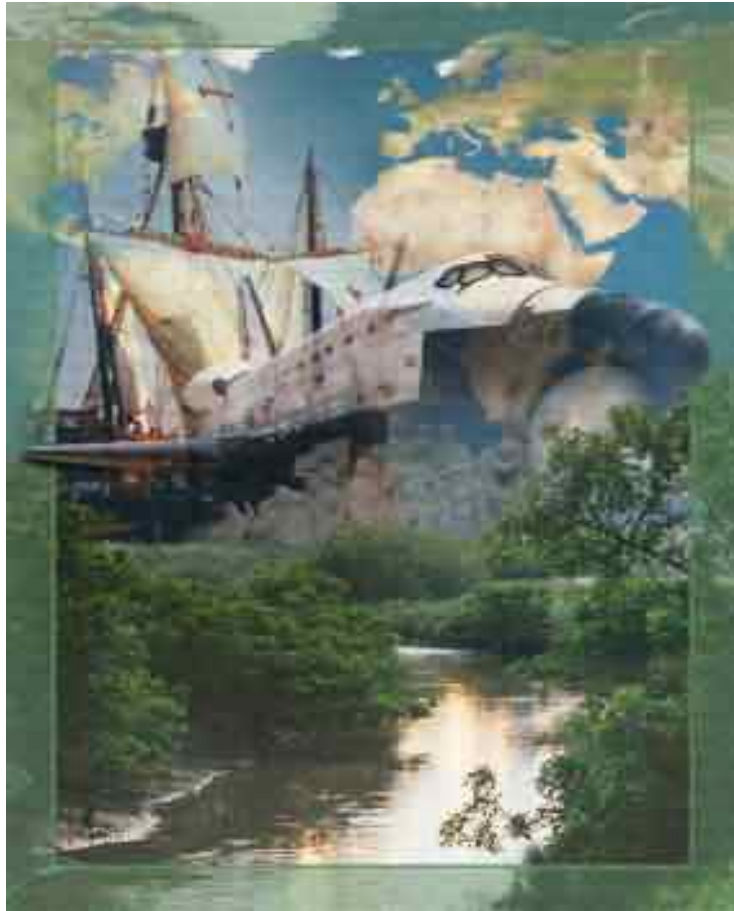


SUMMARY REPORT FOR
2005 C3P-NASA TECHNICAL WORKSHOP



**Portuguese Center for Pollution Prevention (C3P)
Program Office**

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Executive Overview

On 8 & 9 September 2005, the Centro Para Prevenção da Poluição (C3P) and the National Aeronautics and Space Administration (NASA) hosted a technical workshop at the Universidade Católica in Lisbon, Portugal. The two-day workshop provided an excellent forum to showcase innovative and emerging pollution prevention technologies, share lessons learned, and identify new joint opportunities. In total, 133 individuals from 9 countries attended the technical workshop. More than 30 international scientists, technologists, and engineering experts presented PowerPoint slides on topics ranging from advanced coatings and coating removal technologies to fuel cells to lead-free electronics. This exchange of solutions provided direct and tangible benefit to attendees from academia, defense, and commercial industries, thereby helping meet the mission not only of C3P but key workshop supporters such as the Luso-American Foundation for Development (FLAD) and the Office of Naval Research Global (ONRG).

The workshop began with welcoming comments from General (ret.) Pelagio Castelo Branco, C3P Director General. Gen. Branco highlighted those partnerships C3P has begun to form with manufacturers, industry associations, universities, and testing and engineering centers of excellence throughout the European Union. Ms. Olga Dominguez, Deputy Assistant Administrator for Infrastructure, Management, and Headquarters Operations at NASA, discussed how C3P fits into NASA's desire to benefit from international scientific collaborations. Prof. Humberto Rosa, Secretary of State for the Environment, highlighted the importance of C3P in providing innovative ideas to better enable Portuguese development and global competition.

At the workshop, the Israeli Users' Association of Advanced Technologies in Electronics (ILTAM) signed a Cooperation Protocol with C3P. ILTAM is the first Israeli organization to sign a protocol with C3P and represents an opportunity to leverage key resources and knowledge on validating green technologies.

C3P is an international organization that facilitates partnerships with the scientific & technical community in Portugal, Europe, and the United States to identify and evaluate less hazardous and sustainable materials for use in acquisition, manufacturing and sustaining maintenance processes. The C3P is recognized by Ministério do Ambiente, Ordenamento do Território e Desenvolvimento Regional of Portugal (Portuguese Ministry of Environment), and NASA per the *Joint Statement Between NASA and the Portuguese Ministry of the Environment Regarding Cooperation in the Field of Environmental Pollution Prevention Matters*, signed on 18 September 2002.

