

# **NASA Electronic Parts and Packaging (NEPP) Program: CubeSat Commodities**

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***Unclassified***



# Overview

- **Task Objective**
- **NASA CubeSats**
- **NASA CubeSat Parts Database**
- **NASA CubeSat Inspection**
- **Conclusion**



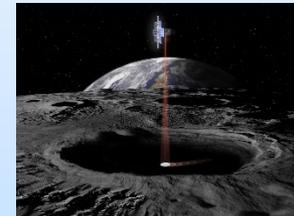
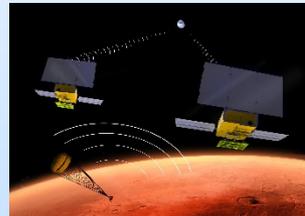
# Task Objective

- 1. Obtain, characterize, and quantify EEE parts information for NASA CubeSat missions**
- 2. Assess current inspection criteria used for CubeSat Printed Wiring Assemblies (PWA)**



# NASA CubeSats

- **The number of NASA CubeSat missions is growing**
  - Extensive involvement and interest throughout the agency, between its centers, and its industry/university partners
  - Desire for deep space CubeSats is increasing (e.g. INSPIRE, MarCO, Lunar Flashlight)



- **A subset of NASA CubeSat projects (13) provided 45 parts lists**
  - Combination of in-house and procured boards for various assemblies (Telecom, C&DH, EPS, etc.)



# NASA CubeSat Parts Database

- **Database represents >2200 individual lines of data**
  - Line = Part and corresponding part number
- **Improvements since 2015**
  - Doubled from ~1100 to ~2200 line items
    - Includes four new CubeSat parts lists
  - Added generic part number for actives, packaging information, part classifications and target industries
- **Consistent Trends since 2015**
  - 33% of total parts are common to at least two or more board designs
  - Ratio between part types has stayed within 5%
  - Approx. 98% of parts in database are rated for industrial (-40C to +85C) or more rigorous temperatures



# Digging Into the Data – Passives

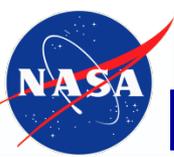
- **Almost all passives are still SMD 0402 or larger**
  - Only 25 parts are listed as SMD 0201; nothing smaller
- **Approx. 33% of passives are designed and qualified for automotive use (AEC-Q200)**
- **Approx. 30% of passives are manufactured by non-QML entities**
- **Polymer tantalum capacitors account for 33% of all tantalum capacitors**
  - These require special attention due to moisture sensitivity



