F-22A Post Multi-Year Procurement Options

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Background

• Congress has authorized 183 F-22A fighters, which are procured in existing contracts through 2009

• At issue is what to do after the last unit in lot 9 is produced
  – Shutdown the production line or shutdown and restart at a later date or continue production at full or low rates

• Air Force asked RAND Project AIR FORCE to assess the costs and the effects on the industrial base of different options
Study Objective

- Evaluate alternative courses of action for the F-22A following the delivery of the last unit under the current multi-year contract by assessing
  - Costs of alternate procurement strategies
  - Effects on industrial base
We Analyzed Four Alternatives After Lot 9

Cold Shutdown
  • Production line closes permanently

Shutdown-Restart
  • Production line closes temporarily

Warm production
  • Production line continues but at a reduced rate

Continued production
  • Production line continues at current rate
We Assumed Three Production Options, Each Producing 75 Aircraft After Lot 9

Contractor-developed rates and factors do not allow analysis beyond FY2016
Alternatives Will Affect Future Costs in Various Ways

• Non-recurring costs may include:
  – Preservation or disposition of tooling, technical information transfer, and facility disposition or preservation
  – Personnel retention, reduction-in-force, rehiring, training, clearances
  – Vendor re-qualification

• Recurring costs include:
  – Loss of learning
  – Loss of skilled workers (and resultant inefficiencies)
  – Lower rates of production
  – Increase in overhead rates due to diminished business base
  – Costs such as Program Agile Logistics Support (PALS), Production Support Annual Sustaining (PSAS), Production Support Other (PSO), Other Government Costs (OGC), and other nonrecurring and support costs
Results Are Near Approximations Due to Many Uncertainties

• Uncertain business base

• Rates and factors contractor-developed, not negotiated

• No restart experience with a 4\textsuperscript{th} generation fighter or recent examples by the primes

• Uncertain number of technical personnel retained for F-22A unique processes and critical technology

• Repercussions on supplier base and DMS based primarily on contractors’ subjective assessments

• Overhead rates are based on contractors’ estimates
Outline of Today’s Presentation

• What are shutdown and restart costs?

• What are costs of 75 aircraft under each production option?

• What are the implications of shutdown for the industrial base

• Overall findings
## Activities Included in a Production Shutdown

<table>
<thead>
<tr>
<th>Activity</th>
<th>Cold Shutdown</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tooling</strong></td>
<td></td>
</tr>
<tr>
<td>Accounting</td>
<td>X</td>
</tr>
<tr>
<td>Breakdown</td>
<td>X</td>
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<tr>
<td>Removal</td>
<td>X</td>
</tr>
<tr>
<td>Tool Scrapping</td>
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<tr>
<td>Shipping / Storage</td>
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<tr>
<td>Line setup / Reorganization</td>
<td></td>
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<tr>
<td><strong>Personnel</strong></td>
<td></td>
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<tr>
<td>Reduction in Force</td>
<td>X</td>
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<tr>
<td>Reassignment</td>
<td>X</td>
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<tr>
<td>Rehiring / Retention</td>
<td></td>
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<tr>
<td>Training</td>
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<tr>
<td>Clearances</td>
<td></td>
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<tr>
<td><strong>Facilities</strong></td>
<td></td>
</tr>
<tr>
<td>Clearing</td>
<td>X</td>
</tr>
<tr>
<td>Reorganization / Setup</td>
<td></td>
</tr>
<tr>
<td>Planning and admin</td>
<td>X</td>
</tr>
<tr>
<td>Inventory disbursement</td>
<td>X</td>
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<tr>
<td>Supplier re-qualification</td>
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</tr>
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Likely Direct Cost for Cold Shutdown
About $65 to $110 Million

Some indirect costs such as those related personnel are covered by the overhead.
## Shutdown-Restart and Cold Shutdown Share Many Activities

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Shutdown-Restart Costs Range From $225 to About $720 Million

- **Low**: $225M
- **Likely**: $450M
- **High**: $720M

**Cost Breakdowns**
- **Requalification**: $720M
- **Planning and Admin Tasks**: $50M
- **Facilities Setup**: $100M
- **Tooling Reorganization**: $50M
- **Personnel Rehired**: $100M
- **Personnel Retained**: $300M
- **Core Shutdown (FY2009)**: $225M
All Options Include Shutdown Costs, But Shutdown-Restart Includes Another Shutdown After the Restart

Cost (TY$, Millions)

- Cold Shutdown: $85M
- Shutdown-Restart: $555M
- Warm Production: $140M
- Continued Production: $95M

Second Shutdown

ShUTDOWN ACTIVITIES

RESTART ACTIVITIES
Outline of Today’s Presentation

• What are shutdown and restart costs?

• What are costs of 75 aircraft under each production option?

• What are the implications of shutdown for the industrial base

• Overall findings
Cost Model Used to Calculate Average Unit Flyaway Price Implications

F-22 Post MY Procurement Price Model

Lot Production Quantities

Priors Units

Restart Year

End Unit

Labor Cost Model

Material Cost Model

Minimum Unit Number

Lot Price by Facility

Total Lot Price

AUP Air Vehicle

Profit

Tail-up

Facility

Labor Trade

Fiscal Years

Calendar Years

FY to CY Index

Loss Assumptions

Shutdown Scenarios

Min Unit Assumptions

Ave. Unit Fraction

Approx. Ave. Unit Fraction
After a Shutdown, the Cost Improvement Curve Shifts, Then Flattens

Source: Reconstituting a Production Capability, Birkler, et al.
We Assumed Three Production Options, Each Producing 75 Aircraft After Lot 9
Production Continues for an Additional 75 Aircraft Buy After Lot 9

