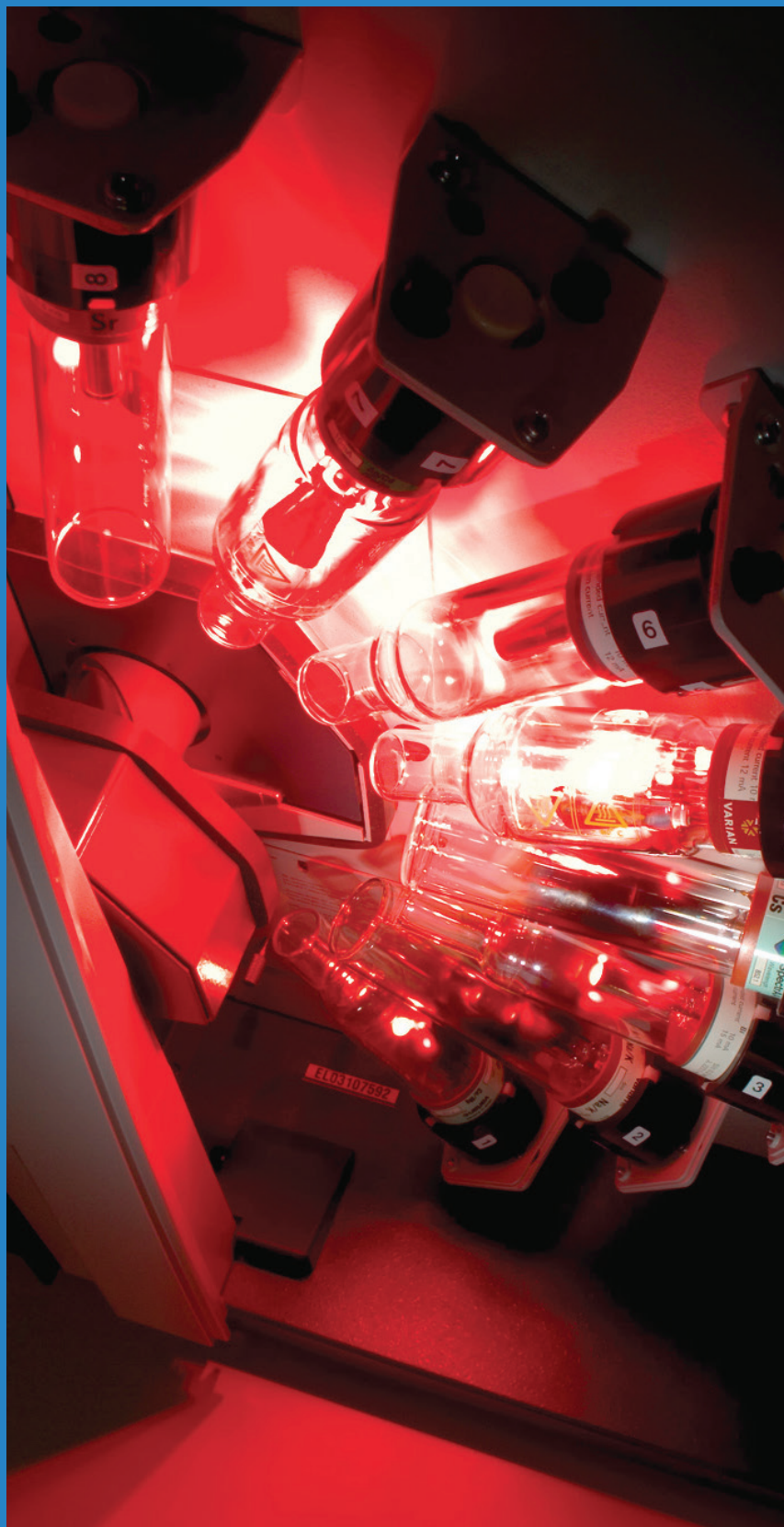


EXECUTIVE OVERVIEW

AA Troubleshooting and Maintenance Guide



a collaboration between



Agilent Technologies

SeparationScience
PREMIER LEARNING FOR ANALYTICAL SCIENTISTS

EXECUTIVE OVERVIEW

AA Troubleshooting and Maintenance Guide

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Tips, tricks and good advice for ensuring your atomic absorption instruments are optimized for best performance, and your maintenance SOPs are robust and reliable.

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Introduction

The objective of this article is to present some real-world tips and tricks that can help you look after and maintain your atomic absorption (AA) instruments – and in so doing help you improve your analyses. Guidelines will be provided to help you with both troubleshooting and maintenance. Some of these tips may be familiar, but there should be at least a few new ideas relating to new maintenance tips or troubleshooting guidelines to improve performance of instruments, applications, or improve ease of use.

Agilent Technologies commissioned an independent survey of lab managers from different market segments. The primary objective of the survey was to understand lab managers' pain points and find out what their most pressing concerns were. The survey was conducted by Frost & Sullivan via a 30-minute online questionnaire in 4 countries: Germany, UK, USA, and China. A total of 700 people were surveyed, varying in experience, company size, role and primary function.

Lab managers face challenges that are largely linked to maintaining instruments and dealing with the increasing complexity of testing requirements. Just over half of the laboratories process 500–1000 samples per week, and 45% of survey respondents said that there is pressure to increase the number of samples over and above their current capacity. Productivity is limited largely by the time consumed in preparing the sample, instrument downtime because of scheduled maintenance or unplanned downtime, and method transfer/validation of new instruments. When asked to select the main causes for unplanned downtime, respondents cited issues with sample preparation (78%), instrument breakdown (64%) and operator/technician error (45%). Interestingly, the survey highlighted 1 in 5 respondents consider laboratory size to be a challenge with 75% believing that space-saving designs of instruments can help overcome this challenge.

