This white paper describes the influences and sources of error which may be present when conducting moisture analyses. It discusses the routine tests which are necessary to ensure reliable determination of the moisture content and correct functioning of the instrument. The recommended tests and their frequencies are presented in the framework of a risk-based approach.

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1. Introduction

To run measurement equipment and analytical instruments in a quality system, industry specific regulatory requirements often have to be followed:

"Measuring equipment shall be calibrated and/or verified at specified intervals […] against measurement standards traceable to international or national measurement standards."

(ISO 9001:2008, 7.6 Control of Monitoring and Measuring Devices)

"Apparatus used in a study should be periodically inspected, cleaned, maintained, and calibrated according to Standard Operating Procedures. It is the responsibility of test facility management to ensure that instruments are adequate and functioning according to their intended use."

(OECD Principles of GLP, 4.2 Use, Calibration, and Maintenance of Equipment)

The statements cited above delegate the responsibility for the correct operation of equipment to the user. This also applies to moisture analyzers. Statements like these are usually formulated vaguely, as they are meant as general guidelines. Therefore, they do not offer specific statements as to how the guidelines should be achieved in everyday practice.

Questions such as “How often should I test my instrument?”, emerge in situations where guidance is needed to design standard operating procedures that are reasonable and appropriate. This means they should neither be too exhaustive, and thus costly and/or time consuming, nor too loose, and thus not adequate to assure the proper functioning of an instrument.

This white paper describes the influences on the performance of a moisture analyzer and explains that periodic routine testing with the appropriate tests reduces measurement errors and ensures reliable moisture determinations.

2. Influences on Accuracy

The accuracy of moisture analyzer results may be influenced by several factors. The most important are variability of the heating temperature, of the weighing results and of the sample characteristics. In this white paper we elaborate on how these influences on the accuracy affect the final drying result and how these influences can be controlled by performing appropriate routine testing.

Before detailing the individual influences which can affect the performance of a moisture analyzer, it is important to know that there are two types of influences that can limit the performance of an instrument - permanent and temporary influences.

2.1 Permanent influences

Permanent influences occur and persist. They limit the accuracy of the moisture analyzer and will be detected when the next performance test is carried out. They do not disappear until a corrective action has been taken. Examples could be incorrect adjustment of the heating unit or mechanical defects of the weighing unit. The consequences of these errors can be limited by applying suitable tests with appropriate frequencies to make sure that the error is detected early enough.
2.2 Temporary influences

Temporary influences limit the accuracy of a moisture analyzer only for the duration of the influence. The limitation on the accuracy will disappear without any intervention or corrective action as soon as the influence has stopped. Examples are air drafts, vibrations, room temperature fluctuations or influences from users such as incorrect sample handling, wrong sample preparation or operating errors in general. Temporary accuracy limitations cannot be detected with systematic periodic tests. To allow for these variations, it is recommended to apply the concept of a safety factor as described below.

2.3 Safety Factor

Reproducibility of the moisture content as determined from a limited number of measurements will vary, even if the setup is left unaltered. Besides these statistical variations, environmental conditions, sample handling and different operators influence the performance of the moisture analyzer. It is therefore recommended to apply a safety factor to stay within the defined acceptance criteria, even if temporary influences lower the accuracy of the instrument.

It is good practice to define two different acceptance criteria, the warning and the control limit. The control limit represents the limit value which has to be adhered to in order to satisfy the required accuracy. The warning limit is defined as the control limit divided by the safety factor and provides an early warning to indicate that the accuracy of the moisture determination might deteriorate. It is recommended to apply a safety factor of minimum 2 by default to compensate for the variations. The safety factor should be increased in accordance with the strength of the expected influences. I.e. in rough environments a higher safety factor should be applied.

