Systems Engineering to Ensure Aircraft Airworthiness

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Sustainment Environment

727th Aircraft Sustainment Wing

Col. Paul Waugh
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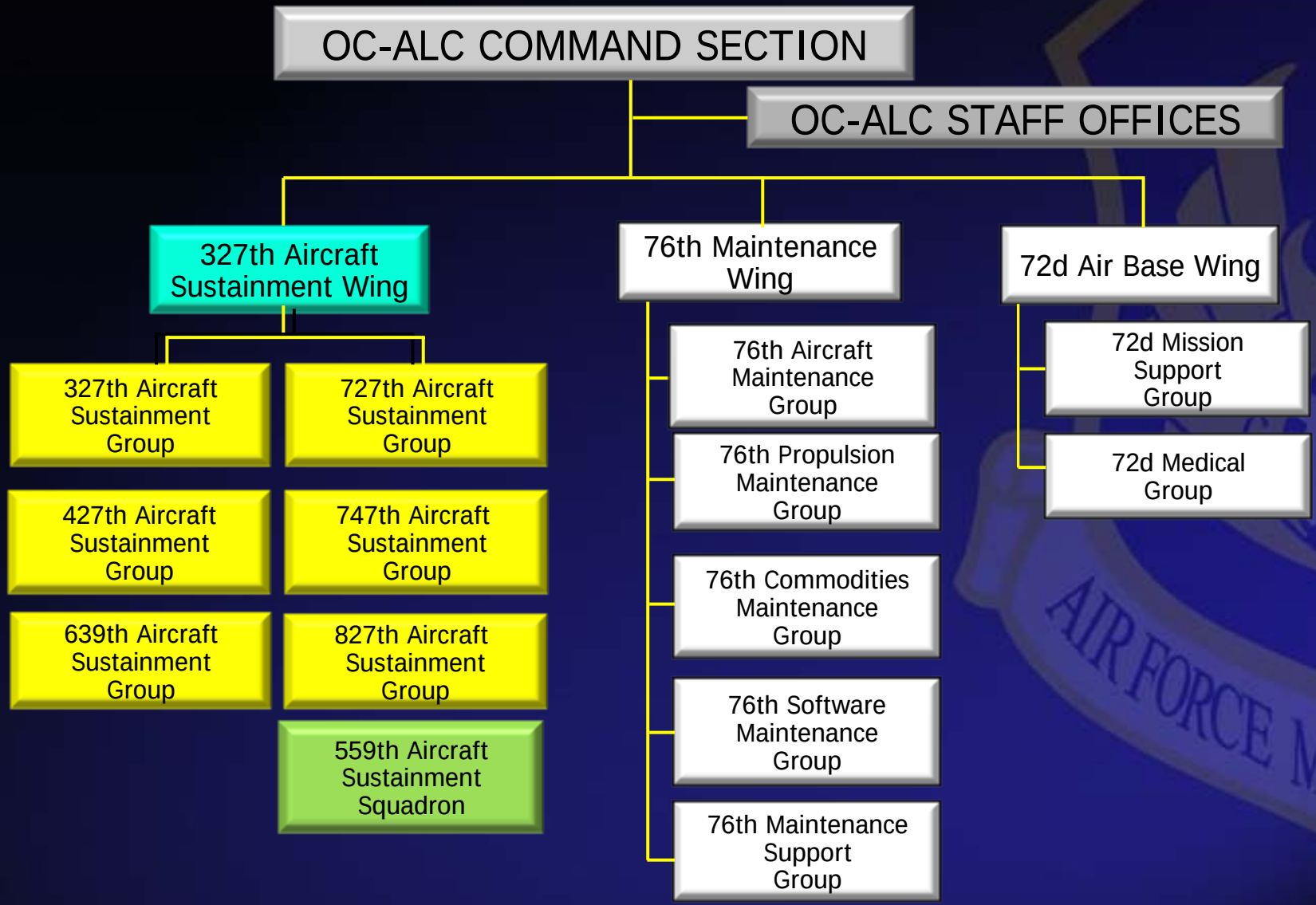
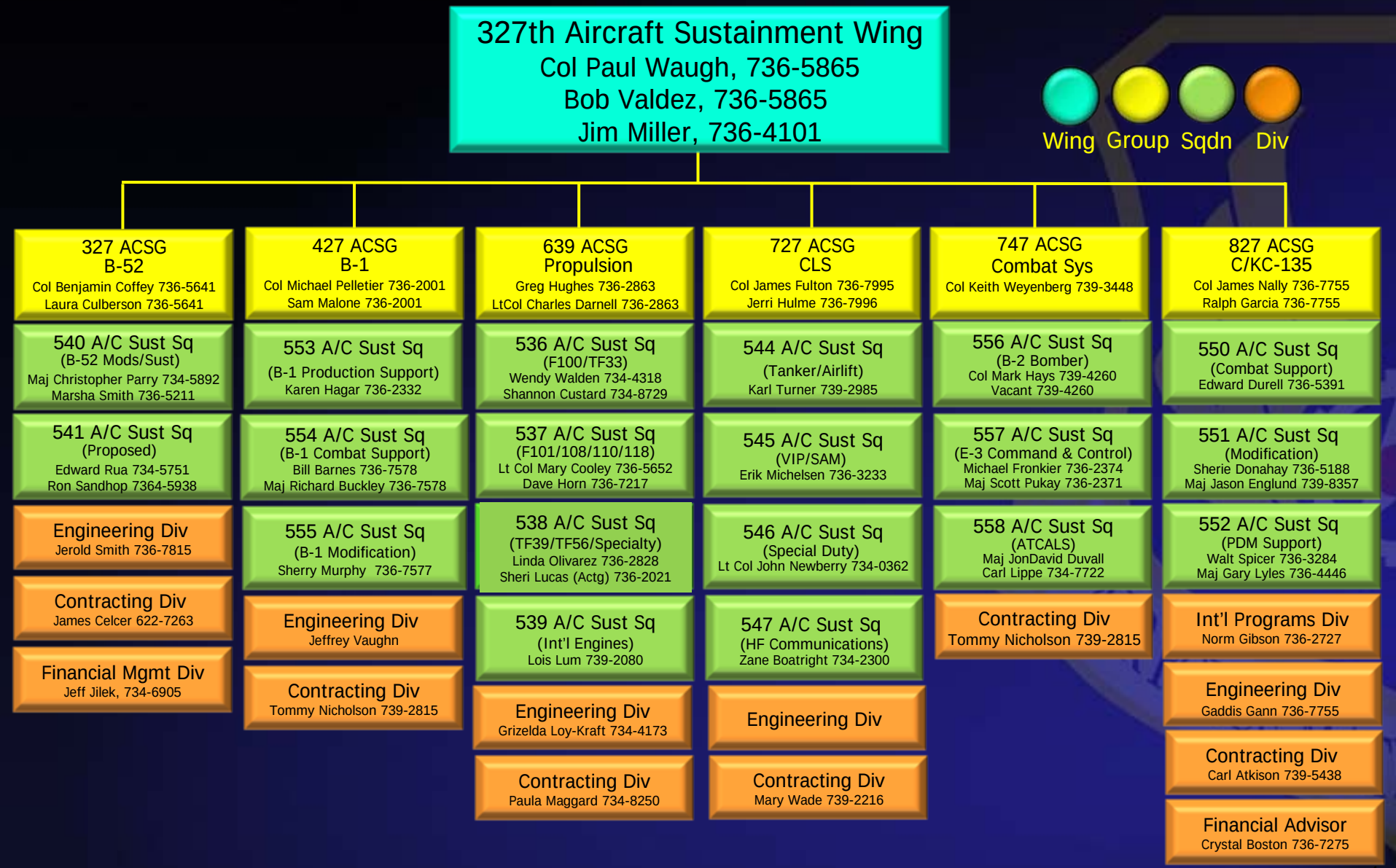
PROVIDING EFFECTIVE & EFFICIENT WEAPON SYSTEM SUPPORT

