IIW Annual Assembly – Helsinki, Finland.
June 28th to July 1st, 2015
Summary of Commission V Activities.
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Summary
Dr. Eric Sjerve from Canada chairs this commission. The commission's 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 Commission V meetings were done in the form of updates by the Sub-commission chairmen on their work during the past year, presentation of papers, group discussion on topics and a joint structural health monitoring session. Descriptions of the papers and summaries of the group discussions are given. The full texts of the papers are available by contacting the CCIIW.

June 29th, 2015 – Commission V Meetings

- **Presentation 1** – Commission V Annual Report, E. Sjerve, Canada, V-1666-15.
    - Eric Sjerve gave the opening remarks and the Helsinki agenda was adopted. The meetings this year will have Sub-commission VE and VC on Monday; Sub-commissions VF and VA on Tuesday; and the Commissions V, XI, XIII and XV structural health monitoring seminar on Wednesday. The commission V annual report was reviewed (V-1666-15) and updates on changes to IIW structure were given. Eric Sjerve then talked about how Commission V needs to attract more young people and asked all Commission V members to work on this. He then asked for a resolution to publish V-1638-14 "Assessment of welded joints stress-strain state inhomogeneity before and after heat treatment based on the metal magnetic memory method" that was presented in Seoul but a resolution was not possible at the end of the Joint Commission XIII session. Eric Sjerve then described that Commission V and Commission XVI – Polymer Joining and Adhesive Technology are planning a joint session for the 2016 Annual Assembly in Melbourne.
- **Presentation 2** – Annual Report for Sub-commission VE (Weld Inspection Topics Based on Electric, Magnetic and Optical Methods), M. Kreutzbruck, Germany, V-1680-15.
    - Marc Kreutzbruck gave the annual report. He gave inspection examples from the automotive industry that is moving to CRP materials to lower vehicle weight and improve gas efficiency. CFRP is a material that has high anisotropy, strong scattering and strong damping. There is also the question of how to joint these materials and it is also necessary to have hybrid materials that joint metals and composites. He then gave a description of an inspection technique called local defect resonance, where the natural Eigen modes of a part are calculated. It is then possible to excite the lowest order, and higher order resonant modes in the part; if there is a defect present then there will be a change in resonant frequencies. Some examples of resonant modes were given.
- **Paper 1** – MMM Paper, M. Kreutzbruck, Germany, V-1685-15.
    - Marc Kreutzbruck presented detailed MMM work that has been done at BAM during the last year. Some background was given on MMM and magnetic theory from the point of view of a traditional approach, including the ISO 24497 MMM standards, the Villari effect, magnetic hysteresis dependence on plastic deformation and the different ways of measuring magnetic fields. It was commented that self magnetic leakage fields can also come through phase transitions from austenite to martensite resulting in the creation of dipoles. Interesting results were presented using tensile specimens where magnetic variations were shown using a 3-axis magnetometer; white light interferometry was used to measure thickness changes. There was some discussion in the areas of geometry effects, depth effects and a request for a quantitative measure of the POD/false call rate. Comments were made that the ISO MMM standards only apply to in-service components. Marc Kreutzbruck asked Commission V to send him any MMM results that were not generally available in the literature. It was not possible to complete this

discussion so it was proposed that it continue within the working party C-V-E-a with a possible working group meeting in Melbourne before the regular Commission V meetings. Delegates of Russian delegation consider that in the MMM work the physical bases presented earlier at the Commission V meetings were not taken into account. It was proposed by professor Dubov to discuss the results of MMM work that was done at BAM during the Second European scientific and technical conference "Diagnostics of Equipment and Structures Using the Metal Magnetic Memory Method" in Budapest in May, 2016.

