

**IIW Annual Assembly – Graz, Austria.**

**July 6<sup>th</sup> to July 9<sup>th</sup>, 2008.**

**Summary of Commission V Activities.**

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## **Summary**

Dr. Gerd Dobmann from Germany chairs this commission. Its focus is in the areas of quality control and quality assurance of welded products, and as such it deals with NDT techniques. The IIW meetings have two main purposes: to gather together experts from around the world to discuss welding related issues, and to allow the flow of information between the member welding societies in the parent countries. The meetings with Commission V were done both in the form of updates by the sub-commission chairmen on their work during the past year, presentation of papers and group discussion on topics. Descriptions of the papers and summaries of the group discussions are given. The full texts of the papers are available by contacting the CCIW.

## **July 7<sup>th</sup>, 2008 – Commission V Meetings**

- **Presentation 1** – Commission V Annual Report, G. Dobmann, Germany.
  - Dobmann presented the annual report for Commission V. There were no interim meetings for Commission V.
  - The average attendance for in Dubrovnik was 17 people from 12 countries.
  - There is a strong worldwide effort in the areas of digital radiography, computed tomography and digital detector arrays. There is the possibility of contrast sensitivity of 1/1000 the of wall thickness with this new technology. There are standardization efforts going on in this area right now.
  - There is much work going on in the area of phased array inspection development. Included in this are SAFT and SPA applications, that allow improvements in sensitivity and resolution over standard phased array techniques
  - There was discussion in the area of hybrid EMAT/MFL/EC sensors being used for pipeline in-line inspection and their ability to perform all of these functions at one time. This was discussed in detail last year in Commission V.
  - There was discussion on how to handle the POD of various NDT techniques, as customers are requiring this information more often. The interest in regard to POD curves is in the area of probabilistic fracture mechanics, which takes into account the material variables and the inspection uncertainties to determine fitness for service. This is currently a very active area of NDT research.
- **Presentation 2** – Report of IIW Secretariat, A. Charbonnier, France.
  - An update on the IIW Web site was provided. There is more Web activity than before and the number of downloads has increased. There are 5000 technical documents currently available on the Web site.
  - IIW is in the process of re-doing the IIW Web site to make it more efficient. There will be three parts to the new Web site: public area, extranet and collaborative area.
  - An update on the Journal Welding in the World was given.
- **Presentation 3** – Update on Activities, P. Benoist, France.
  - Provided an update on his activities at CEA and his background in NDT.
  - Benoist is the head of the NDT department at the French Atomic Energy Commission, which is a public institute in France. He is responsible for roughly 90 people working in 6 labs. They have 65 PhD or high levelled engineers and 25 PhD postdoctoral students with 75% of their revenue provided by industrial contracts.
  - They work primarily in the following areas:
    - CEA develops and maintains the CIVA simulation and modelling software, which is the pre-eminent NDT modelling package in the world. CIVA is used for virtual testing of various NDT configurations, and it allows customers to perform advanced virtual testing of NDT configurations before purchasing

hardware. Information is provided at [www-civa.cea.fr](http://www-civa.cea.fr). They have sold their software to 100 different companies and have 25 dedicated people in this software group. CIVA has the ability to model UT, ET and RT configurations.

