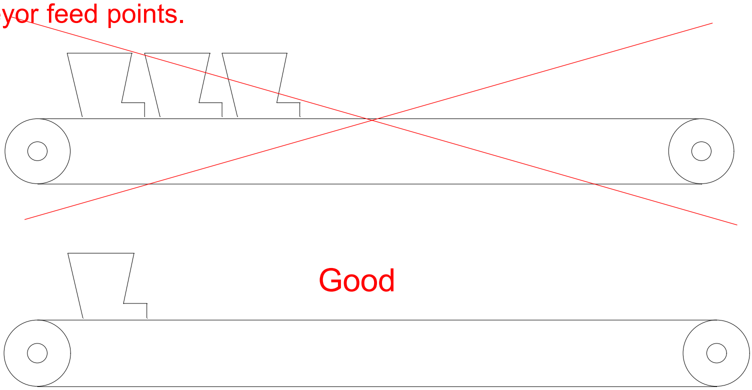
Under normal circumstances, the conveyor angle should not exceed 18 degrees from the horizontal. This is due to the fact that material can roll back down the conveyor and will be weighed twice thus contributing to weighing errors.

Belt loading.

For ideal weighing conditions the belt should be as full as possible. (100% volumetric utilisation). Wherever possible the material should lie along the centre line of the belt and be as even as possible. It is also desirable to prevent material surges.

Low belt loading; for instance running at say 20% of maximum loading can lead to non-linear results. This means usually the totalised load appears to be lighter than the actual result. This is because the ratio of the tension in the belt versus the belt loading is higher than that of a full belt, and therefore there tends to be a belt “lifting action” which causes the non-linearity.

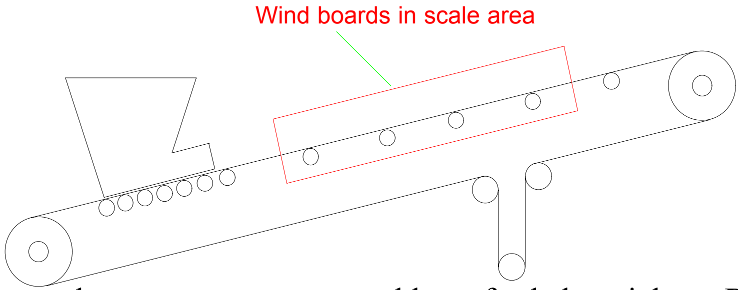
Conveyor feed points.



Belts with multiple feed points can cause weighing errors. This is due to the fact that different feed points create different belt tensions and this then affects the weighing. This is particularly noticeable in high accuracy weigh applications. This is usually assessed by doing multiple weighed load checks and cross referencing the results.

Straight conveyors create ideal weighing conditions for belt weighers. Where possible conveyors with curves should be avoided. When a conveyor has a curve, it is advisable to place the weigher at least 5 idler spaces below the curve.

Weather factors



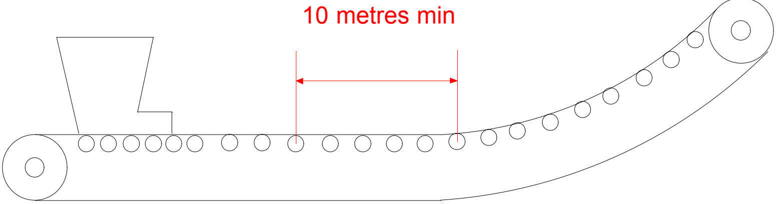
The weather can create many problems for belt weighers. During cold weather, the belt can become stiff. In order to ensure good belt weighing during cold weather conditions, the belt should be run for a period of half an hour before any weighing is attempted. This is also relevant before any calibration is attempted.

Windage can be a major source of weighing in-accuracies. This is caused by the wind getting underneath the conveyor belt and lifting the conveyor belt away from the idlers. On all conveyors open to the elements, wind boards should be employed at least in the vicinity of the belt weigher. The wind boards should be easily removable for cleaning spillage and general weigher maintenance.

