

Headquarters U.S. Air Force

Integrity - Service - Excellence

F-22 Export Configuration Study

This briefing contains the following special access programs:

(b)(1), Sec. 1.4(a)

Need to Know should be strictly enforced.



**SAF/AQL
March 2010**

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Congressional Task (U)

(U) Excerpt from SAP Annex of the 2009 Appropriations Bill

REPORT* OF F-22 FOR EXPORT

“The F-22A fighter was not designed with the objective of selling the aircraft to allies and partners worldwide. Concerns about inadvertent disclosure of sensitive technologies, materials and capabilities have prevented exporting this highly capable aircraft to interested nations. **The Secretary of the Air Force is directed to provide a report to the congressional defense committees, no later than [Date Removed], on: (1) the changes that would be required to produce an export version; (2) how long it would take to design that F-22 variant; and (3) a cost estimate for the design, development, testing and production of the aircraft.”**

* Briefing approved for final product

** Extension to [Date Removed] approved by SAC-D

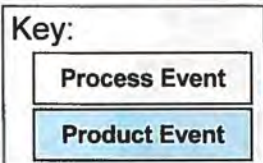
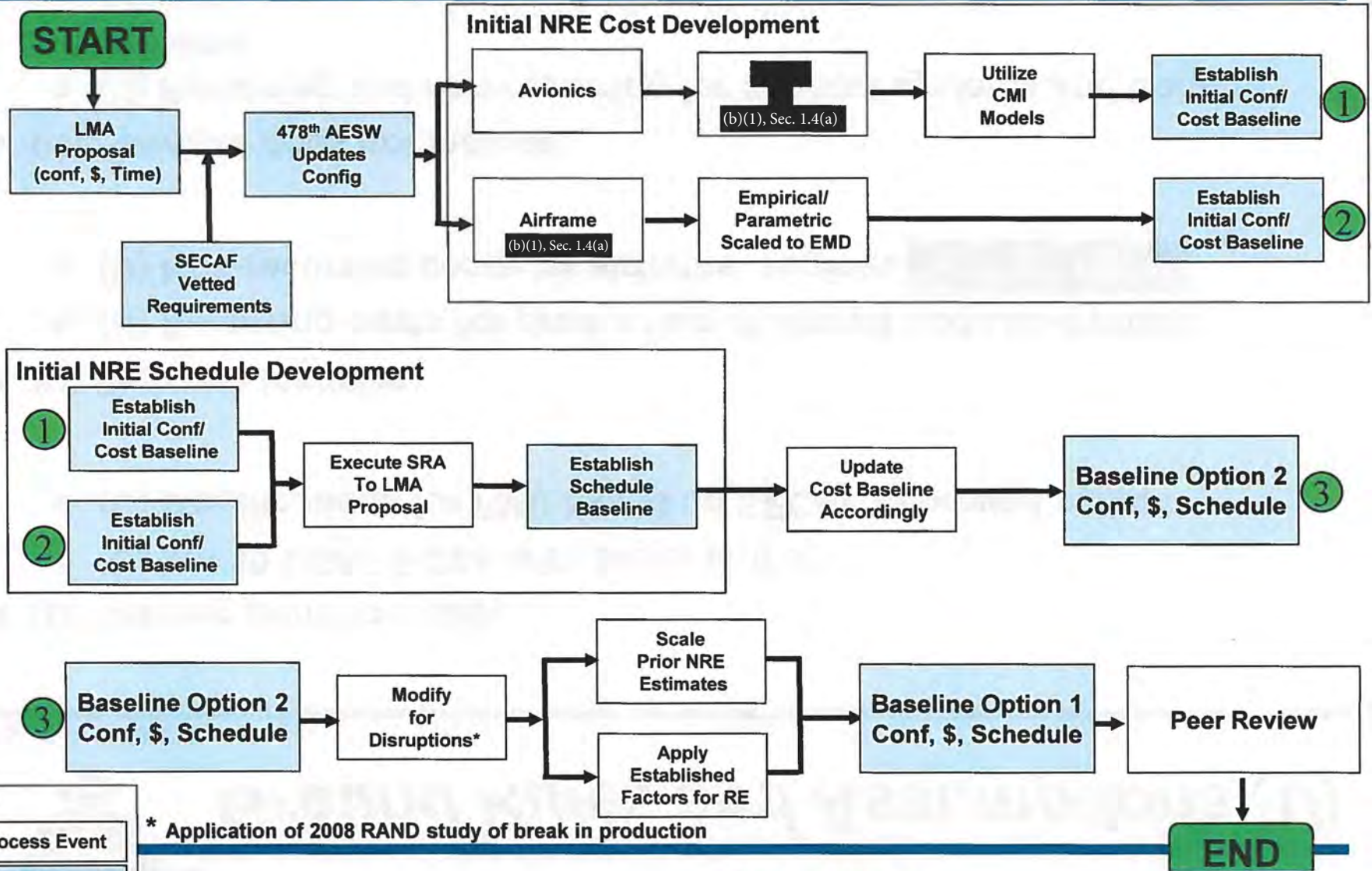
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F-22 FMS Study Process (U)

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* Application of 2008 RAND study of break in production

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Ground Rules and Assumptions (U)

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- **(U) Starting point for study**
 - **(U) Lot 10 USAF F-22A with Increment 3.1**
 - **(U) Modifications for FMS based on SECAF approved variant**

- **(U) Estimate includes:**
 - **(U) Recurring costs for production of aircraft and sub-systems**
 - **(U) Non-recurring costs for airframe, engines** (b)(1), Sec. 1.4(a)

- **(U) Estimate does not include:**
 - **(U) Recurring and non-recurring for support systems and training systems**
 - **(U) Initial spares, base stand-up, or interim contractor support**

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Ground Rules and Assumptions (U)

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- **(U) Development infrastructure**
 - **(U) Cost includes FMS unique subsystem and system labs**
 - **(U) Some development labs and Combined Test Force (CTF) infrastructure shared with USAF**
 - **(U) Schedule assumes 2 DT aircraft from FMS production line, available in 2014**

- **(U) Design will utilize F-35 radar and core processor production parts**

- **(U) Does not include US Government program office, FMS surcharge, or Engineering and Manufacture Development (EMD) recoupment costs**

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(b)(1), Sec. 1.4(a)

F-22A Export Variant (U)

Critical Technology Dispersion

Critical Technology Enhances:

- Low Observable (LO)
- (b)(1), Sec. 1.4(a)
- Situational Awareness, Defense and Lethality
- Speed and Agility

Export Variant Changes

Change ■
 No Change ■

(b)(1), Sec. 1.4(a)

(b)(1), Sec. 1.4(a)

- 2. Supercruise
- 3. Thrust Vectoring

(b)(1), Sec. 1.4(a)

(b)(1), Sec. 1.4(a)

Export changes are based on technology transfer precedents, preservation of US warfighter advantages, and JSF precedents

(b)(1), Sec. 1.4(a)



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F-22 FMS Program (TY\$B) (U)

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- (U) Cost Estimate (40 FMS aircraft)
 - (U) Non-recurring Development \$1.7B
 - (U) Non-recurring Restart Costs \$ 0.6B
 - (U) Production (40 A/C – \$232.5M ea.) \$ 9.3B
 - (U) Total \$11.6B*

- (U) Schedule Estimate
 - (U) First aircraft available for customer (from EMD contract) 6 ½ Yrs

ROM Cost/Schedule Estimate

* (U) Production restart cost/unit flyaway delta based on 2008 RAND study. \$3.3B cost savings possible if production started immediately following the end of US aircraft production. Assumes notional production rate through end of CY 2013. (40 FMS A/C* – \$165M ea.) Schedule = 6 yrs

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Option 1: F-22 Program of Record (U) ***(Necessitates Production Break)***

- **(U) No USAF production after (4) Lot 10 aircraft**
 - **(U) 2 year gap in production activity**
 - **(U) Creates ~ 2.5 yr production delivery break**
 - **(U) Requires concurrent EMD and production authorization**
 - **(U) Funding needed to restart production in 4QCY10**
 - **(U) Personnel retention, rehiring, retooling and facility set-up**
 - **(U) Begin requalification of vendors**
 - **(U) First 2 A/C from FMS production become DT aircraft**
 - **(U) CY14**
 - **(U) EMD schedule completes in 4QCY16**
 - **(U) First FMS production aircraft delivery 2QCY17**
-

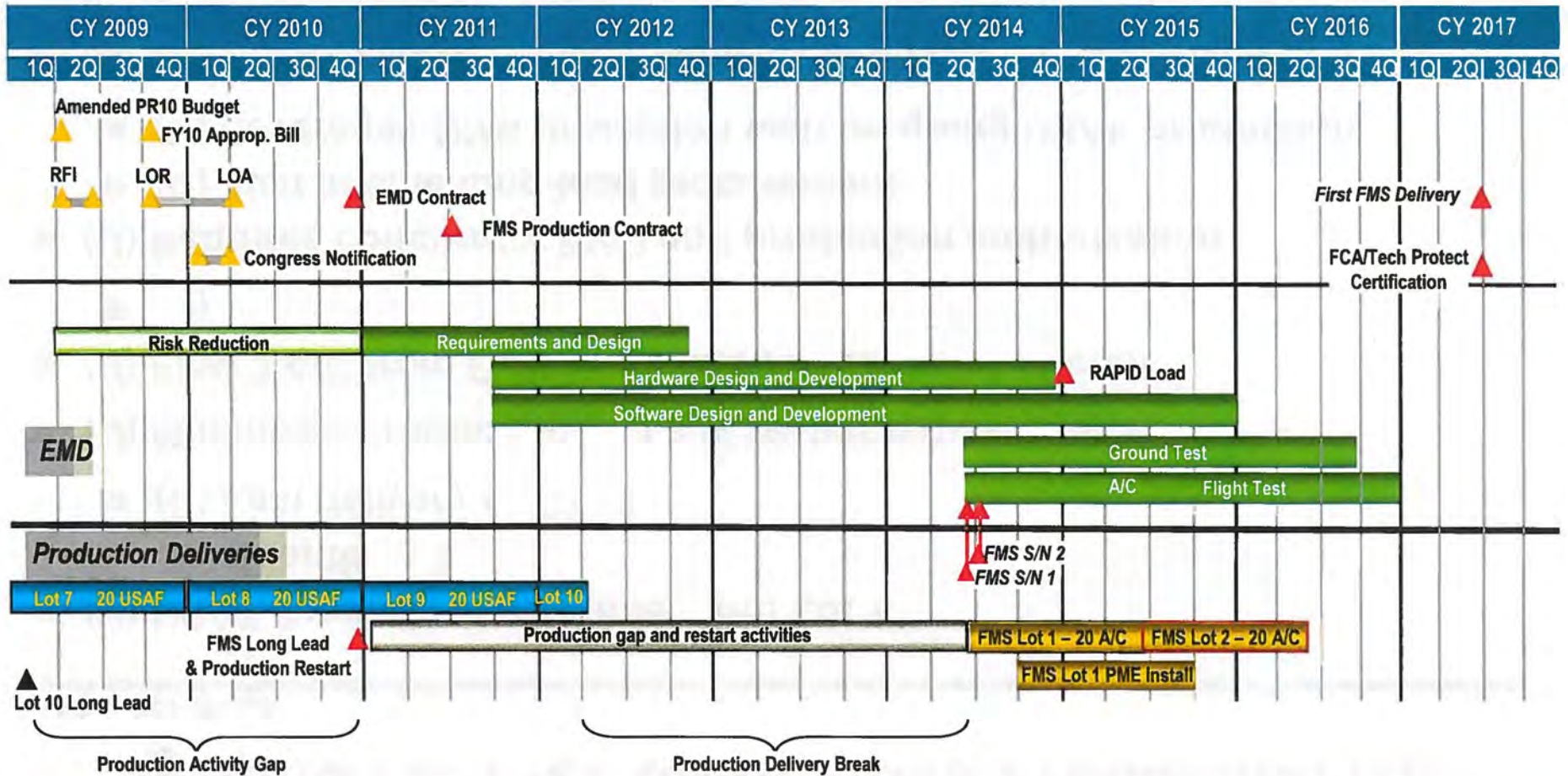
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Option 1 – F-22 Program of Record (U) Schedule with Production Break

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Option 2: F-22 Continuous Production (U)

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- (U) USAF Production continues thru Lot 11
 - (U) Quantities TBD
 - (U) Last delivery 4QCY13
- (U) Minimizes Production gap and restart requirements
- (U) First 2 A/C from FMS production become DT aircraft
 - (U) 1QCY14
- (U) Requires concurrent EMD and production authorization
 - (U) Just in time long-lead procurement
 - (U) Leverages DMS protection with on-going USAF production
- (U) Forces a delayed Primary Mission Equipment (PME) installation in production aircraft
- (U) Protects suppliers, learning curve, efficiencies, etc
- (U) First FMS production aircraft delivery 4QCY16

