

NASA Feedback to DLA Land & Maritime Moratorium on Wafer Fab Audits

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Outline

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- Detailed Explanation of the Moratorium
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- Data Origin, Comments and Caveats
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- Summary of Audit Results (findings for Discretes)
- Some Concerns Found During Discretes Wafer Fab Audits
- Data Analysis of Audit Records for Time Intervals, Location, Discretes (Transistors and Diodes) Versus Integrated Circuits (ICs), Fab Type
- Three Slide Executive Summary

Acronyms List

- AF Air Force
- CONUS Contiguous United States
- DCAA Defense Contract Audit Agency
- DCMA Defense Contract Management Agency
- DLA Defense Logistics Agency
- EEE Electrical, Electronic & Electromechanical
- ESD Electrostatic Discharge
- FSC Federal Stock Class
- IC Integrated Circuit
- MDA Missile Defense Agency
- NASA National Aeronautics and Space Administration
- NEPAG NASA EEE Parts Assurance Group
- NRO National Reconnaissance Office
- OCONUS Outside Contiguous United States
- QML Qualified Manufacturers List
- TRB Technology Review Board

General Comments

- Audit frequency/intervals have not been consistent over time
  - DLA uses internal decision process to determine audit frequency and this results in a varying audit schedule
- Frequency of military audits is not as high as some QML suppliers lead industry to believe or as often as Voluntary Consensus Standards such as AS9100 require
- Allowing minor findings to accumulate over time risks evolving into major findings
- Danger of undermining the market for "space grade" parts by reducing requirements
  - Desire to have secure supply chain for "all grades" going forward
- Broad spectrum of technology levels and automation exists in the wafer fab supply chain feeding QML products
  - Large scale, commercial IC wafer fabs may require less frequent oversight but occasional audits are still essential and some occasionally require greater oversight/monitoring
- ***Allowing ANY commodity's audit time interval to stretch > 5 years is risky… Connectors!***
- Total # of audit findings is a poor metric for several reasons:
  - Findings from early in an audit may be reconciled prior to audit completion and not counted in the final report.
  - ***Goal should be zero findings (complete conformity) so high numbers of findings do not make a good audit.***

DLA Moratorium on EEE Parts Foundry Audits

Associated Risk: Given historical evidence of utility of the audit process to uncover foundry issues, NASA may be put at increased risk of mission failure due to undiscovered deficiencies.

Additional Considerations:

- While initial moratorium was for 6 months, DLA did not provide statement for plan after that initial period
- Different EEE parts foundries were already being audited/re-audited under differing schedules depending on type with some large, commercial IC fabs only being audited internally by customers (no government representation) after an initial DLA QML certification audit or DLA approval visit
  - Re-audits already occur on a 3-5 year interval; further extension to 6-7 years can be expected to increase risks
- Two EEE parts manufacturers reached out to NASA stating that qualification audits for new products were being delayed with potential negative impact to their business
- Quality assurance requirements under the FAR could be violated
- Impact to flight projects likely to begin later in FY18 when seeking newer technology (improved size, weight, and power) devices (i.e., new procurements)
  - Increased risk and decreased accessibility

Strategy, Progress, and Challenges:

- NASA, Air Force, NRO, Navy, and MDA (government agency customers) all worked on inputs to DLA but only NASA formally submitted a letter stating expected concerns and impacts and NASA's opposition to the moratorium
  - NASA has performed data analysis of audit records to better understand the historical auditing practices

Suggested Actions

Continue regular audits of internal wafer fabs

- Audit teams will already be on-site to perform full process audit anyway
- Keeping wafer fab audits to ½ day within the scheduled audit should not incur additional costs

Continue regular audits of external wafer fabs because:

- Benefits of audits outweigh potential risks of not performing regular site visits
- The proportion of external wafer fab audits is lower than expected and more CONUS than anticipated

Intermediate Suggestion involving non-DLA Auditing

- Could DLA place more emphasis on review of "internal audits"/"TRB" from QML supplier self audit or external audit of their wafer fab sources?
- Could DLA accept interim audit support from other govt auditing agencies (e.g., DCMA, DCAA, other)?
- Could DLA accept "customer audits" performed by QML supplier on their wafer fab?
  - Develop a more formalized process for external fab audits by QML supplier. In these cases, the QML supplier may have greater access to fab compared to DLA
  - Audit focus on documentation/criteria for critical factors that impact success of facility

Could DLA make more efficient use of resources by combining audits for 202, 750, 883 rather than doing separate audits for each standard? Similarly can different commodities be audited by a single team?

Consider utilizing DLA-VA (specification writing team) members to support selected DLA-VQ audits

- *Available resource with insights/perspectives (not green with respect to the commodity areas)*
- *Cross training opportunities*

VIRTUAL Audits using streaming video?