Spillage

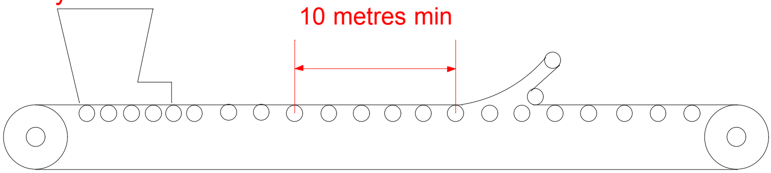
In general, it is usually preferable to keep the weighing area clean and free from any spillage. If this cannot be achieved, then the spillage should be allowed to build up and the weigher calibrated to allow for this. Note well - if the scale is then cleaned afterwards, the scale will then be incorrectly calibrated.

Concave curves



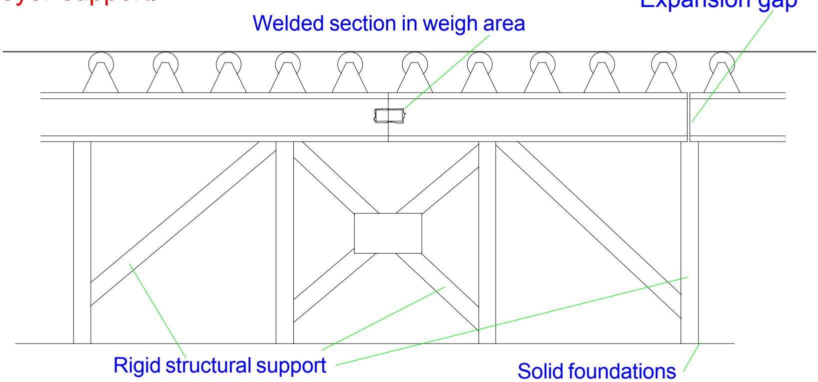
Concave curves tend to cause the conveyor belt to lift away from the idler sets. As the weigher relies on constant contact with the conveyor, this can lead to weighing problems. If a weigher is to be used in a conveyor with a convex curve, it should be placed at least 12 idler spaces or 12 metres below the centre of the curve.

Tripper conveyors



Similar to convex conveyors, a tripper conveyor tends to lift the conveyor belt away from the idler sets. If accurate and repeatable weighing is required, tripper conveyors should not be used for weighing applications. The tripper conveyor also tends to absorb changes can be made as required to the calibration of the electronics. If it is not possible to use material tests then calibration weights can be used.

Conveyor support.

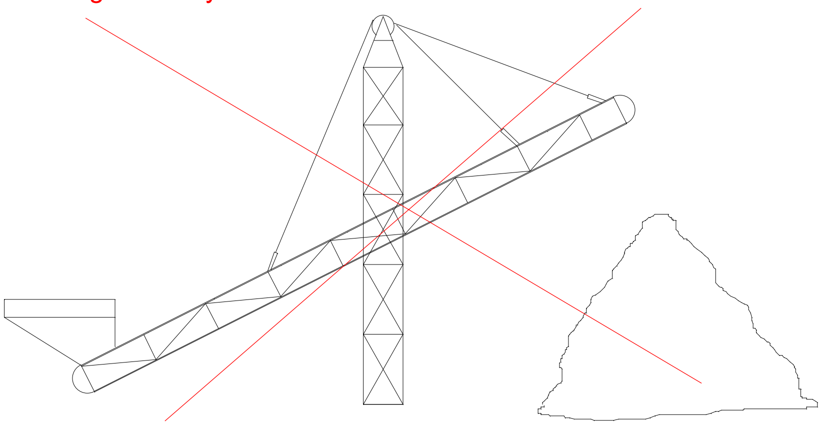


The conveyor section in the area of the weigher should be rigid. The maximum deflection of the weighing idler is only 0.08mm. If the conveyor deflection is greater than this, weighing problems can occur. It also a common mistake to place a belt weigher directly over a conveyer support as this can lead to “hogging”. This is where either side of the weigh section drops below the level of the main support. This is particularly noticeable where large temperature changes occur. It most cases it is better to locate the weigher to one side of the main conveyor support structure. The conveyor should not have any joints in the stringers in the area of the weigher.

Cable and flexi-trough conveyors

Flexible or rope conveyors should be avoided for use as weighing conveyors. If it is necessary to weigh on this type of conveyor, a weighing section, using standard idlers and stringer sections should be designed to fit into the weighing section of the conveyor.

