2017 Professional Training Courses

COMMERCIAL HUMAN SPACEFLIGHT SAFETY
LAUNCH AND RE-ENTRY SAFETY ANALYSIS
RE-ENTRY SAFETY ANALYSIS
ISS PAYLOADS DESIGN AND OPERATIONS SAFETY
DESIGN AND OPERATIONS OF COMPOSITE OVERWRAPPED PRESSURE VESSELS
QUALITY ASSURANCE (QA) FOR SPACE PROJECTS
CONFIGURATION MANAGEMENT FOR SPACE PROJECTS
SPACE DEBRIS: RISK ANALYSIS AND MITIGATION
SOFTWARE SYSTEM SAFETY

For More Information and/or Registration:
http://www.iaass.space-safety.org/events/courses/
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Greetings and Welcome to the first issue of the IAASS Professional Training Courses Catalog.

The IAASS has had a long history of Professional Technical Training with training being one of the principle objectives since its inception in 2004. The first course was held in conjunction with the 2nd IAASS Conference in Chicago, Illinois and since then we have conducted or sponsored courses around the world.

This catalog contains courses that are offered either on a scheduled or on-demand basis. On-demand courses are performed on request of an organization (company, university, agency, etc.) according to two possible schemes: exclusive or sponsored. In the case of exclusive course, it is up to the organization to identify and register participants, and to provide the course venue. No external participants are admitted. Instead in the case of on-demand sponsored course, the organization will buy a minimum number of seats in the course and allow IAASS to bring additional external participants.

The instructors, drawn from the membership of the IAASS, are leaders in their respective fields of knowledge.

If there are subjects, related to Space Safety, that are not listed; please feel free to contact us via the IAASS web site at www.iaass.space-safety.org.

Information on the current course offerings is contained on Page 23, with the most up-to-date information on the IAASS web site.

Thank-you for your interest and see you in class!

Paul Kirkpatrick
Chair IAASS Professional Training Committee

Tell me and I forget,
Teach me and I may remember,
Involve me and I learn.

Benjamin Franklin
The Challenge
The course is designed to provide the participant with an understanding of established safety practices and processes that could be used for design, manufacturing and operations of commercial human sub-orbital and orbital vehicles.

Scope of the course
At the end of October 2013 the US FAA (Federal Aviation Administration), Office of Commercial Space Transportation (AST) released a draft document on “Established Practices for Human Space Flight Occupant Safety with Rationale”. The issuance of the document was meant to continue a conversation between FAA-AST and the commercial space transportation industry, and other stakeholders on commercial human space flight occupant safety. AST has developed the document to share thoughts about established practices for human space flight occupant safety. Ultimately, the goal is to gain the consensus of government, industry, and academia on established practices as part of the FAA-AST mandate to encourage, facilitate, and promote the continuous improvement of the safety of launch and reentry vehicles designed to carry humans. The established practices in the document cover occupants from when they are exposed to vehicle hazards prior to flight through when they are no longer exposed to vehicle hazards after landing.

Through this IAASS course the participant will acquire a detailed understanding of concepts and requirements in the above FAA-AST document and in the IAASS safety standard IAASS-ISSB-S-1700-Rev-B and supporting guidelines, and will familiarize with safety analysis techniques that can be used for their correct and consistent implementation.

Target Audience
- Design and operations engineers and managers new to space safety principles, processes and established practices.
- Safety managers and engineers with no previous experience in space projects.

What You Will Learn
- Why safety management is important.
- The safety culture and philosophy.
- The established safety practices.
- Hazard analysis principles and techniques.
- How interpret standards and guidelines
- Lessons learned from space accidents

How You Will Learn It
- Verbal instructions using Power Point Presentations.
- Videos & Photographs.
- Case studies.
- Group exercises & problem solving.

Why You Need to Know this
- To implement cost/effective safety-by-design measures
- To understand the significance and procedures of safety management.
- To know the experts point of view.

What You Will Take With You
- A set of available standards and practices
- A USB flash drive with all the above.
- A Certificate of Course Completion

Course Duration
2 days
The Challenges

The course is intended to provide the participant with an understanding of analyses for launch and re-entry safety, understanding the significance and procedures of range safety processes; and identifying resources for implementing launch re-entry safety. The participant will gain an understanding of hazards associated with space launch and re-entry operations, the data required to quantify the hazards, methods for quantifying the risks from these operations, and effective means for mitigating the risk.

Introduction

Over the last fifty years the methods for understanding and managing the risks associated with the launch and re-entry of space systems have evolved significantly. These advances have been driven by a combination of larger and more complex space launchers and decreased buffer between populated areas and launch sites. Improved risk management has resulted from increased computational capacity and more refined modelling. The result has been an outstanding record of protecting the public from the inherently dangerous operations of launching and re-entering of space systems.

Scope of the course

This course teaches the principles of launch and re-entry safety analysis and risk management:

- Risk Concepts
- Risk Mitigation Concepts
- Mathematical/Statistical Principles
- Computation/Presentation of Risk
- Risk Analysis Modelling
- Evaluating Catastrophic Risk
- General Launch Risk Analysis Procedure
- Impact Point Prediction and Impact Dispersions
- Impact Dispersions of Normal and Malfunctioning Vehicles
- Aircraft Probability of Impact and Vulnerability
- Impact Probabilities for Planned Jettisons
- Introduction to Debris List Development
- Failure Rate and Failure Mode Development
- Introduction to Exposure and Vulnerability
- Acceptable Risk
- Controlled Re-entry Risk Analysis Methods
- Uncontrolled Re-entry Risk Analysis Methods.

What You Will Learn

The following concepts will be learned:

- Approach to managing risks associated with launch and re-entry operations
- Definition of risk and risk measures (individual, collective, catastrophic)
- Process to perform quantitative flight safety risk analyses
- Sources of debris dispersion and methods of modelling
- Modelling impact probability distributions and computing probability of impacting people, buildings, ships and aircraft
- Consequence analyses: approaches to modelling vulnerability of people
- Structures, ships and aircraft and the consequences of impacting inert and explosive debris
- Concepts for mitigating risk, such as mission/vehicle design, ship and aircraft management, and flight termination system design.

In addition this course is an enhanced version of the course first taught at US ranges and later in conjunction with IAASS conferences. Significant enhancements over the original course include:
a) introduction to considerations of range safety system design
b) updated material on characterizing vehicle breakup
c) updated material on characterizing vehicle failure probabilities and response modes, and
d) extended sample analysis integrated into the course.

