2018 MARPA Conference

FAA PMA Overview

Presented to: PMA 101 Workshop

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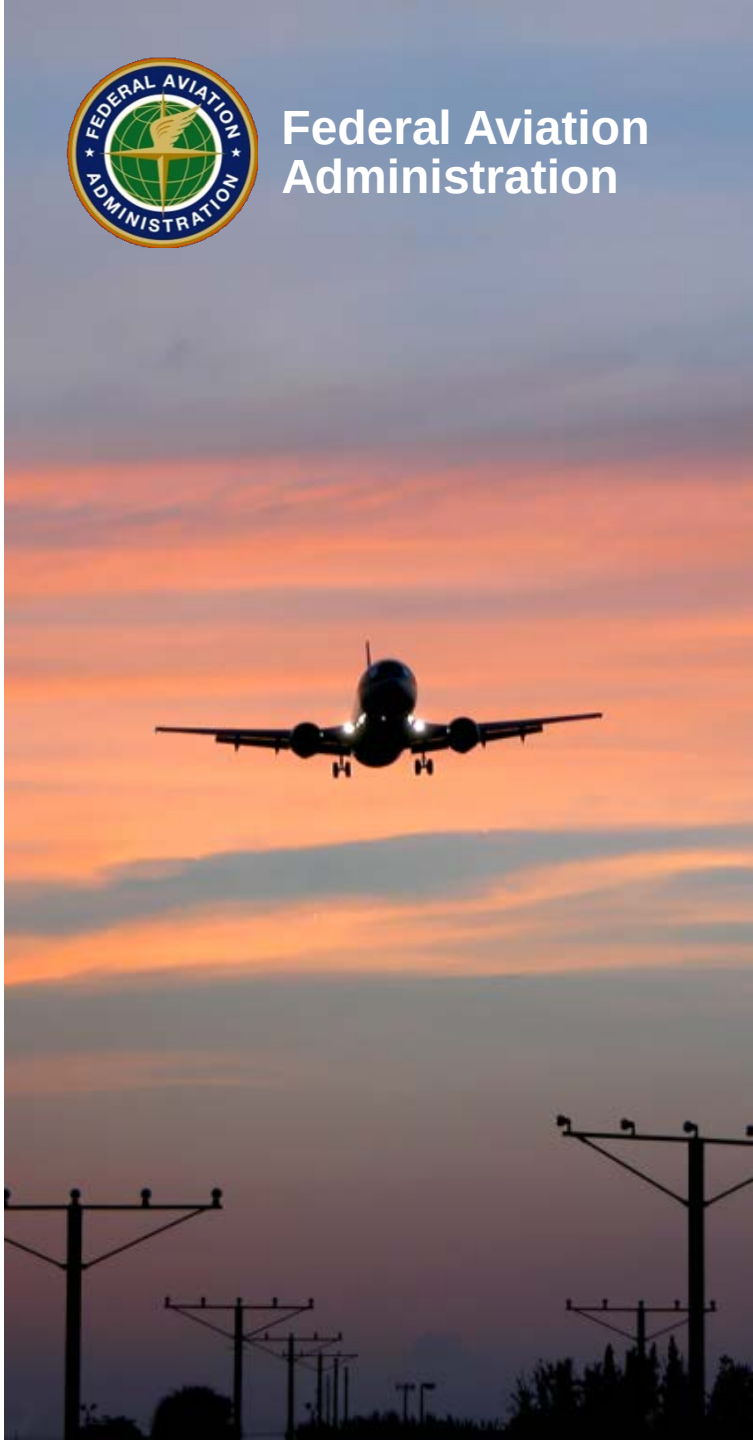
Date: October 2018

Federal Aviation Administration



Topics

- PMA Basics
- How did we get here?
- Metrics
- Current PMA CFRs, Policy and Guidance
- Manufacturing/MIDO and Operator PMA Considerations
- AC 21-303 In-depth PMA Application Walkthrough
- Questions

What is a PMA?

- **Replacement or Modification Article**
- **PMA Includes Installation Eligibility on specific Make/Model Products**
- **Combined design and production approval**
  - Aircraft Cert Offices (ACO) find design compliance
  - Manufacturing District Inspection Office (MIDO) approve the production
- **4 PMA Methods**
  - Test Reports and Computations (T&C)
  - Identicality without a Licensing Agreement
  - Identicality with a Licensing Agreement
    - Approved Design - Application goes straight to MIDO
  - Supplemental Type Certificate
    - Approved Design - Application goes straight to MIDO

Identicality

How did we get here?

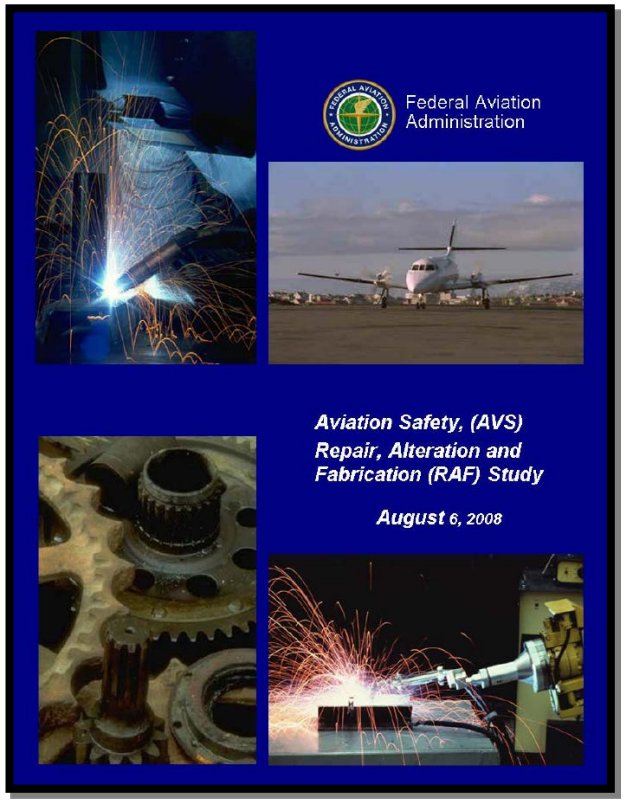
- **Key events in PMA history**
  - July 1955: “PMA” began in with Civil Air Regulation (CAR) 1.55
    - Allowed people other than certificate holders to produce replacement parts for sale on civil aircraft.
    - Filled need to replace parts for out of production military aircraft that were in civil use after WWII
  - 1965: 14 CFR part 21.303
    - Set the original basis for replacement and modification articles (called parts way back then)
    - 21.303 circa 1965 to 1972 was VERY descriptive
      - Contained many of the key steps in what would become known as the “PMA process"

How did we get here?

- **Key events in PMA history**
  - 1972: 14 CFR part 21.303 is revised along with a large portion of part 21 in general
    - Formally establishes 2 main methods of PMA
      - Test and Computation and Identicality
    - AC 21-303.1A becomes the first real “guidance” document issued for the FAA PMA process
      - Design data expectations for identicality and test reports and computations
      - Part numbering requirements
      - Test and Comp must meet airworthiness requirements
      - Identification requirements
      - Detailed guidance on the Fabrication and Inspection System (over 5 pages worth)