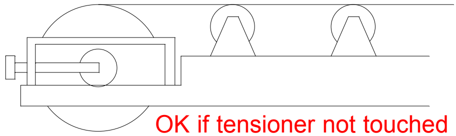
Variable angle conveyors.

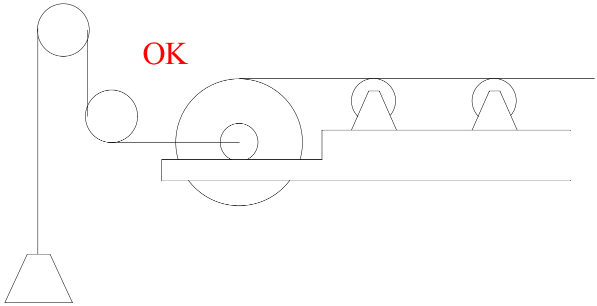


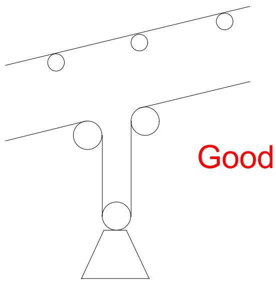
Avoid variable angle conveyors. Although it is possible to weigh on this type of conveyor the results are generally unsatisfactory. Some manufactures offer “angle compensation” devices but generally they do not work.

Gravity Tension Units (GTU)

Preferably all conveyors should have GTU’s. This device minimises the tension changes of the belt and in general keeps the belt tracking to an optimum. When examining weighing problems on a belt with a GTU, the GTU itself should be checked to ensure that it can move freely. Jammed GTU’s are a common source of weighing error. Ideally, the belt should be supported on all of the idlers. This will then ensure that when the belt loading changes the force acting on the weigh idler properly reflects the load. This means that the belt should have sufficient flexibility to sit properly into the trough of the idler sets.

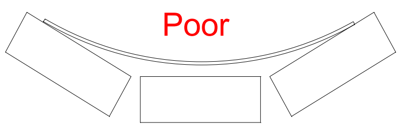


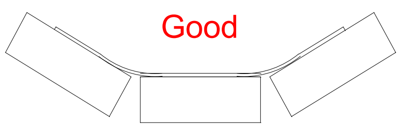




source of weighing error.

Belt settle





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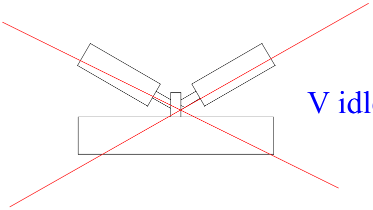
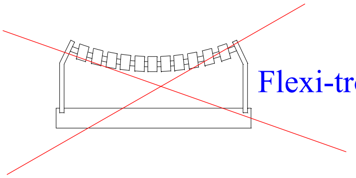
Idler types

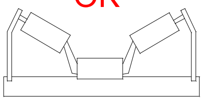


V idlers



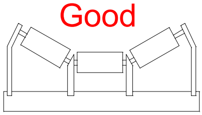
Flexi-trough idlers

OK



Off-set idlers

Good



In-line idlers

With a single idler belt weigher the idlers should be of the “In-line” type. Offset idlers can be used, but the results can be unpredictable. “V” type idlers or vari-trough (rope) idlers should not be used for weighing applications.

Idler specifications

This applies to the weighing idler and the plus three and minus three idlers around the weighing area. The idlers should be round all have the same trough profile to within 0.5 mm and all be of the same manufacture. Ideally if existing idlers are to be used, a cardboard cut out should be made of the weighing idler set, and this then compare to the profile of all other available idlers. The best fit of the idler sets should be selected and used in the weighing area.

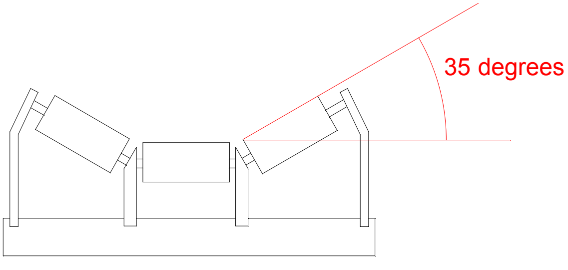
Idler squareness.

