Journal of KONBiN 1(17)2011
ISSN 1895-8281

ISO STANDARDS FOR QUALIFICATION AND ASSESSMENT OF PERSONNEL INVOLVED WITH CONDITION MONITORING

NORMY ISO KWALIFIKACJI I OCENY PERSONELU REALIZUJACEGO MONITOROWANIE STANU TECHNICZNEGO

Kenneth Culverson

kenculverson@optilink.us

***Abstract**: This paper will touch on the current status of ISO standards development for condition monitoring and diagnostics of machines, but will focus on the ISO standards for qualification and assessment for personnel involved with condition monitoring. In particular it will discuss the desirability of tailored training for personnel and the avenues for certification, particularly in the areas of Tribology and lubricant analysis.*

***Keywords:** ISO, Standards, Condition monitoring, diagnostics, prognostics, training, assessment, certification*

***Streszczenie:** Tematem publikacji jest aktualny stan norm ISO dotyczących monitorowania stanu i diagnostyki maszyn, ale skupia się na normach ISO dla kwalifikacji i oceny personelu zaangażowanego w monitorowanie stanu. W szczególności przedyskutowano celowość dostosowania szkoleń dla personelu i drogi certyfikacji, szczególnie w obszarach tribologii i analizy oleju.*

***Słowa kluczowe:** ISO, standardy, kontrola stanu technicznego, diagnostyka, prognozowanie, szkolenie, ocena, certyfikacja*

1. Condition monitoring and diagnostics standardization history

ISO Technical Committee (TC) 108, Mechanical vibration, shock and condition monitoring, first formally investigated the field of ‘condition monitoring and diagnostics as a potential area of standardization in1988 with an ad hoc committee formed to investigate the state of the art in that field. The committee reported back to TC 108 in 1990 that the field was ready for standardization. In 1991, a vibration condition monitoring work group was convened and the consensus of the engineering professionals present was that the field needed to be broader than just vibration. TC 108 also submitted a plan for establishment of a subcommittee dedicated to “condition monitoring and diagnostics of machines”. Later that year, at the, 3rd International Machine Monitoring & Diagnostics conference (IMMDC) held in Las Vegas, NV, USA, the late Dr. Douglas Muster presented a paper on the subject and, at the end of the conference, held an informal meeting to assess the extent of support for the idea of standardization. The general consensus of that group was that the need existed, and the sooner the better.
At the conclusion of the “Condition Monitor 94” conference, held at the University of Wales - Swansea, UK, the British Standards Institute hosted the first plenary session for ISO Technical Committee 108 Subcommittee 5 (TC 108/SC 5). Dr. Muster chaired the proceedings and work started in attempting to define just what work items would be set up and who would participate. A spirited discussion ensued with the champions of various technologies vying to get their agenda on the table. In the end, six work groups were set up to address specific work items.

2. Who is involved

Currently, the subcommittee has 33 member countries:
Participating Countries (21) – Have nominated experts to participate in the discussions, attend meetings, help to write document and have a vote on matters pertaining to the work of the subcommittee.

Australia	(SA)	Chair
Belgium	(NBN)	
Canada	(SCC)	
China	(SAC)	
Czech Republic	(CNI)	
Denmark	(DS)	
Egypt	(EOS)	
Finland	(SFS)	
France	(AFNOR)	
Germany	(DIN)	
Ireland	(NSAI)	
Japan	(JISC)	
Korea, Republic of	(KATS)	
Nigeria	(SON)	
Norway	(SN)	

Portugal	(IPQ)	
Russian Federation	(GOSTR)	
Sweden	(SIS)	
Switzerland	(SNV)	
United Kingdom	(BSI)	
USA	(ANSI)	Secretariat

Observer Countries (12) – May nominate experts to attend and participate in the work of the subcommittee, but have no vote.

