IIW Annual Assembly – Istanbul.
July 11th to July 14th, 2010.
Summary of Commission V Activities.
Report written by: Eric Sjerve (IRISNDT, 780-577-4477, esjerve@irisndt.com).

Summary
Dr. Philippe Benoist from France 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 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 CCIIW.

July 12th, 2010 – Commission V Meetings

- **Presentation 1** – Commission V Annual Report, P. Benoist, France, V-1465-10.
  - Benoist presented the annual report for Commission V. The agenda was accepted.
- **Presentation 2** – Annual Report for Sub-commission VA (Radiography Based Weld Inspection Topics), U. Ewert, Germany.
  - Ewert presented the annual report for Sub-commission VA. This group is active in the area of standardization and harmonization of radiography standards, with special focus on transfer of film RT to digital RT.
  - Sub-commission VA has one working group in Digital Industrial Radiology that is chaired by Dr. Uwe Zscherpel of BAM. This group has two main focuses: Focus 1 – new techniques and standards, and Focus 2 – training in Digital Industrial Radiology. They are conducting meetings in Focus group 1 via e-mail, and Focus Group 2 had four intermediate meetings this year.
  - The working group has CR round robin tests planned in the future. They are looking for more members, especially with CR equipment that can aid with the round robin test. This is an opportunity for Canadian firms that are interested in these results.
  - Ewert gave an update on ISO 17635, which was published after revision of EN 12062. This standard contains general rules for weld inspection, including CR, DR, TOFD and UT. The intention is to replace existing European standards with ISO 17635.
  - Ewert described a new standardization project within ISO 10893 on DR inspection of welded pipes. This standard is for manufacturers, and includes both circ and long welds.
  - Ewert described the new standard ISO 15626, which contains TOFD acceptance criteria, which allows TOFD to be used in lieu of RT for weld inspection.
  - Ewert presented a graph that gave CR SNR dependence on dose. It shows a linear increase over a certain range, but then flattens out. This indicates that the SNR ratio increases, but there is a point where there is no SNR improvement with dose. Information is presented that shows the SNR is higher for low energy radiation, but the exposure time increases exponentially.
  - The focus of most of this work is with x-ray tubes. It is not clear how relevant these results apply for radiography done using gamma sources.
- **Presentation 3** – Annual Report for Sub-commission VC (Ultrasonic Based Weld Inspection Topics), E. Sjerve, Canada, V-1467-10.
  - Sjerve presented the annual report for Sub-commission VC. There were three interim meetings.
- **Presentation 4** – Phased Array Calibration Block, E. Sjerve, Canada, V-1470-10.
  - Sjerve presented an overview of the status of this project. An initial meeting for this working group was held at the ASNT conference in Columbus, USA in October 2009. There are currently eight members from seven countries on the working group.
  - Sjerve gave an update from the initial meeting. The decision was to approach member societies to help decide on what the requirements of the block should have. It is