Support for the workshop was provided by FLAD, ONRG, Instituto de Soldadura e Qualidade (Welding and Quality Institute, or ISQ), Instituto de Engenharia Mecânica e Gestão Industrial (Mechanical Engineering and Industrial Management Institute, or INEGI), Associação Portuguesa das Empresas do Sector Eléctrico e Electrónico (Portuguese Association of Electric and Electronic Industries, or ANIMEE), Faculdade de Engenharia da Universidade do Porto (Engineering Faculty of University of Porto, or FEUP), NASA and ITB, Inc.

Summary Report for 2005 C3P-NASA Technical Workshop

Lisbon, Portugal
September 8-9, 2005

Introduction

Since the year 2003, C3P has held an annual technical workshop for interchange and to help identify new project opportunities.

In September 2005, the C3P and the United States NASA hosted a technical workshop in Lisbon, Portugal. Support for the workshop was provided by the FLAD, ONRG, ISQ, INEGI, ANIMEE, FEUP, NASA and ITB. This report summarizes the activities and key outcomes of the two-day workshop.

Background

C3P is an international organization that facilitates partnerships between Portuguese, European and United States governments, industries and other governmental agencies for identifying and integrating pollution prevention (P2) solutions, practices and procedures that qualify less or non-hazardous materials used in acquisition, manufacturing and sustaining maintenance processes.

The C3P is recognized by the Portuguese Ministry of Environment, and NASA per the *Joint Statement Between NASA and the Portuguese Ministry of the Environment Regarding Cooperation in the Field of Environmental Pollution Prevention Matters*, signed on September 18, 2002. Other associations, namely the Aerospace and Defense European Industries Association in Brussels (ASD), also provide C3P with direct links to Portuguese national and European environmental official bodies.

C3P is a consortium of three elements: ITB, which provides engineering and technical support; ISQ, which supports the identification of pervasive needs and technologies across Portugal and Europe through the 6th Framework Innovative Research Program, as well as providing alternative material, technology identification and demonstration/validation testing; and INEGI, support study requirements for laboratory facilities, equipment and personnel.

The C3P was established to facilitate partnerships not only between NASA and Portuguese government agencies, but also between various Portuguese, American, and European Small and Medium Enterprises (SME). C3P fosters multi-participant cooperation to avoid duplication of effort, costs, and technical risk in reducing or eliminating hazardous materials at multi-program contractor sites and the various national host installations. The C3P program focuses on issues relating to the environmental impact of processes at SMEs and installations where systems and products are designed, manufactured, remanufactured, or maintained.

On a day to day basis, C3P supports program managers, defense contractors and industries from Portugal and Europe, and in particular the SMEs, in addressing multi-participant problems in the uses of hazardous materials, waste generation and disposal. The concept operations of C3P define a systematic, phased methodology for identification and execution of C3P Projects.

Overview of 2005 Workshop

The C3P-NASA Technical Workshop was held on 8 & 9 September 2005. The two-day workshop provided an excellent forum to showcase improved P2 technologies, share lessons learned, and to identify new joint opportunities.

In total, 133 individuals from 9 countries (Portugal, United States, United Kingdom, Spain, France, Germany, Hungary, Israel, and Norway) attended the technical workshop. More than 30 experts presented PowerPoint slides. Feedback from the attendees indicated the workshop was a success and that they would attend again.

The technical workshop began with a general session given by distinguished speakers from C3P and NASA. General (ret.) Pelagio Castelo Branco, C3P Director General, welcomed everyone and thanked Prof. Manuel Braga da Cruz, Rector of Universidade Católica Portuguesa, for the use of their facility for the two-day workshop. Gen. Branco highlighted the need for C3P in Portugal and what partnerships C3P has begun to form with manufacturers, industry associations, universities, and testing and engineering centers of excellence throughout the European Union. Next, Ms. Olga Dominguez, Deputy Assistant Administrator for Infrastructure, Management, and Headquarters Operations at NASA, discussed why NASA is involved in international partnerships, especially C3P, and how such partnerships help NASA meet its agency vision and mission. Prof. Humberto Rosa, Secretary of State for Environment, highlighted the importance of C3P in providing innovative ideas to better enable Portuguese development and global competition. Welcoming remarks were also made by Mrs. Addriene O'Neil, Chargé d' Affaires of US Embassy, Portugal, and Mr. Aaron Ram, Ambassador of Israel in Lisbon.

