EXTRACTING VALUE FROM NASA QUALITY ENGINEERING AND ASSURANCE DATA

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$^3$Kennedy Space Center (KSC)
$^4$Office of Safety and Mission Assurance (OSMA)
Audit findings from the NASA Office of Inspector General (IG) Office of Audits on “NASA’s Parts Quality Control Process”:
- Released March 29th, 2017
- Report No. IG-17-016

Reason for performing the audit:
- NASA builds and operates launch vehicles, propulsion systems, robots, satellites, telescopes, and other complex science instruments
- Using high performing and high quality parts is critical to mission success
- However, IG reports that in the past 10 years NASA has incurred financial losses of approximately $1.3 billion from failures that occur due to parts not meeting expectations
- Concerns also exist regarding NASA’s increased usage of commercially produced “off-the-shelf” items and the risks this may pose to the Agency’s parts quality control process

The IG audit on parts evaluated the following:
- Parts and supplier quality control processes
- Parts and supplier data collection and sharing practices
- Processes for overseeing contractor quality management systems
- Various Agency policies and procedures

The IG auditors spoke with Agency, Government, and industry officials; also spoke with personnel from several major projects
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Date of Loss | Part Failure | Cost
---|---|---
February 24, 2009 | payload fairing | $209 million
March 4, 2011 | payload fairing | $388 million
October 28, 2014 | liquid oxygen turbopump | $51 million
June 28, 2015 | support strut | $118 million
July 7, 2015 | radar power supply | $550 million
1. Expand current NASA data sharing structure to integrate supplier databases with parts databases.

2. Investigate causes of gaps in SAS reporting and formulate remedial actions to ensure compliance with SAS reporting requirements.

3. Identify supplier performance information of common interest and modify SAS data structure to accommodate such information.

4. Collaborate with Office of the Chief Engineer to identify parts history information of common interest and modify EPARTS data structure to accommodate that information and to link to supplier information databases.

5. Examine the feasibility of further expanding NASA’s parts and supplier data collection efforts to include contractor maintained data regarding parts and suppliers utilized in NASA contracts.

6. Evaluate current parts and supplier database system architectures to determine the cost and benefits of establishing an Agency-wide database system as opposed to maintaining current decentralized database systems.

7. Incorporate a feedback process to improve the Agency’s tracking and recording of contractors’ and suppliers’ submissions of GIDEP alerts and Agency action notices.

8. Review a representative sample of PQASPs to identify deficiencies and best practices and revise policy as needed to include quantification and documentation of nonconformance and control risks for ensuring surveillance activities and resources are commensurate with part criticality and overall accepted project risk.
INSPECTOR GENERAL RECOMMENDATIONS

1. **Expand current NASA data sharing structure to integrate supplier databases with parts databases.**

2. Investigate causes of gaps in SAS reporting and formulate remedial actions to ensure compliance with SAS reporting requirements.

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6. **Evaluate current parts and supplier database system architectures to determine the cost and benefits of establishing an Agency-wide database system as opposed to maintaining current decentralized database systems.**

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Recommendation 1: Expand current NASA data sharing structure to integrate supplier databases with parts databases.

Recommendation 4: Collaborate with Office of the Chief Engineer to identify parts history information of common interest and modify EPARTS data structure to accommodate that information and to link to supplier information databases.

Recommendation 6: Evaluate current parts and supplier database system architectures to determine the cost and benefits of establishing an Agency-wide database system as opposed to maintaining current decentralized database systems.

“Although NASA has a number of initiatives in place to help ensure the selection of quality parts from reliable suppliers, Centers generally manage their parts quality and supplier assessment data unilaterally rather than collaborating through a comprehensive, integrated, Agency-wide parts and supplier information system. Specifically, the Agency does not maintain a centralized parts quality history database or facilitate the integration of individual Center systems, track all relevant supplier performance history, or enforce requirements that Centers participate in Agency parts quality management systems.”
RECOMMENDATION VERSUS REALITY

The IG recommendations from the Audit on NASA’s Parts Quality Control Processes (recommendations 1, 4, & 6 in particular) are illustrative of what an outside entity like the IG would naturally assume regarding:

- NASA’s access to basic supply chain and product quality data and,
- NASA’s readiness to analyze the data and use results to drive risk-based decisions

These are arguably relatively sensible assumptions considering the availability of modern data analysis tools

However, these recommendations are in stark contrast to NASA’s data security and (or) access realities:

- Oversight and restrictions... general NASA data protection and security, DCMA data protection and security, proprietary restrictions for commercial data, EAR/ITAR restrictions, et...; all of which would have to be satisfied by an Agency level work flow tool
- The aforementioned brings to question the next point – deciding who gets access to the Agency level work flow tool? To the dashboards? To the analysis? To the trends information? To the raw data? How do you control and monitor users?
- Most NASA maintained data is going to be stored on Center controlled servers; however, NASA Centers have complex firewalls and substantial server security that need to be passed before data can even be reached
- Also, it would be important for the Agency level work flow tool to have real time access to the latest data (i.e. not a snapshot of the past)
- The previous points cover “NASA Controlled” data, but what about the fact that ~80% of hardware is procured rather than developed in-house? In this case, part data is owned and controlled by an external supplier
OTHER OBSTACLES

- Mission-driven organization makes big infrastructure projects programmatically challenging

- NASA Centers are great at solving their own problems – this includes quality control!
  - However, that means that database designs exist that serve relatively limited purposes and users

- Different types of data storage repositories:
  - Databases, each formatted differently, and tracking different types of data
  - Workflow tools, each formatted differently, and tracking different types of data
  - SharePoint and Web-based tools, no telling what can be found here!
  - Excel-based repositories (e.g. the document I created to start tracking quality data found in OCE reports)
  - Hard copies (yes, I mean paper!)

- There are few required closed loop processes that demand stockpiling and analyzing of quality data

- Getting Center-level buy-in; how do you convince and encourage Center level-users to utilize and populate an Agency level work flow tool without laying down new blanket requirements?

- Who manages the Agency Level Work Flow tool and how do you make sure it is up to date?

- Deciding what data to extract?
  - Parts data, supplier data, non-compliance info, corrective actions info, et...
  - Too many “ideas” to list here...
Highlight on OSMA’s Response to Recommendations 1 & 6

1. Expand current NASA data sharing structure to integrate supplier databases with parts databases.
   - OSMA’s Response: **Concur.** The Chief, Safety and mission Assurance (SMA) will collaborate with Office of the Chief Engineer (OCE) and Center, program and project stakeholders to assess the feasibility and benefits of integrating supplier quality and parts databases currently maintained by the Office of Safety and Mission Assurance (OSMA), OCE, and NASA programs/Centers.

6. Evaluate current parts and supplier database system architectures to determine the cost and benefits of establishing an Agency-wide database system as opposed to maintaining current decentralized database systems.
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The purpose of my study derived from OSMA’s agreement to assess better methods and techniques for integration of parts and supplier related quality engineering and assurance data. Here we seek to (1) identify data sources throughout the Agency, (2) understand what is being done with said data, (3) make recommendations on how NASA can integrate this data, (4) demonstrate what can be accomplished with an integrated workflow tool.
OUR APPROACH

➢ **STEP 1: PICK-UP THE PHONE**
  - Contacting all quality engineering and assurance experts throughout the agency

➢ **STEP 2: ASK THE EXPERTS**
  - What data is collected at your Center?
  - Where is the data stored? Excel? SharePoint? Database? Online? Et...?
  - What do you do with the data you collect?
  - Do you currently use historical data for trending analysis?
  - Is your main goal of data collection for closed loop reporting?
  - What obstacles exist to 3rd party access to your data repository?

➢ **STEP 3: DOCUMENT FINDINGS**
  - Counterpart Peter Checklick (KSC) and I have been recording every data source that we identify through these conversations in preparation for future integration activities

➢ **STEP 4: PREPARE FOR INTEGRATION**
  - 3rd party data extraction, integration, and analysis tools exist (e.g. Tableau)
  - Scheduled to take Tableau training in the near term to assess the feasibility of using this tool to meet Agency level integration needs
  - Identifying Center-level databases to use as pilot sources

➢ **STEP 5: DETERMINE FUNDING SOURCES AND PROCEED WITH PILOT PROGRAM**
  - Evaluating OSMA resources... Digital Transformation Resources.... Center Level Resources...
WHAT HAVE WE FOUND SO FAR?

