Chapter Three

SITE SELECTION ISSUES: PLANT AND MAJOR FACILITY REQUIREMENTS FOR FACO

The congressional language requiring this study calls for the identification of each government and industry facility that is a potential site for JSF FACO. Many factors require consideration when selecting an appropriate location for FACO activities. Industrial engineers include manufacturing requirements, specifics of the site, and external local and state issues when making their selection.¹ In this chapter, we describe the general considerations for selection of the FACO site, followed by a discussion of the sites that RAND considers to have reasonable potential. This chapter also provides details regarding the major plant and facility for any FACO location, whether a single or multiple site FACO strategy is used.

We present a discussion of a theoretical approach to site selection that addresses the question of how the universe of potential sites can be whittled down to those that are reasonable. The most practical approach would be selecting a site or sites with a current military aircraft production line that has sufficient capacity to accommodate JSF FACO operations. Within that subset, the most reasonable candidate sites would be those controlled by either Lockheed Martin Aeronautics Company or its partner, Northrop Grumman Air Combat Systems. This approach selects the candidate sites from among the most practical and meets direction provided by the JSF Program Office.

¹Tompkins, 2001.
SPECIFIC SITE PHYSICAL REQUIREMENTS

According to Lockheed Martin, the specific plant and major facilities required to conduct JSF FACO at any given site are as follows:

- A runway at least $8,000 \times 150$ ft.
- A published, FAA-approved instrument approach and controlled airfield environment.
- Arresting gear.
- Taxiways and sufficient ramp space.
- An environmentally conditioned assembly building of approximately 130,000 sq ft (which includes assembly storage and office space).
- An environmentally controlled paint facility (this may be a section of the main assembly building).
- A low-observable testing and verification building (or section of the main assembly building).
- An aircraft flight operations run building (or section of the main assembly building).
- A “hover pad” and a hover pit for ground operation of the STOVL variants.
- Road access from the interstate highway system.
- Sufficient reliable and economical electrical power for all FACO operations.

CATEGORIES OF FACO OPTIONS

Given these requirements, DoD has at least five options for selecting an alternate location for JSF FACO activities. In roughly descending order, according to the number of potential sites (as well as cost to the government), these are as follows:

1. Constructing an airfield with new plant and facilities on a site not previously used for such a purpose (a “greenfield” site).
2. Selecting a site with an appropriate airfield, but without existing plant and facilities capable of supporting JSF FACO operations.

3. Selecting a site with an appropriate airfield, and with existing plant and facilities capable of supporting JSF FACO operations.

4. Selecting a site with an appropriate airfield, and with a current DoD operational or depot activity with excess plant and facilities capable of supporting JSF FACO operations.

5. Selecting a site with an appropriate airfield, and with a current military aircraft production or modification line with excess plant and facilities capable of supporting JSF FACO operations.

What follows is a discussion of each of these approaches, along with their benefits and cost. There is some repetition of the advantages and disadvantages among the alternatives.

**Option 1: A “Greenfield” Site**

Although there are recent examples (such as Denver International Airport) of airport construction at a “greenfield” site, this has proved to be a very expensive process. RAND considers this option highly risky from a JSF schedule viewpoint and does not consider the greenfield option to be cost-effective for JSF FACO, especially given the supply of underutilized airfields currently supporting aircraft production, DoD operations, or logistics activities. U.S. Secretary of Transportation Norman Y. Mineta has noted that adding a runway to an existing airfield can take as long as 10 years. In fact, it took 16 years for the Memphis–Shelby County Airport Authority to receive approval and construct two runways. In addition, the estimated cost of an additional runway at existing airports ranges from $76 million for a runway at Boston Logan to $1.156 billion at Lambert–St. Louis International Airport (which includes acquisition of additional property). The average cost of 14 “critical” runways planned or under construction at existing airports in the United States is just under

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2 That is, a site where there are no facilities whatsoever—literally a green field.
$400 million.\textsuperscript{5} This approach would almost certainly be the most costly and time-consuming alternative to satisfying JSF requirements, especially in the early stages of production, and adds considerable schedule and cost risk to the program. However, it does have some advantages:

- Hundreds or even thousands of candidate sites could be considered.
- The latest designs and technology could be incorporated into the location.
- A site where the economic benefits from the work could help a faltering economy—for example, one with chronically high unemployment—could be selected.
- The site could maximize state and local tax incentives.
- The site could be placed where noise and environmental considerations would be negligible.