Hollow Cathode Lamps

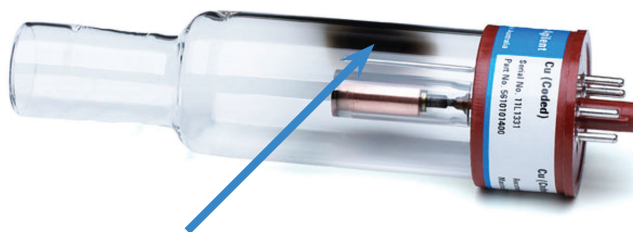
Agilent hollow cathode (HC) lamps are available in both coded and uncoded formats. Coded lamps have extra pins on the base allowing the instrument to identify which element the lamp is for. This means the instrument can

locate and automatically start the lamp, even if it has been placed into the wrong position in the instrument. Uncoded lamps provide the best value and are compatible with all Agilent and most AA systems from other manufacturers (except PerkinElmer and Shimadzu). For improved sensitivity and lower detection limits, Agilent also offers a range of high-intensity, boosted discharge lamps known as UltrAA lamps. These UltrAA lamps use the standard lamp current, but apply an additional boost discharge within the lamp to increase emission intensity. The boost current is supplied from a secondary control module (either integrated into the instrument or supplied from an external module). Agilent UltrAA lamps are a comprehensive range of high-intensity boosted discharge hollow cathode lamps that can replace conventional lamps for AA determinations. UltrAA lamps lower detection limits for the most demanding flame, furnace and vapor AA applications, and offer:

- extended calibration range while retaining analytical precision
- longer lamp lifetimes, exceeding 8000 mA hours operation
- plug and play for simpler operation

Agilent Zeeman AA systems can feature an integrated (factory fitted) control module. Field upgrades are available for other Agilent AA systems, ensuring wide compatibility. The range of UltrAA high intensity lamps

Figure 1



Characteristic black “getter” patch from unique lamp processing. May also see some cathode material deposited during lamp processing

can be used with all Agilent AA instruments. For superior cost-effective performance with challenging applications, select high intensity UltrAA lamps. Agilent UltrAA lamps lower detection limits for the most demanding AA applications.

Agilent also offers a comprehensive range of coded 50 mm lamps that are compatible with all PerkinElmer AA systems. They provide economical operation and match the performance of genuine PerkinElmer Lumina lamps.

Agilent lamps provide many advantages for atomic absorption users. First, they provide the optimum performance – a combination of the proprietary cathode composition and unique lamp processing procedures ensures good intensity and sensitivity, low noise and long-term stable operation. Second, the lamps are also designed to provide very long service, the result of proprietary cathode composition and optimum gas fill within the lamp. Typical lifetime for Agilent lamps exceeds 5,000 mA hours of operation, reducing operating costs and downtime through lamp failure. Third is better stability – Agilent lamps are pre-conditioned to be ready for use immediately out of the box. This can lead to improved productivity and optimal instrument performance without needing to condition the lamp

initially. Next, Agilent lamps are designed to provide improved spectral purity. As shown in Figure 1, the Agilent lamps have a unique black 'getter' patch that comes from a unique lamp processing procedure. This patch is a thin layer of activated zirconium, which helps to absorb some impurities that may be present in the lamp during operation, improving spectral purity throughout the life of the lamp. The final advantage is quality – Agilent lamps are manufactured by hand in an ISO 9001 certified environment and use proven processing steps. Prior to shipment, every lamp is analytically tested to ensure that it meets Agilent's demanding standards for intensity, noise and stability. Test equipment is regularly calibrated.

Performance

Performance of Agilent HC lamps is demonstrated by a competitive analysis that can be found at <https://www.agilent.com/cs/library/competitiveanalysis/Public/5991-5023EN.pdf>. Lamps that require excessive stabilization times or lamps that never reach equilibrium can create problems for the analyst. Once analysis begins, drift in lamp intensity can change the analytical signal, introducing significant errors. This is especially critical at trace levels where the drift could even be more than the sample absorbance. Figure 2 shows the short-term stability for selenium (Se) lamps with the Agilent lamp shown in light blue against other competing lamps. This stability trace is shown after a 10-minute warm up time. While most lamps were suitably stable the lamp represented by the orange trace never appeared to stabilize. Long-term stability is also shown, based on the measured absorbance for a calibration standard at a concentration of 120 ppm. The solid red lines show control limits of $\pm 5\%$ variation from the expected result. The Agilent lamp (light blue) provides the best overall stability with the average precision being $< 1\%$ RSD for all measurements over this 1 hour period, compared with the worst result, which was $> 3\%$ RSD.

The lower chart shows the lamp lifetime for both the selenium (Se) and lead (Pb) lamps. The Agilent lamp (blue colours) gave the longest life for both of these elements, well over 4 times longer than the nearest competitor for the Se lamp, and around 20% longer than the nearest competitor for the Pb lamp.

A comparison of calibration curves for lead (Pb) at 217.0 nm is shown in Figure 3. The Agilent lamp provides good sensitivity, equivalent to the performance of the SGM lamp. A comparison of calibration curves for cadmium (Cd) at 228.8 nm is also shown. The Agilent lamp provides the best sensitivity and linearity. The instrument detection limits for these two elements is also compared. In each case, the Agilent lamp provided the best (or lowest) detection limit, significantly better than the lower priced competitive lamps.

The study also examined the performance/lifetime of the Agilent lamp with several major competitors with respect to arsenic (As), cadmium (Cd), gold (Au), copper (Cu) and sodium (Na) lamps. The Agilent lamp gives the longest life for each of these elements, well over 2.5 times longer than the nearest competitor for most of the elements, and about 25% longer than the nearest competitor for the sodium lamp.