OC-ALC Wing Structure



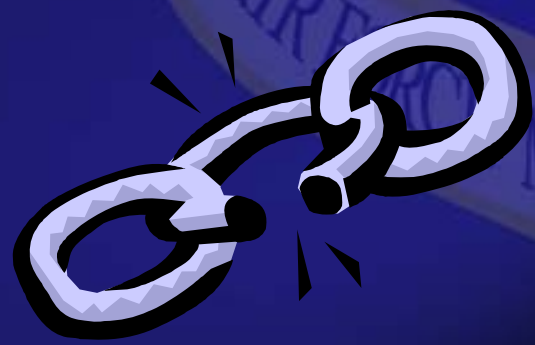
327th Aircraft Sustainment Wing



327th ASW Responsibilities

So What is the Airworthiness Problem?

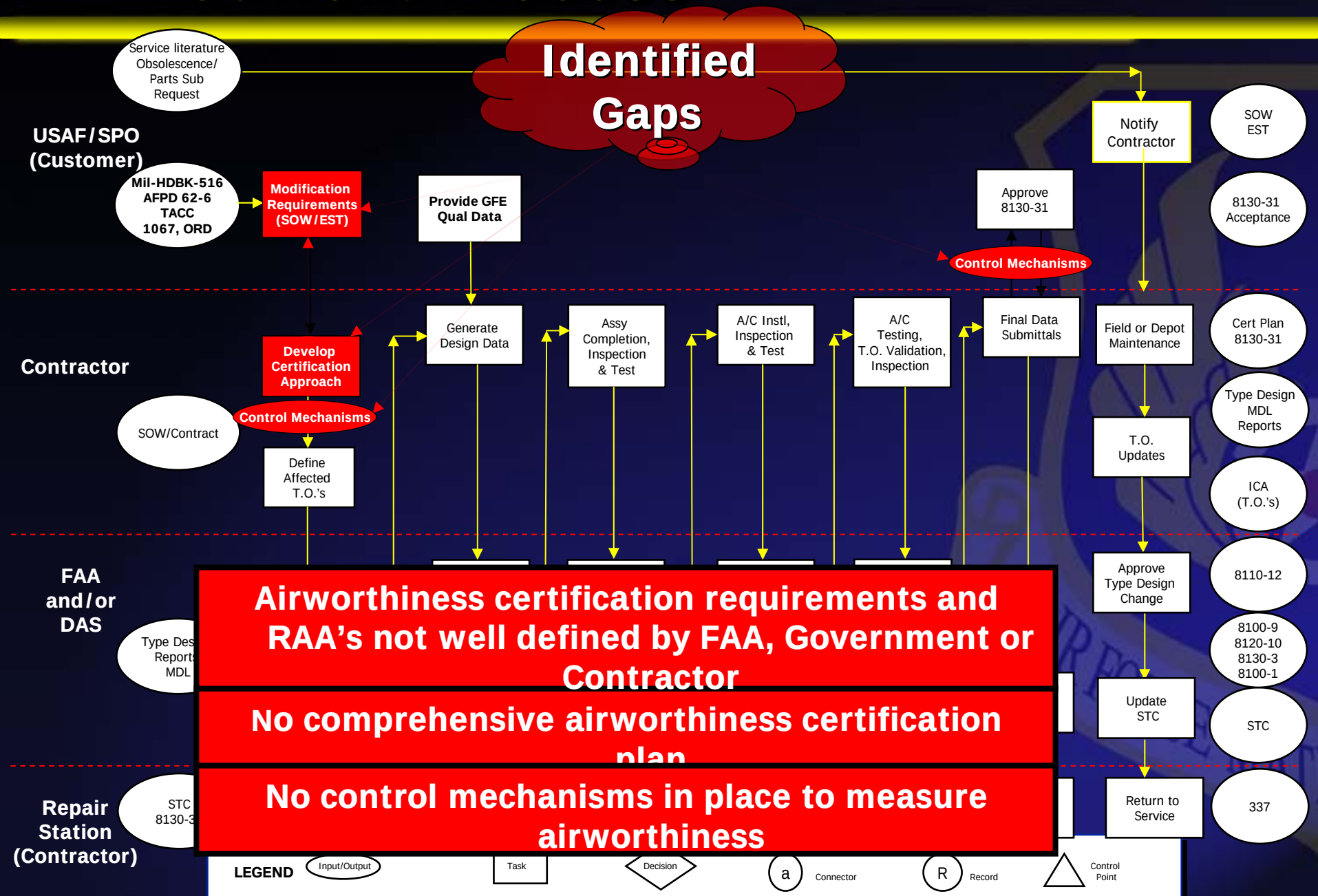
- Airworthiness is a requirement for all aircraft, whether FAA or DoD
- Tinker AFB manages 20-plus different types of CDA
  - Aircraft use a mixture of FAA and Air Force criteria and methods of compliance to verify airworthiness when modifying the aircraft
- Modifying a CDA by a process that combines both FAA Certification and Air Force Certification could result in a hybrid safety standard.
  - Such a standard is unproven by either the FAA or the DoD, and could therefore put the aircraft and crew at risk
- No planning and implementation process to ensure comprehensive and complete airworthiness of all designs and parts
- No tracking the organization's progress regarding airworthiness for upper management in a fleet of over 400 aircraft throughout the entire lifecycle of the CDA



