

CHECKING MOISTURE METER ACCURACY

Everything You Need to
Know About Moisture Meters



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INSTRUMENT CO.
WHEN ACCURACY IS THE POINT.™

Table of Contents

Why Test? The Importance of Accurate Readings	3
Testing Pin-Type Meters.....	10
Testing Pinless Meters.....	13
Testing Thermo-Hygrometers	17

Why Test? The Importance of Accurate Readings

When professionals use moisture meters to measure moisture content in walls, floors, concrete, hay or other materials, they count on the readings being accurate. Even minor differences in moisture content can mean the difference between a job well done and a disaster. The reason professionals use a meter is to ensure success and take away any guesswork. Testing the meter from time to time is not only smart, it is a necessity.

Here are some of the consequences of “bad” moisture readings.

Woodworking and Meter Accuracy

For lumber distributors, beyond just making sure that lumber doesn't have excess moisture, they have to make sure that their lumber is properly acclimated for the region it's being sent to.

Wood is a hygroscopic material, meaning that it absorbs and bleeds moisture until it is in balance with the moisture level of its environment. Wood that isn't properly acclimated will warp, crack, or buckle when shipped to its destination.

To check wood acclimation, lumber distributors and manufacturers of wood furniture and flooring check the moisture content of wood using a moisture meter. However, if the meter is giving inaccurate results, then bad lumber might go out, causing problems down the line and on the bottom line.

Restoration Work and Meter Accuracy

Water damage restoration specialists using an inaccurate meter could incorrectly assess moisture-compromised building materials as being dry.

This can create numerous problems, including:

- Increased chance for mold growth.
- Failure of structural materials.
- Attraction of insects and other pests.
- Buckling, warping, and cupping of flooring.

This leads to callbacks and worse from angry clients who were told that their dry-out was “done” when, in fact, it wasn't.



Flooring Contractors and Meter Accuracy

Flooring installers have to closely monitor the moisture content of wood flooring at several stages of the job.

Another concern for flooring contractors and inspectors is the concrete slab, whether it exists in a newly-constructed building or has been in use for many years.

Monitoring moisture conditions in a concrete slab is important for a flooring professional not only because he or she will want to follow ASTM F-2170 standards, but because it's the only way to know for sure that the concrete slab is ready for flooring installation, coating or painting. For this, flooring professionals use RH meters (thermo-hygrometers) with in-situ probes to measure the core of the slab.

If a probe and meter are not working correctly, however, that could lead to unnecessary delays in the construction (if meter is giving readings that err on the "wet" side), or worse, cause contractors to incorrectly assume that the concrete is dry enough to work on.

Moisture trapped inside a concrete slab can have a serious impact on the finished product, such as a hardwood floor. This causes the wood to buckle, warp, and become unsightly, leading to callbacks and expensive reinstallation/replacement of wood flooring. Excess moisture in the slab can also cause adhesive and coating failures.



Farming and Moisture Meter Accuracy

For farmers harvesting hay, precisely managing the moisture content of hay in the field is critical to ensuring the production of top-quality feed and for disaster prevention.

Why? Because hay with excessive moisture, when baled, cause a reaction that makes the hay bale heat up. In storage conditions, this can lead to the hay bale spontaneously combusting in the silo, causing an explosion.

Why Moisture Meters are Useful

While the consequences of inaccurate readings are severe, using moisture meters is still the best method for getting moisture readings in a number of industries.

Moisture meters are a great tool to document quality control processes. Unlike hand/eye tests which provide little to no real information about the actual %MC of a material, moisture meters provide a quantifiable measurement of moisture in materials such as wood, drywall, hay, grain, concrete, cotton, paper, and even leather. You can also record your readings for later reference.



In addition to being useful for documentation, moisture meters provide readings very quickly. Some tests for measuring moisture for grain and other small materials would have you oven-dry them over the course of several hours and comparing pre- and post-drying weight to calculate %MC. For many jobs, time is of the essence, so the ability of a moisture meter to give a reading within a few seconds as opposed to several hours is invaluable.

The Importance of Checking Meter Accuracy

Moisture meters need to have their calibration checked from time to time in order to ensure that they are providing accurate readings. Even the most rugged moisture meters will, over time, start to drift out of calibration and return inaccurate results.