**Target Audience**

- Engineers and Project Managers involved in launchers and spacecraft design & development
- Engineers and Managers with range safety responsibilities
- Safety Engineers performing and reviewing launch flight safety analyses

**Prerequisites**

Background in mechanical engineering or physics equivalent to a BS. Familiarity with matrix and vector operations.

**Instructor**

The course will be taught by Jerry Haber and by Randy Nyman.

**Mr. Haber** has over 30 years of experience leading risk analysis model development efforts, developing risk acceptability standards, and performing flight safety risk analyses for the full spectrum of U.S. launch vehicles and missiles. He has developed guidelines for flight safety risk analyses for U.S. National organizations and a leader in the development of U.S. consensus risk acceptability standards for launch and re-entry risks.

**Mr. Nyman** with 30 years of engineering practice, has made major contributions in re-entry risk, breakup modelling and toxic risk modelling. Mr. Nyman performed on behalf of ESA the independent re-entry risk analysis for ATV.

Both instructors are the authors or co-authors of numerous technical papers and reports. They have also co-authored the Elsevier graduate level textbook *Safety Design for Space Operations*.

**How You Will Learn**

- Verbal instructions using Power Point presentations
- Videos & Photographs
- Case studies

**What You Will Take With You**

- Data, model results and tools
- A USB flash drive of comprehensive briefing slides
- Certificate of Course Completion

**Course Duration**

4 Days (Monday afternoon – Friday noon)
The Challenges

The course is intended to provide the participant with an understanding of how to perform analyses for assessing the safety risk of space systems re-entry operations. Such analyses should be performed during the early stage of design as they may drive the decision to include controlled re-entry capability, to modify components design and materials selection to enhance demise to meet applicable regulatory risk thresholds, and consideration of alternative launch facilities and orbital inclinations. The participant will gain an understanding of the hazards, methods for quantifying the risks from re-entry operations and effective means for mitigating the risk.

Introduction

As the orbits of non-functional satellites, spent launch vehicle stages and other pieces of debris decay, they lose altitude and enter denser regions of the atmosphere where friction with atmospheric gases at high velocity generates a tremendous amount of heat. As a result, a major portion of the hardware (between 60% and 90%) will typically burn up. However, some components and parts can and do survive the re-entry heating. As the emphasis on accelerating removal of space debris from LEO orbit has gained acceptance to reduce collision risk and orbit pollution, the need to control the safety risk of re-entering space objects has come in focus and will very much impact the overall design of future spacecraft and launch vehicles upper stages. Estimating the re-entry risk with sufficient precision becomes a key design tool. Over the last fifty years the methods for understanding and managing the risks associated with the launch and return of space systems have evolved significantly. These advances have been driven by a combination of larger and more complex space launchers and payloads, increased space launch traffic, growing populations on Earth, and decreased buffer between populated areas and candidate launch sites and re-entry areas. Improved risk management has resulted from increased computational capacity and more refined modelling. The result has been an outstanding record of protecting the public from the inherently dangerous operations of launching while much remains to be done for the re-entry of space systems.

Scope of the course

This unique course teaches the principles of re-entry safety analysis and risk management:
- Risk Concepts
- Risk Mitigation Concepts
- Mathematical/Statistical Principles
- Computation/Presentation of Risk
- Risk Analysis Modelling
- Risk Analysis Procedure
- Evaluating Catastrophic Risk
- Impact Point Prediction and Impact Dispersions
- Consequence Modeling for Impacting Debris
- Acceptable Risk
- Characterizing Populations at Risk
- Managing Ship and Aircraft Risk
- Re-entry Breakup and Demise
- Re-entry Risk Analysis Methods
  - Uncontrolled
  - Controlled

What You Will Learn

- Approach to managing re-entry risks:
  - Definition of risk and risk measures (individual, collective, catastrophic)
  - Process to perform quantitative flight safety risk analyses
  - Sources of debris dispersion and methods of modelling
  - Modelling impact probability distributions and computing probability of impacting people, buildings, ships and aircraft
  - Consequence analyses: approaches to modelling vulnerability of people, structures, ships and aircraft and the consequences of impacting inert and explosive debris
  - Concepts for mitigating risk, such as mission/vehicle design, ship and aircraft traffic management

In addition the results will be reviewed of the benchmarking exercise, performed by the IAASS Working Group, of existing risk assessments tools in US and Europe

This course is an enhanced version of the course first taught at
US Launch Ranges and later given internationally in conjunction with IAASS conferences. Enhancements include:

a) focus on re-entry risks analysis as design driver  
b) re-entry breakup and demise  
c) extended sample problem

**Target Audience**

- Engineers and Project Managers involved in spacecraft and launchers design & development  
- Engineers and Managers involved in space operations (e.g. SSA), or with operational safety responsibility  
- Safety Engineers performing and reviewing re-entry flight safety analyses

**Prerequisites**

Background in mechanical engineering or physics equivalent to a BS. Familiarity with matrix and vector operations.

**Instructors**

The course will be taught by Jerry Haber and by Randy Nyman.  

**Mr. Haber** has over 30 years of experience leading risk analysis model development efforts, developing risk acceptability standards, and performing flight safety risk analyses for the full spectrum of U.S. launch vehicles and missiles. He has developed guidelines for flight safety risk analyses for U.S. National organizations and a leader in the development of U.S. consensus risk acceptability standards for launch and re-entry risks.

**Mr. Nyman** with 30 years of engineering practice, has made major contributions in re-entry risk, breakup modelling and toxic risk modelling.

The instructors are authors/co-authors numerous technical papers and reports. They have co-authored the Elsevier graduate level textbook Safety Design for Space Operations.

