Suborbital Safety Technical Committee Guidelines Manual

IAASS
P.O.Box 127
2200 AC Noordwijk
The Netherlands

Formation of SS TC

- Suborbital Safety Technical Committee (SS TC) was formed over 2 years ago (April 2011) as it was decided that suborbital flights have unique characteristics that are not addressed by current Orbital Space Standards or Aviation Regulations
- It was further decided to split the TC into the following 3 Working Groups in order to focus the tasks and make best use of members time and expertise;
  - Regulatory Working Group
  - Technical Working Group
  - Operations Working Group

SS TC Members

- SS TC members have increased – now 21

Christophe Chavagnac (EADS-Astrium)	Amaya Atencia Yepez (GMV)	Andy Quinn (Saturn SMS) – Chair of SS TC
Norul Ridzuan (STS & Spaceport Malaysia)	Chuck Lauer – Rocketplane (Spacelinq)	Joram Verstraeten (NLR-ATSI)
Diane Howard (McGill University – Air & Space Law)	Michael Klicker (techos GmbH)	Carolynne Campbell (Knights Arrow)
Tanya Masson-Zwaan (Deputy Director International Institute of Air & Space Law)	Jean-Bruno Marciacq (EASA)	Alberto Del Bianco (Altec)
Misuzu Onuki (Japan representative)	Christopher Johnson (Glasgow University)	Rafael Moro Aguilar (Orbspace)
Rafael Harillo Gomez-Pastrana (Stardust Consulting)	Melchor Antunano (FAA-CAMI)	Arno Wielders (Space Horizon)
Martin Griffin (Eurocontrol)	Simon Adebola	Thomas Avanzi (S-3)

SS TC Agreement on Initial Guidelines

- At the 5th IAASS Conference, the SS TC agreed to research the following topics and provide guidelines for consideration:
  - Harmonized regulatory framework for suborbital flights
  - Safety Criteria for suborbital flights
  - Software Qualification for suborbital flights
  - Spaceport Safety Management System
  - Flight Crew & Spaceflight Participant Medical & Training

SS TC Workshop

- SS TC Workshop held at GMV facilities in Madrid

Committee	Research & Study	Workshops & Conferences	Publications
Suborbital Safety	Research Suborbital Regulatory aspects concerning harmonization strategy to provide better informed guidelines and standards	**Suborbital Safety TC Workshop, Madrid (GMV) 11 Jan 2013** The purpose of the workshop was to finalize changes and ratify the standards & guidelines produced. 8 members in attendance (from Europe, America and Japan) and 3 members on teleconference	Suborbital Safety TC Harmonized regulatory framework for suborbital flights Standards & Guidelines
	Research Suborbital Technical aspects to provide better informed guidelines and standards		Suborbital Safety TC Safety Criteria Standards & Guidelines
	Research Suborbital Technical aspects to provide better informed guidelines and standards		Suborbital Safety TC Software Safety Standards & Guidelines
	Research Suborbital Operational aspects to provide better informed guidelines and standard		Suborbital Safety TC Spaceport Safety Standards & Guidelines
	Research Suborbital Operational aspects to provide better informed guidelines and standard		Suborbital Safety TC Flight Crew & Spaceflight Participant Medical & Training Standards & Guidelines
		6th IAASS Session 27 – Suborbital Safety Working Group summary of standards & guidelines	Paper on summary of the above 5 standards & guidelines

Summary of Guidelines

REGULATORY WORKING GROUP

Harmonized regulatory framework for suborbital flights

- The purpose is to clarify and promote a **harmonized** regulatory framework for suborbital flights and includes discussions on the Space ‘v’ Air Law route for the emerging industry.
- The objective is to describe the frameworks now in place to regulate suborbital vehicles and flights, to briefly identify the gaps between these, and to offer a practical solution. We recognize that air law controls air space and space law controls space. We seek a harmonized approach to address the situation where a State goes above its sovereign air space with its own vehicle to suborbital space for a brief period of time, 3 – 5 minutes, with no other State’s involvement.