The RAF Report

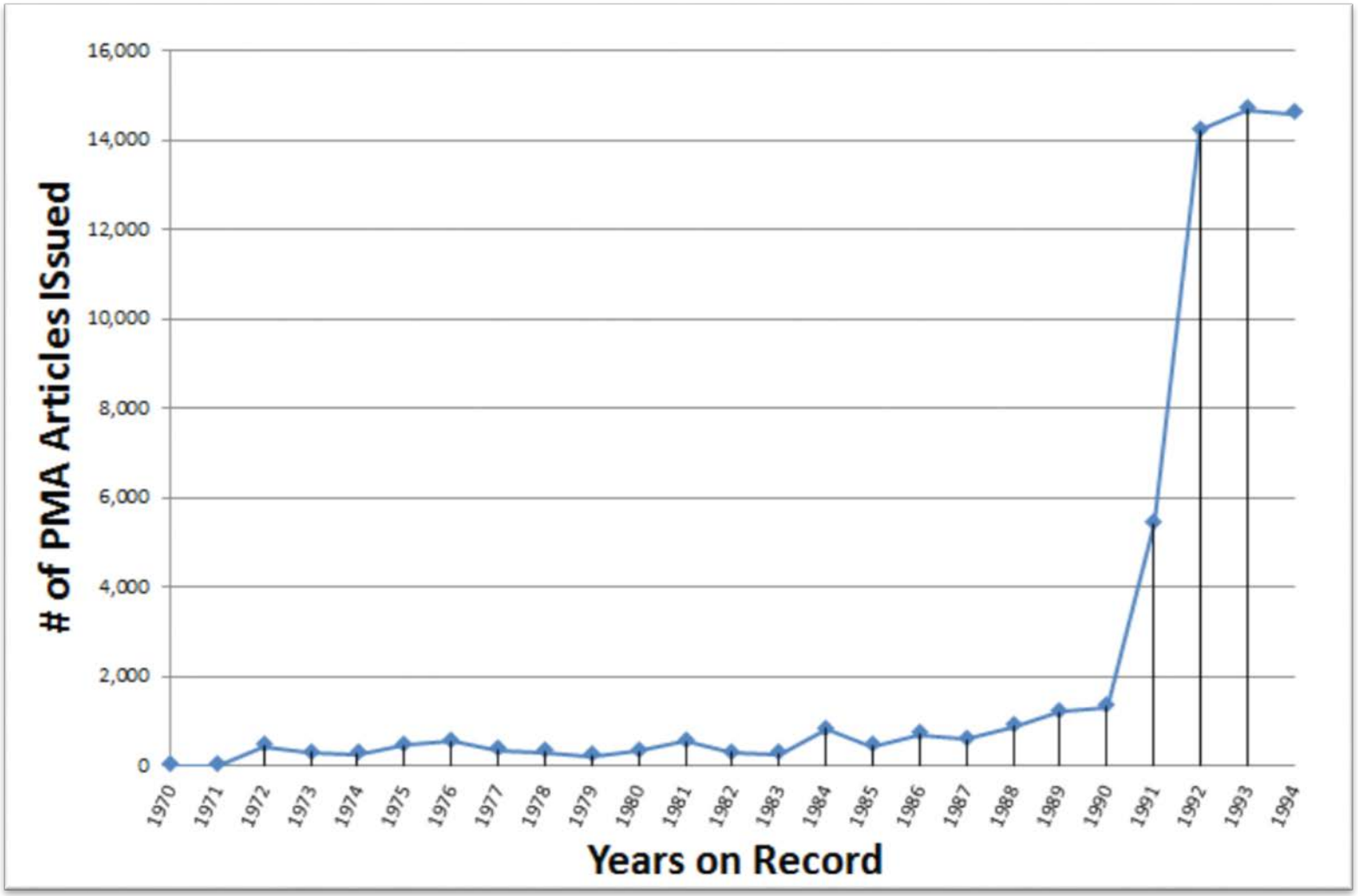
- **Aviation Safety (AVS) Repair, Alteration, Fabrication (RAF) team**
  - Commissioned in 2007
  - Tasked to assess the adequacy of:
    - current and in process regulations, policy, guidance
    - past practices in relation to industry trends for obtaining non-Type Certificate (TC) holder developed replacement parts, alterations, and repairs
- **Published in 2008**



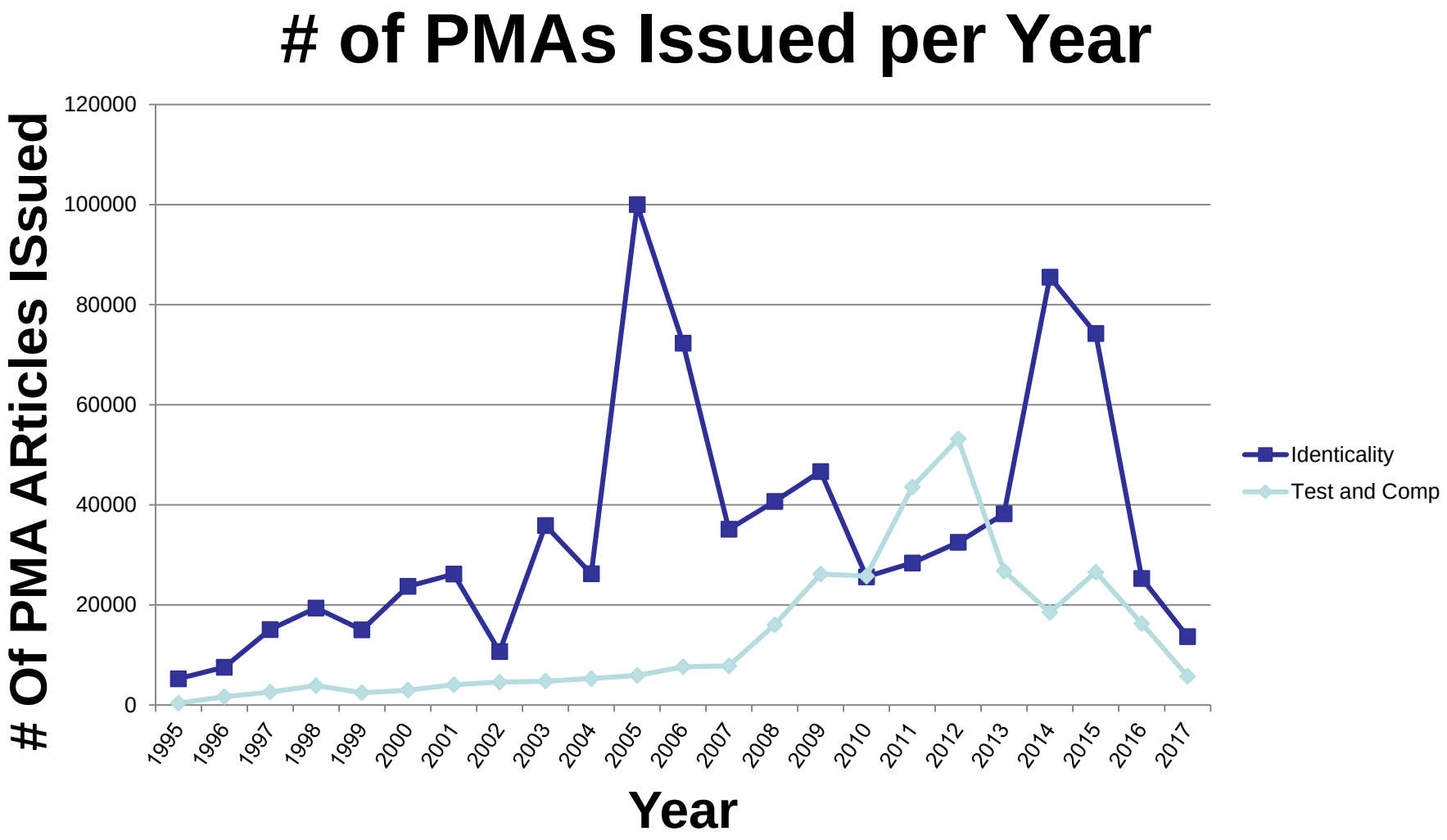
The RAF Report Cont'd

- **RAF Team Key Conclusions (as the relate to PMA)**
  - FAA approved PMAs are not universally accepted around the world by other authorities and owners/operators as having a comparable level of certitude as those developed by the TC/PC holder.
  - A major driver of the debate between TC/PC holders and non-TC/PC holders over the integrity of repairs and replacement parts is the economic business competition between them, not safety.

PMA Metrics


# of PMA Articles ISsued
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
1970
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
Years on Record

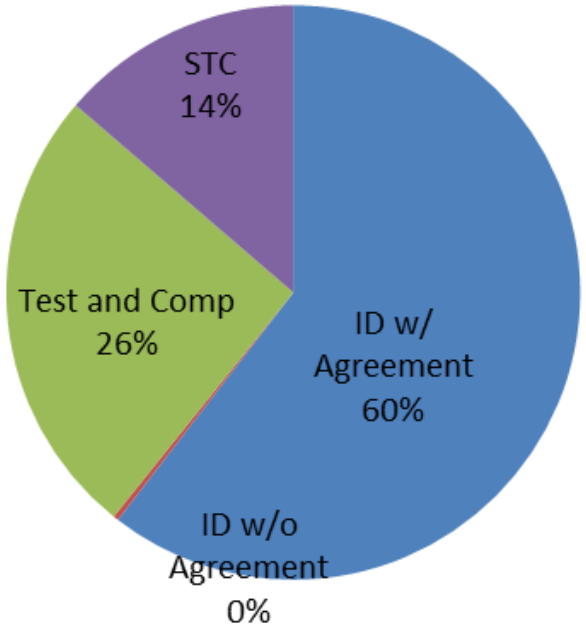
PMA Metrics


# of PMAs Issued per Year
Of PMA ARticles ISsued
120000
100000
80000
60000
40000
20000
0
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
Year
Identicality
Test and Comp