- CEA has developed adaptable flexible arrays, in which flexible array probes move over uneven surfaces and perform inspection. This is a complicated inspection configuration, as real time reconstruction of the beam properties must be performed. They use real time measurement devices to determine the surface profile, and then CIVA to do determine the required beam properties.
  - CEA is also working on flexible ET arrays in a similar manner to the UT flexible arrays. Their coils are also able to provide good depth penetration and a very high spatial resolution compared to regular ET.
  - CEA also works in the areas of concrete inspection and guided wave inspection of wires.
- **Paper 1** – Non-destructive Microstructure Characterization of Materials States After Thermal Aging..., G. Dobmann, Germany, V-1406-08.
    - Considers thermal aging, fatigue and irradiation and how this affects material properties in nuclear applications, as applied to the copper rich steel WB 36 in the temperature range 280 to 400°C. There is embrittlement that occurs due to the copper phase changing from BCC to FCC and thus putting compression stress on the material matrix.
    - The magnetic and mechanical properties of these materials are similar. Barkhausen noise, field harmonics and ET analysis were all used determine material ageing.
    - Fatigue loading occurs in the secondary piping circuits of nuclear power plants where cold water is sometimes injected into hot water lines. This causes fatigue loading in the pipe due to the different temperatures in the water layers. Variation in the hardness of the material is measured depending on the details of the cold water injection.
    - This fatigue behaviour is measured using GMR's (giant magnetoresistance sensors), and there is good correlation between these measurements and stress measurements.
    - Also considers the effects of neutron degradation. Power plants are designed to withstand a certain fluence of neutrons, but the actual fluence is much lower than the design criterion indicating a longer than design life. IZfP has designed an EMUS sensor for dynamic magnetostriction measurements, which establishes a standing wave in the material that shows a reduction in the magnetostriction amplitude as neutron embrittlement increases. This technique is still in the development stage.
  - **Presentation 4** – Annual Report for Commission VA (Radiography Based Weld Inspection Topics), U. Ewert, Germany, V-1401-08.
    - Ewert presented the annual report for Sub-commission VA. This group is active with standardization and harmonization of radiography standards, with special focus on the transfer of film RT to digital RT.
    - There were no intermediate meetings this year.
    - The working group on Digital Industrial Radiology was not active over the past year, or has not been since 2007. Dr. Uwe Zscherpel from BAM has agreed to take over this group. The focus will be on new techniques and standards in the areas computed radiography, digital industrial tomography with digital detector arrays and training in digital industrial radiology.
    - There is a revision for EN 12062 that will be transferred to ISO 17635, which is the key standard in Europe that informs on selection of NDT methods. There will also be development of a new computed radiography weld inspection standard for phosphor imaging plates. These standards are analogous to EN 1435 and ASTM E1032. ASTM E2597 is the first standard that deals with characterization of DDA (digital detector arrays), which addresses dead pixels, over/under responding pixels, noisy pixels, non-uniform pixels, persistent lag pixels and bad neighbourhood pixels. CEN TC 121 SC5 will develop a standard for radiographic weld inspection by DDA's under EN 1435-2.
    - ISO 5817 / ISO 10042 is a standard that defined three quality levels for inspection of pressurized equipment. The concept is to have B vessels (highest quality) for dynamically loaded vessels, C vessels (middle quality) for vessels with a static load and D vessels when there is agreement between the parties on this quality level. The quality

level A is reserved for special applications. This represents a significant departure from the ASME philosophy.

- There are EN standards that are being transferred into ISO standards: EN 1714 (UT pulse echo) is going to ISO 17649, and EN 1713 (characterization) going to ISO 23279.
- There is a UT TOFD standard TS 14751 and the acceptance levels EN 15617. There is disagreement between the TOFD standards and some existing standards, with no good agreement on how to proceed.
- There is a strong effort in Europe to move the EN standards to ISO, which is something that must be considered in North America. If this process proceeds, then the ISO standards will be essentially German standards that have been transferred to EN, and then into ISO standards. This will result in the ASME standards not being represented within ISO to any significant degree.
- There was a discussion about the difference between the film density and S/N ratios that are relevant for digital systems. There is a large difference in images of the same flaws with different S/R ratios (i.e. different exposure times), which strongly affects the acceptance of indications. Film density is replaced by S/R ratio for digital RT.
- Good graphs were presented about the differences between film, CR and DDA that show the behaviour of S/N ratio versus exposure. The DDA get better S/R ratios for less exposure than CR.
- There are a number of inspection applications in Europe that have much higher sensitivity requirements than the 2-2T sensitivity requirement in North America. In general, better hardware is available in Europe due to this increased requirement.
- ISO 10893 is a new standard dealing pipe manufacture, and deals with all NDT methods.

