



Tech Corner
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COMMON QUESTIONS REVOLVING AROUND DETECTOR TUBE ACCURACY

Some of the most commonly asked questions directed to our customer answer center revolve around detector tube system accuracy. Let's take a look at some of the more common questions and see if we can get a better understanding of the subject.

Q: What is the accuracy of your detector tubes?

A: The accuracy specification for detector tube systems is +/-25% of reading as established by NIOSH in their certification program conducted between 1973 and 1983. The American Industrial Hygiene Association (AIHA) in their manual, Direct-Reading Colorimetric Indicator Manual (Second Edition, 1993) makes the following statement on detector tube accuracy:

The accuracy of detector tubes generally is considered to be +/-25% of the reading. This is based on the criteria for certification of detector tubes as originally defined by the National Institute for Occupational Safety and Health (NIOSH).

Q: Does NIOSH or anyone else certify that the tubes are accurate?

A: The NIOSH certification program referenced above was discontinued in 1983, but it was picked up by the Safety Equipment Institute (SEI) in 1986 and continues today. Under both programs, detector tubes are tested by an independent laboratory and must meet an accuracy level of +/-25% at test levels of 1, 2 and 5 times the TLV (ACGIH threshold limit value) and +/-35% at 1/2 the TLV, all at a 95% confidence level. Both programs are limited to tubes in the TLV range and to a handful of listed substances, so by design they cannot cover all detector tubes.

Q: Does the +/- 25% mean that the tubes will always be off by 25%?

A: It does not mean that the system is off by 25% all the time. It means that the worst case should be a 25% error on any particular reading. Actual accuracy of a specific reading will most often be better.

Q: My direct-reading electronic instrument lists an accuracy of +/- 10%. Why is the detector tube accuracy so much worse?

A: Detector tube accuracy is not bad if you take all things into consideration. For example, the direct-reading electronic instrument generally requires a regular calibration, usually a span gas exposure every 30 days. The detector tube requires no user calibration over its listed shelf life, which is usually two years. Detector tubes are also designed to work in a wide array of environmental conditions, from 0 to 40 degrees

C and at least 10 to 90% relative humidity. Often a direct-reading electronic instrument has a narrower temperature and humidity window tied to the accuracy statement. When you add all these variables, the +/- 25% of reading is really pretty good.

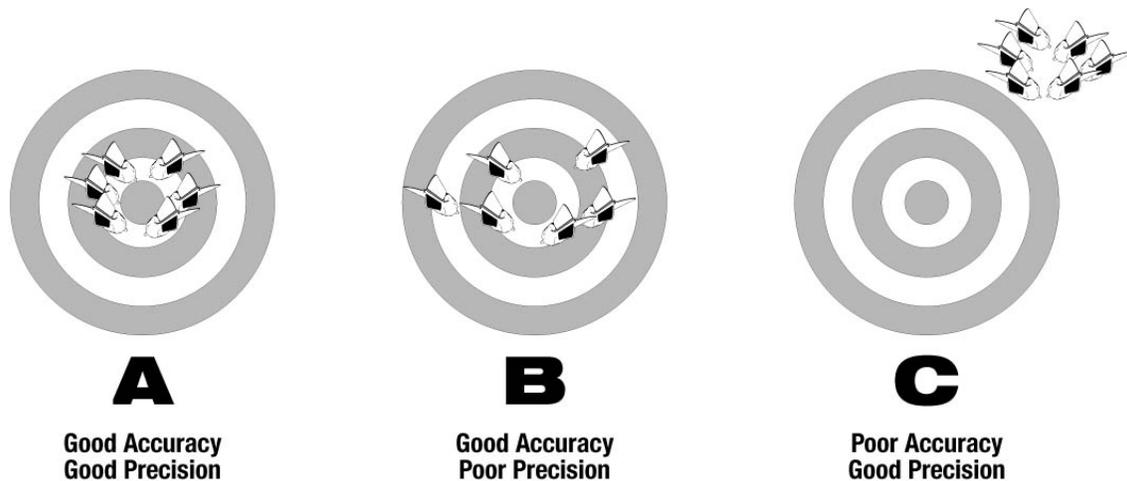
Q: Your competitor's handbook lists an accuracy of +/- 10 to 15% for some of their tubes. Why is their accuracy better?

A: The competitor's handbook is making no such claim. Those listings are statements of standard deviation not accuracy. This is possibly the most misunderstood issue of all. Several of the detector tube handbooks including ours list a standard deviation for each tube on the individual data pages. This listing is often misinterpreted as a statement of accuracy, when it is actually a statement of precision. Worse yet, the standard deviation number is often numerically smaller than the +/- 25% accuracy specification, so such a misinterpretation will overstate the accuracy level of the system.

The *accuracy* of a detector tube system (or any measurement system) is the level of agreement between the system and a known standard, in this case a target gas of known concentration. The *precision* of a measurement value is the level of agreement between it and other measurement values obtained under the same conditions. Standard deviation is a means of measuring precision. Specifically, standard deviation is an indication of how far a group of repetitive measurements will stray from the average of all the measurements. This value is independent of accuracy. A box of detector tubes could display a very small standard deviation (i.e., very good precision) and still produce a large error.

For example, suppose we have a box of carbon monoxide detector tubes that are date expired. We decide to test them, so we sample a standard cylinder gas mixture of 100 ppm CO in air. The tubes produce ten readings between 45 and 55 ppm with an average of 50 ppm. Our standard deviation would be quite low, because all of the readings are close to the average. However, our accuracy is very poor with the average reading showing a -50% error.

The classic illustration of the difference between accuracy and precision is depicted using darts on a dartboard target. In this case the accuracy is based on the distance from the bull's eye.



Q: What can I do to improve or optimize the accuracy of my detector tube measurements?

A: To assure optimum accuracy in using detector tubes, remember the tips below:

1. Detector tubes are calibrated at 20 degrees C (68 degrees F) and 50% relative humidity. Accuracy should improve as these conditions are approached.
2. Fresh detector tubes will generally be more accurate than tubes approaching their expiration date. Never use detector tubes that are past the posted expiration date.
3. Refrigerated storage will prolong the freshness of the tubes and improve accuracy. The recommended storage temperature is 5 to 10 degrees C (41 to 50 degrees F). Detector tubes should not be stored frozen. For optimum accuracy, be sure to allow the tubes to warm up to ambient temperature prior to use.
4. Older detector tube systems using rubber bulbs generally have a wider accuracy specification than systems with high precision hand pumps. If you have one of these older systems, accuracy can be improved by replacing it with a new precision pump system.
5. Crossing certain brands of detector tubes and pumps can cause huge accuracy losses due to the differences in the flow rate curves provided by the various pumps. Always consult the supplier and request test data to back up compatibility claims.
6. Regular leak checks of the pump will help to assure optimum accuracy by assuring that the proper air volume is passing through the tube.
7. The shorter the stain, the harder it is for a tube to meet the accuracy specification. (e.g., +/- 25% of a 1mm stain is a much smaller window than +/- 25% of a 10mm stain). If several ranges are available, choose the tube that will provide a stain length in the upper two-thirds of the tube's range.

For further information on our detector tube system, please contact our customer answer center at extension 782.