IIW Annual Assembly – Shanghai, China.
June 25th to June 28th, 2017
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 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 session with Commission I on additive manufacturing. 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 26th, 2017 – Commission V Meetings

- **Presentation 1** – Commission V Annual Report, E. Sjerve, Canada, V-1769-17.
  - Eric Sjerve gave the opening remarks and the Shanghai agenda was adopted. The meetings this year will have Sub-commissions VC and VE on Monday; Sub-commissions VA, VD and VF on Tuesday; and a joint seminar with Commission I on Additive Manufacturing on Wednesday. The Commission V Annual Report was reviewed (V-1769-17) and updates on changes to IIW were given. A strategic direction of Commission V is to organize joint seminars with other commissions each year. Commission V is planning another joint seminar on additive manufacturing in 2018, and then a joint seminar with SC-AUTO and other interested Commissions and Select Committees on joining and inspection of hybrid materials currently being used to reduce vehicle weight in the automotive industry.
  - There was a special meeting on Sunday June 25th to review comments and revision of ISO 24497 that is currently up for an ISO five-year review. This revision is not progressing as rapidly as expected so it will now take more time to reach consensus. Also, IIW signed a MOU with ICNDT so there are opportunities for Commission V members to participate. Commission V and ICNDT will work on the framework for cooperation in the next year.
- **Presentation 2** – IIW CEO address.
  - Cecile Mayer, IIW CEO, gave an address to Commission V members. Cecil provided updates on how the IIW Web site is being upgraded to Office 365 which will provide additional functionality for all. Commission V has been a test case for this migration and all members have been invited to log into this new interface. Cecil and Gary Marquis (Gary is the IIW President) then did long time service awards and they told Commission V that IIW is very appreciative with the efforts of Pentti Kopiloff and Uwe Ewert for their long service in Commission V. She presented both with attendance awards; Uwe Ewert was not in the room to accept his award, so Uwe Zscherpel received the award. Pentti received an award for attending 30 Assemblies and Uwe received an award for attending 20 Assemblies.
- **Presentation 3** – Commission V Historical Perspectives, E. Sjerve, Canada, V-1797-17.
  - Eric Sjerve gave a presentation on the activities of Commission V over the 30-year period that Pentti Kopiloff has been attending as the Finnish Delegate. It was organized in slides that divided this period into the main activities of the Commission under the six different chairmen. There was some interesting historical information in this presentation that described what technical activities Commission V has engaged in over this period.
- **Presentation 4** – Annual Report for Sub-commission, VC (Ultrasonic Based Weld Inspection Topics), D. Chauveau, France, V-1777-17.
  - Daniel Chauveau gave the annual report. A description of the different possible ISO documents was given: International Standard, Technical Specification and Technical Report. For each of these documents there are seven stages that begin with a proposal for standardization and then end with publication of an ISO standard. A description of EN and ISO standards was then given for many of the NDT disciplines, with a more detailed

description of the PAUT standards ISO 13588 and ISO 19285. Some background was then given on ISO 19675 that was published in January 2017 for design and fabrication of the new PAUT calibration block. It was shown that this PAUT calibration block is necessary to meet ISO 18563-3 PAUT code requirements. Some background was then provided on two current ASTM projects for additive manufacturing standardization.