REGULATORY WORKING GROUP

Harmonized regulatory framework for suborbital flights

- The Technical Committee contemplates a formal agreement or handshake between the relative parties after the following three prongs for safety assessment receive approval:
  - 1) suborbital vehicle safe approval;
  - 2) suborbital operator approval; and
  - 3) suborbital flight/launch approval notification

TECHNICAL WORKING GROUP

Safety Criteria

- There is currently no regulatory requirement for an explicit quantitative safety target that form part of explicit safety criteria for suborbital flights to assure the airworthiness/spaceworthiness of the vehicle (*the only FAA-AST requirement is the Ec of $30x10^{-6}$ per mission to protect the public*). The IAASS believes that it is important to set **airworthiness/ spaceworthines guidelines** now (**to assure the lives of those on-board**) even before the first flights and that these guidelines must be based on global opinion from within the safety and airworthiness/spaceworthiness field of expertise.
- These IAASS proposed guidelines are not biased towards the FAA-AST requirements or any European-based requirements; instead the aim is to provide rationalized standards based on existing information and knowledge gained from recognized papers and conferences and industry knowledge.

TECHNICAL WORKING GROUP

- A catastrophic **Safety Target of $1x10^{-4}$ per mission** is considered the **Acceptable Level of Safety** (ALoS) for suborbital flights.

	Severity (Safety Event)				
Likelihood/Probability	Negligible	Minor (Minor Incident)	Major (Major Incident)	Hazardous (Serious Incident)	Catastrophic (Accident)
Frequent $> 10^{-2}$	B	B	A	A	A
Probable 10^{-2} to 10^{-3}	C	B	B	A	A
Occasional 10^{-3} to 10^{-4}	C	C	B	B	A
Remote 10^{-4} to 10^{-5}	C	C	C	B	B
Extremely Remote 10^{-5} to 10^{-6}	C	C	C	C	B
Extremely Improbable $<10^{-6}$	C	C	C	C	C

Operator Accident Risk Matrix with safety target detailed

IAASS
P.O.Box 127
2200 AC Noordwijk
The Netherlands

TECHNICAL WORKING GROUP

Software Qualification

- One of the key aspects for the success of future suborbital flights industry will rely on the QUALITY of the service provided (understanding QUALITY as a synonymous for customer's trust that can be measured in terms of compliance with functional, reliability, safety, robustness or security expectations). Particularly SAFETY, as a system property, must be present from the very beginning of the development life cycle of any suborbital system or component.

TECHNICAL WORKING GROUP

- The guidelines propose software criticality aligned to the severities of the suborbital safety criteria detailed previously

Safety Event Severity	Software Criticality Level	Description	Remarks / Typical System capabilities involved (examples)
Catastrophic	Level SO-A	On-Board Software that causes or contributes to catastrophic hazards in case of failure.	Flight critical systems
Hazardous	Level SO-B	On-Board Software that causes or contributes to critical hazards in case of failure.	
Major	Level SO-C	On-Board Software that causes or contributes to major hazards in case of failure.	Flight management system
Minor	Level SO-D	On-Board Software that causes or contributes to minor hazards in case of failure.	Systems without direct avionics interaction such as: payloads, entertainment systems, etc. (Lack of interaction with more critical (sub)systems will have to be demonstrated)
Negligible	Level SO-E	On-Board Software that cannot contribute to hazards in case of failure or Software that interacts with on-board systems but is operated outside the vehicle (ground systems, maintenance systems, ...) and cannot contribute to hazards in case of failure.	(Lack of interaction with more critical (sub)systems will have to be demonstrated)

OPERATIONS WORKING GROUP

Spaceport Safety Management System

- There are no explicit regulations concerning SMS for Spaceports, however the FAA-AST have stipulated that Spaceports are to obtain an Environmental Assessment (EA). Within the EA there are limited requirements concerning health and safety and handling of rocket propellants however this does not constitute a formal SMS as required of existing airports and hence the IAASS consider that Spaceports should have a formal SMS that is tailored to the requirements of suborbital vehicles and their unique operations.