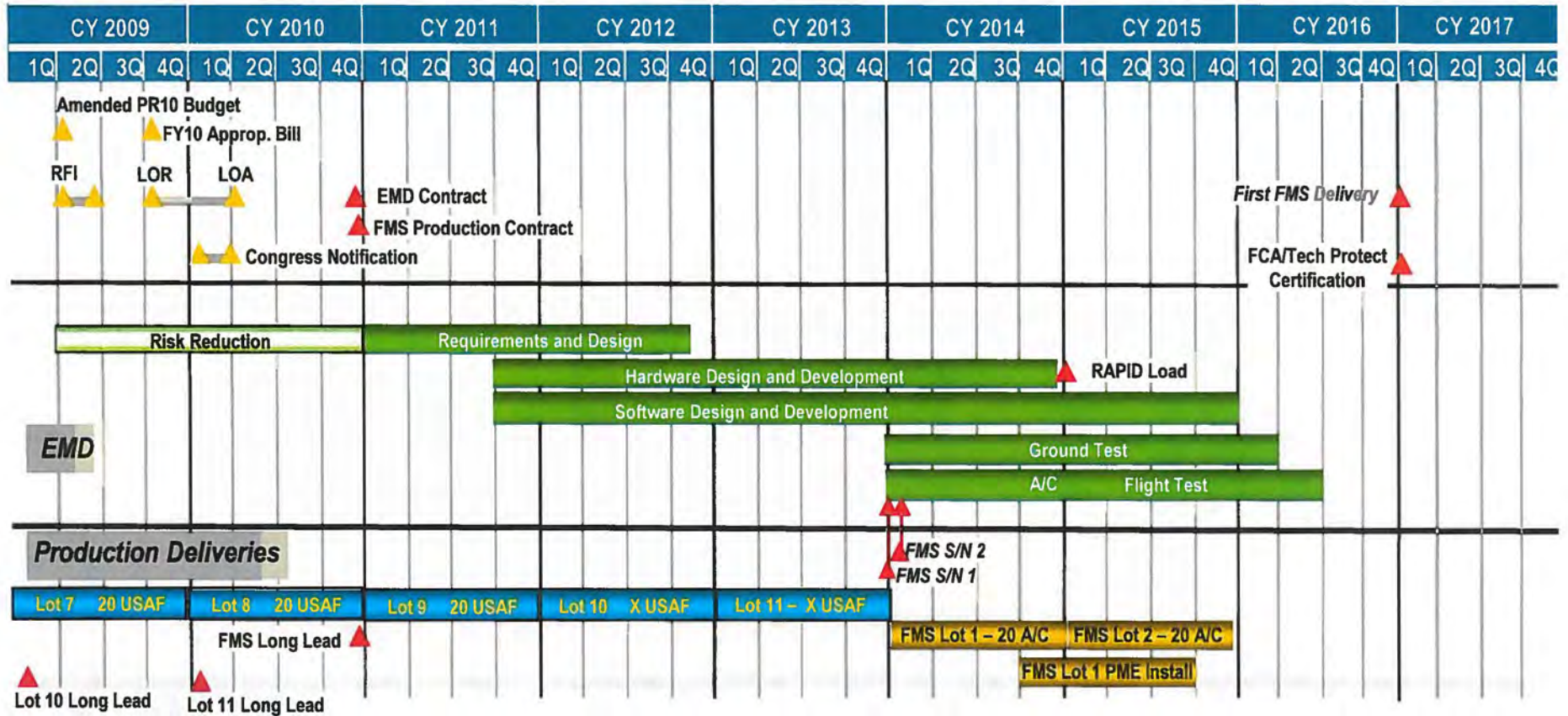
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Option 2 – Continuous Production (U)

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Questions?

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Long Brief

***Phase I
Phase II
Final Study Results
Backup***

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PHASE I

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Government Contributors (U)

SAF/AQL

SAF/AQP

SAF/IAR

USAF Red Team

AFOSI Region 7

AF A5R-A

478 AESW (F-22 SPO)

ACC/A8F

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Outline (U)

- **Background**
- **Study Process and Schedule**
- **Critical Technologies**
- **Study Results**

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(b)(1), Sec. 1.4(a)

Background (1 of 2) (U)

Why the F-22 export situation is different than any other fighter

- (U) F-22A exports currently prohibited; F-35 is an international cooperation program. As a consequence:
 - (U) Different levels of (b)(1), Sec. 1.4(a)
 - (b)(1), Sec. 1.4(a)
 - (b)(1), Sec. 1.4(a)
 - (U) F-35 includes sophisticated (b)(1), Sec. 1.4(a) features
 - (U) (b)(1), Sec. 1.4(a) incorporated from design to production of air vehicle
 - (b)(1), Sec. 1.4(a)

(b)(1), Sec. 1.4(a)



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(b)(1), Sec. 1.4(a)

Background (2 of 2) (U)

Why the F-22 export situation is different than any other fighter

- **(U) Dissimilar amount of design work on export configurations**
 - **(U) No F-22A export configuration currently exists; it was not considered/incorporated during the initial design**
 - [Redacted] (b)(1), Sec. 1.4(a)
- **(U) F-22A supercruise/thrust-vectoring capability have no export precedent**
 - [Redacted] (b)(1), Sec. 1.4(a)
 - [Redacted] (b)(1), Sec. 1.4(a)

(b)(1), Sec. 1.4(a)



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Study Process (1 of 2) (U)

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- (U) Research and data-mine historical related studies
 - (U) 1998 Air Force/Lockheed Martin export study
 - (U) 2006 USAF Red Team: F22A Technology Export Assessment
- (U) Identify potential export countries
- (U) Identify critical technology and systems
- (U) Define changes required for export (b)(1), Sec. 1.4(a)
- (U) Obtain SECAF approval of proposed F-22 export changes for cost/schedule analysis (begin Phase II)
- (U) Brief changes required for export to Congress (interim)
- (U) Provide requirements to Program Office for cost/schedule analysis
- (U) Compile and submit final brief to congress

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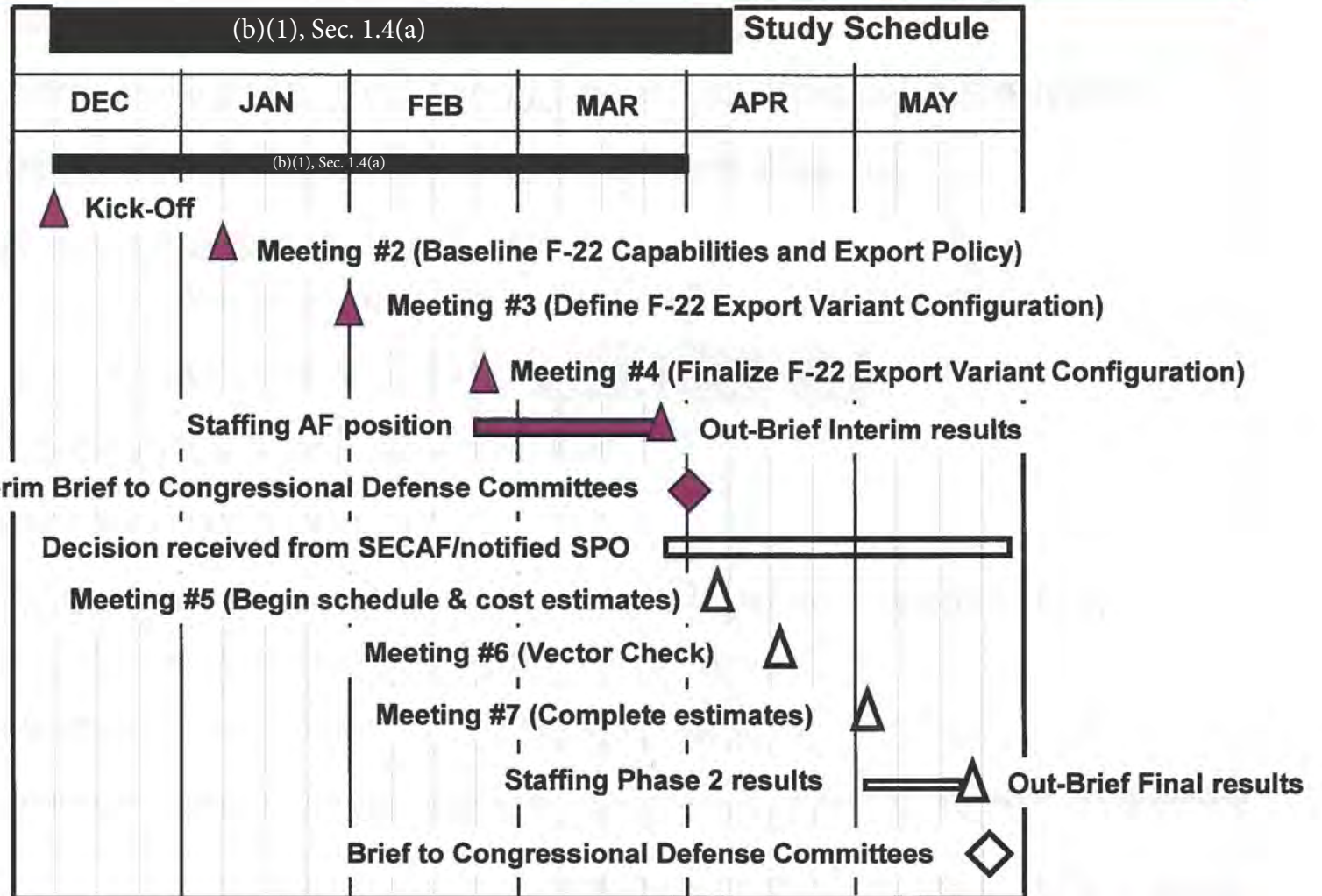
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(b)(1), Sec. 1.4(a)

Study Process (1 of 2) (U)

PHASE 1
Changes required for an export version

PHASE 2
How long to design the export variant and cost to design, develop, test, and produce the aircraft



(b)(1), Sec. 1.4(a)



(b)(1), Sec. 1.4(a)

F-22A Critical Technologies* (U)

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Comparison to F-35

(b)(1), Sec. 1.4(a)	(b)(1), Sec. 1.4(a)		On (b)(1), Sec. 1.4(a) F-35
	(b)(1), Sec. 1.4(a)	(b)(1), Sec. 1.4(a)	(b)(1), Sec. 1.4(a)
<ul style="list-style-type: none"> ■ (b)(1), Sec. 1.4(a) ■ (b)(1), Sec. 1.4(a) ■ (b)(1), Sec. 1.4(a) ■ (b)(1), Sec. 1.4(a) 	<ul style="list-style-type: none"> ■ (b)(1), Sec. 1.4(a) ■ (b)(1), Sec. 1.4(a) ■ (b)(1), Sec. 1.4(a) ■ (b)(1), Sec. 1.4(a) ■ (b)(1), Sec. 1.4(a) ■ (b)(1), Sec. 1.4(a) ■ (b)(1), Sec. 1.4(a) ■ (b)(1), Sec. 1.4(a) ■ (b)(1), Sec. 1.4(a) ■ (b)(1), Sec. 1.4(a) 	<ul style="list-style-type: none"> ■ (b)(1), Sec. 1.4(a) ■ (b)(1), Sec. 1.4(a) ■ (b)(1), Sec. 1.4(a) ■ (b)(1), Sec. 1.4(a) ■ (b)(1), Sec. 1.4(a) ■ (b)(1), Sec. 1.4(a) ■ (b)(1), Sec. 1.4(a) ■ (b)(1), Sec. 1.4(a) ■ (b)(1), Sec. 1.4(a) ■ (b)(1), Sec. 1.4(a) 	<ul style="list-style-type: none"> ■ AESA transmit/receive modules ■ (b)(1), Sec. 1.4(a) ■ Radar missile update ■ Radar gun support ■ Turbine exhaust case ■ Serpentine inlet ducts ■ Airframe and front frame ■ Drain holes and fasteners ■ High-temperature bismaleimide composites ■ Canopy coating (current) ■ (b)(1), Sec. 1.4(a) ■ (b)(1), Sec. 1.4(a) ■ Missile launch detection and IR countermeasure algorithms ■ (b)(1), Sec. 1.4(a) ■ RAM sheets, liquids, fillers, resins ■ Conductive pastes, fillers ■ (b)(1), Sec. 1.4(a) Magnetic RAM

(b)(1), Sec. 1.4(a)

(b)(1), Sec. 1.4(a)



F-22A Critical Technology (U)

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Overview

Critical Technology

Enhances:

- Low Observable (LO)
- (b)(1), Sec. 1.4(a)
- Situational Awareness, Defense and Lethality
- Speed and Agility

(b)(1), Sec. 1.4(a)

(b)(1), Sec. 1.4(a)

2. Supercruise
3. Thrust Vectoring

- Careful design of numerous subsystems required for LO aircraft

(b)(1), Sec. 1.4(a)

(b)(1), Sec. 1.4(a)



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(b)(1), Sec. 1.4(a)

F-22A Critical Technology

Export Variant

Critical Technology

Enhances:

- Low Observable (LO)
- (b)(1), Sec. 1.4(a)
- Situational Awareness, Defense and Lethality
- Speed and Agility

Export Variant Changes

Change ■
 No Change ■

(b)(1), Sec. 1.4(a)

(b)(1), Sec. 1.4(a)

2. Supercruise
3. Thrust Vectoring

(b)(1), Sec. 1.4(a)

(b)(1), Sec. 1.4(a)

Export changes are based on technology transfer precedents, (b)(1), Sec. 1.4(a)

(b)(1), Sec. 1.4(a)

(b)(1), Sec. 1.4(a)



(b)(1), Sec. 1.4(a)

F-22A Critical Technology (U)

Export Variant

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Critical Technology Enhances:

- Low Observable (LO)
- (b)(1), Sec. 1.4(a)
- Situational Awareness, Defense and Lethality
- Speed and Agility

(b)(1), Sec. 1.4(a)

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(b)(1), Sec. 1.4(a)

(b)(1), Sec. 1.4(a)

(b)(1), Sec. 1.4(a)

(b)(1), Sec. 1.4(a)

Avionics

(b)(1), Sec. 1

(b)(1), Sec. 1.4(a)

(b)(1), Sec. 1.4(a)

Export Variant Changes

Change ■
 No Change ■

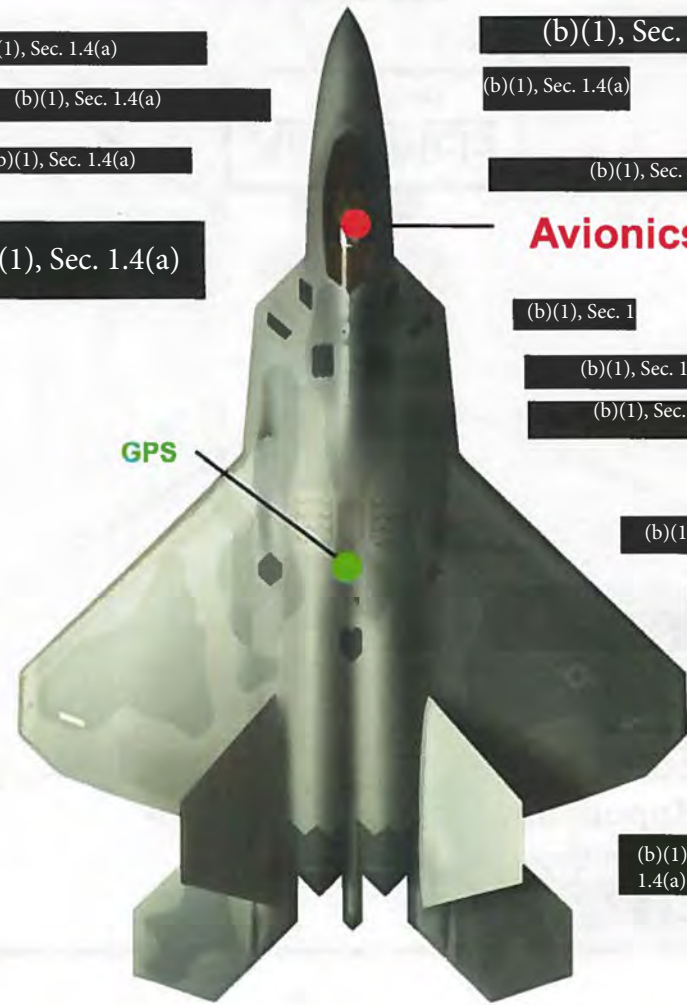
(b)(1), Sec. 1.4(a)

(b)(1), Sec. 1.4(a)

Export changes are based on technology transfer precedents,

(b)(1), Sec. 1.4(a)

GPS



(b)(1), Sec. 1.4(a)

(b)(1), Sec. 1.4(a)

(b)(1), Sec. 1.4(a)

(b)(1), Sec. 1.4(a)

(b)(1), Sec. 1.4(a)

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(b)(1), Sec. 1.4(a)

(b)(1), Sec. 1.4(a)



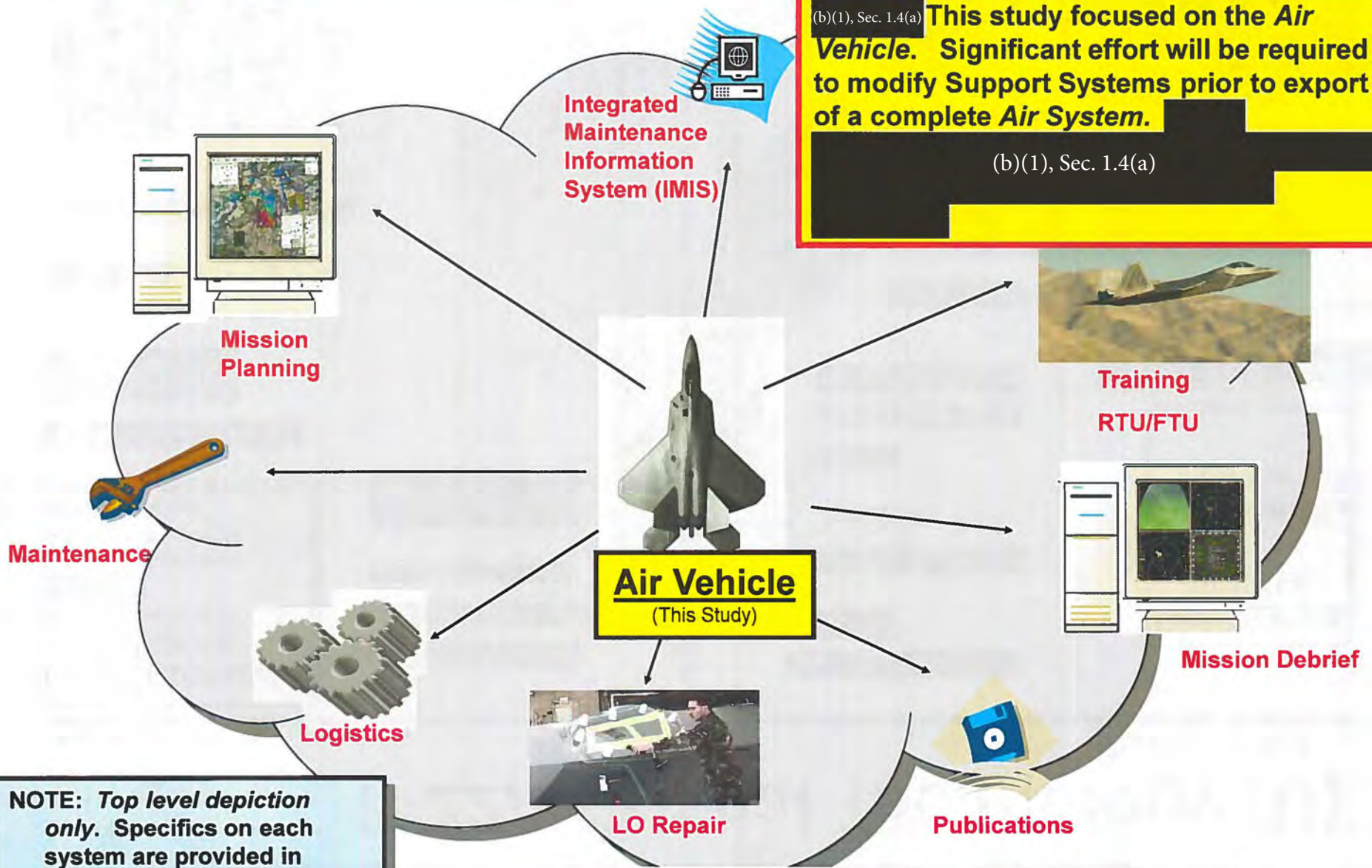
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(b)(1), Sec. 1.4(a)

Air System Considerations (U)

(b)(1), Sec. 1.4(a) This study focused on the *Air Vehicle*. Significant effort will be required to modify Support Systems prior to export of a complete *Air System*.

(b)(1), Sec. 1.4(a)



NOTE: Top level depiction only. Specifics on each system are provided in backup slides.

(b)(1), Sec. 1.4(a)



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PHASE II

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Ground rules and Assumptions (U)

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- (U) Cost estimates are ROM
- (U) Starting point
 - (U) Lot 10 USAF F-22A with Increment 3.1
 - (U) 9 March 2009 Lockheed business development trade study on FMS feasibility
 - [REDACTED] SECAF vetted requirements April 2009
 - [REDACTED] (b)(1), Sec. 1.4(a)
 - [REDACTED] (b)(1), Sec. 1.4(a)
 - [REDACTED] (b)(1), Sec. 1.4(a)
- (U) Estimate includes:
 - (U) Aircraft and engine non-recurring development
 - (U) Aircraft recurring flyaway (airframe, avionics, engines)
- (U) Estimate does not include:
 - (U) Recurring and non-recurring for support and training systems (per guidance)
 - (U) Initial spares, base stand-up, or interim contractor support
 - (U) US Government program office, FMS surcharge, or EMD recoupment costs
 - (U) Production shutdown costs



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Ground rules and Assumptions (U) ***(cont)***

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- (U) Program go-ahead Dec 2010
- (U) Assumes 2 year 40 aircraft FMS buy (Multi-Year Program price)
- (U) Two production scenarios
 - (U) Option 1: USAF production ends with 4 aircraft in Lot 10
 - (U) Production line re-start activities commencing at program go-ahead
 - (U) Production restart cost/unit flyaway delta based on 2008 RAND study
 - (U) Option 2: Continuous USAF production through Lot 11
- (U) Development infrastructure
 - (U) Cost includes FMS unique subsystem and system labs
 - (U) Some development labs and CTF infrastructure shared with USAF
 - (U) Schedule assumes 2 DT aircraft available in 2014
 - (U) Assumes continued LMA risk reduction prior to program go-ahead
- (U) Estimate dependent on continued F-35 program execution
 - (U) Radar and core processor development
 - (U) PME costs assume concurrent F-35 production buys

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Option 1: F-22 Program of Record (U) ***(Necessitates Production Break)***

- **(U) No USAF production after (4) Lot 10 aircraft**
 - **(U) 2 year gap in production activity**
 - **(U) Creates ~ 2.5 yr production delivery break**
- **(U) Requires concurrent EMD and production authorization**
 - **(U) Funding needed to restart production in 4QCY10**
 - **(U) Personnel retention, rehiring, retooling and facility set-up**
 - **(U) Begin requalification of vendors**
- **(U) First 2 A/C from FMS production become DT aircraft**
 - **(U) CY14**
- **(U) EMD schedule completes in 4QCY16**
- **(U) First FMS production aircraft delivery 2QCY17**

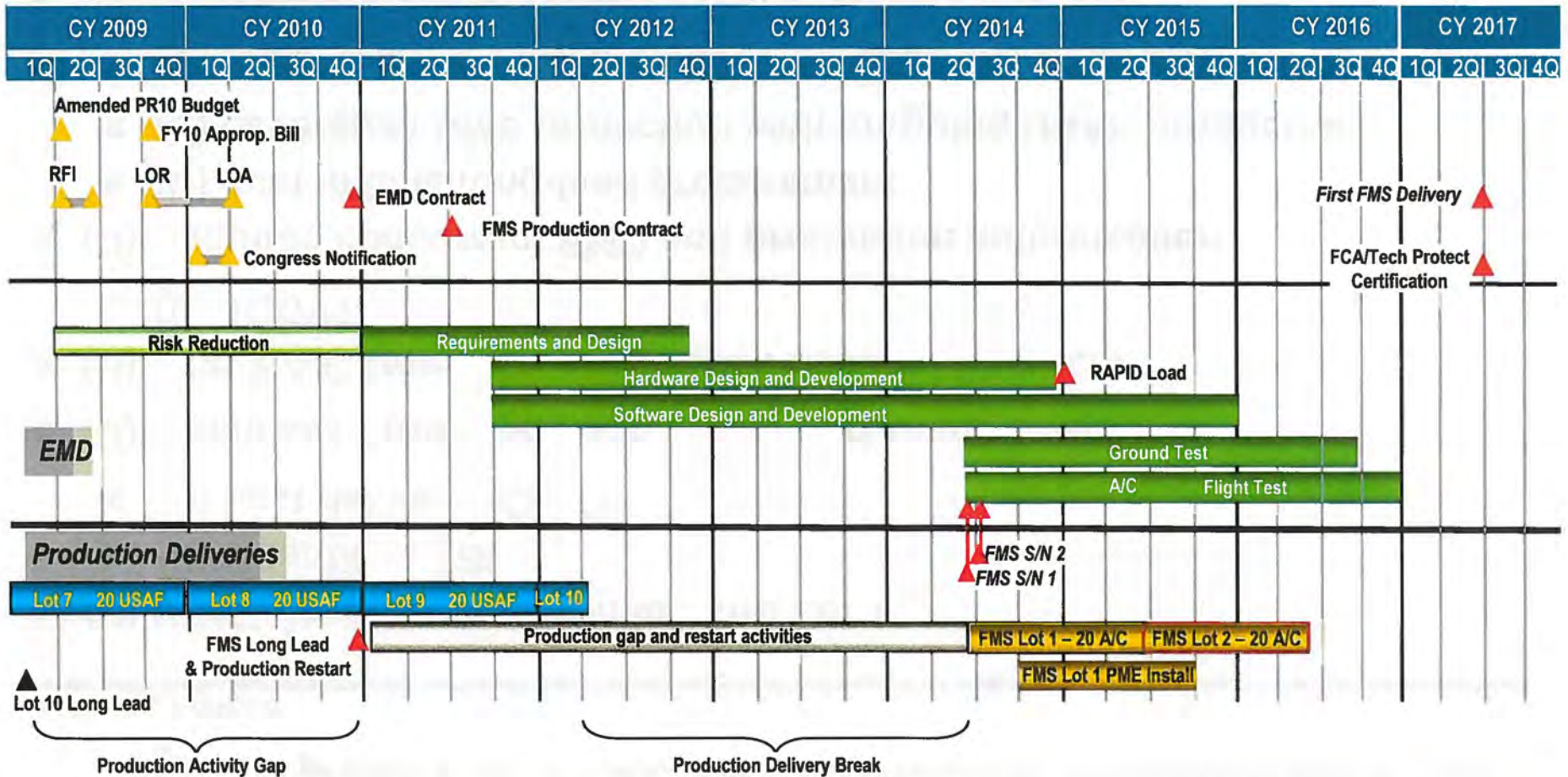
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Option 1 – F-22 Program of Record (U) Schedule with Production Break



