

Nadcap Measurement & Inspection Newsletter

February 2016

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Dave Marcyjanik
 Simon Gough-Rundle
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From the Chair...

The Task Group meeting, as with every October meeting, coincided with the Auditor Conference (Pittsburgh, USA) that was held over the weekend. For M&I this gave the Task Group (Subscriber and Supplier Voting Members) the opportunity to meet the Auditors ‘face to face’ and provide updates. The conference is not just about the Auditors reviewing presentations from the Task Group (TG). This also allowed the Auditors to ask questions of the TG about the program. It was a success for all involved. From a TG meeting standpoint, a total of 64 individuals attended the meeting, which is certainly an increase in participation. With the word spreading about Nadcap M&I and the recent mandates, meeting attendance is expected to increase in the next twelve months. With the increased traction and interest in the program, there is more reason to introduce and explain the program to new representatives in the Supplier community. It is planned that a series of ‘Introductions’ about the M&I program will be given during the TG meetings. For further information, please contact PRI staff.



Simon Gough-Rundle

2015 has been a successful year for the M&I TG:

- The GE mandate for Airflow accreditation (AC7130/5) kick started the M&I audits resulting in 18 accreditations with re-accreditations and more initials required for 2016
- The AC7130/2 (Laser Trackers) and AC7130/3 (Articulating Arms) checklists were released.
- Boeing mandated Nadcap M&I accreditation.
- M&I Auditors have been approved.
- There have been increased participation at the face to face TG meetings (11 Subscriber Voting Members & 18 Supplier Voting Members).

There is still a great deal of work ahead and the TG is ready for the challenge as we lead into 2016 and continue throughout 2017, 2018, 2019, etc. with the various mandates.

I understand that budgets and availability do not always support taking a business trip, however, I would encourage that you take the opportunity to learn more about the Nadcap program and M&I, by attending the face to face TG meetings. There are three to be held in 2016 (Europe - Madrid, London. US - Pittsburgh). There is also opportunity at these meetings to attend free training associated with the Nadcap program.

Simon Gough-Rundle

M&I Chair and Rolls-Royce (Assistant Chief Metrologist)

M&I Newsletter – Want to be on the Circulation?

The M&I newsletter is published periodically throughout the year. The newsletters are read by the Nadcap Subscribers, Suppliers, Auditors and anybody that happens to click on the latest M&I newsletter on the PRI website (www.p-r-i.org/about-pri/media-center/key-documents/). The aim of the Newsletter is to communicate information relating to M&I within the Nadcap program to improve our process and to promote the sharing of best practices at all levels.

Have you stumbled across the M&I Newsletter by chance? Want to receive it on a regular basis? Keep up-to-date regarding the latest Nadcap M&I information by being added to the distribution list! To receive notification when a new edition has been published, please contact PRI (contacts on the last page) with your name, company and email address.

Hello Dave!

My name is Dave Marcyjanik and I have recently transitioned into the Measurement and Inspection Staff Engineer position after Jim Bennett found his fortune pursuing other avenues.



I am a native of the North Hills of Pittsburgh and I have been working as a Non-Destructive Testing Staff Engineer and Auditor with PRI for the last three years.

I began my studies in NDT methods, nuclear science, metallurgy, and metals machining and fabrication in 1977 at AW Beattie Technical Institute in Allison Park, PA.

In 1980, I began my career at Babcock and Wilcox Nuclear Equipment Division in Barberton, Ohio, and worked in their Trident submarine facility as an Ultrasonic and Helium Leak inspector.

Concurrently, I continued my education in NDT, aircraft structural fabrication and machining, by enlisting in the Pennsylvania Air National Guard. As an NDT inspector, with the 112th Tactical Fighter Group in Pittsburgh, I worked primarily on the engines and structural assemblies of A7 fighter aircraft utilizing penetrant, mag-particle, radiographic, ultrasonic and eddy current NDT methods. Additionally, I managed the Oil Analysis Program in Pittsburgh, analyzing aircraft engine oil to detect premature oil wetted system failure.