At the workshop, the Israeli Users' Association of Advanced Technologies in Electronics (ILTAM) signed a Cooperation Protocol for Technology Exchange with C3P. ILTAM is the first Israeli organization to sign a protocol with C3P and represents an opportunity to leverage key resources and knowledge on validating and implementing green technologies.

The signing ceremony was followed by a brief session, "An Introduction to C3P". A presentation, "An overview of the challenges facing Portugal in Pollution Prevention" by the Chairman of the Environment Branch of the Portuguese Order of Engineers, focused on Portugal's main challenges in pollution prevention, the Portuguese Industry framework, and the key factors for environmental sustainability. The key factors for improving a company's competitiveness and innovation, as well as environmental sustainability, are Eco-efficiency and Eco-design. Eco-efficiency is an approach to include environmental issues as opportunities into business and national strategy, and Eco-design is the tool for eco-efficiency. This briefing was followed by a presentation on the progress that C3P has made in assessing innovative technologies ranging from non-chromated coatings for aerospace applications to lead-free soldering to "green" printing.

The afternoon presentations on the first day of the workshop provided a very comprehensive international overview of green electronics. While large commercial companies in the European Union (EU) have mostly converted to lead free, many EU SMEs, U.S. companies and worldwide military and aerospace enterprises are still in the technical/financial study phase of lead free. Issues such as product reliability, rework, and training must be addresses for these latter companies in order for them to even consider substituting lead-free materials. Fortunately, C3P supported efforts such as the Low-Cost Lead-Free Soldering Technology to Improve Competitiveness of European SME (LEADOUT) program and NASA project on lead-free solder testing for high-reliability applications are adding to the lead-free knowledge base and reducing the uncertainties surrounding lead free soldering. Pending C3P efforts with organizations such as ILTAM promise to further address the general concerns of SMEs in Portugal and the EU and address special applications such as military, aerospace and telecommunications.

The second day of the technical workshop opened with a fascinating presentation on work life in Antarctica by NASA's Chief of Medicine of Extreme Environments, noting recent efforts that have been taken to create a more sustainable environment in Antarctica.

The morning session titled "Low VOC Printing Materials and Technologies" provided insight into efforts in the U.S. and Portugal to make printing operations more green. Needs exist in many areas within the Portuguese printing industry, including: material selection; process optimization; reduction, recycling, reuse; waste management; health and safety; best management practices / work methods; and culture/mindset. The Environmental, Health and Safety Manager for the U.S. Printing Industries of America/ Graphic Arts Technical Foundation presented an overview of the U.S. printing industry's environmental efforts and how they might address Portuguese needs. A professor from the Instituto Politécnico de Tomar then presented an overview of the current Portuguese printing environment. Finally, an engineer from ITB (U.S.) introduced a proposal for a C3P-led, national program to green the Portuguese printing industry. C3P proposes a program to work together with European printing and publishing industry associations (e.g., Apigraf, Aind, FAEP, FIPP, etc), individual members of the Portuguese printing industry, USEPA, NASA, the Printing Industries of America/Graphic Arts Technical Foundation, and Portuguese and U.S. Universities.

The printing module was followed by a session on "Corrosion and Pollution Prevention". This session focused on corrosion prevention activities at NASA's Kennedy Space Center (KSC) in Florida and examined the relationship between corrosion mitigation/prevention and NASA's pollution prevention goals. First, the lead scientist with the Corrosion Testbed at NASA KSC, Florida provided an overview of some of the challenges facing KSC in corrosion management and how the KSC corrosion testbed is addressing those challenges. Next, another representative from NASA KSC Corrosion Testbed then discussed the details of a joint project between NASA and the U.S. Air Force Space Command to identify less-hazardous alternatives to aliphatic isocyanate urethane coatings used on steel structures.

Occurring in parallel with the above reviewed sessions on the 9th, two back-to-back sessions of the workshop focused on research efforts begin accomplished at INEGI/FEUP. The first session, titled "P2 and the Automotive Industry", focused on INEGI efforts to further develop green

materials and technologies to reduce the emissions and energy usage of automobiles. First, a professor from FEUP discussed the promise of hydrogen and fuel cells and presented a review of the Fuel Cell Testing and Standardisation NETwork - FCTESTNET, and the European Hydrogen and Fuel Cell Technology Platform – HFP; two European funded projects with a goal of changing the base energy systems in Europe toward a hydrogen and fuel cell society. A second professor from FEUP discussed the advances being made in biodegradable non-toxic lubricants for automotive applications.