DLA Land & Maritime Wafer Fab Audit Moratorium

Memo DSCC-VQ-17-031774 (Alan Will/DLA-VQ Chief Sourcing & Qualifications Division)

- Sept. 1, 2017 DLA-VQ initiated **6-month moratorium for audits involving wafer fabs**
  - Wafer fabs produce semiconductors for integrated circuits (MIL-PRF-38535) and discrete semiconductors (MIL-PRF-19500 diodes, transistors).
  - Reason: DLA-VQ effort to evaluate workload & limited resources vs. risk of modifying current surveillance practices across 70+ Federal Stock Classes (FSC) under the jurisdiction of DLA-VQ

- DLA-VQ has requested data from the community to assist with decisions on wafer fab re-audit cycle
  - NASA has attempted to use available information on audit schedules to provide such data
- This presentation is intended to provide feedback as requested by NASA HQ, DLA-VQ and others

Focus of the Data Analysis

- NASA saw the request for data as focused on the questions:
  - Will there be a noticeable increase in part failures? *Impossible to Answer*
  - What impacts will the moratorium have on the supply chain? *The most critical part of the QML process flow will not be audited*
  - What risks are likely to result? *See Analysis Herein*
  - How will the moratorium change characteristics of the auditing process? *Third party audits acceptable to DLA?* Will discretes and ICs be affected differently? *Probably*
  - Does past performance suggest any ways that costs and resources could be contained without significant negative impact on effectiveness of surveillance? *DLA already employs flexibility when determining audit priorities and audit frequency. For example, suppliers with regular positive audit results tend to be audited at reduced frequency*
  - Will DLA gain significant resources by cutting back wafer fab audits?
- In short, can auditing efficiency be improved while maintaining effectiveness?
- Effective auditing can require special expertise, training and experience without which there is a risk of reduced effectiveness and errors.
- DLA needs to exercise caution when spreading resources from one commodity area to address shortages in others

Data Origin and Comments

- NASA used the following data:
  - DLA audit scheduling history for ICs and Discretes for past 13 years
  - QMLs for M19500 and M38535
  - First-hand input from NASA auditors who support DLA audits worldwide, mostly current or potential QML/QPL suppliers of "Space Grade" parts, Class V and JANS for semiconductors
- There are caveats to the accuracy and completeness of the data but it is believed to provide a useful foundation for understanding historical trends and variations

Caveats for This Analysis

1. EXCEL spreadsheet that compiled the DLA audit scheduling history was not originally intended for this kind of analysis.
2. NEPAG reviewed the EXCEL file and QMLs to categorize audit type as follows:

Internal Wafer Fabs
External Wafer Fabs
Fabless

- ***Facility produces wafers to be used by off-site QML device manufacturers***
- ***Facility produces wafers AND uses them on-site to produce QML devices***
- ***Facility is a QML device supplier that does not produce wafers on-site***

- Added audit location details if missing and if known
- Corrected typos

3. Any audit that is listed is assumed to have been performed on the date and location provided
4. Doesn't fully account for efficiencies from "group" audits (usually OCONUS) where multiple audits are performed by a single team, in one geographic area, in a single trip

Example of DLA Audit Scheduling Spreadsheet

- Since 2005 DLA VQ has provided NEPAG with a weekly audit schedule forecast covering the next 90 days of audits
- NEPAG compiled the DLA audit forecasts into an EXCEL spreadsheet for use in resource planning/participation.
- It has been adapted for analysis of DLA auditing practices for ICs, discrete semiconductors and associated wafer fabs

Example of DLA Audit History for ICs & Discrete Semiconductors.
NASA's historical involvement goes back at least 30 years.

Commodity	Audit Date	Company	NEPAG Member Supported Audit?	Location
Discrete Semiconductor	1/25/2005	International Rectifier		Temecula, CA
Discrete Semiconductor	2/14/2005	International Rectifier	YES	Tijuana, Mexico
IC	2/14/2005	National Semiconductor	YES	Santa Clara, CA
Discrete Semiconductor	2/28/2005	Micropac Industries	YES	Garland, TX
IC	3/1/2005	Landsdale Semiconductor		Scottsdale, AZ
Discrete Semiconductor	3/14/2005	Bourns, Ltd.	YES	Bedford, UK
IC	3/22/2005	LSI Logic	YES	Portland, OR
Discrete Semiconductor	4/5/2005	Microsemi – Scottsdale	YES	Scottsdale, AZ
IC	4/11/2005	Minco Technology Labs	YES	Austin, TX
IC	4/25/2005	Pyramid Semiconductor	YES	Sunnyvale, CA
Discrete Semiconductor	5/2/2005	ChipPac		Kuala Lumpur, Malaysia
IC	5/3/2005	Criteria Laboratories	YES	Austin, TX
IC	5/16/2005	MMT	YES	Bangkok, Thailand
IC	6/7/2005	LSI Logic		Ft. Collins, CO
Discrete Semiconductor	6/13/2005	Microsemi		Broomfield, CO
IC	6/23/2005	Honeywell Aerospace	YES	Plymouth, MN
IC	6/28/2005	Simtek Corporation	YES	Colorado Springs, CO

Importance of Wafer Fab Audits to NASA?