There are several misconceptions about the use of multi-element lamps with the AA technique. For example, many users think that multi-element lamps have shorter lamp life and degrade analytical performance. Agilent offers an extensive range of multi-element lamps that offer similar performance to the range of single-element lamps. As we've shown for the range of multi-element lamps, each gives a satisfactory life – debunking

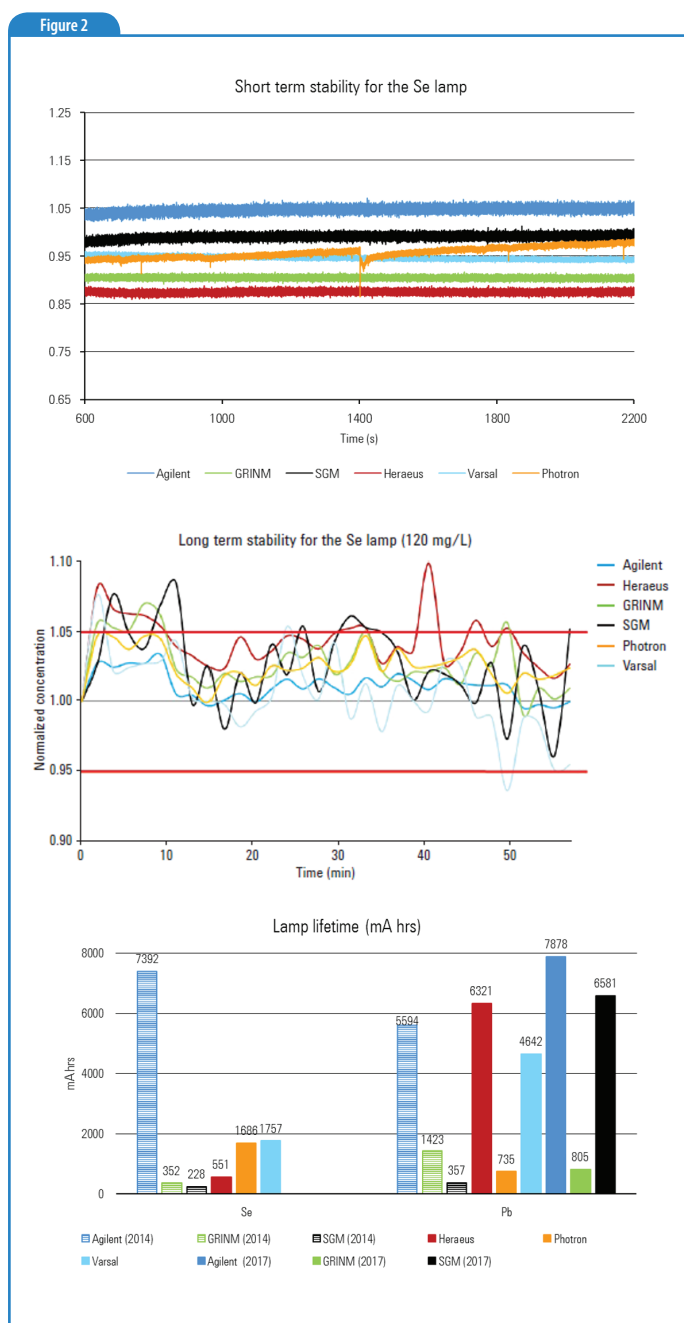
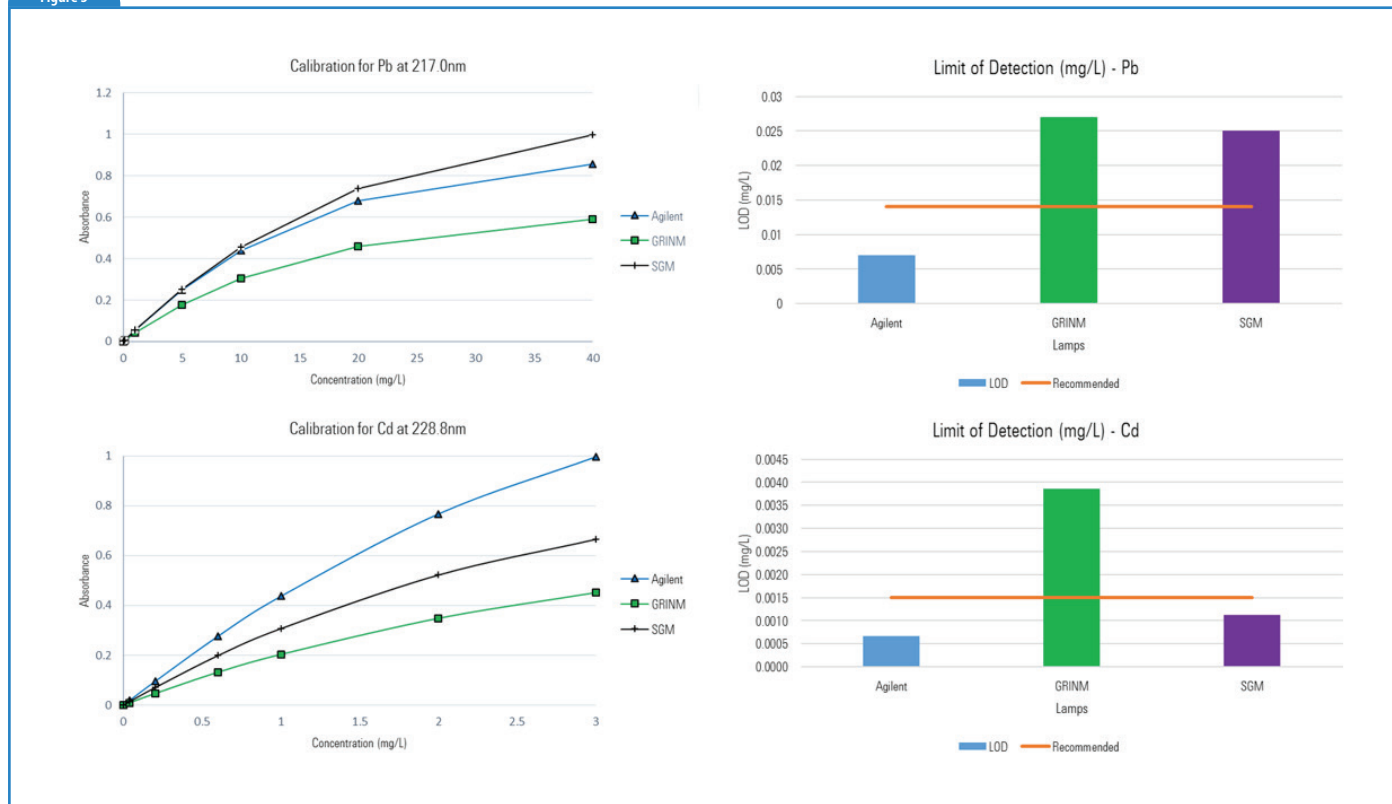