The decisions and reasons defining what tests and what test frequencies are applied are based on the characteristics of the moisture analyzer, the required accuracy of the moisture determination and on the risk that is associated with undetected wrong measurements. Manufacturers, such as METTLER TOLEDO, know the characteristics of their moisture analyzers and recommend suitable tests to ensure adherence to the required measurement performance.
3. Accuracy of Moisture Analyzer Results

The following chapters focus on the main permanent influences that affect the determination of moisture content. To find out what the main influences are and what measures are meaningful in terms of quantifying the accuracy of a moisture analyzer, the questions below need to be answered.

- What causes variations of moisture content results [%MC] in a moisture analyzer?
- Where do these influences come from?
- How strong are the influences with regard to the accuracy of the moisture determination?
- What measures can be taken to control these influences?

Variability in moisture analyzer results is mainly influenced by three elements: the heating unit, the weighing unit and the sample itself.

3.1 Heating Unit

3.1.1 Heating temperature variability

Possible reasons for variability of the heating temperature are:

- The heating unit has never been adjusted.
- The heating unit is not adjusted correctly or has not been adjusted on site, under working conditions.
- The instrument location has changed since the last adjustment/calibration.
- The protective glass or reflector is contaminated.
- The temperature sensor is defective or contaminated.
- The temperature calibration kit is defective.
- The correction values of the temperature calibration kit were not applied correctly during temperature adjustment.

3.1.2. Impact of temperature variability on the moisture result

If the heating temperature is too low

- Not all moisture is able to evaporate since lower layers of the sample are not heated enough.
- Only a certain part of the moisture evaporates (e.g. ethanol but not water).
- Only the surface water but not the crystal water evaporates.

If the heating temperature is too high

- Components may oxidize, burn or combust.
- Properties of the substance change and not all moisture can evaporate (e.g. paint or glue forms a skin when the drying temperature is too high).
3.1.3 Temperature elasticity of the sample

It is important to know how susceptible the sample is to the variations in heating temperature. For some substances, the result of the moisture determination (%MC) barely changes even when the heating temperature changes considerably. Other substances show large differences in moisture content when the heating temperature varies only slightly. The degree to which the %MC result of a sample is affected by a temperature change in °C is called “temperature elasticity”. Therefore, the amount of influence from an erroneous temperature change depends on the temperature elasticity of the sample.

High temperature elasticity
Substances with high temperature elasticity exhibit a big change in the moisture content result with just a small change in heating temperature (typically organic substances).

Low temperature elasticity
Substances with low temperature elasticity need a big change in the heating temperature until an influence on the moisture content result is visible (typically inorganic substances).

3.1.4 Determination of temperature elasticity of a sample

To determine the temperature elasticity of a sample, the following procedure can be conducted:

1. Before testing, make sure that there is enough sample material for several measurements.
2. Keep the sample airtight so that the moisture content does not change during the measurement series.
3. For the first measurement, use the established moisture determination method for this substance. Note the moisture content as result %MC.
4. For the next measurement, set the drying temperature to 5 °C above the correct heating temperature and run the test with a new sample of the substance. Note the moisture content as result %MC+5°C.
5. Next, set the drying temperature to 5 °C below the correct heating temperature and run the test with a new sample of the same substance. Note the moisture content as result %MC-5°C.

Evaluation
The temperature elasticity is the change of the moisture content [%MC] per degree of temperature change [°C]. To evaluate the change in %MC it is determined what the changes of the result are if the temperature is raised +5 °C and lowered 5 °C from the original method temperature. The differences are not always symmetric, therefore the bigger of the two values is then used to evaluate the temperature elasticity.

