



Section 13
System Safety & Mission Assurance
Keith Jaquillard, HEI
Ken Zander, QS

STS-107 Fundamental Biology Project
NASA Ames Research Center



ARC SS&MA



Objectives of the SS&MA Activity

- 1. Ensure the Ames hardware/software and related procedures meet the applicable SS&MA requirements to support flight certification**
- 2. Provide SS&MA support to ESA for Phorbol Science at Principal Investigator labs and at phased safety reviews as requested**
- 3. Provide support to SPACEHAB SS&MA in phased safety reviews**



ARC SS&MA



Applicable Requirements

NSTS 1700.7B	Safety Policy and Requirements for Payloads Using the Space Transportation System
NSTS 13830C	Payload Safety Review and Data Submittal Requirements
NSTS/ISS 18798	Interpretation of NSTS/ISS Payload Safety Requirements
KHB 1700.7C	Safety Policy and Requirements for Payloads Using the Space Transportation System
NASA-STD-3000B	Man-Systems Integration Standards
MDC 91W5023H	SPACEHAB Experiment Interface Definition Document
LLIS	NASA Lessons Learned Information System (http://llis.gsfc.nasa.gov/)
JA-276B	Payload Mission Manager Interface Safety Verification Requirements for Instrument, Facilities, MPE & ECE on STS Orbiter Middeck Payload Missions
ISO 53.QS.0008	SS & MA Support to Projects
QS-TR-2020	STS-107 Risk Management Plan (draft)
QS-TR-2021	STS-107 SS & MA Plan (draft)



Safety Strategy & Status: ESA Phorbol Science

- **Safety Reviews**
 - **ESA serves as safety integrator; ARC provides safety “chapters”**
 - **ESA coordinates with SPACEHAB**
 - **No current request for ARC support**

- **Phase II Flight Safety Data Chapter completed (2/00)**
 - **4 unique hazards identified**
 - **Catastrophic Release of toxic chemicals (formaldehyde)**
 - **Critical Release of toxic chemicals**
 - **Critical Release of biologicals (*Pseudomonas*)**
 - **Critical Release of non-toxic fluids (water, media)**

- **Phase II Ground chemical safety data provided, as requested (3/00)**
- **Phase III - no input requested to date**



Safety Strategy & Status: FRESH-02

Data Package Development

Must align with SPACEHAB Integrated Delta Phase II Flight Safety Review (June TBD) - originally planned an interim Ames-only review

Flight

- **Phase II Flight Safety Data Package completed 3/00**
 - **Safety critical design, data, test & analysis requirements identified**
 - **Project to conduct a splinter prior to the Safety Review**
 - **Provide updated tests/analyses/verification closure**
 - **Some hazards may be at Phase I maturity**
- **Phase III Flight**
 - **Quick turn-around following Phase II review (< 1 week)**
 - **Work on Phase III in progress**

Ground

- **Phase II Ground Safety Data Package completed 4/00**
 - **Safety & ground processing - independent of SPACEHAB**
- **Phase III Ground Safety Data Package - due 7/00**



Safety Strategy & Status: FRESH-02, con't

Animal Enclosure Module - Treated as Series/Reflown with Modifications

- **AEM Unit - Series Hardware**
 - **No new/revised hazards identified**

- **Muffler - Reflown Hardware (no modifications)**
 - **No new/revised hazards identified**

- **CO₂ Manifold Assembly - New Addition**
 - **No structural impact to AEM identified**
 - **No new hazards confirmed (asphyxiation & overpressure being evaluated)**

- **CO₂ Storage & Umbilical Assembly - New Addition**
 - **3 unique hazards identified**
 - **Catastrophic High Pressure ~ 852 psig cylinder**
 - **Critical Low Touch Temperature (< 4° C / 39° F bare handed)**
 - **Critical Unrestrained Objects (cylinder mated to AEM)**



Safety Strategy & Status: FRESH-02, cont'd

Inflight Refill Unit - Series/Modified Hardware

- **Includes accessories - will be modified**
- **No new/revised hazards identified to date**



Additional Safety / Human Factors Considerations (NASA-STD-3000B)

AEM, CO₂ & IRU

- Quick Disconnect
 - Grip size & strength for the 5th percentile female to 95th percentile male
 - Mating
 - Positive indication of QD mating
 - Visual
 - Tactile (e.g., knurled surface)
 - Sharp edges, pinch points
- Pressure Orifice
 - Positive on/off indication (position, labeling)
 - Handle protection from inadvertent actuation & kick-off loads
 - Force/restriction for the 5th percentile female to 95th percentile male
- Packaging & Handling configuration of the CO₂ stowage
 - Designed for single crew transfer - one handed goal
 - Handle or grip



Safety Concerns

- **Potential CO₂ asphyxiant risk in SPACEHAB**
 - **Asphyxiant hazard being evaluated**
 - **STS scrubbers thought to be adequate, pending SPACEHAB direction**
- **Unknown effects of CO₂ on seals & limited life items within AEM (being evaluated)**
- **Rapid safing / penetration from unstowed hardware (IRU & ACOS) (being evaluated against safety interpretation letter MA2-96-190)**



Verification

FRESH-02

- **Safety verification requirements have been provided to engineering via hazard reports**
- **Unique hazard data will be flowed into the verification plan**
- **(via unique Verification Requirement Data Sheets)**

ESA/Phorbol

- **ESA is responsible for the verification plan**
- **Safety verifications identified on hazard reports**



Quality Assurance

Quality Assurance function will be performed in accordance with the STS-107 SS&MA Plan

ISO Work Instruction - 53.QS.0008, *SS&MA Support to Projects*, includes:

- **Chair Material Review Board**
- **Identify inspection points**
- **Review drawings**
- **Support design reviews**
- **Approve final as-built hardware**
- **Verify all Non-Conformance Reports (NCR) are closed before flight**

Quality Assurance will support the following safety tests:

- **AEM - CO₂ thermal test; CO₂ discharge & pressure test**
- **IRU, standard reverification anticipated**
- **ESA Phorbol, e.g., leak test**