important to clearly outline what the block will and will not do before proceeding. The block must meet both ASME and EU code requirements.
    - Benoist gave an update on the work by the French group. They have made a decision to deal with the virtual aperture rather than individual elements when calibrating. There are three EU standards related to this work: one on probe elements, one on phased array electronics and one on the entire phased array system.
    - Benoist and Sjerve led a discussion about index point migration, which is a unique phased array calibration issue where the sound beam index point is not fixed. This causes angle and distance calibration errors to be made, and is not a simple issue to solve. The French working group is working on this also.
    - Sjerve described the technical and commercial issues of this project. There are many possible requirements that could be addressed by the working group. It must be decided how much capability will be included in the block. There are also commercial issues about the cost and availability of the block that are relevant.
    - This calibration block will affect Canadian industry when completed, so there may be interest with getting involved in the working group.
- **Presentation 5** – Handbook for Phased Array Inspection, E. Sjerve, Canada, V-1471-10.
    - Sjerve presented a status report on the IIW Phased Array Handbook. An update on the resolutions and the outstanding work from the Singapore meetings was given.
    - Sjerve presented a summary of the comments by Dr. Drinkwater and any significant changes made to the Handbook. These changes were primarily in Chapter 2.
    - Sjerve discussed editorial consistency, which was done in the following order: consistency with the phased array glossary, consistency with previous IIW Handbooks and then consistency with existing standards nomenclature.
    - Sjerve provided an update on the work done on the glossary, the acknowledgements section and the copyright permissions. The working group decided after the Singapore meeting to not publish the document through ISO, but rather continue with the IIW route.
    - The IIW Phased Array Handbook in revision 12 is now complete and has been submitted to the IIW Secretariat for publication.
- **Paper 1** – Improvement of Ultrasonic Weld Inspection Using Smart Flexible Probes, P. Benoist et al, France, V-1478-10.
    - Flexible phased array probes are a CEA development to allow the ultrasonic probe to contour to a complex surface, unlike a regular probe that is rigid. This uses probes with measuring devices on the individual phased array elements to allow determination of the vertical position of each element.
    - This technology is commercially available, and uses Imasonic flexible probes that are driven by M2M phased array hardware. CIVA is the software engine running in the background doing all of the adaptive focal law calculations in real time (it has a pulse repetition frequency of 150 Hz for 2-dimensional or 300 Hz for 1-dimensional flexible probes), which allows real time inspections to be done.
    - Benoist gave examples, both for linear and for 2-dimensional arrays. One example was a weld with external reinforcement with four SDH's. The system has good ability to detect all of the SDH's as the probe moved over the weld reinforcement. A second example was similar to the OPG application published in the First Canadian NDT Conference, and used a flexible probe to measure the internal weld reinforcement on a pipe weld.
    - Benoist gave other examples from the nuclear industry involving complex geometry large diameter nozzle inspection. Flexible 2-dimenionsional arrays were used that could fit into small areas that other probes could not, and that could adapt delay laws to the specific geometry. The results were good.
- **Paper 2** – Pipe Inspection with Guided Waves, G. Dobmann et al, Germany, V-1482-10.
    - Dobmann gave an introduction to EMAT generated guided waves. There are only Lorentz forces in purely conductive materials, but ferrous materials also have magnetostrictive forces that enhance the efficiency of sound generation. Dobmann gave a summary of the wave modes that are possible with guided waves.
    - Dobmann gave descriptions of the following applications:

- Dissimilar metal welds – EMAT SH waves have advantages for penetration through the areas adjacent to the welds giving better S/N values, provided the anisotropy in the weld is in one direction.
- Inspection of rail wheels –Rayleigh waves are used that give good POD for surface breaking cracking. This is done in-situ, without having to remove the wheels from the train.
- ILI Inspection – IZfP worked with GE on one of their pigs to install EMAT transducers using SH waves.
- LIMA Test – this is a system that inspects light poles for corrosion. The inspection is done at the soil to air interface to detect hidden corrosion. They also have applied this to gas pipes and high voltage towers.
- Fuel tank inspection – SH transducers are used inside the tank to lower the required grid spacing and inspect large areas rapidly.
- Weld inspection – they are using SH0 waves to inspect for large weld flaws using specular reflection. The characteristics of the guided wave are also used to detect smaller flaws like porosity.
- Corrfinder System – IZfP has an EMAT system for long range inspection for corrosion in pipe. It uses a number of EMAT transducers mounted on a scanner, which then rotates around the pipe circumference.