**How You Will Learn**

- Verbal instructions using Power Point presentations  
- Videos & Photographs  
- Extended sample problem

**What You Will Take With You**

- Data, model results and tools  
- A USB flash drive of comprehensive briefing slides  
- Certificate of Course Completion  
- Sample Problem Workbook

**Course Duration**

2 Days

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**COURSE AGENDA**

**DAY 1**

09:00 Welcome & Course Introduction

09:15 General:
- Risk management concepts  
- Risk measures  
- Debris Risk Modelling Approaches  
- General/Debris Risk Analysis  

10:45 Coffee Break

11:15 Fundamentals:
- Debris Footprint Analysis Methodology  
- Population Library  
- Consequence Modelling for Inert Debris

13:00 Lunch Break

14:15 Protection Standards
- Risk Acceptability  
- Ship Protection

18:00 Adjourn

**DAY 2**

09:00 Aircraft Risk Management

10:00 Coffee Break

10:30 Re-entry Risk
- Risk Modelling Functions  
- Breakup and Demise Part 1

12:30 Lunch Break

14:00 Re-entry Risk
- Breakup and Demise Part 2  
- Random Re-entry Risk  
- Planned Re-entry Risk

18:00 Certificates of Completion for Re-entry Risk Course  

Adjourn
ISS PAYLOADS DESIGN AND OPERATIONS SAFETY

The Challenge

The course is designed to provide the participant with an understanding of safety requirements, procedures and processes that are used for design and operations of payloads for the International Space Station.

Scope of the course

This course is designed as a guide to the ISS payload/cargo safety review process. The student will gain an understanding of the applicable safety documents and key safety technical requirements, of payload/cargo safety as it relates to the overall development and integration process, how the payload/cargo safety review process works, and the roles and responsibilities of the various players. In addition the student will be instructed in the hands-on fundamentals of hazard analysis, hazard documentation, and presentation to the Payload Safety Review Panel.

Through this IAASS course the participant will acquire a detailed understanding of concepts and requirements in SSP 51700, SSP 30599, and supporting guidelines, and will familiarize with safety analysis techniques that can be used for their correct and consistent implementation.

Target Audience

• Safety engineers and managers, system engineers, QA personnel, project managers responsible for development, integration and operation of payloads/cargo for ISS;
• Other technical discipline personnel who contribute to the design and operations of ISS payload/cargo and need to understand the process by which hazards are identified and controlled.

What You Will Learn

• Why safety management is important
• The safety culture and philosophy
• The safety documentation
• Where to find requirements
• Basic hazard analysis techniques.
• How to identify hazards
• Common mistakes
• The Phased Review Process
• How to prepare for the Safety Panel Meeting

How You Will Learn It

• Verbal instructions using Power Point Presentations
• Videos & Photographs
• Case studies
• Group exercises & problem solving
• Preparing/completing forms
• Mock presentation to safety panel

Why You Need to Know this

• To design your payload/cargo for safety
• To understand the significance and procedures of the safety process
• To identify resources for implementing payload safety
• To know what the ISS Payload Safety Review Panel (PSRP) expects from you
• To get safety certification to fly

What You Will Take With You

• The course binder with the presentation charts.
• A selected set of documents
• A USB flash drive with all the above.
• A Certificate of Course Completion.

Course Duration

3,5 days

Instructors

T. Sgobba (ESA Ret. – Flight Safety Chair)
P. Kirkpatrick (NASA Ret. – Ground Safety Chair)
Larry Gregg (Lead Instructor for NASA Safety Training Center)
# COURSE AGENDA

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<td>General Definitions</td>
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<td>Man-in-Space</td>
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<td>Accidents &amp; Close Calls</td>
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<td>14:00</td>
<td>System Safety Basics</td>
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<td>- How it started</td>
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<td>- Definitions</td>
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<td>- Basic Technical Requirements</td>
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<td>- Basic Technical Reqs (Continued)</td>
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<td>- Hazard-Mishap</td>
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<td>Safety-by-Design</td>
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<td>- Materials Safety</td>
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<td>- Electrical System Safety</td>
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<td>Safety-by-Design (Continued)</td>
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<td>- Electrical Sys. Safety (Continued)</td>
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<td>11:00</td>
<td>ISS Payload Safety Policy &amp; Rqts</td>
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<td>- SSP 51700</td>
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<td>- NSTS/ISS 18978</td>
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<td>Hazard Report Exercise</td>
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<td>16:00</td>
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<td>11:30</td>
<td>Avoiding mistakes in HRs &amp; SDPs</td>
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DESIGN AND OPERATIONS OF COMPOSITE OVERWRAPPED PRESSURE VESSELS

Code 005

The Challenge

High performance Composite Overwrapped Pressure Vessels (COPVs) have been utilized in the aerospace and automotive industries for many years, providing an inherently safe, lightweight and cost effective storage source for pressurized fluids. COPVs are commonly used for gas and propellant storage in spacecraft and launch vehicles. The consequence of a COPV rupture can be the release of caustic fluids, loss of necessary fluids and the release of stored energy equivalent to several pounds of trinitrotoluene (TNT) depending on the quantity, pressure and fluid contained in the COPV.

In the aerospace sector, the development of a commercial space industry has reinforced the need for light and low cost yet safe and reliable pressure vessels. In the automotive sector, new demands for alternative fuel vehicles driven by changes in the energy sector have given rise to opportunities for durable and low cost, and also safe and reliable pressure vessels, particularly for hydrogen and compressed natural gas. Safety and high reliability are achieved by adhering to rigorous processes throughout the life cycle of a pressure vessel, including the design, manufacture, testing, handling, and operation phases.

Scope of the course

This course will provide an introduction to the basic principles governing the design and operation of Composite Overwrapped Pressure Vessels (COPV). The comprehensive overview of current technological understanding will provide both engineering mechanics fundamentals and practical applications drawn from experience to educate program managers, design engineers, ground and flight operators, safety analysts, quality inspectors and users/customers.

Course Description

Fundamental to the use of COPVs in space applications is the relevant failure modes and the design techniques introduced to ensure safe operation. Flight safety can only be properly understood through appropriate engineering design and quality throughout the vessel lifecycle from design, qualification, manufacturing, acceptance testing, handling and finally operational use. Each step of the product lifecycle has relevant safety considerations, which will ultimately affect the likelihood for catastrophic failure resulting in loss of life during operations.

This course has been developed based on requirements developed for space applications for COPVs. The relative requirements are documented in NASA-developed standards applicable to US and international partners for use on the International Space Station, as well as for future programs such as the NASA Commercial Requirements. These various standards reference the appropriate AIAA requirements and these will be directly addressed in this course. The course is directly relevant to individuals concerned with COPVs in automotive applications. The failure modes are common across these industries. However, there is a difference in usage and need for robustness of typical pressure vessels and a difference in materials commonly selected for these products. Consequently there are different standards and approaches to certification. The class will explore these differences.