Airworthiness Project Overview

- **Problem Statement**
  - **Current practices do not ensure 100% of CDA modification design/parts are correctly certified for airworthiness.**
- **Project Definition and Scope**
  - **727 ACSG aircraft (CDA) sustained by Boeing**
  - **Airworthiness certification to cover various (FAA & Military) compliance methods**
  - **Review and "Walk" the entire process in both orgs**
  - **Define Responsibility Accountability Authority (RAA) for any process decision pts**
  - **Ensure certification means supports lifecycle sustainment**
  - **Must include metrics for upper management visibility**

Current Process



GAPS

- Government does not clearly state airworthiness requirement to contractors
- Responsibility, Accountability and Authority (RAA) not well defined by FAA, Government or Contractor
- No comprehensive airworthiness certification plan
  - Plan not done early in modification process
  - Plan not coordinated between Government, FAA and Contractor
- No control mechanisms in place to measure airworthiness

Gap #1: Requirements Not Clear

- Airworthiness very briefly mentioned
- Rarely states what type airworthiness certification required
- Rarely addessses parts
- Rarely addresses life cycle cost/sustainment aspects
- Does not address who/when airworthiness decisions will be made
- Examples….

Airworthiness SOW Language Examples

- "The contractor shall-obtain FAA approval for this modification…"
- "Any equipment installed as part of this modification not covered with full FAA certification must be…"
- "Obtain FAA approval for engineering drawings…"
- "This SOW directs the contractor to provide an FAA approved modification…
- "Contractor shall obtain FAA approval where applicable…
- "Contractor shall obtain FAA where practical…"

Gap #2: RAA Not Well Defined

- Responsibility, Accountability and Authority (RAA) not well defined by FAA, Government or Contractor
- Neither Gov't nor Contractor have policy in place defining who makes airworthiness decisions throughout process
  - Design: Not clear who decides which of design cert will be followed
  - Parts: Decisions made at various levels, part "pedigree" often assumed, or not given consideration to life cycle cost

GAP #3: No Certification Plan

- MIL-HDBK-516B describes criteria, but not implementation and planning
- Currently no certification plan required for modification
- No plan provided up-front regarding all designs and all parts
- Government usually does not find out until end what the certification is

GAP #4: No Control Measures

- How much FAA certified and how much Military certified?
- Which design certification methods used?
- What are the pedigrees of all the parts?
- Does the actual delivered modification match the planned?
- How can you keep your SPM and Chief Engineer informed of this important topic before the signing of the DD Form 250?

So What Are Doing About It?

- Instigated a step-by-step Operating Instruction to implement air worthiness management throughout the organization
- Implemented tangible approach that is:
  - Aimed at the working level
  - Applies to both contractor and Air Force
  - Applicable throughout entire organization
  - Accounts for status/progress through metrics
  - Always starts with requirements

4 Solution Recommendations

- Improve SOW wording (Requirements)
- Complete airworthiness approach/certification plan for both design and parts early
- Clearly define decision making authority for each airworthiness condition
- Establish control measures to verify 100% certification of designs and parts and keep upper management informed

Sol'n #1: Improved SOW Words

- OI contains decision tree which will drive appropriate level of airworthiness requirements
- Airworthiness certification requirements expanded and clarified to contractor
- OI contains "cut-and-paste" template SOW language for modification contracts
- Templates available for:
  - FAA Airworthiness Certification
  - Non-FAA Airworthiness Certification
  - Airworthiness Sustainment Requirements (Parts)
  - Airworthiness Documentation

Sol'n #2: Airworthiness Cert. Plan

- The Airworthiness Certification Plan Must:
  - Be delivered NLT System Requirements Review
  - Cover 100% of planned design
  - Cover 100% of planned parts
    - Instructions for Continued Airworthiness (ICA)
    - Sustainment plan to ensure availability of airworthy parts throughout life cycle
  - For all non-FAA parts or design, must have SPM or Chief Engineer approval
  - Account for life cycle maintenance
  - Deliver applicable airworthiness certification documentation
  - Include specific control measures (metrics) to track health

