National Aeronautics and Space Administration

NASA/JPL Flight Parts Problem Resolution

(Flight Issues, Hybrid DPAs/FAs, ATL Tools)

Shri Agarwal
Scott Gore
Ryan Ross

From October 2018 through December 2022, NASA will mark the 50th anniversary of the Apollo Program that landed a dozen Americans on the moon between July 1969 and December 1972.

Credits: NASA

May 29, 2020

50 YEARS

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NASA/JPL Flight Parts Problem Resolution

This presentation is divided into three parts:

- Part I will review path to resolve flight parts issues at NASA/JPL. (S. Agarwal)
- Part II will provide a summary of hybrid DPAs and FAs. (S. Gore)
- Part III will describe the capabilities of JPL ATL. (R. Ross)

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514 Processes

Path to Flight Parts Issues Resolution

"The Wiki Page"

S. Agarwal
B. Bodkin

May 29, 2020

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Path to Resolve Flight Parts Issues at NASA/JPL

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- 514 management needed a way to update flight projects on the status of their parts' issues

- The "wiki Page" is a depository of flight parts issues being worked by 514.
  - It's an active page that gives a snapshot of the currently worked issues.
    - Information on part number, manufacturer, project used on, etc
    - Source of problem
    - Current status
    - Going forward plan (recommendation to project)
  - The wiki keeps other useful information, such as history of closed items, etc.
  - This page serves as a resource for 5x management.

- Analysis of wiki data showed that
  - The **hybrids** were on top of the list; they had the most problems.

- Scott in Part II will summarize the results of DPAs and FAs done on hybrids.

- In Part III, Ryan will describe the capabilities in ATL that were utilized to uncover the problems.