However, in addition to the initial cost and schedule risk, a greenfield site has several disadvantages:

- It could require significant regulatory action including environmental and Federal Aviation Administration (FAA) approvals as well as long lead time for airfield construction.
- It requires creating an entire airfield environment encompassing instrument approaches for a required capacity of less than 10 JSF flights per day.
- It adds to existing overcapacity in the aircraft industry.
- The entire cost of operating the airfield would be borne by the JSF FACO, unless other commercial or DoD uses could be found.
- There would be no sharing of overhead, security, and other support costs with other DoD programs.

\textsuperscript{5}Airports with planned runways or runways already under construction are in Detroit, Miami, Orlando, Houston, Denver, Minneapolis, Charlotte, Atlanta, Boston, Cincinnati, Seattle, St. Louis, Washington (Dulles), and Dallas (Cho, 2001).
In terms of new facilities costs to create an alternative site to the Fort Worth facility, we estimate that the cost of this option would far outweigh the amount of work that JSF FACO represents. A few billion dollars of FACO activity spread over 20 years does not justify the likely costs and especially the schedule risks involved in this approach.

**Option 2: A Site with an Existing Airfield Only**

This option would involve the use of an existing U.S. civil airfield capable of handling jet aircraft that has a runway and taxiways sufficient to meet JSF requirements, but also one that currently does not have appropriate ramp space, buildings, and other facilities for FACO operations. Research\textsuperscript{6} has revealed that there are approximately 375 airfields within the continental United States (CONUS) with runways of at least 8,000 ft in length and widths of 150 ft or more and FAA or military airspace controls. This option shares some of the advantages of a greenfield site in addition to some others:

- Hundreds of sites in the United States would be candidates.
- The latest designs and technology could be incorporated into the buildings and other facilities constructed.
- A site where the economic benefits from the work could help a faltering economy—for example, one with chronically high unemployment—could be selected.
- State and local tax incentives might be available.
- A site with relatively few regulatory restrictions, such as noise and environmental, could be chosen, although it might still require some regulatory approvals.
- The costs of operating the airfield could be shared with activities or organizations already there.

However, this option also has several disadvantages:

• It could require significant construction effort for additional ramp space, buildings, and other facilities.
• If it were a nonactive airfield, the costs to reopen and refurbish the facilities would be significant.
• It adds to existing overcapacity in the aircraft manufacturing industry.
• It provides for no sharing of overhead, security, and other support costs with other DoD programs.

Option 3: An Airfield with Existing Buildings Capable of Supporting JSF F ACO

This option would involve the use of an existing U.S. civil airfield (or closed DoD or commercial airfield) capable of handling jet aircraft that has a runway, taxiways, and ramp and building space sufficient to meet most JSF requirements. Some minor construction or refurbishment might be required to the airfield or buildings to make them suitable for JSF F ACO operations. Assessing the facilities available at each of the 375 airfields was both impractical and beyond the scope of this study. However, given knowledge of the existing facilities and using a generic list of facilities and equipment costs, an estimate of the required investment at each site could be developed, after the availability and condition of facilities at a site were determined.

Although this option somewhat narrows the number of candidate airfields, compared with the second option, it has some of the same advantages:

• While the exact number of sites that fall into this category cannot be determined without site surveys, we believe that dozens of sites in CONUS would be candidates.
• A site where the economic benefits from the work could help a faltering economy—for example, one with chronically high unemployment—could be selected.
• State and local tax incentives might be available.
Site Selection Issues

• A site with relatively few regulatory restrictions, such as noise and environmental, could be chosen, although it could still require some regulatory approvals.

