ing instruments may be affected by improper maintenance, component unreliability, lack of calibration, poisoning of the catalysts by interfering substances in the atmosphere, changes in airflow rates and volumes, and weak batteries For these reasons, a routine schedule of maintenance and calibration is necessary

The colorimetric tubes and papers present a somewhat different problem They are deceptively simple to operate Air is usually drawn through the tube with a squeeze bulb so this means no motor to fail or battery to replace However, there have been and still are variations from one tube to another due to manufacturing conditions which have not been controlled Practically all tubes have been improved as experience has been gained by users and makers, and some tubes have been withdrawn from production

One form of variability which has been troublesome, but is obvious to the user, is that produced by nonuniformity in particle size of the media (usually silica gel) which supports the reacting chemical The result in some tubes is that in transportation the gel fractionates into various sizes by gravity and the line between stain and no stain is not sharp but stretches irregularly across the tube and may extend much further up one side than the other, thus making it impossible to obtain an accurate reading

The tubes also vary considerably in their degree of chemical stability, although their useful storage life can often be prolonged considerably by storage in the refrigerator The purchaser may not know how long the tubes have been on the supplier's shelf and what have been the storage conditions, unless the manufacturer puts an expiration date on the tubes.

Rates of chemical reaction are very dependent on temperature, many tubes will give incorrect readings at high or low temperatures When tubes must be used in cold locations, they should be carried in an inside pocket next to the body where they can be kept warm and used quickly after removing them from the pocket Even then, the air drawn through the tube is cold and the results obtained must still be interpreted with caution Extreme temperatures change the volume of air drawn through the tube, which also affects results

If more than one substance is present in the atmosphere, it may interfere with the accuracy of the tube to give an incorrect reading or a color which cannot be matched with a standard Some detailed instructions for tube use include a list of possible interfering substances Unfortunately, many people fail to read the instructions completely or they are unaware of the presence of the interferences

Color blindness, which may be unsuspected by the operator, can also give false results in color-matching

The airflow through the tube usually is produced by either a squeeze bulb or a hand pump, which can produce volume variations New precision-made pumps are a recent development which is helping to lessen this difficulty, as many tubes are affected by the rate of airflow as well as by the total volume drawn through the tube This flow rate usually is regulated by a fixed or variable orifice, which must be checked regularly Airborne dust or lint will quickly plug such orifices, producing low airflow rates

Calibration of these instruments is not difficult but requires facilities not always available in an industrial situation—some method of producing an atmosphere containing a known concentration of the contaminants in a closed chamber Since a tube once used for calibration is worthless for further use, this method does not give complete reassurance about the accuracy of measurement with other tubes The reliability of the color tube method of air analysis therefore differs from electrical devices or a collection of samples for laboratory analysis The best that can be done is to test a definite number of tubes from each lot produced by the manufacturer If the number of tubes used does not justify purchase of a considerable number from a given production lot, the cost for tubes used for such calibration may make their use unjustified

Because of these variabilities (which affect the reliability), many use the detector tubes for screening purposes, when a given tube indicates the presence of a gas or solvent, they follow up with a more detailed method of analysis

The dangers from improper use of electrical direct-reading instruments or from false readings on color indicating tubes are fairly