\[
\text{Temperature elasticity} = \frac{\Delta \%MC}{\Delta T} \\
\Delta T = 5°C \\
\Delta \%MC = \text{Maximum magnitude of } \Delta \%MC_{+5°C} \text{ and } \Delta \%MC_{-5°C} \\
\Delta \%MC_{+5°C} = \%MC_{+5°C} - \%MC \\
\Delta \%MC_{-5°C} = \%MC_{-5°C} - \%MC
\]
Example Milk Powder (high elasticity)
Measurements:
\[
\begin{align*}
\%MC & = 4.60 \ \%MC \\
\%MC_{+5^\circ C} & = 4.85 \ \%MC \\
\%MC_{-5^\circ C} & = 4.45 \ \%MC \\
\end{align*}
\]
Evaluation:
\[
\begin{align*}
\Delta \%MC_{+5^\circ C} & = 0.25 \ \%MC \\
\Delta \%MC_{-5^\circ C} & = -0.15 \ \%MC \\
\Delta \%MC & = 0.25 \ \%MC / 5 \ ^\circ C \\
\Delta T & = 5 \ ^\circ C \\
\end{align*}
\]
Evaluation:
\[
\text{Temperature elasticity} = 0.25 \ \%MC / 5 \ ^\circ C = 0.05 \ \%MC / \ ^\circ C
\]

Example Potato Chips (medium elasticity)
Measurements:
\[
\begin{align*}
\%MC & = 1.35 \ \%MC \\
\%MC_{+5^\circ C} & = 1.48 \ \%MC \\
\%MC_{-5^\circ C} & = 1.23 \ \%MC \\
\end{align*}
\]
Evaluation:
\[
\begin{align*}
\%MC_{+5^\circ C} & = 0.13 \ \%MC \\
\%MC_{-5^\circ C} & = -0.12 \ \%MC \\
\Delta \%MC & = 0.13 \ \%MC \\
\Delta T & = 5 \ ^\circ C \\
\end{align*}
\]
Evaluation:
\[
\text{Temperature elasticity} = 0.13 \ \%MC / 5 ^\circ C = 0.026 \ \%MC / \ ^\circ C
\]

Example Butter (low elasticity)
Measurements:
\[
\begin{align*}
\%MC & = 14.87 \ \%MC \\
\%MC_{+5^\circ C} & = 14.89 \ \%MC \\
\%MC_{-5^\circ C} & = 14.87 \ \%MC \\
\end{align*}
\]
Evaluation:
\[
\begin{align*}
\%MC_{+5^\circ C} & = 0.02 \ \%MC \\
\%MC_{-5^\circ C} & = 0.00 \ \%MC \\
\Delta \%MC & = 0.02 \ \%MC \\
\Delta T & = 5 \ ^\circ C \\
\end{align*}
\]
Evaluation:
\[
\text{Temperature elasticity} = 0.02 \ \%MC / 5 \ ^\circ C = 0.004 \ \%MC / \ ^\circ C
\]
3.2 Weighing Unit

There are several properties which limit the performance of the weighing unit. The most important are repeatability, eccentricity, nonlinearity and sensitivity [1].

3.2.1 Sensitivity

Sensitivity is the ratio between the weighing value (indicated on the balance) and the actual mass of the reference weight. A sensitivity of 1 (one) means that the displayed mass value equals the mass of the reference weight.

The evaluation of the moisture content [%MC] is based on the difference between the wet sample weight and the dry sample weight. The result is the percentage of the moisture content with regards to the wet sample weight. Determining the moisture content is based on relative weight measurements. I.e. the relationship between the wet and dry sample weights remains the same even if the sensitivity is not adjusted correctly. Hence sensitivity has no impact on the moisture result. Figure 2 illustrates this finding with an example.

![Diagram](image)

Figure 2: Wrong adjustment of sensitivity does not influence the accuracy of the moisture content result (%MC). Even though the weighing unit which is represented by the graph SE2 (in blue) has a wrong adjustment, the calculation of %MC remains the same compared to a correctly adjusted weighing unit represented by the graph SE1 (in green).

Nevertheless, routine sensitivity tests by the user are recommended. The sensitivity test is fast and easy to perform and assesses the condition of the weighing cell with regards to sensitivity adjustment, stability and speed. Changes in these factors may indicate a potential problem in the weighing unit that triggers further testing and diagnostics. Sensitivity testing therefore helps indirectly to maintain the accuracy of the moisture analyzer.
3.2.2 Eccentricity

Eccentricity is the deviation in the measurement value caused by eccentric loading, in other words, asymmetrical placement of the load on the weighing pan. It is important to note that the eccentricity error does not explicitly apply to the weight of the sample itself but to the weight loss.