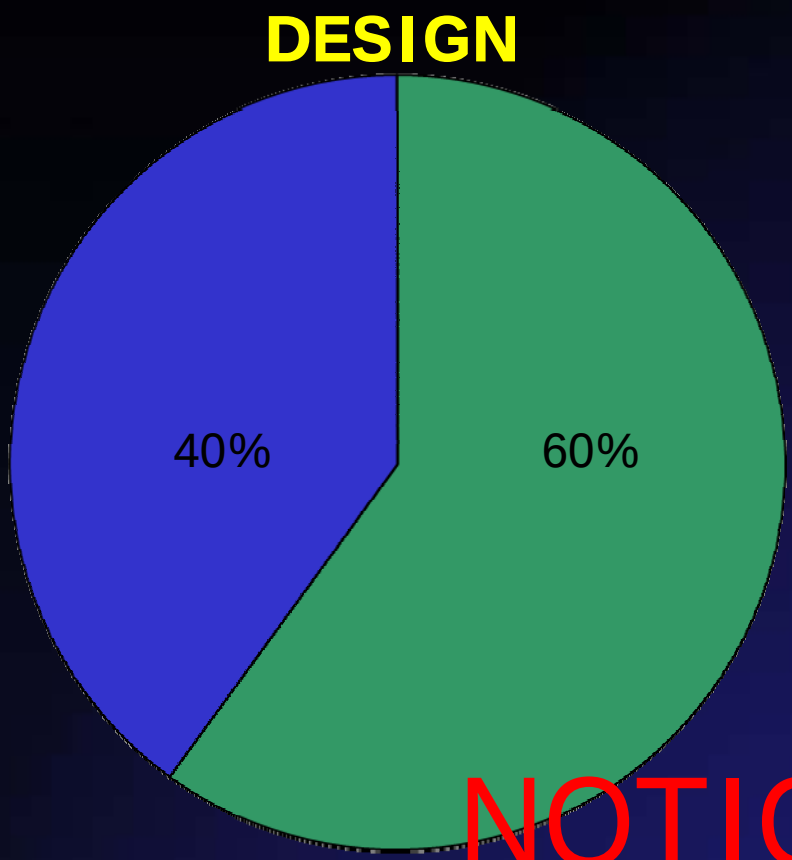
Sol'n #3: Decisions at Right Level

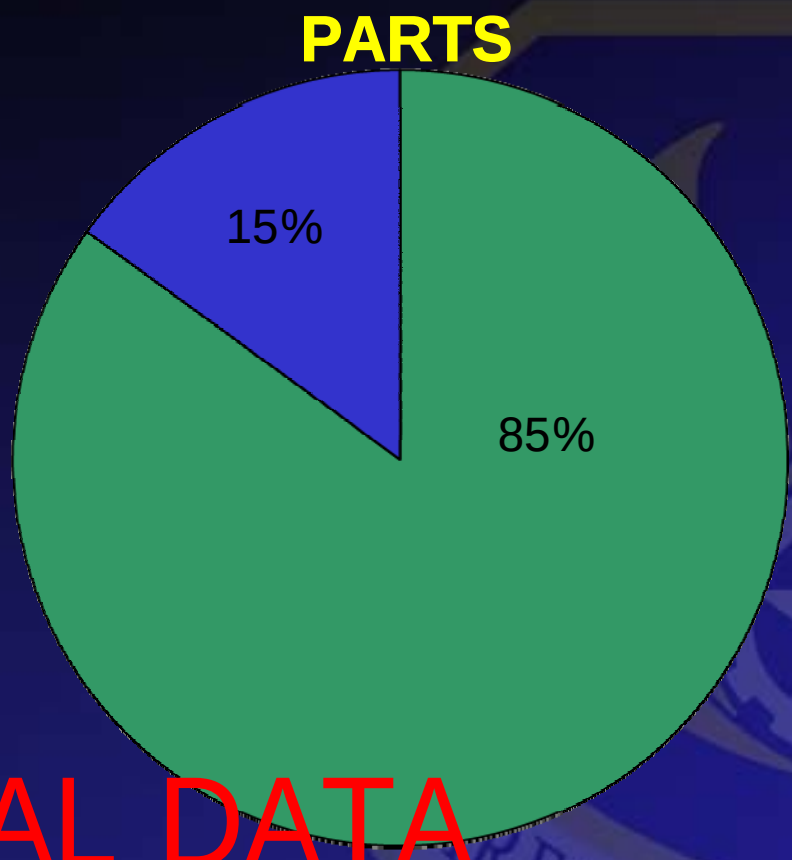
- **Clearly define decision making authority for each airworthiness condition**
  - **OI contains detailed matrix for each certification method, part certification and documentation requirement**
  - **OI clearly defines for each condition what level has approval authority**
    - **Chief Engineer or Single Manager**
    - **Engineering Flight Director**
    - **Lead engineer or program manager**
  - **Boeing make similar changes to their internal processes**

Sol'n Gap #4: Developed Metrics

- Establish control measures to track the following:
  - Design/part certification method
  - Design certification breakout
  - Part certification breakout
- Start tracking at beginning and continue through delivery
  - Brief to Upper Management Quarterly
  - Metrics must have ability to roll-up
  - For a collection of modifications
  - For entire aircraft
  - For entire organization