- **Presentation 3** – Summary of the VIII international conference on the MMM method, S. Kolokolnikov, Russia, V-1686-15.
    - Sergey Kolokolnikov gave a summary presentation on the VIII international conference on MMM held in Moscow in February 2015. There was a short description of the MMM technique, and then a summary of the keynote speech given by Prof. Dubov. Select papers from the conference were described. Results from Poland on inspection of pipelines and turbine blades were described. Interesting results on MMM applied to a shaft of a pump were presented where detection of defects early in their growth cycle is required due to the rapid growth of fatigue cracking making conventional NDT difficult. Results of NCMD (non-contact magnetometric diagnostics) measurements on buried pipelines were presented. This is an interesting topic for the pipeline industry that is currently evaluating different methods of inspecting buried unpiggable pipelines. There is much work to be done qualifying this technique, but there is also a great need in industry for a solution to this inspection problem.
- **Presentation 4** – Annual Report for Sub-commission VC (Ultrasonic Based Weld Inspection Topics), D. Chauveau, France, V-1679-15.
    - Daniel Chauveau gave the annual report. A description of the organization of EN and ISO standards for NDT techniques was given. There has been some confusion about how the ISO standardization process works, so a good concise description of this process was given. A short summary of the phased array (PAUT) calibration block project was then given and the group was informed this ISO standardization project is at stage 40. A French proposal to introduce flow charts to improve ultrasonic flaw sizing processes was then described; examples were given of possible reflections from defects. This is an attempt to standardize the flaw sizing process to give similar results in different parts of the world. Lastly, description of a Dutch proposal was given to extend the allowable lower thickness range for PAUT inspection; this proposal didn't pass because not enough experts agreed to participate.
- **Paper 2** – Application of the non-destructive testing technique based on a bacteria solution in different cases, L. Coutinho, Portugal, V-1697-15.
    - Luisa Coutinho gave an update on the project that she described in Commission V last year; reference IIW document V-1634-14 "Surface defect detection using bacterial suspensions". This project evaluated the feasibility of using fluorescent bacteria in a manner that is similar to penetrant testing for detection of surface breaking flaws. Results on real flaws have shown that this technique is adequate for detection of micro and nano surface flaws. It was also shown that penetrant testing is more effective at detection of high depth/width ratio defects (i.e. when the depth to width ratio is greater than 10, or crack like flaws) and bacterial testing is more effective at detection of low depth/width ratio defects (i.e. when the depth to width ratio is less than 1.5, or porosity like flaws).
- **Paper 3** – Non-destructive inspection in diffusion bonding, L. Coutinho, Portugal, V-1687-15.
    - Luisa Coutinho gave a paper on a European project called Bondtest for non-destructive testing of diffusion bonds. This is being done by a consortium or partners, and it is early in the research stage. Diffusion bonding is a large market in Europe with applications for printed circuit boards, compressor blades and multi-finned channels. They are working with full matrix capture phased array techniques with I-Deal PAUT equipment with the goal of developing a high sensitivity technique capable of detecting flaws down to 0.1 mm. They also want to develop automatic defect recognition software and a prototype PAUT system. Some early results were presented with varying diameter side drilled holes and small spherical defects. There was discussion about the potential of this technique for

detection of cold bond; this is where there is some level of bonding between the surfaces, but full diffusion has not been achieved and the bond doesn't have sufficient strength for the service. Detection of cold bond is a difficult application that still needs some consideration.