To know why a particular moisture meter might become inaccurate, it is important to know how they work, and how you can check their calibration.

There are two types of moisture meters that are commonly used:

1. Pin-Type Meters
2. Pinless Meters



In addition to these, there are thermo-hygrometers that are used to check relative humidity over a large area. Each of these devices has its own advantages and drawbacks. Here is a quick rundown of each:

Pin Type Meters

Pin-type meters are so named for the pins that these moisture meters use to penetrate materials to get a reading of the internal moisture content of that item.

How do they work?

These meters operate on the principle of electrical resistance. When the pins of the meter are pushed into a material, an electrical current is run through one of the pins, traveling through the material to the other pin. The meter measures how much resistance there is to the electrical current to determine the moisture content of the material. Since wood is a natural insulator and water is a conductor of electricity, low resistance means that more water must be present, and more resistance means that there is less water present.

Most pin-type moisture meters are calibrated for wood, but some have been calibrated for other materials such as drywall, insulation, hay, grain, paper, leather, and almost any other material you can think of that can be penetrated with pins. It also matters what type of wood the meter is calibrated for. You can use a species correction chart to find the actual %MC reading for your sample.

Pros of Pin-Type Meters:

Pinpoint accuracy of testing site between pins allows for testing a sample of material at both shell and core depths to demonstrate distribution of moisture.

Highly reliable readings.

Pins are easily replaceable.

Usable on uneven surfaces.

Cons of Pin-Type Meters:

Only able to measure material between the two pins. If a moisture pocket occurs elsewhere in the material being tested, it will have to be hit exactly between the two pins to be detected.

Pins break from time to time (though this is easily remedied by replacing them).

Leave pinholes in materials.

Pin meters are a staple tool for contractors, restoration experts, woodworkers, and many other professionals.



Pinless Meters

Unlike pin meters, which have to penetrate the surface of a material to get a moisture content reading, pinless meters can get a reading of a sample of material without leaving pinholes.

How do they Work?

Pinless meters use radio waves to “scan” a sample of wood or other material. The meter reads the fluctuations in these electromagnetic radio waves to determine the moisture content of the object being scanned.

Pinless meters are primarily used for wood, and their calibration is based on the specific gravity of a certain wood species. When taking readings on species other than the base calibration, adjustments need to be made by either using a species correction chart, or using a pinless moisture meter that features built-in specific gravity adjustments.



Pros of Pinless Meters:

Great for scanning large areas quickly. Since there are no pins to insert, you can press the sensor plate onto the material, take a reading, and then lift & repeat along the length of the material to quickly find a moisture pocket (just be careful not to drag the meter along the surface, as this can damage the material being tested, such as wallpaper or wood finish).

Ability to take multiple readings in the same material and average the results. Because it is so fast and easy to take a reading in a material, you can repeatedly scan an object several times to ensure accurate results.

They don't leave pinholes.

Cons of Pinless Meters:

HAS to have a flat surface large enough to accommodate the entire sensor plate. If a surface is too small or is uneven, then the reading given by the meter will be thrown off.

Scan to a fixed depth. Pinless meters scan to a fixed depth, and if the material is thinner than that fixed depth, you'll get moisture readings for whatever is beneath/behind the material being scanned, and not the material you're actually scanning. If the material is too thick, or the user has to measure through one surface into another, such as a subfloor, the pinless moisture meter cannot identify the source of the moisture.



Metal in an object may throw off readings. Nails and other foreign metal objects interfere with the electromagnetic radio waves sent out by a pinless meter, causing bad readings. Pinless meters have no means of excluding metal objects from a scan beyond moving the meter to a spot that doesn't have metal.

Surface moisture on the material can affect meter readings.

Fast and easy to use, pinless meters are a great tool for restoration experts and flooring contractors who need to scan large areas very quickly.

Thermo-Hygrometers

These devices work a bit differently from moisture meters. Strictly speaking, they aren't moisture meters, but, because they are important tools for restoration and woodworking professionals, we felt they still needed to be mentioned in this guide.

Instead of measuring moisture inside of a sample of material, these devices check the relative humidity and temperature of their immediate surroundings. Because they check relative humidity and not moisture content, these meters are sometimes referred to as RH meters.

How do they work?