Figure 3



the myth of shorter lifetimes. In terms of performance we see that when the lamp is operated at the recommended current for the multi-element lamp, the sensitivity achieved with the multi-element lamp is comparable to that achieved with a single-element lamp. There may be a slight degradation in the detection limit achieved, but that change is relatively small. Concerns about poor performance of a multi-element lamp is also a myth.

Figure 4 compares performance for a number of elements in a multi-element lamp for Co/Cu/Cr/Fe/Mn/Ni. As shown in the traces on the left, short-term stability for each element is very good after an initial warm-up period. On the right-hand side, we show the expected calibration graph for the elements listed taken from the flame AAS cookbook. The larger calibration graph shows the sensitivity achieved for those elements using the multi-element lamp. The measured sensitivity matches the performance expected from the cookbook – again confirming there are no performance compromises when using a multi-element lamp, operated using recommended conditions for that lamp type.

Operational Tips & Recommendations

As noted earlier, multi-element lamps often require different operating conditions to that used for a single element lamp. The lamp current, recommended slit width and even the recommended wavelengths may be different when using a multi-element lamp. However, when operated using the recommended conditions, the performance of the multi-element lamp is equivalent.

What else should we keep in mind when working with any HC lamp. First, let's consider general care and operation of the lamp. The lamp is fragile so we need to avoid any undue shock or stress. We must also ensure there are no fingerprints on the end window of the lamp, where the light passes into the optical system of the instrumentation. Oil and grease from your skin can build up on this surface and reduce the transmission of the light into the optics, degrading performance. This is especially critical for elements

that have emission wavelengths in the UV region or for elements that are relatively low intensity, such as lamps for As, Se and Ni.

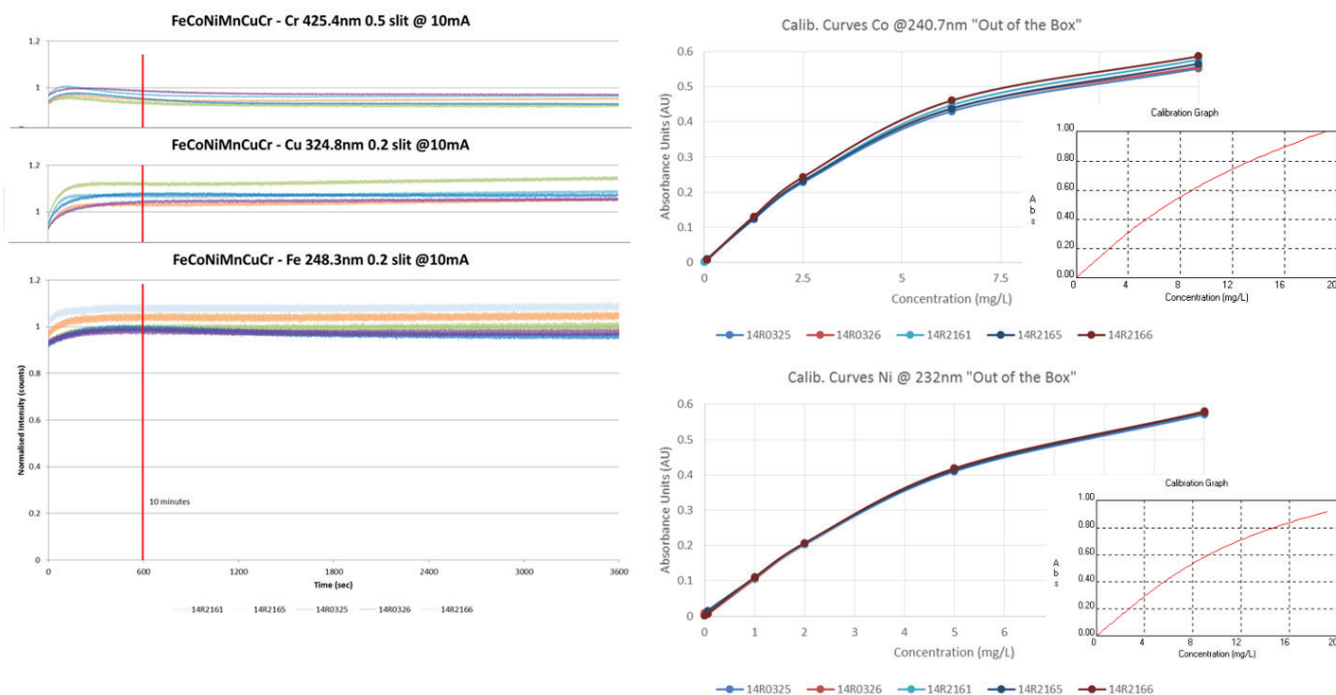
It's always good practice to allow the lamp to warm up for about 10 minutes at the start of the analysis enabling the output to stabilize and, as already highlighted, to work with the recommended operating conditions – for the Agilent lamp these are conveniently listed on the label on the base (including the recommended current, wavelength and spectral bandwidth). When working with the lamp it's good to monitor performance – in particular, the per cent 'Gain' value shown or displayed during optimization. You should compare this value with the typical 'Gain' values that are available on the Agilent website (<https://www.agilent.com/en/support/icp-ms/kb005762>). A significant change in the 'Gain' value for the lamp can indicate that the lamp is reaching the end of its operational life. If working with a graphite furnace system we recommend that you align the lamp without the furnace work head in the light path – align the lamp first, then place the work head in position and align the work head so that you are achieving maximum light throughput through the work head of the graphite furnace system.