In the second INEGI session titled “P2 and Sustainability”, a representative from INEGI provided an overview of INEGI’s contribution to a sustainable future by highlighting activities of INEGI’s Environment and Energy Unit (CETERM) in innovative projects related to wind Energy, non-toxic combustion, energy management, wind energy, fuel cells and hydrogen energy. Another researcher from INEGI/FEUP concluded the session with a presentation on the innovative developmental work to recycle materials using polymer concrete.

An INFODAY on the LEADOUT program was held throughout the morning and afternoon on Day 2 of the workshop. This seminar was organized with the support of ANIMEE (a C3P Protocol signatory) and the Portuguese company SILGAL Lda. The membership of LEADOUT is European national research organizations, technical experts and industry bodies interested in enabling lead-free solutions in micro-electronics. C3P member ISQ is the primary manager of LEADOUT. LEADOUT is providing a platform to coordinate, integrate and optimize research, enabling electronic producers in the EU to optimize solutions and meet the EU deadline of introducing lead-free soldering in consumer products by July 2006.

The afternoon session included a session, “Corrosion and P2 in Marine Environment”. An engineer from Transtejo, Portugal discussed the different types of corrosion (microbiological, flow induced, intergranular, exfoliation, pitting, etc.), that affect maintenance and operations of their fleet of water craft, and presented a review of the most common failure zones. Next, a researcher from ISQ discussed the state of the art in the EU of antifouling ecopaints for ship hull uses. Reviewed were the EU regulations regarding antifouling coatings in European and international waters. New developments in natural antifoulant coating systems based on enzymes were addressed, as well as ecological alternatives like: non-toxic, non-stick coatings to prevent settling (smooth silicone, Teflon or hydroviscous coatings), self-polishing, anti-fouling paints without biocides and fibre-flock coatings. The ISQ presenter concluded that the data reviewed and testing conducted thus far looks promising and justifies continued analysis.

To complete this session, Hempel’s European Quality Environmental Manager discussed their company’s coating products for marine vessels, and presented a review on the EU chemical legislation from a Paint Manufacturer's Perspective. Examined were the REACH programme, Solvents Emission Directive and the Biocidal Products Directive, as well as Hempel’s strategy and progress thus far in conforming to these directives.

A session on “P2 and Sustainability” reviewed ISQ’s relevant projects. Presentations included an overview of ISQ’s environmental project areas, a discussion of the integrated water management of transboundary catchments (TRANSCAT project), and a presentation on ISQ’s environmental friendly helicopter project.

A session on 'Corrosion and P2 in Aeronautics' provided much information on projects in the U.S. and Portugal to reduce chromium, VOCs, and other hazardous materials in aerospace applications. The F-16 Environmental Program Manager discussed the successes of the U.S. Air Force's Acquisition Pollution Prevention Program. Next, an engineer from TAP reviewed the promising results to date from the laboratory and field testing by C3P project stakeholders NASA, TAP, OGMA, and ISQ of two chrome-free low-VOC coating systems for aircraft exteriors. Next, a representative from Hill Air Force Base, Utah, presented the U.S. Air Force's increasing successes in flying non-chrome conversion coating systems on military aircraft surmising that becoming entirely chrome free remains a goal for the US Air Force on its aircrafts and weapon systems.

A researcher from ISQ reviewed promising environmentally friendly pre-treatments for aluminum alloys. Specifically addressed was combining the barrier properties of silane coatings with the inhibiting properties of cerium (Ce) ions as a potential pre-treatment on AA2024-T3 substrates. Initial laboratory analysis shows that reduced anodic activity observed 10 min after defect formation. It is concluded that the cerium ions entrapped in the silane film can move to the corrosion area and form hydroxide precipitates on top of cathodic intermetallic particles due to the enhanced pH and presence of H₂O₂ in such areas. The precipitate blocks the cathodic zones suppressing the corrosion activity of defects.

Finally, a representative from the U.S. Air Force Coatings Technology Integration Office reviewed the many U.S. Air Force Space Command efforts in reducing corrosion and preventing pollution in the maintenance and operation of launch structures and weapon systems.