Generally speaking, thermo-hygrometers use a built-in sensor to get a reading of the moisture in the air. The exact style and composition of this sensor element varies greatly from one meter to the next, as different manufacturers use different materials for their sensor elements.



Pros of Thermo-Hygrometers:

- Can be used to measure the RH of a concrete slab in accordance with the ASTM F-2170-11 standard.

- Fast, effective way to determine general risk for mold growth in a moisture-affected structure.

- Helps flooring installers determine the temperature and RH at which wood reaches EMC.

Cons of Thermo-Hygrometers:

- Temperature changes alter reading results. Especially at high humidity levels, slight changes in temperature can alter readings fairly drastically. Thankfully, accounting for temperature with a thermo-hygrometer should be easy, as it provides both RH and temperature readings.



Every thermo-hygrometer has a built-in “margin of error,” also referred to as “sensor tolerance.” This means that there may be a difference between the reading given and the actual level of humidity in a given area. For example, say that the actual RH of a room is 50%, if a hygrometer has a sensor tolerance of $\pm 3\%$, then you might get a reading of 53%, or a reading of 47%. This level of error can be okay if other factors such as the temperature have been accounted for.

No matter which type of meter you’re using for your work, you want to have the most accurate readings possible. In order to know that you’re getting an accurate reading, you need to test your meter and see if it is still in calibration. The following sections will cover how you can test your meters, as well as the common causes of inaccurate readings (and how to fix them, if possible).



Testing Pin-Type Meters

What Causes Inaccurate Readings in Pin-Type Meters?

Here are a few reasons that a pin-type meter can give you an inaccurate reading, and simple fixes, where applicable:

Rusted or Broken Pins

The Issue

The pins of a pin meter take a lot of punishment in day to day use. Not only do these pins have to withstand the force of being pushed into solid materials, they can be exposed to any number of harsh environments that cause extra wear and tear or rust.

Over time, these stresses can cause pins to corrode, rust, or even break. If rust or corrosion on the pins gets bad enough, it can interfere with the passing of electricity from one electrode to the other, throwing off the accuracy of the reading. Broken pins are tougher to push into a sample of wood, and limit the penetration depth that can be achieved as well.

The Fix

Thankfully, for most pin-type meters, fixing this problem is easy. Simply remove the rusted or broken pins and replace them with a new set of pins. This should restore normal function quickly.



Bad PC Board/Internal Problems

The Issue

Sometimes, a moisture meter can take a bad drop, be left in an environment that's too hot or wet, or suffer from some other accident that results in damage to the internal components of the meter. When this happens, it can cause the meter to malfunction, returning inaccurate readings, shorting out parts of the display so that it doesn't give you the whole number (for example, removing the top right bar in an 8 so that it looks like a 6), or simply prevent the meter from working at all.

The Fix

If you suspect that your meter's PC board is broken, do not attempt to fix it yourself. Contact the manufacturer and check to see if your meter is covered under warranty for such damage. If so, send the meter to the manufacturer for repairs. If not, you still may send the meter in for repairs, for a



fee. Talk this over with the manufacturer before sending in a unit for non-warranty repairs, as they should be able to provide you with an approximate repair cost, or help you determine if it is time to purchase a new one.

Low Batteries

The Issue

Before you send in a meter that you think needs repair or replacement, check the batteries first. Sometimes, low batteries can cause problems such as bad/inaccurate readings, dim or nonfunctional display, inability to activate meter, etc.

The Fix

If the problem is a low battery, then the solution is simple: take out the old battery and replace it with a new one. Delmhorst meters operate on a standard 9-volt battery, but some other manufacturers might use a different battery type.

Not Making Species Corrections

The Issue

When measuring wood, this is the most common reason for a “bad” moisture content reading. Different species of wood have different electrical resistances because of their varying physical properties. As a result of this, two different species of wood, even when they’re at the same actual %MC, can return two different results.

The Fix

Most manufacturers provide a species correction chart to allow you to make alterations to your reading results based on the species of wood being tested. Some moisture meters even have the ability to make species corrections automatically.

Testing Pin-Type Meters

The above issues are just a few of the more common causes of inaccurate readings in a pin-type moisture meter. Now that we know a few common causes of bad readings, how can you check to see if your pin-type meter is working properly?

Test Method #1: Using a Reference Meter

One of the most common methods of verifying a moisture meter’s accuracy is to test it against a second moisture meter.