Generally, the eccentricity error has no considerable influence on the moisture content result: Firstly, the weight loss due to the drying process is usually small compared to the balance capacity, and secondly, the sample is not moved during drying. Consequently, eccentricity is not a dominant contributor to the measurement uncertainty. Even for the case of sample sizes close to the capacity of the balance with high moisture content, the eccentricity error can generally be neglected: This is due to the fact that the relative eccentricity error, compared to the weight loss, is small.

Consequently, routine eccentricity tests by the user are not recommended. Eccentricity will be tested by the service technician when performing preventive maintenance and calibration.

3.2.3 Nonlinearity

The ideal characteristic weighing curve of a balance is a straight line through the measurement points of no-load and full load (nominal weighing capacity). Nonlinearity is the deviation of the indicated weighing value from this straight line. It is important to note that the nonlinearity error does not explicitly apply to the weight of the sample itself but to the weight loss.

A nonlinearity error has no considerable influence on the moisture content result as the weight loss due to the drying process is generally small compared to the balance capacity. Even for the case of sample sizes close to the capacity of the balance with high moisture content, the nonlinearity error can generally be neglected: This is due to the fact that the relative nonlinearity error, compared to the weight loss, is small.

Consequently, routine nonlinearity tests by the user are not recommended. Nonlinearity will be tested by service technician when performing preventive maintenance and calibration.

3.2.4 Repeatability

Repeatability is the ability of a weighing instrument to provide identical results when the same load is placed several times and in a practically identical way on the weighing pan under reasonably constant test conditions. Repeatability is the dominant error for small sample weights. It influences both readings (wet weight and dry weight). However, repeatability has a very small influence on the accuracy as compared to a possible temperature deviation between the programmed target temperature and the actual temperature (see chapter below). It is therefore sufficient to test repeatability with a very low frequency.

Routine repeatability tests by the user are not recommended. Repeatability will be tested by the service technician when performing preventive maintenance and calibration.
3.3 Relevance of deviations of Heating Unit and Weighing Unit

In general, measurement errors due to the influence of repeatability of the weighing unit are less likely than measurement errors due to differences between the programmed target temperature and the actual temperature. As previously stated, the impact of a change in heating temperature is larger for samples with higher temperature elasticity. To compare different samples, example calculations are presented for samples (same as chapter 3.1.4) having high, medium and low temperature elasticity.

The following assumptions are made:

- The typical deviation between target temperature as programmed in the moisture analyzer and actual temperature is 2°C.
- The typical repeatability of the weighing unit is 0.08 mg (data of HX204).

For the three examples, it is calculated which deviation between target temperature and actual temperature and which variability of the weighing result due to repeatability would be necessary to change the indicated moisture content by a specific percentage. These values are set in relation to the typical temperature deviation and to the typical repeatability. The larger this quotient is, the less likely it is that the indicated moisture content deviates critically from the true value. In other words, the smaller it is, the more critical is the respective unit, and the more it has to be assessed by appropriate tests.

Sample with a high elasticity of 0.05 %MC/°C (Milk Powder)

For a sample size of 5 g, a change of the indicated moisture content by 0.05% can be induced by a:

- 1 °C temperature deviation between target temperature and actual temperature, or a 2.5 mg variability of the weighing result due to repeatability.

The quotient for the temperature unit based on the typical temperature deviation is 1 °C / 2 °C = 0.5, whereas the quotient of the weighing unit based on the typical repeatability is 2.5 / 0.08 mg = 31.25.