- **Presentation 5** – Update from FMC/TFM working group, D. Chauveau, France, V-1781-17.
    - Daniel Chauveau gave an update on what this IIW working group has been doing in the last year; it is working group C-V-C-a "Develop a methodology to use FMC/TFM for field inspections" that reports to Sub-commission VC. Commission V formed this working group in 2016 to address standardization in this important ultrasonic technology that is rapidly advancing and being adopted for industrial weld inspections. Some background on the principles of FMC/TFM was provided and then the names of people participating in the working group were given. The working group has prepared a draft document, which was shown to Commission V and is posted to the IIW Web site. One of the areas that this technique shows promise for is detection of HTHA (high temperature hydrogen attack). This working group has many good members and is motivated to complete this standardization work. An update was provided on how close to being complete all sections of the document are.
- **Paper 1** – Metallic weld ultrasonic testing based on coded excitation, J. Zhang, China, V-1782-17.
    - Jiaying Zhang gave a presentation on the work she is doing for her PhD degree at the Harbin Institute of Technology in China. When performing ultrasonic testing, the pulse length of the ultrasonic signal provides a measure of the resolution and the S/N ratio provides a measure of sensitivity. Also, it is desired to have high amplitude ultrasonic pulses so that there is more sound energy introduced to the material being inspected. This work is focused on improving the time resolution, the S/N ratio and reducing side lobes of ultrasonic pulses by coded excitation and pulse compression. Jiaying examined both a linear frequency modulation (LFM) and a chirped pulse modulation. It was found that the chirped pulse excitation provided better results with respect to shortening the time duration of the main pulse and reducing side lobes. This conclusion was supported by both theory and experimental results that were provided in this paper.
- **Paper 2** – The immersion ultrasonic testing of tubular and thin-walled magnetically impelled arc welded automotive components, M. Korzenlowski, Poland, V-1783-17.
    - Marcin Korzenlowski gave a presentation on work being done at the Wroclaw University of Technology. It was described that there are great pressures to reduce the weight of automobiles to reduce fuel consumption; an example was given that reducing a vehicle weight 100 kg reduces fuel consumption by 800 liters per year. This work focused on reducing the weight of metallic drive trains; current components have a thickness of roughly 3 mm, and this work aims at reducing this to a 1 mm thickness. High strength steels are required, which, along with being thin, makes welding difficult. Joining is done using magnetic impelled arc butt welding. This paper then described the inspection advance that uses high frequency immersion ultrasonic inspection with lateral sub-surface waves for detection of small imperfections in the thin welds. A fixture to hold the probe and a software interface were designed for this inspection. Ultrasonic testing results were given for some artificial flaws, and these results were compared to computed tomography inspection.
- **Presentation 6** – Discussion of Nardoni proposal for an IIW ultrasonic calibration block, D. Chauveau, France, V-1784-17.
    - Daniel Chauveau gave an update on this opportunity. Guiseppe Nardoni owns the Nardoni Institute in Italy, and this is a company that has been active in ultrasonic inspection. Some years ago they designed what they refer to as a V3 ultrasonic testing block. Nardoni approached Commission V with an offer that IIW can own this ultrasonic calibration block design and handle subsequent standardization. Daniel's presentation described the different functions of the current calibration blocks: V1 block (ISO 2400), V2 block (ISO 7963), V3 (Nardoni) and PAUT block (ISO 19675). Before IIW can adopt this block design it must be clear how the V3 ultrasonic block fits with the current ultrasonic calibration block designs. It was also pointed out during the discussion that the

V3 block will not work well for phased array; that it is much lighter than the V1 block so it is preferred by some technicians in Italy; and to achieve two reflections for calibration the ultrasonic probe must be moved. Commission V will form a working group to consider this proposal. There is currently no leader for this working group so any interested parties should contact Daniel.

- **Presentation 7** – Detection and characterization of hydrogen damages with TFM techniques, P. Benoist, France, V-1785-17.
    - Philippe Benoist gave a presentation about the use of FMC (full matrix capture) and TFM (total focusing method) for detection of hydrogen damage in steels. Some background on the FMC/TFM techniques was given. There are two damage mechanisms that occur with hydrogen in steels. The first is hydrogen cracking (also called LTHA – low temperature hydrogen attack) which is a damage mechanism that results in atomic hydrogen accumulating as molecular hydrogen that eventually tears the steel into laminar blistering that can also connect vertically into step wise cracking. Philippe presented inspection results showing higher resolution results than are possible with conventional phased array. The second damage mechanism with hydrogen is HTHA (high temperature hydrogen attack), which is a different damage mechanism that can result in catastrophic failure of high pressure vessels. This is a very active topic in industry right now, with a desire for a reliable inspection technique. Philippe presented some excellent capabilities of an optimized FMC/TFM technique to detect HTHA in flawed samples, which will be very interesting for industry. Industry has already starting joint industry projects to quantify the capabilities of this new promising inspection technique.
- **Presentation 8** – Annual Report for Commission VE (Weld Inspection Topics Based on Electric, Magnetic and Optical Methods), E. Sjerve, Canada, V-1779-17.
    - Eric Sjerve gave the annual report in the place of Marc Kreutzbruck, who could not attend in Shanghai. The main area of activity for Sub-commission VE is in inspection of advanced composite materials that are being used in the automotive and aerospace industries. These are non-metallic components that have been engineered to meet the requirements of a specific application. There was a description of the work using LDR (local defect resonance) for detection of flaws in these materials. This is an inspection technique that uses audible sound generated by a conventional speaker to excite the composite material. There will be resonant frequencies in the composite that will be excited as the frequency of sound is changed; the presence of a defect in the composite changes the resonant behavior. Eric provided descriptions of the three different ways used for detecting resonances: laser vibrometry, thermography and shearography. A future direction of Sub-commission VE will be to join with other Commissions and groups with expertise in this area for the purposes of advancing capability and for standardization.