PMA Metrics

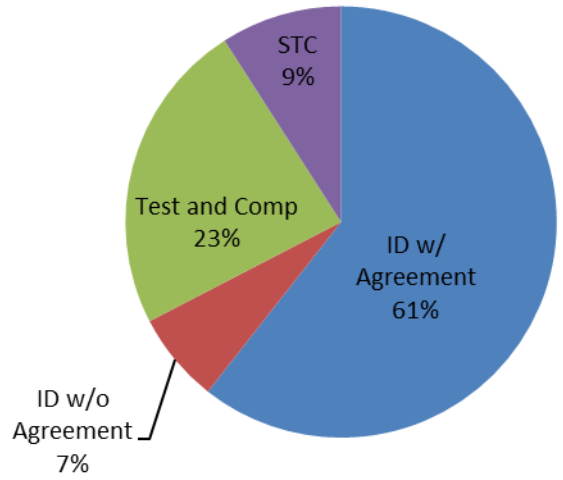
Parts Manufacturer Approval - Totals

22,488 PMA articles in 2017

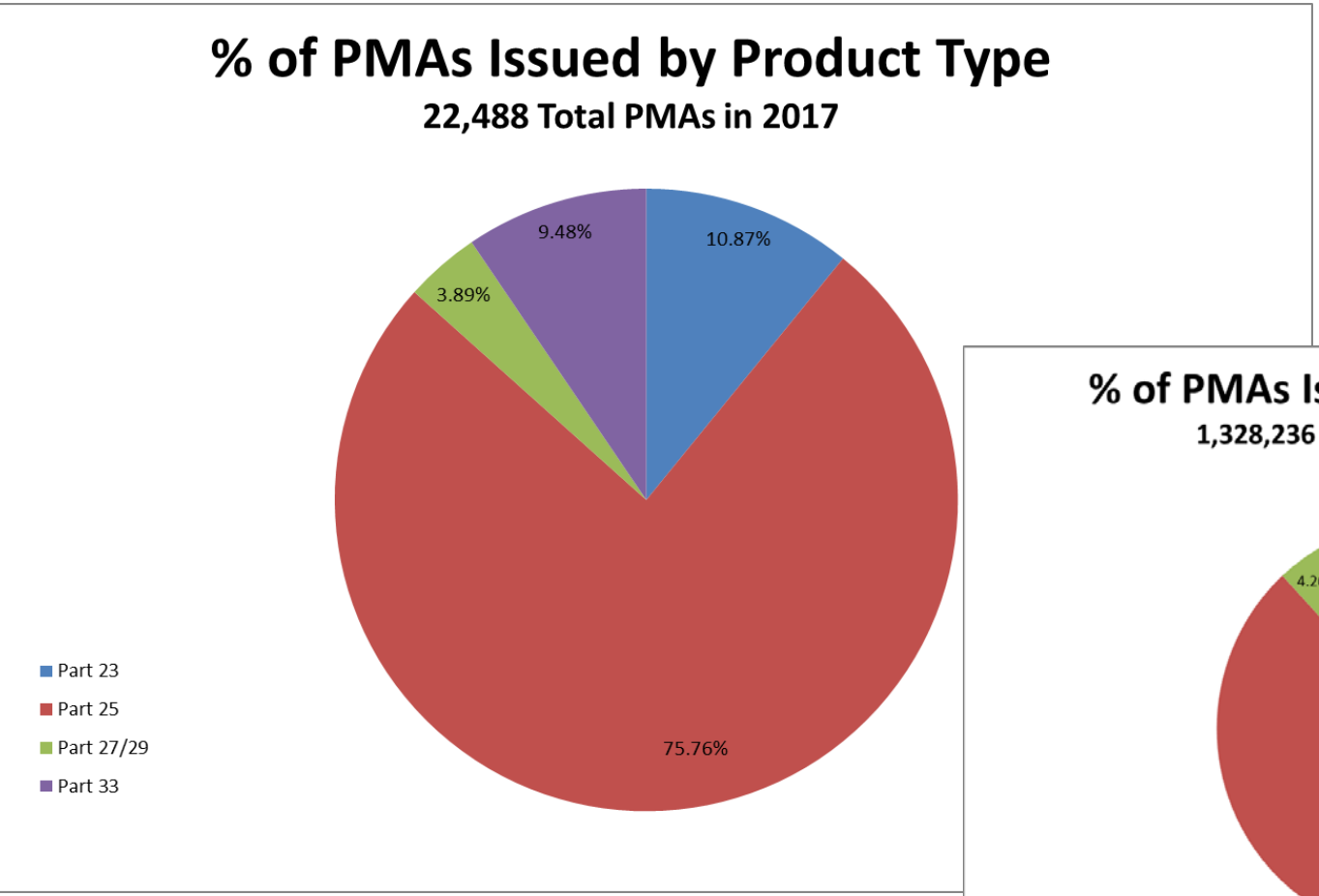


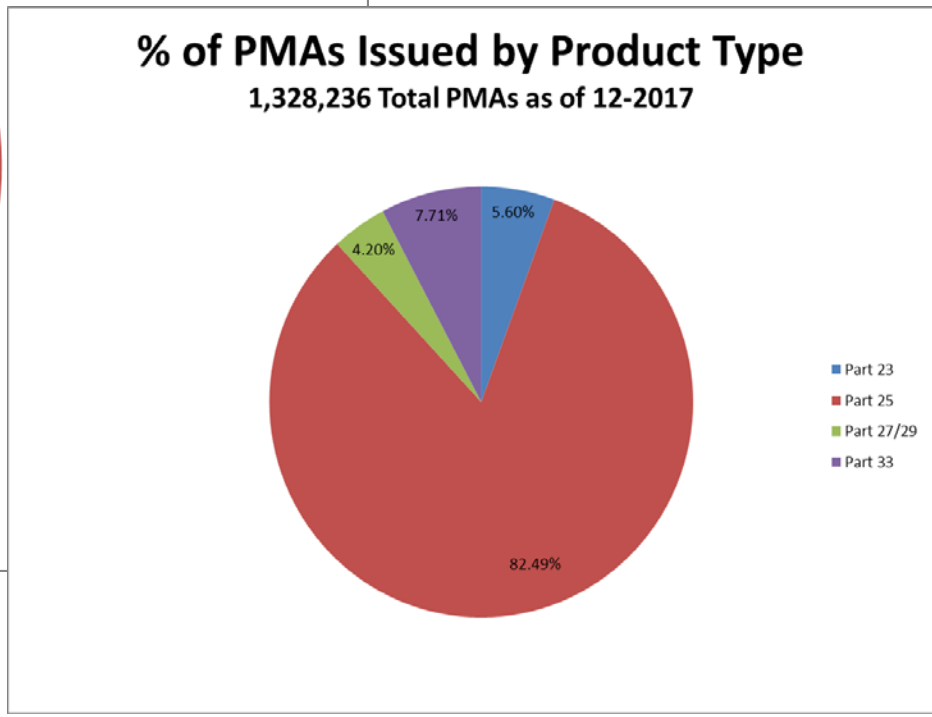
Parts Manufacturer Approval - Totals

1,328,236 PMA articles as of 12-2017

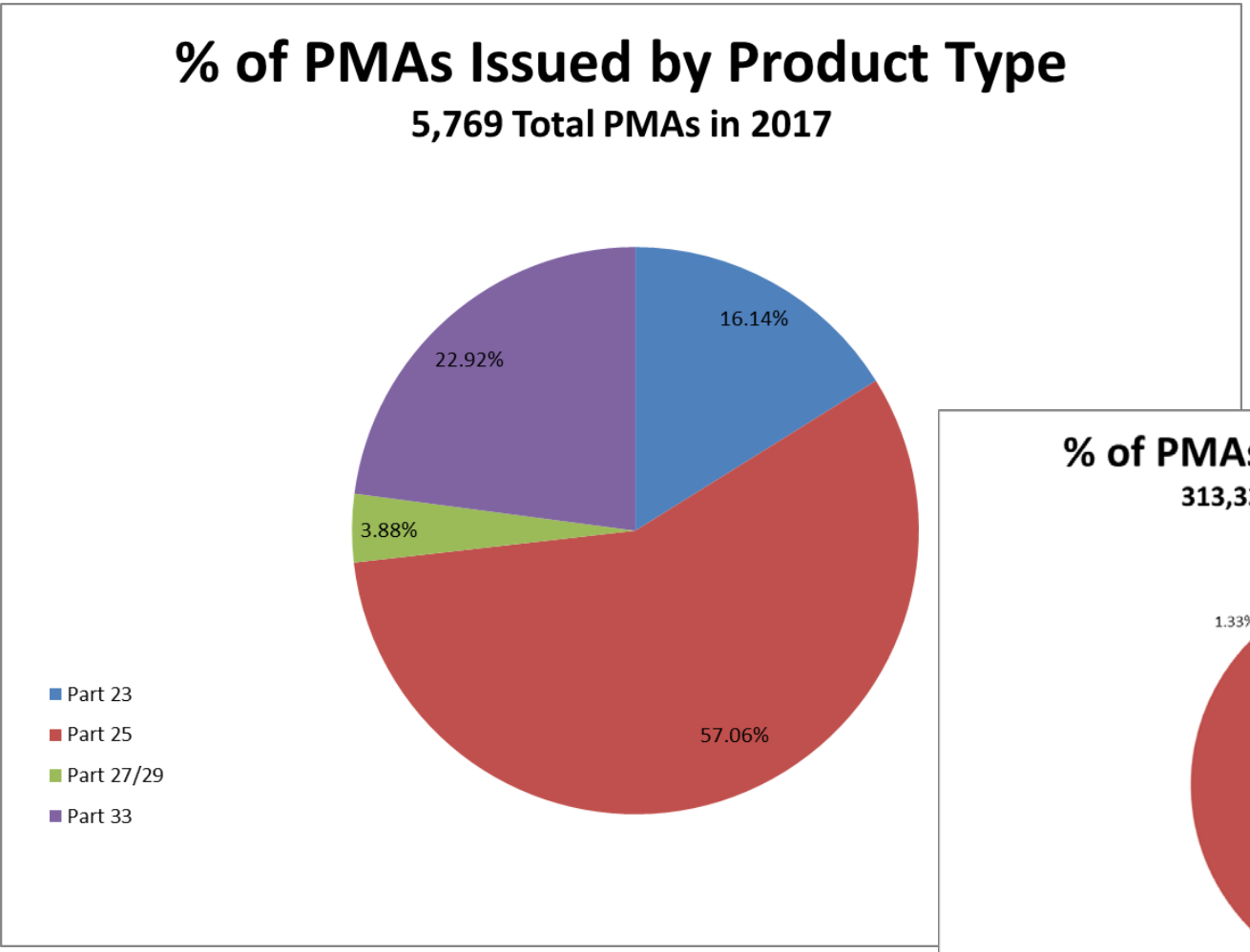


