

# Brooks Tube Auditor™

## Frequently Asked Questions

### Key Features and Benefits

- ✓ Rapid, non-contact volume measurement and precipitate detection in a single audit pass
- ✓ Minimizes downstream costs from the processing of empty plate wells
- ✓ Increases confidence in the concentration of delivered output samples
- ✓ Helps avoid damage to liquid handling tips caused by failed de-cap operations

### Q: How does the Brooks Tube Auditor™ work?

**A:** The Tube Auditor uses a high-resolution vision system to detect the liquid meniscus within the sample tube. Once the position of the meniscus has been determined, the volume of liquid is calculated. Additional algorithms are used to detect the presence of a cap on the tube and also any precipitate in the base of the tube.

To correlate the meniscus position to a liquid volume, the Tube Auditor requires a calibration data set; calibration involves auditing a known set of tubes for which the actual volume in each tube is supplied in a data file. The instrument software automatically generates a calibration line, specific to the tube and liquid type, allowing sample volume to then be determined from the measured liquid height.

### Q: What advantages does the Brooks Tube Auditor™ have over other methods / instruments?

**A:** Liquid volume may be determined by weighing the sample tube, however this requires the tare weight of the empty tube to be known, which may not always be available. Whilst an estimated tare weight may be used, significant variation in tube and cap weights has been observed, which can lead to inaccuracies.

Weighing sample tubes by hand is extremely time consuming and prone to error. Whilst instruments are available to help automate this process, they still take between 20 to 30 minutes to audit a rack of 96 tubes.

Liquid volume may also be calculated by determining the position of the meniscus using ultrasonic or other similar sensing technologies. Instruments using this technology rely on the tube being uncapped so that the sensor can 'look down' into the tube. This exposes the sample to possible moisture uptake and/or cross-contamination.

The Tube Auditor avoids the need to weigh sample tubes, operates with capped (or uncapped) tubes and combines accuracy with high speed operation.

### Q: What is the Brooks Tube Auditor Pro™?

**A:** Tube Auditor Pro is a software licence that enables precipitate detection and provides a facility to save and recall audited tube images. It can be added to any Tube Auditor configuration at any time.



### Q: What tube types does the Brooks Tube Auditor™ work with?

**A:** The Tube Auditor has been designed to operate with standard microtubes in SBS format 96- and 48-way tube racks, from major labware suppliers such as FluidX, Thermo Matrix, Abgene and Micronic.

A full list of currently supported tubes is available on request. Please enquire for other labware formats and custom applications.

### Q: Does the Brooks Tube Auditor™ support different tube types within the same rack?

**A:** The initial version of the instrument is designed to operate with racks containing one particular tube type; the characteristics of the tube determine the volume calculation, and this is currently defined at the rack level.

Different tube types could be processed within the same rack provided that they are i) physically compatible i.e. height, diameter etc. must be the same (or close enough to allow reliable handling within the instrument), and ii) any variation in volume characteristics is acceptable to the user.

It may be possible to enhance the instrument in the future to indicate that certain tube types are located in specific positions within the rack, which would then allow the software to use the appropriate liquid detection and volume calculation methodology; this would allow, for example, Matrix flat-bottom and V-bottom tubes to be audited intermixed within the same rack (as long as the positions are known) and achieve the stated accuracy for each tube.

Alternatively, Tube Auditor could be configured to report back the height of the liquid and the customer system could then calculate the volume based on its own knowledge of the tube type.

In either case, the tubes must be physically compatible i.e. height, diameter etc. must be the same (or close enough to allow reliable handling within the instrument).

### Q: What liquids does the Brooks Tube Auditor™ work with?

**A:** The Tube Auditor has been tested with DMSO-solubilized samples, Water, DNA (in TE buffer), Plasma, Blood and Urine.