Another type of source lamp that should be considered is the Deuterium lamp, which is used for background correction in your AA system. In most AA instrumentation, the Deuterium lamp is used particularly in that wavelength range between 200–400 nm. We don't use it above 400 nm as there's no useable output from the lamp. Most of the background observed is between 200–400 nm. The Agilent background correction system provides good capability so it can correct up to 2.5 absorbance units in background and provide fast correction with less than a 2 ms delay between readings – this can minimize the correction error that occurs when working with the background corrector.

Other common questions about the Deuterium lamp include:

- Is the lamp always on? The answer is 'No' because the lamp will only be on when the instrument is being initialized and then it's switched

Figure 4



off, unless you are using background correction in the current method you are running.

- What is the lifetime of the lamp? It's hard to quote a specific value because there are so many variables but, typically, we see lifetimes that exceed 1000 hours of operation. For most users who are working with the background corrector frequently, the lamp will typically need replacing on an annual basis.

Now let's consider some other tips to help you maximize the performance of your AA system.

Preventing Nebulizer Blockage

One of the most important consideration when looking to prevent nebulizer blockage is to work with a rinse solution. That is, a reagent blank solution to rinse the nebulizer both between samples and, especially, for a few minutes at the end of the run before extinguishing the flame. This allows removal of any remaining sample residue from the nebulizer and can help to prevent blockage occurring. Sample preparation also plays a critical role here – any large particles must be removed from the sample. This means either filtration or centrifugation of samples. If the latter, when working with an autosampler, or even when manual sampling, sampling above the level where there is any sediment in the sample vessel is essential. When wiping sample capillaries between samples, lintless wipes should be used or fibres can build up with the potential for nebulizer blockage. When a nebulizer is blocked, the best solution is to disassemble the nebulizer completely and sonicate the components in a detergent solution in an ultra-sonic bath. The nebulizer can then be rinsed and re-assembled. It is also possible to immediately remove the blockage with a cleaning wire but only as a short-term solution. However, it is always best to think 'prevention' and take care with sample preparation and rinsing the sample introduction system.

Tuning the atomization system can also help us to reduce nebulizer blockage. So, for most applications the mixing paddles should be fitted inside the spray chamber. Optimize the impact bead position so that you're

getting the best combination of sensitivity and precision. Use narrow bore capillary tubing. If you want better sensitivity, then you can take the mixing paddles out. You can adjust the impact bead further away from the nebulizer. If you fit wide bore tubing, you'll get a much higher uptake rate, and that means you'll get an improvement in sensitivity. Your noise level will go up a little bit, but signal will also go up dramatically. So, overall signal-to-noise performance will be better. For more difficult samples where there are higher levels of dissolved solids, you should first ensure the mixing paddles are in place. Then adjust the bead for maximum sensitivity, and rotate the bead adjuster at least half a turn clockwise closer to the nebulizer from the optimum sensitivity position. That means you're going to trade off sensitivity a little bit – perhaps reduce this about 10%, but by being closer to the nebulizer, there'll be less chance of blockage of the sample introduction system. And, of course, that means you can get better long-term performance and stability.

It is important to consider the procedures that we go through at the end of the day once analysis is complete as this also has a big impact on how the instrument performs. The recommended shutdown procedure is as follows:

- aspirate the rinse solution for a few minutes before shutting off the flame (to wash out the nebulizer and remove any remaining sample residue)
- extinguish the flame and allow the burner to cool
- remove the burner and pour at least 500 mL of water through the spray chamber (to wash out any acid residue from the liquid trap)
- empty the waste vessel
- shut off the gases at the supply to the instrument
- close the software
- switch off the instrument

By following this procedure we're going to flush out all of the sample introduction system and rinse out all the acid residue. This means we're going to have less chance of blockage and less chance of degradation in the instrumentation.

Maintenance of the Sample Introduction System

Here are some guidelines that can help you with cleaning the atomization system. The burner is probably the one that many users struggle with. For cleaning the burner we recommend polishing the burner, and particularly the inside of the burner slot. Use a metal polish, something that you use for cleaning brass. We use a material called 'Brasso', but if that's not available, another liquid metal polish recommended for cleaning brass will work very well. Use the burner cleaning strip to introduce that metal polish inside the burner slot (Figure 5, top). And then use the card to polish the inside of the burner slot on both sides. The more you polish it, the better it's going to perform. In the end it will give you much better performance and much better resistance to blockage if you have a clean and well-polished burner.

Cleaning the spray chamber is straightforward – disassemble and wash in a detergent solution. It is also critical to monitor the condition of the components inside, particularly the glass impact bead. Figure 5 (bottom) shows the condition of a bead that's well used. This one is quite badly pitted. If you see a lot of indentations or pitting on the surface of the bead, then it's not going to perform very well in terms of breaking up the flow of sample. You should replace the bead immediately if it has this appearance. The impact bead is critical because it allows you to control the performance of the instrument. The external bead adjuster allows you to control the position of the bead. By adjusting the bead position, you can tune the instrument to achieve the sensitivity you need. If you move the bead further away from the nebulizer, you'll see an increase in signal. The signal should go through some maximum, and then as you move the bead position further away, the absorbance will go down again. Positioning of the bead is critical to helping you achieve good performance.