Participants in this workshop will gain appreciation of a wide range of epoxy-matrix composites that are used in overwraps based on fibers such as: S-glass, aramids (e.g., Kevlar®49) and carbon (e.g., T1000), and also various current liner materials including metals such as aluminum, stainless steel, titanium and Inconel, and polymers such as high density polyethylene. Attention will be paid to the potential effects of processing variables (e.g., heat treatment, welding, annealing) on ultimate liner performance as influenced also by the fiber used in the overwrap.

Various steps in the COPV design and manufacturing processes will be discussed, particularly aspects strongly influenced by end-use requirements and vessel geometry (cylindrical vs. spherical). To manufacture the overwrap, both wet filament winding and prepreg winding methods will be discussed, including their respective pros and cons and their relative importance in various designs. Another topic discussed will be the potential for liner distortion and buckling during winding, the consequences and candidate countermeasures to protect this phenomenon from occurring. Advantages and risks in bonding the overwrap to the liner will be discussed with respect to the overall design and potential failure mechanisms. Autofrettage and proof-testing will be discussed in terms of plastic yielding of the liner that induces a significant compressive stress component beneficial to improving fatigue life. In this context, the Bauschinger effect on the final liner stress state and the potential for liner buckling will also be discussed. The relevant analysis and test methods used to demonstrate com-
What You Will Learn

- Failure modes in COPVs and requirements for safe operation in space environments
- Designing for Maximum Operational Pressure and Relevant Factors of Safety
- Approaches to Liner Fatigue Modeling under Pressure Cycling
- Liner Buckling: Models, Trigger and Methods of Prevention
- Composite Stress-Rupture Phenomenon and Reliability Modeling
- Nondestructive Evaluation (NDE)
- Considerations for Ground Operations and Damage Control Mitigation Techniques.

Target Audience

- Engineers and Managers who are interested in the latest techniques for COPV design, development, manufacture and test
- System engineers who develop requirements for systems which incorporate the use of pressure vessels
- Safety, reliability and quality engineers who want to understand the approach to safety and mission assurance of systems which incorporate the use of pressure vessels
- Ground Operators and test engineers who performed non-destructive evaluation of pressure vessels. The course would be beneficial to both seasoned experts in the field and new engineers to the technology.

Course Length and Duration

5 days

Instructors

Instructors: The course instructors are internationally recognized experts in the field of COPV Design and Operations:

S. Leigh Phoenix (PhD Cornell) is professor of Mechanical and Aerospace Engineering at Cornell University, where he has been on the faculty since 1974, and teaches courses in composite materials, solid mechanics and applied mathematics. Much of his research involves micromechanically-based statistical modeling and experiments on long-term reliability of fibrous composites (e.g., aramids, carbon, S-glass, PBO) under high stress in difficult environments. Examples include composite-overwrapped pressure vessels, pressurized hydraulic lines and wind turbine blades. He also models ballistic impact into fibrous materials in support of developing improved materials and architectures for soft body armor and flexible composite panels. In 1983 Phoenix received the Fiber Society Award for Distinguished Achievement in Basic or Applied Fiber Science, and in 1992 he won the ASTM Harold DeWitt Smith Award in fiber mechanics. In 2005 he was awarded the NASA-NESC Engineering Excellence Award for his pressure vessel work in support of the Shuttle’s Return to Flight.

Michael T. Kezirian is an Associate Technical Fellow with the Boeing Company. He has brought extensive experience in composite materials, propulsion systems and system safety to address safety concerns for the Space Shuttle, International Space Station and Commercial Crew CST-100 Starliner Programs. As an Adjunct Associate Professor of Astronautical Engineering at the University of Southern California, he has taught undergraduate and graduate classes in Polymer Science, Spacecraft Dynamics and Safety of Space Systems and Space Missions. He is the founding Editor-in-Chief of the Journal of Space Safety Engineering. Dr. Kezirian is an Associate Fellow of the AIAA and Fellow Member of IAAASS. In 2009 he was awarded the NASA Astronaut Personal Achievement Award (Silver Snoopy).
COURSE AGENDA

Day 1
Afternoon

1. General Introduction
   a. Definitions and Examples
   b. Spherical and Cylindrical COPV architecture and wind patterns
      • Overwrap wind patterns and implications
   c. Overwrap materials (and fiber properties): carbon, Kevlar®, S2-Glass
   d. Liner materials (and properties): aluminum, titanium, Inconel, stainless steel
   e. Manufacturing processes: wet winding, and prepreg, elevated temperature curing
   f. Manufacturing: autofrettage

2. Failure Modes
   a. Liner fatigue (parent material and welds)
   b. Composite Stress Rupture
   c. Collateral damage/impact damage
   d. Liner failure during autofrettage or first pressurization
   e. Liner buckling

3. Standards
   a. NASA Requirements
      • Commercial Crew Requirements (ESMD-CCTSCR-12.10) and flow down to CCT-REQ-1130 and others
      • ISS Visiting Vehicle Requirements (SSP 50808 and 30558/30559)
      • Unmanned Programs
   b. AIAA Standard (S-080, S-081a and future versions)
   c. MIL-STD-1522
   d. Other requirements and standards (ISO, EU, UN)

Day 2
Afternoon

5. Overwrap Design Considerations
   • Considerations for Thick-Walled vs. Thin Walled COPV

6. Winding Pattern Effects
   a. Implications on overwrap shear stress profiles within layers and between layers
   b. Isotensoid and other dome designs in cylindrical pressure vessels
   c. Theoretical models for liner and overwrap response
   d. Shear stress behavior and influence on the liner
   e. Potential for delamination and debonding
   f. Effects of winding pattern on impact damage sensitivity

7. Autofrettage and Proof Testing
   a. Effect on stress state
   b. Role of Bauschinger effect
   c. Connection to buckling risk and fatigue risk

Day 3
Morning

8. Liner Fatigue Modeling
   a. Advanced fracture mechanics approaches, modeling fatigue crack growth (connection to Safe Life and Leak Before Burst concepts)
   b. Description of NASA-developed NASGRO, fracture mechanics and fatigue crack growth analysis software
   c. NDE methods for detecting small cracks and flaws (probabilities of detection)
   d. Strain-life models (Morrow, Fatemi-Socie)
   e. Cyclic stress-strain laws (Ramberg-Osgood)
   f. MLE-based statistical analysis approaches, reliability modeling, test data generation, including size effects, uncertainty