In 1984, I began a new career as a Federal employee with the 171st Air Refueling Wing, also in Pittsburgh, and in 1993, became the NDT Lab Manager. There, I managed and trained fulltime Federal NDT technicians and Air National Guardsmen. I was responsible for the NDT inspection workload of the KC-135 refueling aircraft assigned to Pittsburgh, which was one of three Air National Guard Super-Tanker units in the Air Force.

Our Pittsburgh lab was rated as one of the best in the Air Force and was awarded the 2008 USAF NDI Lab of the Year Award by the Air Force NDT Programs Office Assessment Team. I was also personally awarded the Excellence in Government Federal Service, Gold Award, in Technical and Engineering Series in 2002, and again in 2010.

In 2010, I continued my education in aircraft fabrication, and moved on to manage the 171st Aircraft Structural Maintenance (sheet-metal repair) facility. I retired from the military in December 2012 with over 32 years in Aircraft Maintenance as an Air National Guardsman.

I am excited to be working with the Measurement and Inspection community, and with the M&I Task Group and Suppliers.

I am looking forward to our first M&I meeting together in Madrid, Spain.

Nadcap Meeting Schedule

Nadcap meetings take place three times a year in locations around the world and are open to all Nadcap stakeholders and interested parties. The table identifies the meeting dates and locations through 2016.

2016	
Feb 22 - 26	Madrid, Spain
Jun 20 - 24	London, UK
Oct 24 - 28	Pittsburgh, Pennsylvania, USA

The October meeting is held annually in Pittsburgh, Pennsylvania, USA. The Saturday and Sunday prior to the Task Group meeting is comprised of an annual conference where all the Nadcap Auditors are updated on the program, policies, expectations and commodity (e.g. M&I) related issues.

The Task Group meetings are comprised of open and closed meetings. Open meetings are for all Nadcap stakeholders and interested parties when items of a confidential nature are not discussed. Some examples are checklist discussions, procedural requirements, technical clarifications not associated with an audit, metrics, general M&I information, etc. A closed meeting is held for Nadcap Subscribers where confidential information is discussed, for example: mandate discussion / status, auditor issues, process escapes, supplier advisories, audit report packages, etc.

There are many advantages to participating in a Nadcap meeting, such as:

Learning about and participating in Task Group activities, such as checklist development

Attending Nadcap Management Council (NMC) and Supplier Support Committee (SSC) meetings to learn about current activities in the Nadcap community and sub team initiatives

Networking with other delegates including aerospace Prime contractors, Suppliers and PRI Staff

Benefiting from free eQuaLearn training, such as Root Cause Corrective Action, Nadcap Audit Preparation and Introduction to Pyrometry

If you are interested in attending the Nadcap Task Group meeting, please register at

<http://www.p-r-i.org/nadcap>

And note also that there are no fees to attend the meetings.

Dave Marcyjanik – PRI Staff Engineer

Job Audits

Job audits, compliance jobs, witnessed jobs, paper audits, historical jobs, etc. The list goes on. There are many terms used when a Nadcap Auditor watches a part being processed by the Supplier. This is considered one of the most critical aspects of the Nadcap audit. This is where all the procedures, calibration certificates, PO's, training records, inspection records, software control, program control, operators capability, etc, are verified to confirm compliance with the requirements. Compliance applies to all the Nadcap accreditations.

From an M&I perspective, we use the term 'job audit'. Within the M&I checklists there is an expectation that two 'job' audits be witnessed for each of the technologies. Now, depending on the number of technologies audited and the types of technologies, this can differ. For example, in M&I there are two types of Measurements. The first is measuring by using coordinates known as CMS (Coordinate Measurement Systems). CMM (Coordinate Measurements Machines), LT (Laser Trackers) and AA (Articulating Arms) falls into this

category. The second is measuring by mass airflow. The latter does not mean a whole lot if you do not deal with mass airflow. For those that do, it is a very important aspect.

- For a CMM accreditation, two job audits are required
 - For an Airflow accreditation, two job audits are required
1. What happens if you add LT accreditation to CMM?
 2. What happens if you add CMM accreditation to Airflow?

To help explain, please refer to the table on the next page.

