Standards and Regulations

(and you!)

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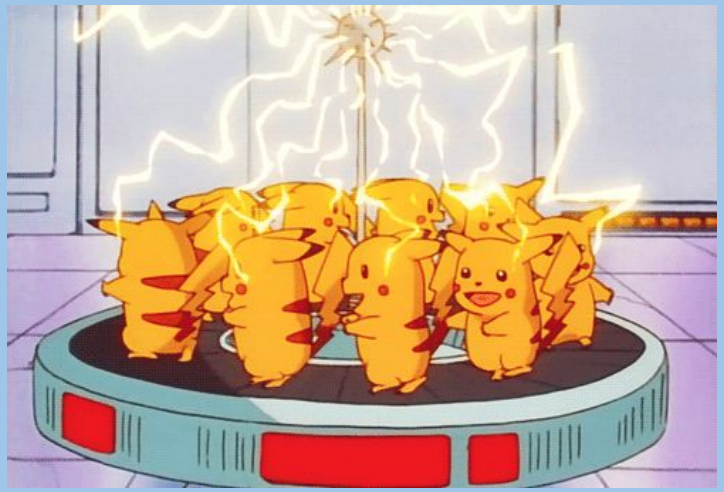
Team B: Arcus

NASA HandBook 4002a

Mitigating In-Space Charging Effects

What is it??

- Spacecraft charging is defined as the buildup of charge in and on spacecraft materials
- Charge buildup can lead to electrostatic discharge which can damage electronic systems



How does it happen?

- Free electrons at varying energies get embedded in materials at different rates
- Eventually differences in charge in different surfaces start to emerge
- This eventually causes a discharge which can induce high currents and damage electronic circuits

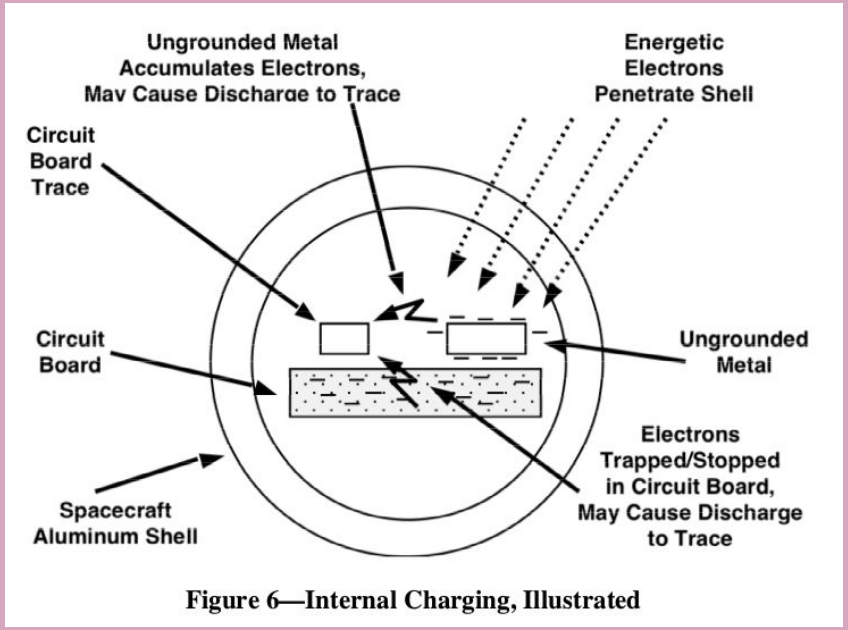
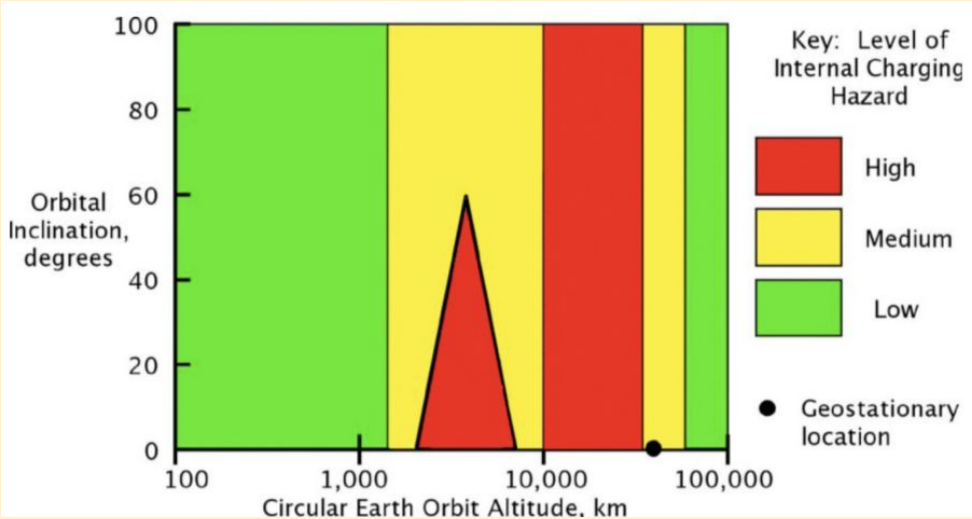
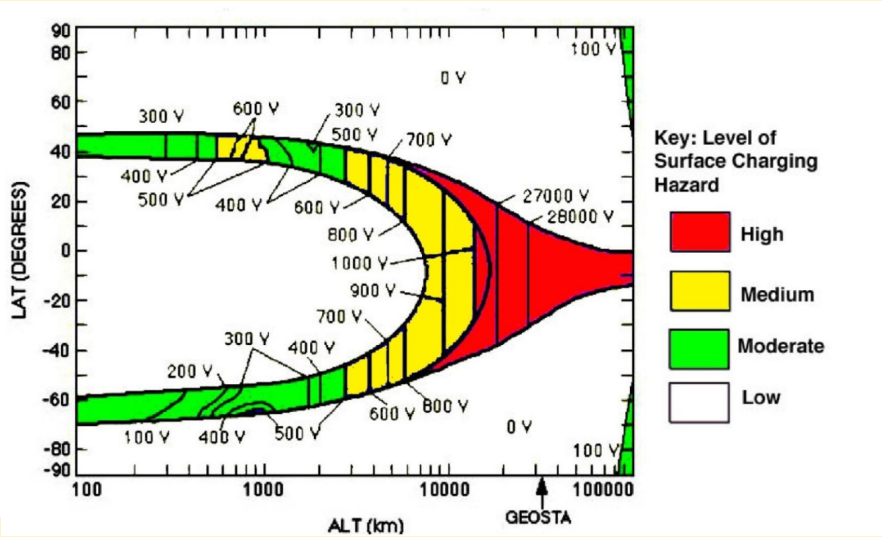