Design/Part Certification Method

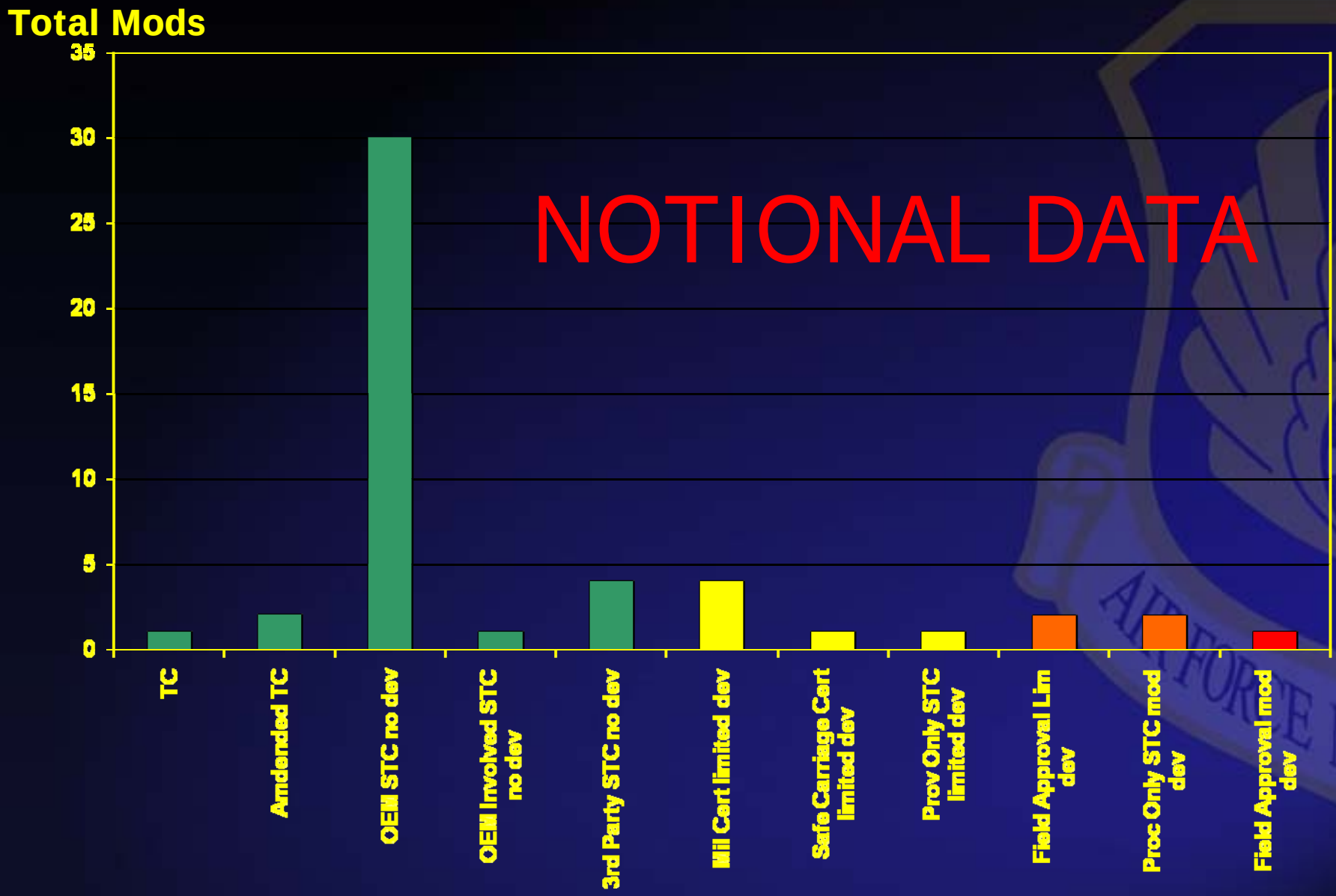




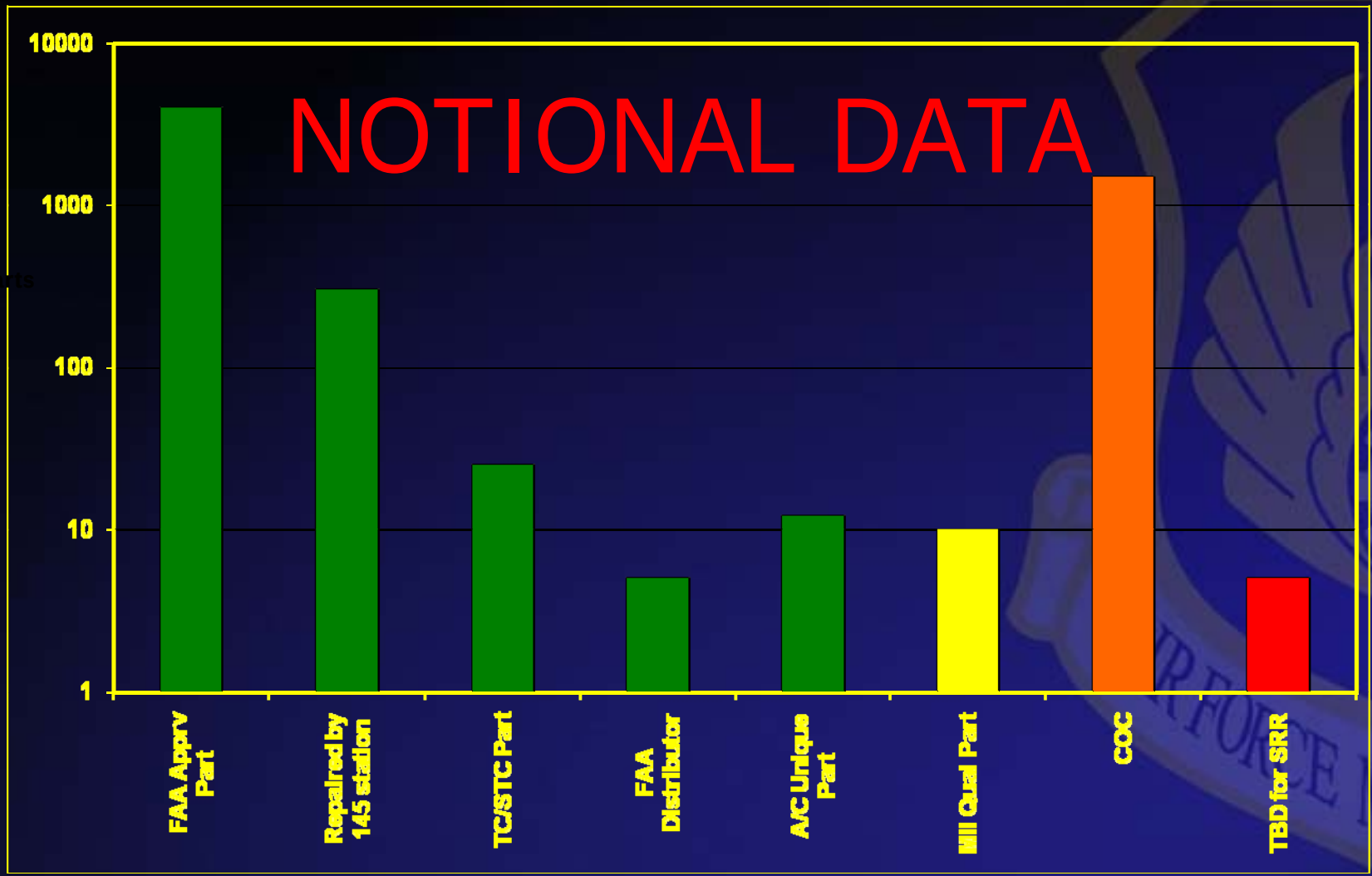
NOTIONAL DATA

- FAA represents fully commercial compliant
- Military is anything but fully commercial compliant