- Fab audits can identify issues in earliest part of process, the most effective way to prevent problems downstream
- Audits help to identify low risk suppliers, candidates for less frequent surveillance
- Audits help to identify high risk suppliers and opportunity for corrective actions
- Audits demonstrate to the supplier that the government customer is serious about compliance to requirements
- Audits may reveal inadequately specified or unachievable military requirements, thus prompting needed modifications to specifications, standards and practices
- Audits provide access to knowledgeable, valuable contacts within the supply chain

Summary of DLA Audit Results for Discrete Semiconductors December 2014 to December 2017

(Includes Only Audits with NEPAG Participation)

Observation: "Minor" findings have the potential to evolve into MAJOR findings if the audit surveillance does not catch the issue in time

December 2014 to Present	Total Number of DLA Audits	Fab-Related Findings		Non Fab-Related Findings		Total Findings
		major	minor	major	minor	
External Wafer Fab	11	6	122			128
Internal Wafer Fab	7	3	32	8	127	170
Fabless	12			4	187	191
Totals	30	1 major every 2 fab audits (external and internal fabs)	~9 minors average per fab audit	~ 0.6 major per audit	~ 17 minors average per audit	~ 17 average major & minor per audit

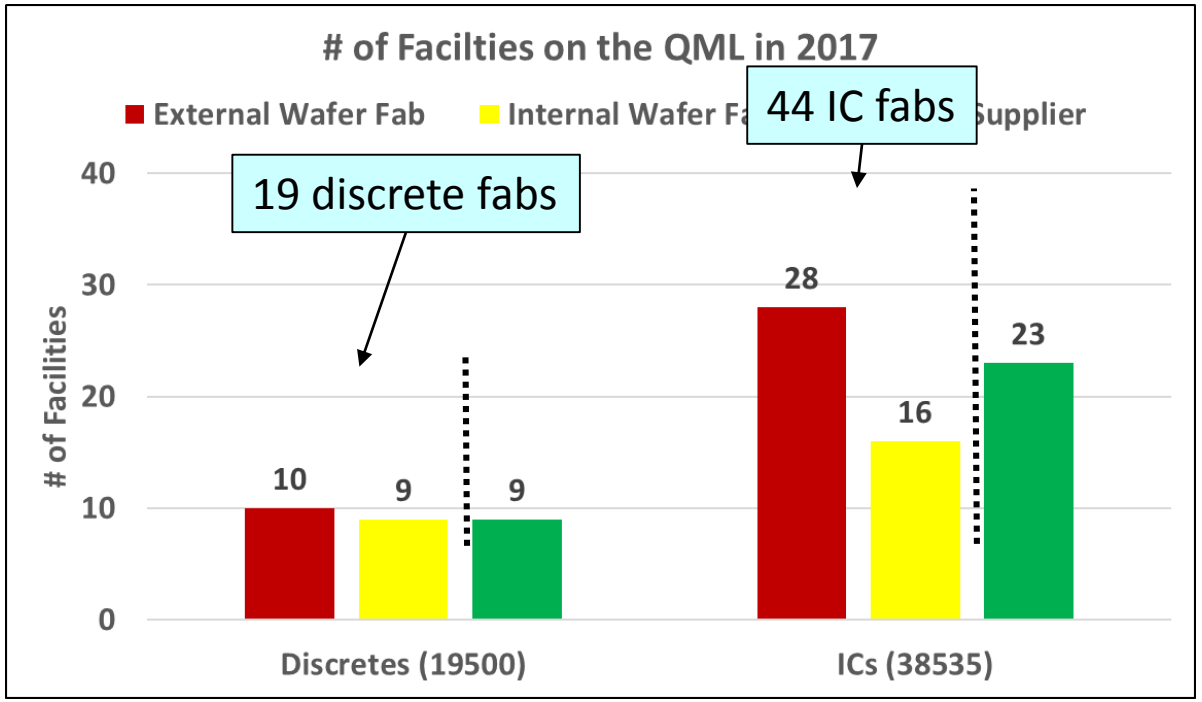
- Fabless Audits = 12/30 or 40%
- Internal Wafer Fab Audits = 7/30 or ~25%
- External Wafer Fabs = 11/30 or ~35%
- **Major** non conformances are being found in Fabs

Types of Major Audit Findings Include:

- **Various issues that (might) have a direct effect on product quality/reliability**
- **Blatant failure to implement/comply with military standard or customer-specific requirements.**
- **Evidence of improper operation/disrepair of a critical system or procedure.**
- **Repeat audit finding for an issue identified during previous audits where supplier did not implement corrective actions they planned to have made**

