**Analytical Balance Maintenance and Calibration –**

**Guidelines and Example SOP**

**Background Information**

Analytical balances are precision instruments that are important in clinical laboratories for accurate weighing. The most common uses include weighing for the preparation of reagents and for pipette calibration.

Electronic analytical balances, used in the clinical laboratory, work on the principle of magnetic force restoration. When an object is weighed, the force that is registered is lifted by an electromagnet. The electrical current required to oppose the downward motion of the weight in the magnetic field is measured by a detector and converted to a weight that can be read on the balance’s digital display panel.

Analytical Balance Precision Tests

The components to the testing of analytical balances include the following four tests:

* Reproducibility
* Linearity
* Calibration
* Cornerload

*Reproducibility*

The ability of the instrument to give the same weight reading for a given object and it is expressed as a standard deviation.

*Linearity*

Quantifies the accuracy of the balance at intermediate readings throughout the weighing range of the instrument.

*Calibration*

This test involves the comparison to the weight reading of a given mass standard and the actual value of that standard.

*Cornerload*

The cornerload test checks that a given object gives the same reading regardless of its position on the weighing pan.

**Important Points to Remember When Conducting Analytical Balance Checks**

*Annual Calibration Requirements*

The complete requirements for the annual checking of balances consist of four tests. Two are required tests and the others are recommended tests. Reproducibility and Annual Calibration Check are required tests and Linearity and Cornerload tests are recommended but not required. All four tests should be performed at the initial validation of the balance.

The required tests should be performed annually and under the following circumstances:

* Major maintenance is performed on the balance
* The balance is moved to a new location
* The performance of the balance is in question

*Test Weights*

* Standard test weights should be treated as precision devices and handled with forceps. Direct hand contact should always be avoided. Care should also be taken to avoid sliding weight across any surface and especially stainless-steel weighing pans. Weights should be stored in a covered protected box.

*Temperature*

* The accuracy of an analytical balance is affected by room temperature. For the best stability there should be a variation of no more than one degree Celsius within any weighing period.

*Air Drafts*

* Moving air will affect measurements of .001mg or less. An enclosure around the weighing pan to avoid fluctuations in moving air is recommended.

*Static Electricity*

* Static electricity will affect the accuracy of an analytical balance. Sources of static electricity are carpets, plastic draft shields, and melamine or Formica table tops.

*Vibration*

* Balances are very sensitive to any kind of vibration or movement. It may be necessary to obtain a very sturdy table for the analytical balance to minimize the effects of vibration or movement.

**Analytical Balance SOP Example/Template**

**Purpose**

To describe maintenance and calibration procedures for the analytical balances used for the weighing of reagents or for gravimetric pipette calibration.

**Definitions**

*AMR - Analytical measurement range*

*SD - Standard Deviation*

*CV - Coefficient of variation*

**Analytical Procedure**

Instruments

* List the name and model of the balances in use at your laboratory

Supplies

* List your reference weights and any other equipment you will be using
* Plastic weigh boats
* Forceps for the manipulation of standard weights

Calibration intervals

*Daily* - Auto calibration and calibration verification with one weight.

*Annually* - Calibration Check and Reproducibility Tests

Linearity and Cornerload testing are recommended but not required.

Operation Instructions

*Daily Maintenance*

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| --- | --- |
| **Step** | **Action** |
| 1 | Clean the balance with a soft brush following each use. If necessary, clean the balance with a damp cloth to remove debris and allow the balance to dry before the next use. |
| 2 | Prior to use, check for spilled substances, that the balance is level and on a firm surface free from drafts or air currents. |
| 3 | Check the balance pan to ensure that it is properly seated. |

*Balance Internal Calibration*

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| **Step** | **Action** |
| 1 | Perform an auto calibration or internal calibration according to the instruction in the instrument manual ***(insert those instructions here)*** |

*Daily Calibration Check*

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| --- | --- |
| **Step** | **Action** |
| 1 | Check your balance for drift each day using an external weight. ***(Include the weight to be used in your procedure)*** |
| 2 | Weigh the external weight following the instructions for operation. |
| 3 | Document the results on the Daily Calibration Check sheet and check that the weight is within the allowable range. (Refer to Related Documents) |
| 4 | |  |  | | --- | --- | | **If** | **Then** | | The weight is not within the acceptable range | Take the balance out of service until corrective action can be performed or it is repaired by the service representative. | |

*General Operation of the Balance*

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| --- | --- |
| **Step** | **Action** |
| 1 | Check that the balance is leveled and select an appropriate container or weigh boat. |
| 2 | If applicable, allow the substance that is going to be weighed to come to room temperature |
| 3 | Place the weigh boat or container to be used on the center of the pan, close the balance door and tare the balance. |
| 4 | Remove the weigh boat or container from the balance and insert the substance or object to be weighed |
| 5 | Open the balance door and place the weigh boat or container with the object or substance being weighed on the center of the balance pan and close the door to avoid drafts and air currents. |
| 6 | Allow the weight reading to stabilize and record the weight from the digital display panel. |
| 7 | Carefully remove the weigh boat or container and the weighed object or substance from the balance and close the door. |

Annual Calibration Check /Accuracy Check

*Required Annual Checks*

* Reproducibility: Measures the ability of a balance to repeatedly deliver the same weight reading for a given object or weight expressed as a Standard Deviation.
* Annual Calibration Check/verification: Refers to a comparison of weight readings of a standard or certified weight and the actual value of that standard weight.