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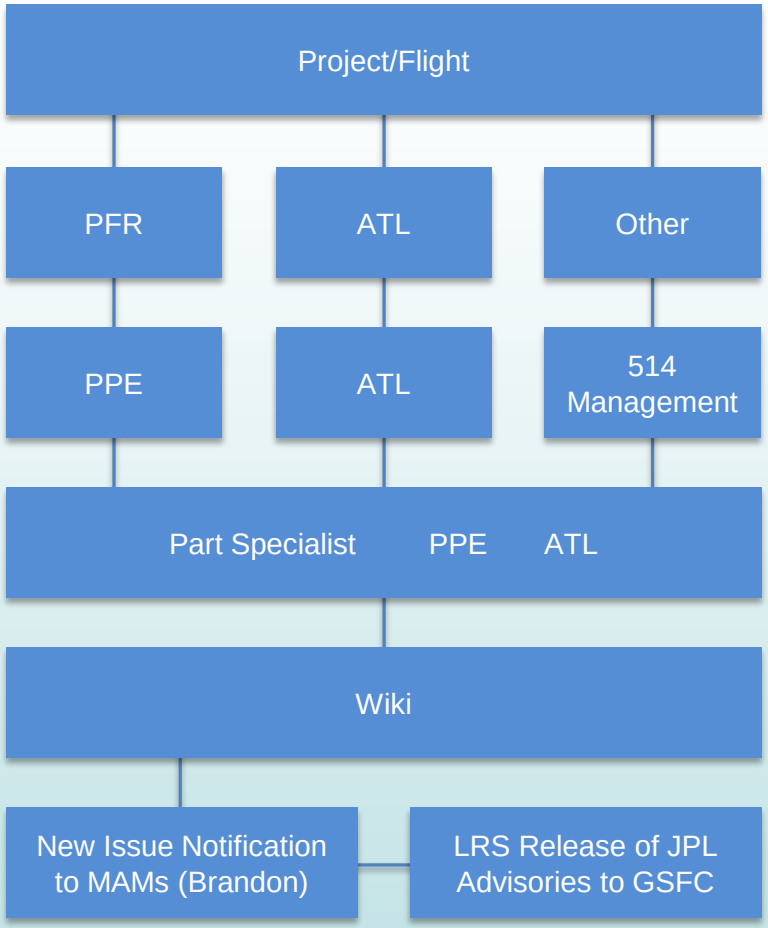
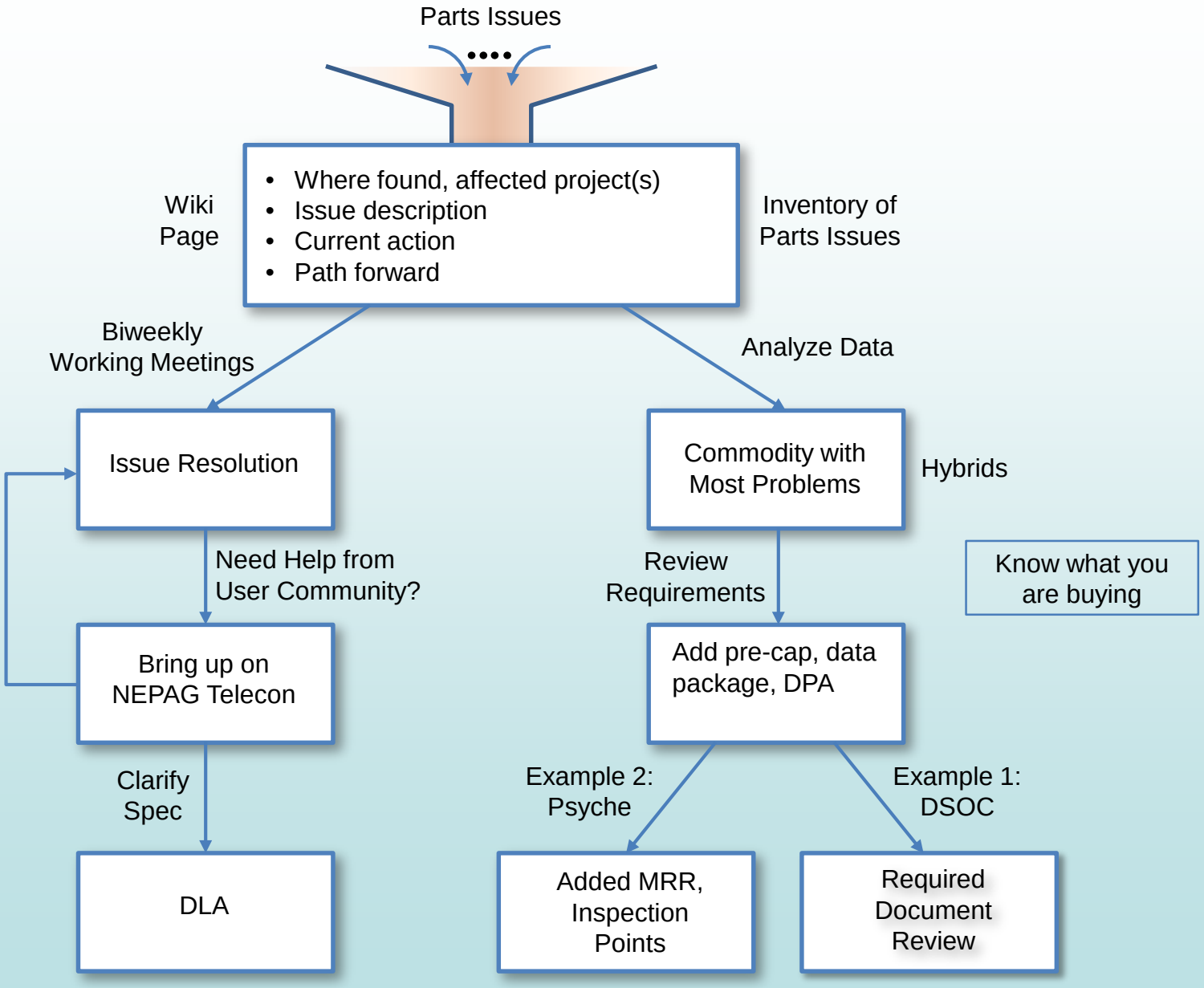
Flight Issues Process Flow



PFR- Parts Failure Report; ATL-Analysis and Test Lab; PPE-Project Parts Engineer; MAM-Mission Assurance Manager; LRS-Limited Release System

Path to Parts Issues Resolution



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Flight EEE Parts Issues Wiki Page

https://wiki.jpl.nasa.gov/display/electronicparts/Flight+EEE+Parts+Issues

Issue #0XX

Date of Occurrence	PARS Descriptor - Part Description	Manufacturer - Location	Generic P/N SMD P/N JPL P/N	Where found (During Fab, Assembly, Receiving Inspection, Upscreening, Board/system test, flight)	Project(s)/Subsystem	514 POC(s)	DATE ADDED to ECD
							DATE to DATE

Summary Details

Issue:

- Text

Current Action:

- Text

Path Forward:

- Text

Status Key	
RED	OPEN for all: no reasonable path to resolution
YELLOW	OPEN for all: there is a reasonable path to resolution
GREEN	CLOSED for Projects and 514/512, but OPEN for NEPAG
BLUE	CLOSED for all stakeholders; will drop off the list

indicates the supplier is an approved supplier on the Approved Supplier List (ASL). The icon is a link to the supplier's ASL page.

indicates the supplier is withheld on the Approved Supplier List (ASL). The icon is a link to the supplier's ASL page.

indicates the supplier's status has expired on the Approved Supplier List (ASL). The icon is a link to the supplier's ASL page.