# Digging Into the Data – Actives (1 of 3)

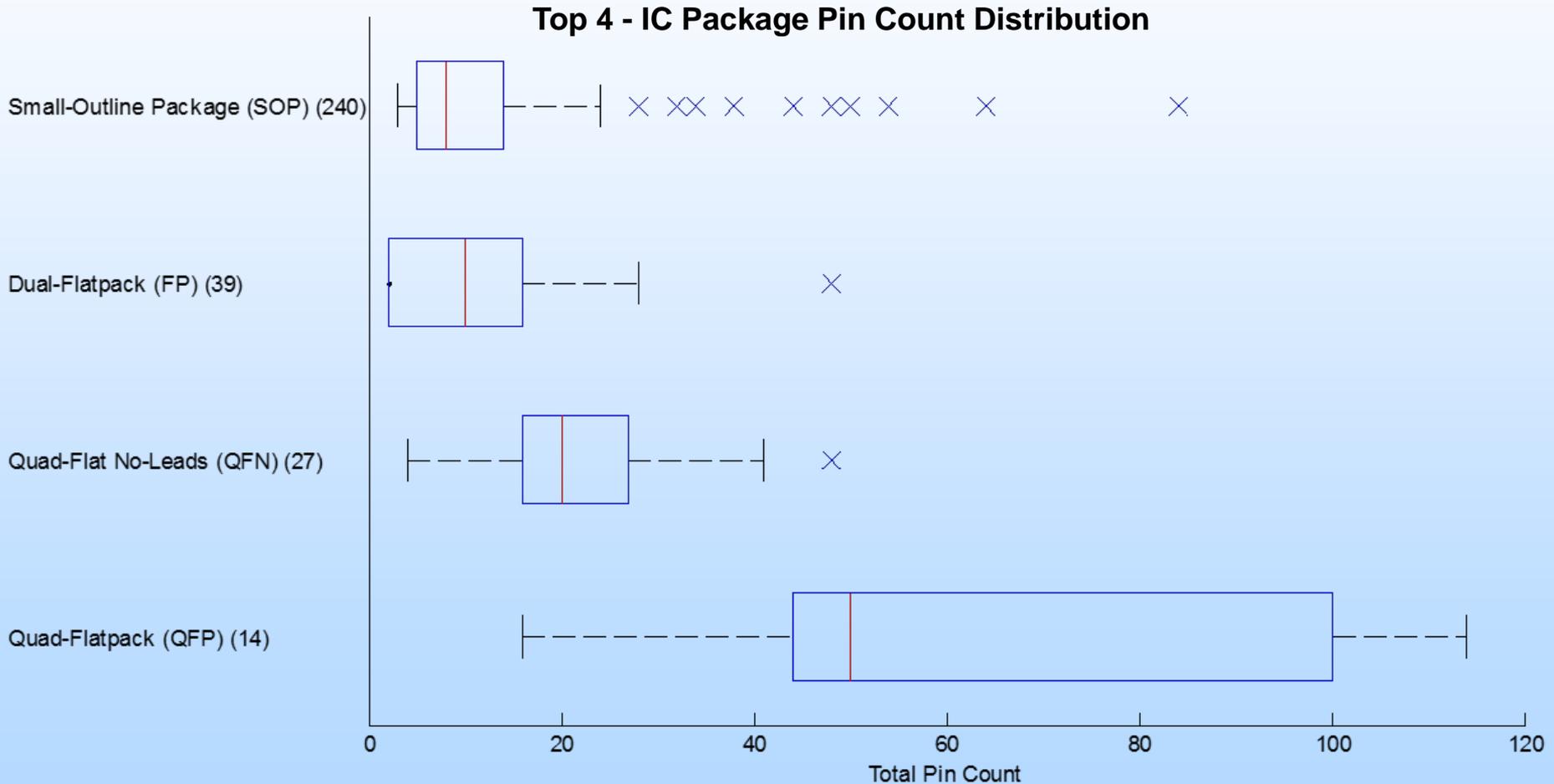
- **Small-Outline Package (SOP) and Dual-Flatpacks (FP) account for ~75% of IC packages**
  - ★ Future research focus on QFN/DFNs, CSPs and LGAs may be beneficial

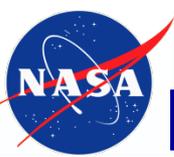




# Digging Into the Data – Actives (2 of 3)

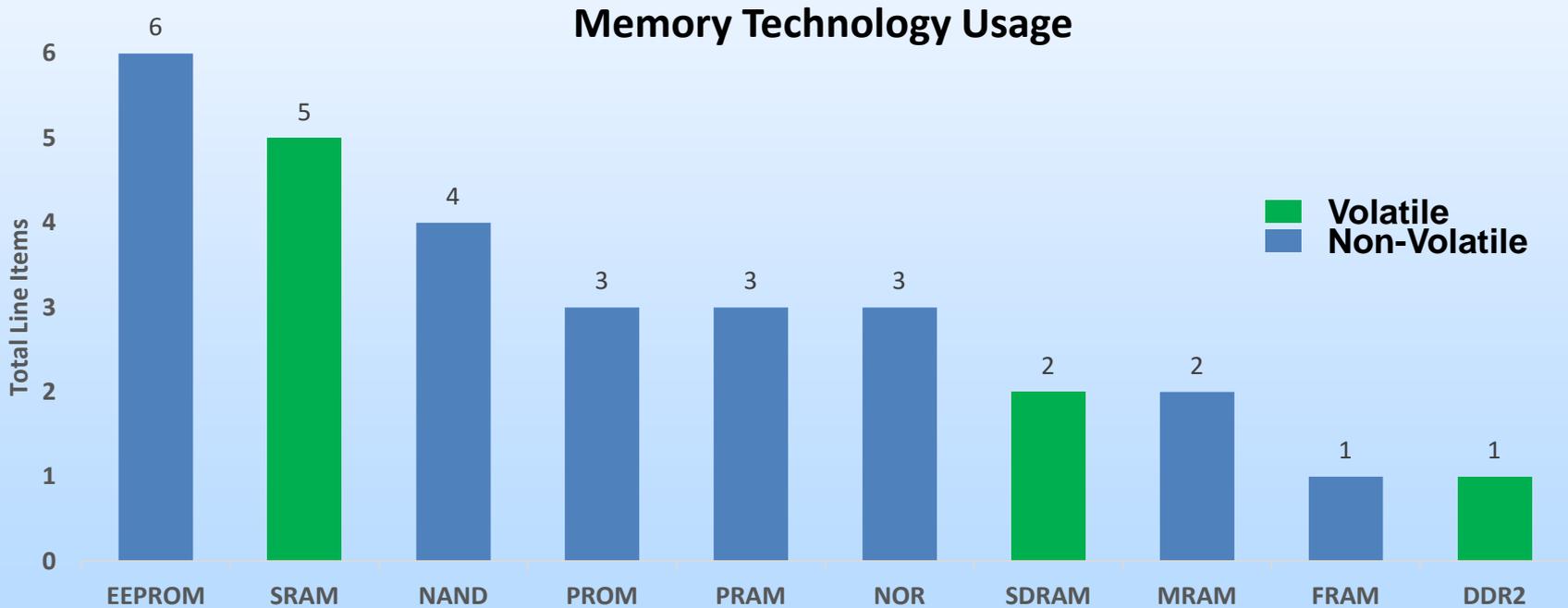
- The majority of these SOPs and FPs have less than 20 pins