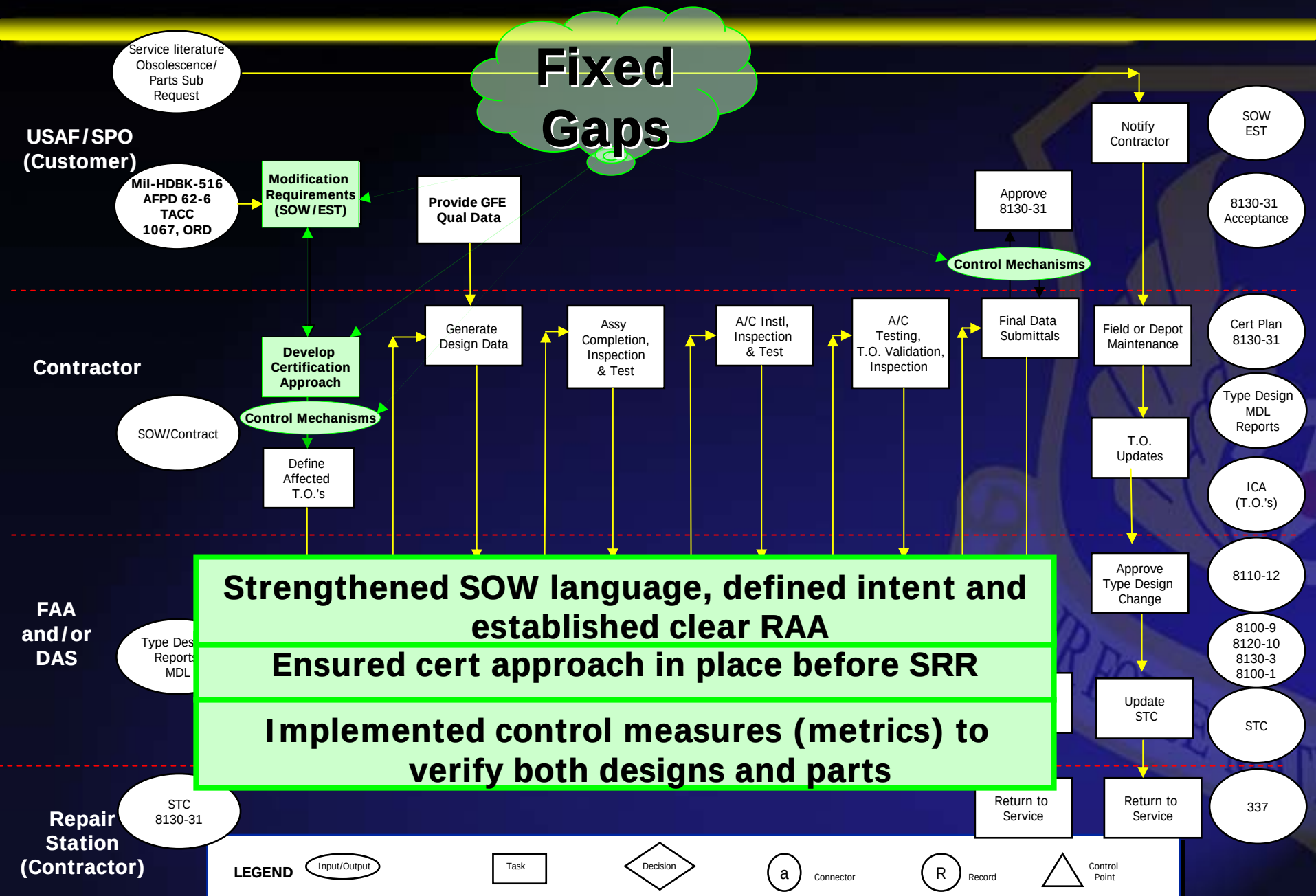
Design Certification Breakout



Part Certification Breakout



New Process to Ensure Airworthiness

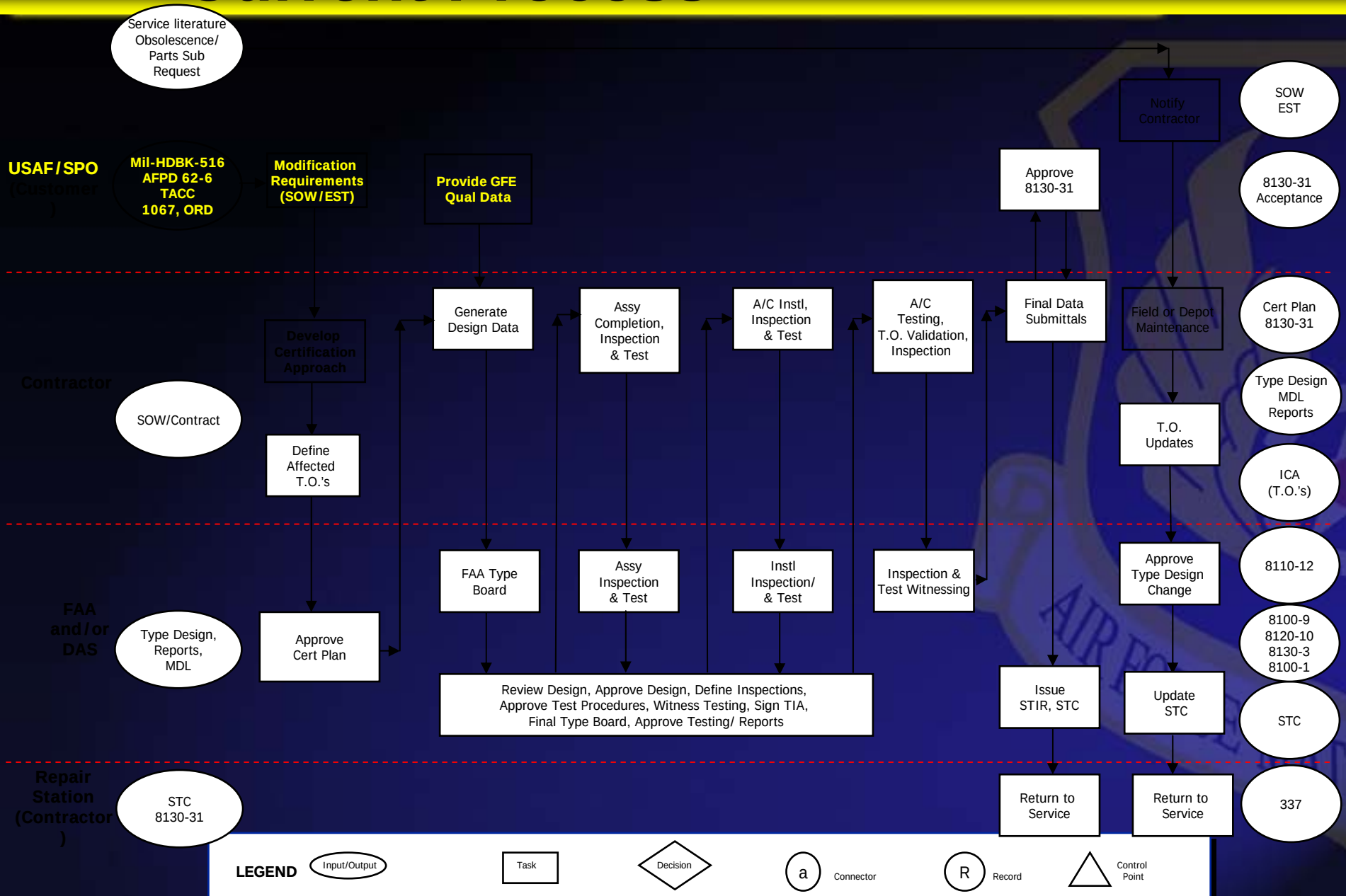


Summary

- Focuses on airworthiness certification planning and implementation rather than establishment of airworthiness certification criteria
- Provides a standardized proactive airworthiness certification management process consistent with Air Force policy
- Provides a process to ensure airworthiness certification requirements are an integral part of program management—contractor and DoD
- Ensures “the right” airworthiness certification requirements, for both design and parts, are identified, implemented, monitored, controlled, and reported.