Wiki page maintained by Brandon Bodkin (5114)

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Flight EEE Parts Issues Booklet

Flight EEE Parts Issues Wiki Number	Part Type	Issue	Where Found	Time to resolution
095	Optocoupler	Lid Seal Voiding	Destructive Physical Analysis (DPA)	2 months

Summary

Optocouplers showed lid seal voiding. Three out of three devices submitted to JPL's Analysis and Test Laboratory (ATL) failed Destructive Physical Analysis (DPA) for lid seal voiding based on Class H requirements. The parts specialist requested 100% hermeticity, 100% x-ray inspection, and lid seal evaluation of the lot. Two out of 27 devices passed lid seal voiding requirements at 63.8% and 67.4%. The average lid seal voiding percentage of the 27 devices was 87.4%, failing the requirement of less than 75%. All devices passed Class H hermeticity requirements. High voiding percentage appeared mostly on one particular side of the devices, with the other sides having acceptable seals.

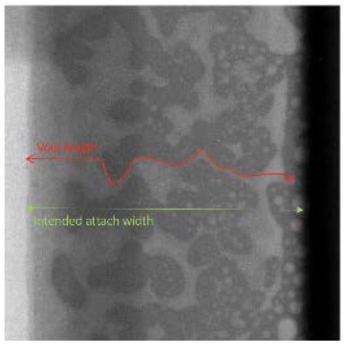
Resolution

The parts specialist cherry picked the best looking devices from those that passed hermeticity. 10 of those devices were selected for kitting based on lid seal voiding, with a range of 63.8% to 85% and an average of 78.6%. The project created a waiver and the parts specialist performed a risk assessment and determined the risk to be low.

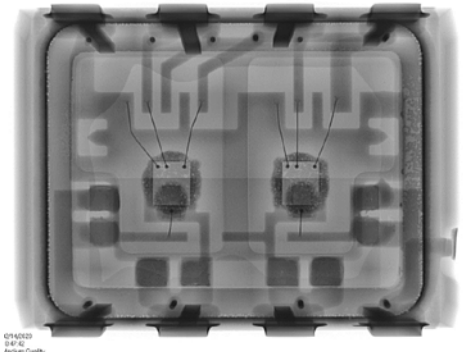
Because this was the second occurrence of the same issue from the supplier over two separate lot date codes, JPL worked with the NASA Electronic Parts Assurance Group (NEPAG) community to determine next steps and corrective actions to request from the supplier.

JPL Process Improvement

None. The existing processes caught the issue.



Representative X-Ray image from DPA report



Top-down X-Ray of optocoupler showing lot-typical location of excessive lid seal voiding along right edge of the image

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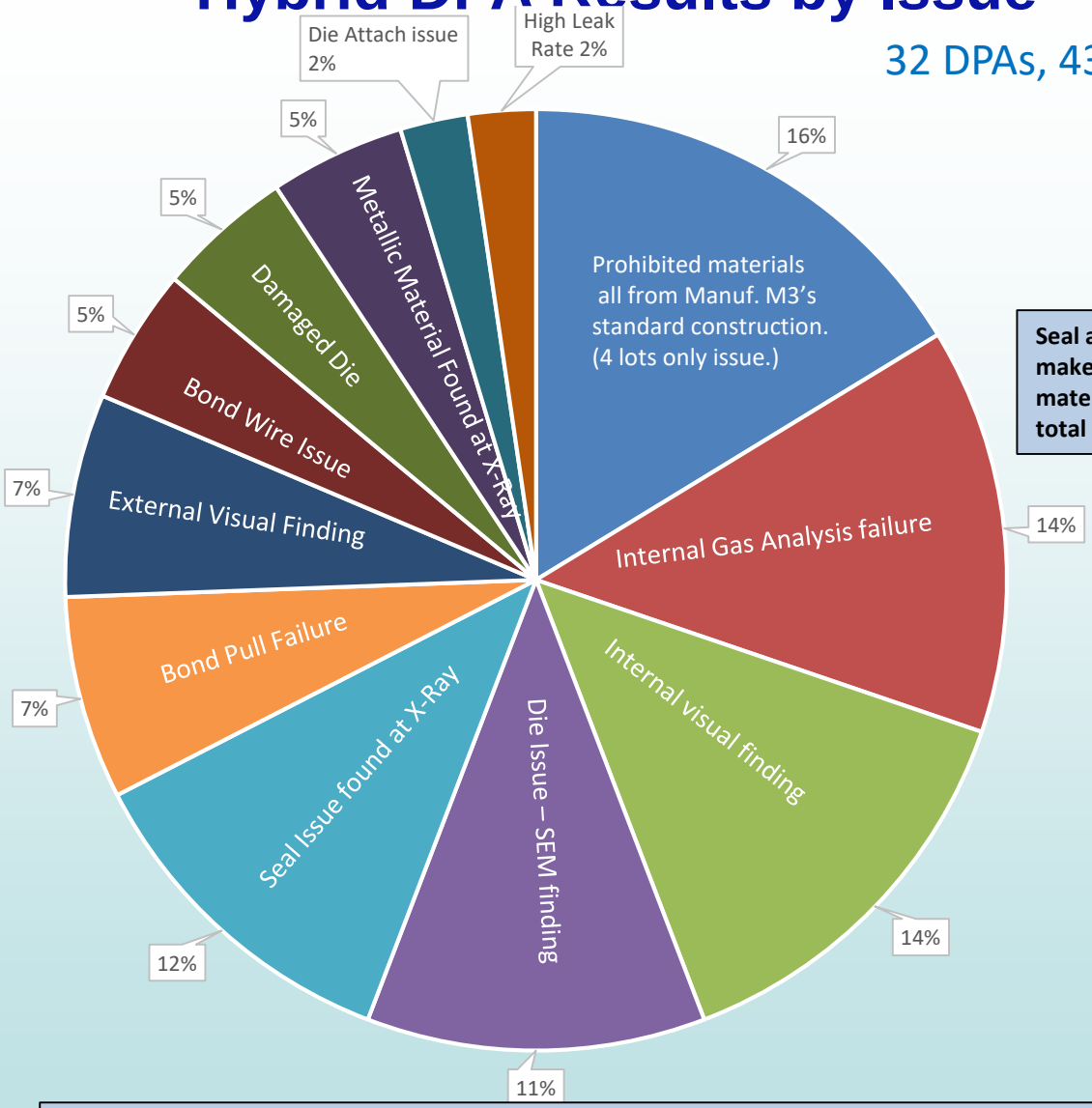
Summary of Hybrid DPA and FA Findings
2017 - Present