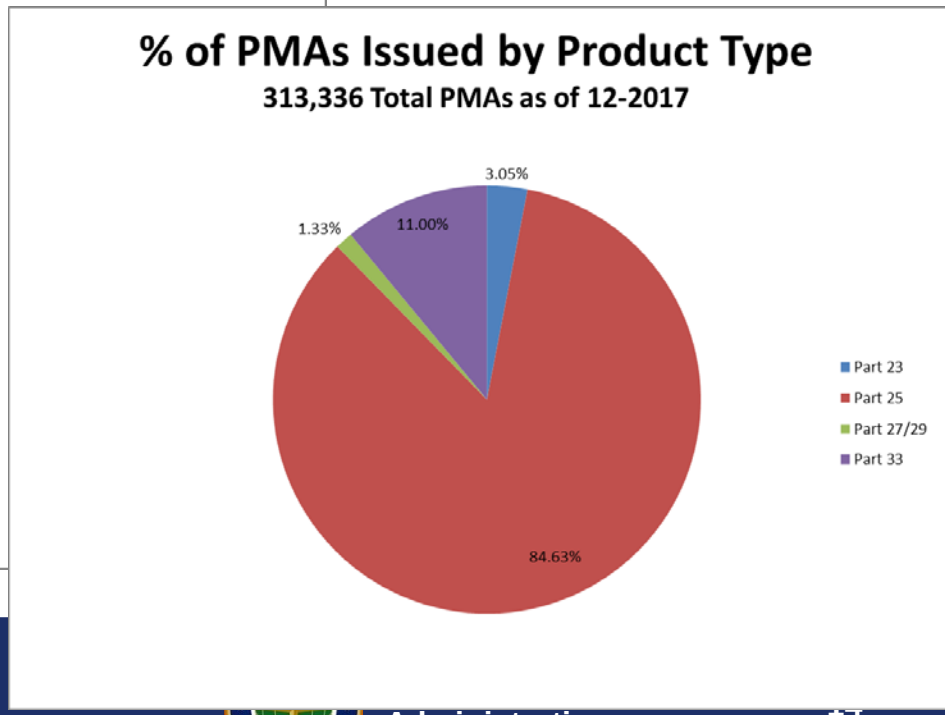
PMA Metrics


% of PMAs Issued by Product Type
22,488 Total PMAs in 2017
10.87%
75.76%
3.89%
9.48%
Part 23
Part 25
Part 27/29
Part 33

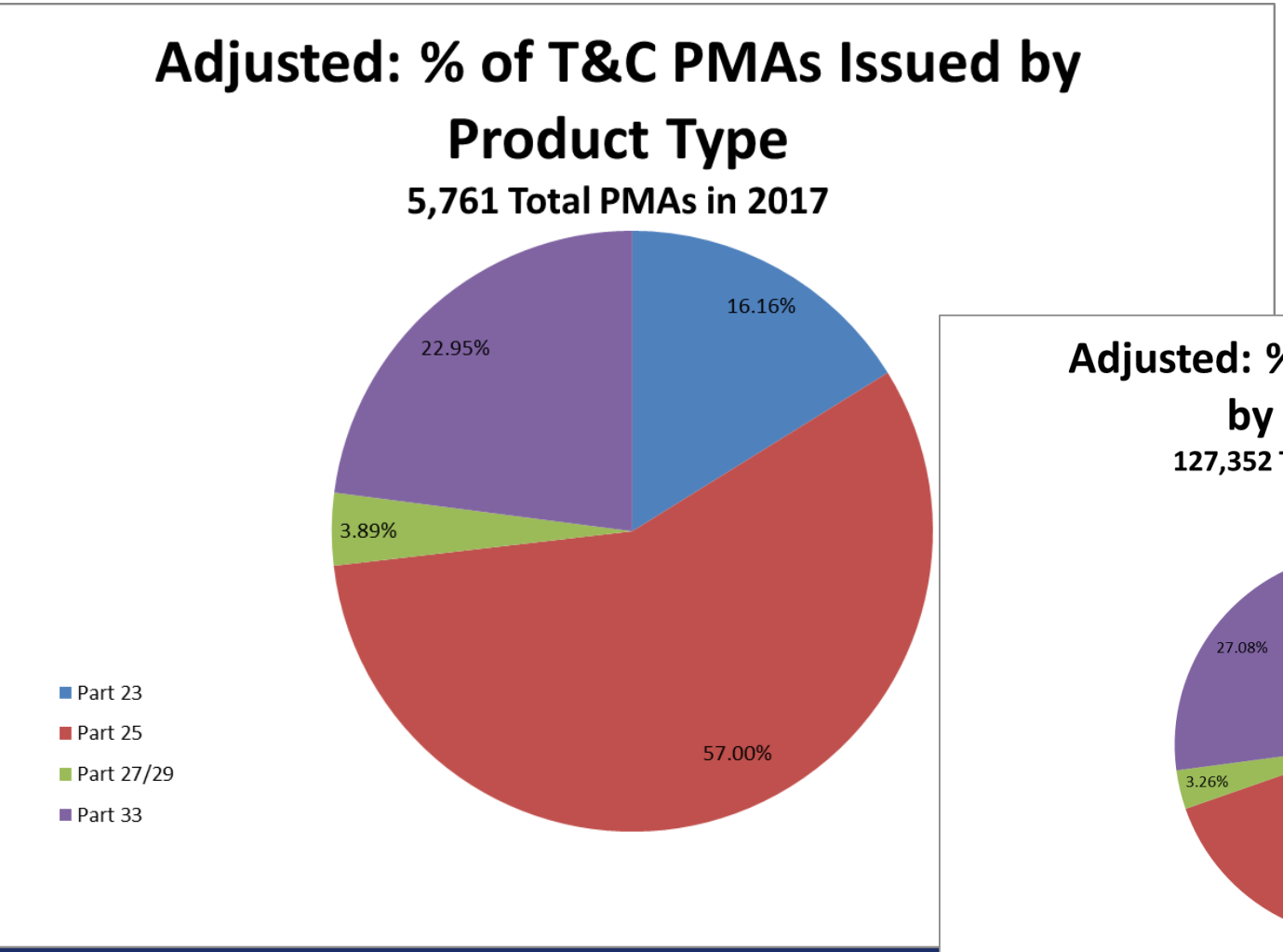

% of PMAs Issued by Product Type
1,328,236 Total PMAs as of 12-2017
5.60%
82.49%
4.20%
7.71%
Part 23
Part 25
Part 27/29
Part 33