July 13th, 2010 – Commission V Meetings

- **Presentation 6** – Inspection of Above Ground Pipelines and Plant Piping Using LRGW, F. Bresciani, Italy, V-1479-10.
  - This working group is using the Italian standard UNI TS 11317 as a basis for the LRGW white paper. This document was translated and sent out for comment.
  - Bresciani discussed how the Italian government asked industry to work on this standard. There is little standardization in this area of NDT, which this working group will address.
  - The Italian standard does not take into account unusual or complex uses of LRGW. It is limited to guided waves on piping and only deals with corrosion, not cracking. It deals with complementary NDT that is done to follow up on guided wave inspection, including VT and UT. It requests two inspection reports; a guided wave inspection report and a complete report with the follow up NDT results.
  - The training is as per EN 473 with manufacturers training. Bresciani commented that it is easy to acquire data with guided wave equipment, but difficult to interpret the results. Proper interpretation requires experienced personnel.
  - Bresciani described some LRGW limitations:
    - Suggests extensive follow up NDT for diameters greater than 26 inches due to low sensitivity for flaws.
    - Wall thickness is limited to the range 2 mm to 55 mm.
    - Limit of number of bends the guided wave can go through, and suggests repeating the scan after every bend.
    - Road crossing length of inspection depends on detecting welds.
    - Temperatures less than 70 C.
    - Limit scanning length to 100m.
  - Bresciani then gave a description of UNI TS 11317 and what it contains.
  - The goal of this working group is to write a white paper on LRGW inspection that is able to answer many of the questions now being asked by users and service suppliers. This is of interest to Canadian companies, as LRGW is routinely performed in Canada.
- **Paper 3** – Comparison of Guided Wave Inspection and Alternate Strategies for Inspection of Insulated Pipelines, C. Wassink et al, Holland, V-1481-10.
  - This paper is a comparison between guided wave inspection and other piping inspection techniques. There is also a limited comparison between Teletest and Wavemaker.
  - Wassink makes the comment that Teletest and Wavemaker are essentially equal with their technical capabilities, but they are different in their ease of use. He also makes the comment that both technologies have made very significant improvements over the years.

- There is information provided on details of guided wave inspection, like wave modes, range, etc.
- There was also a discussion on the POD for these systems, and some limited information given from defect trials. Comments are made that the main difficulty is with human interpretation of the data, which leads to a generally poor POD for smaller types of piping defects. Wassink states that critical wall loss defects with greater wall loss were almost always detected.
- Wassink comments that guided wave has a higher POD than visual inspection. Some limited POD data is given in support of this conclusion.

- **Presentation 7** – IIW Update, C. Mayer, France.
  - There were two international congresses held in Bangkok and Hammemet.
  - Glenn Ziggenfuss stepped down and there is a new standardization officer from France.
  - Work is almost complete on the Web site to improve access to documents.
- **Presentation 8** – IIW Update, B. de Meester, Holland.
  - Meester gave an update on the journal, Welding in the World.
  - Welding in the World has been accepted into the Thompson Reuters Web of science, which is a good step towards accepting this journal as a premier scientific publication that is now part of the citation index. There is an IIW working group to modernize the journal and all articles are now subject to full peer review.
- **Presentation 9** – Annual Report for Sub-commission VE (Weld Inspection Topics Based on Electric, Magnetic and Optical Methods), G. Dobmann, Germany, V-1468-10.
  - Dobmann presented the annual report for Sub-commission VE. No interim meetings were held.
  - Dobmann led a short discussion on the basics of micromagnetic NDT techniques and their ability to determine residual and applied stress. He will be forming a working group to compile an ISO Technical Report on this.
- **Paper 4** – Estimation of Hardness in Nickel-Based Hardfaced Deposit, A. Bhaduri et al, India, V-1474-10.
  - These nickel based deposits have good wear resistance, corrosion resistance and high temperature properties. They are used in the Indian nuclear industry, and are replacing cobalt based alloys that become radioactive after prolonged exposure.
  - There are typically dilution problems with the underlying stainless steel substrate reducing the overall hardness, so they like to put down thick layers. Cracking problems can then occur.
  - Bhaduri correlated deposit hardness with magnetic response using a number of samples prepared with different conditions. They use the ratio of Ni to Fe as an indicator of dilution. Significant variations occur depending in the welding layer measured.
  - Bhaduri's measurements were done using a Ferrite Scope and Magnegage, and showed good correlation to dilution levels, which is essentially the hardness of the overlay.
- **Paper 5** – Physical Basis and Industrial Applications of 3MA - Micromagnetic, G. Dobmann, Germany, V-1475-10.
  - Dobmann gave an overview of the basis of these techniques and examples of their use. Dobmann commented that these techniques are mature and being used regularly.
  - Dobmann gave a description of magnetic basics in ferromagnetic materials. He described magnetic domains, and how they change with stress/strain. A description of how the hysteresis curve changes with applied compression and tensile stresses was given. The Barkhausen noise effect is described as small jumps in the hysteresis curve due to pinned block walls moving with applied magnetic field.
  - Dobmann explained that many of the magnetic parameters are correlated to mechanical parameters. IZfP uses 3MA transducers to measure the required magnetic parameters.
  - Examples were given on fatigue hardening measurements, steel strip mechanical properties measurement, laser hardening, material characterization of precipitation hardened copper materials and neutron degradation in nuclear power plants.
  - The next step with this technology is to get the manufactures together and start the standardization process. Dobmann feels that the time is right for this effort to start.