9. Liner Buckling
   a. Mechanical models (including effects of autofrettage)
   b. Bonded vs. unbonded liners
   c. Triggers and methods of prevention
   d. Rippling effects from wrap pattern imprint

Day 3
Afternoon

10. Composite Stress Rupture Phenomena and Reliability Modeling
    a. Background and Definitions
    b. Mechanisms and Micro-Mechanics
    c. Fiber, Tow and Vessel (including sub-scale) Testing
    d. Factors affecting stress rupture and testing
    e. Weibull based probability models
### Day 4

#### Morning

11. **NonDestructive Evaluation – Liner**
   a. Visual (dents, scuff marks)
   b. Dye penetrant methods
   c. X-ray and ultrasonic
   d. Eddy current
   e. Borescope based profilometry

12. **NonDestructive Evaluation – Liner Special Topic Laser Profilometry**

Afternoon

13. **NonDestructive Evaluation – Overwrap**
   Raman Spectroscopy

14. **Mechanical Impact Damage Control**
   a. Purpose
   b. Element of a Damage Control Plan
   c. Failure Consequences
   d. Quantifying Consequences
   e. Threat Assessment
   f. Reporting
   g. Protective Covers

#### Day 5

Morning

15. **Risk to the Public**
   a. Range Safety Approaches
   b. Risk Factors
   c. Failure Consequences
   d. Quantifying Consequences

16. **Micro Meteoroid and Orbital Debris (MMOD)**
   a. The (Un) Natural Environment
      - Measurement
      - Sources
      - Characterization
   b. Modeling
   c. Government Regulations (US and International)
   d. Space Vehicle Protection
      - Thermal expansion coefficients (fibers, liners and COPV)
      - Effects of temperature excursions on overwrap and liner response
   e. Recent Hyper Velocity Impact Experiments on Metallic Pressure Vessels
   f. Implications for Pressure Vessel/COPV operations in Space

17. **Special Topics**
18. **Summary**

---

### Computational Workshop:

Students will be provided the student version of Abaqus FEA (Dassault Systèmes (3DS)) and workbooks on the Wound Composite Modeler (WCM). Results of Abaqus simulations are used throughout the course.

### Computational Workbook A

In this workshop, the user step through the process of generating an axisymmetric model of a COPV and post processing the results using the Wound Composite Modeler (WCM). The model will consist of both helical and hoop layers.

### Computational Workbook B

In this workshop, the user steps through the process of generating a three-dimensional model of a COPV and post processing the results using the WCM.

### Computational Workbook C

The focus of this workshop is the use of the WCM as a COPV design tool. The WCM will be used to gauge the effect of parameters such as wind angle, number of layers, and liner materials on the stresses during operations (changes in COPV pressure).

### Computational Workbook D

This workshop explores the concept of autofrettage. An autofrettage analysis will be performed to demonstrate how tensile stresses in the liner may be reduced in order to extend the fatigue life of a COPV.
QUALITY ASSURANCE (QA) FOR SPACE PROJECTS

Code 006

The Challenges

The course is designed to provide the participant with an understanding of basic principles of Quality Management, Quality Assurance and Quality Control, as they are usually applied to space projects. (The course material copyright is owned by IAASS).

Scope of the course

- The key role of management in setting quality objectives for the organisation, how to establish policy, goals, organisation and allocate responsibilities.
- Key principles of quality control/assurance, and their evolution. Measuring the quality and promoting improvements.
- Formal quality systems. European (ECSS), NASA requirements standards, international standard (ISO).
- The need for a Quality and relationship to contractual QA Plans. Conducting internal and external quality audits.
- Quality in design. Specifications, the V-cycle, support to Projects Reviews.
- Managing the non-conformities resolution process.
- The importance of alerts systems.
- Quality Assurance. Quality records, process control, workmanship standards, traceability, inspections, measuring equipment calibration system.
- Statistical methods in brief.
- Space environment effects on materials. Including materials used in space, requirements and testing, materials evaluation, and process control.

In summary, the participant will acquire an understanding of quality principles, requirements and techniques, and how to apply them for achieving product conformity, customer satisfaction and for increasing productivity.

Target Audience

- Managers and engineers new to quality principles and processes.
- QA managers and engineers with no previous experience in space projects.

What You Will Learn

- Why Quality is important.
- The Quality culture, philosophy and organisation.
- The Quality standards.
- Basic principles and techniques.
- How to satisfy the Customer
- Common mistakes.

How You Will Learn It

- Verbal instructions using Power Point Presentations.
- Videos & Photographs.
- Case studies.
- Group exercises & problem solving.

Why You Need to Know this

- To prepare and implementing cost/effective QA plans
- To understand the significance and procedures of quality assurance.
- To identify and justify resources for implementing a quality system.
- To know what ESA expects from you.
- To convince your management of the benefits.

What You Will Learn

- The course binder with the presentation charts.
- A set of ECSS standards.
- A USB flash drive with all the above.
- A Certificate of Course Completion.

Course Duration

3 days

Instructors

Tommaso Sgobba (ESA Ret. - PA/QA Manager)
# COURSE AGENDA

## DAY 1

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
</tr>
</thead>
<tbody>
<tr>
<td>09:30</td>
<td>Course Introduction</td>
</tr>
<tr>
<td>09:45</td>
<td>General Introduction</td>
</tr>
<tr>
<td></td>
<td>- The space environment</td>
</tr>
<tr>
<td></td>
<td>- Some key concepts in system development</td>
</tr>
<tr>
<td></td>
<td>- Consideration on failures and causes</td>
</tr>
<tr>
<td></td>
<td>- What is Product Assurance?</td>
</tr>
<tr>
<td>11:15</td>
<td>Coffee break</td>
</tr>
<tr>
<td>11:30</td>
<td>Basic concepts</td>
</tr>
<tr>
<td></td>
<td>- What is Quality?</td>
</tr>
<tr>
<td></td>
<td>- Evolution of quality systems</td>
</tr>
<tr>
<td>13:00</td>
<td>Lunch break</td>
</tr>
<tr>
<td>14:00</td>
<td>Basic values and principles</td>
</tr>
<tr>
<td>15:00</td>
<td>Main elements and techniques (Part I)</td>
</tr>
<tr>
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<td>- Organisation</td>
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<td>15:45</td>
<td>Coffee break</td>
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<tr>
<td>16:00</td>
<td>Main elements and techniques (Part I) (Continued)</td>
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<td></td>
<td>- Manual, procedures, plans and records</td>
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## DAY 2