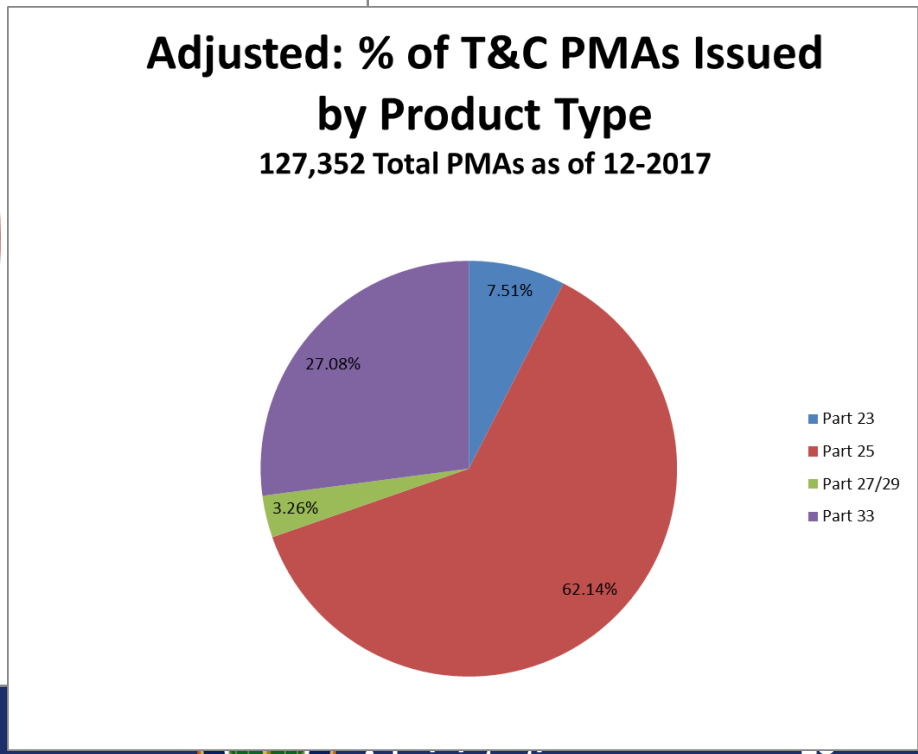
PMA Metrics, T&C





PMA Metrics, T&C adjusted





PMA Regs/Policy/Guidance

- **14 CFR 21, Subpart K**
  - Last updated 16 April 2011
- **FAA Order 8110.42D Change 1**
  - Released 15 September 2017
- **FAA Advisory Circular 21.303-4**
  - Released 21 March 2014
- **FAA Order 8110.119**
  - Released 30 November 2012
- **Production specific guidance**
  - FAA Order 8120.22A & FAA AC 21-43A

14CFR Subpart K, PMA

Subpart K--Parts Manufacturer Approvals

Sec. 21.301	Applicability.	21-92	04/16/2011
Sec. 21.303	Application	21-92	04/16/2011
Sec. 21.305	Organization	21-92	04/16/2011
Sec. 21.307	Quality system	21-92	04/16/2011
Sec. 21.308	Quality manual	21-92	04/16/2011
Sec. 21.309	Location of or change to manufacturing facilities	21-92	04/16/2011
Sec. 21.310	Inspections and tests	21-92	04/16/2011
Sec. 21.311	Issuance	21-92	04/16/2011
Sec. 21.313	Duration	21-92	04/16/2011
Sec. 21.314	Transferability	21-92	04/16/2011
Sec. 21.316	Responsibility of holder.	21-92	04/16/2011
Sec. 21.319	Design changes	21-92	04/16/2011
Sec. 21.320	Changes in quality system	21-92	04/16/2011

CFR §21.303 PMA Application

- The governing regulation for PMA design is 14 CFR § 21.303
  - § 21.303(a)(3), the design of the article, and
  - § 21.303(a)(4) Test reports and computations must show that the design of the article meets the airworthiness requirements.
    - The test reports and computations must be applicable to the product on which the article is to be installed, unless the applicant shows that the design of the article is identical to the design of a article that is covered under a type certificate
- Compliance to regulations can be shown by Comparative Analysis or General Analysis, or a combination of both

§21.307, PMA Quality System

§21.307 refers to Section 21.137, which defines the requirements for the applicant's quality system

Also Orders 8120.22 & 8120.23

Same requirements for a PC under 14 CFR, Subpart G or production of a TSOA

PMA Policy/Guidance

- **Order 8110.42D**
  - Provides guidance to FAA Aircraft Certification Offices (ACOs) working projects
  - Only applies to PMA via Identicality without a licensing agreement or via Test & Comp
  - Identifies what is required for all PMA applications
  - Details the steps to finding compliance with the regulation in Subpart K.
  - Clarifies the “grey areas” and puts requirements in “plain language”
  - Provides examples for notification letters and draft supplements

Order 8110.42D Test and Comp

- PMA T&C Safety Assessment
  - Review articles safety significance to determine
    - Critical, life-limited, influencing
    - AC 33-8 – Category 1, 2, 3
    - No safety effect, minor, major, hazardous, catastrophic
  - The basis for this determination lies in an associated Failure Modes and Effects Analysis (FMEA)
    - Analysis is at least qualitative
    - Each system and subsystem is broken down into its basic functions using a functional block diagram
    - Consider the effect of article failure on the next higher assembly
    - Describe failure effects of the next higher assembly on the product given the failure of the embedded article

Order 8110.42D Test and Comp

- Coordination needed with Certificate Management ACO or Product Standards Staff?
- Part Specific Certification Plan (PSCP)
  - Identify Cert. Basis in a Compliance Matrix
- Review in-service History (SDR, AD, SAIB etc)
- Review Reverse Engineering
  - Number of OEM articles sampled
  - Accredited laboratory
- Evaluate Data & Dwgs.
  - Completely defines the article; Includes all necessary specifications, processes, materials etc.
  - Tolerances within measured samples
  - Part Marking and Numbering

Order 8110.42D Test and Comp

- Part Conformity Plan
  - Test and/or Installation Conformity
- Any Required Tests
  - General Compliance or Comparative testing
  - FAA approval of test plan/report and witnessing
- Instructions for Continued Airworthiness (ICA)
  - Impact statement or new
  - Life Limits?
- Continued Operational Safety (COS) Plan
  - Design Control, Part Monitoring, Defect and Failure Responsibilities.
- Proof of Model Eligibility
- Statement of Compliance

PMA Policy/Guidance

- **Order 8110.119**
  - Known as the Streamline PMA Process
  - Developed to utilize the applicant ONLY showings ideology within AIR
    - Recognizes MARPA Document 1100
    - Does NOT allow FAA designees into the process
    - Does NOT shortcut any current PMA requirements
    - No net-differences between PMAs approved via the streamline process or traditionally via 8110.42
  - Limited scope
    - Only applicable to qualified applicants
    - Only open to Non-Safety Significant (NSS) articles

PMA Memorandum Of Understanding (MOU)

- **Agreement between a Company and ACO**
- **Focus PMA activities on "everyday" projects**
  - Varies drastically based on experience
- **Considered "ODA lite"**
- **MOUs must be a benefit <u>both</u> parties**
- **Meet applicant and industry needs**
  - Increases certification efficiency
- **Reduce FAA workload**

PMA Policy/Guidance

- **Product Specific Guidance**
  - Detailed PMA information is conveyed in standard staff issued ACs
    - AC 33-8
      - Guidance for Parts Manufacturer Approval of Turbine Engine and Auxiliary Power Unit Parts under Test and Computation
    - AC 33-11
      - Materials: Oxidation, Hot Corrosion, Thermal Fatigue, and Erosion Characteristics Testing to Support 14 CFR, Part 33, § 33.15, Compliance for Turbine Engines
    - AC 33.83-1
      - Comparative Method to Show Equivalent Vibratory Stresses and High Cycle Fatigue Capability for Parts Manufacturer Approval of Turbine Engine and Auxiliary Power Unit Parts
    - AC 33.87-2
      - Comparative Endurance Test Method to show Durability for PMA of Turbine Engine and Auxiliary Power Units

Manufacturing Inspection District Office

- **MIDOs are responsible for**
  - Certification of Manufacturing Facilities
  - Post approval certificate management
  - Approval and management of designees
    - *Individual designees*
      - DMIR: Designated Manufacturing Inspection Representative
      - DAR: Designated Airworthiness Representative
    - *Organization designees*
      - ODA: Organization Designation Authorization Unit Member
  - Conformity support for ACOs during design approvals.