#### July 8<sup>th</sup>, 2008 – Commission V Meetings

- **Presentation 5** – Annual Report for Commission VC (Ultrasonic Based Weld Inspection Topics), E. Sjerne, Canada, V-1402-08.
  - Sjerne presented the Annual report for sub-commission VC. There were four interim meetings of this group.
  - The publishing house of the German Society of NDT will be publishing the Handbook on the Ultrasonic Examination of Austenitic and Dissimilar Welds in the next few months. The editing of figures for this Handbook is now complete.
  - The IIW block project group has completed its work. The German committee has decided to recommend personnel with IIW blocks should replace them, as this is less expensive than testing existing blocks. A standard practice for manufacturing IIW blocks has been issued that will be used henceforth by the manufacturers of these blocks.
  - There was a discussion about guided wave techniques. It was decided that the IIW should form a group within Sub-commission VC to work in this area. The following goals were laid out for this working group:
    - Francesco Bresciani was chosen to be the chairman of this working group.
    - Guided wave experts will be approached to participate, including personnel from Imperial College (GUL), TWI (Teletest), SWRI, Dr. Rose and IzFP. End users will also participate.
    - The goal of this initial work is to draft a best practices document that describes guided waves as applied to pipe inspection.
- **Presentation 6** – Handbook for Phased Arrays, M. Moles and E. Sjerne, Canada.
  - A comprehensive presentation was given to Commission V on the draft version of the Phased Array Handbook. An overview of the background of the Handbook was given, and then all of the authors were acknowledged. Following this was a description of each chapter in the Handbook with discussion and figures presented. The chapters are as follows:
    - Acknowledgements
    - Chapter 1 – Scope
    - Chapter 2 – Phased Arrays Principles and Design
    - Chapter 3 – Scanning Patterns and Views

- Chapter 4 – Codes and Calibration
  - Chapter 5 – Modelling and Imaging
  - Chapter 6 – Weld Inspection Applications – New Fabrication
  - Chapter 7 – Weld Inspection Applications – In-Service
  - Chapter 8 – Non-Weld Related Phased Array Applications
  - Chapter 9 – Summary
  - Glossary of Terms
- Following the presentation, Sjerve submitted a request for an IIW resolution to publish the Handbook. This resolution was accepted, contingent on satisfactory resolution of external editors comments.
- **Presentation 7** – Phased Array Calibration Blocks, M. Moles, Canada.
  - A presentation was given to Commission V on calibration blocks that are currently used for phased arrays. The blocks included in this description were:
    - ASTM E-2491 verification block
    - NAVSEA calibration block
    - Sonatest phased array calibration block
    - The Welding Institute phased array calibration block
    - Olympus NDT phased array calibration block
    - Materials Research Institute phased array calibration block
  - Sjerve then requested formation of a working group within Sub-commission VC to work on design of an IIW phased array calibration block. There was broad support within IIW Commission V for this project, and a working group will be formed to address this issue. The details from the discussion are:
    - The chairman will be sought from BAM or TWI. Dr. Ewert and Dr. Lozev both agreed to go back to their respective institutes and see if there is interest.
    - There is also the potential for drawing a chairman out of the Institute de Soudre in France or IZfP.
    - The time frame for this project is to have a recommendation ready for the calibration block by the 2009 Annual Assembly.