Questions ?

Current Process



Parking Lot Gaps

Gap	727 ACSG	Boeing	ASC/FAA
(G1) MACC's not being prepared for each modification	X		
(G1a) Cert plans that are generated by contractor are not coordinated with Government		X	
(G2) No approach in 727 ACSG for military certification path	X		
(G2a) Contractor processes do not support military certification path or have firm understanding of military airworthiness requirements (i.e. AFPD 62-6, AFPD 62-4, AFPD 62-5, MIL-HDBK 516B)		X	
(G3) User and contractual requirements provide insufficient details to ensure airworthiness certification for 100% of designs/parts	X		
(G3a) Definitive definition of correct level of certification has not been provided by FAA			X
(G3b) Definitive definition of correct level of certification has not been provided by ASC/EN			X
(G3c) Contractor processes do not support different methods of airworthiness certification or incorporate FAA order 8110		X	
(G4) Responsibility, Accountability, Authority (RAA) is not defined or documented on Government or contractor side resulting in Program Managers, Equipment Specialists making airworthiness decisions on designs/parts	X		
(G4a) Contractor does not have defined and documented RAA's for airworthiness decisions		X	
(G4b) FAA has not defined and documented RAA's for airworthiness decisions			X
(G4c) ASC/EN has not defined and documented RAA's what airworthiness decisions should be made at what level for the different methods of certification			X
(G5) Airworthiness certification for entire provisions only installation not attained	X		
(G6) Methods of maintaining continued airworthiness not fully understood	X		
(G6b) Sustainment and modification teams on ASC/EN team not integrated			X
(G6a) Sustainment and modification teams on contractor team not integrated		X	
(G7) Contract requirements impact on existing airworthiness decisions not understood	X		
(G8) Sustainment (parts or services procurement and repair) not necessarily in accord with design/certification basis	X		
(G8a) Contractor sustainment teams are not involved with new mod development		X	
(G9) FAA certification of COTS do not play well together	X		
(G9a) Air Force customer mission requirements and airworthiness requirements do not support each other			X

RCM Template

	Event	Requirement		
0	Effort kickoff or major review/change	• Identify scope of modification, including functions/ capabilities affected/incorporated, major hardware elements and LRUs, areas of a/c affected, and system or systems involved.	Step 1	Step 1
1	Overall Certification	• R1 – Prepare an integrated airworthiness certification plan to accomplish comprehensive design certification. • R2 – Provide Instructions for Continued Airworthiness to permit aircraft sustainment in accordance with certified design • R22 – Provide control measures (metrics) to track design/part certification method, part certification breakout and design certification breakout on or before SRR with updates to metrics throughout modification program • R23 – Provide delivery dates for metrics and supporting data in program integrated master schedule	Step 2	Step 2
2	Are there portions of the modification which can/should be fully FAA certified? That is elements (A) which are: • Similar/identical to widespread commercial requirements • Similar to private initiatives in effects on airworthiness, flight characteristics, operational characteristics, or pilot technique • Are similar to private initiatives in aircraft usage or implementation of mission or interior accommodations • Can meet all applicable FAA regulations and the same requirements for a commercial modification	• R3 – Obtain FAA approval/certification for (A) equipment/ capability implementation in accordance with requirements applicable to aircraft operating under FAR Part (91, 121, etc. as applicable).	Step 3	Step 5
3	Are there adaptations or alterations of commercial aviation equipment required to suit military or mission requirements?	• R4 – Modify (E) to provide capabilities (Z) • R5 – Obtain FAA certification for (E), as modified	Step 3a	Step 3a
3a	Will existing STCs (S) be partially changed as a result of this modification?	• R18 – Obtain FAA approval of changes to (S) Gov't note: Military a/c primarily don't maintain the airworthiness certificate (from the strict FAA stance). Recommend that a technical risk		

RCM Template

	Event	Requirement		
5	Are there elements of the modification which cannot be approved for carriage by the FAA (B)? Examples include: •Hazardous materials or equipment •Equipment which cannot be demonstrated to be safe even when not operating	•R6 – Obtain Provisions Only FAA approval/certification of interfaces/provisions for (B).	Step 6	Step 6
6	Will military qualified equipment (C) be needed/used in the modification?	•R7 – Obtain FAA installation certification/approval for (C) using military qualification and operational data. •R8 – Perform necessary analysis to support FAA certification/approval for (C) •R9 – Perform additional testing required to support FAA certification/approval for (C)	Step 7	Step 7
7	Will the modification use/apply non-aviation commercial- or consumer-grade equipment	•R10 – Perform safety analyses covering use and operation of (L) •R11 – Obtain FAA certification/approval for (J) •R 12 – Identify any equipment in (L) which is unsafe or hazardous when applied to this modification (H)	Step 8	Step 8
8	Is there hazardous commercial/consumer equipment?	•R13 – Design enclosures and/or accommodations to control hazards posed by (H) •R14 – Obtain FAA certification/approval for enclosures and/or accommodations for (H)	Step 9	Step 9
9	Is there doubt that sustainment parts and repairs can be readily obtained for FAA certified design, throughout the life of the modification?	•R15 – Develop a sustainment plan to ensure availability of FAA parts repair capability throughout the life of the modification •R16 – Develop a sustainment plan to ensure availability of FAA replacement parts throughout the life of the modification Gov't note: Requires a Logistics Support Analysis to determine right path FAA or not – don't assume pure FAA is the right approach.	Step 10	Step 10