Conformity During Design Certification

- A conformity inspection is a process for determining that the product being certified complies with the proposed type design
- Conformities include making sure that the correct raw materials are used, parts are consistently made, processes are followed; that is, quality is built-in
- Conformities must occur before compliance finding ground or flight testing
- Parts, assemblies and installation of assemblies are all conformed. Manufacturing processes are conformed.
- Applicant will do 100% conformity inspection. The FAA will do a second conformity only on items deemed necessary

Production Approval: Minimum Quality System Requirements

- Quality system described in writing (manual)
- Description of assigned responsibilities
  - Delegation
  - Relationship of those responsible for quality to management

- AC 21-43 provides info for production approval holders (PAH)

  AC 21-43, Production Under 14 CFR Part 21, Subparts F, G, K, and O

Production Approval Similarities

- What PAH must provide
  - Organization
  - Quality System
  - Quality manual
  - Location of/changes to manufacturing facilities
  - Requirements for inspections and tests
- System characteristics
  - Issuance
  - Duration
  - Transferability
- PAH management
  - Responsibilities of holder
  - Changes to the quality system
  - Reporting
  - Record retention

Elements of the 21.137 Quality System

- **A PC quality system must have procedures for:**
  - Inspection and testing
  - Status of inspection and testing
  - Implementing corrective and preventative actions
  - Preventing damage and deterioration of product & parts
  - Accomplishing internal audits
  - Processing feedback on in-service failures
  - Identifying and initiating corrective action on quality system escapes

AC 21-43 provides details about each element

Elements of the 21.137 Quality System

- **A PC quality system must control:**
  - Design data
  - Documents
  - Supplier and vendors
  - Inspecting, measuring and test equipment
  - Non-conforming products and parts
  - Quality records
  - Manufacturing processes

AC 21-43 provides details about each element

Certificate Management

- Order 8120.23 - Certificate Management of PAHs
  - Risk Assessments
  - Production Based System Audits
    - Quality System Audits
    - Supplier Control Audits
    - Principal Inspector Audits
    - Product Audits
  - Additional Responsibilities
    - Audit of Changes to PAH Quality System
    - Investigations into Service Difficulties

Table 3-1. Ongoing CM Audit Responsibilities (Minimum Requirements)

Level 3 Low	Level 3 Medium	Level 2 Low	Level 2 Medium	Level 2 High	Level 1 Low	Level 1 Medium	Level 1 High
1+ Audit within every 60 months	1+ Audit within every 48 months	1+ Audits within every 36 months 1 QSA NTE 48 months	3+ Audits within every 24 months 1 QSA NTE 36 months	4+ Audits within every 12 months 1 QSA NTE 24 months	6+ Audits within every 12 months 1 QSA NTE 36 months	12+ Audits within every 12 months 1 QSA NTE 24 months	18+ Audits within every 12 months 1 QSA NTE 24 months

Operator Part Control Requirements

- Operators are required to have policy and procedures in place that ensures 14 CFR 43.13 is complied with when any maintenance or alteration is performed

- 14 CFR 43.13 requires that maintenance and alterations be performed in such a manner and use materials of such a quality (this includes PMA parts), that the condition of the aircraft, airframe, aircraft engine, propeller, or appliance worked on will be at least equal to its original or properly altered condition, with regard to aerodynamic function, structural strength, resistance to vibration and deterioration, and other qualities affecting airworthiness

- Part 121 or 135 and Part 129 operators holding operations specifications are required by their operating specifications to provide continuous airworthiness maintenance and inspection of the aircraft that also ensures that 14 CFR 43.13 is fulfilled.

Operator specific PMA considerations

- Certificated operators are responsible for maintaining the airworthiness of their aircraft and knowing the part configuration of their aircraft
- FAA operator/airline requirement regarding any replacement part is that the parts installed are part of an FAA approved configuration (14 CFR 43.13)
- PMA parts are FAA approved, and no further technical approval by an airline is legally required (14 CFR 21.9)

Typical Operator PMA Activities

- Every part on the aircraft including PMA replacement parts must be shown to be approved for installation on the operators' aircraft in an engineering document.
  - The technical approval of a PMA part can be as simple as ensuring that the part is FAA approved and documenting the review

  OR

  - A full technical review of the PMA part design and performance to ensure that it will meets the airworthiness requirement of the product it is being installed
- Revise their customized Illustrated Parts Catalog to show the PMA parts approved for the aircraft they operate

PMA Policy/Guidance

- **AC 21.303-4**
  - Speaks to PMA applicants submitting projects to their regional ACOs
  - Only applies to PMA via Identicality without a licensing agreement or via Test & Comp
  - Mirrors Order 8110.42 but from the applicants point of view
  - Provides more detail in certain specifics needed to make an acceptable application for “showing” compliance
    - One way but not the only way
    - Sets the FAA’s “expectations”

AC 21-303-4: Applying for PMA

- **Application Considerations**
  - New to PMA?
    - FAA coordination is highly recommended upfront
  - Is PMA the right approval for you?
    - Is there an exception that would work better?
      - Owner/Operator Part, Air Carrier Part, Repair Station Fabricated Part, Standard Part, Commercial Part, etc
  - What is the appropriate method of PMA?
    - Identicality?
    - Test Reports and Computations?

Initial Application: T&C or Identicality

- **By letter (or PSCP), sent to the appropriate ACO**
  - Expectation is the geographic area of your manufacturing facility
    - The FAA will not travel to an international location to conduct manufacturing oversight. A foreign airworthiness authority may conduct the oversight if specifically authorized by an existing bilateral agreement and the FAA accepts the oversight function
    - If the Quality System is in the United States and the manufacturing is done outside the Untied States, the FAA needs to verify that the applicant can do adequate inspections of incoming parts

Initial Application: T&C or Identicality

- Provide the following:
  - Applicant name and address of the manufacturing facility
  - The replacement article name and P/N
  - The original P/N from a type certificate (TC, STC or Amended Type certificate (ATC))
  - The makes, models/series of aircraft, engines or propellers the part is eligible for
  - The method of compliance showing to airworthiness requirements
    - T&C using either general analysis, or comparative analysis, or a combination of both methods; or identicality without a license agreement
  - A draft PMA supplement
  - Proof of installation product eligibility

Initial Application: T&C or Identicality

- Show use of a quality system that meets the requirements of 14 CFR 21.137 per 14 CFR 21.307
  - If using a previously approved quality system, cite the associated quality manual, its latest revision, and date. See AC 21-43, *Production under 14 CFR Part 21, Subparts F, G, K, and O,* for further guidance
  - If establishing a new quality system per 14 CFR 21.307, provide your manual to your geographic MIDO for FAA approval per 14 CFR 21.308
- Drawings and specifications necessary to show the configuration of the article
- Information on dimensions with tolerances, materials and processes necessary to define the structural strength of the article;
- The marking scheme for the article that complies with 14 CFR 45.15

Initial Application

- **If the PMA basis is Identicality**
  - Show compliance to 14 CFR 21.303 (a)(4)
    - *"…unless the applicant shows that the design of the article is identical to the design of a article that is covered under a type certificate"*
    - Same in every respect including dimensions, tolerances, processes, etc. Provide sufficient data to show your design is identical
    - Typically the applicant possesses and submits the original design drawing and related production specifications referenced within that drawing
    - No minor design changes (except cosmetic)

Initial Application

- **If the PMA basis is T&C, add the following as enclosures:**
  - A Project Specific Certification Plan (PSCP)

•PSCP Table of Contents Example

•1.0 Introduction
- •1.1 Scope
- •1.2 Project Description
- •1.3 Background (in service history)
- •1.4 Component Description
- •1.5 ICA plan

•2.0 Applicable Documents (Drawings, Supplement, IPC, ICA, etc)

•3.0 Project Schedule

•4.0 Certification Basis (with Compliance Matrix)

•5.0 Tests (FAA approves certification test plans)

•6.0 Conformity Inspections

•7.0 Communication and Coordination (Points of Contacts)

•8.0 Delegations

•9.0 Signatures/Concurrence

Initial Application

- **If the PMA basis is T&C, add the following as enclosures:**
  - A compliance checklist or matrix
  - Once compliance is found
    - A statement of compliance with applicable regulations per AC 21-51

Project Number: _____ Date: _____
Originator: _____ Revision: _____

Regulation Title 14 CFR *(1964 CAR 3)*	Applicable Amendment	Method of Compliance*	Plan, Drawing, Report Number	Person or Entity Finding Compliance	Applicable Guidance, References, & Remarks
Title 14 CFR part 23: *(CAR 3)*					
Subpart A -- General					
Section					
23.1 Applicability. *(3.0)*		DE			AC 23-8B
23.2 Special retroactive requirements.		AN, GT			
23.3 Airplane categories. *(3.20 (last 2nd sent. of (a)(2) and 2nd and 3rd sent. of (b)), 3.20-1, 3.20-2 (1st sent.)*		DE			AC 23-8B
Subpart B -- Flight					
GENERAL					
23.21 Proof of compliance. *(3.61, 3.71-1)*		AN, GT, FT			AC 23-8B
23.23 Load distribution limits. *(3.71)*		DE, AN, FT			AC 23-8B
23.25 Weight limits. *(3.74, 3.75)*		AN, FT			AC 23-8B
23.29 Empty weight and corresponding center of gravity. *(3.73 (1st sent.) 3.73-3(b))*		AN, GT			AC 23-8B
23.31 Removable ballast. *(3.72)*		DE, AN			AC 23-8B

*Methods of Compliance:
FT = Flight Test, GT = Ground Test, AN = Analysis, DE = Design, SI = Similarity, ELOS = Equivalent Level of Safety Finding, PExmpt = Petition for Exemption, N/A = Not Applicable

Page ___ of ___

Initial Application

- Test reports and computations that show the article's design meets the airworthiness requirements of its eligible product(s)
  - As called out in the compliance checklist;
- A safety assessment that characterizes the nature of the article and the impact of its failure modes on safety;
- A continued operational safety plan reflective of the article's safety significance;
- If applicable, a list of proposed designated engineering representatives (DER) and their respective authorizations.