# Digging Into the Data – Actives (3 of 3)

- What memory technologies are used in CubeSats?





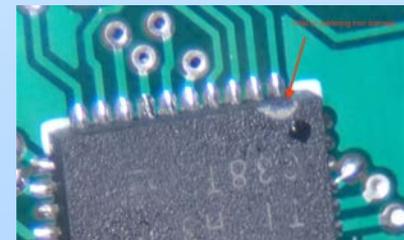
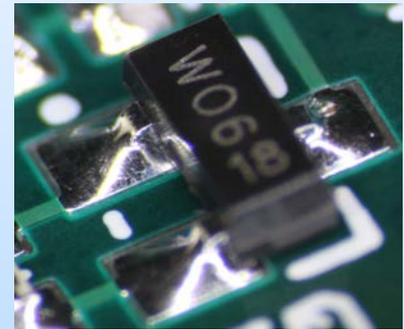
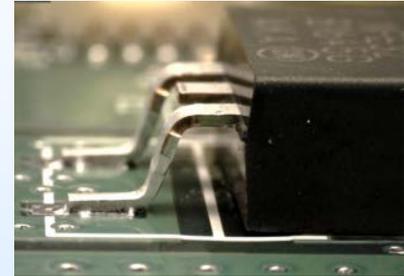
# NASA CubeSat Inspection

- **CubeSat Boards Sources**
  - Universities
  - Industry
  - NASA Centers
- **Inspection Methods**
  - Lowest Quality – General cleanliness and workmanship
  - Commercial Quality – J-STD-001 Class 1 or 2
  - Highest Quality – J-STD-001 Class 3 or Space Addendum
- **Experience Required**
  - Quality Inspector - Identifies findings
  - Responsible Engineer - Dispositions findings
    - Use-As-Is (UAI) or Rework