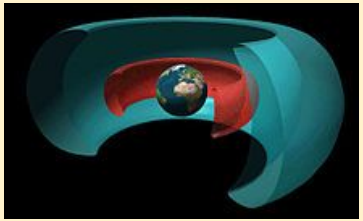
Figure 6—Internal Charging, Illustrated

Where does it happen?

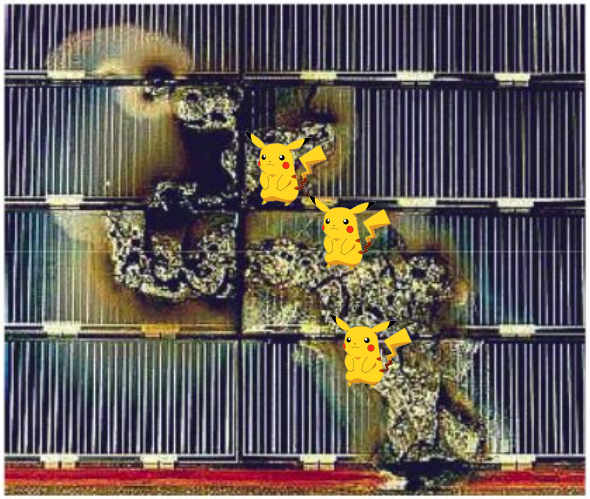




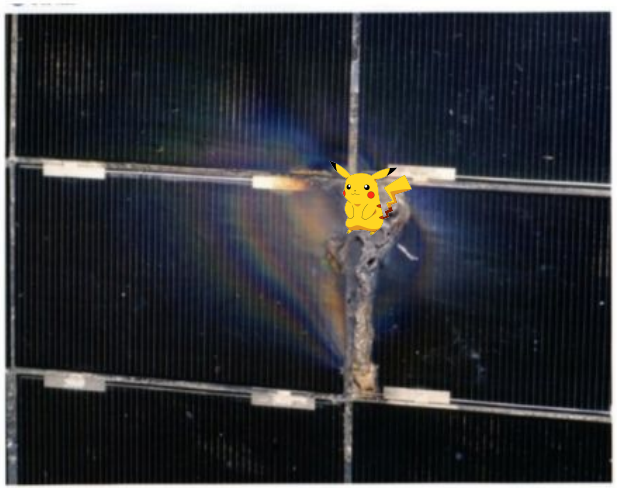
- Risk of ESD is everywhere but plasma measuring equipment have determined risky orbital parameters.
- Van Allen Radiation Belt



Why is it important?