• The costs of operating the airfield could be shared with activities or organizations already there, if it were an active airfield.

However, many of the same disadvantages remain:

• It could require some new regulatory approvals, especially environmental ones, particularly if the airfield were not active.

• If it were an inactive airfield, the costs to reopen and refurbish the facilities would be significant.

• Developing the capacity to conduct JSF FACO at a new site would add to existing overcapacity in aircraft industry.

• It provides for no sharing of overhead, security, and other support costs with other DoD programs.

Option 4: A Site with a Current DoD Operation or Depot Activity with Excess Building Capacity

This option would involve placing JSF FACO at one of the 1887 airfields in CONUS that has an active-duty, reserve, National Guard, or DoD depot organization present. The site(s) selected would have existing, underutilized building space so only minor construction would be necessary to accommodate FACO operations. This option offers the opportunity for the JSF FACO operation to share many facility and airfield operations costs with the other DoD-funded activities. As such, it offers the following advantages:

• A site where the economic benefits from the work could help a faltering economy—for example, one with chronically high unemployment—could be selected.

• State and local tax incentives might be available.

Option 5: Selecting a Site with a Current Military Aircraft Production Line That Has Sufficient Capacity to Accommodate JSF FACO Operations

Although this option yields the fewest FACO candidate sites, it also provides the greatest direct savings or cost avoidance to the JSF and other DoD production or maintenance programs. Approximately 20 locations in CONUS have either new production lines or heavy maintenance activity for military aircraft. This option will reduce FACO overhead costs. If the FACO workload is put at existing locations, overhead costs (especially those related to contractor management organization), facilities, security, airfield operation, etc., can be shared with other programs. In addition, taking advantage of the existing contractor management organization may lower some direct costs.

In addition, other advantages include the following:
Although more limited than previous options, the site with the weakest economy—for example, one with the highest unemployment rate—could be selected.

It uses some of the overcapacity in military aircraft production.

It avoids the requirement for other than minor construction of facilities, thereby avoiding costs and schedule risk to the program.

It should limit the number of new environmental or noise issues at the location.

It uses the expertise of contractor employees already on site, including production workers, engineers, and managers.

Much of the cost of a FACO operation stems from overhead costs. Performing FACO at a location with other DoD business would allow the sharing of overhead costs over a wide range of products and cut costs for both the JSF and other military programs.

It allows the use of the existing DoD plant representative organization at the location.

Recruiting FACO production workers should be easier near existing aerospace activities.

However, with the number of such sites limited, some of the disadvantages of this option are the following:

- It may conflict with current and planned production at a site in terms of facility asset utilization and schedules.
- State or local tax incentives might be limited at candidate sites compared with other locations.

**OPTION AND SITES CHOSEN FOR ANALYSIS**

Based on the pros and cons identified above for each of the five options, RAND judges that it would be most cost-effective to choose option 5 for in-depth analysis. While the numerical magnitude of the costs and benefits associated with all these options could not be explicitly assessed, an examination of the construction and adminis-
tractive tasks associated with the first four options supports that reduction in candidate categories for further study.

Within option 5, RAND assessed the following four locations for in-depth analysis: Lockheed Martin’s plant at Fort Worth; Lockheed Martin’s plant at Marietta; Lockheed Martin’s plant at Palmdale; and Northrop Grumman Air Combat System’s leased sites Three and Four at Palmdale. All four locations are run by members of the Lockheed Martin JSF Team. We did not assess locations operated by firms not already associated with JSF, as we will discuss below.

The selected sites meet the basic plant and facilities (excluding tooling) requirements for FACO, with some additions (see Table 3.1). Each site would require some investments. For example, for a split production approach, it would cost $27–65 million to bring any of the three alternative sites up to FACO requirements. This is on top of the approximately $14 million that would be needed at Fort Worth for post-SDD investments for its remaining portion of the work. The costs of these individual site requirements are included in the RAND cost model.