#### July 9<sup>th</sup>, 2008 – Commission V Meetings

- **Presentation 8** – Annual Report for Commission VE (Weld Inspection Topics Based on Electric, Magnetic and Optical Methods), G. Dobmann, Germany, V-1403-08.
  - Dobmann presented the Annual report for sub-commission VE. No interim meetings were held.
  - Other topics considered were materials characterization using micro magnetic techniques, and applied and residual stress measurements. Both of these non-destructive testing techniques are expected to have a larger impact in the future. Residual stress measurements are important, as the residual stress is now an important parameter that is required for fracture mechanics calculations.
  - The MMM Training Handbook was published last year as an IIW document. They have also published through the IIW a document describing education of MMM personnel. This has been sent out to a number of publishing houses by the IIW board of directors, and publication of this document is expected in the coming year.
  - There was also discussion on an Indian project that uses thermography to characterize the weld bead during the welding process to better control the welding process. A paper will be given next year on the state of the art with this application.
  - MMM technology is now being applied in more than 15 countries in the world. There was a proposal from the Russian delegation to form a new Sub-commission within Commission V that deals only with MMM. This proposal did not receive enough support to pass.

- **Paper 2** – Comprehensive Testing of Bends and Welded Joints of Boiler and Steam Pipelines, S. Kolokolnikov, Russia, V-1404-08.
  - Concerned with damage in bends in power plants resulting from laminations and in-service degradation. There is currently no other NDT technique that can find this damage in its earliest stages (i.e. before the damage becomes macroscopic).
  - Employs the detection of SCZ's before macroscopic flaws have been formed. A brief description of the basics of this technique was given.
  - Able to detect corrosion and small cracks in the bends. The cracked areas had an increase in hardness of 20%. Also detected SCZ signals in one area that were revealed through replication as creep. This area was removed through grinding, and verified with a second MMM inspection.
  - Weld inspection of steam pipe welds was performed and revealed high SCZ signals, that were shown using ultrasonic testing as LOF in the root area up against a backing bar.
  - This paper will be submitted to the journal *Welding in the World* as a class A paper.
- **Paper 3** – The Problems of Residual Stress Testing in Welded Joints and Their Solution Using the MMM Method, S. Kolokolnikov, Russia, V-1405-08.
  - Graphs are given showing the correlation between the residual stresses on welded plates and the corresponding self magnetic field leakage fields. There is good qualitative agreement between these measurements. Comparisons between x-ray diffraction residual stress measurements and MMM are presented. These results are slightly different, but explained through the differences in what the two techniques measure.
  - Future work will include attempting to classify the magnitude of the magnetic signals and what flaws they correspond to, and trying to determine the signals caused by geometry of the material.
  - There are first order residual stresses (bulk stress which corresponds to the location of the x-ray peak in x-ray diffraction measurements), second order stresses (stress over the grain size and measured by the width of the x-ray peak) and the third order stresses (stress over single atoms that can't be measured by x-ray diffraction).
  - There was strong disagreement within the group with some of the statements made using MMM for stress measurements and how this technique compares to other techniques.
- **Presentation 9** – Annual Report for Commission VF (Weld Defects and Their Significance), P. Benoist, France.
  - Report given by Benoist. There is currently no activity in this area. Benoist will take over as chairman of Sub-commission VF.
  - Issues to discuss
    - Influence of different parameters on POD: welding, material geometry
    - Uncertainties linked to NDT
    - Link between POD and fracture mechanics
    - Link between simulation and NDT reliability
  - With modelling, there are a large number of parameters that can be taken into account – probe, geometry, defect and material characteristics. Some thought is needed on how these parameters can be linked to the inspection results.
  - Presented some results on the variation of defect position and defect amplitude for different inspection conditions (i.e. austenitic stainless steel, cast stainless steel and rough surfaces), which show a large variation in the results depending on the inspection conditions.
  - There is a French group that has been working on integrating data from POD curves. All of the parameters are not independent, and the uncertainties all interact. This project is trying to deal with this non-linearity using modelling. There are also groups in Germany and USA working in these areas.
  - The proposal for this sub-commission is to work with these external groups to determine the best way to model this behaviour. This involves a slight change in direction away from the significance of defects to a modelling approach.
  - Sub-commission VF is looking for participation from various groups around the world. If there is Canadian interest, the contact person is Sjerne.