June 27th, 2017 – Commission V Meetings

- **Presentation 9** – Update on revision of ISO 24497 standards on Metal Magnetic Memory, U. Zscherpel, Germany, V-1786-17.
    - Uwe Zscherpel gave an update on the revision of ISO 24497. Commission V formed a Working Group C-V-E-b "Revision of ISO 24497 taking into account outstanding ISO and IIW comments" to address this revision, and it is being led by Uwe Zscherpel. This working group has attracted experts from a variety of countries to contribute to this revision process. A summary of the activities of this working group were given, as well as some history on the original publication of ISO 24497. There is strong disagreement within this technical working group that is not yet resolved. Some background on the technical disagreement is given in IIW documents V-1798-17 and V-1799-17. To summarize, one technical opinion is that these standards are based on a long history of using this technique and represent a summary of this experience; the other opinion is that the standards need to be more grounded in standard ISO and physics principles rather than experience. ISO standards are necessarily a compromise between many parties and they will not be exactly what any one country wants. This process is difficult as this technique moves from a methodology developed in one country into the ISO environment

where many countries are involved. It is not clear that consensus will be reached; if there is no consensus within the working group then IIW Commission V will not vote on the revision and ISO will withdraw these standards.

- **Presentation 10** – Annual Report for Sub-commission VA (Radiography Based Weld Inspection Topics), U. Zscherpel, Germany, V-1776-17.
    - Uwe Zscherpel gave the annual report. Uwe gave a very detailed description of standardization activities, and he provided updates for ASME, ISO, CEN and DIN. There was discussion of ISO-20769-1 and -2 for profile radiography on piping for detection of corrosion, sediment and wall thickness measurement. This is a very common technique used in industry, and it is good to have standards in this area. There was a very interesting description of the wire ILI requirements in ASME. There has been work showing that there was a mistake when these standards were written, and that it is easier to achieve radiographic sensitivity using wire than hole IQI's; a graph showing this was presented. There was also a discussion about EN-12681-1 and -2 that are used for film replacement for castings inspection. Uwe then provided some history of reference radiographs at IIW and on the recent project to digitize and sell them on the Google store. Uwe then recommended that preparation of an electronic version of the old IIW film collection of 1985 for steel weld imperfections and free electronic distribution via the IIW web server, which was also discussed in Melbourne with resolution C-V-5-2016 in meeting minutes V-1748-16.
- **Presentation 11** – Defect assessment and quality control using neutron scattering techniques, A. Paradowska, Australia, V-1804-17.
    - Anna Paradowska gave a presentation on the work being done at ANSTO (Australian Nuclear Science and Technology Organization). ANSTO has very significant neutron resources that are available for contract for projects; this presentation focused on material characterization for additive manufacturing, but ANSTO has capabilities in other areas. A good graphical description of the spatial resolution versus penetration that is possible with neutrons was given. Anna than gave examples of measurements using two of the detectors; the Dingo and Bilby. There were examples of stress measurement and inspection showing excellent spatial resolution. There was then a good group discussion about the ANSTO interest in additive manufacturing and standardization development. This topic will be discussed in more detail during the joint Commission I and V seminar on Wednesday.
- **Presentation 12** – Annual Report for Sub-commission VD (Structural Health Monitoring), B. Chapuis, France, V-1778-17.
    - Bastien Chapuis gave the annual report for this new Sub-commission that was first created by resolution during the Melbourne meetings. Description of the first standardization document providing guidelines for SHM in the aerospace industry was provided; this is document ARP 6461. Some discussion of the difficulties of standardizing SHM solutions were given along with estimates of the time taken for new techniques to have commercial success. Two SHM techniques that have now been implemented commercially are CVM (comparative vacuum monitoring) and ultrasonic thickness sensors. CVM technology uses alternating compartments of vacuum and higher air pressure; if there is a surface breaking crack it affects the pressure in the alternating compartments and it is detected. For ultrasonic thickness monitoring, there are several commercially available technologies for SHM ultrasonic thickness measurements, and they usually use wireless communications to send data back to nodes. There was then some discussion about the reliability of SHM, and how simulation can help estimate the POD for a SHM installation. There was discussion about the need for collaborating with other Commissions and doing presentations about the applications for SHM.
- **Paper 3** – Experimental study of on-line monitoring for fatigue crack in weld based on vibro-acoustic modulation technique, J. Zhang, China, V-1787-17.
    - Jiaying Zhang gave a presentation on the work of Bin Lui from the Harbin Institute of Technology. Unfortunately, Bin was delayed with air travel and missed the Commission V meetings. This work involves exciting a specimen with both a high frequency in the range of several hundreds of kHz generated using ultrasonic probes, and also a low

