Business Considerations of Equipment Refresh in a Calibration Laboratory

White Paper

Abstract— *Calibration laboratories operate in a world of constant change, and this is never more evident than in the products that are requested to be calibrated. Technology producers survive on innovation and constantly pushing measurement demands to new limits. This creates a constant need for better measurement standards, and calibration laboratories are all too familiar with the dilemma of whether or not to update the existing test equipment that they use. This paper acknowledges the upgrade costs, but then focuses on identifying advantages achievable from such an upgrade effort. Those advantages are further explored to identify underlying factors that can realize a benefit.*

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Introduction

Managing a calibration laboratory presents numerous challenges. One of these relates to updating the lab to handle new products with higher performance that demand better measurement standards. This is a never-ending process as several instrument companies operate predominately in the space of new measurement capability. Therefore, these performance innovation companies constantly strive to introduce new instruments that will stretch the measurement capabilities of even their own calibration laboratories.

The higher performance can appear in different respects. Sometimes it is the demand to extend a parameter (e.g., frequency) coverage of the lab to higher frequencies. Or maybe the demand is to measure smaller values than previously offered. Sometimes neither the range nor sensitivity is improved, but the accuracy is improved, requiring better measurement uncertainties. Regardless of where the performance enhancement lies, the improved capability often requires the purchase of newer and higher-performing measurement standards.

Whether or not to expand a laboratory's capability is not the focus here. The question is whether or not to leverage that expansion to a general refresh of the equipment used in the laboratory to meet existing capabilities. Also, within view is the scenario where older equipment has failed and a repair/replace decision must be made. Alternately, it may simply be a decision to refresh existing equipment without additional factors.

The cost to purchase new test equipment is only part of the operational cost. The author touches on some of the other costs associated with such upgrades. However, the focus of this paper is on benefits that can be realized by upgrades in existing capabilities. That is, the issue in view here is whether to replace existing test equipment used on currently supported instruments and devices with newer test equipment.

2. Costs of Equipment Refresh

Upgrading the capability of a calibration laboratory does not come for free. Obviously the first cost is based on the purchase of the new instrumentation. (Other papers address the lease-vs.-buy decision but generally calibration laboratories will purchase the test equipment. This decision is immaterial for the purposes of this paper.) There are other costs associated with refreshing the measurement standards used and some key ones are acknowledged here.

2.1 Procedure Development

With new equipment comes the need for new procedures. To the extent that the procedures are unique to the instruments or devices for which new capability is being added this cost is expected and outside the scope of this evaluation.

The additional opportunity and cost is where instruments or devices that currently are being calibrated could have their current measurement standards replaced with the newly purchased assets. This means that the calibration procedure for each existing product that will be impacted by the refresh must be updated. In some cases a completely different measurement method will now be used. The total cost of this additional development effort will be affected by the structure and sharing between procedures.

2.2 Measurement Uncertainties

As the improved performance of new instrumentation is applied to existing procedures there may well be a reduction in the measurement uncertainty for many measurements. It is necessary to address each measurement uncertainty analysis associated with measurement routines that are affected. The newer uncertainties will need to be applied to the measurement reports of the associated calibrations subject to accreditation.

2.3 Accreditation

In some cases the improvement of capability from the purchase of new instrumentation will allow for the improvement of the calibration and measurement capability (CMC) that the calibration laboratory is accredited to. Thus, in some cases the scope of accreditation will need to be reviewed and updated.

2.4 Software Validation

Where calibration laboratories use automation to enhance their repeatability and efficiency, there are additional steps that will be required for any upgrades. When software is updated it must be validated. The extent and impact of the software validation process will be dependent upon the impact the new instrumentation has on existing measurement procedures.

3. Benefits of Equipment Refresh

The primary purpose of this paper is to explore potential benefits from equipment refresh. This refresh may be associated with required additions associated with enhanced capabilities or an 2011 NCSL International Workshop and Symposium isolated refresh. Usually such a decision is not totally isolated from other events, such as the failure of older equipment and the necessary decision to repair (if possible) or replace. A similar situation occurs where an older instrument starts to consistently be just out of tolerance at its calibration. Thus the cost of the out-of-tolerance (OOT) analysis and the increasing number of calibrations place additional pressure to replace a unit.

3.1 Reduced Variety of Owned Assets

The core competency of a calibration laboratory is performing calibrations on a range of instruments and devices. Generally the lower the variety of instruments supported (i.e., calibrated) the more efficient an operation can be. Variety increases cost. A low-mix highvolume operation will be more efficient than a high-mix low-volume operation. But alas, most customers have an assortment of instruments and devices that must be calibrated.

This economic factor is not an "all or nothing" situation. The scale is somewhat continuous and incremental changes will affect the overall economics. Thus there can become a point where maintaining older measurement standards carry a significant cost – much larger than the obvious expenses. Laboratory managers should consider the entire support model for each of these older standards. To maintain the calibration of a standard requires the maintenance of its calibration procedure plus all the equipment used in that calibration. The requisite equipment pool should be carefully analyzed. It is not inconceivable that multiple measurement standards could be required to be maintained just in support of older lab-owned equipment. This suggests that there will be scenarios where the refresh of one or more instruments results in the opportunity to drop support on a larger set of standards, reducing overhead costs.

3.2 Reducing Test Stations

As an extension of reducing the number of measurement standards a laboratory must maintain, the number of testing stations may be reduced as well. This leads directly to two additional benefits.

3.2.1 Reduced Floor Space

Each test station consumes facility resources. The first and most obvious is the amount of floor space required to accommodate the equipment and operator space to use the test station. A secondary impact is the additional energy consumed by the additional equipment and, depending on location and the season, cooling to manage the heat generation.