Scott Gore
T. Apple
J. Martinez
R. Evans

May 29, 2020

Hybrid DPA Results by Issue

32 DPAs, 43 Issues



Seal and RGA issues combined make up 26%. Adding metallic material found at X-ray brings total to 31%.

Hybrid Issues Found are Varied – Pre-seal Inspection and Sealing Process Significant Portion of Issues

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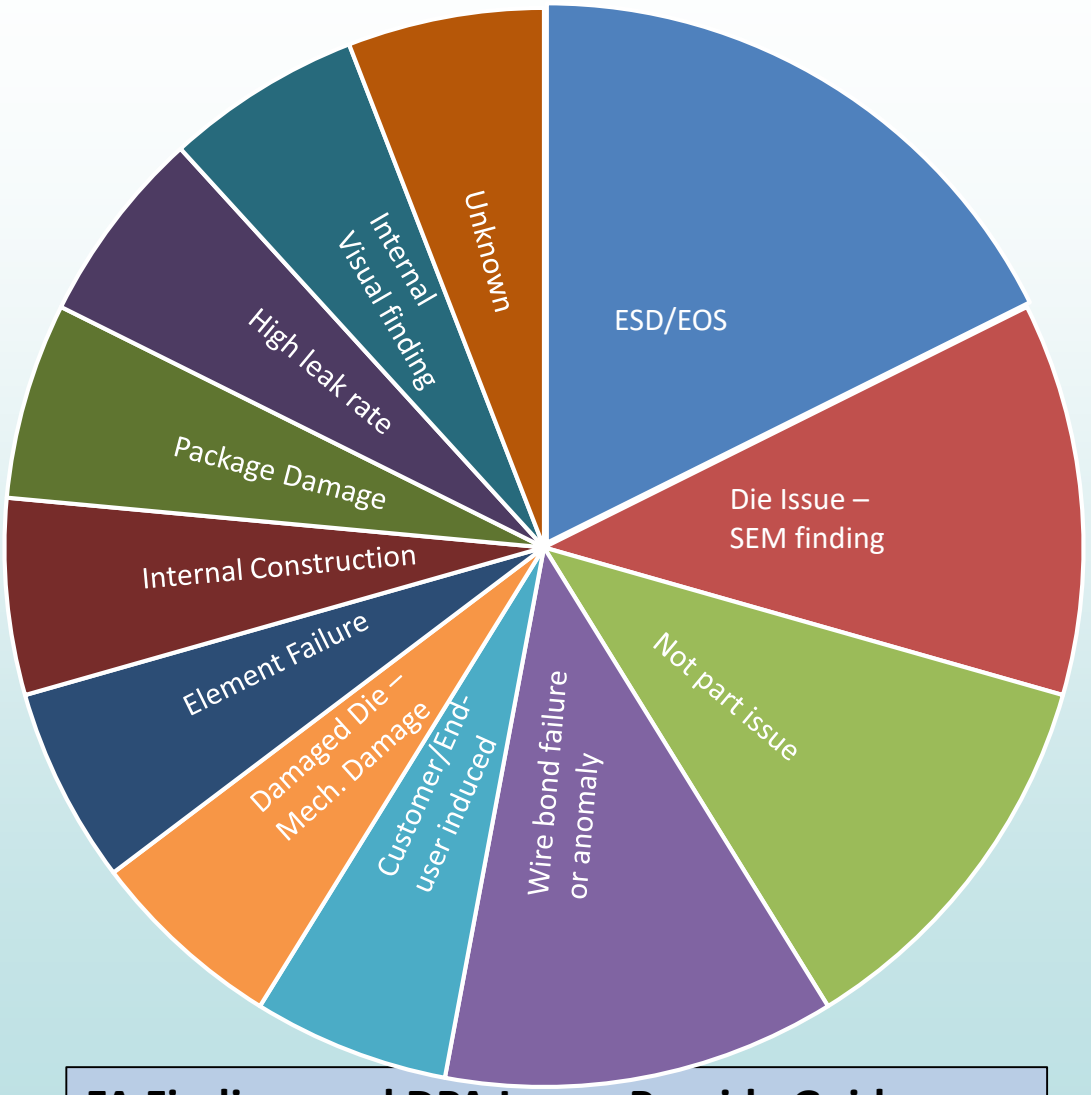
Hybrid FA Analysis by Issue