- **Paper 6** – Effect of Carbon Content on ET Response to Sensitization and Intergranular…, H. Shaikh, India, V-1473-10.
    - This paper describes an ET technique to quantify carbon content in the heat affected zones of welds in nuclear service. When welding authentic stainless steels, there can be problems with sensitization in the HAZ and hot cracking.
    - Lower carbon content and higher chromium reduce sensitization. There are ASTM standards that detail tests to determine the sensitivity to intergranular corrosion, which are typically slow, destructive and only qualitative. These standards are typically used during fabrication.
    - Shaikh described an ET technique that can be used to measure the changes in electrical properties in materials with chromium depletion. They primarily use the ET amplitude response at relatively low frequencies to detect sensitization. Sensitized materials show larger ET voltages than un-sensitized materials.
    - Shaikh described that when there is chromium depletion, the effective nickel content goes up. Since nickel is magnetic, it is effectively making the material more ferromagnetic causing the ET signals to rise.
    - Shaikh will be doing more investigation into this technique in order to properly determine if it can be used more widely.

July 14th, 2010 – Commission V Meetings

- **Paper 7 –** NDT With Micro and MM Waves – Where We Are and Where We Go, G. Dobmann et al, Germany, V-1476-10.
    - Dobmann focussed this talk on wavelengths in the microwave range (i.e. mm range or tens of GHz).
    - IZfP uses a network analyser to continuously sweep a microwave pulse in frequency, and then use algorithms to deconvolve the signals. The object is scanned in through transmission mode with transmitting and receiving antennas on either side of the material. The antenna design is very important to properly shape the microwave pulses.
    - Dobmann described the following applications they are using this technique on:
        - Injection Moulding – gas bubble detection in castings. IZfP uses a very small radar chip (3x2 mm^2) to detect strong changes in microwave signals depending on air content.
        - Near Field Scanning – scanning in the near field is done to achieve a much higher resolution to inspect items like stroboscopic plates that have small slits.
        - Aging of Rubber – a 94 GHz radar module is used to scan rubber coated on steel. They have been able to separate between unaged and strongly aged rubber (there is no difference in signal between unaged and slightly aged rubber).
        - Ceramic Parts – inspection of ceramic parts for dents using 94 GHz focussed millimetre waves and elliptical mirrors. Detection of small dents is possible.
        - GFRP (Glass Fibre Reinforced Plastics) – inspection of these materials for subsurface flaws.
        - Homeland Security – inspecting letters with 75 – 100 GHz antennas for things that should not be there. IZfP has good resolution to detect hidden plastics as well as metals. IZfP is also working on detection of hidden objects under clothing using SAFT reconstruction of microwave images.
- **Paper 8** – Magneto-Elastic Effects, G. Dobmann, Germany, V-1493-10.
    - Dobmann gave a description of magnetic field properties in carbon steels to help understand the physical basis of the MMM technique.
    - Dobmann described the following effects: magnetostriction, the Villari Effect, the Matteucci Effect and the Wiedemann Effect. Good descriptions of the physical basis of these effects are provided, along with macroscopic effects that can be measured.
    - Dobmann concludes that MMM is based on the Villari effect using the earth's magnetic field. The macroscopic effect is the superposition of the Villari effect and macroscopic leakage fields due to closed domains around macroscopic hindrance of Bloch wall movements due to discontinuities in the lattice.

