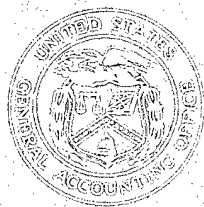


February 1997

# U.S.-JAPAN FIGHTER AIRCRAFT

## Agreement on F-2 Production



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National Security and  
International Affairs Division

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February 11, 1997

The Honorable Strom Thurmond  
President Pro Tempore  
United States Senate

The Honorable Newt Gingrich  
Speaker of the House of Representatives

The Honorable Richard Gephardt  
Minority Leader  
House of Representatives

U.S.-Japan  
Fighter Aircraft:  
Agreement on F-2  
Production

The FS-X fighter aircraft program, now the F-2,<sup>1</sup> is the first U.S.-Japan joint development and production of a weapon system, marking a significant departure from previous licensed production agreements between the United States and Japan. The early stages of the program were characterized by strong congressional concerns regarding the terms of the codevelopment agreements. In particular, Congress was concerned about the enhancement of Japan's aerospace industry through the transfers of U.S. technology to Japan, and the value of Japanese technologies to be transferred to the United States.

This is an unclassified version of our 1997 classified report. This report examines the status of the F-2 fighter aircraft program as development nears completion and provides information on the agreements signed on July 30, 1996, by the two countries for the production phase of the program. Specifically, we address the following issues: (1) the proportion of production work that will be done in the United States and how the U.S. workshare will be calculated and monitored, (2) the status of technology transfers from Japan to the United States and whether these technologies are of interest to the U.S. government and industry, and (3) the program's potential contributions to Japan's future aerospace plans.

This report responds to a requirement that we periodically review the F-2 program. This requirement is part of the conference report for the fiscal year 1990 appropriations act for the Departments of Commerce, Justice, and State; the Judiciary; and related agencies. It also responds to a request from the House Minority Leader that we examine aspects of the production phase agreements signed by the two countries.

<sup>1</sup>The production phase agreements renamed the FS-X program to the F-2 program. For clarity and consistency, we refer to the program as the F-2 throughout the report, regardless of which program phase is discussed.

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## Background

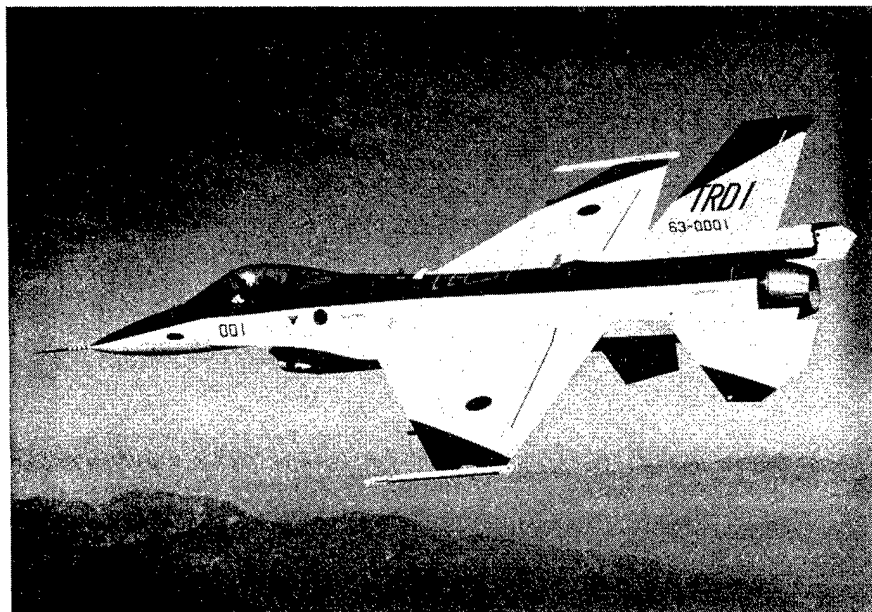
In the mid-1980s, Japan was interested in developing an indigenous fighter aircraft to replace its aging F-1 fighter. On the other hand, the United States preferred that Japan purchase an off-the-shelf U.S. fighter. As a compromise, in November 1988, the United States and Japan agreed to cooperatively develop a fighter aircraft, with all funding to be provided by the government of Japan. The development phase,<sup>2</sup> which began in 1989 and will end in the year 2000, included the development and manufacture of six prototype aircraft incorporating major Japanese modifications to the F-16C/D Block 40.<sup>3</sup> According to Department of Defense (DOD) officials, the F-2 program was expected to enhance the bilateral security relationship with Japan. In addition, the United States was to receive free and automatic flowback of improvements to F-16 technologies and have access to Japanese indigenous technologies developed for this program. Also, U.S. industry was to receive 40 percent of the development work.

The F-2 is a multi-role, single engine, fighter aircraft based on the F-16C/D Block 40 and tailored to Japan's requirements. (See fig. 1.) The F-16 and the F-2 are both multi-role fighters with air-to-air and air-to-surface capability, but the F-2 places more emphasis on the air-to-surface capability because its primary mission is sea-lane protection. Since one of the F-2's operational requirements included extended range and shorter take-off and landing capability, Japan selected the co-cured composite wing to maximize strength while minimizing weight. The F-2 wings are about 25 percent larger than the F-16's, increasing fuel capacity and allowing for more weapon stores stations—11 as compared to 9 on the F-16. Also, the F-2's fuselage has been stretched to increase fuel capacity and accommodate the larger wings.