3.2.2 Workflow

The second aspect of reducing test stations is improved workflow. Work can proceed through the laboratory more efficiently if there is not a need to queue customer devices for a limited number of test stations. Adverse concentration of work onto limited stations can result in station under-utilization and increased delays on completing work.

In very small operations this is seen as test stations sitting idle. This is caused either by a lack of work that can be calibrated on a specific station or the lack of technician capacity to keep all stations fully utilized. This may be best seen through an example.

A-1 Cal Labs previously had only one test station for voltage. Typical usage of this station runs around 80%. The mix of instruments calibrated on this station is rather large and represent maybe 20 years of product introductions to the market.

> A-1 is endeavoring to expand and grow their business and has just purchased newer test equipment that will allow them to calibrate some recently introduced advanced voltmeters. This station can also easily support a few other instruments currently calibrated on the old station as the manufacturers provided measurement procedures which support both sets of measurement standards. The addition of the new test station was clearly a good move, as business is increasing rapidly. A-1 has also discovered that those products that can be calibrated on either station take substantially less time on the new station.
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> A new challenge that A-1 did not anticipate is managing the workflow of voltmeters between the two stations. Clearly they would prefer to calibrate every instrument they can on the new station because it is faster. But if they schedule all those instruments for that station then on their busier days there are products stacked waiting for time on the station.
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> The older station, meanwhile, stays moderately busy but rarely is there more than one or two instruments waiting for calibration on it. Thus the management team is forced to watch their calibration volume daily and sometimes route instruments that could be done on either station to the older station just to keep the turnaround-times of the newest products within their advertised limits.
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> The management team would like to replace the older test station with a duplicate of the new station. This decision is not trivial. They would eliminate the effort spent on managing the routing of instruments. They could improve their throughput and reduce the turnaround times. They would have more capacity for additional growth. But the task would require updating procedures on the oldest products to be able to use the latest standards found in the new station.

Regardless of the mechanism, under-utilized equipment is costly. Capital is invested in the purchase of measurement standards and good business metrics will look for the revenue that is generated by that capital. Unused assets represent no return on the investment; underused assets represent diminished return on the investment. Neither of these lead to a healthy and growing business.

Equipment refresh allows for higher utilization of the measurement standards that are maintained for use in production and therefore improved return on the invested capital. (Remember that refreshing equipment includes the full decommissioning and disposal of replaced equipment.)

3.3 Improved Measurement Uncertainties and Margins

Equipment refresh means replacing older equipment with newer equipment. That does not necessarily mean replacing older equipment with newer and better equipment. If the refresh process is leveraging an expansion in capability then almost certainly the newer required equipment will also be better in some performance manner. For isolated refresh considerations improving performance is almost always justified.

In many cases the higher performance instrument will offer better accuracy. This provides the opportunity to update the measurement uncertainty analysis (a cost covered above) and lower the overall uncertainties of calibrations performed. This in itself may be a benefit to customers. Lower uncertainties mean a reduction in erroneous decision making. Depending on the calibration service provided, the customer may have constraints on the probabilities of false acceptance or false rejection. Viewed from the perspective of the calibration laboratory, depending on the process applied when a calibration determination is a failed instrument, avoiding that process on good instruments will represent a savings.

3.4 Improved Throughput

While newer instruments may extend the parameter range (e.g., higher frequency, lower voltage) or improve the accuracy, they often make comparable measurements faster. This contribution can be significant in improving the efficiency of the calibration operation. For certain types of RF measurements, average reductions of 80% have been seen. This is a benefit that should not be ignored. (This was mentioned in the example scenario above.)

It is worth noting that such speed improvements can come from more than one source. In some cases, the measurement circuitry is improved to allow for faster measurements. One enhancement that allows for potential speed improvement is an increase in bandwidth to allow for faster response and thus settling time in making the measurement. Or the noise of the circuit might be reduced, creating more measurement margin, allowing for faster settings on the instrument. Be aware, however, that increased bandwidth allows for increase broadband noise which can adversely affect the measurement integrity.

In other cases, speed improvements are derived from greater processing power within the instrument. Today high performance instruments often achieve that performance through implementation of digital signal processing (DSP) and other mathematical processing of the measured data. These speed improvements drive the performance and create a positive impact on the bottom line.

3.5 Maximizing the Benefits

One intangible advantage is that by purchasing improved performance a laboratory reduces the probability that it will be forced into additional purchases in the near future in order to accommodate a new demand for expanded capability. In other words, purchasing a new higher performing today, even extending capability beyond what is currently required, could avoid a must-purchase situation arriving in the future.

Aside from the capital costs, the other costs of Refresh are relatively the same regardless of the degree of improvement. In contrast, the benefits are directly related to the degree of improvement in the performance of the replacement standard. So the return on investment increases as the performance level of the new equipment increases.

Purchasing at the high end of the performance range should always be seriously considered.

4. Summary

At one time the decision whether to refresh equipment in a calibration laboratory was primarily a question of whether or not the capital funding was made available. Today there are many other considerations that affect that business decision.

Costs include the engineering or metrology work to update both measurement procedures and the associated measurement uncertainty analysis. Improved performance of the laboratory will often lead to an update in the scope of accreditation, which while costing resources is still generally a good thing. Finally, where software is used; it must be updated for the new procedures and revalidated before use.

The benefits begin with a reduction in the variety of assets that must be maintained and usually a reduction in the number of test stations that will be in the laboratory. This reduction provides both savings in floor space as well as enabling a more productive workflow plan. The improved measurement uncertainties enhance the value of the calibration product offering and increase margins in the production process. Finally, the refresh may well lead to faster throughput which lowers the cost to perform the calibration.

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Revised: June 8, 2011

Product specifications and descriptions in this document subject to change without notice.

Published in USA, October 5, 2011
5990-9191EN

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