Accurate Standards

Because all sample measurements are made with reference to the initial calibration, the accuracy of the analysis is dependent on the accuracy of calibration standards. The calibration standards used must be free of contaminants, and most importantly, should be certified using the most rigorous and robust techniques, with evidence to prove it. The definition of a "Certified Reference Material" (CRM) is a reference material, which is supplied with a certificate, which has had one or more of its concentration values certified by a procedure which establishes traceability to an accurate standard or unit, and for which each certified value is accompanied by an uncertainty at a stated level of confidence.

Using CRMs for preparation of calibration standards improves accuracy, establishes traceability and allows quantification of the measurement of uncertainty. The other reason for customers wanting to work with CRMs is regulatory driven. Increasingly, national regulatory bodies such as National Association of Testing Authorities, Australia (NATA) and the United Kingdom Accreditation Service (UKAS) are requiring ISO Guide 34 certified laboratories to use CRMs (where available and appropriate) for the verification/validation of their methods.

Agilent CRMs are manufactured in an ISO 9001, ISO Guide 34 facility and certified in an ISO/IEC 17025 testing laboratory. Agilent standards use the highest purity elements and compounds available (typically 99.999+%) as well as high-purity acids and solvents. Raw materials are assayed and analyzed for trace impurities using an Agilent ICP-MS. Metals are acid pre-cleaned and rinsed with high-purity water, and salts are dried to a constant weight. Solutions are prepared gravimetrically, in an ultra-clean



environment. Acid digestions are performed in pre-cleaned, high-density polyethylene (HDPE) or PTFE containers to avoid contamination from the reaction vessel. Balances and volumetric flasks are calibrated according to NIST procedures. Petroleum standards are blended in pre-cleaned HDPE or glass reactors.

Agilent spectroscopy CRMs are certified using the high-performance spectroscopy protocol developed by NIST, and through classical wet chemical methods (titrimetry or gravimetry). Both the certified concentration and uncertainty values are traceable to NIST SRM 3100 series of spectrometric standards to ensure the highest accuracy and traceability. The standards are packed in pre-cleaned, HDPE bottles before being shipped in poly-sealed bags with tamper-evident seals. The bottles are acid leached and triple rinsed with de-ionized water prior to use. The standards have a long shelf life, up to 18 months, supported by long-term stability studies performed as part of the requirements for Guide 34 accreditation.

All Agilent standards are accompanied by a comprehensive Certificate of Analysis (COA). Trace impurities are assayed using an Agilent ICP-MS and reported on the COA for ICP-OES/ICP-MS standards.

Agilent now offers a complete line of spectroscopy CRMs, manufactured under ISO 17025 and ISO Guide 34, for AA, MP-AES, ICP-OES, and ICP-MS applications. Agilent also offers a full range of single and multi-element metallo-organic and biodiesel standards, base oil and pure solvent for the preparation of working standards for analysis of lubricant additives, wear metals and petroleum products. The Agilent metallo-organic and biodiesel standards use unique methods to synthesize metallo-organic materials that offer the necessary purity and stability required to produce this range of single and multi-element CRMs in organic matrices, which are also certified

to ISO Guide 34. With Agilent CRMs, your laboratory is assured of quality, purity, and consistency.

Here are a few questions to consider with the preparation of your calibration standards. Let's focus on the things that are common, the things we should probably already know, but maybe we don't always remember, or maybe we don't always follow the correct procedures:

- Is the standard still within its 'Use By Date'?
- Are you working with the best calibrated pipettes and grade A glassware?
- Are you regularly checking the accuracy of the pipettes?
- Are you using de-ionized water to minimize contamination?
- Are you working with serial dilution so that you avoid introducing large dilution errors?
- How are you storing samples? Standards should be acidified to make sure that they have the best stability. Plastic vessels (PFA or FEP) ensure better stability.
- Are you replenishing standards frequently? Particularly if you're working at trace levels, it's critical that you prepare standards fresh every time you run your instrument. This might be every day, it might be once a week, depending on your sample workload.

Reducing Contamination

You must think about the chance of contamination, because contamination can come from everything that your sample contacts, whether it's during storage, whether it's during digestion, or even during analysis. Think about the reagent purity – always find the best reagents that you can, and make sure you check the COA for those reagents. This can vary from one batch to the next. What's the level of potential contaminants in that sample? Checking the COA will highlight if there are elements present at a higher level, that could potentially cause a problem for your application. Make sure you reseal the reagents immediately after use.

Another common causes of contamination is the reagent water. If you're not working with de-ionized water, or if you're not maintaining your water system properly, this can be a potential issue. If you're working with colored pipette tips, these can introduce potential contamination, particularly from elements such as copper, iron, zinc, and cadmium. Working with natural tips is preferred.

Improving Accuracy

To improve accuracy, you also need to focus on your sample digestion procedures. Verify that you're using the most appropriate digestion. You want to make sure that the method that you're using is suitable for your application. This is also just as important if you are working with a block digestion system, or even a microwave digestion system.

Have you checked to see whether there is any loss of analyte during digestion? Have you checked to see whether there is any contamination taking place during preparation? To do that, take a CRM through your preparation and analysis process. That's a very good check to verify that your system is working correctly.

Another check for contamination is to work with a reagent blank and include that with every sample batch that you prepare. This means taking reagent water through your preparation process. Measure that as a sample, and if you observe higher levels, it can highlight the contamination.