In this test type, you take two pin-type meters and use them to test a single piece of wood or other material a few times. If both meters are accurate, then their readings for that wood sample should be close to matching.



For the best results follow these tips:

1. Use two of the same type of meter from the same manufacturer. Different manufacturers calibrate their meters to different standards. Because of this, if you use two different kinds of meters, then you'll end up with different results almost every time.
2. Take at least two measurements with each meter in two different spots. With extra measurements in different locations, you minimize the chances that a pocket of excess moisture in your testing material will cause an inaccurate reading.

Test Method #2: Moisture Content Standards

A moisture content standard is a device that is meant to verify the moisture content readings of a moisture meter. These pin-type meter specific devices provide a metal contact surface for users to press the pins of their meter against. This creates a closed circuit between the moisture content standard and the meter's pins, with resistance being controlled by the content standard.

Typically, there are two "moisture content levels" that a moisture content standard will test against, allowing a meter to be verified for accuracy at both "high" and "low" moisture levels. Moisture Content Standards are made for a particular type of meter, as different models might have different high/low values and electrical current outputs from others. For example, you wouldn't use the same moisture content standard to check the calibration of a wood moisture meter as you would use to check a hay moisture meter.

Test Method #3: Built-in Calibration Checks

Some moisture meters have a built-in ability to test their calibration. The way this works is actually similar to the operation of the moisture content standard, it just happens to be built into the meter itself instead of being an external device.

Built-in calibration checks are the most convenient method of checking the calibration of a pin-type meter. There are no external devices to carry around, and the whole process can be done on the job site in moments.

Combining Test Methods

Of course, if you really want to make sure that your moisture readings are as accurate as possible, combining test methods can be a huge help. For example, if there is internal damage to a moisture meter causing inaccurate readings, then the built-in calibration check might not be as reliable. Checking built-in calibration test results against a moisture content standard can provide a second point of calibration check over the built-in check point.



Testing Pinless Meters

Unlike pin-type meters, pinless moisture meters use radio waves to scan a material. This gives them the ability to read the moisture content of a large section of material at once.

Testing accuracy is just as important for pinless moisture meters as it is for pin-type meters. Professionals need these devices to test large areas of materials quickly, and often don't have the time to waste during a job.



What Causes Inaccurate Readings in Pinless Meters?

Many of the things that cause inaccurate readings for pinless meters are similar to the causes for inaccurate readings in pin-type meters. However, the operation of pinless meters is different enough from pin-type meters to introduce whole new issues. Some of the issues that can throw off reading accuracy include:

Damage to the Scanning Plate

The Issue

To give the best, most accurate readings, the scanning plate on the underside of a pinless moisture meter should be unblemished. Scratches, pits, and dents in the scanning plate prevent it from making smooth contact with the surface underneath it, which can lead to inaccurate reading results.

The Fix

Fixing this problem would mean replacing the scanning plate, which may mean sending the unit back to the manufacturer for repair. You can prevent this from happening by taking care not to drag a pinless moisture meter along the surface of the materials you are testing. Also, finding a moisture meter with a durable scanning plate made from solid metal instead of a soft pad can help to prolong the life and accuracy of your moisture meter. For example, Delmhorst's pinless ProScan and TechScan moisture meters both use solid plates for their contact surface.



Damage to the PC Board

The Issue

Just like with pin-type meters, damage to the internal components of the moisture meter from drops, heat stress, or water intrusion can cause a pinless moisture meter to become inaccurate or even stop working.

The Fix

Just like with pin-type meters, it is important that you don't try to take the meter apart to fix the PC board yourself. Instead, check with your meter's manufacturer to see if you can get a warranty repair/replacement for the meter, or what the cost of a non-warranty repair would be.

Uneven Surfaces

The Issue

In order to give an accurate measurement, the entire scanning plate of the pinless moisture meter needs to be able to make contact with the surface of the material to be scanned. Curved surfaces or objects that are too small to cover the scanning plate can't be read properly.

The Fix

The only fixes here are to either make the surface flat, or to use a different meter. An uneven surface simply won't provide a good reading with a pinless meter, and this is where a pin-type moisture meter would be a better alternative.