<table>
<thead>
<tr>
<th>Time</th>
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<tbody>
<tr>
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<td>Main elements and techniques (Part I) (Continued)</td>
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<tr>
<td></td>
<td>- Audits</td>
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<td>- Non-conformance control</td>
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<tr>
<td></td>
<td>- Training</td>
</tr>
<tr>
<td></td>
<td>- Qualification/Certifications</td>
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<tr>
<td>10:45</td>
<td>Coffee Break</td>
</tr>
<tr>
<td>11:00</td>
<td>QA standards</td>
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## DAY 3

<table>
<thead>
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<tbody>
<tr>
<td>09:00</td>
<td>QA during major project phases</td>
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<td>10:45</td>
<td>Coffee break</td>
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<tr>
<td>11:00</td>
<td>ECSS-Q-20B</td>
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<tr>
<td>11:30</td>
<td>Special techniques</td>
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<tr>
<td></td>
<td>- Statistical techniques</td>
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<td>12:30</td>
<td>Lunch break</td>
</tr>
<tr>
<td>13:30</td>
<td>Special techniques (Continued)</td>
</tr>
<tr>
<td></td>
<td>- Cost of Quality</td>
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<tr>
<td></td>
<td>- Alert systems</td>
</tr>
<tr>
<td>15:15</td>
<td>Coffee break</td>
</tr>
<tr>
<td>15:30</td>
<td>Audit [Exercise]</td>
</tr>
<tr>
<td>16:45</td>
<td>Space environment effects on materials</td>
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<tr>
<td></td>
<td>- Materials used in space</td>
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<td></td>
<td>- Requirements and testing</td>
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<td></td>
<td>- Evaluation of materials</td>
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<tr>
<td></td>
<td>- Processes for space</td>
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<tr>
<td>17:30</td>
<td>End of QA course</td>
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</tbody>
</table>
CONFIDENTIAL - PERSONAL USE ONLY

CONFIGURATION MANAGEMENT FOR SPACE PROJECTS

Code 007

The Challenges

The course is intended to provide the participant with an understanding of how to conduct the technical-administrative discipline of Configuration Management (CM). The course will be held in two parts. First part will be a generic, common sense approach to CM based on more than three decades of CM experience gained by the instructor. The second part will compare the lessons learned in part one with the ECSS CM standard ECSS-M-ST-40C. The participant will gain an understanding of the principles and procedures applied through CM to space projects; the interdisciplinary activities between CM and other project activities; and will get an idea of CM requirements tailoring for the level of project complexity.

Introduction

The technical-administrative discipline Configuration Management was born in the post WWII era when technical system’s complexity increased. Driver for CM establishment were the US armed forces followed by NASA in the second half of the fifties. CM at these days was all mechanical and electrical oriented and so were the CM practitioners. This proved later on to become a problem when electronics and, in conjunction with this, software started to take more and more share within systems. As software is a non-tangible product, CM procedures had to be rethought.

The next break in CM proceedings was caused by the proliferation of Personal Computer. While configuration status was mainly done by use of file cards for less complex projects, mainframe computer were utilised to manage configuration metadata of bigger systems. Nowadays, almost every CM exercising organization utilizes either tailored off-the-shelf, or self-developed programs for accountability of configurations controlled by them.

Whereas CM for software (and firmware embedded code) at component and unit level has, due to its unique processes, mostly been established as an independent discipline, the battle at the level of software integration with hardware is still going on.

Scope of the Course

This course lectures the five plus one CM functions:

• Configuration Identification
• Configuration Control
• Configuration Status Accounting
• Configuration Verification & Audit
• CM Planning and Organizing
• CM of Digital Product Data

and the principles for implementing these functions.

What You will Learn

• How to structure and document a system.
• How to control the evolution of such a system.
• How to enable the reporting of a certain configuration at a certain point of the product’s life-cycle.
• How to verify that a desired configuration state has been achieved.
• How to plan a CM organization and how to anchor it in contract language.
• How to manage the configuration of digitized product definitions.

Target Audience

• Engineering manager and project engineers involved in spacecraft and launcher development and design.
• Engineers and project staff involved in production planning and control.
• Engineers and technicians responsible for verification of product compliance with documented requirements and design.

Prerequisites

Engineers or technicians with good skills in reading and understanding of technical documentation (specifications, drawings/lists, diagrams).
**How You Will Learn**

- Verbal instructions by use of Power Point presentations.
- Shown samples of configuration controlled documents.
- Shown samples of configuration reports.

**What You Will Take With You**

- A USB flash drive with Power Point presentation
- Certificate of Course Completion

**Instructor**

The course will be taught by Mr. Wolfgang Weiss.

Mr. Weiss has over 35 years of experience in CM matters from big size projects such as the Boeing E-3 “AWACS” to medium size, multi-national missile projects such as the RIM-116 “RAM”, to small projects such as aerospace components.

Mr. Weiss was contracted by ESA in the early 90s for developing an ESA standard CM discipline including a set of 8 ESA PSS type of documents. Due to the switch from ESA PSS to ECSS standards, these PSS’s were not formally released but did provide a sound basis for developing ECSS-M-40A.

Mr. Weiss was co-author of ECSS-M-40A and -40B, participant in authoring of various US military CM and TDM standards of the past, and is voting member of the SAE (formerly EIA, GEIA, TechAmerica) G-33 committee on CM.

