Best Practices

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Quality Statement

H&M Analytical Services, Inc

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Purpose

This document is intended to convey the manner in which:

- Administration and documentation procedures are conducted
- Analytical services are performed consistent with good laboratory practices
- Equipment is maintained in proper calibration and alignment
- Analytical tools are used in the analysis of the X-ray data

Administration & Documentation

Minimum Documentation Required

Upon the acceptance of any sample(s) from a customer, H&M requires that the following minimum documentation be provided:

- Purchase Order or other notice of commitment of funds for work requested
- Transmittal Letter, created by the requesting party, that fully describes the work that is being requested, including any special considerations or details that are being sought, and that gives notice of how the sample materials are to be disposed (returned, trashed, etc.) If available, MSDS sheets should be supplied.
- The Technical contact and the Billing contact information for the requesting party's company.

Invoice Generation and Sample Identification

When all the relevant and necessary minimum documentation is available, H&M creates the original invoice for the work requested. The invoice serves several purposes:

- Contains the sample identification from the requestor's transmittal letter for each sample received
- An H&M unique Sample ID is manually entered which links to the data files that are generated and which can be later used for archive retrieval purposes
- Provides a list of the total number of samples, the type of test(s) to be conducted on each, which aids with H&M's machine scheduling and loading
- Contains all necessary billing information and job total value for the enumerated services

Job Ticket Traveler

The invoice for each job is printed and placed in a job ticket traveler along with the transmittal document(s) and the sample(s). This package is kept in the lab in an individual job tray which is placed in FIFO order on the lab sample prep table.

When the job's sample(s) has (have) been suitably prepared for the requested test(s), the job ticket traveler goes with the sample holder(s) that contain(s) the material(s) for test and stays with the machine that is chosen for the test. The job ticket traveler is not moved from that machine's control area until all the samples have been run.

The job ticket traveler then goes to the office where the analytical report is prepared and all relevant data from the invoice is transferred to and referenced in the analytical report.

Raw Data File Handling

The raw data files are moved electronically from the chosen machine's control computer to the office computer on which is located a licensed copy of the analytical software, and the materials databases used for search and match identification. The data files are placed into a folder that is identified by the customer company's name. Sub-folders may be created if several projects are in-process for the same customer; this precludes confusion and the need to search through one common folder to find project-specific raw data files or reports.

The filename assigned to each sample corresponds to the unique identifier assigned during the sample log-in process. During analysis, derivative files are frequently generated that retain the unique identifier but use a separate file identifier to distinguish it. In this way, the original raw data file is stored without alteration.

MS Word Document Generation and Handling

Analytical reports are generated in the MS Word application. These reports contain sample identifiers, sample preparation history, testing history, description of analysis, methods, test results, and interpretation when warranted. Graphs of the X-ray spectra are included as separate figures.

The reports are electronically transmitted via e-mail or fax to the recipient (requestor), and that file is also stored in the customer folder (or sub-folder) with a filename that gives the date of the report. Updates / additions are issued a suffix letter to differentiate from the original report; all versions are retained.

Security of Analytical Report Documents

The MS Word documents do not carry the H&M letterhead nor do they carry the preparer's signature. This is because our customers have told us that they may use the document's contents in a cut-and-paste fashion for inclusion in their own reports. However, it is H&M policy to provide a US Mail hard copy which is printed on letterhead and carries a handwritten signature. Security of the H&M letterhead, names, and the original text is afforded in this way.

PDF Documents -- Security Concerns Addressed

We can offer PDF documents as well, but those that are computer-generated directly from MS Word documents can be reversed and things can be altered; therefore, we advise against this method of archiving at our customer's facility. PDF documents may be prepared by scanning which flattens everything to bit-mapped pages, thus preventing alteration of text or value tables, although these can result in significantly large files. The customer shall determine how it wishes to deal with such issues.

Archiving of Data and Reports

At the end of each calendar year, the entire H&M customer file (including any associated sub-folders) from the office computer is copied to a CD-ROM. This compact disk archive is kept in a fire-safe location off-site. It can be accessed at any time in order to help in assessing historical trends or for other purposes, not the least of which may have relevance in a legal proceeding. The CD-ROM medium is a once-writable medium; therefore, it is not possible to alter any file that is held on it and re-write the altered file back to the CD-ROM. Thus, data integrity in our archive media is assured. These CD-ROMs are stored indefinitely.

Good Laboratory Practices

Good laboratory practices insure that submitted samples will be handled with care to avoid:

- Loss
- Exposure to contaminants
- Compromise of material's structure

Good laboratory practices also insure that personnel who handle the submitted samples do so with a thorough understanding of:

- How to properly prepare the samples for analysis
- Material composition and safe handling (MSDS information, if presented)
- Minimizing their own personal exposure to potentially hazardous materials
- How to recover sample material for return to customer

Finally, good laboratory practices assure that the work area, tools, prep equipment, labware, etc. are reasonably clean, serviceable, and suitable for the intended use.

Sample Handling

H&M requests all of its customers to provide a minimum sample quantity of 250 mg (dry powder) with an upper limit of 2000 mg. We prefer a quantity greater than the minimum in order to prevent loss from spillage, grinding or other sample preparation, or other events that would render the sample amount inadequate. As a matter of course, we use clean, new weighing papers under our sample holders so anything that does spill off the sample holder can be recovered to be used again or to be placed back into the original sample container.