frequency in the hundreds of Hz generated by a fatigue vibration machine. The high frequency is also swept through a frequency range. Both frequencies will interact in the sample providing a more complex amplitude pattern. As the sample progresses towards failure with crack growth in the fatigue machine, this amplitude pattern is studied. It was shown that there are changes in the Fourier transform of the modulated intensity as the crack grows.

- **Presentation 13** – Recent developments in SHM at CEA, B. Chapuis, France, V-1788-17.
    - Bastien Chapuis gave an update on the project that he described in Commission V last year; reference document V-1670-15. This is a novel technique whereby passive fibre Bragg sensors are used to detect guided waves propagating on a plate due to ambient noise in the structure. This is quite different than active SHM systems where energy is inputted into the structure. Since the update in 2015, there has been significant improvement in the analysis algorithms; the newest analysis algorithm is called HARBUT, which combines two different calculation approaches. Some results of applying HARBUT were then given using an active tomography example that showed improvements in accuracy of measurement of remaining wall thickness. Results were then provided using HARBUT for passive tomography in a flat plate that also showed excellent results. Lastly, an application of passive tomography on a composite airplane engine cover was described. This application is to detect de-lamination between the aluminum covering and the underlying honeycomb. Augmented reality was used to display the inspection results.
- **Presentation 14** – Annual Report for Sub-commission VF (NDT Reliability Including Simulation of NDT Techniques), P. Calmon, France, V-1780-17.
    - Pierre Calmon gave the annual report. Major recent areas of accomplishment for this Sub-commission are publication of documents for validation of NDT simulation and simulation assisted POD studies. It was stated that the validation of simulation document has been accepted very well in the NDT modeling community and that it is now being used regularly. Some description of the French MOSAIC project to simulate ultrasonic propagation through coarse grained structures was given; this project ended in 2015. There are now two new European projects that are continuing this work: Muscad is continuing the MOSAIC work but is more focused on the nuclear industry, and Advise is focusing on inspection of complex structures. Both projects are expected to drive further improvements in the CIVA modeling software in several areas. There was then some discussion about how to include human factors into simulation. There has been some work in this area by other groups and it is now being considered how to add this feature to simulation. Finally, there was some discussion about the accuracy of simulation and how to calculate a probability of a certain accuracy for a given inspection.
- **Presentation 15** – POD calculation in the context of a European project for nuclear application (RI-ISI), P. Calmon, France, V-1789-17.
    - Pierre Calmon gave an update on an interesting project within the European Union in risk based inspection (RBI); some background on the concepts of probability of failure and consequence of failure were provided. This project is working on a framework to calculate the risk reduction when using an in-service methodology whereby the sites for inspection are chosen using an RBI process. This is a well-established methodology in North America with current standards that involve specific degradation mechanisms. Some examples were then given for application of the IIW simulation assisted POD studies. There was then discussion of a meta-model strategy, which involves building a smart-interpolator by running CIVA many times to generate a large numerical database. This meta-model is then used for calculating intensive simulations for generating many POD curves when input variables are changed. This can be used for sensitivity analysis where there is a need for calculating beams of POD curves. Lastly, there was discussion about how to compare simulated and experimental POD curves. There are sometimes sources of disagreement between the two data sets, but this doesn't necessarily indicate that the simulation is incorrect. More work will be done in this area to better understand the differences in data sets.

