Lessons learned from launching university satellite projects ~Safety requirements~

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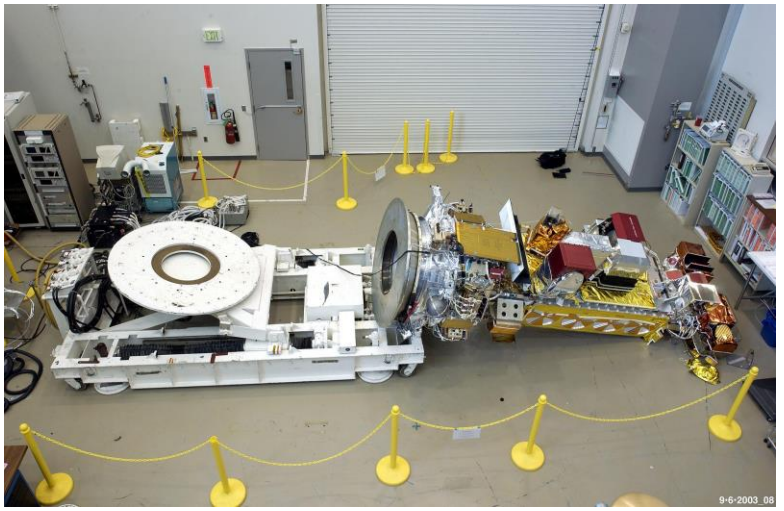
4th UNISEC Global

Accidents

Antares launch failure

http://www.nasa.gov/sites/default/files/thumbnails/image/launch-pad-looking-south-after-failure.jpg

NOAA-19



https://en.wikipedia.org/wiki/NOAA-19#/media/File:NOAA-N%27_accident.jpg

SOYUZ-11

https://astronomiayfilatelia.files.wordpress.com/2012/04/accidentes0004m.jpg

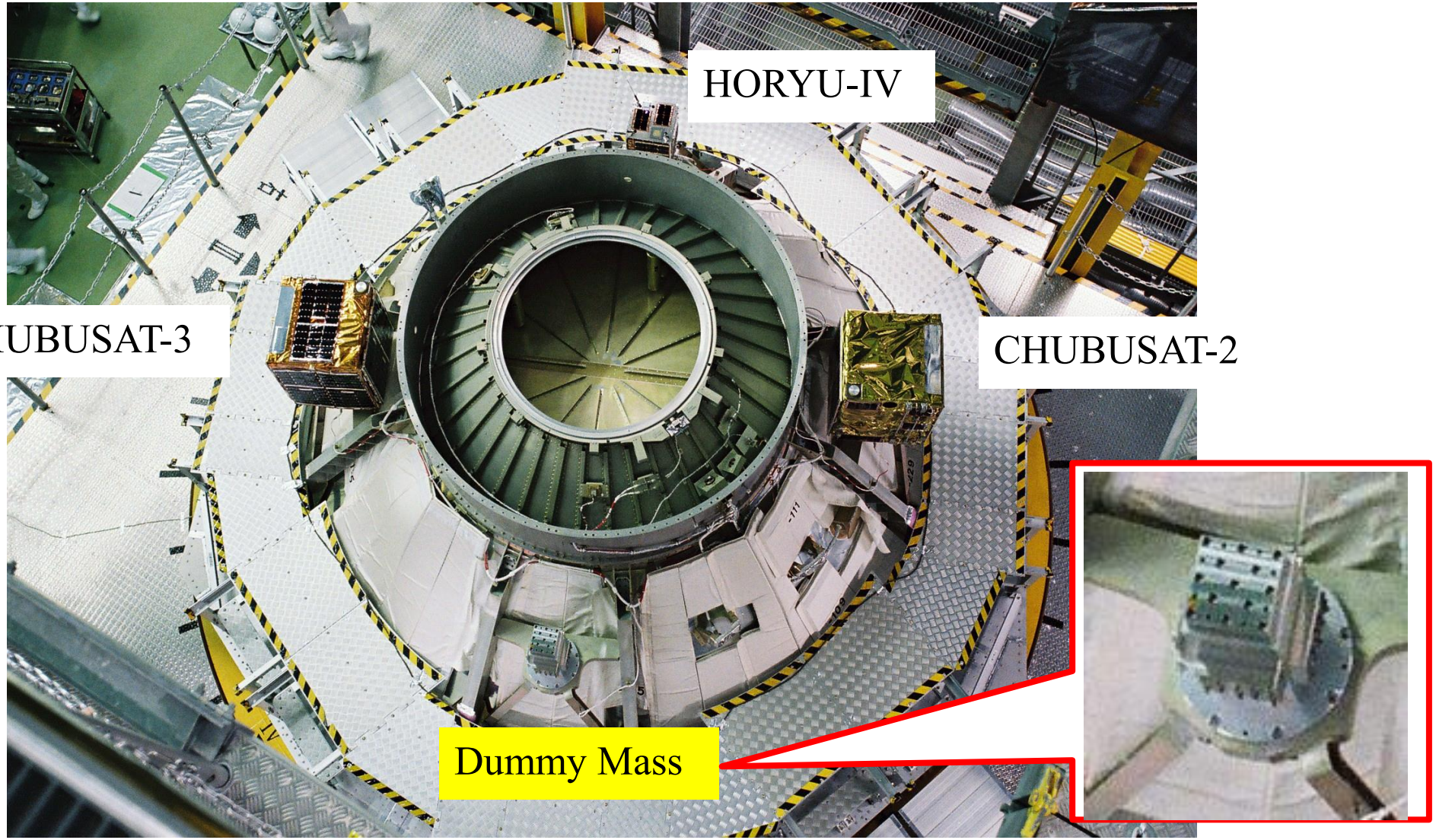
Columbia

http://www.dallasnews.com/incoming/20130130-us-space-colombia_5331661.jpg.ece/BINARY/original/US-SPACE-COLOMBIA_5331661.JPG