AC 21.303-4 Applying for PMA

- **So now that you know what a proper application needs to contain, we will go into more detail on the main items.**
  - Product Eligibility
  - PMA on Critical Parts
  - Safety Assessment
  - Testing
  - COS Plan
  - Methods of Showing Compliance
  - Instructions for Continued Airworthiness (ICA)
  - Marking Requirements

Product Eligibility

- **Identify the eligible aircraft, engines or propellers for proposed installation of your article**
  - List each product by make, model or series, and if appropriate serial numbers, as specified on the applicable type certificate data sheet (TCDS)
- **Also identify the corresponding article from the type design by a descriptive name and part number**
  - Show this article's location in its respective products

Product Eligibility

- **Consider using an IPC along with other data**
  - Technical Drawings - Purchase Orders
  - Service bulletins - Maintenance Manuals
  - Technical publications indexes
  - Master drawing lists from holders of design
  - Other evidence of installation eligibility includes:
    - FAA airworthiness approval tag
    - Other evidence including owner or operator assist letters

PMA on Critical Part

- PMA of critical and limited parts is possible when a replacement part's design produces only a minor change in its product
- Small differences in the designs of these replacement parts may affect associated life limits and represent a major change to its product
- PMA will generally require the same rigor of compliance showings as an STC process

PMA on Life Limited Part

- Supply analyses and tests that establish a part's life limit using a life system accepted by the FAA
- Fatigue tests of these parts by applicants are typically essential to setting life limits
- Applicants must have robust system to ensure manufacturing, testing and process controls that preserve the life limits inherent in their designs
- Publish these life limits in the instructions for continued airworthiness

PMA Safety Assessment: Definitions

- System Safety Assessment (SSA):
  - A systematic, comprehensive evaluation of an system, its architecture and its installation to show compliance with the safety requirements.
- Failure Modes and Effects Analysis (FMEA)
  - A bottom-up method of identifying the failure modes of a system, item, or function and determining the effects on the next higher level.
- Common Cause Analysis (CCA):
  - Establishes independence (or lack of) between functions, systems or items

PMA Safety Assessment: Definitions

- Functional Hazard Analysis (FHA):
  - A top-down, comprehensive examination of airplane and system functions to identify potential Minor, Major, Hazardous, and Catastrophic Failure Conditions that may arise as a result of a malfunction or a failure to function
- Fault Tree Analysis (FTA)
  - Focuses on one particular undesired event and provides a method for determining causes of this event. A “top-down” system evaluation in which a qualitative model for a particular undesired event is formed and then evaluated

PMA Safety Assessment

- **FMEA**
  - Qualitative Process
    - Independent of failure rates and probabilities
  - Each system and subsystem is broken down into its basic functions using a functional block diagram
    - Use ATA nomenclature for identification of systems
  - The functional block diagram defines each system or subsystem.
    - Determine all part-to-part and part-to-system influences.
  - Describe failure effects of the next higher assembly on the product given the failure of the embedded article
  - Categorization Process

PMA Safety Assessment

- **Categorization Process**
  - Focus on function of part and its potential effects on physically and/or functionally mating parts
  - System Interactions
    - Influences a part or set of part has on the engine or aircraft through form, fit or function
    - Can be direct or indirect and can develop over time
      - Direct Impact – Form and Fit
        - » Influences are based on physical contact and interference
      - Indirect Impact – Functional in nature
        - » Could be Aerodynamic, thermal or vibratory impact

PMA Safety Assessment - AC 33-8

- **Section 5 – Part Criticality**
  - Most severe failure mode based on FMEA or other
  - Category 1
    - Failure could prevent continued safe flight and landing
      - Reduce safety margins
      - Degrade performance
      - Loss of Capability to perform certain flight operations

Example Potential Failure Effect	Part Examples
Non-containment of High energy debris	Any Life Limited Part
Uncontrolled Fire	Containment structure
Loss of protection	Fuel system shut off
Effect or influence on a Category 1 part	Main engine mounts

PMA Safety Assessment - AC 33-8

- **Section 5 – Part Criticality**
  - Category 2
    - Part failure would not prevent continued safe flight and landing but;
      - Reduce the capability of the aircraft or crew to cope with adverse operating conditions or subsequent failures

Example Potential Failure Effect	Part Examples
Significant uncontrollable thrust oscillation	Not Life Limited Rotating parts
High vibration levels	Accessory gearbox
Release of propeller	Engine Bearings
Inability to shut down engine	Control System Actuators

PMA Safety Assessment - AC 33-8

- **Section 5 – Part Criticality**
  - Category 3
    - Part failure would have no effect on continued safe flight and landing of the aircraft but;
      - Would be partial or complete loss of engine thrust or power (or associated engine services).

PMA Safety Assessment

- **Along with the FMEA, the safety assessment considers in-service data**
  - Service history of the original article or its next higher assembly on the type-certificated product
  - The following available databases can help you with your investigations:
    - Service Difficulty Report (SDR)
    - Airworthiness Directive (AD) database
    - Special Airworthiness Information Bulletins (SAIB)
    - National Transportation Safety Board (NTSB)
    - Also review pertinent safety bulletins and airworthiness directives from other airworthiness authorities.

Continued Operational Safety (COS)

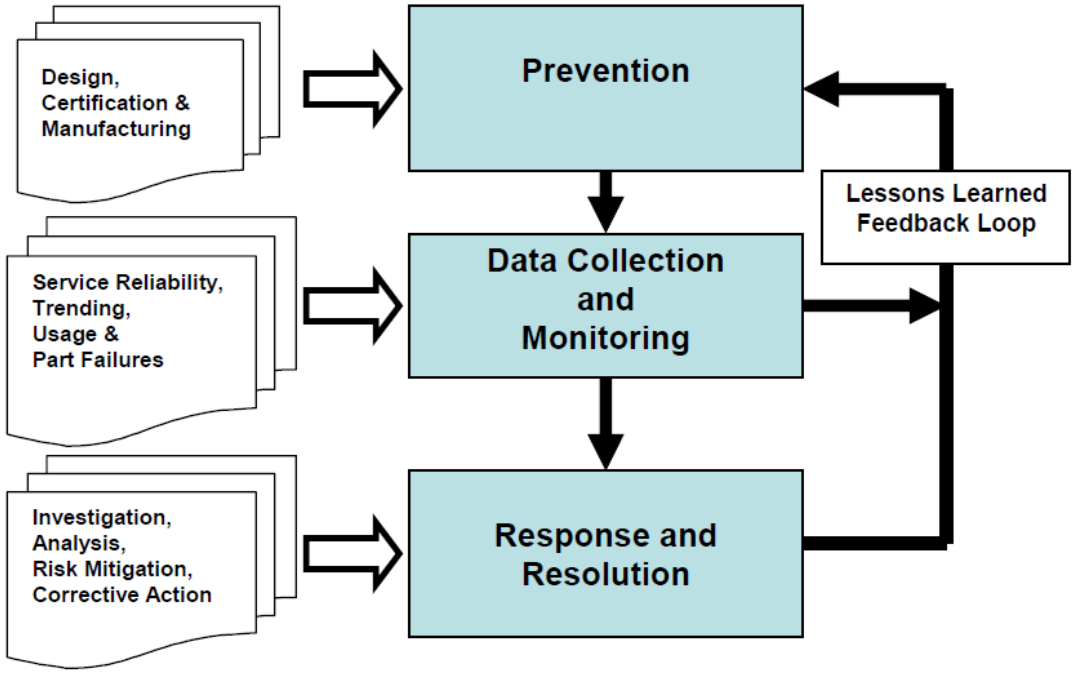
- **PMA holders are responsible for the integrity of their designs throughout their articles' service lives**
  - The same requirement as for any other DAH
  - A good COS plan is required upfront
- **COS depends on three principles:**
  - monitoring an article's performance in service
  - investigating its problems and then providing remedies
  - problem prevention

COS Plan

- **General COS Plan**
  - Standing document recommended for active PMA holders
  - Defines general COS requirements for part development planning, design reviews, supplier and manufacturing control, internal COS organization, general data collection and monitoring processes, reporting procedures, and corrective action plan
  - Could be standalone SOP or integrated into a QM or PM
- **Article Specific COS Plan**
  - Expands on General COS Plan for detailed information article specific life management
- **Good information on COS plans in AC 33-8 and MARPAs COS Guidance Document.**

COS Plan

- **A closed-loop technical and logistical support system that ensures the continued safety of a part and subsequently the product on which it is installed, throughout its lifetime.**