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Job Audits continued

JOB AUDIT COMPLIANCE TABLE

CMS Accreditation (CMM/LT/AA)	
One Technology	2 jobs
Two Technologies	2 jobs for one technology 1 job for remaining technology
Three Technologies	2 jobs for one technology 1 job for each remaining technology

Airflow Accreditation
2 job audits

So to answer the earlier questions

Question 1 = 3 job audits

Question 2 = 4 job audits

There are many different scenarios that occur during an audit that can make witnessing job audits a little more difficult. Examples being, lack of parts, inspection of a single part taking longer than two shifts to complete, etc. Each scenario does vary, so it is not easy to capture in such an article. If such situations occur, notify the Auditor and Staff Engineer.

Dave Marcyjanik – PRI Staff Engineer

Auditor Hiring

One of the challenges PRI faces with new programs is obtaining Auditors. PRI utilizes Independent Contractors to conduct the audits after they have gone through the hiring process, which includes an interview with the TG voting members and training audits.

At the moment, M&I has two Auditors approved and three others in the training phase. Obviously, with Boeing's mandate, the audit needs will increase considerably, albeit these audits will trickle in at first. As with anybody, Independent Consultants need work to rely on income. While there is not a high audit demand in Dec/Jan/Feb, it does not make sense to hire numerous Independent Contractors and have them 'sitting around' waiting for work. They would simply go elsewhere. With that in mind, the Auditor hiring process has ramped up due to the impending audits and the timelines required to train Auditors. To become an Auditor, the following criteria applies (taken from Operating Procedure 1116 Appendix M&I):

Mandate Status - Update?

The mandate issued earlier this year from The Boeing Company has certainly placed M&I on the map. Many Suppliers have been in contact with PRI directly to ask various questions about the program, and not to mention our Vice Chairperson (Norm Gross) from Boeing also receiving many queries. This is great news, as the M&I TG is working to emphasize the need to prepare and obtain as much information as possible, to prevent some of the common hurdles that new Suppliers face. This newsletter is one of the tools the TG is using to remove these hurdles from the racetrack.

There has been added momentum with the possibility of another engine manufacturer considering mandating M&I, although some issues need to be resolved first. The Boeing Company has asked other Subscribers when they will be mandating. This is especially important for Suppliers who perform M&I to multiple Subscribers. The benefits of Nadcap are seen when multiple Subscribers mandate, especially when it comes to redundant audits. Why have three Subscribers auditing your company in the same manner for M&I, when you can have one audit? Therefore reducing redundant audits.

2016 will see a change in the number of mandates, which will benefit the Supplier and Subscribers. As additional news becomes available, we will publish this information in the newsletter.

Dave Marcyjanik – PRI Staff Engineer

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Auditor Hiring continued

The Staff Engineer will review each candidate's a-firm-04 submitted into eAuditStaff and make a determination to submit to the M&I Task Group for interview. This decision will be based on consideration of the following guidelines:

- 5 years' experience as a Manufacturing / Quality Engineer
- Metrology knowledge
- Ability to read and understand engineering drawings / CAD Data
- Inspection System Experience
 - Method
 - Computer Aided Inspection (Laser Trackers, CMM's, etc.)
 - First principles (clocks, gage blocks, sine plate, micrometers, calipers, etc.)
 - Measurement Analysis
- Inspection jigs and fixtures
- Programming experience
- Degree or equivalent in an Engineering field
- Relevant training and inspection in M&I
- Auditing experience

If you know someone that would fit the above criteria and is looking for a change in direction, then ask them to apply in the eAuditStaff system (www.eAuditStaff.com)

Dave Marcyjanik – PRI Staff Engineer

- National Physical Laboratory (NPL) is the UK's National Measurement Institute (NMI).
- NPL is a center of excellence in developing and applying the most accurate measurement standards, science and technology available.
- Part of our mission is to raise measurement awareness, support and deliver large scale impact to industry, in the UK and globally.

NPL Product Verification-Findings

In response to industry-wide challenges, NPL developed the **Product Verification Health Check (PVHC)**, which combines metrology and manufacturing expertise from industry and academia.

This article explores the similarity of challenges identified by the Nadcap M&I Task Group and shares the experience and the potential opportunities arising from effective and efficient Product Verification.