- **Presentation 5** – PAUT calibration block project update, D. Chauveau, France, V-1683-15.
    - Daniel Chauveau gave a presentation on this project, and he said that it is near completion. The technical work is done, the calibration block design is compete and the ISO standard has been written. The ISO standard has been through stage 30 balloting, and it has now been resubmitted for stage 40 balloting. This will be complete with comments back to the working group by October 2015. It is hoped that the comments can be resolved with the final standard published by January 2016. A description of some of the ISO comments received at stage 30 was given, along with how they were resolved. Included in this were: clarification of the figure showing ultrasonic attenuation, comments about moving some of the vertically oriented 3 mm side drilled holes, moving the 1.6 mm diameter AWS side drilled hole and changes made to the block design to allow easier machining. A summary of relevant working group documents is posted to the IIW Website for download. It was commented that this project has been a very significant piece of work, and it has the potential of resulting in a calibration block used world wide for both ultrasonic and PAUT calibration.
- **Paper 4** – The testing of resistance spot welded joints with scanning acoustic microscopy system, M. Agocs, Hungary, V-1698-15.
    - Mihaly Agocs gave a presentation on this work that is being done at the College of Dunaujvaros in Hungary for inspection of spot welds using a high frequency ultrasonic immersion technique. The work was done using a high accuracy x-y positioning system attached to an ultrasonic probe; the ultrasonic signals were then digitized and analysed with Labview. One of the applications for this technique is inspection of resin encapsulated electronics used in the automotive industry. It is necessary to detect bubbles in the resin as well as defects in the electronics. High resolution measurements were presented, that show voids in the resin and of cross sections of the electronics. Results were then presented on spot welded joints. Both good bond where there is no reflection at the interface, and what was considered bad bond with a reflection at the interface were shown. There was some discussion about this work, and it was commented that a difficult aspect of the practical inspection are managing spot welds that do not have normal surfaces making ultrasonic inspection difficult. It was also commented that one of the most difficult aspects was detection of cold bond, where there is no good ultrasonic reflection from the interface but the bond doesn't have sufficient strength. This is something that will be considered as part of further research.
- **Presentation 6** – GWT ISO standardization project update, E. Sjerve, Canada, V-1682-15.
    - Eric Sjerve gave a presentation on the IIW guided wave testing standard that was written in Commission V under a working group formed by Francesco Bresciani. This standard (ISO/DIS 18211.2) is currently at Stage 40 of the ISO process. It was voted on in 2014 and it didn't receive sufficient positive votes to pass Stage 40. A history of this project within IIW was given, and then a summary of some of the ISO comments was given along with their resolution, including: expanding on the nature of GWT reflections from discontinuities and the grouping into three qualitative levels of severity; modification of the interval of periodic verification of equipment to 12 months; expanding the data collection section; adding a pipe wall thickness limit to the testing section; expanding the detection sensitivity section; and adding clarification to Annex A about the dispersive nature of guided waves. This standard has been resubmitted again at ISO stage 40. There was discussion about the issues regarding the British GWT Standards.