Argentina	(IRAM)
Austria	(ON)
Brazil	(ABNT)
Hong Kong, China	(ITCHKSAR) (Corresponding Country)
India	(BIS)
Italy	(UNI)
New Zealand	(SNZ)
Pakistan	(PSQCA)
Romania	(ASRO)
Slovakia	(SUTN)
South Africa	(SABS)
Spain	(AENOR)

Actual work is carried out by work groups who have a fairly narrow, defined scope of endeavor. This is the place where standards are developed by interested experts.

3. Twelve Work Groups

WG 1	Terminology
WG 2	Data interpretation and diagnostics techniques
WG 4	Tribology-based monitoring and diagnostics
WG 5	Prognostics
WG 6	Formats and methods for communicating, presenting and displaying relevant information and data
WG 7	Training and accreditation in the field of condition monitoring and diagnostics
WG 8	Condition monitoring and diagnostics of machines
WG 10	Condition monitoring and diagnostics of electrical equipment
WG 11	Thermal imaging
WG 14	Acoustic techniques
WG 15	Ultrasound
WG 16	Condition Monitoring and diagnostics of wind turbines

4. Technical standards

The technical standards work is carried out by TC 108 for purely vibration related items but the bulk of the technical work is done by the above work groups. The work load has grown considerably and the membership has grown modestly, in

large part due to the fact that the Sub-committee was "hidden" within a technical committee that was titled "Mechanical vibration and shock.
Only recently was the name of the technical committee modified to the current title "mechanical vibration, shock and condition monitoring" to reflect work of subcommittee 5. The work groups are always looking for additional input from other personnel in the field of condition monitoring and diagnostics to augment the knowledge base. As shown below, the standards we have published are a fairly diverse group. We are also updating many of these standards to maintain their currency and continuing to develop additional standards to expand the field.

5. Published standards

*ISO 13372:2004	Condition monitoring and diagnostics of machines – Vocabulary
ISO 13374-1:2003	Condition monitoring and diagnostics of machines – Data processing, communication and presentation – Part 1: General guidelines
ISO 13374-2:2007	Condition monitoring and diagnostics of machines – Data processing, communication and presentation – Part 2: Data processing
ISO 13379:2003	Condition monitoring and diagnostics of machines – General guidelines on data interpretation and diagnostic techniques
ISO 13381-1:2004	Condition monitoring and diagnostics of machines – Prognostics – Part 1: General guidelines
ISO 17359:2011	Condition monitoring and diagnostics of machines – General guidelines
ISO 18434-1:2008	Condition monitoring and diagnostics of machines – Thermography – Part 1: General procedures
ISO 22906:2007	Condition monitoring and diagnostics of machines – Acoustic emission
ISO 29821-1:2011	Condition monitoring and diagnostics of machines using airborne/structure borne ultrasound – Part 1: General guidelines

Published standards written by TC 108

ISO 13373-1:2002	Condition monitoring and diagnostics of machines – Vibration condition monitoring – Part 1: General guidelines
ISO 13373-2:2005	Condition monitoring and diagnostics of machines – Vibration condition monitoring – Part 2: Processing, analysis and presentation of vibration data

6. Qualification and assessment standards

It appears that the subcommittee broke new ground when it started developing the qualification and assessment standards. This series is designed as a guideline for establishing training, assessing that training and the specific experience of personnel in different categories within a technical discipline and provide the framework whereby an independent body can set up a certification scheme.

The ISO 18436 series of documents comprise a comprehensive approach to the process of training, qualification and assessment of personnel in the various technical disciplines that make up condition monitoring and diagnostics of machines. The technology related documents, i.e., vibration, tribology, infrared thermography, etc. detail the knowledge and experience required by personnel at each category in that discipline. These parts work in conjunction with the two broader documents in the series. ISO 18436-1 which spells out the processes to be followed for certification to the technology standards in the series. This standard is an adjunct to ISO/IEC 17024, Conformity assessment — General requirements for bodies operating certification of persons, which spells out the processes to be followed for certification to an ISO standard by independent bodies. ISO 18436-3 deals with the special requirements for training bodies and the training process. This standard applies to any training organization that wishes to train to the ISO 18436 series technical standards.