of Facilities that Support the QML Supply Chain

For ICs and Discrete Semiconductors only

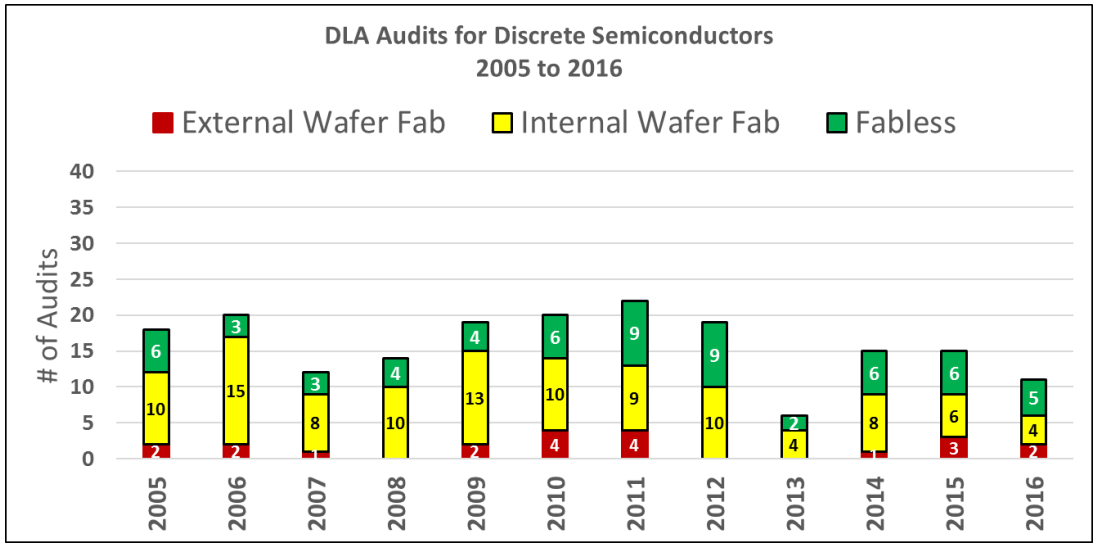


- **External Wafer Fab = produces wafers and sells them to other companies for use in the finished QML device**
- **Internal Wafer Fab = produces finished QML device using die from wafers produced in-house**
- **Fabless Supplier = produces finished QML device using die produced by an external wafer fab**

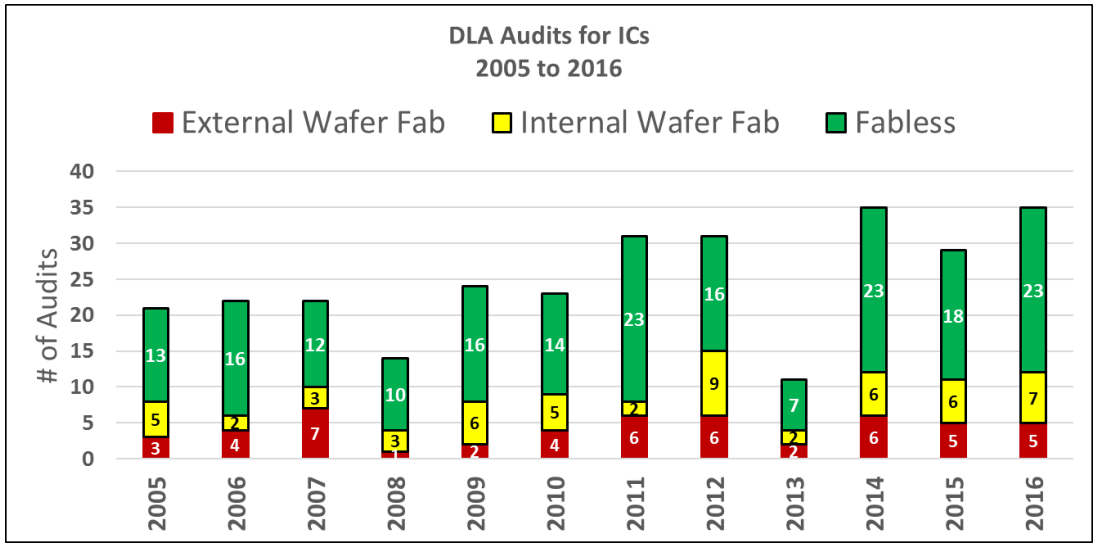
- **Observations & Effects of Moratorium:**
  - **19 discrete and 44 IC wafer fabs will not be routinely audited**
  - **9 discrete and 16 IC internal fabs could be audited during routine DLA audits of QML suppliers**
  - **~1/3 of all facilities are fabless**
  - **ICs are proportionally more dependent on external wafer fabs**