June 30th, 2015 – Commission V Meetings

- **Presentation 7** – Commission V Update, E. Sjerve, Canada.
    - Eric Sjerve presented the minutes from yesterday's meeting. Sergey Kolokolnikov requested some changes to the minutes, which were updated and reposted to the IIW Web site. The document V-1662-15 – "Commission V Agenda Helsinki Rev 4" was revised and uploaded to the IIW Web site to reflect changes to the Monday agenda. Documents V-1697-15 – "Application of the non-destructive testing technique based on a bacteria solution in different real cases" and V-1698-15 – "The testing of resistance spot welded joints with SAM system" were also loaded to the IIW Web site.
- **Paper 5** – Use of an encoded arm for manual phased array ultrasonic testing of austenitic welds, D. Chauveau, France, V-1688-15.
    - Daniel Chauveau gave a description of a project done at the Institut de Soudure to inspect welds in a Tokamak fusion reactor. In each reactor there are housings that contain superconducting coils. The housings are made from 316L stainless steel with 50 mm thick butt welds. An inspection procedure using 2.5 MHz PAUT focused beams and refracted longitudinal waves. A test block was manufactured to qualify the inspection procedure. Testing was done with a special arm having three degrees of freedom – it also allowed rotation of the probe. This allowed flaws to be detected from different angles. It was also commented that the biggest effect with coarse grained welding is the electrode position. They did a set of trials with more than 20 samples and found this to be generally true more than other parameters.
- **Presentation 8** – Welding in the World Update, T. Bollinghaus, Germany.
    - Welding in the World editor Thomas Bollinghaus presented information about Welding in the World to Commission V. WiW uses the impact factor of the journal as their main metric for quality; this is a measure of how many times a paper in WiW is referenced by articles in other journals. The impact factor has been rising for several years, indicating the quality of the articles is also increasing. He also talked about the need for reviewers for articles to help with timely reviews.
- **Presentation 9** – Annual Report for Sub-commission VF (NDT Reliability Including Simulation of NDT Techniques), P. Calmon, France, V-1681-15.
    - Pierre Calmon gave the annual report. There are two main areas of work: validation of NDT modeling and simulation assisted POD approaches. The one active work area is to write a best practice document about using simulation to assist POD studies (see V-1696-15). There is strong interest in industry for POD approaches to inspection, and simulation is being accepted as a very good way of reducing overall POD costs. There was also discussion of simulation of full matrix capture and total focusing methods; these methods are now becoming used in industry due to commercial equipment being available. There is a benchmark proposed to evaluate the ability of models to reproduce FMC inspection results. It was also proposed that VC and CF could work together on a UT benchmark comparing different imaging techniques. Adaptive TFM, TOFD and RT were also proposed as possible activities for VF. Pierre Calmon wants feedback from Commission V members with regards to future projects that are interesting for VF to explore. Peter Mudge commented that the structural health monitoring stability project is of interest to him and from his experience is needed.
- **Presentation 10** – Update of the Recommended practices for the use of simulation in POD curves estimation for UT weld inspection project, P. Calmon, France, V-1689-15.
    - Pierre Calmon gave an update on this project. Comments were received by experts in the area of NDT simulation since the Seoul IIW Annual Assembly that are now being considered and integrated into this document. See document V-1696-15 for the most recent version; this document gives detailed methodologies and practical recommendations for using simulation to help determine POD curves. A summary of some sections of this document were given. There was an interesting discussion on reducing the confidence interval of a POD by multiplying the amount of simulated data. Since the document is not complete now, it was not possible to vote in Helsinki on publishing it as an IIW document. As such, there will be an e-mail vote for CV delegates before the next IIW Assembly for publication of this standard as an IIW document. Eric

Sjerve will send out notification to CV delegates in advance of the vote to allow time to consider the document first. This vote will require more than 50% of all CV delegates to vote positive to pass.