There is still work to be done, as shown below, there are revisions being made to ISO 18436-1, ISO 18436-2 and ISO 18436-3 in addition to new work in technical requirements areas.

7. Published standards

*ISO 18436-1:2004	Condition monitoring and diagnostics of machines – Requirements for training and certification of personnel – Part 1: Requirements for certifying bodies and the certification process
ISO 18436-1:2004/Corr 1:2006	
*ISO 18436-2:2003	Condition monitoring and diagnostics of machines – Requirements for training and certification of personnel – Part 2: Vibration condition monitoring and diagnostics
*ISO 18436-3:2008	Condition monitoring and diagnostics of machines – Requirements for qualification and assessment of personnel – Part 3: Requirements for training bodies and the training process
ISO 18436-3:2008/D Amd 1	
ISO 18436-4:2008	Condition monitoring and diagnostics of machines – Requirements for qualification and assessment of personnel – Part 4: Field lubricant analysis
ISO 18436-6:2008	Condition monitoring and diagnostics of machines – Requirements for qualification and assessment of personnel – Part 6: Acoustic emission

ISO 18436-7:2008	Condition monitoring and diagnostics of machines – Requirements for qualification and assessment of personnel – Part 7: Thermography

8. A word about certification

There is some confusion about ISO certification. Of course, ISO does not certify anyone or anything. ISO develops and publishes standards which may then be adopted by the market. If the market feels that the content of a standard should become formalized then national standards bodies may accredit organizations to provide third party certification that a standard has been met. This is the case with ISO 9001 and ISO 14001.

ISO terminology specifies that certification is only based on independent third party assessment of qualifications. Anything else is not certification to an ISO standard. The ISO 18436 series of documents are unique in that they attempt to provide a baseline that the market can use to assess the qualification of condition monitoring and diagnostic practitioners in the various condition monitoring and diagnostic technologies. The goal of the subcommittee was to raise the bar in each of the technologies, and provide some semblance of order for the market. It is hoped that the use of the standards will enhance the experience of condition monitoring and diagnostic personnel and give greater recognition to their accomplishments, education and experience.

9. Why train to the standards?

Condition monitoring and diagnostics schemes require not only knowledge of the technologies and techniques involved in the process but knowledge of the machines being monitored. This is true regardless of the technology being used. All of the technologies require a certain amount of investment into monitoring equipment and supplies and the time and effort required to set up which machines will receive what kind and what amount of monitoring.

In the aviation community, lubricant analysis is the primary condition monitoring technology employed today. With most of NATO using the Joint Oil Analysis Program, training for the analysts is readily available. For non military aviation concerns, laboratories that will provide the analysis of the lubricants are available in most if not all regions. Training courses are available for management and technical personnel from a variety of commercial sources which will provide a good foundation for understanding the results of the analysis. This training is critical for those people who will make decisions on the availability of an aircraft to perform any flying mission.

While this top level training is critical to properly implement a lubricant analysis program, no less important is the necessity of providing training for the supervisory and support people who will carry out other functions related to lubrication.

In one instance, I was tasked with determining the causes of fluid spills on aircraft carriers. The problem was that the hydrocarbons were attacking the non-skid