The idlers should be as square as possible to the stringer sections. This can either be done using an engineering square, or by triangulation. (see manual for details). The TIR of each roller should be better than plus or minus 0.5 mm

Idler alignment.

The weighing area should be raised above the other idlers by a factor of 10 mm. String lines should be employed along the length of the weighing section: Ideally two per idler. The idlers should be aligned to within a tolerance of plus or minus 0.5 mm of each other. This process can take up to a day if performed correctly.
It is only if the idler alignment is properly carried out, that the belt weigher will perform correctly.

Idler troughing angles.



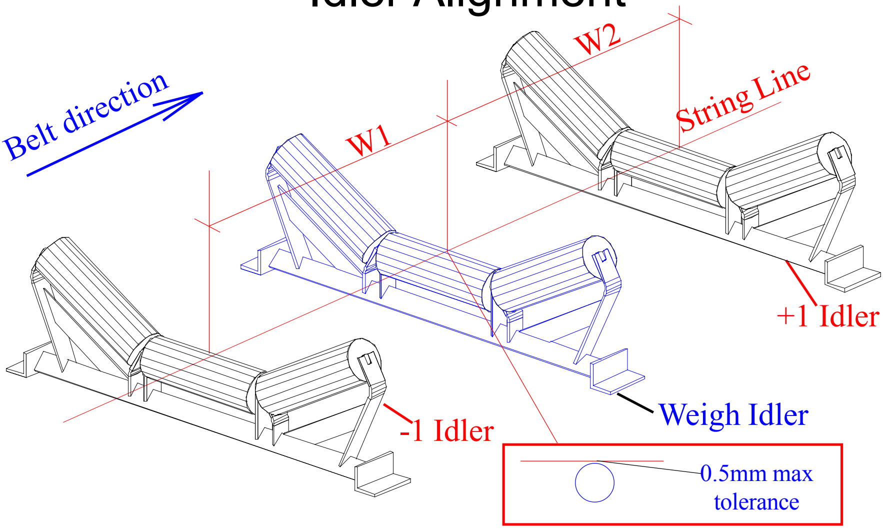
For the best weighing performance a flat belt should be used. This is not possible in most cases. Ideally the lower the troughing angle the better the weighing. Idler troughing angles are acceptable in certain cases up to 45 degrees, but extra care should be taken during the application engineering phase.

Training or tracking idlers.

The use of tracking idlers should be avoided. If they are used there should be a minimum distance of seven idler spaces from the weighing area.

The advice given in this document cannot be adhered to on every conveyor. It indicates the ideal situation for weighing. Some compromises have to be made, but the closer one gets to the ideal the better the weigher will perform. Weigher performance also depends to a great extent on good maintenance. If the application engineering is sound, and the maintenance is good, your belt weigher will give you useful information for many years.

Idler Alignment



The secret of good belt weighing is ensuring that the idler alignment is correct. The idlers should be square (90 degrees) to the belt. They should be aligned within 0.5mm of each other within the weighing area. A string line should be stretched tightly over the weigh Area, and the idlers shimmed to this reference point. The "Weigh Area" , which consists as a minimum of the weigh idler plus the +1 and -1 idler, and preferably two to three idlers either side of the weigh idler should be shimmed 10mm above the basic belt line.

Weigh Length Calculation

The weigh length (entered into the Material Calibration Screen) is calculated by W1 divided by two plus W2 divided by two; or :-

(W1/2) + (W2/2) = Weigh Length

Belt Length Calculation

If a standard Lodestone Jockey wheel Tacho is being used with a standard 200mm wheel, the belt length (entered into the Belt Speed Calibration screen) may be calculated as follows:

(WD * PI) / PPR * AP = Belt Length in metres

WD= Jockey Wheel Diameter (Metres [0.2m standard]) ~ PI =3.142 ~ PPR = Pulses per rev of the Tacho (30 standard) ~ AP = Pulses accumulated over 1 revolution of the belt . If the belt is measured by other means, it should be accurate to within 10mm.

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