Reproducibility testing: The reproducibility test involves repeatedly weighing a given object 20 times and analyzing the results. Select a test weight that is nearly equal to the capacity of the analytical balance.

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| **Step** | **Action** |
| 1 | Tare the balance and record value (“without weight”) reading on a log. |
| 2 | Place the test weight in the center of the pan and record the stabilized reading under the heading “with weight reading”. |
| 3 | Remove the weight |
| 4 | Repeat steps 1 to 3 until there are a minimum of 10 readings in both columns. |
| 5 | Subtract each “without weight” reading from the corresponding “with weight” reading and record the differences (ie, deltas) on a log |
| 6 | Calculate the SD of the deltas |
| 7 | |  |  | | --- | --- | | **If** | **Then** | | The calculated SD is within specifications | The balance is acceptable for use. | |
| 8 | |  |  | | --- | --- | | **If** | **Then** | | The SD is outside of specifications | Check that environmental and operational conditions are met. | |
| 9 | |  |  | | --- | --- | | **If** | **Then** | | Environmental and operational conditions are met | Repeat the test. | |
| 10 | |  |  | | --- | --- | | **If** | **Then** | | The precision is still outside the specifications | Notify the laboratory manager and contact qualified service personnel for repair. | |

Calibration Check/Verification (also known as Analytical Balance Accuracy)

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| **Step** | **Action** |
| 1 | Select 5 or 6 standard weights that cover the AMR of the balance. |
| 2 | Tare the balance so that it reads zero. |
| 3 | Weigh each of the standard weights and record the observed weight in the log (see Related Documents). Note that if different sets of weights are available, it is important to use the same weight from the same set each time. Compare the observed weights with the previous weighing. |
| 4 | The results are acceptable if there has been no significant change from previous weighings. Tolerance limits should be available from the instrument manufacturer. |
| 5 | |  |  | | --- | --- | | **If** | **Then** | | A weight does not agree | Reweigh and document new reading | |
| 6 | |  |  | | --- | --- | | **If** | **Then** | | The calibration results are not within the acceptable range | Take balance out of service and contact the manufacturer for service | |

**Recommended Additional Annual Balance Checks**

***(These tests are recommended but not required)***

* 1. Linearity Test: The Linearity test verifies the accuracy of the balance at intermediate values of weight.
     1. For this test use 2 certified weights that should be approximately half the weighing range of the balance. The two weights should not be interchanged during the procedure, identify them as weight A and weight B.
     2. Zero the balance and place weight A on the pan and record the weight on the linearity chart (see Related Documents) in the column marked 0% to 50%.
     3. Remove weight A and place weight B on the pan near the center. Re-zero the display with B still on the pan.
     4. Place weight A on the pan with B still on the pan. Record the reading under the column marked 50% to 100%.
     5. Calculate the difference between the 2 readings. The difference should be less than the advertised tolerance for linearity or accuracy.
  2. Cornerload Test: This test is used to check that the balance delivers the same weight when it is put on different positions on the weighing pan.
     1. Use a certified weight that is close to the maximum capacity of the balance.
     2. Place the test weight in the center of the pan record the weight and then re-zero the display.
     3. Move the weight one-half way from the front edge of the balance. Record the reading on the cornerload chart under the "Front" column.
     4. Repeat step 3 at the half way locations for the right, left and rear of the balance.
     5. Compare the results against the recommended tolerances for the balance.

**References**

1. CAP All Common Checklist, 2021
2. DAIDS GCLP. Version 4.1, 2021
3. CLSI. General Laboratory Equipment Performance Qualification, Use, and Maintenance, 2nd ed. CLSI guideline QMS23. Clinical and Laboratory Standards Institute; 2019.
4. Environmental Protection Agency Office of Pesticide Programs (EPA/OPP) Microbiology Laboratory, SOP EQ-03-07 for Calibration and Maintenance of Weigh Balances January 2014).
5. Use and Maintenance of Analytical Weighing Balances, Center for Biological Engineering (CBE Laboratories, SOP 018 v.003 June 2022).

**Related Documents**

Analytical Balance: Daily/Annual Maintenance and Calibration Logs