Sample with a medium elasticity of 0.026 %MC/°C (Potato Chips)

For a sample size of 5 g, a change of the indicated moisture content by 0.026% can be induced by a:

- 1 °C temperature deviation between target temperature and actual temperature, or a 1.25 mg variability of the weighing result due to repeatability.

The quotient for the temperature unit based on the typical temperature deviation is 1 °C / 2 °C = 0.5, whereas the quotient of the weighing unit based on the typical repeatability is 1.3 mg / 0.08 mg = 16.25.

Sample with a low elasticity of 0.004 %MC/°C (Butter)

For a sample size of 5 g, a change of the indicated moisture content by 0.004% can be induced by a:

- 1 °C temperature deviation between target temperature and actual temperature, or a 0.1 mg variability of the weighing result due to repeatability.

The quotient for the temperature unit based on the typical temperature deviation is 1 °C / 2 °C = 0.5, whereas the quotient of the weighing unit based on the typical repeatability is 0.2 mg / 0.08 mg = 2.5. Even for samples with low temperature elasticity, the influence of deviations between the target temperature and the actual temperature is dominant as compared to the influence of repeatability of the weighing unit.
Conclusion of the above sample calculations
Measurement errors due to deviations between the programmed target temperature and the actual temperature are more likely and have a higher impact on the accuracy of the %MC results than measurement errors due to the influence of repeatability of the weighing unit. Hence, tests that detect temperature deviations (SmartCal, temperature calibration) are more often required than weighing performance tests. These tests are described in detail later.

4 Routine testing of moisture analyzers

4.1 Comprehensive testing in routine operation

Maintaining the accuracy of an instrument and reducing the risk of being out of specification requires testing by the service provider, the user and the instrument itself.

Service
By calibrating all measurement components of the instrument using traceable standards and manufacturer SOPs, a comprehensive statement of its condition will be provided. Cleaning of the instrument and functional tests of all supporting components assure correct functioning and best technical condition of the moisture analyzer.

User
In between maintenance and calibration by the service provider, the user should perform routine tests to monitor the most important parameters influencing measurement accuracy. This ensures that quality requirements are met and that measurements fulfill the required accuracy, i.e. stay within the associated warning and control limits.

Instrument
Many state-of-the-art instruments include built-in test and adjustment functionalities, as well as software and hardware features (e.g. LevelControl) that help to avoid measurement errors.

4.2 Hierarchy of tests – Temperature versus weighing

As described above, measurement errors due to deviations between the programmed target temperature and the actual temperature are more likely and have a higher impact on the accuracy of the %MC results than measurement errors due to the influence of repeatability of the weighing unit. Weighing is a more stable and controlled process than heating. Hence, the risk stemming from the weighing unit is rather low, as long as no defect occurs. Therefore, the main reason to test the weighing unit is to check its proper functioning and/or detect defects. This can be done by performing periodic sensitivity tests. Periodic testing of eccentricity, nonlinearity and repeatability is not as important and can be done by the service technician within the framework of periodic maintenance when performing a calibration. Temperature deviations are more likely and have a bigger impact on the moisture result than variability in weighing. The impact depends on the temperature elasticity of the sample.

Conclusion
The frequency of tests that focus on temperature should be higher than tests that focus on the weighing accuracy. Moisture analyzers that are used to measure the moisture content of samples with higher temperature elasticity require more frequent testing than those used for samples with lower temperature elasticity.
4.3 Test frequencies in routine operation

The recommendation of testing procedures and corresponding frequencies is based on:

- The required accuracy of the moisture content result [± %MC].
- The impact on the business, consumer or environment, should the moisture analyzer not be functioning properly.
- The detectability of a malfunction.
- The temperature elasticity of the sample.
- The availability of built-in adjustment and testing functionalities.

The recommended frequencies for the routine tests extend from weekly, monthly, quarterly and twice a year up to yearly (e.g. calibration by authorized personnel).

