ISS BIO mission experiments integrated safety

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Introduction

- Payload safety
  - Regards payload as stand alone item
  - Zooms in on equipment design
- Integrated safety
  - Regards combination of equipment
  - Zooms out on multiple combined items
  - Particular interest on interfaces

Combination of equipment

Zooming out

Looking into interfaces

BIO missions

PGB

KUBIK

Soft Pouches

10 day mission

Soyuz

KUBIK

Soft Pouches

BIOKIT

Soyuz

BIO missions Integrated safety

- Process
  - Identical to payload safety process
  - Only phase III review
    - Up to date details of experiment available
    - Close cooperation with experiment PO necessary
  - At the same time as the experiment phase III
    - Directly after experiment review
    - Maximize cross reference of experiment review
    - Minimize schedule impact

BIO missions Integrated safety

- Systematic assessment
  - Mechanical interfaces
  - Material hazards
  - Electrical hazards
  - Stored energy
  - Thermal hazards
  - Release of hazardous materials
  - Crew operational procedures
  - Unique hazards
  - Standardized hazards (1230)

BIO missions Integrated safety

- Mechanical interfaces
  - Mostly covered in experiment SDP when launched in soft pouch
  - BIO-3 experiment BIOKIN-4 launched inside KUBIK
  - BIO-4 XENOPUS and KIP operational configuration

BIO missions Integrated safety

- Material Hazards
- Toxic offgassing
  - Sufficiently covered in experiment SDP
- Flammability
  - Inside volume like KUBIK or PGB
  - Material control by experiment design
  - Ignition source covered by experiment and facility design
  - Fire propagation assessed in integrated assessment
  - Detection and suppression as defined for facility

BIO missions Integrated safety

- Electrical hazards
  - Power interface compatibility
    - Circuit protection
    - Surge current
    - Capacitive load
  - Mating/demating powered connectors
  - Radiated Emission
    - Integrated EMC assessment

BIO missions Integrated safety

- Stored energy
  - Compressed springs
    - Sufficiently addressed in individual SDP
  - Rotating equipment
    - Experiments integrated in KUBIK centrifuge
  - Batteries
    - Experiment and facility batteries

BIO missions Integrated safety

- Thermal hazards
  - Overheating
    - Assess experiment compatibility with facility thermal capability
  - Touch temperature
    - Worst case single failure assessment integrated KUBIK
    - MELFI covered by MELFI controls

BIO missions Integrated safety

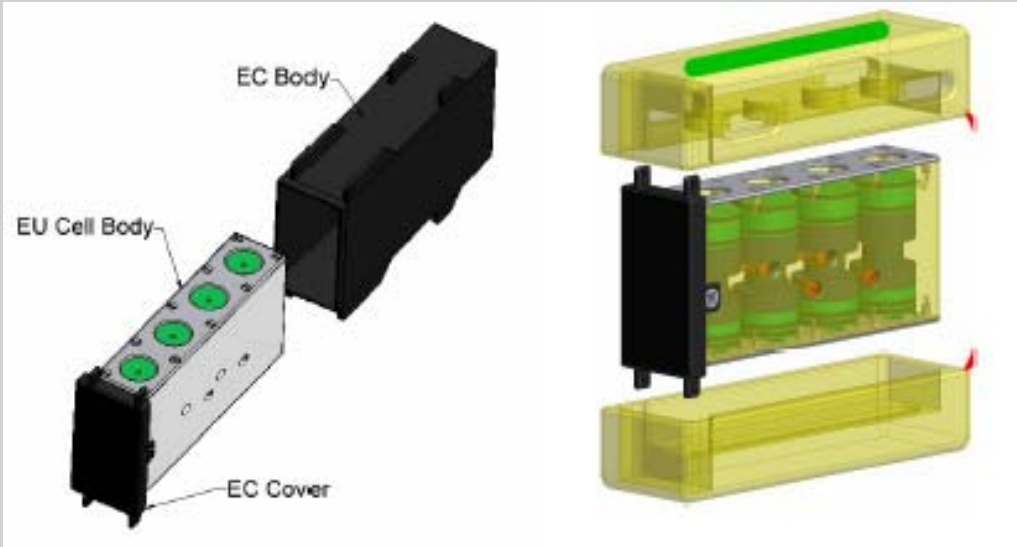
- Release of hazardous materials
  - Integrated PGB and experiment assessment
    - Levels of containment assessment
    - Material compatibility with
      - Seal and glove material
      - Filter capability (including liquid absorber if necessary)
    - Cleanup procedure
      - Cleanup kit to be available
      - Crew procedure to direct set-up inside PGB (cleanup kit, liquid absorber)
      - Assessment to clean up PGB internal air