of DLA Audits by Commodity, Fab Type vs. Year 2005 to 2016

Discrete Semiconductors



ICs

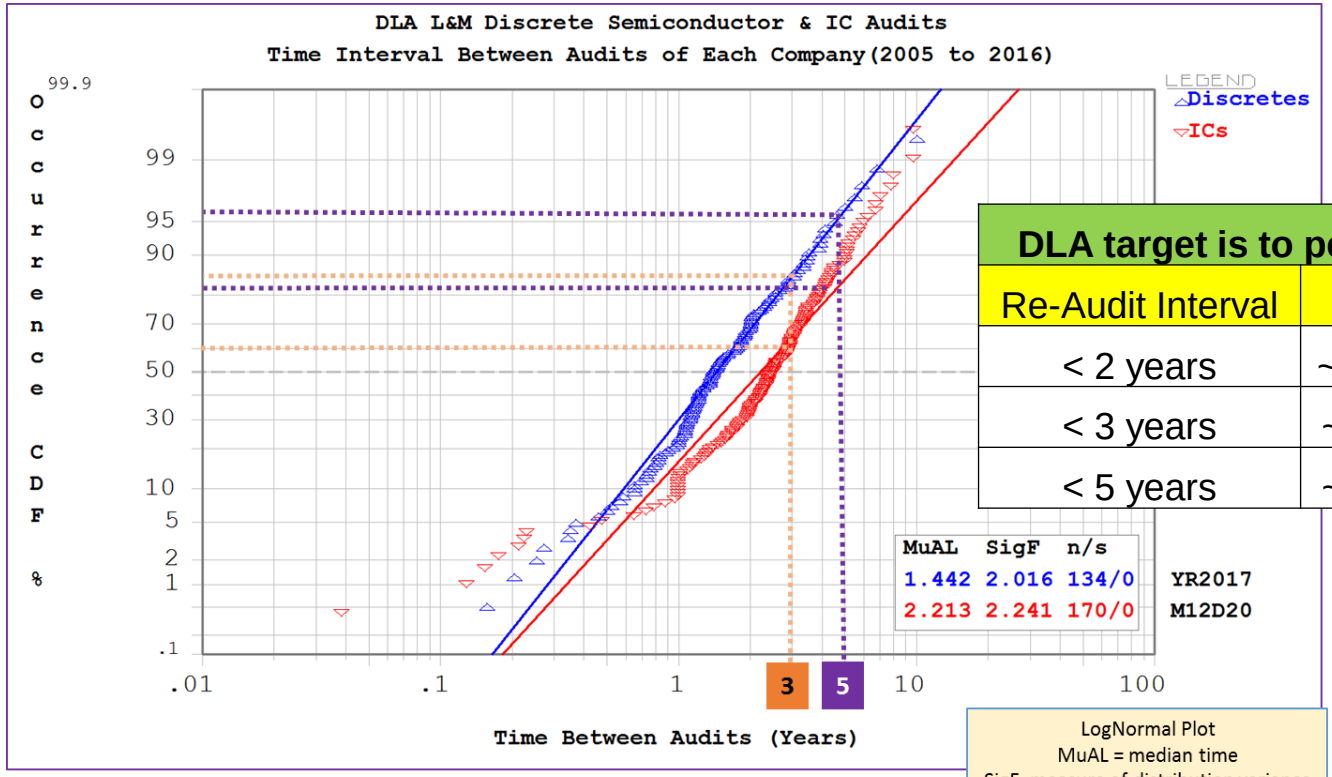


Observations:

1. *Recommend DLA continue audits of "internal fabs" since audit teams will already be on location for routine QML supplier audits.* ***Discontinuing internal fab audits might only save 1/2 day***
2. *Continuing internal wafer fab audits would have proportionally greater benefit for Discretes than for ICs*

DLA Re-Audit Time Interval

Discrete Semiconductor and IC Audits from 2005 to 2016



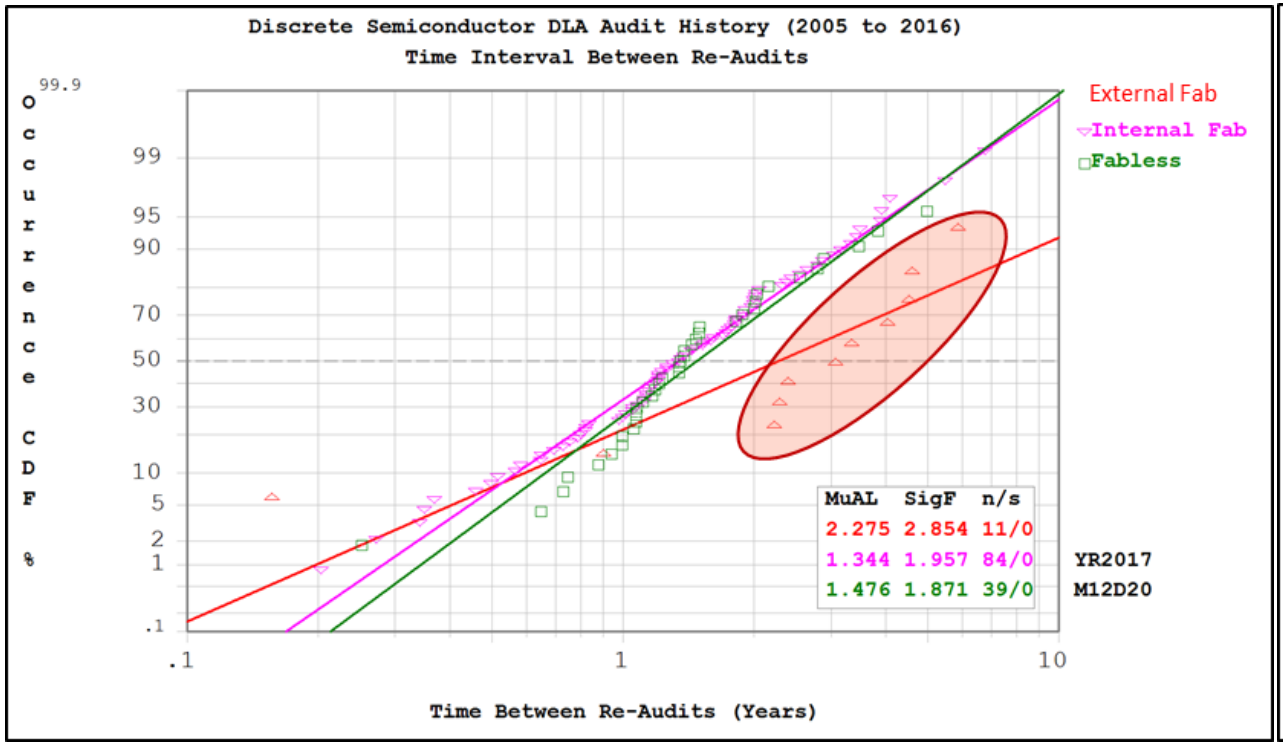
DLA target is to perform Re-Audit ~ 2 year Intervals		
Re-Audit Interval	Discretes	ICs
< 2 years	~70% of Audits	~48% of Audits
< 3 years	~85% of Audits	~60% of Audits
< 5 years	~97% of Audits	~82% of Audits