- Conducted in-depth interviews, often face-to-face, with quality engineering and assurance experts across the agency:
  - Task was split between myself and counterpart Peter Checklick (KSC)
  - In general, we’ve discussed what’s collected, where it’s put, and what it’s used for
  - Developing a comprehensive list of data storage repositories and Center level points-of-contact (POCs)

- Interviews still remaining or in works include ARC, SSC, and MSFC (Checklick) and JPL, AFRC, LaRC (Walker)

Excluding M&P items found at all centers such as MAPTIS, PA Lab, Fastener DB, PCB Coupon files...
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Approved Supplier List (ASL)
Property Accountability Reporting System (PARS)

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The Defense Contract Management Agency (DCMA) has a work agreement (MOU/LOD) to perform surveillance, conduct audits, and collect data for NASA for:
- Suppliers and vendors
- Prime and Sub-contractors
- Suppliers, vendors, and contractors are all tracked by CAGE codes
- Data can also be tracked by Project Codes

DCMA tools and data repositories you may be familiar with:
- Supplier Risk System (SRS)
- CAR/ECAR

Utilizing DCMA data has its own challenges:
- Although they collect data that is useful to NASA, DCMA is really structured to support Department of Defense needs and requirements
- Access to data is highly controlled
- Generating **NEW** forms and reports to get the data NASA need’s in a format that is useful to us is not as straight forward as you might think; in general, I’ve found that the data we need is there, but DCMA is not readily able to report the data in a way that supports data analysis and trending

How do we improve NASA’s ability to access and utilize DCMA data?
SHARING PLATFORM: TABLEAU

The overall focus is extraction of value from quality engineering and assurance data:

- With data sources and POCs identified, how do you go about extracting data?
- Aside from previously mentioned obstacles to an agency level workflow tool, we could potentially implement this via a sharing platform
- Multiple tools exist (e.g., ClickShare and Tableau)

Tools like ClickShare and Tableau (currently leaning this direction) are designed to extract data, of any kind, from lots of data repositories and to help you do the following:

- Organize the data
- Observe and analyze the data and trends
- Present the data and trends
- Always use the latest data as a function of all agency level inputs
ADCC PMO TEAM DEVELOPED TABLEAU DASHBOARDS: AGENCY OMB SCORECARD

Facility Utilization
Target 80%

PUE
Target 1.5

Energy Metering
Target 100%

Facility Utilization
Target 80%

59

PUE
Target 1.5

1.55

Energy Metering
Target 100%

100

Storage Utilization
Target 70%

28

Server Utilization
Target 60%

48

Virtual Hosts
Target 20%

20

Virtual Density
Target 10 OS per Host

6.09

Virtualization Ratio
Target 4

2.22
ADCC PMO TEAM DEVELOPED TABLEAU DASHBOARDS: AGENCY KPI TREND

Facility Utilization
59% vs Target >= 80%

Storage Utilization
20% vs Target >= 70%

Virtual Hosts
20% vs Target >= 20%

PUE
1.57 vs Target <= 2.50

Energy Metering
100% vs Target = 100%

Server Utilization
48% vs Target <= 60%

Virtual Density
6.09 OS per Host vs Target <= 30

Virtualization Ratio
2.22 vs Target <= 4

AGENCY KPI TREND
Current FY/Q
From FY15 Q1 to FY19 Q1

Click here for printer-friendly version.
ADCC PMO TEAM DEVELOPED TABLEAU DASHBOARD: DATA CENTER CLOSURE DASHBOARD

Quarterly Summary Report - FY18 Q4

- Total DC Closures Prior to FDCI Reporting: 10
- Total NASA Tiered Data Centers to Remain Open: 19
- Total NASA DC Closures Reported to FMS thru FY18 Q2: 40
- Total Closures for FY18 Q3: 0
- Planned Closures Remaining for FY18: 0
- Planned Closures for FY19: 0
- Total Square Footage Disposed/Repurposed Reported: 50,956
- Total Servers Decommissioned Reported: 312
- Total Servers Moved to Other DC Reported: 2,554

Data Center Closure Status Dashboard

- Data Center Closure Status Totals
  - Retain
  - Closed

Data Center Closures By Fiscal Year

- Data Center Details

Data Center Name | Closing Stage | Date Closed
--- | --- | ---
AFRDC1 | Retain | Q2/2011
AFRDC2 | Closed | Q2/2012
AFRDC4 | Closed | Q2/2014
AFRDC5 | Closed | Q3/2013
AFRDC6 | Retain | Q2/2010
AFRDC7 | Closed | Q3/2011
AFRDC8 | Closed | Q4/2010
AFRDC9 | Closed | Q2/2016
AFRDC10 | Closed | Q4/2015
AFRDC11 | Closed | Q4/2010

**Note:** SSC and RGSC Combined into BCCOR.
## FY19Q1 PUE Update Summary

![Map Diagram](image)