To avoid exposure to contaminants, all items that come in contact with sample materials are either new one-use items, or are thoroughly washed and dried between uses. All other agents that could produce contamination are at a safe distance or are totally isolated in different parts of the lab.

Occasionally, it is necessary to break down a sample to a finer powder if it has a tendency to agglomerate (produce large particles which will fall apart with light mechanical force), or if it is not of sufficient fineness to pass through a -400 mesh sieve. In that case, a mortar and pestle or a shaker mill is employed. While most materials will not undergo phase changes under such preparation, it is well-known that pharmaceuticals can experience polymorphic changes with small amounts of heat and pressure. The use of the mortar and pestle for these types of materials is indicated and only the barest minimum of pressure and grinding movement is used to break down such samples to the required fineness.

Personnel Training

The laboratory is under the supervision of a PhD-level scientist, who trains and supervises all personnel. All personnel who will have anything to do with sample preparation and handling are instructed in the proper manner and methods to be used. Trainees are supervised until they can demonstrate proper technique and repeatability.

Any documents that may contain warnings or other information related to the safety of any material being handled as a sample (MSDS, for example) are to be read and understood so that precautions like goggles, face masks, etc. can be utilized if necessary.

Sometimes the customer will require that sample materials be returned, as much as can be recovered after the testing is complete. Again, the use of new, one-use items such as weighing papers and clean spatulas are used to transfer the sample

material from the sample holder back to the original sample container. Personnel engaged in such handling will also be trained to maintain the cross-checking so as to not introduce a sample material to be returned into the wrong container.

Housekeeping

The best way to keep sample contamination to a minimum and to provide for the best working environment is paying attention to simple housekeeping in the laboratory work space.

Reusable glass or plasticware is washed in a neutral detergent, sometimes in an ultrasonic cleaner to guarantee removal of debris from tiny crevices. Items are rinsed and then set out to air dry or may be hand dried if more appropriate.

Lab work surfaces are washed down at regular intervals in order to remove traces of sample materials that may be present.

Reusable hardware items such as spatulas, sectioning knives, and glass slides are washed and rinsed after each use. Milling balls and milling containers are subjected to a high-pressure air stream to get rid of most fine dust particles and are then cleaned using aggressive means such as alumina pebbles inside the containers with the milling balls, where the contamination is abraded from the sidewalls and the ball surfaces. The resulting reduced alumina pebble material is discarded and the interior of the containers and the balls are washed, rinsed and dried, ready for the next use.

Any preparation equipment that is reusable but shows signs of wear or potential failure will be immediately discarded and replaced with new.

Facility maintenance is done as-needed or on a seasonal schedule.

Equipment Maintenance – Calibration and Alignment

An accurate result is directly related to the alignment and calibration of the X-ray equipment.

Since the equipment is heavy and is not moved, it is reasonable to assume that once aligned mechanically, the machine will preserve that setting and not deviate. The reasoning is valid, but all mechanical systems experience wear and tear and alignments may shift over time.

To guarantee that the equipment is “on-target”, there are several standard reference materials (SRMs) that can be used to prove alignment and proper response of the diffraction system. The SRMs are traceable to NIST and are certified to be used as standards for such purposes.

Three groups of diffraction standards are used. The first group is used to align or characterize the instrument and includes:

- Silicon (SRM 640; line position standard)
- Alumina Plate (SRM 1976; intensity standard)
- LaB_6 (SRM 660; peak shape standard)
- Mica (SRM 675; low angle standard)

The second group is used to calibrate the analytical methods, especially for quantitative phase analysis. These include:

- SiN_x (SRM 656; quantitative standard)
- Portland Cement Clinker (SRM 2686; quantitative standard)
- Hydroxyapetite (SRM 2910; quantitative standard)

The third group constitutes additives that may be blended with the test sample and serve as internal standards. These include:

- Si (SRM 640, 640b, or 640c)

At least once every 6 months, each diffractometer undergoes an alignment check-out using the appropriate SRM. For our Bruker and Panalytical machines, we use NIST-certified pure Si (silicon) and Al_2O_3 (corundum). Each of these SRMs has documented intensity and angular response data that can be checked by running a sample and comparing it to the NIST Certificate for those materials. If all of the relative intensities and angular locations of the peaks are correct, the machine is considered in alignment and there is nothing further to do.

If there is an error in the sample response, the whole of the mechanical alignment of X-ray source, sample holder plane, slit systems, and detector orientation must be inspected, adjusted, and set in order to make the correction. After this procedure is done, another sample test is run and the comparison to the knowns is checked again. Usually, everything returns to “on-target” after one re-alignment procedure.

Other routine maintenance that is required includes changing filters in the cooling water loop, observation and setting of flow rates and temperature set-points, and observation of X-ray tube anomalies that may indicate end-of-life conditions in the tube.

Analysis of Data

Once the diffraction spectra have been obtained, analysis is performed using several commercial analytical software tools:

- *Powder Diffraction File* (published by the International Centre for Diffraction Data) – updated yearly
- *JADE Analysis Program* (produced by Materials Data Inc.) – upgraded as newer versions are released

- *Inorganic Crystal Structure Database* (published by Fachinformationzentrum Karlsruhe) – upgraded twice yearly

Each of these software packages is considered the leader in its respective field and H&M installs the updates / upgrades as the newer versions become available.

Conclusion

The quality of the product that is output from H&M Analytical Services, Inc., requires that all of the foregoing be strictly adhered to.

H&M is committed to producing the best quality analyses of sample materials and it is in both its and the customer's best interests to adhere to same.