Method Name	QA/QC Procedure		
Method	FAS-QA/QC Procedure	**Approved By**	M. Desilets

Purpose:

This procedure provides guidelines for routine quality assurance (QA) and quality control (QC) of all elemental determinations performed by Florin Analytical Services (FAS). Figure 1 shows the flow chart for quality control for samples as they move through the FAS laboratory and the emphasis on quality at each step of analysis.

At FAS, QA/QC occurs at each step of the analyses from sample check-in to final reporting. These verification steps are carried out at every step of the analysis by each analyst handling the sample. As samples are checked in and labelled, the numbering and order of the samples are verified. The sample numbers and sequence are verified when the method worksheet is created. During sample weighing the numbering of the sample and the vessel that the sample is being transferred to is checked. The sequence that samples are loaded for digestion is specified in each procedure and verified by the analyst. After digestion the sequence and numbering is again verified as the digested material is transferred to either culture or centrifuge tubes for anlysis. At FAS the quality of the blanks, replicates and standard reference material (SRM) samples are assessed by the analyst as the determination is performed as well as the QC manager and the Senior Chemist.

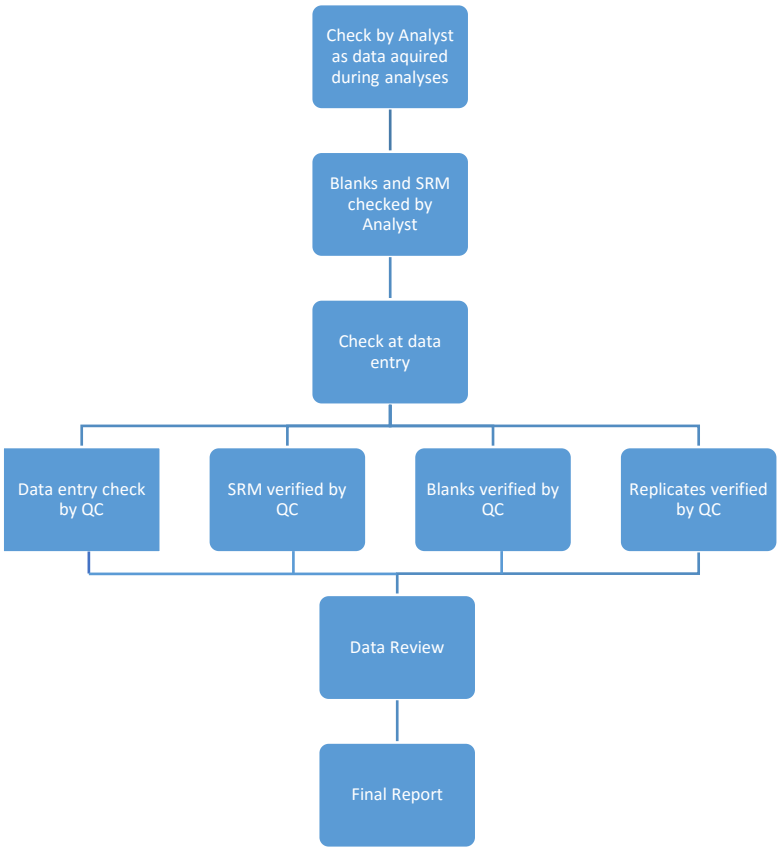

Figure 1, FAS, QC Flow Chart

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Sample log in:

1. All clients, either Kappes, Cassiday and Associates (KCA) or FAS commercial are assigned a client number. KCA clients are designated by three to four numbers followed by a letter (e.g., 8043c). FAS clients are designated beginning with the letter "F" followed by a number (e.g., F800). All FAS jobs are assigned a unique six digit number, with the first two numbers indicating the year and the final four number indicating the order received starting at 1001. For example, in 2016 the first job number of the year was 161001. The assigned job number is followed by the assigned client number.
2. Sample numbers assigned by KCA or by FAS clients are checked during sample log in. The samples are assigned a job number and a work order is prepared. If the work order is prepared by the client the contact information, sample type, analyses and sample numbers are verified. A spreadsheet is created with the job number, client number, sequence numbers and sample numbers listed. Figure 2 shows an example of a spreadsheet created for Acme Mines, job number 169999, client number F000, sequence numbers 1, 2, 3 for sample numbers SG#1, SG#2, SG#3. The spreadsheet is used to generate sample labels, analysis worksheets and final assay reports containing all this information. The sample numbers on the printed labels are check to see that they match the client labels. Every effort is made to not cover the original client numbers with the printed label. The three labels created for this job are shown in Figure 3. These labels are transferred to sample envelopes or bottles for sample identification. The job number, client number and sample numbers are used on all analysis worksheets (Figure 4) created for the job. Sample numbers and sequence numbers are checked at every step during analyses.