Objects Being Too Thin

The Issue

Because pinless meters scan to a specific depth, very thin objects cannot be scanned by themselves. The pinless meter, when used on an object that is too thin, will read the moisture content of items behind the object being scanned.

The Fix

Here, the fix depends on the situation. If scanning numerous lengths of thin lumber, you could try to stack them one on the other. When scanning floors or walls on the job site, use a pin-type moisture meter in conjunction with the pinless meter to help verify readings.



Failing to Correct for Specific Gravity (SG)

The Issue

Just like with pin-type meters, pinless meters are typically calibrated to a specific type of wood, such as Douglas Fir. When used to test a different type of material, pinless meter readings can be thrown off by differences in the specific gravity of the different material.

Fixes

Most manufacturers provide correction charts for making corrections based on the specific gravity of different types of wood and other materials for their pinless moisture meters. Alternatively, some pinless meters feature a built-in species correction that allows you to get readings that are accurate for that species of wood.

Low Batteries

Sometimes, the only problem with a pinless moisture meter is a bad battery. If your meter isn't working properly and you can't seem to pinpoint why the screen is dim, the built-in calibration isn't working or the meter keeps shutting off mid-use, try replacing the battery. You might be surprised at how much of a difference a fresh 9-volt can make.



Methods of Testing a Pinless Meter

Before each job, it's important to test your pinless moisture meter's accuracy to make sure that it is still providing accurate results. For pinless moisture meters, there are three ways to check meter calibration:

Pinless Moisture Meter Test #1: Using a Reference Meter

In this test method, the pinless meter is used to scan an object, and then a second reference meter is used on the same object.

As with the pin meter version of this test, it is important to use two of the same make and model moisture meter to ensure that both have been calibrated to the same standards.

Pinless Moisture Meter Test #2: Using Sensor Blocks

Many moisture meter manufacturers also supply special sensor blocks for their pinless moisture meter products. These sensor blocks are created to return a specific %MC reading when scanned by a pinless meter. If the meter measures a %MC value other than the one specified for that sensor block and pinless meter, then you'll know that the meter's readings are off, and by how much.



For best results, these sensor blocks should be kept in storage whenever they're not actively being used.

Pinless Moisture Meter Test #3: Built-in Calibration Checks

Instead of having to carry extra moisture meters or sensor blocks to test moisture meters, some pinless moisture meters, such as the TechScan and ProScan moisture meters from Delmhorst, have a built-in calibration check that lets you know on the spot if your meters are reading right.

This is perhaps the most convenient method of testing moisture meter accuracy, and one that can be done any time you have your meter on you.

Using Multiple Tests

You don't have to restrict yourself to only one method of testing your pinless moisture meters. You can do reference checks with two meters on a sensor block, or use a sensor block in tandem with a built-in calibration check.

By checking your moisture meter's accuracy before each and every job, you can rest easy knowing that you're getting the right readings, every time.



Testing Thermo-Hygrometers

When compared to pin and pinless moisture meters, thermo-hygrometers are very different. Even the most precise RH sensor has a margin of error. However, despite this “sensor tolerance,” it is still very important to have readings that are as accurate as possible to make better-informed decisions during restoration dry-out or flooring work when dealing with concrete subfloors.

What Causes Inaccurate Readings for Thermo-Hygrometers

Over time, as thermo-hygrometers are exposed to hostile conditions, they will start to lose accuracy. This loss of accuracy, sometimes called “sensor drift,” is virtually inevitable, even with the highest quality RH sensor available on the market. Here, we’ll explain some of the causes of sensor drift or other, more temporary inaccuracies in thermo-hygrometers.

Exposure to Harmful Chemicals/Corrosion

When placed in an environment with powerful corrosives or other free-floating chemical particles in the air, the sensor element of a thermo-hygrometer can become damaged very quickly. Chemicals that can cause damage to a thermo-hygrometer include plastics, PVC, polystyrene, and acetate. Once the sensor becomes damaged, it cannot be repaired, only replaced.

The best way to deal with this kind of damage is to prevent it from happening in the first place. Keeping the hygrometer out of caustic environments is paramount to keeping it operational. To further prevent exposure to harmful chemicals, avoid opening up the meter for any reason.

Contaminants on the Sensor Material

Even non-corrosive compounds on the sensor can cause the accuracy of readings to become compromised. Over the course of time, dirt and dust particles from job sites can settle on the sensor material, throwing the readings off little by little.