BIO missions Integrated safety

- Release of hazardous materials
  - BIO-2 LEUKIN
    - LEU-M plunger operated by special tool
    - LEU-L injection by dispenser
      - Complex operational procedure
      - Detailed assessment of LOC

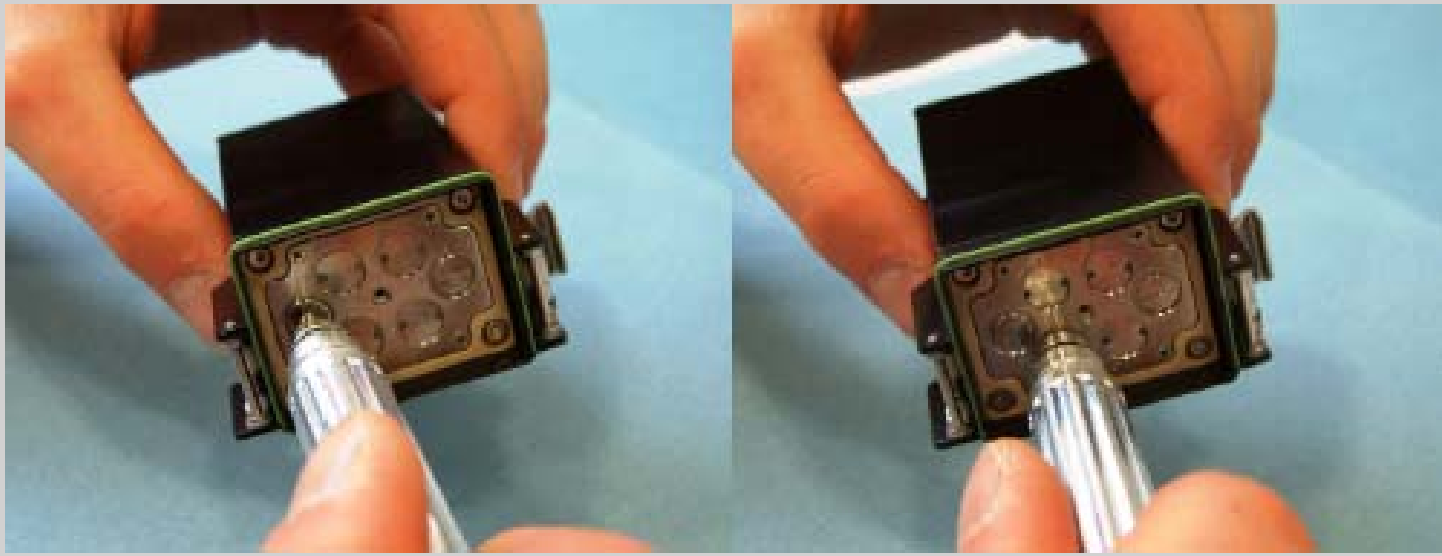
BIO missions Integrated safety

- Release of hazardous materials
  - BIO-3 PKINASE
    - Retraction of experiment body from EC
    - Application of special tool



BIO missions Integrated safety

- Release of hazardous materials
  - BIO-3 AT-SPACE
    - Removal of EC cover
    - Application of special tool



BIO missions Integrated safety

- Crew operational controls
  - Identification of controls called out in facility hazard report affecting experiment procedures
    - Experiment leakage requires procedure to bring experiment in safe configuration prior to cleanup
    - KUBIK and/or PGB configuration set-up to be documented in operational crew procedure

BIO missions Integrated safety

- Unique hazards
  - Resulting from assessment of integrated configuration and operations
  - Experiment sharp edges inside PGB

BIO missions Integrated safety

- Standardized hazards hazards
  - Assessment according 1230 form

Looking to the future

- ISS
  - Well defined operational scenarios
  - Relative short time to communicate and upload hardware
- Moon and Mars
  - Less pre-defined scenarios
  - More difficult communication
  - Limited or no possibility to upload equipment
- Challenges
  - Assessment of the complete mission may not be possible prior to mission start
  - An adopted way to assess safety needs to be defined
  - Crew needs to be involved in detail