Medical Issues for Commercial Suborbital Space Flight Crewmembers

Aerospace Medical Association

Commercial Space Flight Working Group

Medical Issues for Commercial Suborbital Space Flight Crewmembers

Working Group was formed at the request of the AsMA in May 2009
Issued final report in December 2010
Peer reviewed and approved by the AsMA Council (30 members)
Published in Aviation Space Environmental Journal in April 2011
Aviat Space Environ Med 2011; 82:475 - 84.
Working Group Composition -26 Individuals
14 Aerospace medical professionals
3 Astronauts
1 Lawyer
2 NASA, 4 Wyle
2 FAA
8 Academic
7 Commercial Spaceflight Industry

Previous Studies – Commercial Orbital Space Flight Participants

- AsMA Task Force on Space Travel. Medical Guidelines for Space Passengers. ASEM 72:948-950. 2001.

- Position Paper on Medical Safety and Liability Issues for Short-Duration Commercial Orbital Space Flights .IAA. 2009.

Previous Studies – Commercial Suborbital Space Flight Participants

- AsMA Task Force on Space Travel. Medical Guidelines for Space Passengers -II. ASEM 73:1132-1134. 2002.

- Guidance for Medical Screening of Commercial Aerospace Passengers" FAA. 2006.

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- AsMA Ad Hoc Committee. Medical Certification for Pilots of Commercial Suborbital Space Flights. ASEM 80: 824-826. 2009.

Design Reference Mission Virgin Galactic -SpaceShipTwo Profile

Two pilots, six passengers. Total mission duration 150 mins.
Pressurized cabin. 21% O2
Horizontal launch at 50,000 ft
70 sec - Gx 3.8g boost to apogee of 360,0000 ft
4 minutes of 0g with restrained pilots and unrestrained passengers
Re-entry 6.0 Gx for passengers but 6.0 Gz for pilots (short duration)
Glide beginning at 80,000 ft for 30 mins with pilot controlled unpowered landing

Operational Suborbital Space Flight Experience Limited

Mercury-Redstone - 1961

MR-3

MR-4 Loss of capsule on recovery

X-15 – 1963

199 flights, but only 2 flights above 100 km

Soyuz 18a - 1975

Inadvertent on abort during launch

SpaceShipOne – 2004

Three flights above 100 km

Vehicle	Suborbital trajectory	Altitude > 60,000 ft	Altitude > 50 miles	Altitude > 100 km
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NF-104A	302	302	0	0
X-15 (XLR-99)	146	143	13	2
Trident II	100	98	0	0
Trident IISE	96	94	0	0
F-84G ZELMAL	28	0	0	0
X-15 (XLR-11)	28	8	0	0
SM-30 ZELL	26	0	0	0
Trident I	25	0	0	0
X-24B	24	17	0	0
X-15A2	22	21	0	0
M2-F3	22	22	0	0
HL-10	20	14	0	0
X-24A	18	9	0	0
F-100D ZEL	18	0	0	0
X-2	13	8	0	0
F-104G ZLL	13	0	0	0
SpaceShipOne	6	6	3	3
Mercury	2	2	2	2
Ba 349 Natter	1	0	0	0
Soyuz 18a	1	1	1	1

Total	911	745	19	8

X-15 Program

Total of 199 Flights 1961-1968
Only two flights above 100 km altitude
Flight 191 – 1967 - Only fatality (Michael Adams)
- **Vertigo**
- **Spatial disorientation**
- **Panel misinterpetation**
- **Distraction / Work overload**

Medical Issues

Acceleration/Weightlessness

+Gx – Launch

0-G for four minutes

+Gx or +Gz – Entry

Rapid Acceleration-0g-Deceleration Profile

- Push-Pull Effect

- Little operational experience

- Can not be simulated

Medical Issues

Cardiovascular

- Launch has 4-6 +Gx
- Acceleration-0G-Deceleration
- Entry has 6 +Gz

Neurovestibular

- Vertigo
- Spatial disorientation
- Pilot performance

Space Motion Sickness

Entry Sickness

Post-Flight Medical Problems

- Multiple flights per day

Environmental Issues

Space Craft Cabin

- **Temp/Pressure/Humidity**
- **Composition – O_2, CO_2**

Pressure Suit use advantages

Ionizing Radiation

Noise

Vibration

Concerns

- Minimal operational experience with suborbital flights above 100 km
- X-15 Program fatality
- Rapid acceleration – weightlessness - deceleration effect
  - Push-pull effect described by high performance fighter pilots
  - Minimal experience
  - Cannot be simulated

Conclusions

FAA First Class Certification
Pre-Flight Medical Evaluation (esp. early flights)
Post-Flight Medical Debriefs (esp. early flights)
Independent data repository of medical data for analysis
Periodic re-evaluation of medical standards