- **Paper 6** – Can differentiated NDT improve decision making, A. Oberg, Sweden, V-1684-15.
    - Anna Oberg gave a talk based on her research at Chalmers University and Volvo. Anna described a typical method of decision making called the Push method, which follows the following steps; defect and properties; data presentation; information created; and then ends with the internal customer. It is then proposed that it would be better to have the opposite steps followed, which is referred to as the Pull method. Detailed description of how this would be implemented was given, with examples given using the weld toe radius. Volvo has determined that the weld toe radius is a critical parameter that influences fatigue life, so must be considered very carefully. There was a discussion of how the organizational structure of a company affects the ability to implement these changes in inspection processes.
- **Presentation 11** – Methodology for modeling ultrasonic inspections of austenitic welds: The MOSAICS project, P. Calmon, France, V-1692-15.
    - Pierre Calmon gave a summary of this project supported by the French National Research Agency for development and validation of simulation code for numerical tools for ultrasonic testing of austenitic welds in 3D configurations. There was a discussion about the difficulties of inspection of austenitic materials due to beam deviation and attenuation. Current simulation codes have limitations for this inspection as they are not adapted to highly heterogeneous materials. This work was done with both CIVA that uses semi-analytical models and Athena that does finite element analysis. An advance resulting from this project is to model the system using a semi-analytical model until getting to a smaller volume, and then doing a full finite element analysis. Doing finite element analysis over the entire volume is too computationally intensive, so this is a good compromise between efficiency and accuracy. Examples were given comparing to experimental results using differences in the properties of the grains using one grain structure pattern.
- **Presentation 12** – Annual Report for Commission VA (Radiography Based Weld Inspection Topics), U. Zscherpel, Germany, V-1678-15.
    - Uwe Zscherpel gave the annual report. There are two main areas of work: new techniques and standards for weld inspection, and training in digital industrial radiology (DIR). There has been training done many countries and a new draft guideline for DIR training. A detailed description of standardization activities and updates for both ASME and ISO was given. A good overview of all ISO standards as they apply to the basic NDT techniques was given, with particular attention given to radiography standards. Standards used for in-service inspections of primary coolant circuits components in nuclear reactors was given; there is a special requirement that the radiation direction be within ±5° to the pipe surface for double walled techniques. Description of how to use the BAM snail to determine source location and thus radiation angle to meet this criterion was given.
- **Presentation 13** – Digital radiographs update, U. Zscherpel, Germany.
    - Zscherpel gave a good live demonstration of the tablet version of the digital radiographs, which is now almost ready for commercial release. This is a project that was proposed in 2012 for mobile tablet based reference radiographs, and there is now a full set of radiographs completed. Each radiograph has with it associated pictures of the weld, and the ability to apply different fine structure filters to better show flaws. Zscherpel talked about the AWS product that is sold on computers, which allows users to copy the radiographs in high resolution format to other devices. DVS will be selling this product already loaded onto a tablet making copying the radiographs much more difficult as the tablet communications functions will be disabled.
- **Presentation 14** – IIW CEO update, C. Meyer, France.
    - Cecile Mayer was in the audience during the digital radiographs presentation by Uwe Zscherpel and she gave some history about this project. She stated that IIW still wants to sell the film radiographs, but that it is important to modernize. She sees the digital

product as something that is important for the future, especially with younger professionals. This project has full IIW support and it will now be the responsibility of the Marketing Group to work with DVS to bring it to market. Cecil also gave information about the election that is necessary in Commission V. Eric Sjerve has been the chairman for three years, so an election must be done. Some months ago the IIW approached the member societies to solicit nominations for Commission V chairman, but none were received. Eric Sjerve is thus elected for a second three year term.

- **Paper 7** – Real Time Radiography for Observation of Crack Growth, F. Boateng, Germany, V1691-15.
    - Francis Boateng presented his thesis work on using real time radiography for detection of hot crack growth that occurs at the phase transition between liquid and solid during welding. A description of the experimental setup was given that allows real-time visual imaging of the weld pool as it cools as well as x-ray radiography using a Delexa DDA encased in a protective case. The main goal of this work was to be accurate enough to measure the volume of the individual cracks, which requires more than one x-ray projection. A technique called limited angle tomography was used, which scans the object within an angular range of ±20°. Moving the sample with a fixed x-ray tube and DDA provided the different radiation incident angles. An example of the reconstructed data was given in the form of a cross section that shows the cracks at different depths, thus providing the information necessary for calculating crack size.

July 1st, 2015 – Commissions V, XI, XIII and XV Joint Seminar on Structural Health Monitoring