material on the flight deck making it even more hazardous than necessary. After researching the extent of the problem from maintenance records both from aircraft and from the aircraft carriers themselves, no clear picture emerged that would account for the wide range of spills, leaks, etc.
To look at the problem closer, my team and I were deployed aboard carriers conducting operations in different areas of the world. Some of the major spills became very apparent the second day at sea in hot climates. Aircraft had been refueled after landing the evening before. Behind each fighter, a large trash can was set up to try and capture the fuel that came out of the vent valves as the sun came up and the temperatures rose by 20 to 30 degrees. This had been going on so long that no one thought to question the practice. This was extremely easy to resolve this problem by changing the refueling quantity loaded into the aircraft in the evenings.
The vexing problems were not the major spills or leaks but the myriad small leaks from seemingly every aircraft on the flight deck. Fighters, attack aircraft, reconnaissance aircraft and helicopters all had small leaks of fuel, hydraulic fluid and lubricants. We spent the rest of the at sea periods following the ground crews around observing how the fluids were handled going into the aircraft and how samples were taken for analysis. It turned out that the vast majority of "hydraulic leaks" and "oil leaks" came from filling operations. When queried, the ground crews stated that they were doing the job the way they had been trained. Many of the supervisors felt that leaks were part of the job and had not been informed that it caused any problems.
As for the fuel leaks, most fuel sample ports are located on the bottom of the aircraft. Taking a sample required pushing a spring-loaded valve opens, turning it a quarter turn, and holding it while the half liter fuel sample was taken. To keep the jet fuel from running down the arm while taking the sample, many of the ground crew would use their screwdriver to wedge the valve open. Of course this damaged the seal around the valve and a small leak would develop. Fortunately, we came up with an easy fix to integrate the screwdriver into a cap that screwed into the sample bottle. We had very well trained analysts on the aircraft carriers, but nobody had provided specific training to the ground crew in lubricant handling, or servicing to decrease the volume of fluid that was causing problems for the ship. Likewise, no one had provided training, or explanation to the ground crews on why the existing method of opening fuel drains was not appropriate. As part of the study, my team developed a training program for the ground crews which could be easily tailored to the needs of each aircraft type and model to address the specific problems found.
A lubrication program will only be as successful as the people who operate it. This includes everyone from senior operations management, maintenance management, supervisors, technicians, and yes, even the plane captains who do the dirty work around their aircraft when it is on the ground.
If appropriate education and training is not provided, the program is doomed to failure. At a minimum, inadequate training will make the program less than

effective, lead to unnecessary costs which can cause the organization to lose faith in the program. As a person who has benefitted from a well run lubricant analysis program, I personally feel that would be tragic.

In today's world, we are being asked to do more with less. However, certain areas still require tailored training to safely perform the mission and there needs to be a way that people can demonstrate their mastery of the subject area. Certification is certainly an excellent method to ensure people have the requisite training and experience to perform the job well. The ISO schemes have been developed primarily by the people that perform the tasks covered by the technology. These are real world objectives, vetted by a large group of people who are very experienced in the technology. Members of the working groups have reached out to experts that do not sit on the subcommittee and used their expertise and experience to keep the standards grounded in reality. This is particularly true in the lubrication area where working group members hold ad hoc meetings at lubrication related seminars to get input from the participants. More and more training organizations are realizing the validity of the standards and are now offering courses based on the standards for field and laboratory analysis training.

10. Summary

In the past seventeen years, TC 108 / SC 5 has come a long way. I look back to that first plenary meeting in Swansea and the optimism that we left with about the road ahead and feel that we are approaching the vision that started this whole effort. The road has been a rocky one and hit some roadblocks that slowed us down and unexpected pathways that brought in new and different ideas, but the members of the subcommittee have persevered and brought out documents which will, we believe, enhance the practice of condition monitoring in the future. This is especially true of the ISO 18436 series documents. This was not on our agenda at that first plenary meeting, but when the idea of developing them arose, it was obvious that they were as necessary as the technical documents we were working on. As stated earlier, we paved new ground within ISO and plunged headlong into a bureaucratic jungle that we have finally mastered, if not conquered. As always, the subcommittee is searching for additional experts to assist in the ongoing work we are striving to produce. We urge those who would like to participate in the effort to contact their national standards body and find out what you can do.

Mr. Culverson is an experienced Reliability Engineer having over 30 years experience in the field. He holds an undergraduate degree in Physics, an MBA and a MS in Logistics Engineering. He is the Convenor of Work Group 1, Co-Convenor of Work Group 7 and an individual expert in Work Groups 4, 10 and 11 of TC 108/SC5. Mr. Culverson is certified in vibration analysis, lubrication analysis, infrared thermography and lubrication operations. Mr. Culverson has published over a dozen papers on topics relating to reliability and condition monitoring.