The sponsors of this project directed RAND to analyze Lockheed Martin Team options because to do otherwise would be to diverge from the long-standing JSF winner-take-all strategy, which was reaffirmed as recently as 2001.8

Although option 5 could be modified to include a situation where the Lockheed Martin Team could subcontract some of the FACO activity, this would be a unique practice in recent military aircraft experience. Estimating costs associated with it would be problematic because no recent, large-scale experience with aircraft FACO subcontracting has occurred, and thus no relevant precedents exist. Even if other plants were included in this option, it would be difficult to assess the numerous uncertain or unknown costs. These could include payments to Lockheed Martin to share intellectual property for the FACO activities occurring at other companies’ locations. The scope

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8Birkler et al., 2001.
of the study did not include an investigation into what kinds of data would have to be shared with an outside firm or how and whether this could effectively be done. This study also did not investigate potential contracting vehicles that would be required to get the Lockheed Martin Team to share proprietary design and production data with outside, non-JSF firms. Further, the issue of warranties on work completed would also have to be negotiated between parties.

Table 3.1
Facilities Requirements for JSF FACO

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Lockheed Martin–Fort Worth&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Lockheed Martin–Marietta&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Lockheed Martin–Palmdale</th>
<th>Northrop Grumman–Palmdale</th>
</tr>
</thead>
<tbody>
<tr>
<td>8,000-ft runway</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
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<tr>
<td>FAA instrument approach</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Arresting gear</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Taxiways and ramp space</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Building (130,000 sq ft)</td>
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<td>Y</td>
<td>Y</td>
<td>Y</td>
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<tr>
<td>Air conditioned</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>Paint facility</td>
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<td>P</td>
<td>N</td>
<td>P&lt;sup&gt;d&lt;/sup&gt;</td>
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<td>Low-observable building or space</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
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<td>Flight operations run building</td>
<td>Y</td>
<td>P</td>
<td>N</td>
<td>Y</td>
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<tr>
<td>Hover pad</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Road access</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Adequate electric power</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
</tbody>
</table>

KEY: Y = present, N = not present, P = partial.

<sup>a</sup>The Fort Worth facilities assessment is after JSF SDD facilitization.

<sup>b</sup>The Marietta facilities assessment assumes use of F-22 production facilities where possible after that program finishes, for example, painting, low-observable testing, flight operations run stations; additional requirements are added to these capabilities at Marietta where needed. Some overlap in 2011 and 2012 between F-22 and JSF production would have to be resolved, depending on the strategy chosen.

<sup>c</sup>“Partial” means some of the required capability is present or will be present when JSF production begins.

<sup>d</sup>Some overlap with B-2 building use will have to be resolved if Site 4 were used as an alternative location.

NOTE: Specific tooling and equipment requirements are listed in Chapter Nine.
CONCLUSION

In terms of alternate locations to the current JSF plan of having all FACO at the Fort Worth plant, any of the other three sites assessed are viable candidates in terms of new facility costs, schedule risk, and retention of the overall JSF winner-take-all strategy. For comparison purposes, the difference in facility investments only between performing all FACO at Fort Worth and performing half at Fort Worth and half at one of the other three locations ranges from a savings of about $15–20 million to an additional investment of a little more than $30 million over the base case of 100-percent FACO at Fort Worth (in FY 2002 dollars; these numbers are based on our analysis, which will be discussed later). This equates to a difference for the 3,002 aircraft buy of saving between about $5,000 per aircraft and adding about $10,000 per aircraft for new facilities costs only. The savings in facilities costs will result if part of JSF FACO activities are moved to Marietta after the F-22 goes out of production. However, these facility cost differentials must be factored into the total cost calculations for nonrecurring and recurring costs at varying production rates at the four sites, as will be described in the cost model results covered in Chapter Ten.