Exposure to Extremely Overpowering Humidity for a Prolonged Period of Time

Even though a thermo-hygrometer is designed to measure ambient moisture conditions in an area, they shouldn’t be left in extremely high humidity for too long. As the meter sits in a high-humidity environment, the sensor material will be exposed to moisture particles filled with contaminants that will settle on the sensor (bringing us back to the previous problem of contaminants). Also, the humidity itself can cause damage to the internal components of the meter if severe enough.



Low Batteries

To run at peak efficiency, a thermo-hygrometer needs to have a steady supply of electricity. Without enough juice to run, the meter might return inaccurate results or simply not work at all. Thankfully, a low battery is an easy fix. Simply take out the drained battery and put in a fresh one.

For most causes of sensor drift, the only real fix is to replace the sensor, which means sending the meter back to the manufacturer if the sensor is permanently mounted on the meter, or purchasing a new sensor if it is removable. Avoid opening the casing of your hygrometer yourself, as this may void your warranty if you have one.

Testing a Thermo-Hygrometer

Testing a Thermo-hygrometer is a little different from checking the calibration of a pin or pinless moisture meter. The two most common methods of test a hygrometer's accuracy are to use a second reference meter, or to use a salt solution.



About Using a Reference Sensor: Sensor Tolerance

Using a reference sensor to check calibration is a little different with two thermo-hygrometers than it is with pin or pinless meters. With thermo-hygrometers, the built-in sensor tolerance of your hygrometers means that a large spread in the readings of each meter is possible.

For example, say that the relative humidity of the room is 44%, and the thermo-hygrometers being tested have a sensor tolerance of 4%. One could read as low as 40% RH, and the other could go as high as 48% RH. In this example, both meters would still be within acceptable (for that model) tolerances, but you might think that one is off by a lot more than it is.

Tips for Using a Reference Sensor

Take multiple readings with both the test meter and the reference meter and average the results for each one. Also, place both meters as close to one another in the room where the test is taking place as you can without one meter blocking the other's ability to measure relative humidity.

With thermo-hygrometers, keeping the reference sensor out of harm's way when it isn't being used is of the utmost importance to ensure accurate readings to compare to your everyday use sensor. Keeping the reference meter in its original packaging and storing it in a clean, dry place when not in use prevents it from being compromised by contaminants and chemicals in the air, preserving its accuracy for longer.



Using a Saturated Salt Solution

Saturated salt solutions have long been a widely-accepted method of testing the calibration of a thermo-hygrometer sensor. When using a salt solution test, however, keep in mind the following:

1. For most thermo-hygrometer sensors, the sensor should be left in the salt solution bottle for a minimum of 12 hours in order to reach the intended RH level.
2. Prolonged exposure to high humidity can cause permanent sensor drift. Because of this, you should take care to limit the length of the time you leave the sensor in the solution bottle to the minimum 12 hours, and certainly not more than 24 hours.
3. Keep the bottle's temperature stable. If the temperature of the bottle fluctuates too much, it will throw off the final RH reading of the hygrometer.

Caring for a Thermo-Hygrometer

To prolong the useful life of your thermo-hygrometers, it is important to exercise care in the handling and storage of these devices.

When a hygrometer is not in use, take care to store it in its proper packaging and limit exposure to open air. Keep the meter in a cool, dry storage area where the packaging won't be exposed to temperature extremes or the chance of becoming immersed in liquids.

During use, avoid placing the meter in extreme temperature environments, such as a freezer or an active kiln operating at more than 140 °F (60 °C). Using a membrane or protective covering/filter over the meter's intake can prevent dirt and other free-floating contaminants from reaching the sensor material, prolonging its useful life.

Avoid touching, washing, or using compressed air to blow on the sensor element, or otherwise allowing it to come into direct contact with any other material.

If you take care of your moisture meter devices, no matter which ones you use for your line of work, and periodically check their calibration before you use them, then they'll take care of you by providing accurate, reliable, quantifiable readings of moisture for you work.

Learn more about moisture meter-related issues on the Delmhorst blog today, or contact us using the information provided at the end of this eBook.





Feel free to give us a call or email for answers to your questions about what kind of meter to use for your project, and where to purchase. And remember, we value our customers and look forward to your feedback.

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