# NASA CubeSat Inspection

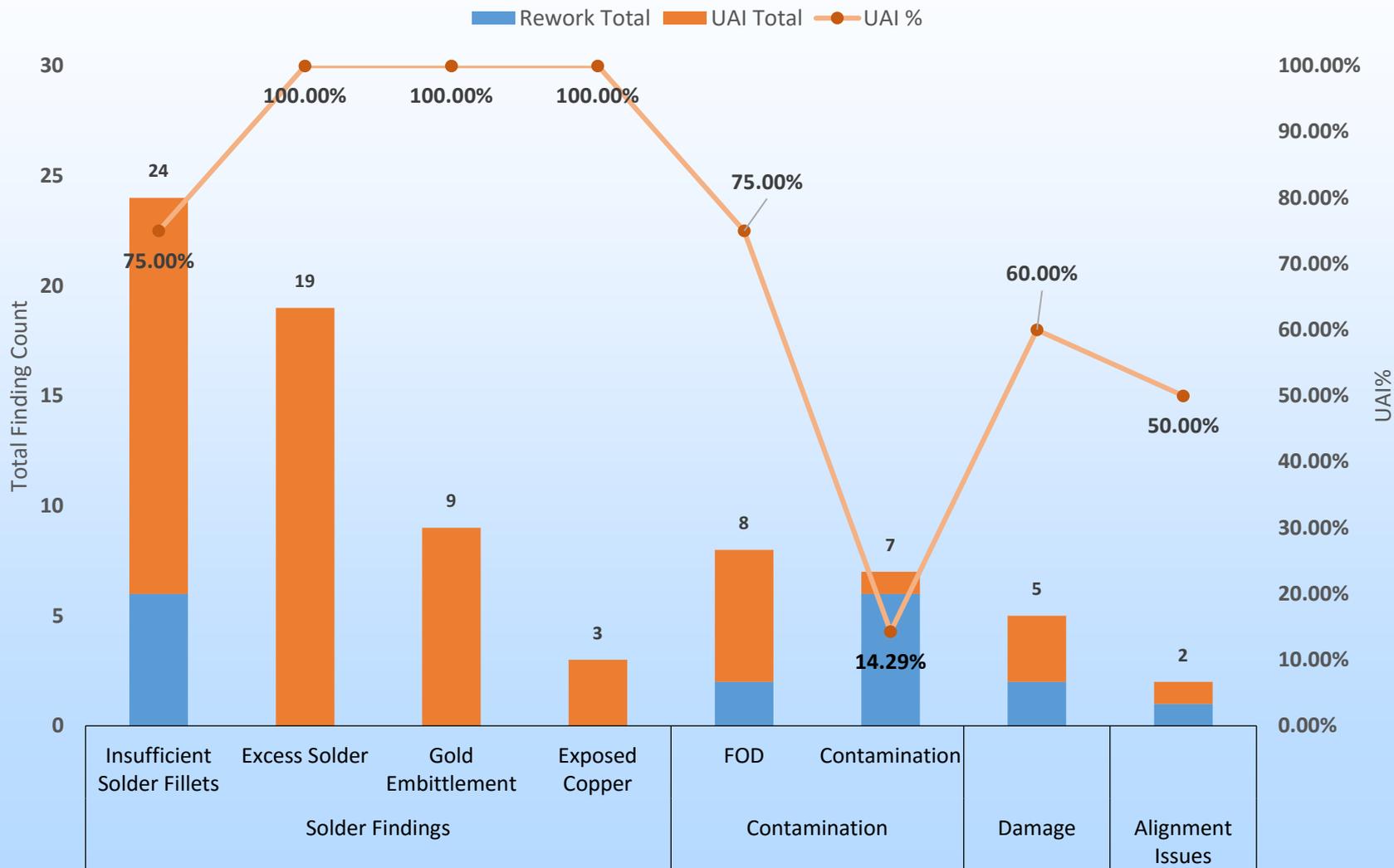
- Reviewed 12 externally manufactured CubeSat PWA Inspection Reports
- Categories of findings:
  - Solder Issues (71.4%)
    - Insufficient solder fillets
    - Excess solder
    - Gold embrittlement concerns
  - Contamination (19.5%)
    - Foreign Object Debris (FOD)
    - Solder Flux Residue
  - Component/Board damage (6.5%)
    - Burns
    - Gouges
    - Scratches
  - Component Alignment (2.6%)
    - Pads too small or too large
    - Reversed polarity





# NASA CubeSat Inspection

## Rework and UAI Dispositions





# NASA CubeSat Inspection

- **Mission Impacts of Use-As-Is (UAI)**
  - Largely depends on mission environment
    - One month in LEO vs two year journey to Mars
    - May need to consider storage time on the ground (e.g. Launch vehicle availability, Mars launch opportunities)
  - Requires discussion between responsible hardware engineer and quality inspector
    - These inspections need to be a two way street
  - Need focus on flowing gold embrittlement mitigation requirements on subcontracted board procurements
    - This is especially critical for longer duration missions



# Conclusion

- **CubeSat Parts Database has been refined and expanded**
  - Data is still being analyzed for trends
  - Expect revision of last year's EEE Parts Database of CubeSat Projects and Kits Report with new findings this summer
- **Success of CubeSat parts requires more than just radiation considerations**
  - Need adequate design margins
  - Need adequate inspections



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