Observations:

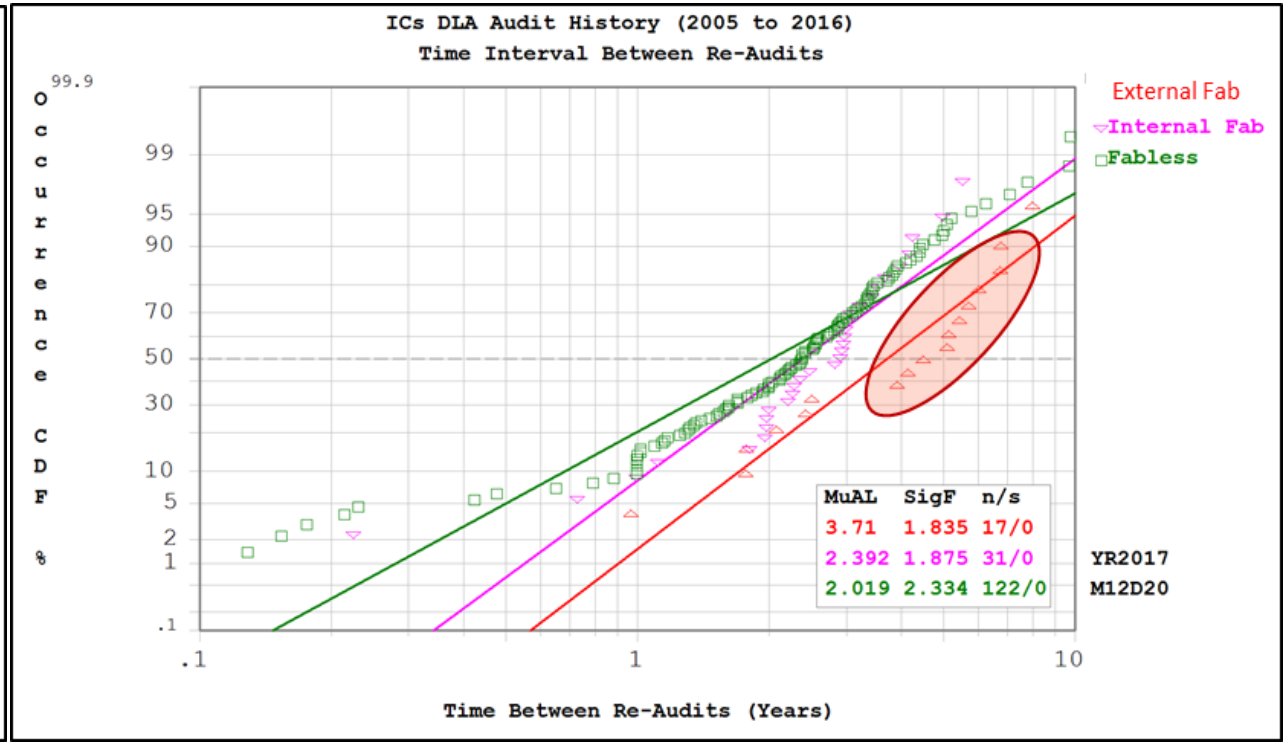
- Attainment of 2 year re-audit time interval has been close for discretes but not for ICs
- Re-audit time intervals may be influenced by comings and goings:
  - Mergers, acquisitions, new players, etc. AND problem audits and facility moves

DLA Re-Audit Time Interval based on Commodity and Fab Type Audits from 2005 to 2016