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Option 2: F-22 Continuous Production (U)

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- **(U) USAF Production continues thru Lot 11**
 - **(U) Quantities TBD**
 - **(U) Last delivery 4QCY13**
- **(U) Minimizes Production gap and restart requirements**
- **(U) First 2 A/C from FMS production become DT aircraft**
 - **(U) 1QCY14**
- **(U) Requires concurrent EMD and production authorization**
 - **(U) Just in time long-lead procurement**
 - **(U) Leverages DMS protection with on-going USAF production**
- **(U) Forces a delayed PME installation in production aircraft**
- **(U) Protects suppliers, learning curve, efficiencies, etc**
- **(U) First FMS production aircraft delivery 4QCY16**

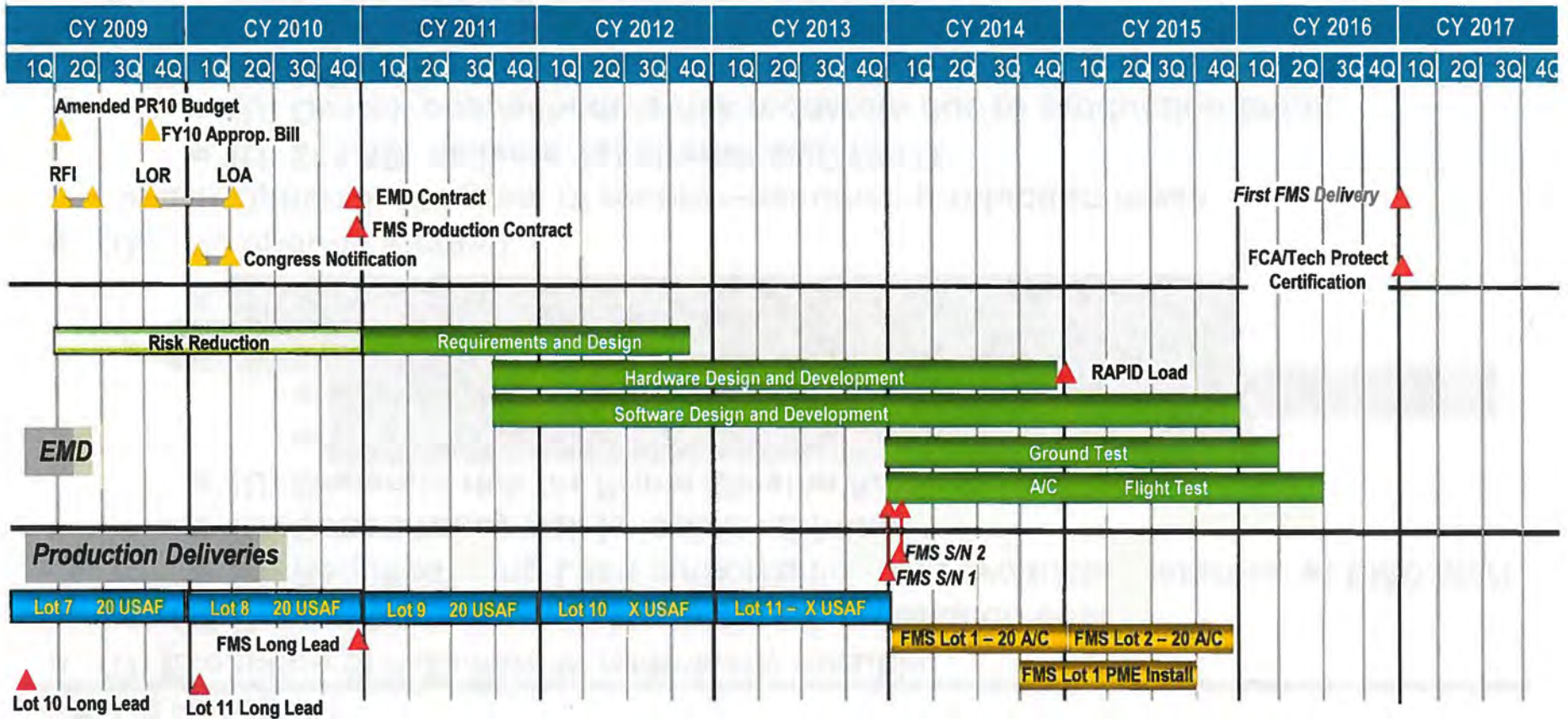
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Option 2 – Continuous Production (U)

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Phase II (U)

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- (U) Execution of F-22 FMS is technically feasible
 - (U) Concurrency essential to minimize production cost
 - (U) Requires Long Lead authorization and production start-up at EMD start
 - (U) Concurrency risk is low for airframe
 - (U) Moderate risk for Prime Mission Equipment (PME)
 - [REDACTED]
 - [REDACTED]
 - [REDACTED]
 - [REDACTED]
- (U) Two options studied:
 - (U) Option 1: Program of record—assumes production break
 - (U) \$11.6B, delivers 1st aircraft 2QCY2017
 - (U) Overall cost/schedule risk moderate due to production break uncertainties
 - (U) Option 2: USAF buys through Lot 11 enabling continuous production
 - (U) \$8.3B; delivers 1st aircraft 4QCY2016
 - (U) Overall cost/schedule risk is low to moderate based on program history

(U) Break in Production Drives ~40% Increase in Cost of 40 Aircraft Buy

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FINAL STUDY RESULTS (U)

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Study Results (1 of 2) (U)

Phase I

- **(U) What Changes Would be Required?**
 - (b)(1), Sec. 1.4(a)
 - (b)(1), Sec. 1.4(a)
 - (b)(1), Sec. 1.4(a)
 - **(U) The complete Air System contains significant technology transfer and security concerns that must be addressed in any future FMS studies or export discussions**
- **(U) How Much Would it Cost?**
 - **(U) \$11.6B**
- **(U) How Long Would it Take?**
 - **(U) 6 ½ Yrs.**

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F-22 FMS Program (TY\$B) (U)

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- (U) Cost Estimate (40 FMS aircraft)
 - (U) Non-recurring Development \$1.7B
 - (U) Non-recurring Restart Costs \$ 0.6B
 - (U) Production (40 A/C – \$232.5M ea.) \$ 9.3B
 - (U) Total \$11.6B*

- (U) Schedule Estimate
 - (U) First aircraft available for customer (from EMD contract) 6 ½ Yrs

(U) ROM Cost/Schedule Estimate

* (U) Production restart cost/unit flyaway delta based on 2008 RAND study. \$3.3B cost savings possible if production started immediately following the end of US aircraft production. Assumes notional production rate through end of CY 2013. (40 FMS A/C* – \$165M ea.) Schedule = 6 yrs

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Next Steps (U)

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If law changes and F-22A export is desired, potential steps forward include:

- (U) Re-establish F-22A Foreign Military Sales Integrated Product Team (FMS IPT) to examine export issues
- [REDACTED] (b)(1), Sec. 1.4(a) [REDACTED] evaluate, including, export configuration based on [REDACTED] but not limited to:
 - [REDACTED] (b)(1), Sec. 1.4(a) [REDACTED] properties and capabilities
 - (U) Air Vehicle performance and capabilities
 - (U) Complete Air System requirements
- (U) F-22A program develop a comprehensive [REDACTED] plan and obtain approval [REDACTED] (b)(1), Sec. 1.4(a) [REDACTED] for:
 - (U) Air Vehicle
 - (U) Complete Air System (*Maintenance, Mission Planning, Training, Logistics, Publications, etc.*)



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QUESTIONS?

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BACKUP

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Study Focus (1 of 2) (U)

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- (U) This study focused on:
 - (U) Identifying changes that would be required to produce an export variant of the F-22 aircraft
 - (U) Identifying the timeline required to design export variant
 - (U) Estimating the cost for design, development, testing and production of the defined export variant

- (U) This study did not consider:
 - (U) Political implications related to F-22 export
 - (U) Industrial or financial benefits related to F-22 export
 - (U) Details on modifications to broader support systems were not addressed

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(b)(1), Sec.
1.4(a)

Assumptions (1 of 3) (U)

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1. **(U) Minimize costs to develop and produce an export variant**
 - **(U) No new technology development**
 - **(b)(1), Sec. 1.4(a)**
 - **(U) P3I technology insertion/refresh okay**

2. **(U) Critical technologies must be protected for any customer**
 - **(U) Potential technology transfer**
 - **(U) Potential for counter-tactics development against US capabilities**

(b)(1), Sec.
1.4(a)



(b)(1),
Sec. 1.4(a)

Assumptions (2 of 3) (U)

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3. (U) Export variant

- [Redacted] (b)(1), Sec. 1.4(a)
- [Redacted] (b)(1), Sec. 1.4(a)
- [Redacted] (b)(1), Sec. 1.4(a)

4. [Redacted] (b)(1), Sec. 1.4(a)

- [Redacted] (b)(1), Sec. 1.4(a)

[Redacted] (b)(1), Sec. 1.4(a)

(b)(1), Sec. 1.4(a)



(b)(1), Sec.
1.4(a)

Assumptions (3 of 3) (U)

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5. ***(U) No software source code or software documentation will be exported***
6. ***(U) Unclassified documentation is export controlled***
7. ***(U) No engineering, manufacturing data, or processes will be exported (end-item only)***
8. ***(U) Training and support will be provided under US controls to minimize the redesign required***
9. [Redacted]

(b)(1), Sec. 1.4(a)



F-22A Inc 3.1 Baseline Configuration (U)

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Airframe

- **Lot 12 Airframe**
- (b)(1), Sec. 1.4(a)
- **9g aircraft with full internal weapons**

Integrated Avionics

- (b)(1), Sec. 1.4(a)
- **Fiber-Optic Transmit/Receive**
- **Integrated Comm/NAV/ID**
- (b)(1), Sec. 1.4(a)
- **HQ I/II/III/A/B**
- (b)(1), Sec. 1.4(a)
- **Common Integrated Processor**
- **AN/APG-77 v(1) AESA Radar** (b)(1), Sec. 1.4(a)
- (b)(1), Sec. 1.4(a) **RWR with Missile Warning and Countermeasures**
- **Performance Driven By Mission Data Files**

Signature Management

- (b)(1), Sec. 1.4(a)
- (b)(1), Sec. 1.4(a)



Propulsion

- **Two F119-PW-F100 35,000-lb Thrust Class Engine**
- **Supercruise Capability**
- **Full-Authority Engine Control**
- **Two-Dimensional Thrust Vectoring**

Stores and Weapons

- **Internal Carriage**
- **AIM-120C5,7**
- **AIM-9M**
- **1000 lb GBU-32 JDAM**
- **250 lb GBU-39 SDB**
- **600-gal fuel tank**
- **Internal Gun**
- (b)(1), Sec. 1.4(a)

Sustainment System

- **Encrypted Mission Data and OFF**
- **Two-Level Maintenance**
- **Integrated Maintenance Information System**
 - **Tech Data**
 - **Interfaces With A/C for Ground Ops**
- **Base-Level LO Maintenance**
- **Pilot and Maintenance Trainers**

(b)(1), Sec. 1.4(a)



Critical Technology Changes (U)

U.S. AIR FORCE

Low Observable Properties

(b)(1), Sec. 1.4(a)



U.S. AIR FORCE

(b)(1), Sec. 1.4(a)

F-22 Avionics (Part 1 of 5) (U)



(b)(1),
Sec.
1.4(a)