### Q: What happens if the tubes are empty?

**A:** The Tube Auditor can detect and report empty tubes.

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**Q: What happens if the tubes are full?**

**A:** The Tube Auditor requires a minimum gap of approx. 1 mm between the base of any cap fitted to the tube and the meniscus of the liquid in order to reliably detect the meniscus position.

**Q: Does the liquid color matter?**

**A:** The color of the liquid has no effect on the accuracy of volume measurement; testing has shown successful precipitate detection with all but the darkest of samples. Generally, if it is possible to discern the precipitate from the colored sample by eye, then the Tube Auditor should also be able to detect it.

**Q: What if the liquid is cloudy?**

**A:** The cloudiness of the liquid has no effect on the accuracy of volume measurement; testing has shown reliable precipitate detection is difficult with very cloudy samples (in the same way as for darkly colored samples).

**Q: Does the Brooks Tube Auditor™ work with frozen samples?**

**A:** Tube Auditor was designed to operate with thawed samples. Limited testing shows that volume measurement can be undertaken with frozen samples provided there is no excessive frosting. Precipitate detection does not operate with frozen samples.

**Q: Does the Brooks Tube Auditor™ only work with full racks of tubes?**

**A:** No; the Tube Auditor is designed to work with racks containing anywhere from 1 to 96 tubes.

**Q: Does the Brooks Tube Auditor™ only work with complete columns of tubes?**

**A:** No; the Tube Auditor is designed to work with racks containing anywhere from 0 to 8 tubes per column.

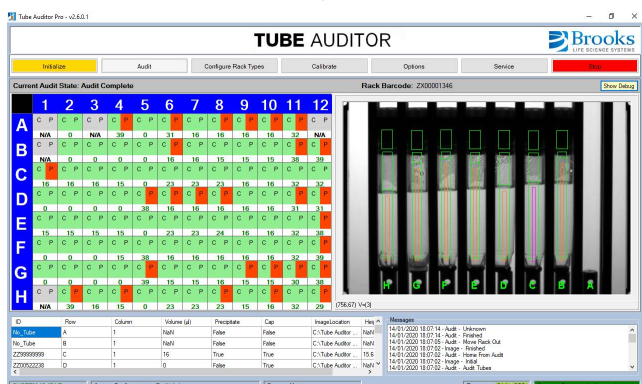
**Q: What happens if there is no cap on the tube?**

**A:** The Tube Auditor is designed to operate with tubes which are capped, thus protecting the sample from contamination or moisture uptake during auditing; the presence of a cap can be detected and reported.

**Q: Does the Brooks Tube Auditor™ work with tubes containing mixing beads?**

**A:** Yes; the Tube Auditor works equally well with tubes containing mixing beads; a compensation factor should be applied to adjust for the volume of the beads themselves.

The precipitate detection feature can be used to detect the presence of beads within the tube; note however it is not possible to differentiate precipitate from mixing beads or vice-versa.



**Q: Does the Brooks Tube Auditor™ need calibration?**

**A:** To correlate the meniscus position to a liquid volume, the Tube Auditor requires a calibration data set; calibration involves auditing a known set of tubes for which the actual volume in each tube is supplied in a data file (.xls format). The instrument software automatically generates a calibration line, specific to the tube and liquid type, allowing sample volume to then be determined from the measured liquid height.

**Q: Does the sample need to be centrifuged before auditing?**

**A:** Centrifugation of samples prior to auditing has been shown to result in optimum levels of system accuracy. This is particularly true in the case of aqueous samples where centrifuging helps give a better-defined meniscus and thus improved accuracy.

Tubes fitted with split-septum sometimes exhibit a tendency for liquid to sit underneath the septum, following liquid handling operations. In these cases, centrifuging ensures that the entire sample is in the main body of the tube and thus is audited.

**Q: How accurate is the Brooks Tube Auditor™ and is it affected by dimensional variations in labware?**

**A:** The Tube Auditor vision system is capable of detecting sample volume changes to better than ±10µl, however overall system accuracy can be affected by a number of factors e.g. dimensional variations in labware, sample droplets on tube walls etc. The Tube Auditor is intended as a high-speed liquid level measurement device as compared to a high resolution measurement device, such as an analytical balance.