Working with a reagent blank is recommended for every analysis. It may not be necessary to check your digestion process every time you run, but it is good to do that check periodically, and especially if you're setting up a new method.

Analytical Sensitivity

One of the last checks that we should do if we want to improve the performance of our instrumentation is to check the analytical sensitivity that we're getting. One of the things that many users have trouble with is burner

Figure 6



Lean
Reduce acetylene flow



Stoichiometric



Rich
Reduce acetylene flow

alignment. We need to optimize the burner position vertically, horizontally and rotationally. The best way to do this is to use burner aligning and cleaning strips. You can position these on the burner and then use the target area as a way to ensure the burner is correctly aligned with respect to the light from the HC lamp. In that way you can do a very quick visual check to verify that the light beam is running parallel to the burner slot. It's also good practice to check the nebulizer uptake rate. Ideally it should be in the range close to 5 mL/min. If necessary, you can adjust the nebulizer or clean it if there's a partial blockage and you have a low sample uptake rate. Once you've done those preliminary adjustments you should aspirate a standard and then optimize the system a little further for maximum sensitivity. Here we want to focus on things such as the impact bead position so that we can use the adjuster to make sure that we're getting the best sensitivity and best precision.

Next we'll focus on the flame chemistry – the flame stoichiometry is especially critical for elements that use the nitrous oxide/acetylene flame, but even for elements that work with an air acetylene flame. By adjusting your gas flows you can change the sensitivity and optimize your performance.

Adjustment of the acetylene flow becomes much more critical when using the nitrous-oxide/acetylene flame. Figure 6 provides an example of optimization conditions for the nitrous-oxide acetylene burner. Usually when working with this burner type, it's because you're needing to measure the more refractory elements. And these elements need extra acetylene to be added into the flame, to get good atomization, and be able to get a good signal. Typically, when running with the nitrous-oxide flame, you need to add extra acetylene into the flame. In the analytical conditions in the cookbook, you'll often see references in the notes to the feather, or the height of the cone in the flame. This refers to the height of the colored region which you can see in Figure 6. To achieve a rich flame, you need to increase the acetylene flow up to eight liters per minute.

Recommended Maintenance Schedule

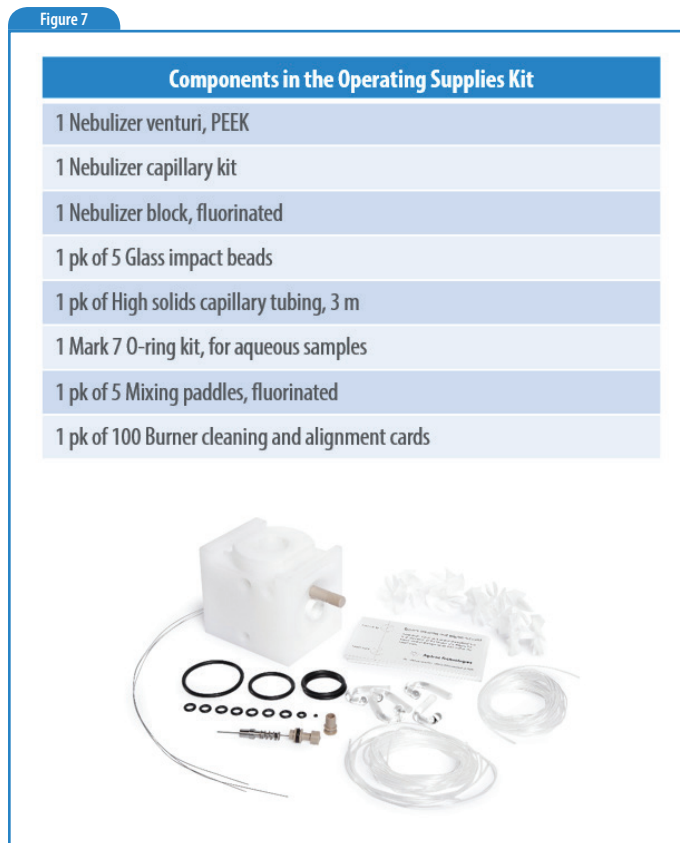
Here are some guidelines to help you with maintenance. These are recommended maintenance schedules for flame AA. Note that these are recommended conditions only - the timings may vary depending on your application and on your workload. Adjust these as necessary based on your own usage.

The most important thing are the checks that you need to do every time you run your instrument. Check that there is enough gas in the cylinders at the start of the run, especially important for the acetylene to make sure that there is no carryover of acetone into the gas box of the instrument. Check that the exhaust is working correctly. Check the nebulizer uptake rate and inspect the burner to make sure it's clean and OK for analysis. Then you should be ready to start your analysis.

At the end of the run, follow the recommended shut down procedure to wash out the sample introduction system, and then empty the waste container. It's also good practice to wipe down the exterior surfaces of your atomic absorption system especially in the sample compartment to remove any acid residue that may have built up on those surfaces.

On a weekly basis or perhaps as necessary, clean both the burner and the flame atomization system. While doing that, inspect the components, particularly the impact bead and the condition of all the O-rings, to make sure they're in good condition. If the O-rings are knicked, damaged or obviously stretched, replace them immediately otherwise they won't do

Figure 7



their job and won't give you a good seal. Periodically check the optical window on the instrument and clean as necessary.

If you follow these procedures, you should be able to achieve good and consistent performance from your instrumentation.

Key Consumables for AA

Here are some broad guidelines on the common types of consumables and supplies that you may want to have on hand to support usage of your instrumentation. All instruments will need HC lamps as well as the standards that are used for calibration (CRMs). For flame AA it's mostly parts for the sample introduction system, such as impact beads, burner cleaning strips, nebulizer components, capillary tubing etc. that you want to have on hand. If you have a blockage or a breakage, you can disassemble the nebulizer, replace the component, and continue the analysis.

