

Lessons learned from launching university satellite projects ~Safety requirements~



La SEINE

Mengu Cho

Laboratory of Spacecraft Environment Interaction Engineering

Kyushu Institute of Technology

Kitakyushu, Japan

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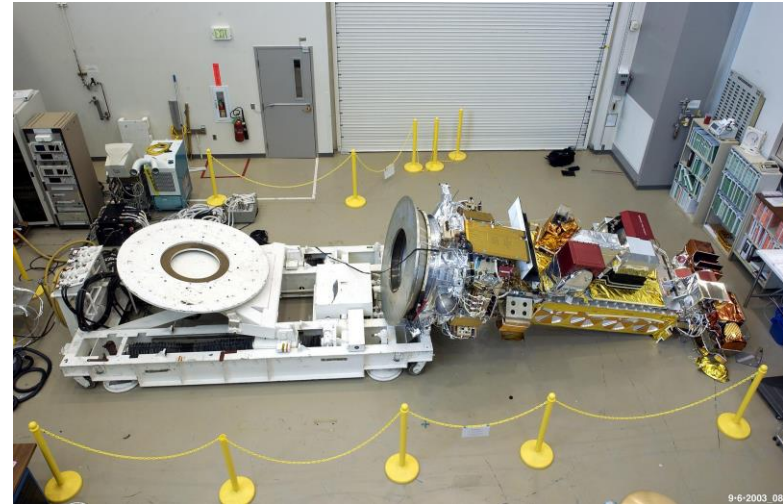
Accidents

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

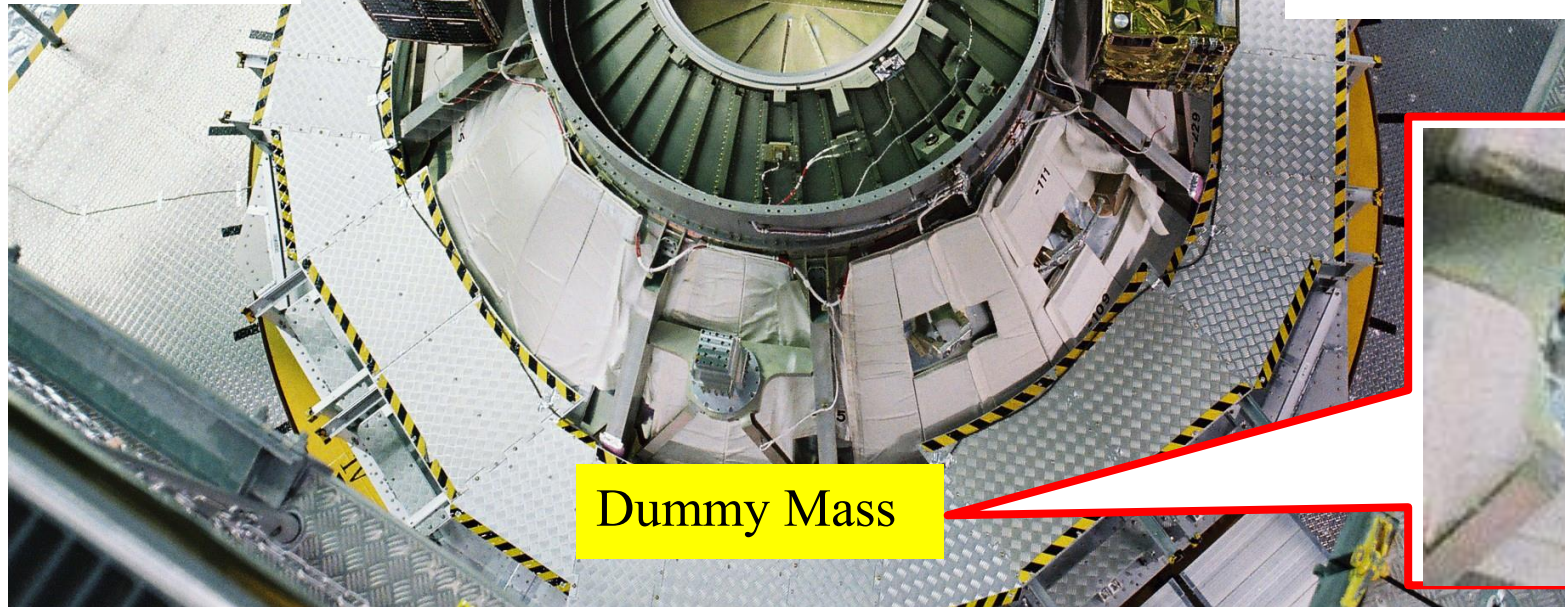


http://www.dallasnews.com/incoming/20130130-us-space-columbia_5331661.jpg.ece/BINARY/original/US-SPACE-COLOMBIA_5331661.JPG