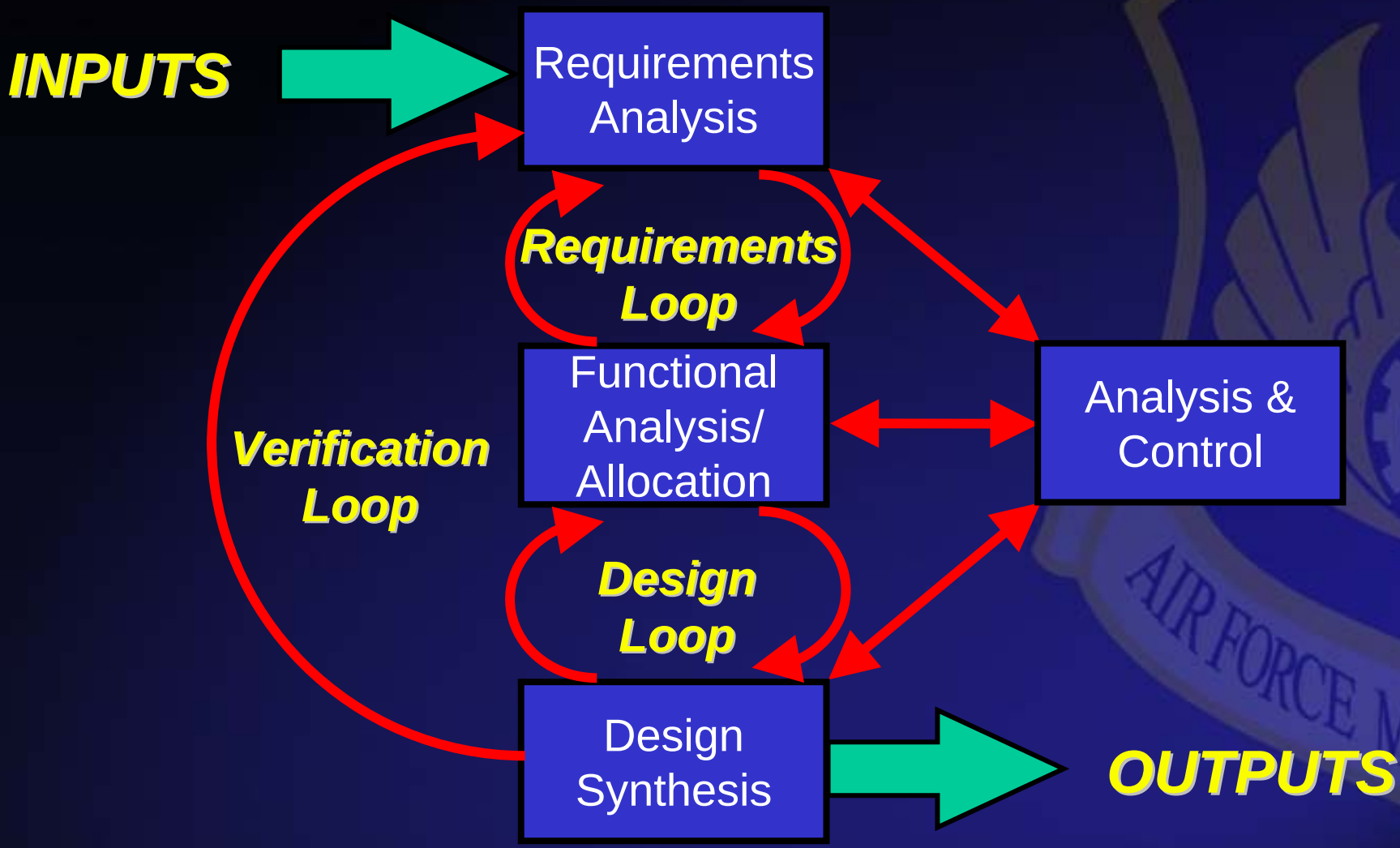
RCM Template

Event		Requirement		
10	Are there elements (M) that will not be FAA certified?	•R17 – Develop a comprehensive plan to certify (M) in accordance with military airworthiness certification requirements (MIL-HDBK-516)	Step 11	Stop
11	Are there elements B?	•R18 – Conduct analyses, tests, and demonstrations to qualify (B) •R19 – Prepare and submit data to support certification of (B) for airworthiness, including operation in-flight	Step 12	Step 12
12	Are there elements K?	•R20 – Conduct analyses, tests, and demonstrations to demonstrate/develop safe installation and use of (K) •R21 – Prepare and submit data to support certification or approval of (K) for installation and use	Step 13	Step 13
13	Military Certification	•R21 - Conduct necessary analyses, test, and demonstrations to support airworthiness and operations approval for (M)		

RCM Template Key

- A Elements of modification which may receive full FAA certification/approval
- B Military only elements of the modification – those which cannot be approved for installation by FAA and require provisions only approval
- C Military qualified equipment for which FAA certification may be obtained
- E Commercial aviation equipment which must be altered or adapted to meet military requirements (subset of A)
- H Non aviation commercial or consumer equipment which is unsafe or poses hazards which cannot be mitigated (subset of L)
- J Non aviation commercial or consumer equipment which may be FAA certified (subset of L)
- K Non aviation commercial or consumer equipment which cannot be FAA certified or for which accommodations cannot be designed to permit certification (subset of L and possibly H)
- L Non aviation commercial or consumer equipment needed/used as part of modification
- M Elements requiring military airworthiness certification (Includes B and K)
- S Existing STCs modified in the course of the current modification
- Z Capabilities or features for military purposes which must be incorporated into commercial aviation equipment

Basic Systems Engineering Process



Major Modification Programs

17 Current Programs

Y	KC-10 AMP – ASC Lead (ACAT II)	$1.03B
G	KC-10 Dual 406 MHz ELT Upgrade (ACAT III)*	$2.4M
G	KC-10 Iridium Phone (ACAT III)*	$2.7M
G	KC-10 UHF SATCOM Antenna (ACAT III)*	$2.6M
G	VC-25 Forward Lower Lobe (FLL) Cooling (ACAT III)	$14.4M
G	VC-25 Presidential Data System (PDS) (ACAT III)*	$223.3M
G	VC-25 CNS/ATM (ACAT III)*	$41.8M
G	C-20 Gulfstream Test Vehicle (GTV) (ACAT III)*	$8.7M
G	E-9 Telemetry Sys Upgrade (ACAT III)*	$5.9M
G	E-4B Mod Block I (ACAT II) *	$421.4M
G	E-4B 256 Kbps High Speed Data via INMARSAT (ACAT III)*	$8.4M
R	C-12 EFIS (ACAT III)	$77.7M
Y	HFGCS Network Control Station – West (ACAT III)*	$23.2M
Y	HFGCS AFSPC Test Range HF Modernization (ACAT III)*	$3.9M
G	HFGCS Network Optimization – Spiral II (ACAT III)*	$7.1M
G	HFGCS Navy Consolidation (ACAT III)*	$6.4M
G	HFGCS Audit Log Upgrade (ACAT III)*	$189K

*Program is fully funded