Integrated Avionics

(b)(1), Sec. 1.4(a)

(b)(1), Sec. 1.4(a)

(b)(1), Sec. 1.4(a)

(b)(1), Sec. 1.4(a)

(b)(1), Sec. 1.4(a)

(b)(1), Sec. 1.4(a)

(b)(1), Sec. 1.4(a)

(b)(1), Sec. 1.4(a)

(b)(1), Sec. 1.4(a)

(b)(1), Sec. 1.4(a)

(b)(1), Sec. 1.4(a)



U.S. AIR FORCE

(b)(1), Sec. 1.4(a)

F-22 Avionics (Part 2 of 5) (U)

Radar

Detection Range

(b)(1), Sec. 1.4(a)

(b)(1), Sec. 1.4(a)

(b)(1), Sec. 1.4(a)

(b)(1), Sec. 1.4(a)



(b)(1),
Sec.
1.4(a)

(b)(1), Sec. 1.4(a)



U.S. AIR FORCE

(b)(1), Sec. 1.4(a)

F-22 Avionics (Part 3 of 5) (U)



(b)(1), Sec. 1.4(a)

(b)(1), Sec. 1.4(a)

(b)(1), Sec. 1.4(a)

(b)(1), Sec. 1.4(a)

(b)(1),
Sec.
1.4(a)

(b)(1), Sec. 1.4(a)



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(b)(1), Sec. 1.4(a)

F-22 Avionics (Part 4 of 5) (U)



Communication, Navigation and Identification

(b)(1), Sec. 1.4(a)

(b)(1), Sec. 1.4(a)

(b)(1), Sec. 1.4(a)

(b)(1), Sec. 1.4(a)

(b)(1), Sec.
1.4(a)

(b)(1), Sec. 1.4(a)



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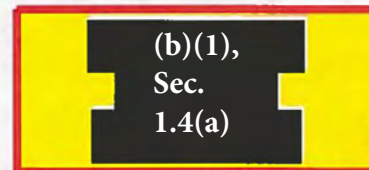
(b)(1), Sec. 1.4(a)

F-22 Weapons (U)

Weapons

Missile launch zone symbology (LZIWG) – Adjust to authorized weapons & capabilities

(b)(1), Sec. 1.4(a)



(b)(1), Sec. 1.4(a)



U.S. AIR FORCE

(b)(1), Sec. 1.4(a)

F-22 Avionics (Part 5 of 5) (U)

Electronic Warfare

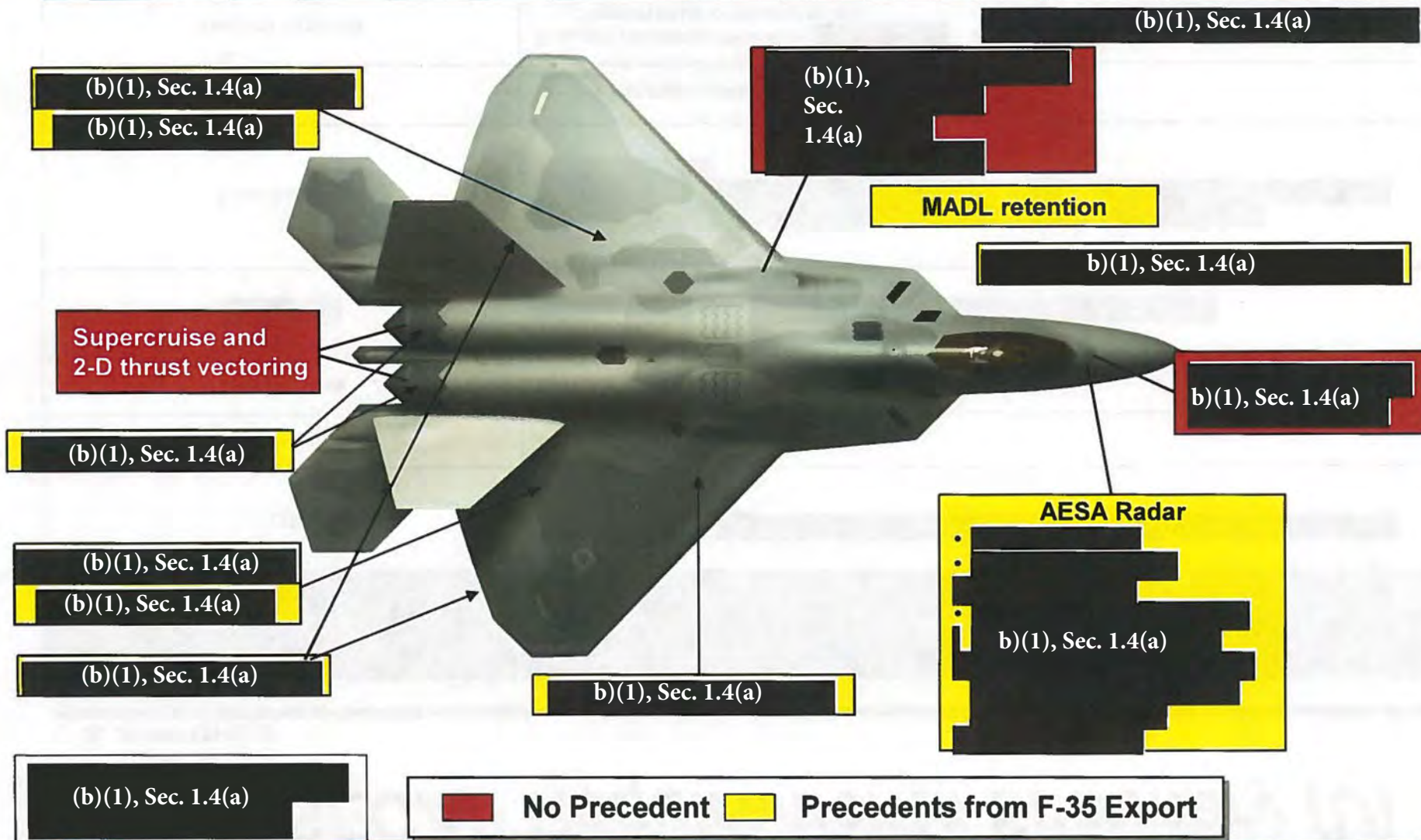
(b)(1), Sec. 1.4(a)

(b)(1), Sec. 1.4(a)

Export Precedent Comparison* (U)

U.S. AIR FORCE

Critical Technology Tech Transfer Precedents





(b)(1), Sec. 1.4(a)

SECAF Requirements Summary (U)

U.S. AIR FORCE

Capability / Attribute	Requirement
LO	(b)(1), Sec. 1.4(a)
Thrust-vectoring	Full capability
Supercruise	Full capability
(b)(1), Sec. 1.4(a)	(b)(1), Sec. 1.4(a)
Functionality	(b)(1), Sec. 1.4(a)
Weapons	US-only weapons capability
Support Systems	Encrypt critical/classified data: (b)(1), Sec. 1.4(a) Support in US controlled space.
Training Systems	Eliminate non-exportable features in courseware and trainers. Train in US controlled space.

(b)(1), Sec. 1.4(a)



(b)(1), Sec. 1.4(a)

Overall System Changes (U)

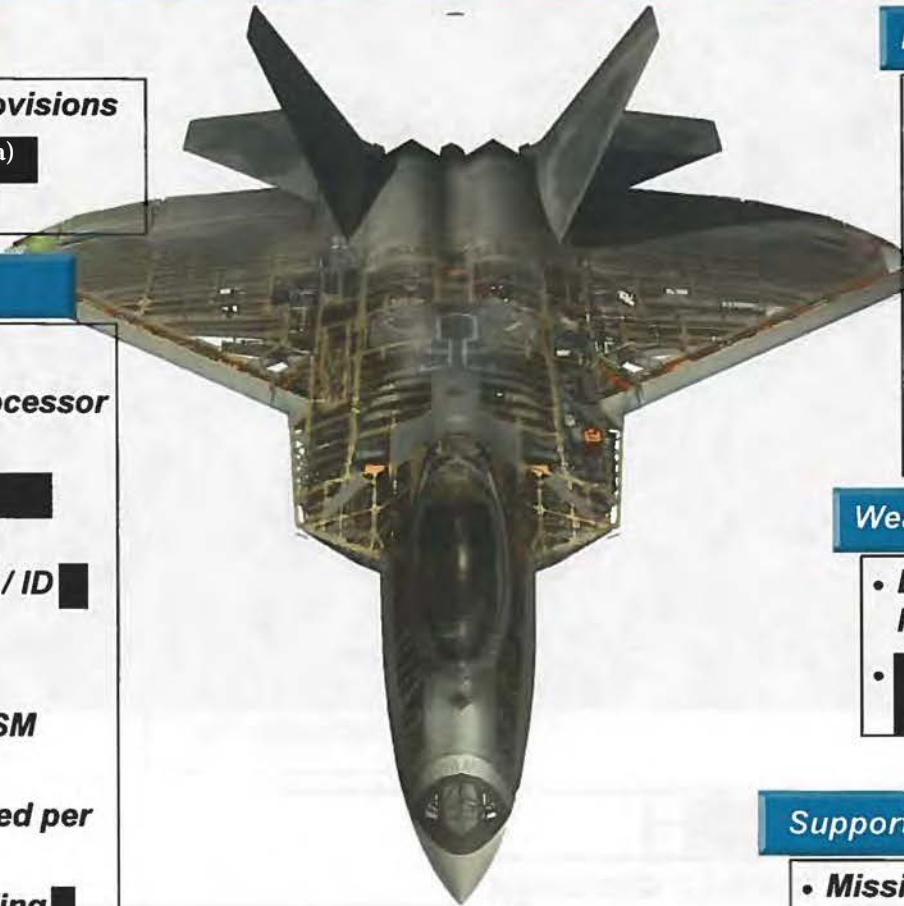
U.S. AIR FORCE

Airframe

- **New radar mounting provisions**
- **Group-A for** (b)(1), Sec. 1.4(a)
- (b)(1), Sec. 1.4(a)

Avionics System

- **AESA radar** (b)(1), Sec. 1.4(a)
- **Common Integrated Processor** (b)(1), Sec. 1.4(a)
- (b)(1), Sec. 1.4(a)
- **Integrated Comm / NAV / ID** (b)(1), Sec. 1.4(a)
- **EW** (b)(1), Sec. 1.4(a)
- **GPS receiver with SAASM module** (b)(1), Sec. 1.4(a)
- **Mission data files tailored per customer**
- **Encrypted video recording** (b)(1), Sec. 1.4(a)
- (b)(1), Sec. 1.4(a)
- (b)(1), Sec. 1.4(a)
- (b)(1), Sec. 1.4(a)



Low Observables

- (b)(1), Sec. 1.4(a)
- (b)(1), Sec. 1.4(a)
- (b)(1), Sec. 1.4(a)
- (b)(1), Sec. 1.4(a)
- (b)(1), Sec. 1.4(a)
- (b)(1), Sec. 1.4(a)
- (b)(1), Sec. 1.4(a)

Weapons

- **Enhanced Stores Management System (ESMS)**
- (b)(1), Sec. 1.4(a)

Support & Training Systems

- **Mission Planning & Signature Assessment** (b)(1), Sec. 1.4(a)
- **Logistics Reporting** (b)(1), Sec. 1.4(a)
- **Pilot Training Systems**

(b)(1), Sec. 1.4(a)

(b)(1), Sec. 1.4(a)



Top Level Security Risk Structure (U)

U.S. AIR FORCE

Depiction of Technology Distribution

Weapons System

No or Min. Risk

Low Risk

Moderate Risk

High Risk

(b)(1), Sec. 1.4(a)

Air Vehicle

Support System

(b)(1), Sec. 1.4(a)

(b)(1), Sec. 1.4(a)