(a) Failure caused by in-flight ESD arcing

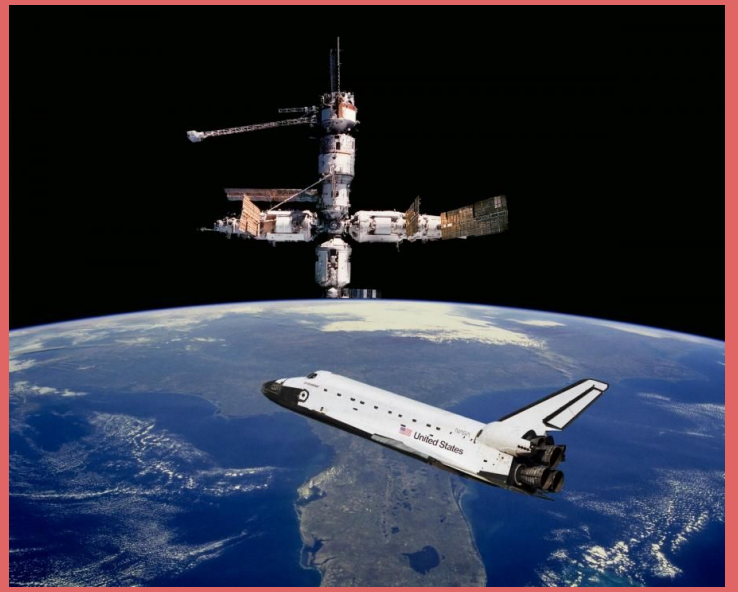


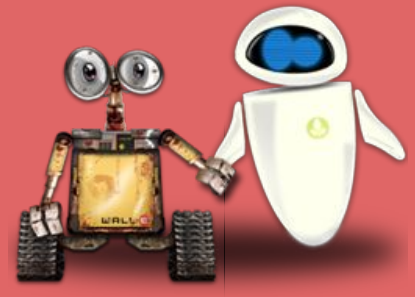
(b) Failure caused by ground ESD arcing

- ESD can cause rapid deterioration if all electronics are not carefully designed to minimize risk.

Who needs it?

- Spaceships
- Satellites
- Spacecrafts in geosynchronous (GEO) or interplanetary orbits
- Spacecrafts in certain Earth/other planetary environments
- Any system with a floating ground (i.e. many robots)

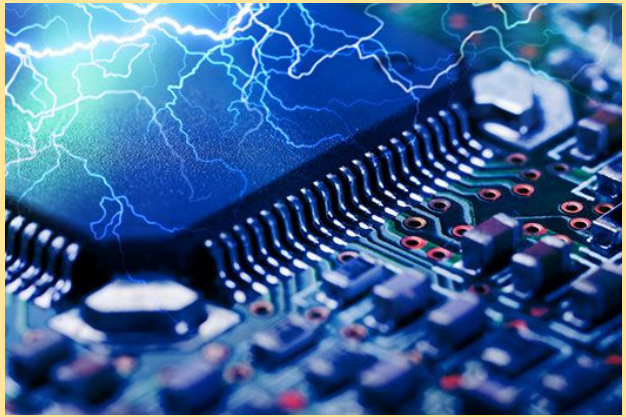




What does it say?

Goal: Mitigate any charging threats in an environment that a spacecraft passes through or stays in

- Determine target, source, and coupling in electrical charge issues
- Design guidelines
  - General
  - Surface Charging
  - Internal Charging
  - Solar Arrays
  - Special Situations



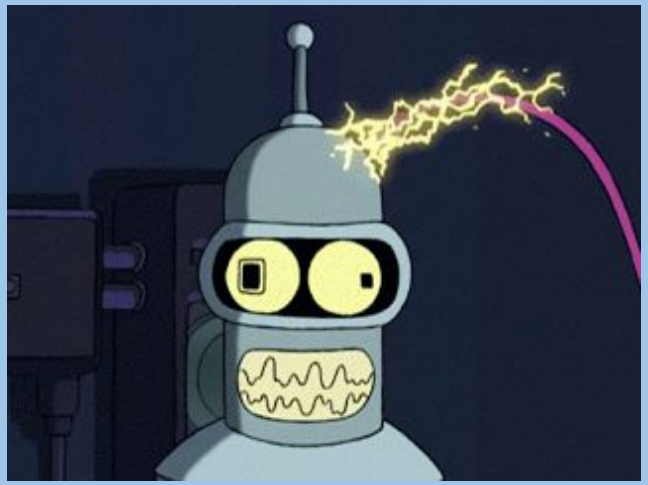
What does it say?

In general...

- Shielding
  - Electrically-shielded with 110-200 mil aluminum-equivalent shielding
  - Shield in Faraday Cage
  - Cables outside cage must be shielded
- Grounding
  - All spacecraft surface materials are conductive and grounded
  - Handling, assembly, inspection, and test procedures for electrical continuity
- Filter wires inside Faraday cages
- Use leaky dielectrics and grounded metal on circuit boards

Why does Arcus need it?