17 FAs



FA findings of die SEM and die damage correlate with DPA findings.

FA Findings and DPA Issues Provide Guidance for Manufacturer Corrective Actions

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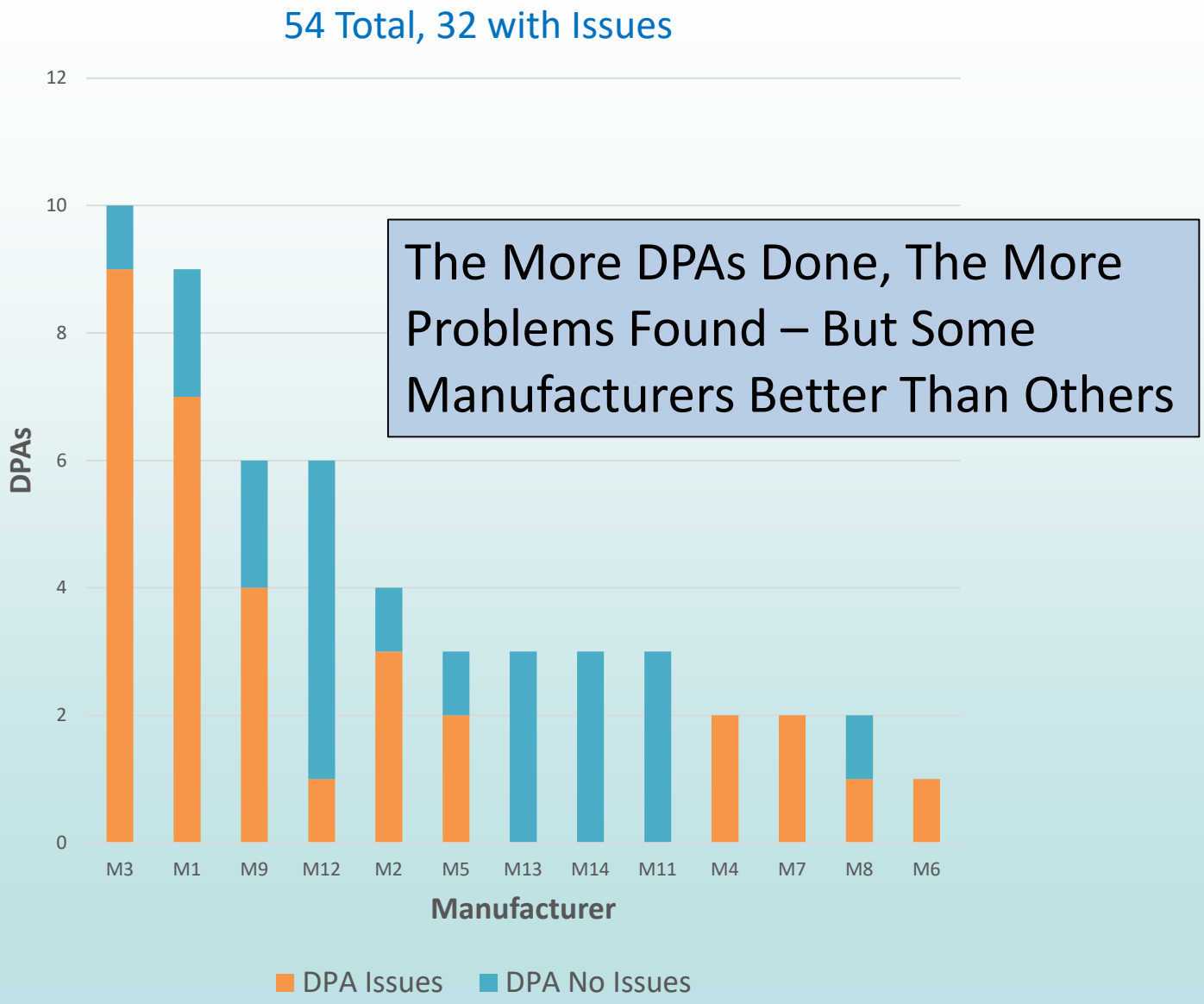
Hybrid DPA Totals by Manufacturer from 2017 - Present