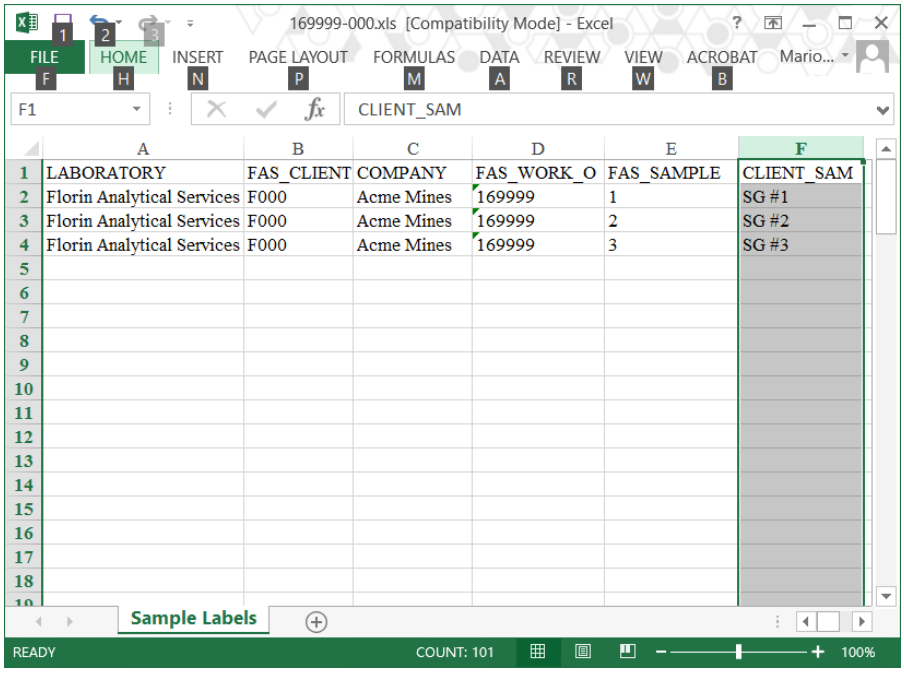

Figure 2, Sample Tracking Spreadsheet

Client: Acme Mines Client No.: F000 Work Order: 169999, 1 Client ID: SG #1 Florin Analytical Services	Client: Acme Mines Client No.: F000 Work Order: 169999, 2 Client ID: SG #2 Florin Analytical Services	Client: Acme Mines Client No.: F000 Work Order: 169999, 3 Client ID: SG #3 Florin Analytical Services

Figure 3, Sample Labels

						Date: 27 Oct 2016			
	Submitted By: Acme Mining					Laboratory No: 169999-F000			
	Sample Mark	Sample wt	Volume	Tube	Elements: FA Au Ag Grave				
#		grams	mls	#					
1	SG#1								
2	SG#2								
3	SG#3								
4									
5									
6									
7									
8									
9									

Figure 4, Sample Worksheet

Quality control for each FAS job:

1. Each group of analyses done at FAS will have at least one suite of QA/QC samples. The suite will consist of a reagent blank(s), replicate sample(s) and standard reference material(s). The number of QA/QC samples will vary depending on the analysis. The QA/QC suite will follow each step of the analytical method with the unknown samples from weighing, digestion and analysis.
2. During QA/QC processing, reagents blanks will be checked for any detectable concentrations of each analyte. If concentrations of any analyte is greater than 10% of the lower detection limit for that analyte then the blank value will be subtracted from the unknowns or the analyte will be rerun at the discretion on the QA/QC manager or the Chief Chemist.

3. For replicate samples, if the replicate sample varies by +/- 20% from the original sample the set will be rerun at the discretion of the QA/QC manager or the Chief Chemist.
4. SRMs are purchased from Rocklab, NIST, CANMET, OREAS and the USGS. As much as possible, standard reference materials are selected with detectable concentrations of the elements being determined. Some determinations will require multiple SRMs. For each analyte, the concentration determined by FAS is compared to certified, provisional or informational values published for that SRM. The goal at FAS is to get as close as possible to recommended, provisional or informational values. If a value falls outside of +/- two standard deviations of the certified or provisional value, the data in that set will be evaluated and may be rerun at the discretion on the QA/QC manager or the Chief Chemist.

QC charts:

1. QC charts are maintained for many of the commonly run elements at FAS. These charts plot the concentration of the analyte over time. The chart includes the mean of the FAS determinations, the recommended value, and the upper and lower control limits for the element. The upper and lower control limit is 2x the published, between-labs, standard deviation for that SRM. Figure 5 shows an example of a typical control chart.