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

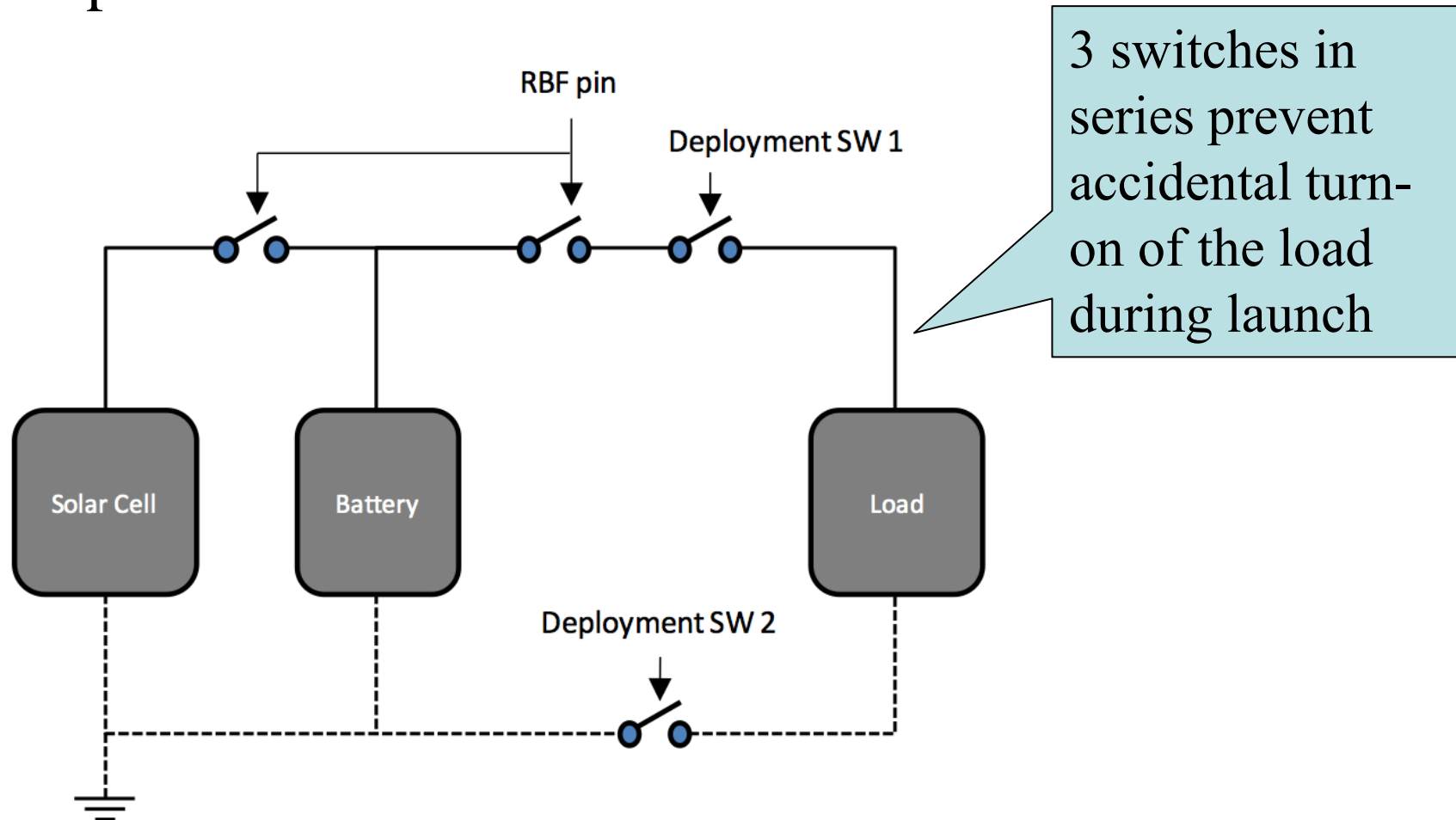


Figure 2.2.1-2 Example of two Deployment Switches and the RBF pin Arrangement

Safety basics

- Likelihood
 - Each hazard item has its own likelihood
 - 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

		Likelihood				
		A	B	C	D	E
severity	I	Red	Red	Red	Yellow	Green
	II	Red	Red	Yellow	Green	Green
	III	Red	Yellow	Green	Green	Green
	IV	Green	Green	Green	Green	Green



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