June 28th, 2017 – Commissions I and V Joint Seminar on Additive Manufacturing

- Doug Kautz and Eric Sjerve gave some opening remarks for the joint seminar. Eric described that Commission V wants to be part of joint seminars each year with other IIW Commissions as NDT is a collaborative discipline within the IIW. He also stated that additive manufacturing is an important field today and that it is a very good area for IIW lead in due to the collaborative nature of the IIW organization. Commission V would like continued collaboration with Commission I in the future with this joint seminar as a beginning of the cooperation.
- Doug then presented the IIW White Paper on Additive Manufacturing. Commission I is the home for additive manufacturing within the IIW, but there are many areas of collaboration with other IIW Commissions. For example:
    - Commissions II and XII for providing input on arc processes for large products
    - Commission III for solid state joining for using dissimilar metals
    - Commission IV for power beam processes for additive manufacturing
    - Commission V for inspection
    - Commission VI for additive manufacturing terminology
    - Commissions VIII and XIV for providing input into the safe usage of additive manufacturing
    - Commissions XI and XV for design of additive manufactured components
    - Commission XVI when using polymers for additive manufacturing
- **Presentation 16** – Introduction to Commission I activities, D. Kautz, USA, V-1790-17.
    - Doug Kautz gave a presentation on the history and the activities of Commission I. Doug started by giving background on the structure and naming of Commission I over the years since 1950 when the Sub-commission first started. Currently, Commission I has the following Sub-commissions that are active: I-C surfacing; I-E thermal cutting and related processes; and I-F additive manufacturing. There are three Sub-commissions that are currently not active. In these active areas, the goal is for Commission I to gain a better scientific understanding and identify practical applications. Sub-commission I-C focuses on: thermal spraying, laser cutting and hardfacing. Sub-commission I-E focuses on laser cutting, oxy-fuel cutting and edge cut quality. Sub-commission I-F was activated in 2015 and this has been an intense area of work and collaboration within the IIW.
- **Presentation 17** – Introduction to Commission V activities, E. Sjerve, Canada, V-1791-17.
    - Eric Sjerve gave a presentation on the structure and the activities of Commission V.
- **Presentation 18** – Summaries of contributions from the IIW ICWAM conference on additive manufacturing, D. Chauveau, France, V-1792-17.
    - Daniel Chauveau gave a summary of the contributions to the ICWAM conference (International Congress on Welding and Additive Manufacturing) in Metz France in May 2017. This conference brought 280 participants from 22 countries together, with very strong attendance from industry. There were three thematic areas for the conference – welding, powder additive manufacturing and wire based additive manufacturing. A summary of the different NDT techniques as they are applied to additive manufacturing was given. Then some examples of presentations from the conference were provided, that included: laser scanning for determining the depth of rippling on a surface before machining to determine if processing should be done; computed tomography on a WAAM aluminum mockup for determining porosity diameters; a closed loop system that monitors quality during the welding process to provide better quality assurance; and computed tomography for inspection of additive manufactured parts. It was concluded that there is no single NDT technique that can be used for all additive manufactured parts; it is necessary to apply many techniques to achieve quality assurance.
    - There was some discussion in the group about the differences between conventional welding and additive manufacturing. In welding, there is a material with design properties and then a welded area with different metallurgical properties. There follows an inspection on the weld and heat treatment to re-gain desirable properties for service. In additive manufacturing, it was commented that the entire component is a weld as layers are deposited to form the entire component. This is a very significant difference from conventional welding. It was also commented that components that are made by additive manufacturing are often more complex than are possible with standard fabrication

processes. It is also not known in all cases where the critical areas are for inspection; this can be a significant issue for NDT as in many cases these critical areas are buried inside the part. Lastly, there was a discussion about several categories of additive manufactured components. It was commented that in many cases, the parts will be of low commercial value, meaning that an inspection will not be done due to cost. It will be more beneficial to focus on the components that have high value and are in more critical service as these will require, and can justify commercially, an NDT inspection.