It is assumed that the more stringent the accuracy requirements of a moisture determination are, and the higher the temperature elasticity of the sample is, the higher the probability becomes that the moisture content result does not meet the accuracy requirements. In this case, the test frequency is increased. Similarly, if the severity of the impact increases, the tests should be performed more frequently. More frequent tests lower the likelihood of a negative impact occurring i.e. risk is reduced. If a malfunction of the moisture analyzer is easily detectable, the test frequency is decreased.

![Diagram showing test frequency increases as a function of more stringent moisture content accuracy requirement, increasing temperature elasticity and increasing impact of incorrect moisture determination.](image)

Figure 3: The test frequency increases as a function of more stringent moisture content accuracy requirement, increasing temperature elasticity and increasing impact of incorrect moisture determination.

4.4 Recommended tests

During the routine operation of a moisture analyzer only those tests are recommended which deliver a meaningful statement with regards to controlling the quality of the measurement result. The purpose and coverage of all recommended tests are described below.
4.4.1 Calibration (by service engineer)

Calibration by a service engineer is an extensive test of all important parameters of a moisture analyzer. It is performed by using manufacturer SOPs and traceable measurement equipment. Preferably, a calibration is combined with preventative maintenance where all parts are cleaned and the functions of all components are tested before calibration.

**Purpose**
Provides an overall on-site calibration certificate based on international standards using traceable measurement equipment.

**Weighing unit**
The calibration of the weighing unit comprises the comprehensive tests of the weighing parameters. If deviations from manufacturer tolerances are detected, an adjustment is carried out. The calibration results are documented and handed out to the user.

**Heating unit**
The calibration of the heating unit using the temperature calibration kit is performed against manufacturer tolerances. If deviations occur, an adjustment is performed. The calibration results are documented and handed out to the user.

4.4.2 SmartCal test (by user)

The SmartCal reference substance is highly temperature elastic and contains a specific amount of moisture which makes it an ideal test substance for verifying the performance of moisture analyzers. Specific control limits for the SmartCal test are provided by METTLER TOLEDO (not to be confused with the control and warning limits for the weighing accuracy). Being out of these control limits indicates that the moisture analyzer might have a substantial deviation of the measurement result that could compromise the required accuracy of the moisture determination [2, 3, 4].

**Purpose**
SmartCal test is a performance check that verifies the instrument’s overall functionality.

**Weighing Unit**
SmartCal is a system test which does not test the weighing unit separately. It therefore does not provide information about the weighing cell in terms of weighing deviations \([Δg]\). However, a defect or substantial variability will be detected with SmartCal by showing a result outside the SmartCal control limits.

**Heating Unit**
SmartCal is a system test which does not test the heating unit separately. It therefore does not provide information about the heating unit in terms of temperature deviations \([Δ°C]\). However, a defect or substantial inaccuracy will be detected with SmartCal by showing a result outside the SmartCal control limits.
4.4.3 Sensitivity Test (by user)

The sensitivity test is performed by placing a known reference weight on the weighing pan and comparing the displayed value from the moisture analyzer with the reference value. The values must be within the applicable warning and control limits. If a critical deviation occurs, an adjustment may have to be performed [5].

Purpose
Performing the sensitivity test delivers an indication of incorrect adjustment of the weighing unit as well as defects of the weighing cell that require more in depth diagnosis before further use of the moisture analyzer (e.g. defect due to improper transportation).

Weighing unit
The sensitivity test detects deviations that may be caused by a defect or incorrectly adjusted weighing unit. The sensitivity test is also capable of detecting instable weighing behavior that may also indicate mechanical problems of the weighing cell.

Heating unit
The sensitivity test is not capable of providing any diagnostic information about the condition of the heating unit.

4.4.4 Temperature calibration (by user)

Temperature calibration is performed by using a temperature calibration kit as a reference. The kit is inserted into the heating unit and is heated to the target temperature. After stable temperature conditions are achieved, the reading of the kit is compared with the displayed temperature of the moisture analyzer. The reading must be within the specified warning and control limits [6].