Post Lot 9 Delivery Options

Lot Size (Number of Aircraft)

20
18
16
14
12
10
8
6
4
2
0

(Lot 9)

MYP

Continued Production
For Continued Production Option, AUPC Remains Virtually Constant

*Excludes shutdown and restart costs
Warm Production Rate Is 5 Aircraft per Lot for Three Years

Lot Size (Number of Aircraft)

Post Lot 9 Delivery Options

Lot 9 (2009)

Warm Production
AUPC Increases Due to Low Production Rate in Warm Production Option

AUC Excluding Shutdown and Restart Costs (TY$, Millions)

- **Warm Production**
- **Continued Production**

*Excludes shutdown and restart costs*
After Two Year Hiatus, Restart with Low Rate Production and then Ramp Up

Post Lot 9 Delivery Options

Lot Size (Number of Aircraft)


MYP

Shutdown-Restart

RAND
AUPC Increases Substantially After 2-Year Production Gap

AUC Excluding Shutdown and Restart Costs (TY$, Millions)

- Shutdown-Restart Costs
- Warm Production Costs
- Continued Production Costs

*Excludes shutdown and restart costs
Loss-of-Learning Sensitivity Analysis After Production Gap

The range is based on historical restart experience.

AUC Excluding Shutdown and Restart Costs (TY$, Millions)

The range is based on historical restart experience.
Comparison of Total Price of 75 Additional Units

Post MYP Options

- Shutdown-Restart: $19.0B
- Warm Production: $17.7B
- Continued Production: $13.7B

Note: Average Loss-of-Learning
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Industrial Base Assessment Overview

• Industrial bases assessment examines only the effect of a production hiatus

• Vendor assessment surveys provided to the supply managers at each prime. Survey requested information for 346 vendors (35% of the vendor base and over 90% of vendor value).

• Subjective vendor assessment made by supply managers at each of the primes forecasts vendor availability

• Considered common assessment criteria set for vendors: exit business, product redesign, process unavailable, labor/skill unavailable, security clearances issue, facility/tooling concerns
Primes Outsource About 60 Percent of the Airframe and Engine

**Airframe**

- **Lockheed Martin**
  - Internal (25%)
  - Teaming
  - Single Source Suppliers (32%)
  - Competition (11%)

- **Boeing** (32%)
  - Internal (12%)
  - Single Source Suppliers (14%)
  - Competition (6%)

**Engine**

- **Pratt & Whitney**
  - Internal (42%)
  - Single Source Suppliers (22%)
  - Competition (36%)

5% of F-22A Vendors Account for Half the Vendor Value
Primes See About 20% of Vendors Have Greater Chance of Issues That Compromise Their Availability Following Production Gap…

High: A 50% chance or greater of a vendor issue arising upon restart that would compromise their availability.

Medium: Approximately 10 to 50% chance of a vendor issue arising upon restart that would compromise their availability.

Low: Less than a 10% chance of an issue arising upon restart that would compromise their availability.

RAND
Few Vendors Likely to Exit Business But Other Issues Drive Concerns Over Availability…

Note: Figure reports concerns regarding vendor availability following a production gap. Data for Pratt & Whitney not available.
However, Many Vendors Involved in F-22A Production Are Also Involved in F-35 Program
Outline of Today’s Presentation

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### Summary of Our Findings

<table>
<thead>
<tr>
<th>Options (2010-2016)</th>
<th>Shutdown and Restart Likely Direct Costs ($TY)</th>
<th>Flyaway Unit Costs* ($TY)</th>
<th>AUC* ($TY)</th>
<th>TOTAL ($TY)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shutdown</td>
<td>85 M</td>
<td>__</td>
<td>__</td>
<td>0.5 B**</td>
</tr>
<tr>
<td>Shutdown - Restart</td>
<td>555 M</td>
<td>200 M</td>
<td>250 M</td>
<td>19.0 B</td>
</tr>
<tr>
<td>Warm Production</td>
<td>140 M</td>
<td>170 M</td>
<td>235 M</td>
<td>17.7 B</td>
</tr>
<tr>
<td>Continued Production</td>
<td>95 M</td>
<td>145 M</td>
<td>180 M</td>
<td>13.7 B</td>
</tr>
</tbody>
</table>

* Average over the last 75 units

** $0.5B is the rounded sum of $85M direct shutdown cost, and $365M in sustainment costs over FY2010-FY2016
Each Option Has Different Implications for the Air Force — All Cost Money

<table>
<thead>
<tr>
<th>If:</th>
<th>Then:</th>
<th>Therefore:</th>
</tr>
</thead>
<tbody>
<tr>
<td>AF: shutdown</td>
<td>Suppliers shutdown permanently and tooling and equipment disposed of</td>
<td>AF must decide if future SLEP or major mod are likely; if so, what tools, equip &amp; data must be saved (add. $ req.)</td>
</tr>
<tr>
<td>Cost: ~$85M</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AF: shutdown-restart</td>
<td>Restart planning must begin now. AF needs authorization to manage suppliers that would otherwise need to be re-qualified</td>
<td>Preserves production capability, but aircraft will be on average 40% more expensive over next 75 units</td>
</tr>
<tr>
<td>Cost: ~$450M</td>
<td></td>
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</tr>
<tr>
<td>AF: warm production</td>
<td>Supplier shutdown must be mitigated through advance procurement funding at start of FY2009</td>
<td>Keeps production line open, but aircraft will be on average 30% more expensive over next 75 units</td>
</tr>
<tr>
<td>Cost: ~$1.5B for the first 5 aircraft</td>
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