F-22A Critical Signature Technology Transfer Risk**

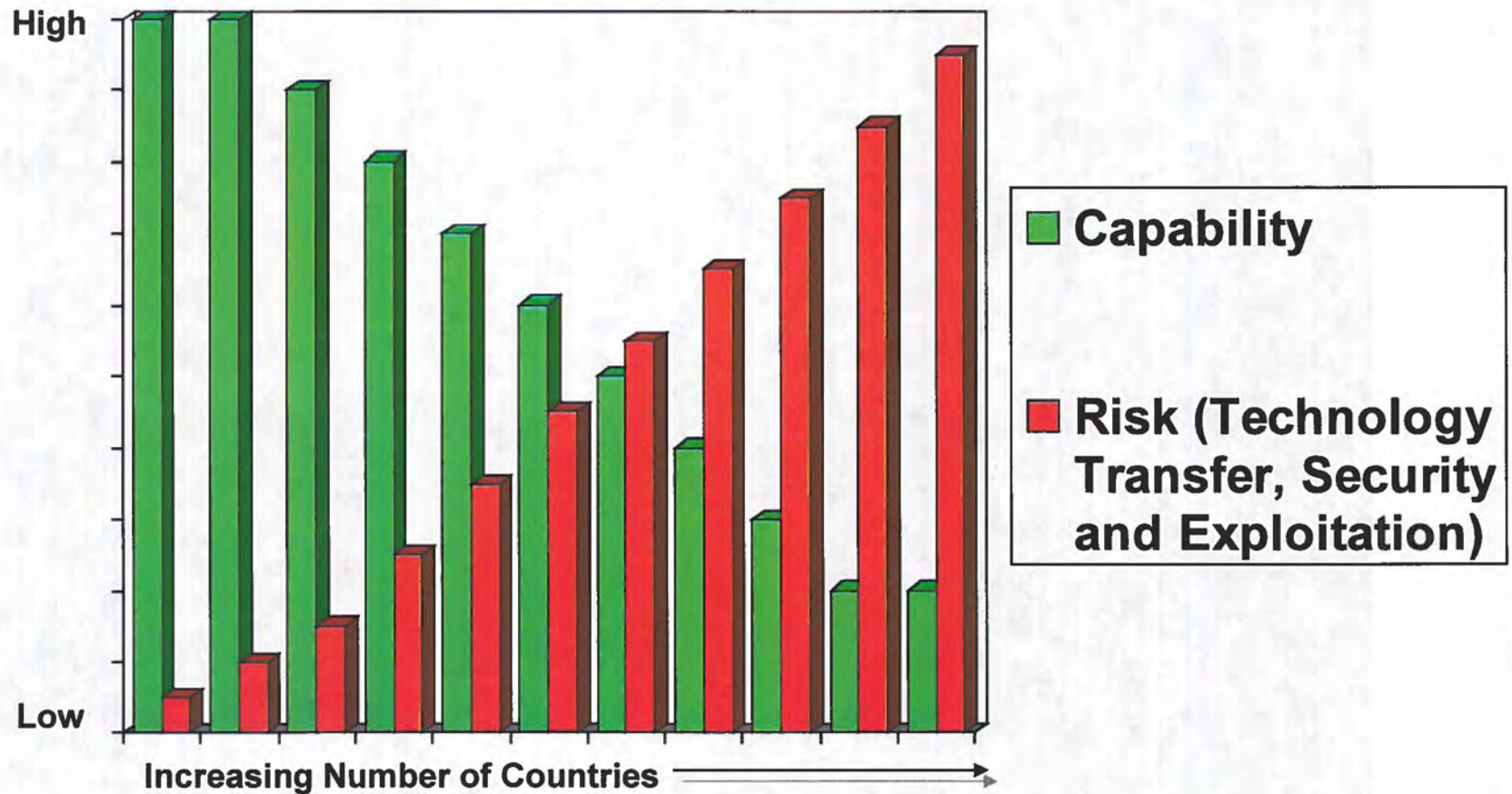
(b)(1), Sec. 1.4(a)



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Notional Export Risk vs. Capability (U)

U.S. AIR FORCE



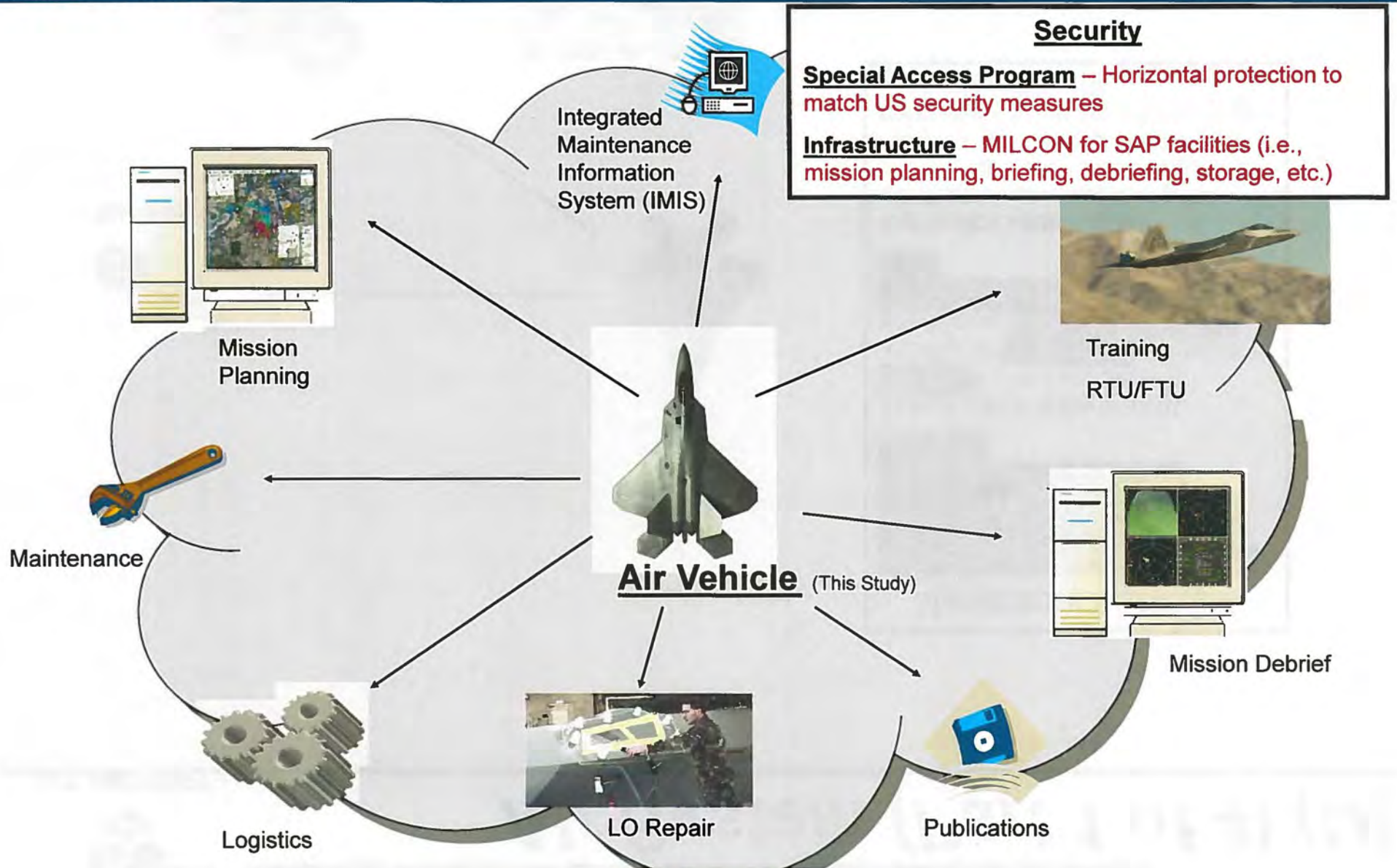
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UNCLASSIFIED

Air System Considerations (U)



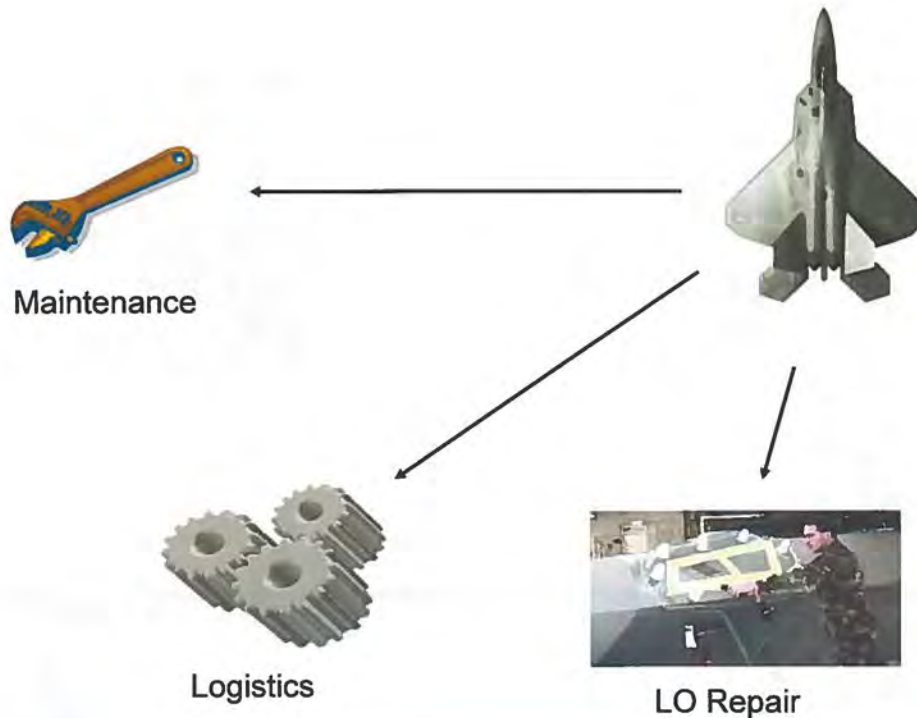
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(b)(1), Sec. 1.4(a)

Air System (Part 1 of 4) (U)



Maintenance & Logistics

(b)(1), Sec. 1.4(a)

Supply Chain Management –
 Control and tracking
 required for hardware in
 supply chain (b)(1), Sec. 1.4(a)

Contractor Logistics Support –
 USAF paradigm must change to
 provide “Operational Sovereignty” to
 customer (i.e., no Lockheed Martin
 personnel in maintenance force that
 must deploy with units)

(b)(1), Sec. 1.4(a)



U.S. AIR FORCE

(b)(1), Sec. 1.4(a)

Air System (Part 2 of 4) (U)

Training and Publications

Training – Deconflict location, scheduling, tactics and multinational activities

(b)(1), Sec. 1.4(a)

Publications – Changes to technical orders required for hardware and software differences between US configuration and FMS configuration & to eliminate manufacturing and design details not required for operational maintenance activities

(b)(1),
Sec.
1.4(a)



Training
RTU/FTU



Publications

(b)(1), Sec. 1.4(a)



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(b)(1), Sec. 1.4(a)

Air System (Part 3 of 4) (U)



Mission Planning



Mission Planning/Debrief

(b)(1), Sec. 1.4(a)

Information Assurance – Required for information systems, classified data on networks & in air system components (e.g., aircraft, IMIS, SAS database, etc.)

Documentation – Possible modifications to technical orders (b)(1), Sec. 1.4(a)



Mission Debrief

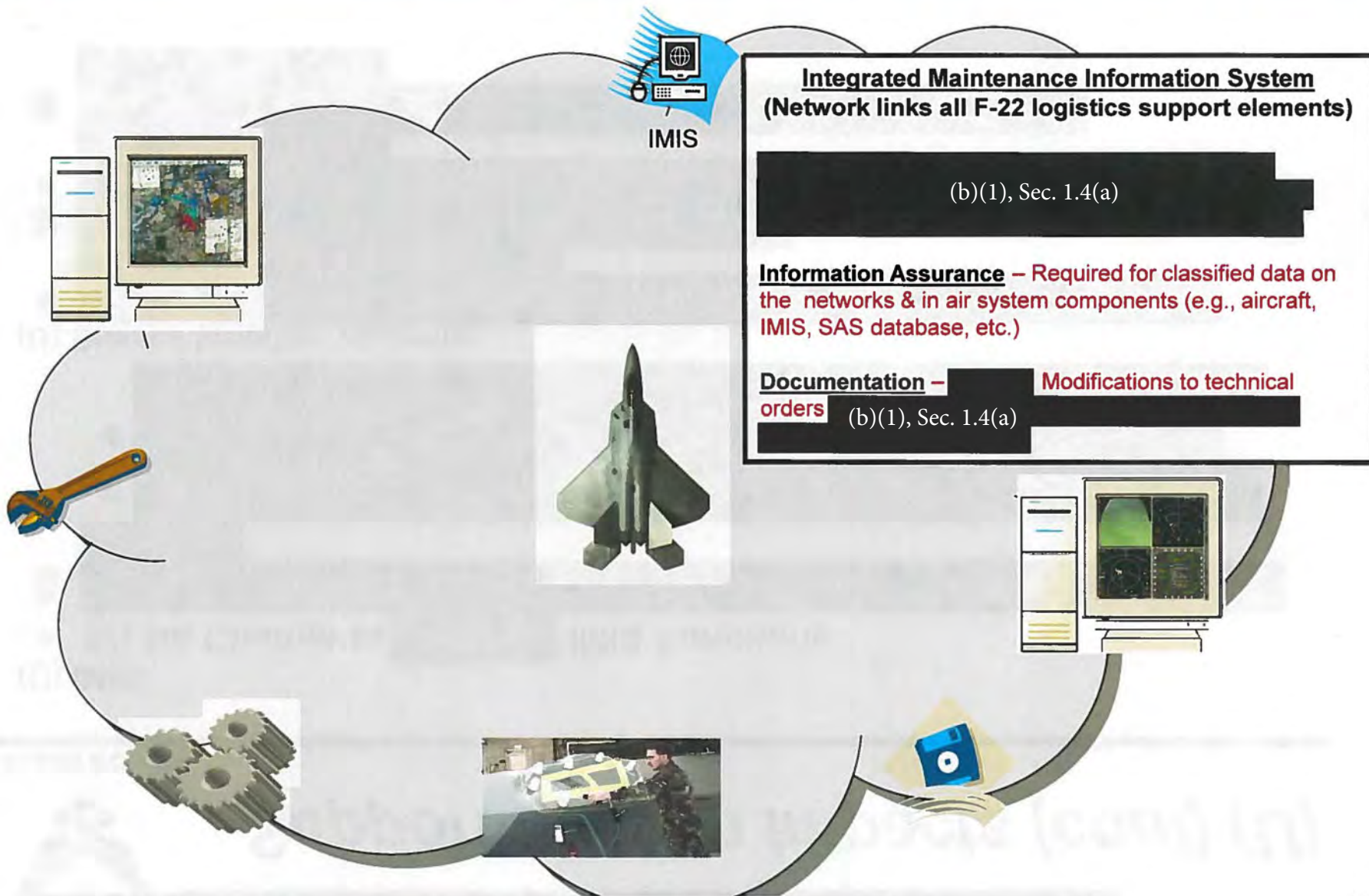
(b)(1), Sec. 1.4(a)