- **Paper 8** – Introduction to structural health monitoring, B. Chapuis, France, V-1667-15/XV-1493-15.
    - Bastien Chapuis gave a summary of structural health monitoring (SHM), which is the process of acquiring and analyzing data from on-board sensors to evaluate the health of a structure. This often requires embedding a network of sensors on a structure that feeds data back to a system that allows decision making for follow up maintenance actions. There was a discussion of the technical challenges involved in implementing SHM, which is often difficult due to environmental conditions. Short examples were given from SHM applications on wind farms, bridges and aeronautics.
- **Paper 9** – Local defect resonance for structural health monitoring, M. Rahammer, Germany, V-1668-15.
    - Markus Rahammer gave a presentation on using changes in local defect resonance to detect flaws in components. The premise of this work was that components will have natural resonant frequencies that can be calculated. These resonances will include both the fundamental frequency, as well as higher order harmonics that correspond to flexural modes of vibration. When the component is actively driven at by a sweeping frequency, these resonances will be obvious in the data. The presence of flaws in the component will be detected as resonant modes that are different than the natural modes with component displacements at the location of the flaw. Detection of these displacements was done using ultrasonic thermography, ultrasonic shearography and vibrometry. Examples were given of different flaws in CFRP plates.
- **Paper 10** – Ultrasonic monitoring of corrosion with permanently installed sensors, F. Cegla, UK, V-1669-15.
    - Frederic Cegla gave a presentation on wall thickness monitoring using permanently installed ultrasonic thickness sensors (PIMS). These sensors are mounted in-situ on the component and are able to give repeated thickness measurements over long time periods on operating components at temperatures up to 600 °C. Examples were given of SHM data that is used for process optimization; the measurements allowed end users to vary corrosion mitigation programs to reduce corrosion rates. Some of the technical challenges of this application were described, including environmental conditions that the sensor must operate in, temperature gradients through the wall thickness and different techniques to gate the signals to improve accuracy. Comparison of different signal processing techniques was done to produce accurate wall thickness measurements. There

was also a discussion on the statistically significance difference of two measurements and the probability of detecting small changes in thickness.

- **Paper 11** – Passive SHM system for corrosion detection by guided wave tomography, B. Chapuis, France, V-1670-15.
    - Bastien Chapuis gave a presentation on a passive system using guided waves to detect flaws. This technique uses the ambient elastic noise always present in the system rather than generating conventional ultrasonic signals using probes. This makes the system simpler and less expensive, as there is no need to have any of the hardware necessary to generate ultrasound signals. Rather than using piezoelectric transducers, optical fibres with Bragg gratings are used for ultrasound reception as they are smaller and less intrusive. Large numbers of fibres are used, and then the data is inverted using tomographic algorithms. First results were presented on a plate with artificially embedded flaws. It was shown that repeated iterations of the algorithm produced increasingly accurate flaw imaging.
- **Paper 12** – On the way to use welds for monitoring of structures integrity, D. Chauveau, France, V-1671-15.
    - Daniel Chauveau gave a presentation on a novel method of SHM that uses the welds of a structure as smart sensors that are able to receive ultrasonic guided waves. A short background on magnetostriction guided wave generation and the basic principles of guided waves was given. This work came from a five year study initiated at Institut de Soudure in France where a magnetostriction guided wave sensor was mounted on a test loop. It was noticed that there was degradation of the sensors that occurred due to environmental effects. Initial results were presented on using welds for guided wave reception, and comparison between magnetostriction systems was done. The smart welds are able to receive signals, but they still have poorer performance compared to conventional systems. More work will be done in the future to determine if this is a technique that could be used.
- **Paper 13** – Use of guided wave inspections to monitor the integrity of nuclear power station boilers, P. Mudge, UK, V-1672-15.
    - Peter Mudge gave a presentation on a guided wave application that was developed for a nuclear plant inspection in the UK. Guided wave SHM sensors were permanently mounted on a small accessible section of the boiler spine above the main boiler area for in-situ monitoring; the boiler spine was 21 m long, it had many geometry changes and it is fabricated from a variety of ferrite and creep resistant alloys. Technique development was done to allow proper interpretation of the guided wave signals. During a scheduled inspection, a defect signal was detected in the guided wave data. Work was then initiated using full scale mock-ups, a series of artificial defects machined into the mock-ups, and finite element modelling to better understand the flaw signal. This resulted in a good understanding of the interaction of the guided wave with the complex geometry of the boiler spine. It was determined that the flaw signal was real and the plant was shut down. A flaw was found at the location of the guided wave signal that matched very well with what was predicted from the finite element modelling. Continued GWT monitoring is being done on all boiler spines.
- **Paper 14** – A study on prediction of fatigue crack propagation life using MFC sensors, M. Kim, South Korea, V-1673-15/XIII-2585-15.
    - Myung Kim gave a presentation on the development of a novel SHM sensor for detection of surface breaking cracking. Background on SHM applied to systems was given, including choice of sensors, algorithms for extracting data and then decision making. Examples were used from offshore platform and ship hull monitoring. A review of possible sensors was given, including acoustic emission, vibration sensors, fibre optic, fatigue monitoring and air gap sensors. The macro fibre composite sensor was then described, which is fabricated using several layers of piezoelectric sensors. The resulting sensor is flexible and durable, and it is capable of impedance based crack detection. Background was given on how to measure stress intensity at the crack location by using the varying response from the MFC sensor due to effective area of the sensor decreasing