- **Paper 9 –** The Metal Magnetic Memory Method Application for Online Monitoring Damage Development in Steel Pipes and Welded Joint Specimens, S. Kolokolnikov et al, Russia, V-1472-10.
    - This paper describes work using steel specimens under applied tensile and cyclic load. The goal is to correlate the SMLF (self magnetic leakage fields) and its derivative to the remaining cyclic lifetime. The SMLF and its derivative are typical of MMM parameters.
    - Kolokolnikov is using standard tensile specimens with SMLF being measured at the middle of the necked area with small MMM sensors.
    - Kolokolnikov presents a number of graphs that show the correlation between MMM measurements and applied tensile and cyclic loads. The normal component of the magnetic field did not show a variation, but the tangential component did.
    - Kolokolnikov then presents results using curved pipeline samples machined for SCC measurements using a four point bend technique with 16 MMM transducers under the sample. A number of different experimental configurations were presented with different numbers of cycles and applied loads.
    - Kolokolnikov also presented results from a spiral welded pipe with the weld going through the centre of the four point bend specimen. This work was done in a corrosive environment to simulate SCC.
    - These are initial results. They show some promise, but will require more work to better define the absolute ability of MMM to measure remaining cyclic load lifetime.
- **Paper 10** – Totals of the Metal Magnetic Memory Method Introduction in Russia and Other Countries, S. Kolokolnikov et al, Russia, V-1477-10.
    - This paper is a summary of the MMM technique and how it works.
    - Kolokolnikov explained that MMM functions by detecting residual stresses in welded joints as a determination of potential flaw locations. These areas are called SCZ (stress concentration zones), and sometimes correspond to micro flaws that are not detrimental to service, and in other cases correspond to macroscopic flaws.
    - When the metal cools down in the earth's magnetic field, there is a magnetic signature frozen into the material, and MMM is based on measuring SMLF (self magnetic leakage fields). There is no external magnetization required for MMM.
    - Kolokolnikov discussed that conventional NDT methods are limited to detection of macroscopic defects, whereas MMM can detect damage in its early stages before it grows into flaws. A list of Russia ISO standards for MMM was given.
    - Kolokolnikov presented a graph with acceptance levels based on the magnitude of the derivative of the SMLF, which is a new development for MMM.
- **Presentation 10** – Annual Report for Sub-commission VF (NDT Reliability Including Simulation of NDT Techniques), P. Benoist, France, V-1469-10 and V-1480-10.
    - Benoist presented the Annual report for Sub-commission VF. Three interim meetings were held.
    - Benoist described the two objectives of this commission:
        - Guidelines for simulation use in NDT and how to validate the models.
        - Objectives for POD supported by simulation – this work is to use simulation to support POD work. The POD work is important because people working in fracture mechanics need NDT uncertainties and confidence intervals to calculate safe operating conditions. The difficulty with physical POD trails is that they are prohibitively expensive to have enough samples to properly define phase space. Augmenting POD trials with modelling is an effective solution to drastically reduce the cost.
    - Benoist described a strong movement within NDT to simulate inspection configurations before doing physical work. This is done to qualify existing techniques, develop new techniques, help with flaw interpretation and to predict inspection performance. It is currently being done in all areas of NDT. Examples were given.
    - Benoist discussed the requirement of validating the simulation codes to determine if they are properly modelling field conditions. Some results comparing simulation to real measurements were provided that showed good agreement for UT, ET and RT. However, these comparisons have not yet been written into standards.

- Benoist referenced V-1480-10 that has much more detail on the preliminary work done in this area. There was discussion about handling material variations, with discussions on isotropic and anisotropic microstructures.
- Benoist states that there are several software models on the market now, so this work needs to be done with each of them. There is currently an effort to approach the companies that are working in this area to submit data for validation to experimental models. This is the beginning of standardization in this area.