Discrete Semiconductors



ICs

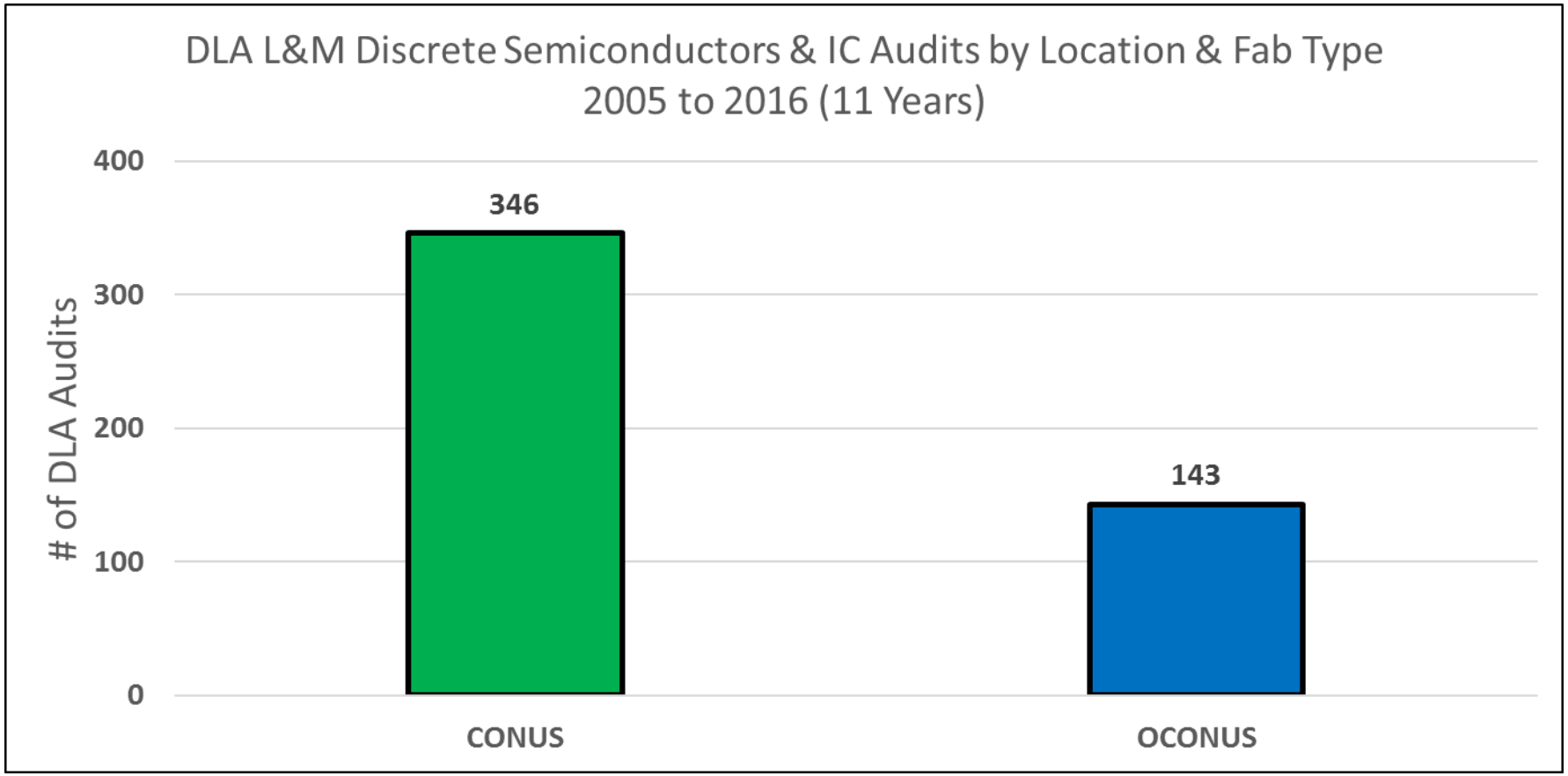


Observations:

1. External Wafer Fab Re-Audits occur ~ 2.3 years for discretes and ~3.7 years for ICs

MuAL = median time
SigF = measure of variance
n/s = number of repeat audits

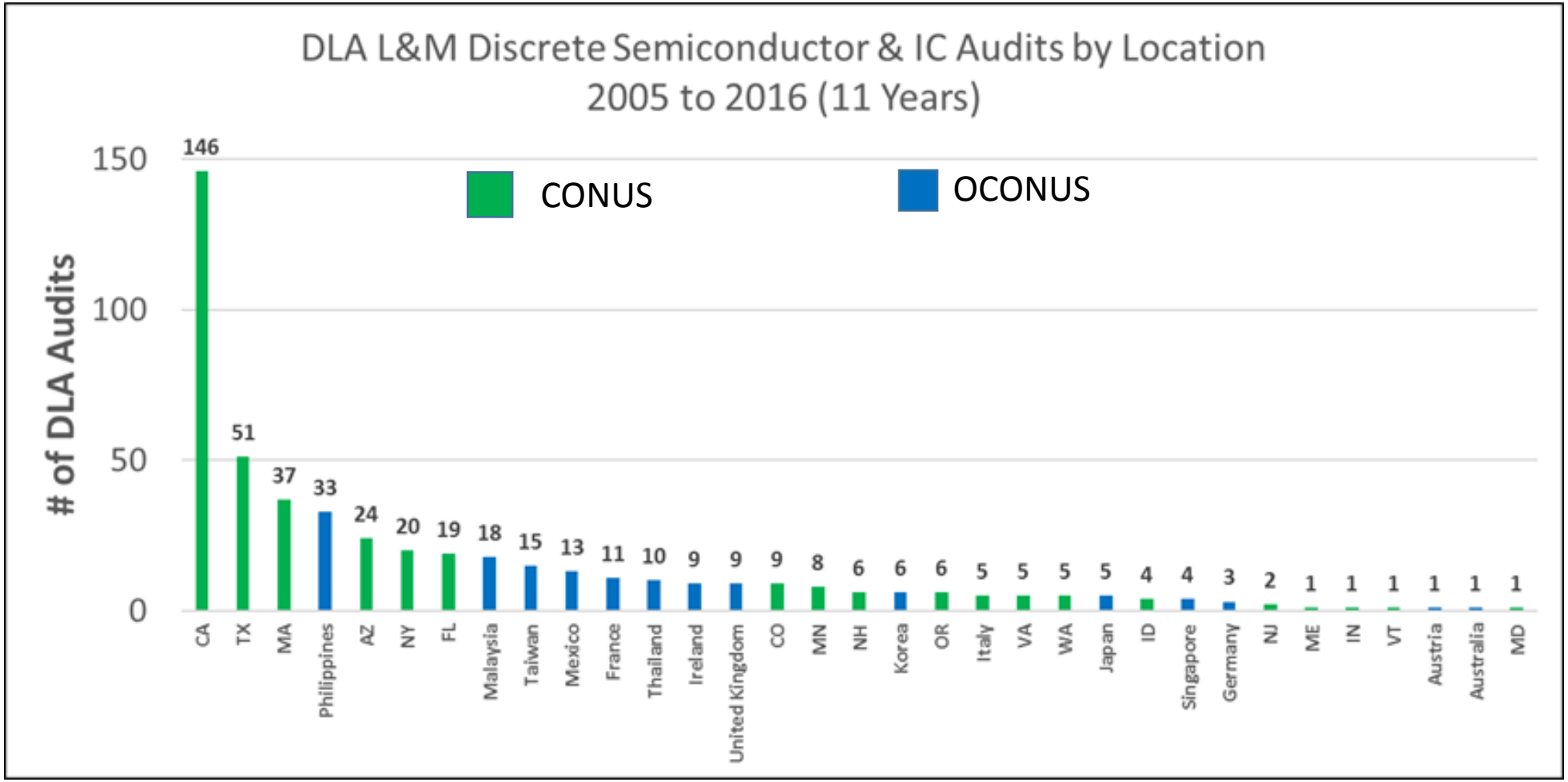
of Audits by Geographic Region Over 11 Year Period (2005 to 2016)



Observations:

1) 2.4 times as many domestic audits compared to international audits during this time period

of Audits by Geographic Region Over 11 Year Period (2005 to 2016)



Three Slide Executive Summary

NASA Data Analysis

- NASA saw the DLA request for data as focused on the questions:
  - Will there be a noticeable increase in part failures?
  - What impacts will the moratorium have on the supply chain?
  - What risks are likely to result?
  - How will the moratorium change characteristics of the auditing process?
  - Does past performance suggest any ways that costs and resources could be contained without significant negative impact on effectiveness of surveillance?
- In short, can auditing efficiency be improved while maintaining effectiveness?

General Comments From NASA Analysis and Discussions

- Audit frequency/intervals have not been consistent over time
- Frequency of military audits is not as high as some QML suppliers lead industry to believe
- Large scale, commercial IC wafer fabs may require less frequent oversight but occasional audits are still essential
- Allowing minor findings to accumulate over time carries risk of evolving into major findings
- Danger of undermining the market for “space grade” parts by reducing requirements
- Broad spectrum of technology levels and automation in the supply chain, especially discretes
- External Fabs may impose restrictions on DLA such as Non Disclosure Agreements (PDAs)
- ***Allowing wafer fab (indeed ANY commodity) audit time interval to stretch > 5 years is risky… Connectors***
- An audit with zero findings can be as valuable as one with many

The Goal Of Auditing Is To Identify And Eliminate The Source Of Nonconformances And Low Quality With The Ideal Result Of Zero Findings

Recommendations

- Continue regular audits of **internal** wafer fabs; the team is already there
- Continue regular audits of **external** wafer fabs:
  - Benefits outweigh technical risks and analysis shows number of external fab audits is less and more CONUS than expected
- Intermediate Suggestion involving non-DLA Auditing
  - Place more emphasis on DLA data review of QML self audit or external audit of their wafer fab sources
  - DLA accept interim audit support from other govt auditing agencies (e.g., DCMA, DCAA, other)?
  - Accept “customer audits” performed by QML supplier on their external wafer fabs?
- Make more efficient use of resources - combine test lab audits for 202, 750, 883 rather than doing separately
- Consider utilizing DLA-VA (specification writing team) members to support selected DLA-VQ audits