- Arcus' end goal is to operate in extraterrestrial environments. These environments include a wide variety of conditions pertinent to ESD
- All of its obstacle flight and navigations systems on one board
- If board resets or goes offline, UAV is completely incapable of continuing its mission



FAA Small UAS Rule (Part 107)

What is it??

- First FAA document formally outlining the regulations for unmanned air systems (UAS) for commercial (and research) use

- Includes limitations for:
  - Operators (who)
  - Operations (what, where, when, why)

This is great!

Because there were no regulations before, commercial companies in the US could not (legally) use drones

Now they can!

Who needs it?

Everybody who flies a drone and wants to make money with it or perform research in outdoor spaces (non hobbyists)

What does it say?

- Operational limits:
  - Weight < 25 kg (55 lbs)
  - Speed < 100mph (45m/s or 160kmph)
  - Altitude:
    - 400 ft above ground
    - If higher than 400ft, within 400ft of a structure
  - Weather visibility > 3miles
  - Visual Line of Sight of pilot in-control/in command/visual observer
  - Presence of certified remote pilot in-command
- No operations from a moving aircraft
- Unless in a sparsely populated area, no operations from a moving vehicle
- No carriage of hazardous materials

What does it say?

- Remote Pilot in Command:
  - Remote pilot airman certificate - UAS or higher
  - Can operate the UAS or supervise another operator
  - Mandatory (unless in case of an in-flight emergency):
    - Responsible for presenting UAS, upon request, to FAA
    - Report to FAA upon accidents with injury and damages > $500
    - Conduct pre-flight check of UAS
    - Ensure that the UAS complies with the existing FAA requirements

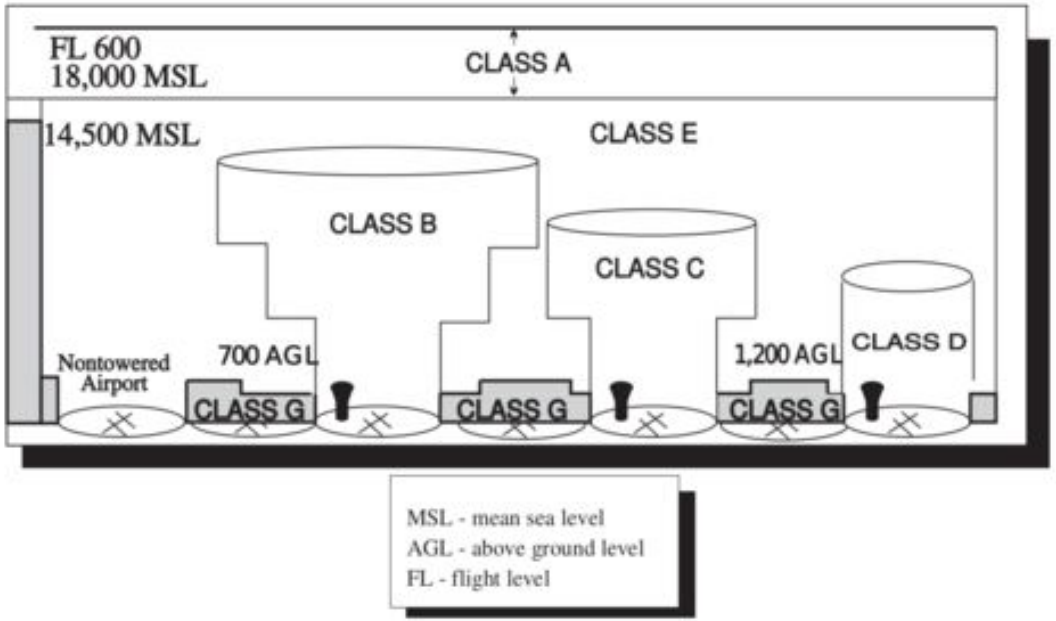
What does it say?

- Certification:
  - Tests or course
    - Aeronautical knowledge test at FAA-approved centre OR
    - Hold a part 61 pilot certificate other than student pilot, complete a flight review within the previous 24 months, and complete a small UAS online training course provided by the FAA
  - Vetted by TSA (Transportation Security Administration)
  - > 16 yrs old

What does it say?

Airspace Permissions:

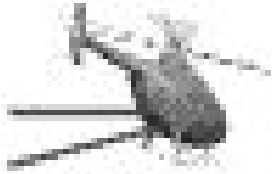
- NO ATC permission - Class G
- ATC Permission - Class A, B, C, D, E

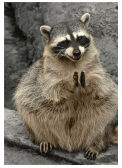


Why does Arcus need it?

- We fly and operate a UAS in an academic research setting
- We are civilians
- Safe operation in public spaces is a necessity
- Drone of more than 5 kg - risk of dropping out of the sky - property or physical harm

Thank You





Please clap