The UK has a 17% global market share in aerospace industry revenues second only to the US and lies 5th in aerospace manufacturing attractiveness worldwide. It's known that product verification in high value manufacturing can be challenging, accounting for up to 20% of the product cost.

The UK faces similar challenges to the aerospace sector globally, in that there are real issues around skills, increasingly

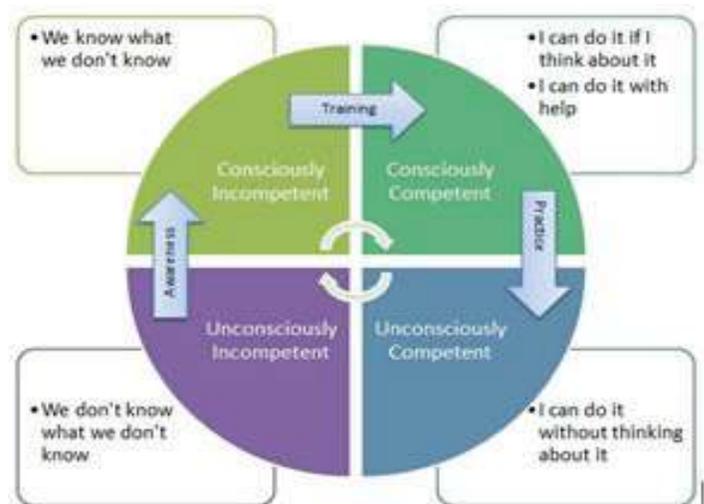


Figure 1: Competency Learning Process

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NPL Product Verification- Findings continued

stringent customer requirements, and improving production rates while assuring product quality and profitability.

The Product Verification Health Check (PVHC) is unlike an audit in that the NPL carry out an independent in-company assessment of an organization's measurement capability and quickly identify opportunities for improvement in four main areas listed below:

1. Measurement fundamentals and foundations
2. Measurement and process setting and validation
3. In-process control and verification
4. Post process and part verification

The PVHC is carried out by specialists with experience of manufacturing processes, design and metrology systems. Unsurprisingly, the NPL produce a report of our observations, but more importantly the NPL work with the company to develop an action plan that describes recommended activities and sources of further help. This Health Check enables the company to safely move through the learning process (figure 1) and supports the NPL's NMI mission of raising metrology awareness and supporting industry.

Insights into the current status of PV Capability

The top level findings listed below are based on the reviews that the NPL PVP team have carried out, primarily the Aerospace sector, within the UK. In general, the PV capability findings were at a fairly basic level, with a few exceptions, where pockets of excellent practice were found.

Overall, the findings showed:

- The upfront **planning stages** and post verification **feedback into design** were areas of common weakness.
- Significant **gaps in understanding** the potential of the value of data collected - gathering, analyzing & **using** data to inform and drive the business. (figure1: unconsciously incompetent).
- In many cases, inspectors and operators were being trained either on the job (OTJ) or via OEM training. Formal **measurement training**, including Measurement Systems Analysis (MSA) was infrequent.

- We found across all of the 4 stages that a **skills and competency matrix** highlighting the measurement aspects and supported by documented procedures would have been beneficial.

In the review, we rate the findings in each of the 4-stages on a scale highlighting "significant measurement best practice aspects are missing" to a company "exhibiting examples of 'World Class' behavior". Summarized below are common findings we have observed in each of the stages.

Stage 1: Measurement fundamentals and foundations

check that measurement requirements have been taken into account during the planning process. This is essential to ensure that the measurement process is optimized for quality, cost and delivery requirements at the outset.

- We found that specific metrology aspects that underpin product inspection were lacking in the QMS, i.e. the Metrology Management System.
- The **cost and time of measurement** was rarely evaluated at the planning stage, being absorbed as a cost to the business and impacted on meeting delivery schedules.
- Metrology process and **equipment selection** was not made using objective evidence of capability compared against specified requirements.
- Where **MSA** was applied, there was limited understanding of the techniques and associated benefits.
- **Potential effects of environment** (temperature, vibration, lighting etc.) on measurement results and conformance decisions were very rarely taken into account when generating the inspection plan.