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(b)(1), Sec. 1.4(a)

Air System (Part 4 of 4) (U)



(b)(1), Sec. 1.4(a)



Support System Impacts (cont) (U)

U.S. AIR FORCE

- (U) IMIS

- (U) No Change to [REDACTED] IMIS Functions

- [REDACTED]
 - [REDACTED]
 - [REDACTED]
 - [REDACTED]

(b)(1), Sec. 1.4(a)

- (U) Special logistics reporting

- [REDACTED]
 - [REDACTED]
 - [REDACTED]
 - [REDACTED]

(b)(1), Sec. 1.4(a)



(b)(1), Sec. 1.4(a)

Training Systems Concept (U)

U.S. AIR FORCE

- (U) Pilot Trainers



(b)(1), Sec. 1.4(a)

- (U) Trainer Will Be Installed in a Facility In The US



(b)(1), Sec. 1.4(a)

- (U) Software changes required consistent with released functionality

- (U) Maintenance Trainers



(b)(1), Sec. 1.4(a)



- (U) Courseware will be updated per new CIP and radar configuration

- (U) Training Courseware

- (U) Courseware Must be Purged of non-releasable capabilities

(b)(1), Sec. 1.4(a)



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USAF Cost – Training & Support (U)

U.S. AIR FORCE

- **(U) Initial Spares –**
 - **(U) ~8% of production recurring**
- **(U) Training and Support Equipment –**
 - **(U) ~5% of production recurring**
- **(U) Contractor Logistics Support –**
 - **(U) ~\$3M/yr/aircraft (without engine overhaul)**

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Requirements Definitions (U) (see following charts)

Critical Technology (CT)
Non-critical Item - No Mitigation required
High Interest - Mitigation may be required (b)(1), Sec. 1.4(a)
Critical Item - Mitigation required; deletion or redesign or accept risk

Variant Capability Change
NC = No Change required
DC = Design change required
X = Remove Capability

(b)(1), Sec. 1.4(a)
(b)(1), Sec. 1.4(a)
(b)(1), Sec. 1.4(a)
(b)(1), Sec. 1.4(a)

Capability / Attribute	CT	Variant Capability Change		Comments	Design change
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(b)(1), Sec. 1.4(a)



LO Requirements (U)

U.S. AIR FORCE

Capability / Attribute	CT	Variant Capability Change		Comments	Design change
(b)(1), Sec. 1.4(a)	Red	Yellow	Red	(b)(1), Sec. 1.4(a)	(b)(1), Sec. 1.4(a)
(b)(1), Sec. 1.4(a)	Green	Green	Green		
(b)(1), Sec. 1.4(a)	Red	Green	Red		
(b)(1), Sec. 1.4(a)	Red	Green	Yellow		(b)(1), Sec. 1.4(a)
(b)(1), Sec. 1.4(a)	Red	Yellow	Yellow	(b)(1), Sec. 1.4(a)	(b)(1), Sec. 1.4(a)

(b)(1), Sec. 1.4(a)



LO Requirements (cont) (U)

U.S. AIR FORCE

Capability / Attribute	CT	Variant Capability Change		Comments	Design change
[Redacted]	Red	Yellow	Red	[Redacted]	(b)(1), Sec. 1.4(a)
[Redacted]	Red	Green	Red		
[Redacted]	Green	Green	Green		
[Redacted]	Green	Green	Green		
[Redacted]	Red	Yellow	Red	[Redacted]	(b)(1), Sec. 1.4(a)
Gaps and Seals	Green	Green	Green		
Drain Holes	Green	Green	Green		
Fasteners	Green	Green	Green		
(b)(1), Sec. 1.4(a)	Red	Yellow	Red	(b)(1), Sec. 1.4(a)	(b)(1), Sec. 1.4(a)
[Redacted]	Yellow	Red	Green	(b)(1), Sec. 1.4(a)	[Redacted]

(b)(1), Sec. 1.4(a)



Aircraft Performance Requirements (U)

U.S. AIR FORCE

Capability / Attribute	CT	Variant Capability Change		Comments	Design change
Thrust-vectoring	Red	Green	Red		
Supercruise	Red	Green	Red		

(b)(1),
Sec.
1.4(a)



Avionics System Requirements (U)

U.S. AIR FORCE

Capability / Attribute	CT	Variant Capability Change	<input type="checkbox"/>	Comments	Design change
(b)(1), Sec. 1.4(a)	Red	Green	<input type="checkbox"/>		(b)(1), Sec. 1.4(a)
Track Prioritization	Red	Green	<input type="checkbox"/>		(b)(1), Sec. 1.4(a)
Sensor Management	Red	Green	<input type="checkbox"/>		(b)(1), Sec. 1.4(a)
	Red	Yellow	<input type="checkbox"/>	(b)(1), Sec. 1.4(a)	(b)(1), Sec. 1.4(a)
Emission Control (EMCON)	Red	Yellow	<input type="checkbox"/>	(b)(1), Sec. 1.4(a)	(b)(1), Sec. 1.4(a)
Mission Data	Yellow	Yellow	<input type="checkbox"/>	Commensurate with individual systems provided (country specific). (b)(1), Sec. 1.4(a)	(b)(1), Sec. 1.4(a)
Embedded Training	Green	Yellow	<input type="checkbox"/>	Changes as required based on other functionality changes.	Scoring and weapon launch zones will be changed accordingly. (b)(1), Sec. 1.4(a)

(b)(1),
Sec.
1.4(a)



(b)(1), Sec. 1.4(a)

Avionics System Requirements (cont) (U)

U.S. AIR FORCE

Capability / Attribute	CT	Variant Capability Change	<input type="checkbox"/>	Comments	Design change
Core Processing			<input type="checkbox"/>	The Core Processor contains no inherent critical technology. (b)(1), Sec. 1.4(a)	(b)(1), Sec. 1.4(a)
Fire Control			<input type="checkbox"/>	(b)(1), Sec. 1.4(a)	Software changes will be made (b)(1), Sec. 1.4(a)
Displays			<input type="checkbox"/>	(b)(1), Sec. 1.4(a)	(b)(1), Sec. 1.4(a)
(b)(1), Sec. 1.4(a)			<input type="checkbox"/>	(b)(1), Sec. 1.4(a)	Appropriate software changes will be made. (b)(1), Sec. 1.4(a)
Air-to-Air (AA) Modes			<input type="checkbox"/>	(b)(1), Sec. 1.4(a)	Appropriate software changes will be made. (b)(1), Sec. 1.4(a)
Air-to-Ground (AG) Modes			<input type="checkbox"/>	(b)(1), Sec. 1.4(a)	Appropriate software changes will be made. (b)(1), Sec. 1.4(a)

(b)(1),
Sec.
1.4(a)



Radar Requirements (U)

U.S. AIR FORCE

Capability / Attribute	CT	Variant Capability Change		Comments	Design change
Detection Range [0 dBsm (1m) target, 20k, 2k fps Vc, co-alt, +/- 30 azimuth]	Yellow	Yellow	Red	[Redacted]	[Redacted]
[Redacted]	Red	Yellow	Red	[Redacted]	[Redacted]
Operational Bandwidth [Redacted]	Red	Yellow	Red	[Redacted]	[Redacted]
Instantaneous Bandwidth [Redacted]	Red	Yellow	Red	[Redacted]	[Redacted]
[Redacted]	Red	Yellow	Red	[Redacted]	[Redacted]
Field of Regard (FOR)	Green	Green	Green	[Redacted]	[Redacted]

(b)(1),
Sec.
1.4(a)



Radar Requirements (cont) (U)

U.S. AIR FORCE

Capability / Attribute	CT	Variant Capability Change		Comments	Design change
	Yellow	Green	Red		
	Red	Yellow	Red		
	Red	Yellow	Red		
	Red	Yellow	Red		
	Green	Green	Green		

(b)(1),
Sec.
1.4(a)



Comm/Nav/ID Requirements (U)

U.S. AIR FORCE

Capability / Attribute	CT	Variant Capability Change	<input type="checkbox"/>	Comments	Design change
Intra-Flight Data Link (IFDL)		<input type="checkbox"/>	<input type="checkbox"/>		
Link 16 Rx		<input type="checkbox"/>	<input type="checkbox"/>	Allow transmit Link 16 for basic interoperability if requested and feasible (foreign country pays).	No changes.
MADL (3.2 upgrade, but still included)		<input type="checkbox"/>	<input type="checkbox"/>		
[REDACTED]		<input type="checkbox"/>	<input type="checkbox"/>	[REDACTED]	[REDACTED]
[REDACTED]		<input type="checkbox"/>	<input type="checkbox"/>	[REDACTED]	[REDACTED]
[REDACTED]		<input type="checkbox"/>	<input type="checkbox"/>	[REDACTED]	[REDACTED]
[REDACTED]		<input type="checkbox"/>	<input type="checkbox"/>	[REDACTED]	[REDACTED]

(b)(1),
Sec.
1.4(a)



(b)(1), Sec. 1.4(a)

Electronic Warfare Requirements (U)

U.S. AIR FORCE

Capability / Attribute	CT	Variant Capability Change		Comments	Design change
[REDACTED]	Red	Red	Green	[REDACTED]	[REDACTED]
[REDACTED]	Yellow	Yellow	Yellow		[REDACTED]
[REDACTED]	Green	Green	Green		
[REDACTED]	Green	Green	Green		
[REDACTED]	Green	Green	Green		
[REDACTED]	Red	Red	Green	[REDACTED]	[REDACTED]
[REDACTED]	Red	Red	Red	[REDACTED]	[REDACTED]

(b)(1),
Sec.
1.4(a)

(b)(1), Sec. 1.4(a)



Modernization Requirements (U)

U.S. AIR FORCE

Capability / Attribute	CT	Variant Capability Change	<input type="checkbox"/>	Comments	Design change
Increment 2					
Missile launch zone symbology (LZIWG)	Yellow	Green <input type="checkbox"/>	<input type="checkbox"/>		
IFDL Improvements	Red	Green <input type="checkbox"/>	<input type="checkbox"/>		
[Redacted]	Green	Green <input type="checkbox"/>	<input type="checkbox"/>		
[Redacted]	Red	Red <input type="checkbox"/>	<input type="checkbox"/>	[Redacted]	[Redacted]
SS JDAM	Green	Green <input type="checkbox"/>	<input type="checkbox"/>		
Increment 3.1					
SDB Basic	Green	Green <input type="checkbox"/>	<input type="checkbox"/>		
Geolocation	Green	Green <input type="checkbox"/>	<input type="checkbox"/>		

(b)(1),
Sec.
1.4(a)



Support System (U)

U.S. AIR FORCE

Capability / Attribute	C T	Variant Capability Change		Comments	Design change
Support Equipment					
Mission Support System (MSS)					
Portable Maintenance Aid (PMA)					
Operational Debrief System (ODS)					
Integrated Maintenance Information System (IMIS)					
Signature Assessment System (SAS)					

(b)(1),
Sec.
1.4(a)



Support System (cont) (U)

U.S. AIR FORCE



Capability / Attribute	CT	Variant Capability Change	<input type="checkbox"/>	Comments	Design change
Other test sets		<input type="checkbox"/>	<input type="checkbox"/>		
Supply Chain Management		<input type="checkbox"/>	<input type="checkbox"/>		
Depot Level Drivers (CLS...)		<input type="checkbox"/>	<input type="checkbox"/>	US data protection issues need to be resolved	
Regional Support Centers (Global?)		<input type="checkbox"/>	<input type="checkbox"/>		
Aircraft Production Acceptance		<input type="checkbox"/>	<input type="checkbox"/>		
Aircraft Documentation (T.O.'s, etc)		<input type="checkbox"/>	<input type="checkbox"/>		
ASIP DATA		<input type="checkbox"/>	<input type="checkbox"/>		
Security (SAP facilities, etc.)		<input type="checkbox"/>	<input type="checkbox"/>		

(b)(1),
Sec.
1.4(a)



Training (U)

U.S. AIR FORCE

Capability / Attribute	CT	Variant Capability Change	 	Comments	Design change
Trainers		■			
Simulators (PTT, WTT, FMT)		■		OFF/Sim re-write based on capabilities provided	
MX Trainers		■			
Publications (3-1, etc.)		■			
MX Training		■		Location/exposure issues still not resolved in JSF program	
Pilot Training (RTU)		■		Location/exposure issues still not resolved in JSF program	
Courseware		■		Courseware must be purged of any critical data.	