Conclusions - Training

Emergency egress training
Physiologic (altitude chamber)
training to recognize hypoxia and depressurization
Centrifuge or other G training
Parabolic flight (acceleration-weightlessness-deceleration)

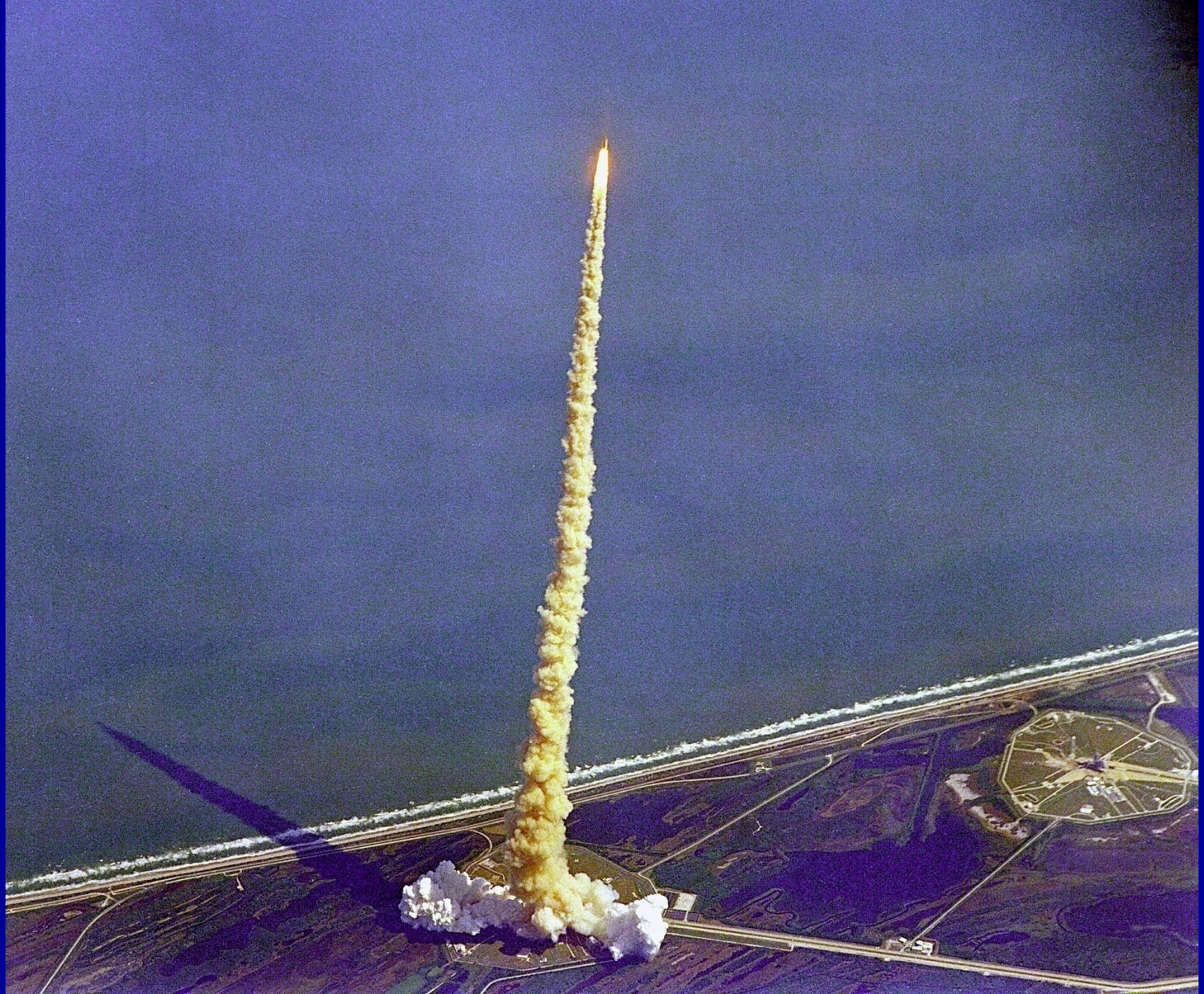
Conclusions – In-Flight Equipment

Passive ionizing radiation dosimetry
Auditory protection (helmet/headset)
Anti-G Suit (esp. early flights)
Pressure Suit

- **Tremendous controversy**
  - **Weight, expense, thermal loading, and decreased pilot performance**
  - **No redundancy for depressurization**
- **Soyuz 11**
- **Pre-Challenger Shuttle**

Conclusion

- **Further investigation should be conducted on the effects on pilot performance from the rapid changes in the acceleration - microgravity - entry deceleration flight profile as this can not be simulated or trained for and there is little operational experience. Especially of concern is the impact on an individual involved with repetitive flights. Current data suggests that this may be well tolerated, but only actual flight experience will show if this is actually true.**



Medical Issues for Commercial Suborbital Space Flight

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