In **summary**, there were missed opportunities in the planning stage to utilize measurement data as a tool to improve both inspection and manufacturing processes and inform future investment needs. Both would contribute to the competitive advantage of any business.

Stage 2: Measurement Process and Validation,

which is concerned with the validation of measurement processes that support production. (i.e. fit for purpose)

- Fixture Design, Tool Setting / Job Setup rated well with fixtures and components tending to be independently checked.
- In many cases, the **Calibration** function was not optimally managed and **requirements flow down** was often lacking; as were **software verification post updates**, both are requirements in international quality standards such as AS9100.
- There was little in the way of **procedures on how the inspections** were to be carried out, including optimal equipment handling. We found inspections typically relied on OTJ training.
- Requirements flow when setting up and validating the measurement process tended to be **one way from design to manufacturing** without much feedback interaction.

Stage 3: In-Process Control and Verification focuses on the adherence to the plans and the controls that are apparent when actually taking the measurements both during and after manufacture.

- We found that the execution stage scored reasonably well, continuous and attribute data were being recorded, but opportunities were missed to use this data to check, set and monitor processes, supported by documentation and training to ensure consistency.
- We did have an example where a company was using the SPC data collected to feedback and help drive new processes and improvement.

Stage 4: In post process and part verification

we look at the processes which help discern what can be learned about the product following the measurement process and how those lessons can be fed back into the business to make future improvement.

We found that formal inspection reporting scored well, primarily driven by the existence of FAIRs, which were generally of a good standard and were compliant with customer requirements.

- Opportunities exist to **analyze the measurement data** generated to determine valuable manufacturing or measurement trends.
- Formal feedback loop for **lessons learned**, especially involving setters, inspectors was often absent. These experienced members of staff are well placed to determine recurring issues. Capturing this learning would provide a valuable insight to the manufacturing process capability.

In summary, while the measurement capability in this subset of the Aerospace supply chain provides evidence of gaps in measurement knowledge, on a more positive note, we also have evidence that with the right support, companies can meet the challenges and capitalize on the improvement opportunities facing them.

Rising to the Opportunity

NPL has worked on developing and supporting companies to address the findings of the PVHC as part of a holistic business support program called "Sharing in Growth". We have found that there is an untapped opportunity to apply measurement knowledge available which could be used to transform the aerospace supply chain.

Here are some of the ways companies are benefiting from, not just increased awareness of what they don't know, but accessing and applying existing knowledge:

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NPL Product Verification- Findings continued

- **Validating your inspection process can avoid unnecessary costs and ensure compliancy to International standards.**

In a typical support activity, we reviewed a CMM program and its approach to the inspection process. We identified opportunities to improve the program, which was generating false rejects. Through developing an optimized program and correct validation, the reject rate was reduced and is saving the company circa £100K GBP (\$148,148) / annually.

- **Having knowledge of how to evaluate measurement capability is a core skill in advanced manufacturing.**

This company was recording visual inspection data, we provided them with *techniques to analyze* the data and *understand* their performance. It was identified that the inspection didn't have robust comparative standards and the process was falsely identifying parts for rework. Using objective evidence, they were able to agree on the appropriate standard with their customer, which led to reduced rework rates and reclaimed production capacity.

The examples above highlight how these companies acknowledged and addressed the measurement knowledge gaps, not only in production, but within the management and economic buyer teams.

There are challenges that should be openly addressed, for example:

- The fear of discovering unpleasant truths, which can be offset by adopting a pragmatic, phased approach to rolling out new ways of working, such as adopting best measurement practice via New Product Introduction (NPI).
- The initial investment in raising awareness and up skilling, from top management through to operators and thus moving from unconsciously incompetent to consciously competent.
- The acknowledgement that changing the measurement mind-set is a journey that takes time and practice to be embraced and embedded into the culture of any organization.
- Initiatives such as Nadcap M&I really do provide a useful driver for manufacturing companies, not only will they assure compliancy with existing industry standards but more importantly, by embracing measurement best practice one will reap tangible economic business benefits.

Lisa Leonard - National Physical Laboratories Head of Regional New Ventures