OPERATIONS WORKING GROUP

- The maximum tolerable probability of the spaceport directly contributing to a catastrophic accident involving a **suborbital vehicle** shall not be greater than **$3x10^{-5}$ per mission** (*This figure is based on 1 catastrophic accident every 10 years for a spaceport with 10 missions each day*). The maximum tolerable probabilities of less severe accidents and incidents shall be derived from this safety target.
- The maximum tolerable probability of any hazardous condition at the spaceport that may cause death or serious injury to the **uninvolved public or supporting personnel** shall be extremely improbable, and shall not be greater than $1x10^{-6}$ per spaceport **operating hour** for an accident at or around the spaceport involving a suborbital vehicle, a rocket, or rocket propellant and resulting in death or serious injury to the uninvolved public or supporting personnel.

OPERATIONS WORKING GROUP

Flight Crew & Participant Medical/Training

- The IAASS considers that the current FAA-AST requirements are not robust for **global suborbital flights** i.e. the requirement is for a Class II Aerospace Medical Certificate (AMC) for pilots – the IAASS guideline is for a Class I AMC
- The IAASS requirements are primarily concerned with applying robust and practical standards for Flight Crew and Space Flight Participants (SFP) in order to (i) ensure the safety of the vehicle such that the flight crew remain in control and are also not hindered by SFPs and (ii) to ensure the physical safety of each crew member and SFP of the flight.

OPERATIONS WORKING GROUP

- The IAASS guidelines specify medical and training requirements (centrifuge, simulators, psychological training etc.)
- Additionally recommends g-suits for pilots and radiation limits:

Population	Normal Annual Exposure	Annual Limit	Career Limit
General Public	1mSv	1mSv	-
Frequent Flyer of Future long distance Suborbital flights (participants)	1-2mSv	2mSv	-
Nuclear Radiation Workers	6-50mSv	20mSv	100mSv (20mSv/yr averaged over 5 years)
Future long distance Suborbital flight (pilots)	7-15mSv	50mSv	-
Suborbital Pilots	**7-15mSv**	**50mSv**	**100mSv**
Orbital - NASA Astronauts	36mSv	500mSv (Blood Forming Organs)	2000mSv + 0.0075 x (Age – 30(male) or 38(female))

SS TC Next Steps

- SS TC Workshop agreed the following areas for research:

Committee	Research & Study	Workshops & Conferences	Publications
Suborbital Safety	Continue to research Suborbital Regulatory aspects concerning harmonization strategy to provide better informed guidelines and standards	Regulatory Working Group teleconferences	Regulatory Framework for non-winged vehicles – guidelines
	Continue to research Suborbital Technical aspects to provide better informed guidelines and standards	Technical Working Group teleconferences	Guidelines for: -Hardware Safety & System Requirements -Software System Requirements -Safety Factors for Structures -Large scaled pressurized structures
	Continue to research Suborbital Operational aspects to provide better informed guidelines and standards	Operational Working Group teleconferences	Guidelines for: -Suborbital Flight Air Traffic Management Integration/Co-ordination

SS TC Next Steps

- SS TC guidelines disposition:
  - Incorporate into Suborbital Safety Guidance Manual – Issue 1 (Apr 2014 with IAASS Board approval)
  - Provide as industry guidelines to ICAO for consideration
  - Provide to existing and future regulators
  - Provide to existing and future designers and operators
  - Update to Issue 2 (Oct 2014)
    - Additional guidance material per previous slide
  - Update every 18 months (new guidance plus update current guidance based on industry best practice or lessons learned

Questions?

IAASS
P.O.Box 127
2200 AC Noordwijk
The Netherlands