Purpose
Performing a temperature calibration indicates the condition of the heating unit. Temperature deviations due to changes in the environment, contamination of the protective glass or the reflector, or an incorrect adjustment of the heating unit will be detected. Critical deviations may be adjusted.

Weighing unit
Temperature calibration does not provide any diagnostic information on the weighing unit.

Heating unit
The temperature calibration detects deviations of the drying temperature. Deviations may be caused by incorrect adjustments, dirt on the protective glass, reflector or temperature sensor, or by environmental influences such as strong air currents.
4.4.5 Test or adjustment with built-in reference weight

Testing and adjustment mechanisms built into instruments consist of one or more reference weights, and a loading mechanism that is activated either manually or automatically. Such a mechanism allows convenient testing and/or adjustment of the sensitivity of the weighing instrument. Because the built-in weight cannot be lost, cannot be touched and is kept in a protected place inside the instrument, this concept has advantages over testing or adjusting with an external weight, which is vulnerable to damage, dirt and other adverse effects.

However, because the built-in test weight is not accessible, it cannot be declared as being traceable, since traceability requires that the weight can be removed and compared periodically with another reference weight of a higher class. Nevertheless, the built-in weight can be tested against an external reference weight using the very weighing instrument as the comparator. With this comparison, the integrity of the built-in calibration mechanism can be tested.

If a weighing instrument features such an adjustment mechanism, it should be frequently used. As a consequence, routine sensitivity tests with external reference weights may then be performed less frequently. This practice is in line with guidance issued by the US Food and Drug Administration [7].

Purpose
Performing the test or adjustment with internal weights delivers an indication of incorrect adjustment of the weighing unit as well as defects of the weighing cell that require more in depth diagnosis before further use of the moisture analyzer (e.g. defect due to improper transportation).

Weighing unit
The test detects deviations that may be caused by a defect or incorrectly adjusted weighing unit. It is also capable of detecting instable weighing behavior that may also indicate mechanical problems of the weighing cell. By means of an adjustment, these deviations can be frequently corrected, provided there is no mechanical problem of the weighing unit.

Heating unit
The test is not capable of providing any diagnostic information about the condition of the heating unit.
5 Summary

To be conform with guidelines and standards such as ISO, GLP/GMP, IFS/BRC routine testing of moisture analyzers is necessary. Testing should be reasonable and appropriate to assure the proper functioning of the instrument. Only by understanding the influences upon the moisture analyzer’s performance, a decision can be made as to which tests are required and how often they should be performed.

Deviations of a moisture analyzer are mainly influenced by three elements: the heating unit, the weighing unit and the sample itself. Temperature deviations are more likely than weighing deviations and have a bigger impact on the moisture result. Therefore, the frequency of tests that focus on temperature deviations is higher than for tests that focus on the weighing accuracy. Further, the degree of the deviation depends on the temperature elasticity of the sample.

Maintaining the accuracy of an instrument and reducing the risk of being out of specification requires testing by a qualified service provider, by the user and utilizing the instrument’s built-in reference weights (if existing).

The following tests are recommended for a risk-based performance monitoring of a moisture analyzer:

- Calibration (by service engineer)
- SmartCal test (by user)
- Sensitivity test (by user)
- Temperature calibration (by user)
- Test with built-in reference weight (FACT, by instrument)

The frequency of each routine test depends on the risk that is associated with the measurement process.
6 References

[1] GWP® – Good Weighing Practice™ – A Risk-Based Approach to Select and Test Weighing Instruments, White Paper, Order-Number 11793489 40/12, Mettler-Toledo AG, Greifensee, Switzerland, July 2009


[4] SOP for Periodic SmartCal™ Test of Moisture Analyzers, Order-Number 30031480, Mettler-Toledo AG, Greifensee, Switzerland, November 2011


[6] SOP for Periodic Temperature Calibration of Moisture Analyzers, Order-Number 30031481, Mettler-Toledo AG, Greifensee, Switzerland, November 2011