The More DPAs Done, The More Problems Found – But Some Manufacturers Better Than Others

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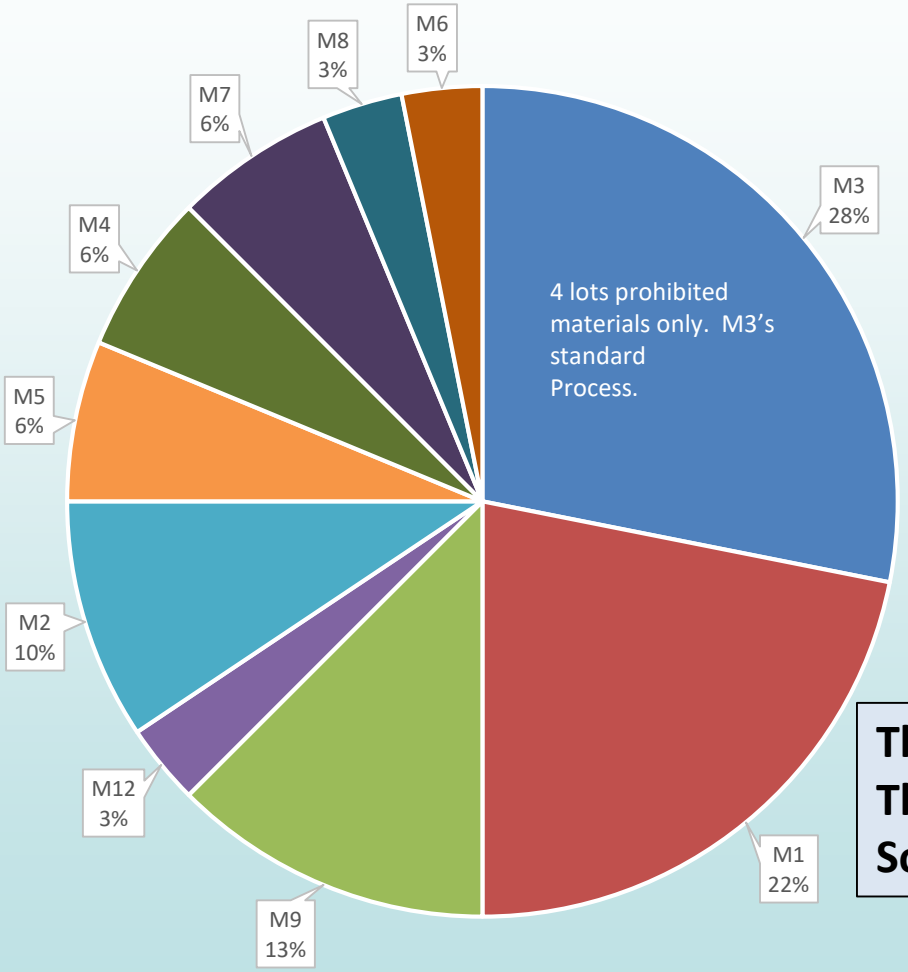
Hybrid DPA Issues by Manufacturer