- **Presentation 19** – Additive manufacturing processing and common discontinuities, D. Kautz, USA, V-1793-17.
    - Doug Kautz started the presentation with some background on the size of the market and common systems used for additive manufacturing. Powder bed fusion and direct energy deposition are the two most common methods in industry and a description was provided for both. He then gave a summary of the types of defects that can be present in additive manufacturing. This was a detailed summary and included the following common defects: porosity of all sizes, shapes and locations within the part; unfused powder due to insufficient melting during the deposition process; balling due to lack of wettability with the previous layer, which is sometimes more common on large parts where layers cool before further deposition; cracking due many factors; warping between layers or at boundaries; delamination due to not enough melting overlap between successive layers; and swelling that is similar to humping in welding.
    - There then followed a good group discussion about the NDT techniques for finding these flaws. It was commented that there needs to be a good understanding about what defects are critical to find with the NDT technique. There are many well established NDT techniques that can detect many of these flaws, but it is critical to know what the fitness for service requirements are, as well as acceptance criteria to properly match to the NDT application. There was also a discussion on the reference standards required for applicable NDT techniques. There are many calibration blocks and sensitivity tests currently in use, but it is not known if these can be used for NDT of additive manufactured components.
- **Presentation 20** – Status of AWS D20.1 committee fabrication of additively manufactured parts, D. Kautz, USA, V-1794-17.
    - Doug Kautz gave a presentation on AWS code development in the USA for additive manufacturing. He first gave some background on the AWS code structure, which is like the structure of IIW. Doug stated that the goal of this standardization work is to create standards containing requirements for fabricating metal components that, when adhered to, will result in the repeatable production of metal components that meet functional requirements. The main areas that this standard deals with are: design requirements, procedure qualification, machine operator performance demonstration, fabrication and inspection. These areas were then described in more detail. For inspection, the standard allows the engineer to divide different areas of the additive manufactured part into inspection zones with different required levels of quality. Each of these quality levels has acceptance criteria associated with it that vary in the size of allowable discontinuities that can remain in the component. It will be the responsibility of the engineer to decide on relevant quality levels for different parts of the component. Doug said that this document had started the balloting process at AWS, and that it would likely be published in 2018.
- **Presentation 21** – Computed tomography inspection of additive manufactured parts, F. Kong, China, V-1795-17.
    - Fanqin Kong gave a presentation on the advances in computed tomography (CT) for additive manufacturing inspection that GE has been working on. She first gave some background on CT and the two ways that the x-ray beam can be oriented: cone beam that is fast but susceptible to scattered radiation; and fan beam that is slower but not susceptible to scattered radiation. However, GE has developed a scatter correction algorithm that allows for the speed of cone beam CT with reduction in the scattered radiation effects. Fanqin then described how she is using the CT system for verifying additive manufacturing system performance; checking powder grains size and distribution; aiding with rapid prototyping; and for helping with setting inspection

guidelines with the complementing use of other NDT techniques. She then gave examples of CT used for additive manufactured components, including: medical rotary carousel for test tubes using QR codes for measurement of powder entrapments; reaction wheel bracket where the inspection compared the part to the model to show deviations from design specification; and an inspection where the deliverable was a particle size analysis showing the size distribution of metal powder granules.

- There was then a group discussion about the commercial viability of CT for additive manufactured parts. The GE system can perform enough cross sections on the components to build a 3D part model in minutes, meaning that it can be commercially competitive for many applications. This is done through advances in both the software and the hardware that then allows for this speed of inspection. There was discussion about neutron scattering work and how many more cross sections are required, along with the additional time necessary for each cross section.

- **Presentation 22** – Additive manufacturing: challenges and opportunities, P. Calmon, France, V-1796-17.
  - Pierre Calmon then gave a final presentation on some challenges and opportunities for additive manufacturing with some interesting ideas on how this field will progress in the future. He first described the different parts of the manufacturing chain where NDE could be used; NDE is only applicable for high-value parts later in the manufacturing process. Some description of the reasons for needing NDE for process control during the additive manufacturing process were then given, with emphasis on the fact that prior inspection of bulk material is not possible and that this process has more variability and less reproducibility than conventional welding. Pierre then commented that NDE of additive manufactured parts is not fundamentally different than conventional NDE, but there are some specific issues that must be considered including: the roughness of the parts, specific defects like un-melted power than must be detected, high anisotropy and geometrical complexity. There was then a discussion of the different NDE methods that can be applied, along with comments on their strengths and weaknesses. Simulation was one tool that was shown to be a powerful method of determining the ability of a specific NDE technique for find certain flaws.
  - There was then a group discussion at the end of the seminar about the how the two Commissions can work together in the future. This seminar was a good start to identify some of the ways that there can be collaboration, and there was some good discussion about the challenges of applying NDE to additive manufactured parts. There was a decision taken that there should be continued collaboration in the future, and that Commission V will appoint Dr. Anna Paradowask as a liaison to ensure that this collaboration continues.