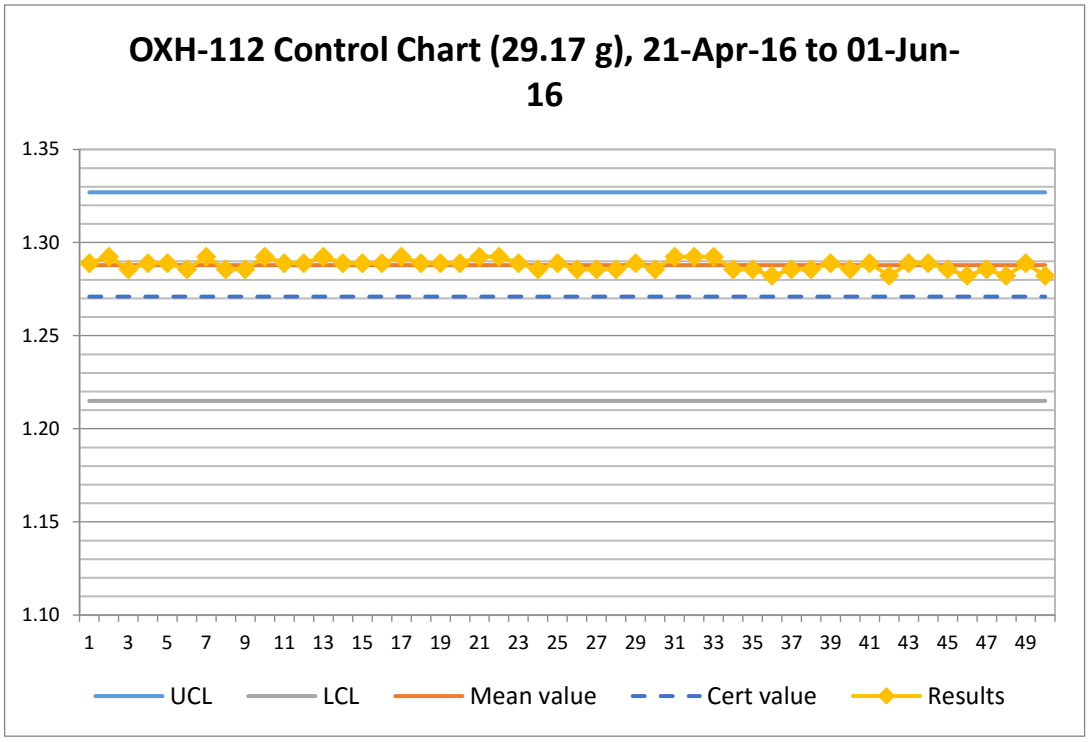

Figure 1, Control Chart for Gold by Fire Assay for Rock Lab SRM OXH-112

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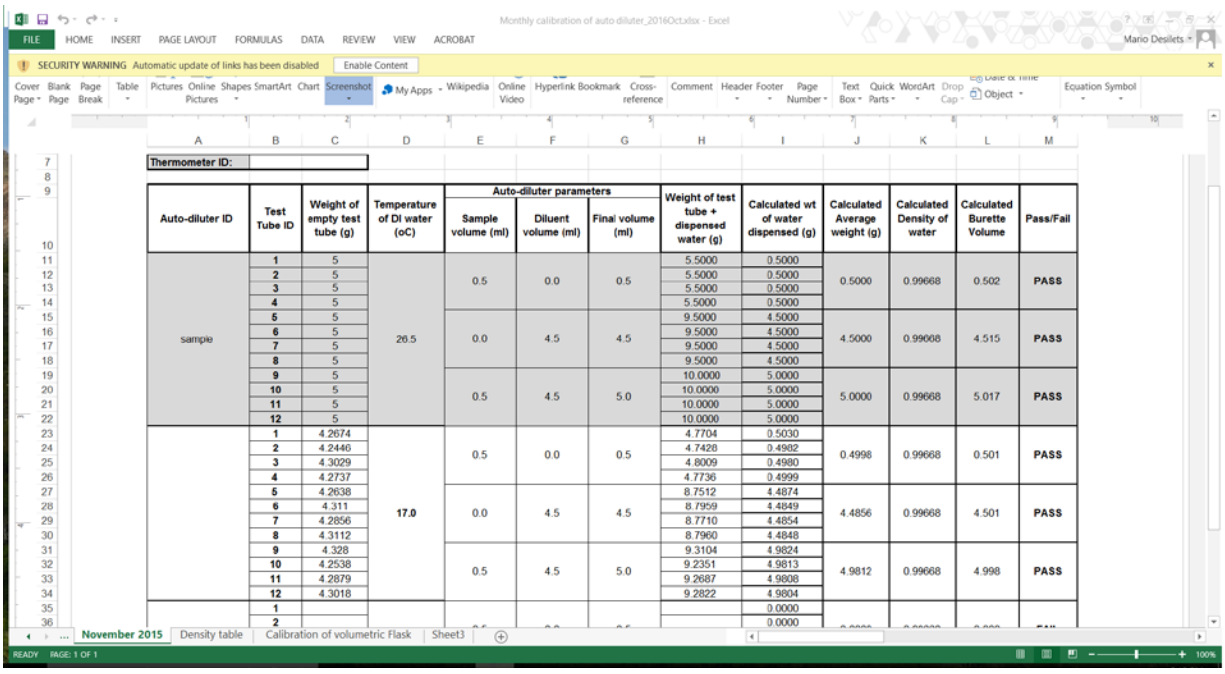
Analytical Balances:

1. All analytical balances used at FAS are calibrated annually by an external calibration service. The calibration certificates are maintained in a binder in the laboratory office.
2. FAS analytical balances are also operationally verified each day. Calibration weights are used to check that the balance accurately weighs a calibration weight within +/- 1%. The records of these checks are maintained in notebooks kept by each balance.
3. In addition to the daily single weight verification the Cahn microbalance is verified monthly with three calibration weights, 1mg, 2mg and 20mg. These records are also kept in a binder next to the balance.

Hamilton Diluter:

1. The Hamilton diluter will be calibrated annually by an external calibration service starting in April 2017.
2. Monthly verification is performed at the beginning of every month. The template for that calibration is shown in Figure 6. These tables are maintained in a binder next to the Hamilton.
3. Daily verifications are performed on the Hamilton by dispensing 3 aliquots of 5ml each of deionized water and verifying the weight to +/- 2%. Records of the daily verifications are in the binder next to the Hamilton.



Thermometer ID:

Auto-diluter ID	Test Tube ID	Weight of empty test tube (g)	Temperature of DI water (oC)	Auto-diluter parameters: Sample volume (ml)	Diluent volume (ml)	Final volume (ml)	Weight of test tube + dispensed water (g)	Calculated wt of water dispensed (g)	Calculated Average weight (g)	Calculated Density of water	Calculated Burette Volume	Pass/Fail
sample	1	5	26.5	0.5	0.0	0.5	5.5000	0.5000	0.5000	0.99668	0.502	PASS
	2	5					5.5000	0.5000				
	3	5					5.5000	0.5000				
	4	5					5.5000	0.5000				
	5	5		0.0	4.5	4.5	9.5000	4.5000	4.5000	0.99668	4.515	PASS
	6	5					9.5000	4.5000				
	7	5					9.5000	4.5000				
	8	5					9.5000	4.5000				
	9	5		0.5	4.5	5.0	10.0000	5.0000	5.0000	0.99668	5.017	PASS
	10	5					10.0000	5.0000				
	11	5					10.0000	5.0000				
	12	5					10.0000	5.0000				
	1	4.2674	17.0	0.5	0.0	0.5	4.7704	0.5030	0.4998	0.99668	0.501	PASS
	2	4.2446					4.7428	0.4982				
	3	4.3029					4.8009	0.4980				
	4	4.2737					4.7736	0.4999				
	5	4.2638		0.0	4.5	4.5	8.7512	4.4874	4.4856	0.99668	4.501	PASS
	6	4.311					8.7959	4.4849				
	7	4.2856					8.7710	4.4854				
	8	4.3112					8.7960	4.4848				
	9	4.328		0.5	4.5	5.0	9.3104	4.9824	4.9812	0.99668	4.998	PASS
	10	4.2538					9.2351	4.9813				
	11	4.2879					9.2687	4.9808				
	12	4.3018					9.2822	4.9804				
	1							0.0000				
	2							0.0000				

Figure 2, Template used for monthly verification of Hamilton diluter

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Adjustable Pipettes:

1. All adjustable pipettes used by FAS are calibrated annually by an external calibration service. The calibration certificates are maintained in a binder in the laboratory office.
2. The pipettes are also validated at least once a day by each analyst as they are being used. This is done by confirming a known volume of deionized water dispensed on an analytical balance. These weights confirm that the pipette is dispensing to within +/- 2%.

Preventative Maintenance:

1. Annual preventative maintenance is performed on all Agilent Atomic Absorption Spectrometers (AAS) and Perkin Elmer Inductively Coupled Plasma Optical Emission Spectrometers (ICP-OES).

Round Robin:

1. In order to assess the quality of our determinations compared to that of other laboratories, FAS routinely participates in round robin analyses. Groups that regularly host round robins in which FAS participate are Geostats Pty. Ltd., Society of Mineral Analyst (SMA) and ASTM International.

Calibration Solutions:

1. Manufactures Certificates of Analysis are maintained for all solutions used for instrument calibration. These certificates include dates of manufacture, expiration date, and analytical results for trace element impurities. All calibrations standards are disposed of and replaced at their expiration date.