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**COURSE AGENDA**

**DAY 1**

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
</tr>
</thead>
<tbody>
<tr>
<td>09:30</td>
<td>Welcome and Course Introduction</td>
</tr>
<tr>
<td>09:45</td>
<td>Configuration Management (CM) Basics</td>
</tr>
<tr>
<td></td>
<td>- Explaining Configuration Management</td>
</tr>
<tr>
<td></td>
<td>- Policy and Principles of CM</td>
</tr>
<tr>
<td>11:00</td>
<td>Coffee Break</td>
</tr>
<tr>
<td>11:20</td>
<td>The five plus one functions of CM</td>
</tr>
<tr>
<td></td>
<td>- Configuration Identification</td>
</tr>
<tr>
<td></td>
<td>- Configuration Control</td>
</tr>
<tr>
<td></td>
<td>- Configuration Status Accounting</td>
</tr>
<tr>
<td></td>
<td>- Configuration Verification &amp; CM Process Audit</td>
</tr>
<tr>
<td>13:00</td>
<td>Lunch Break</td>
</tr>
<tr>
<td>14:00</td>
<td>The five plus one functions of CM (cont’d)</td>
</tr>
<tr>
<td>16:00</td>
<td>Coffee Break</td>
</tr>
<tr>
<td>16:20</td>
<td>The five plus one functions of CM (cont’d)</td>
</tr>
<tr>
<td>17:30</td>
<td>Adjourn</td>
</tr>
</tbody>
</table>

**DAY 2**

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
</tr>
</thead>
<tbody>
<tr>
<td>09:00</td>
<td>CM Planning and Organizing</td>
</tr>
<tr>
<td>11:00</td>
<td>Coffee Break</td>
</tr>
<tr>
<td>11:20</td>
<td>CM of Digital Product Definition Data</td>
</tr>
<tr>
<td>13:00</td>
<td>Lunch Break</td>
</tr>
</tbody>
</table>

**DAY 3**

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
</tr>
</thead>
<tbody>
<tr>
<td>09:00</td>
<td>Space Project CM at ESA</td>
</tr>
<tr>
<td></td>
<td>- Understanding ECSS-M-ST-40</td>
</tr>
<tr>
<td></td>
<td>- Walking through the standard</td>
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<tr>
<td>11:00</td>
<td>Coffee Break</td>
</tr>
<tr>
<td>11:20</td>
<td>Comparing the ECSS requirements with Day 1 lessons</td>
</tr>
<tr>
<td></td>
<td>- Discussing the differences and evaluating them</td>
</tr>
<tr>
<td></td>
<td>- Tailoring to suit the project size and needs</td>
</tr>
<tr>
<td>13:00</td>
<td>Lunch Break</td>
</tr>
<tr>
<td>14:00</td>
<td>Space Project CM at NASA</td>
</tr>
<tr>
<td></td>
<td>- Understanding NASA-STD-0005 and the SAE/EIA-649 Set of Documents</td>
</tr>
<tr>
<td></td>
<td>- Walking through the standards</td>
</tr>
<tr>
<td>15:00</td>
<td>Lunch Break</td>
</tr>
<tr>
<td>16:00</td>
<td>Summary of the CM Course – the lessons learned</td>
</tr>
<tr>
<td>17:00</td>
<td>Adjourn</td>
</tr>
</tbody>
</table>
SPACE DEBRIS: RISK ANALYSIS AND MITIGATION

The Challenges:
The course is designed to provide the participant with an understanding of the orbital debris environment, and of the hazards that space debris represent for spacecraft on orbit and for public on ground. The course explains the regulations for space debris mitigation, ways of compliance, and the application of risk analyses methods and tools.

Scope of the course:
The student will gain an understanding of the following topics:
- Main sources of space debris location in space, orbital lifetime
- Observation means: radar, optical, on-ground or in-orbit, system
- On orbit and reentry risks analysis
- Protection and prevention measures
- Introduction to remediation measures
- Overview of regulations and standards
- On orbit risk analysis models and tools
- Distribution and models for space debris
- How to evaluate probability and consequences of collisions with small and large debris
- Concepts for protection, prevention, remediation and their application
- Process of destructive reentry, risks to people on ground and to airplanes
- How to predict uncontrolled reentries and mitigate the risks
- How to applied international and national regulations, standards and guidelines
- How to find and use main tools for prevention of risks and application of mitigation measures

Target audience:
Design and operations engineers and managers new to space debris risks and mitigation principles, processes and regulations.

What you will learn:
- Definition of space debris, main sources, distribution in space, lifetime, comparison with meteoroid, future evolution
- Definition of risks: in-orbit collisions, atmospheric reentries, other risks
- Observation means: radar, optical, on-ground or in-orbit, system

How you will learn it
- Verbal instructions using PowerPoint presentations
- Videos and photographs
- Cases studies
- Software tools demonstrations

Why you need to know this
- To understand the threat linked with space debris population
- To applied in an efficient way space debris mitigation requirements

What you will take with you
- A USB flash drive with all the above and a set of available standards and practices
- A certificate of course completion
# COURSE AGENDA

## DAY 1

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
</tr>
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<tbody>
<tr>
<td>09:30</td>
<td>Welcome and course introduction</td>
</tr>
<tr>
<td>09:45</td>
<td>General introduction</td>
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<tr>
<td>10:30</td>
<td>Space surveillance</td>
</tr>
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<td>11:00</td>
<td>Coffee break</td>
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<tr>
<td>11:30</td>
<td>Space surveillance (Continued)</td>
</tr>
<tr>
<td>12:00</td>
<td>Risks analysis on orbit</td>
</tr>
<tr>
<td>13:00</td>
<td>Lunch Break</td>
</tr>
<tr>
<td>14:00</td>
<td>Risks analysis on ground</td>
</tr>
<tr>
<td>15:00</td>
<td>Risks mitigation: Protection</td>
</tr>
<tr>
<td>16:00</td>
<td>Coffee break</td>
</tr>
<tr>
<td>16:30</td>
<td>Risks mitigation: Prevention</td>
</tr>
<tr>
<td>17:30</td>
<td>Adjourn</td>
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</table>

## DAY 2

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
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<tbody>
<tr>
<td>09:00</td>
<td>Risks mitigation: Prevention (Continued)</td>
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<td>10:00</td>
<td>Active debris removal</td>
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<td>11:00</td>
<td>Coffee break</td>
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<tr>
<td>11:30</td>
<td>Risk mitigation on ground</td>
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<tr>
<td>12:30</td>
<td>Risk mitigation at launch</td>
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<tr>
<td>13:00</td>
<td>Lunch Break</td>
</tr>
<tr>
<td>14:00</td>
<td>Regulations and standards</td>
</tr>
<tr>
<td>15:30</td>
<td>Models and tools</td>
</tr>
<tr>
<td>16:00</td>
<td>Coffee break</td>
</tr>
<tr>
<td>16:30</td>
<td>Models and tools (Continued)</td>
</tr>
<tr>
<td>17:00</td>
<td>Attendances certificate and end of courses</td>
</tr>
</tbody>
</table>

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**Instructors**

The course will be taught by Fernand Alby and Bruno Lazare.