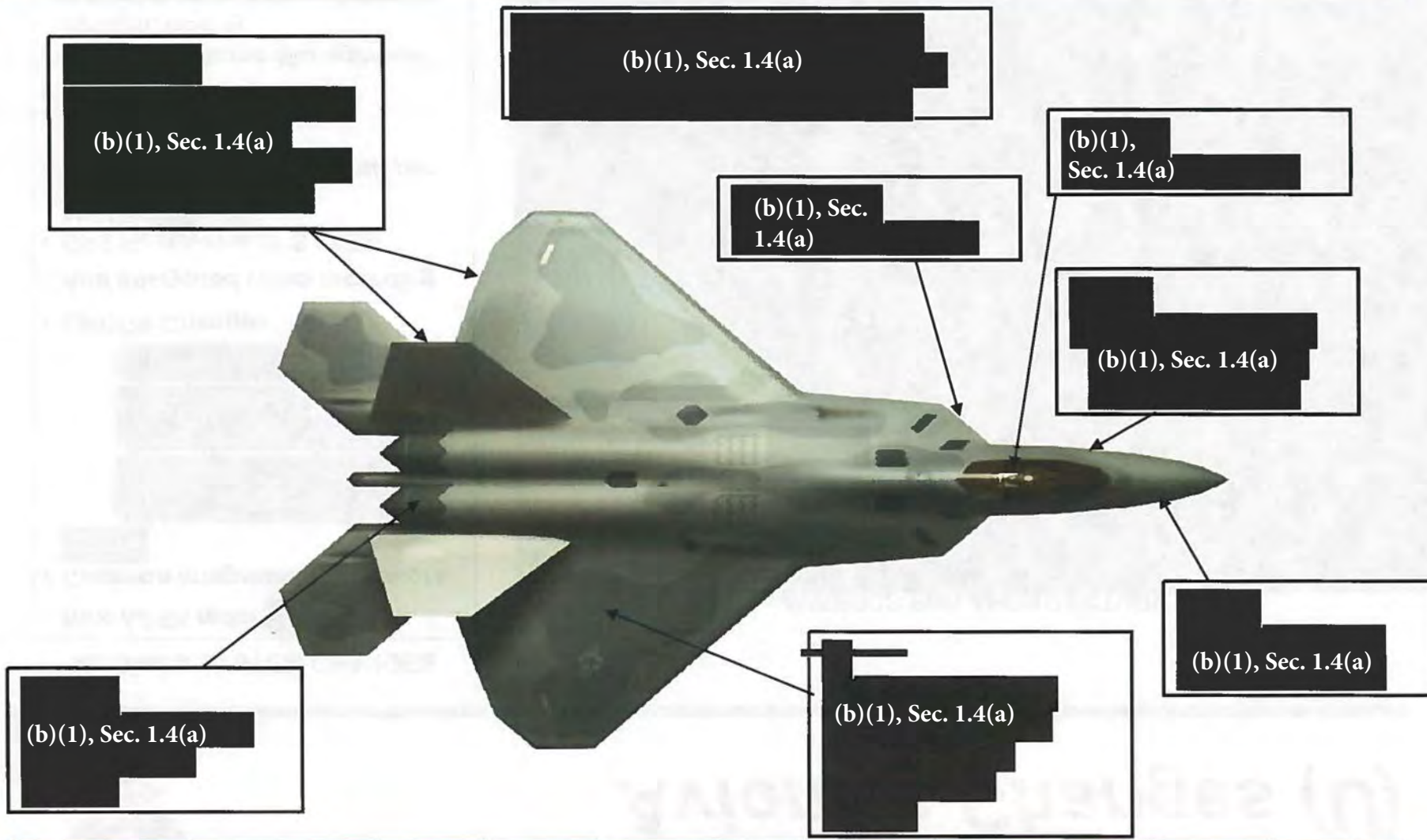
(b)(1),
Sec.
1.4(a)



(b)(1), Sec. 1.4(a)

(b)(1), Sec. 1.4(a)

U.S. AIR FORCE



(b)(1), Sec. 1.4(a)



Avionics Changes (U)

U.S. AIR FORCE

AVIONICS SYSTEM CHANGES

- **New AESA radar** (b)(1), Sec. 1.4(a)
- **Common Integrated Processors**
(b)(1), Sec. 1.4(a)
 - (b)(1), Sec. 1.4(a)
 - (b)(1), Sec. 1.4(a)
 - (b)(1), Sec. 1.4(a)
- **EMCON Changes**
- **Add encrypted video recording**
- **GPS Receiver with SAASM Module** (b)(1), Sec. 1.4(a)
- **Mission Data Files Tailored per customer**
- **DMS Resolution**
- **Enhanced Stores Management System (ESMS)**
(b)(1), Sec. 1.4(a)
(b)(1), Sec. 1.4(a)

AVIONICS EMS ARCHITECTURE

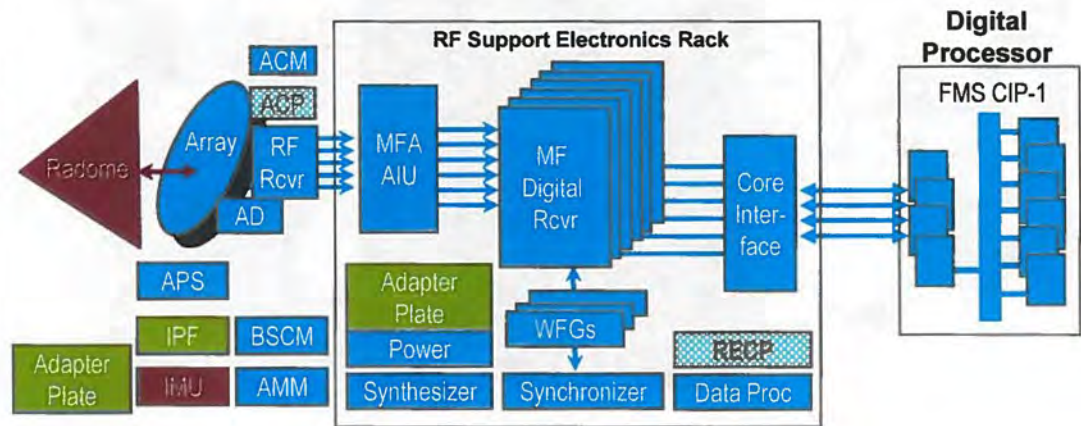
(b)(1), Sec. 1.4(a)



Radar Changes (U)

U.S. AIR FORCE

Detection Range	(b)(1), Sec. 1.4(a)
	(b)(1), Sec. 1.4(a)
Operational Bandwidth	(b)(1), Sec. 1.4(a)
	(b)(1), Sec. 1.4(a)
Instantaneous Bandwidth	(b)(1), Sec. 1.4(a)
	(b)(1), Sec. 1.4(a)
Power management	(b)(1), Sec. 1.4(a)
	(b)(1), Sec. 1.4(a)
	(b)(1), Sec. 1.4(a)
	(b)(1), Sec. 1.4(a)
	(b)(1), Sec. 1.4(a)

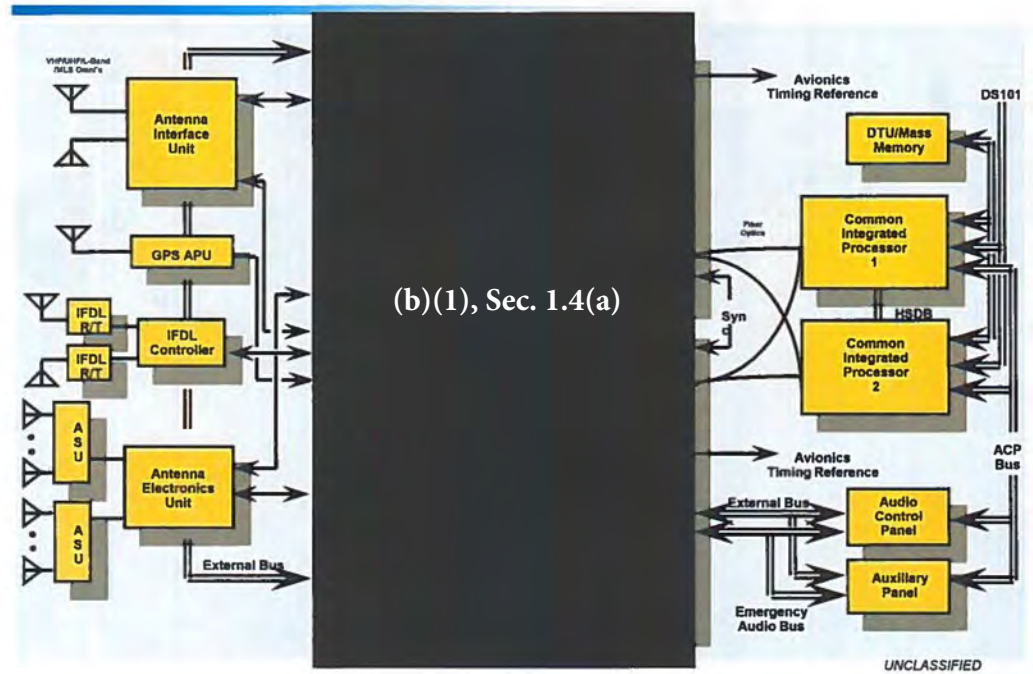




CNI Changes (U)

U.S. AIR FORCE

- (b)(1), Sec. 1.4(a)
- (b)(1), Sec. 1.4(a)
- (b)(1), Sec. 1.4(a)
- (b)(1), Sec. 1.4(a)
- Add MADL





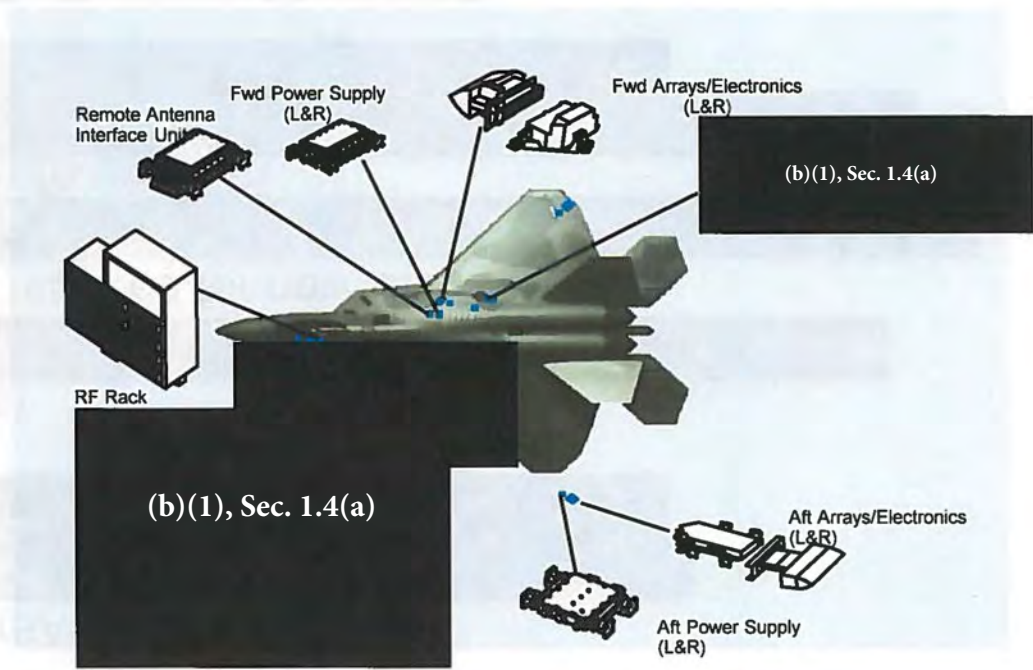
U.S. AIR FORCE

EW Changes (U)

(b)(1), Sec. 1.4(a)

(b)(1), Sec. 1.4(a)

(b)(1), Sec. 1.4(a)





Support System Impacts (U)

U.S. AIR FORCE

- (U) Signature Assessment System (SAS)

- (b)(1), Sec. 1.4(a)
-

- (U) Secure Information System (SIS)

- (b)(1), Sec. 1.4(a)

- (U) JMPS Interface change required for new SIS

- (b)(1), Sec. 1.4(a)

- (U) ODS Interface Change with new SIS

- (b)(1), Sec. 1.4(a)
-

- (b)(1), Sec. 1.4(a)