What is safety requirement

- Safety
  - To human (ground personnel, flight crew, yourself, etc)
  - To system (launch vehicle, ISS, launch site, etc.)
  - To environments (ground, space, etc.)
- Requirement
  - Things you have to comply with
  - Compliance must be verified with documents
- Verification
  - Prove the system was built right in compliance with the requirements

Safety is requirement. If you fail to comply,



http://jda-strm.tksc.jaxa.jp/archive/photo/P100010489/5590ac570abed216cfe9acfe71681338.jpg

Piggy-back satellites on H2A-F30 (2016)

Safety basics

- Hazard
  - Item that may injure somebody, damage something or contaminate environment
  - Categorized into several levels depending on severity
    I. Catastrophic
       - Death or severe injury, System loss, Grave impact to environment

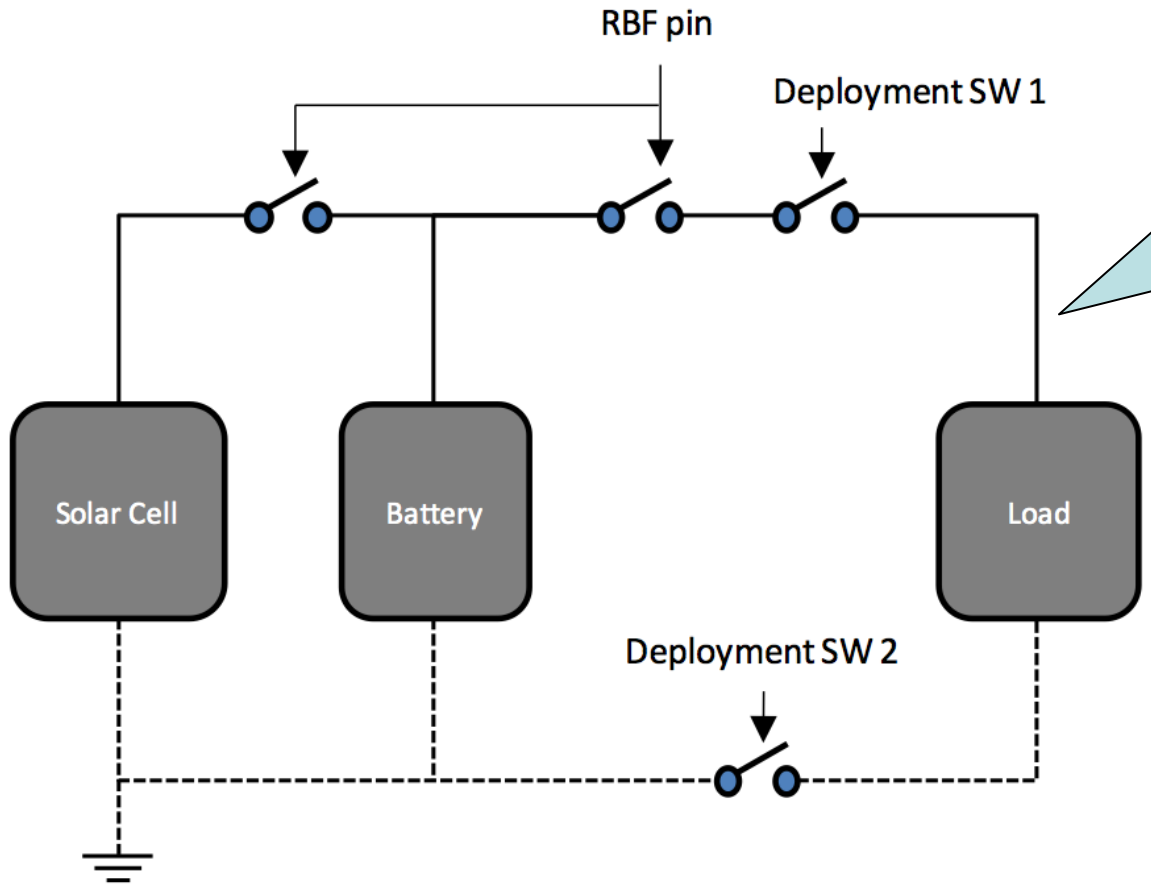
    II. Critical

    III. Marginal

    IV. Negligible
  - Hazard items identified as “Catastrophic” must be prevented by 3 inhibits (2 fault tolerant)

Catastrophic hazards

- Even if two prevention mechanism fails, the hazard must be prevented



3 switches in series prevent accidental turn-on of the load during launch

Figure 2.2.1-2 Example of two Deployment Switches and the RBF pin Arrangement

Safety basics

- Likeliness
  - Each hazard item has its own likeliness
    A. Frequent (Likely to occur immediately)
    B. Probable (Probably will occur in time)
    C. Occasional (May occur in time)
    D. Remote (Unlikely to occur)
    E. Improbable (Improbable to occur)

Hazard analysis

		Likeliness				
		A	B	C	D	E
severity	I					
	II					
	III					
	IV					

Need to write hazard reports

Documentations

- Each safety review requires tons of documents
  - Need to be traceable by documents
- Document package must be submitted well before each review (1 month in advance)
  - Many interactions between the satellite developer and the launch provider before the review

Tips

- Items that often become a safety concern
  - Battery
  - Deployment mechanisms (antenna, boom, membrane, etc.)
  - Cold launch
  - Radio emission delay after satellite separation or release
  - Structural integrity and fracture of external parts (solar cell glass)
- Be imaginative about safety risks