Mr. **Alby** has devoted most of his career to space debris studies. He was responsible of space debris and space surveillance activities at the French Space Agency (CNES) until his retirement in 2014. His field of work included flight dynamics studies, operations and regulations. He participated to all important committees dealing with space debris such as UN-COPUOS, ISO and IADC. Mr. Alby is Honorary Member of IAASS, and winner of the J. Loftus Space Sustainability Award.

Mr. **Lazare** has over 30 years of experience in the field of space safety and quality management, performing launch and reentry risk analysis, drafting launch safety standards and developing a Launch and reentry risk assessment tool. He participates to several committees dealing with space debris and safety such as UN-COPUOS, IADC, ISO and IAASS.

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The instructors are authors and co-authors of numerous technical papers and reports. They have been major contributors to the drafting of the French Space Operations Act technical regulations.
SOFTWARE SYSTEM SAFETY

The Challenge
The course is designed to provide the participant with an understanding of the application of system safety during software design phases.

Scope of the Course
This course is an integrated combination of system safety and software engineering technology. Some of the material used dates back to 1985 when A-P-T Research, Inc., (APT) conducted some of the first highly successful software safety training. The material has been updated to include the most current techniques and in-depth processes.

Target Audience
Safety professionals interfacing with safety wanting to advance their skill and knowledge in techniques of software system safety.

What You will Learn
This course begins with an overview of mishap risk management and principles of system safety. The Risk Acceptance Matrix is described and illustrated by several examples. Several analytical techniques are presented including Preliminary Hazard Analysis (PHA), Functional Hazard Assessment, Failure Modes and Effects Criticality Analysis (FMECA), and Operational Safety and Hazard Analysis (OSHA). An overview of in-depth techniques such as fault tree and event tree Analyses are also provided. To prepare the student for the software system safety process, an overview of software development is also covered. To set the stage for the Software System Safety (SwSS) process, the course will provide an introduction and review of risk management, system safety, and software development. Following the introduction and review, the course will provide details of the SwSS process, beginning with a discussion of the importance of integrating SwSS activities into the system safety program, the software development activities, and systems engineering activities. The relationship of the software hazard criticality matrix (SHCM) and level of rigor (LOR) to the overall system safety effort will be included, as well as the importance of identification and tracking of safety-significant requirements. Specific analyses and evaluation tools will be discussed and illustrated by examples. Details of the SwSS process will be discussed for each of the software development phases: 1) concept refinement, 2) requirements and architecture development, 3) design and coding, 4) test, validation, and verification, and 5) software release (delivery). The course will also cover developing safety metrics and supporting software safety technical reviews.

How you will learn it
• Verbal instructions using Power Point Presentations
• Group exercises and problem solving

Why you need to know this
• To design your system for safety
• To understand the significance and procedures of the safety process
• To identify resources for implementing system safety including software system safety
• To know what the safety review boards expects from you
• To get safety certification to field

What you will take with you
• The course binder with the presentation charts.
• A Certificate of Course Completion.

Course Duration
3 days

Instructors
T. Delong
M. Pessoney
## Calendar & Venues 2017

<table>
<thead>
<tr>
<th>Code</th>
<th>Frequency</th>
<th>Next course dates</th>
<th>Next course venue</th>
<th>Registration Fee (*)</th>
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<tbody>
<tr>
<td>C001</td>
<td>On-demand</td>
<td>25-26 April 2017</td>
<td>Houston - Texas - USA</td>
<td>$ 1200</td>
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<tr>
<td>C002</td>
<td>Annual (**)</td>
<td>27-30 March 2017</td>
<td>Les Mureaux - France</td>
<td>Not Public</td>
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<tr>
<td>C003</td>
<td>On-demand (**)</td>
<td>16-17 October 2017</td>
<td>Toulouse - France</td>
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<tr>
<td>C004</td>
<td>Annual &amp; On-demand</td>
<td>23-26 May 2017</td>
<td>Kayser Italia&lt;br&gt;Via di Popogna 501&lt;br&gt; Livorno - Italy</td>
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<td>C005</td>
<td>On-demand (**)</td>
<td>9-13 October 2017</td>
<td>Paris - France</td>
<td>€ 1950</td>
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<tr>
<td>C006</td>
<td>Annual &amp; On-demand</td>
<td>26-29 June 2017</td>
<td>Athlone Institute of Technology, Dublin Rd Athlone - Ireland</td>
<td>€ 1550</td>
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<td>C007</td>
<td>Annual &amp; On-demand</td>
<td>TBD</td>
<td>Athlone Institute of Technology, Dublin Rd Athlone - Ireland</td>
<td>€ 1550</td>
</tr>
<tr>
<td>C008</td>
<td>Annual &amp; On-demand</td>
<td>5-6 April 2017</td>
<td>Toulouse - France</td>
<td>€ 1350</td>
</tr>
<tr>
<td>C009</td>
<td>Annual &amp; On-demand</td>
<td>11-13 October 2017</td>
<td>Toulouse - France</td>
<td>€ 1950</td>
</tr>
</tbody>
</table>

(∗) To download Registrations Form and for further information visit:<br>http://iaass.space-safety.org/events/courses/

(∗∗) Restrictions on students attendance from non-NATO countries may apply

## Discount Policy

<table>
<thead>
<tr>
<th>Beneficiary</th>
<th>Discount</th>
<th>Discount Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>IAASS individual member</td>
<td>€/$ 100</td>
<td>Cannot be combined</td>
</tr>
<tr>
<td>IAASS instit./corporate member</td>
<td>€/$ 100</td>
<td>For individual students (cannot be combined)&lt;br&gt;- For a group of 6 students&lt;br&gt;- For each additional student &gt; 6 ≤ 12&lt;br&gt;- For each additional student &gt; 12</td>
</tr>
<tr>
<td>Institutions/Corporations (non-IAASS member)</td>
<td>10%</td>
<td>- For a group of 6 students&lt;br&gt;- For each additional student &gt; 6 ≤ 12&lt;br&gt;- For each additional student &gt; 12</td>
</tr>
<tr>
<td>IAASS members &amp; SGAC members younger than 35 y/o</td>
<td>30%</td>
<td>For individual members (cannot be combined)</td>
</tr>
</tbody>
</table>

NOTE: Institutions and Corporations registering more than 6 student for a course can offer to host the course at their premises. Concurrently they would agree to allow access to external students registered by IAASS up to a maximum of 20 students in total for the course.