Although we have not focused on the other AA techniques in this presentation, there are also some key consumables you may want to have to hand. For graphite furnace AA systems you should have graphite tubes, sample vials, dispensing capillary and syringe for the autosampler, and matrix modifiers. For vapor generation AA systems you should have quartz atomization cells, peristaltic pump tubing, and connecting tubing.

Agilent does have a range of consumable kits, as we call them, operating supplies kits, that basically bundle all the supplies you need into one part number. We have them for flame AA (Figure 7), and graphite furnace AA, as well as some of the other techniques, or some of the other accessories that you may be using. Each of these kits includes all the components that you'd need to support operation of your instrument for typically one year of routine operation.

Having one of those kits is a very convenient way of ensuring you've got the spares that you need at the time that you need them. These operating supplies kit can be ordered on a yearly basis to ensure optimum instrument performance all year long.






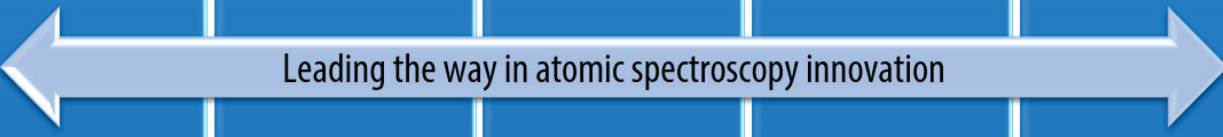
Flame AA	MP-AES	ICP-OES	ICP-MS	ICP-QQQ
				
Agilent's 55 and 200 Series includes <i>Fast Sequential flame AA</i> and <i>high performance furnace</i> .	Agilent's 4210 MP-AES runs on air for the <i>lowest cost of ownership</i> and <i>improved safety</i> .	Agilent's 5110 ICP-OES includes the <i>world's most productive, and only Synchronous Vertical Dual View ICP-OES</i> .	Agilent's 7800 & 7900 ICP-MS are <i>robust, sensitive, accurate, and easy to use quadrupole ICP-MS</i>	Agilent's 8900 ICP-QQQ with MS/MS mode provides <i>unique control of interference removal in reaction mode</i>
 Leading the way in atomic spectroscopy innovation				

Figure 8 provides an overview of Agilent's atomic spectroscopy portfolio. Agilent offers a comprehensive range of instrumentation ranging from flame AA systems all the way through to high-end ICP-QQQ ICP-MS that provides MS/MS capability to enable unique control of interference removal in reaction mode. Regardless of the technique that you are working with, regardless of the type of analyses that you are doing you can be confident that Agilent will have the products that you need for your particular application.

Summary

We've provided some tips and guidelines to help you achieve best performance, and to help you achieve quality data from your instrumentation. Most of the challenges that you face are dependent on the condition and set-up of your sample introduction system. By focusing on the set-up, on the condition, on the maintenance of your sample introduction system – the burner, spray chamber, and nebulizer – and doing the proper maintenance on those areas will help you achieve the best performance.

Deposits anywhere in the sample introduction system can affect the rate sample is introduced into the flame, contributing to signal drift and potentially introducing contamination. Proper maintenance of this area can help you improve your results, improve the data quality and overcome potential issues. Establishing routine maintenance procedures can help you to provide analysts with simple ways of identifying and correcting the problems.

These tips and guidelines will help you maintain your instrumentation and help you achieve the best performance and productivity from your instrumentation.

Resources

Finally, here is an overview of additional resources that are available to help you. Agilent has recently introduced the 'AA Resource Hub', an information page for all atomic absorption instrument users (https://www.agilent.com/en/promotions/aa_resources). One key feature of the 'AA Resource Hub' are the maintenance and troubleshooting videos that cover flame-, atomic absorption, graphite furnace atomic absorption and HC lamps.

Below is a list of additional resources available to support atomic absorption users:

Lamp FAQs: <https://www.agilent.com/search/?No=0&Nrpp=20&Ntt=lamp+FAQs&redirect=0>

Atomic absorption parts and supplies: https://www.chem.agilent.com/store/en_US/Cat-SubCat1ECS_30279/Atomic-Absorption

Application notes: <https://www.agilent.com/en-us/library/applications?N=129+900006641>

Consumables catalog for spectroscopy: http://www.agilent.com/cs/library/catalogs/public/5991-5455EN_Spectroscopy_Catalog_LR.pdf

Standards/CRMs: http://www.chem.agilent.com/Library/catalogs/Public/5991-5678EN_Chemical_Stnds_Catalog_LR.pdf

Supplies for PerkinElmer instrumentation: https://www.agilent.com/cs/library/catalogs/public/5991-6788EN_CL_Spect_AA_MiniCatalog_Offset_LR.pdf

Webinars for atomic spectroscopy: <http://www.agilent.com/en-us/training-events/eseminars>

AA Quick Reference Guide: https://www.agilent.com/cs/library/selectionguide/public/5990-9476EN_AA_Supplies_QRG.pdf

About the Author



Eric Vanclay is the Spectroscopy Supplies Product Marketing Manager for Agilent Technologies, based in Melbourne, Australia. He graduated from Monash University in Melbourne, Australia with a Bachelor of Science degree majoring in Chemistry in 1985. Eric joined Varian in 1988 and has worked in a number of roles including Atomic Absorption Product Specialist, Atomic Absorption Product Manager, Export Marketing Manager, European Field Sales/Applications Specialist (atomic spectroscopy), ICP-OES Product Manager and MP-AES Product Manager. After the acquisition of Varian by Agilent Technologies, Eric took on the role of Spectroscopy Supplies Product Marketing Manager, with responsibility for field sales support, customer support, product development and marketing of the spectroscopy supplies. He has over 30 years' experience with all of the atomic spectroscopy techniques.