COS Plan – Problem Prevention

- During Design, Certification, Manufacturing
  - Internal Audits
    - Monitor compliance with airworthiness standards and production procedures
  - Part Field Experience
    - Process for PMA producer to preform comprehensive review of part SDR/ASB/SB/ADs and operator/maintenance input
  - Article Development Planning Process
    - Structuring the design effort into elements to ensure safety and reliability. Includes a defined design review.
  - Failure Modes and Effects Analysis (FMEA) and Safety Assessment procedures

COS Plan – Problem Prevention

- During Design, Certification, Manufacturing
  - Supplier Control and Performance metrics
    - Method for monitoring supplier performance. Could include details on include Incoming Article Verification
  - Manufacturing Process Change Control and Substantiation
  - Design Change Control and Substantiation
    - Structured process for evaluation and disposition of design changes.
  - A description of the methods and resources used to identify causes of failures

COS Plan – Article Monitoring

- In service reliability, usage and failure data
  - Closed Loop Process for all Field Inquiries
    - Process to review, evaluate, and respond to service issues
  - Article Specific Performance Data Trend Analysis
    - PMA parts with potential adverse effect on the operational safety should track the parts, and receive inspection and qualitative feedback from the users
  - Part Delivery Statistics
    - Basic information about parts shipped, lot number and customer for even for non-serialized parts
  - Continuing ICA review
    - Process to review new and revised TC holder's maintenance instructions, service bulletins, and ADs

COS Plan – Problem Response Action

- Investigating and Analyzing Part Failures
  - Reporting required under 21.3
  - Customer Notification Process
  - Failure Analysis Process and Capabilities
  - Risk Assessment, Analysis and Management
    - Minimum of qualitative assessment
    - Quantitative assessment is required if it cannot be determined the condition is not unsafe
  - Process to Develop and Implement Corrective Action
  - Ability to Measure Effectiveness of Corrective Action

COS Plan – Problem Response Action

- Investigating and Analyzing Part Failures
  - Feedback into Preventative Systems and Procedures
    - Process to feedback lessons learned to the existing engineering, quality, manufacturing, and safety systems
    - Can be implemented through training activities, continuous monitoring, and refinement of company processes
  - Prevent recurrence of similar problems

Showing Compliance

- Test reports and computation must show the design of their article complies with applicable airworthiness
  - Applies to both comparative or general test and analysis
- These applicable requirements stem from the certification basis of eligible products
  - Parts 23, 25, 27, 29, 31, 33, 35
- PMA of a TSO'd part
  - Describe the effect of the replacement article on the TSO assembly.
  - If installation of a replacement article prevents a TSO assembly from meeting its minimum performance requirements, but it still complies with the associated product's airworthiness requirements, then direct installers of your replacement article to remove the assembly's TSO markings in a supplemental ICA.

Showing Compliance

- **General tests and analyses**
  - Shows that an article directly complies with all airworthiness regulations applicable to the product affected by article installation.
- **Comparative tests and analyses**
  - Substantiates that the PMA article is at least equal to the original article approved under a type certificate. Form, fit, function shown to be equivalent
- **A combined approach**
  - Uses both general and comparative analyses for different aspects of an article's design

Similar to STC process

Traditional Reverse Engineering

Showing Compliance

- **Comparative Analysis**
  - Often through Reverse Engineering
    - One way to obtain an article's design but most often the process used for PMA via test reports and computations.
    - Relies on key design attributes and comparisons
      - Sample size
      - Sample sources
      - Dimensional tolerances
      - System level dimensional characteristics and datums
      - Materials
      - Weight and mass properties

Showing Compliance

- **Materials**
  - Use Qualified or Accredited labs only
  - Typically, most PMA applicants seek to replicate the OEM's material exactly (or as close to exact as possible)
    - This is more than acceptable but not required by rule. For comparative analysis it is still beneficial to know original material characteristics.
      - Composition of each material in the article
      - Material metallurgical, mechanical and physical properties
      - Form of material (casting, forging, bar stock, sheet, etc.)
      - Use of special processes (nitriding, heat treat, shot peen, etc.) and resulting effects on material properties

Showing Compliance

- **Test Scope and Plans**
  - Not all PMAs require specific regulatory testing such as flammability or crash worthiness
  - Many PMAs are compliant with company only testing and results
  - Many PMAs do require ACO approved test plans, MIDO approved conformity, and ACO approved results
    - These tests can be functional in nature, flight test, comparative tests or regulatory compliance tests

Showing Compliance

- **Functional testing**
  - Verifying design characteristics (vibratory, fatigue, coating effectiveness, etc.)
  - Verifying that variations in the manufacturing process have no detrimental effects on the functional design of the replacement article;
  - Verifying article interactions with the next higher assembly and affected systems (gears, bearings, seals, blades, etc.)
  - Evaluating sophisticated articles made of intricate components.

Showing Compliance

- **Test Plans**
  - Test purpose; Number of test units; Unit identification;
  - Physical and functional description of the test article and setup;
  - Test conditions and duration;
  - Test methods and their suitability;
  - Test method accuracy;
  - Criteria for test success and failure;
  - Test instrumentation and data collection;
  - Test safety control; and Control of test procedures.

Instructions for Continued Airworthiness (ICA)

- Maintenance Instructions and ICA
  - ICA give information essential to the airworthiness of your article in its product
    - Note the FAA provides information in the appropriate product appendix in 14 CFR for the content and format of these ICA
  - Design differences between your replacement article and the OEM may warrant revised instructions
    - Supplemental ICAs are not to be feared but additional time considerations are need for required FAA coordination between our cognizant offices
- If the OEM ICAs remain applicable, provide evidence and/or rationale, not just a statement

Marking Requirements

- **14 CFR 45.15(a) requires permanent and legibly markings on your articles**
  - These markings identify the article's manufacturer, part number and its production under FAA-PMA
  - Define the marking location and method in your design package
  - Ensure the marking location and process does not degrade airworthiness

Marking Requirements

- **Marking Critical Parts**
  - Parts with a fixed replacement time, inspection interval or related procedure as specified in the airworthiness limitations section of a product's ICA require a serial number per 14 CFR 45.15(c)
  - Criticality is a specific term within the PMA policy (defined in the Order and AC) but it also is further defined within the product-specific guidance available form the cognizant FAA Directorate Office
    - 14 CFR XX.1529, 33.4 and associated ACs

Marking Requirements

- **Marking an assembly**
  - Specified in 14 CFR 45.15, apply PMA article markings to the top-level assembly
    - No requirement for markings on subassemblies or individual detail articles **unless** the associated PMA supplement lists them separately
  - The assembly caveat is delineated as to what is being approved by the FAA
    - PMA assemblies by themselves are PMAs **only** within their whole design
    - You may **not** sell subassembly articles as replacement articles for OEM subassembly articles
    - PMA articles with unique approvals may combine to form an assembly which is also FAA PMA

Marking Requirements

- **Part Numbering**
  - Test and Comp PMAs must be distinguishable from the corresponding TC/STC article number
    - Caveats are allowed for OEM “suppliers” in some case
  - Prefix or suffix is the typical method utilized around the industry

Marking Requirements

- **Articles impractical to mark**
  - 14 CFR 45.15(d) provides relief for articles determined by the applicant to be too small to mark.
    - This determination must be accepted by the ACO
  - This relief does not mean there are no additional requirements to ensure proper information and documentation is provided to the installer
    - Typically, the additional information that is not able to fit on the physical article is recorded via the “bag and tag” method
  - This relief is similar to the eligibility marking issues which prompted the rule change in April of 2016

Delegation in PMA

- **Designees can expedite the review and approval process for PMA**
  - Individual designees can make findings of compliance to airworthiness standards within their authorized limitations in support of the T&C PMA process or Identicality w/out licensing
  - Identify the names, contact information and authorizations of your proposed designated engineering representatives (DER) in your application letter or PSCP
- **Get prior approval from the ACO before these designees make any specific findings of compliance**
- **PMA ODAs are available for qualified organizations**

One last time

- **Article Design Changes to Product**
  - T&C PMAs should be a minor design change to the product per 14 CFR 21.93.
    - Minor changes have no appreciable effect on the weight, balance, structural strength, reliability, operational characteristics, or other characteristics affecting the airworthiness of the product.
    - Per 14 CFR 21.113 – Major Changes require STC
- **After Issuance – PMA Design Changes**
  - PMA Major Design Changes requires new Application
  - Minor Design Changes have no impact to the approval basis of the article
    - Identically approval basis 14 CFR 21.303
      - Changes limited to cosmetic
    - T&C approval basis are the applicable regulations for which compliance what shown.

One last time

- **Communication and Coordination**
  - Don’t make the ACO look for things or have to ask obvious questions
  - We have limited resources
  - You know your design and installation better than us (we manage 1000s of PMAs per year)
- **Every PMA applications stands on its own**
  - You are required by law to show compliance and state as such per 14 CFR 21.303 (a)(5)
  - The FAA doesn’t supplement applicants lack of knowledge with ours

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