A final session on "Innovative Depainting and Surface Preparation" presented some of the novel, environmentally friendly technologies for removing coatings. Sponge Jet provided an overview of their successful technology, which uses more environmentally friendly sponge media as a blast medium for removing coatings. Nitrocision reviewed their technology, which uses liquid nitrogen (which is not damaging to the environment) to remove coatings. A final presentation discussed the state of the art in induction paint removal technology.

Workshop Outcomes

The workshop provided an excellent forum for information exchange among the international science and technology community in a broad range of technical areas of interest to academia, defense and commercial industries. Technological applications ranged from coatings, coatings removal, printing, and green electronics, and included virtually all modes of transportation (aircraft, naval craft, automotive) as well as infrastructure. Throughout the workshop, the concept of collaboration and its inherent benefits was stressed.

As a result of ILTAM's signing of an Exchange Protocol with C3P, C3P looks forward to collaborating with Israel electronics manufacturers on matters of green electronics.

As a direct result of the workshop, C3P will follow up on a number of potential opportunities for further collaboration, including:

- Submission of a proposal on greening the printing industry to the Portuguese Ministries for the Environment and Economy.
- Further communication with printers already visited.
- A possible meeting at INASMET in Spain.
- Further collaboration on green electronics between LEADOUT and the U.S.-NASA Lead-Free Solder team.
- A Technical Review in January or February of 2006 to discuss the development of new C3P projects.
- A C3P review (and possible migration) of depainting technologies and corrosion management strategies to Transtejo and the Portuguese ship and naval maintenance and operations sector.
- Plans for another C3P-NASA Workshop in 2006 in the U.S.

The [Centro Para Prevenção da Poluição \(C3P\)](#)
and the
[National Aeronautics and Space Administration \(NASA\)](#)
presents

C3P AND NASA TECHNICAL WORKSHOP 2005

“PARTNERING FOR SHARED SOLUTIONS TO COMMON ENVIRONMENTAL PROBLEMS”

at [Universidade Católica Portuguesa](#)
Lisbon, Portugal
September 8-9, 2005

Hosting **LEADOUT** Project in collaboration

TIME	EVENT TITLE
	Thursday, September 8
	Welcome Remarks
9:30 am – 10:15 am	- C3P – Centro Para a Prevenção da Poluição - NASA – National Aeronautics and Space Administration - Ministério do Ambiente, do Ordenamento do Território e do Desenvolvimento Regional
10:15 am – 10:45 am	Break
	An Introduction to C3P
10:45 am – 12:00 pm	- An overview of the challenges facing Portugal in Pollution Prevention – Prof. António Brito, Universidade do Minho - C3P Solutions to Environmental Issues – E. Dias Lopes, ISQ
12:30 pm – 2:00 pm	Lunch
	Green Electronics
2:00 pm – 4:00 pm	- Lead-free Soldering in Europe – Soldertec Roadmap – E. Dias Lopes, ISQ - RoHS Compatible Electronics boards Design and Assembly in Israel – Moshe Salem, ILTAM G.M - JCAA/JG-PP Lead-Free Solder Testing for High-Reliability Applications – Brian Greene, ITB
4:00 pm – 4:30 pm	Break
4:30 pm – 6:00 pm	- Automotive Lead-Free Electronics – António Aires, Visteon Corporation - Lead-Free Soldering Situation in Spain – Patricio Aguirre, INASMET

ANIMEE – Associação Portuguesa das Empresas do Sector Eléctrico e Electrónico (Portuguese Association of Electric and Electronic Industries)

ELFNET – European Lead Free soldering NETwork

FEUP – Faculdade de Engenharia da Universidade do Porto (Engineering Faculty of University of Porto)

ILTAM – Israeli User's Association of Advanced Technologies in Electronics

Fundación INASMET – Inovação e Tecnologia

INEGI – Instituto de Engenharia Mecânica e Gestão Industrial (Mechanical Engineering and Industrial Management Institute)

ISQ – Instituto de Soldadura e Qualidade (Welding and Quality Institute)

JCAA/JG-PP – Joint Council on Aging Aircraft / Joint Group on Pollution Prevention

KSC – Kennedy Space Center

LEADOUT Project – LowCost Lead-Free Soldering Technology to Improve the Competitiveness of European SMEs, European Funded Project

NASA/AFSPC AIU – NASA / Air Force Space Command Aliphatic Isocyanate Urthane Replacement