**Q: What happens if I want to audit a new tube type?**

**A:** The Tube Auditor is supplied ready-configured to suit a specified set of tube types; new tube types may be defined by the user providing that the physical characteristics are compatible with the existing instrument configuration. If the new tube type is significantly different, the instrument may require re-configuration; please contact Brooks for further advice.

**Q: Can I use a non-standard cap with my tube?**

**A:** Non-standard caps may be used though this will depend upon the physical characteristics of the caps and tubes concerned; please contact Brooks for further advice.

**Q: Does the Brooks Tube Auditor™ read the (1D) barcode on the tube rack being audited?**

**A:** Yes; the Tube Auditor can be configured to read a barcode label affixed to any one of the four sides of the tube rack.

**Q: What format is the output data available in?**

**A:** Data may be output in either .CSV or .XML format. This is user-definable.

**Q: Do the light bulbs need replacing?**

**A:** The Tube Auditor uses a power saving LED backlight system with a thin design and very uniform surface light emission profile; it is nominally rated for 25,000 hours continuous operation and replacement should only be required if the light source fails.

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**Q: Will the Brooks Tube Auditor™ be as accurate when the lens of the camera gets dirty?**

**A:** Significant levels of dirt/dust on the camera lens are unlikely, given the environment that the Tube Auditor is used in; it is essentially a closed instrument and should not be subject to undue contamination.

If however there are some specks of dust on the lens this should not cause any issue to either the accuracy or the detection of precipitate. This is because the particles would be so close to the camera as to be completely out of focus.

If the camera lens is highly contaminated or smudged, there will be some effect, but this would tend to cause the image to blur if anything; this should not compromise the performance of the image system significantly.

It is straightforward to clean the lens and this is something that forms part of maintenance activities.

**Q: Will it affect the precipitate detection if there are particles on the lens?**

**A:** No - see answer above

**Q: What warranty is the Brooks Tube Auditor™ supplied with?**

**A:** The Tube Auditor is supplied with a 12 month return to base warranty that provides protection against design faults and premature failure of components, including software, which may occur under normal operating conditions; it does however exclude any consumable items. Warranty does not cover accidental or wilful damage or, misuse. Warranty is only valid if the instrument is operated and maintained / serviced as recommended by Brooks.

**Q: Do I get software upgrades?**

**A:** Software updates will be provided during the 12-month warranty period to rectify any reported issues.

**Q: Can I take out a service & support contract for the Brooks Tube Auditor™?**

**A:** Yes; we recommend that this option is taken to ensure continued optimum performance

**Q: Can the Tube Auditor discriminate between empty locations and empty tubes with no cap?**

**A:** Yes; our vision system uses algorithms specifically designed for that function

**Q: What effect does a 2D barcode reader have on the audit cycle time?**

**A:** Addition of 2D will add around 30 seconds to the audit time

**Q: Does calibrating with a full 96 tube rack result in better accuracy than using a rack of 8 tubes?**

**A:** Yes, as long as the volumes of the tubes used for calibration are all different and well spread from low to high volume. This will enhance the accuracy of the calibration curve as it will be based on a higher number of points.

**Q: Can the Brooks Tube Auditor™ be integrated with a shovel-type robotic gripper?**

**A:** The current version of the Brooks Tube Auditor has not been designed for integration with this particular type of robotic gripper.

**Q: Is it possible to measure the quantity of precipitate in the audited tubes?**

**A:** With the current version of software the Tube Auditor indicates the presence or absence of precipitate.

**Q: What is the minimum amount of volume that can be detected?**

**A:** The current version of the Brooks Tube Auditor™ can accurately measure volumes as low as 35µl. Lower volumes can be detected with some compromise in accuracy.