2017 to 5/2020
32 Total



The More We Buy, The More Issues – But Some Raise Concerns

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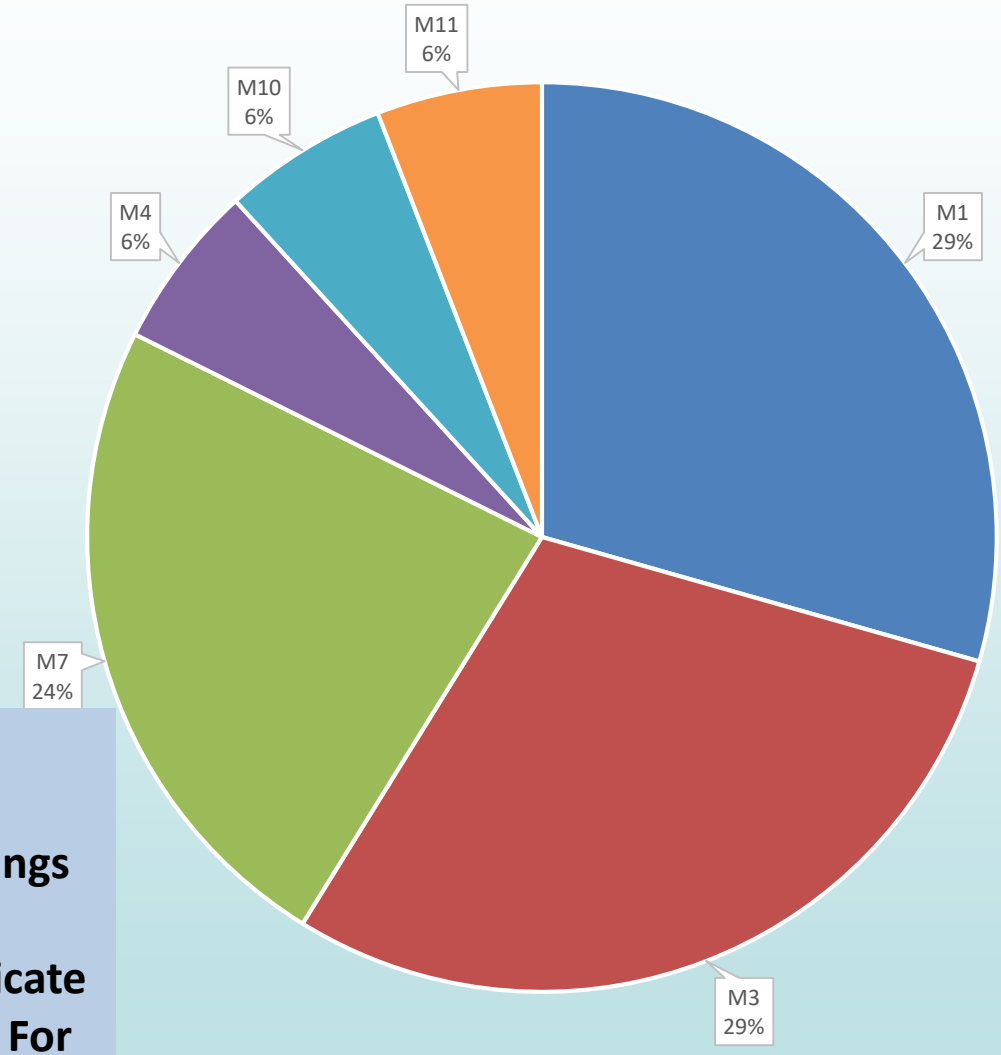
FAs Performed by Manufacturer

17 Total 2017 - 5/2020



In General, Correlates With DPA Findings and Volume – Exceptions Indicate Manufacturers For Additional Focus

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Hybrids Assurance Proposal for FY21

- Hybrids are complex devices
- History indicates frequent reliability issues, screening, or lot qualification failures across all manufacturers
- Issues cause project cost increases and schedule delays

To reduce issues, need to establish oversight and evaluation methods beyond MIL-PRF-38534 Class K requirements

- Tailor enhanced approach to manufacturer and part type
- Enhanced processing flow to be used for procurements, special focus on DC-DC converters
- Use FA and DPA history to create enhanced processing
- Start with DC-DC converters, then extend to other types of hybrids

Goal is reduced issues and failures during all phases of the supply chain from order placement through available for project use

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Analysis & Test Laboratory

Ryan Ross

May 29, 2020

https://atl.jpl.nasa.gov/

Analysis & Test Laboratory Introduction

- Characterization, testing and failure analysis experts serving Agency project and technology customers, enabling Agency to remain at the forefront of space exploration while ensuring mission success.

- Non Destructive Evaluation
- Environmental Qualification
- Electrical Testing
- Destructive Physical Analysis
- Physical Characterization
- Part Screening
- Construction Analysis
- Failure Analysis
- Scanning Electron & Focused Ion Beam Microscopy

The material in this presentation covers many, but not all capabilities.
Please contact Ryan.Ross@jpl.nasa.gov with any specific support inquiries

https://atl.jpl.nasa.gov/

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Analysis & Test Laboratory
Virtual Tour

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Analysis & Test Laboratory
Select New Capabilities

- 4 Dimensional Analysis online (3D CT + Motion)

- Enhanced Analysis now online
  - Part to CAD tolerance deviation mapping
  - Void location & size quantification
  - Unrolling of circular seal interfaces into flat views
  - Topology & warpage comparison vs. perfect shape

- Coming soon
  - FY20: Environmental CT in vacuum (~170C to ~15 Kelvin)
    - Visualize CTE mismatch
    - Enable CT at failing cold and elevated temperature