### quarterly update

<table>
<thead>
<tr>
<th>Data Center Name</th>
<th>DC Description</th>
<th>FY PUE</th>
<th>Total DC (kW)</th>
<th>Total IT load (kW)</th>
<th>Annual PUE</th>
<th>Change</th>
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<td>CRCOC1</td>
<td>Consolidated IT Center [DDI]</td>
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<td>HQDC1</td>
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<td><strong>Annual Combined</strong></td>
<td>Combined Power usage for all data centers: Agency-wide</td>
<td>1.53</td>
<td>19,499</td>
<td>10,367</td>
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### PUE (Rolling Aggregate of Last 4 Quarterly Updates)

- Quarterly Update
- Annual Combined
SUMMARY AND FUTURE ACTIVITIES

- In response to recommendations from the Inspector General Audit on NASA’s Parts Quality Control Processes, we are assessing better methods and techniques for integration of parts and supplier related quality engineering and assurance data. To accomplish this we seek to:
  - Identify data sources throughout the Agency
  - Understand what is being done with the data
  - Make recommendations on how NASA can integrate the data
  - Demonstrate what can be accomplished with an integrated workflow tool

- Assessing the feasibility of implementing Tableau to meet these needs:
  - Participating in a 3 day training next week
  - Collaborating with KSC IT experts who have already begun evaluation of the software
  - Identifying ideal NASA quality data repository candidates to use in pilot study

- Working to improve NASA benefit from DCMA data:
  - Continue dialog with DCMA counterparts to better understand the current status-quo of the NASA/DCMA relationship
  - Gaining access to DCMA tools (SRS, CAR, et...) to document what can and can’t be accomplished by a NASA individual with log-in credentials
  - Evaluating current report templates that are available
  - Discussing what should be included in a future report template that is designed to reflect NASA’s needs

Bottom Line: The quality engineering and assurance data is there, we “simply” need to develop methods that maximize the overall value that we can extract.
QUESTIONS?
1. Expand current NASA data sharing structure to integrate supplier databases with parts databases.

2. Investigate causes of gaps in SAS reporting and formulate remedial actions to ensure compliance with SAS reporting requirements.

3. Identify supplier performance information of common interest and modify SAS data structure to accommodate such information.

4. Collaborate with Office of the Chief Engineer to identify parts history information of common interest and modify EPARTS data structure to accommodate that information and to link to supplier information databases.

5. Examine the feasibility of further expanding NASA’s parts and supplier data collection efforts to include contractor maintained data regarding parts and suppliers utilized in NASA contracts.

6. Evaluate current parts and supplier database system architectures to determine the cost and benefits of establishing an Agency-wide database system as opposed to maintaining current decentralized database systems.

7. Incorporate a feedback process to improve the Agency’s tracking and recording of contractors’ and suppliers’ submissions of GIDEP alerts and Agency action notices.

8. Review a representative sample of PQASPs to identify deficiencies and best practices and revise policy as needed to include quantification and documentation of nonconformance and control risks for ensuring surveillance activities and resources are commensurate with part criticality and overall accepted project risk.

**OSMA’s Response: Concur. The Chief, Safety and mission Assurance (SMA) will collaborate with Office of the Chief Engineer (OCE) and Center, program and project stakeholders to assess the feasibility and benefits of integrating supplier quality and parts databases currently maintained by the Office of Safety and Mission Assurance (OSMA), OCE, and NASA programs/Centers.**
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8. Review a representative sample of PQASPs to identify deficiencies and best practices and revise policy as needed to include quantification and documentation of nonconformance and control risks for ensuring surveillance activities and resources are commensurate with part criticality and overall accepted project risk.

OSMA’s Response: Concur. The Chief, Safety and Mission Assurance, in collaboration with the OCE, will evaluate the benefits and feasibility of potential modifications of EPARTS to accommodate parts history information and links to supplier databases.
1. Expand current NASA data sharing structure to integrate supplier databases with parts databases.

2. Investigate causes of gaps in SAS reporting and formulate remedial actions to ensure compliance with SAS reporting requirements.

3. Identify supplier performance information of common interest and modify SAS data structure to accommodate such information.

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8. Review a representative sample of PQASPs to identify deficiencies and best practices and revise policy as needed to include quantification and documentation of nonconformance and control risks for ensuring surveillance activities and resources are commensurate with part criticality and overall accepted project risk.

OSMA’s Response: Concur. The Chief, Safety and mission Assurance (SMA) in collaboration with Office of the Chief Information Officer (OCIO), Centers, and Program Offices, will evaluate the benefits and costs for establishing an Agency-wide system architecture that can accommodate cross-Agency quality parts data.