NASA AP2 – NASA Acquisition Pollution Prevention Program Office

TIME	EVENT TITLE General Session	Parallel Session 1	Parallel Session 2
	Friday September 9		
9:00 am – 9:15 am	Day 2 Welcome – Keynote Address		
9:15 am – 9:45 am	- Keynote Speaker: Dr. Desmond Lugg, Chief, Medicine of Extreme Environments, NASA "Shared Solutions to Environmental Problems on Earth and in Space: Lessons learned from the extremes of Antarctica"		
	Low VOC Printing Materials and Technologies	LEADOUT INFODAYS ⁽²⁾	P2 and the Automotive Industry (INEGI Projects)
9:45 am – 10:40 am	- US Printing Industry's Environmental Efforts – Gary Jones, U.S. Printing Industry Association - Indústria Gráfica - Indústria Amiga do Ambiente – Prof. A. Guilhermino Pires, Instituto Politécnico de Tomar - Greening the Portuguese Printing Industry, Introduction to the National C3P Project – Joana Vide Pereira, C3P; Marta Antas, ISQ; Matthew Rothgeb, ITB	- Opening – Margarida Pinto, ISQ - Presentation of the LEADOUT Project – Margarida Pinto, ISQ - National transposition of the EC Directives WEEE & RoHS – Tereza Silva, ANIMEE	- Hydrogen and Fuel-Cells for a more sustainable future – Prof. José Luis Alexandre, INEGI/FEUP - Biodegradable non-toxic lubricants for automotive applications – Jorge Seabra, INEGI/FEUP
10:40 am – 11:00 am	Break		
	Corrosion and Pollution Prevention		P2 and Sustainability (INEGI Projects)
11:00 am – 12:30 pm	- An overview of some of the challenges facing KSC in corrosion management and the NASA/KSC Testbed: a leader in corrosion analysis and testing – Dr. Luz Marina Calle, KSC Corrosion Testbed, NASA - NASA/AFSPC AIU Replacement – Joe Curran, KSC Corrosion Testbed, NASA	- Lead-Free Overview on Wave Soldering – Ian Wilding, Henkel - Pb free & Low VOC Soldering Process Implementation at Pioneer – Micael Santos, Pioneer	- Environment and Energy-Two sides of the same coin. INEGI's contribution to a sustainable future – Francisco Mota Torres, INEGI - Development of new Polymer Concretes with recycled materials – António Ferreira, INEGI/FEUP
12:30 pm – 2:00 pm	Lunch		
	Corrosion and Pollution Prevention in Marine Environment		P2 and Sustainability (ISQ Projects)
2:00 pm – 3:00 pm	- Corrosion in Aluminium Ships: Practical Cases – F. Gomes Lopes, Transtejo - A brief state of the art in EU of ecopaints for ship hull uses – E. Dias Lopes, N. Duarte, ISQ - Hempel and the Environment; Painting a Cleaner Future – Alda Confraria, Hempel	- LEADOUT and the Benchmarking importance on the production reliability of electronic products – Helder Ferreira, Crossline - Status on SME Lead Free Soldering Implementation in Europe and their Concerns – ELFNET & LEADOUT Projects – Sandra Estanislau, ISQ	- Paving the way for sustainable development at ISQ – Lobato Faria, ISQ - Water management of transboundary catchments – Marco Estrela, ISQ - Environmentally friendly helicopter – Aristides Chaves, ISQ
	Corrosion and Pollution Prevention in Aeronautics ⁽¹⁾		Innovative Depainting and Surface Preparation Technologies
3:00 pm – 4:30 pm	- U.S. Air Force Acquisition Pollution Prevention - Mary Wyderski, F-16 Environmental Program Manager - TAP/OGMA Chrome Systems Replacement Project E. Dias Lopes, ISQ; Ana Ricardo, TAP Portugal - Air Force / Hill AFB efforts in Non-chrome Coating Systems – Dick Buchi - US Air Force Space Command efforts/progress in corrosion and pollution prevention regarding low-VOC coatings, and non-hazardous chemical strippers - Lt. Lauren Beaumont - Environmentally Friendly Pre-Treatments for Aluminium Alloys – Ana.M.Cabral, ISQ/ISEL	- Lead-Free Overview on Reflow – Ian Wilding, Henkel	- Sponge Jet Surface Preparation Technology - TBD, Sponge Jet - Liquid Nitrogen Depainting – Dr. Howard Hume, Nitrocision - Induction Paint removal technology – Tom Arne Baann; Bjorn Erik Alveberg
	Workshop Closing Remarks Farewell Port Wine		

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