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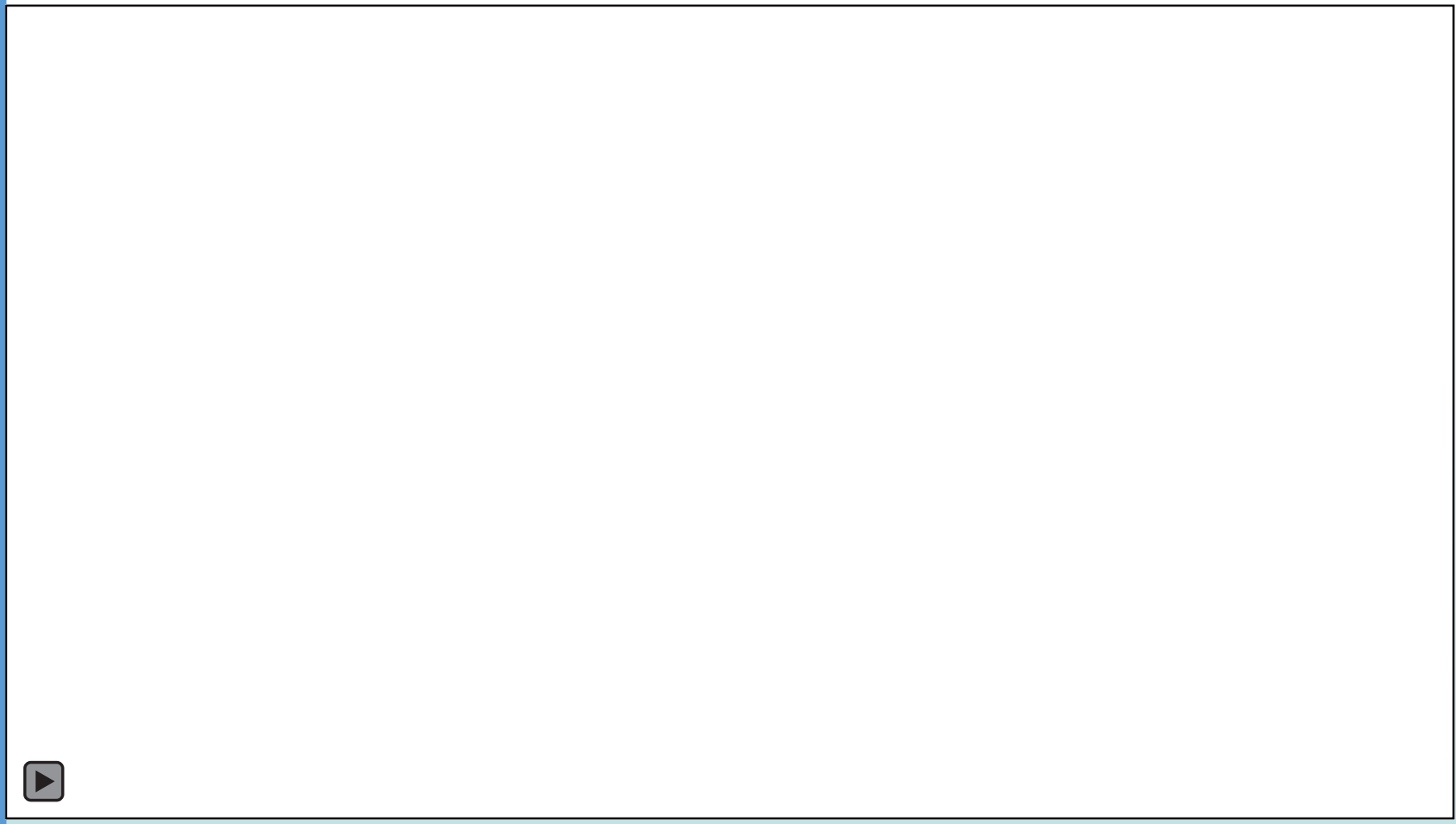
Analysis & Test Laboratory New Capabilities
4D & Enhanced Computed Tomography Analysis



4D CT example of rotary connector mating / de-mating

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Analysis & Test Laboratory
Future Capabilities

- Advantest T5833ES Memory Tester
- Anticipated to be online in FY21
- Enables testing of DRAM, NAND Flash, multi-chip packages (MCPs), and next generation non-volatile memories including MRAM, RRAM and PCM
- Will be adjacent to a LN2 Thermal cycling chamber & fault isolation equipment

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Analysis & Test Laboratory
Future Capabilities

- Advantest 93K tester will be installed in FY21

- Enables testing
  - Mixed signal
  - Analog
  - RF
  - System on a chip (SOC)
  - Power management
  - Higher power devices (GaN)

- Will be adjacent to a LN2 Thermal cycling chamber & fault isolation equipment

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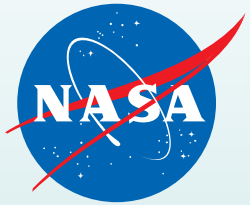
http://nepp.nasa.gov



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