due to crack growth. Some results were presented using fatigue cracks grown in a lab environment.

- **Paper 15** – MMM applied for online monitoring of fatigue crack propagation in an industrial steel structure, S. Kolokolnikov, Russia, V-1674-15/XIII-2585-15.
    - Sergey Kolokolnikov gave a presentation on using the metal magnetic memory technique (MMM) for SHM on an industrial cocoa press. Background was given on the MMM technique, including how the method is based on natural self magnetic leakage fields that result from residual magnetization in components that result from weak magnetic fields present when cooling. These leakage fields are measured and they indicate where stress concentration zones are located. The cocoa press is subject to severe pressure fluctuations during regular usage, so it is susceptible to fatigue cracking. Several areas of high stress concentration were detected during a routine inspection, and one was found to have a surface breaking crack. This indication was monitored using fixed flux gate transducers over a period of time to ensure safe operation of the cocoa press. Differences in the MMM signals were shown as a function of the internal pressure in the vessel.
- **Paper 16** – Full-scale measurements and hull monitoring on ships, H. von Selle, Germany, V-1675-15/XV-1494-15.
    - Hubertus von Selle gave a presentation on work done at DNV doing full scale monitoring of container ships for in-service degradation. This program monitors local strains at critical areas, global strains, local accelerations, global accelerations and shell pressures with many embedded sensors on the container ships. Hull girder vibrations are also monitored, both for whipping motion corresponding to hydrodynamic impact loads and springing motion corresponding to harmonic vibration caused by regular wave excitation. Fatigue tests show that linear damage accumulation can be applied for both high and low frequency loads. This data is then sent to an interface accessible to the captain to allow good decisions to be made in terms of required maintenance and continued safe operation. This data is also used to benchmark what is occurring during regular usage and allow best practices to be established.
- **Paper 17** – Simulation of guided waves inspection, from NDE to SHM, P. Calmon, France, V-1676-15.
    - Pierre Calmon gave a presentation on the usage of simulation for SHM applications. Background on simulation in NDT was given, and it was commented that simulation is now an important part of the NDT field. Examples of simulation were given in the fields of ultrasonic testing, guided wave testing and radiographic testing. Details was given about using the CIVA software for simulation of guided waves propagating in complex structures where finite element analysis is required to properly predict flaw responses. There was then a discussion about using simulation to predict probabilities of detection for an SHM application using guided waves for inspection of a composite structure for delamination and for inspection of an aluminium plate with a stiffener. The use of simulation allows much higher confidence in the SHM technique being able to detect the required flaws at a lower cost.
- **Paper 18** – Algorithms for an optimal false calls management, M. Mountassir, France, V-1677-15.
    - Mahjoub Mountassir gave a presentation on different ways of using SHM data to make decisions. This is an important area that is quite different from the previous presentations, as all SHM systems require a methodology for making good decisions based on the data gathered. Some background was given on the method of baseline subtraction, and the problems that can arise when there are changes to environmental conditions like temperature, humidity, etc leading to higher false call rates. A review of different compensation methods was given and analytical methods of data analysis. There was also a discussion about what signal features from the data should be extracted to allow decisions to be made. Examples were given using guided wave inspection where different methods of data analysis were done with varying accuracies.