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<sup>2</sup>The development program has been implemented almost exclusively through commercial contracts. Mitsubishi Heavy Industries was the prime contractor; other Japanese contractors included Fuji Heavy Industries, Kawasaki Heavy Industries, and Ishikawajima-Harima Heavy Industries. Lockheed Martin and General Electric were the principal U.S. subcontractors.

<sup>3</sup>The block number refers to a specific stage of the F-16's development.

**Figure 1: The F-2 Prototype**

Shortly after the codevelopment agreements were signed, Congress became concerned about the merits of the agreements, especially the transfers of U.S. aerospace technology to Japan and the contributions this would make to the development of Japan's aerospace industry. Congress was also concerned about U.S. access to and the potential value of Japanese-developed technologies. As a result, we were tasked to periodically review the status of the program. Since November 1989, we have issued a number of reports dealing with the F-2 program.<sup>4</sup> In general, these reports concluded that during the development stage:

- the United States was adequately controlling the release of F-16 related technical data to Japan, but U.S. government agencies were not adequately sharing licensing information;
- the value of technology transfers from Japan to the United States was uncertain; and
- the program had helped to enhance Japan's aerospace industry.

<sup>4</sup>See the list of our related products at the end of this report.

Our August 1995 report<sup>5</sup> noted that program officials believed that the United States and Japan should clearly define U.S. workshare in the production agreement and include a specific list of items to be manufactured by U.S. industry.

During the development phase, the United States provided the F-16 technical data package on which the F-2 design was based and U.S. industry received about 40 percent of development phase work (approximately \$1.2 billion).

In 1995, Japan conducted the initial flight of the first prototype aircraft and the Japanese cabinet approved the production of 130 F-2 aircraft over the next 15 years at an average estimated procurement cost of about \$80 million per aircraft.<sup>6</sup> Mitsubishi officially turned the first prototype over to the Japan Defense Agency in March 1996 to begin government testing. In May 1996, the Japanese parliament approved about \$1.3 billion for production of 11 aircraft commencing in fiscal year 1996.<sup>7</sup> Finally, on July 30, 1996, the United States and Japan signed a memorandum of understanding to produce 130 F-2 aircraft for Japan's Air Self Defense Force.

## Results in Brief

Under the F-2 production agreements, U.S. industry is expected to receive approximately 40-percent workshare, currently estimated at \$4.1 billion if the Japanese fully implement the planned production of 130 aircraft. The agreements specify the items to be procured by Japan from U.S. industry, which provide for a 40-percent workshare based on estimates of the production costs at the time the agreements were signed. A constant exchange rate of 110 yen to the dollar was used to estimate the value of the U.S. workshare and this rate will remain constant throughout the life of the program.

<sup>5</sup>U.S.-Japan Cooperative Development: Progress on the FS-X Program Enhances Japanese Aerospace Capabilities (GAO/NSIAD-95-145, Aug. 11, 1995).

<sup>6</sup>The \$80 million per aircraft average is in constant 1996 dollars at 110 yen per dollar. Japan Defense Agency budgets will be slightly higher as they will include Japanese taxes and will reflect adjustments for inflation. Japan is funding the entire F-2 program at a cost of about \$14 billion, including both development and production phases.

<sup>7</sup>Japan's fiscal year 1996 began on April 1, 1996.

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The U.S. Air Force plans to verify that contracts for the items identified in the production agreements are awarded to U.S. companies.<sup>8</sup> The value of payment amounts will not be tracked and a workshare percentage will no longer be recalculated based on actual payment amounts as had occurred during the development phase. As a result, the Air Force will not have the means to determine whether this approach in fact enabled U.S. companies to receive approximately 40 percent of the production work over the course of the program.

Technology transfers from Japan to the United States have generally been in accordance with the development phase agreements, but some issues remain unresolved. In 1993, Japan requested that 12 items be recategorized as Japanese indigenous technologies (i.e., not essentially derived from F-16 technical data). The United States is to receive free and automatic flowback of F-2 technologies that are derived from U.S. technical data while access to non-derived or indigenous technologies is more limited. In 1994, the United States agreed to reclassify 4 of the 12 items as non-derived or Japanese indigenous technologies. However, at the time of this review, the United States and Japan had not resolved the classification issue. As we reported in August 1995, while this issue is unresolved, the United States is not receiving free and automatic access to these technologies.

The United States conducted several visits to explore the potential benefits of F-2 technologies. Two technologies that were initially of interest to the U.S. Air Force and to DOD contractors—the co-cured composite wing and the active phased array radar—are now generally considered too costly to produce. However, Lockheed officials indicated that tooling techniques from the F-2 program are being applied to the Joint Advanced Strike Technology program.

The F-2 program enhances Japan's military aircraft industry by improving its overall systems integration capability, according to experts. However, Japan's exports of military technology and equipment continue to be constrained by the country's policy prohibiting exports of weapon systems or exclusively military technology.

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<sup>8</sup>The agreements include the Memorandum of Understanding, the Implementing Arrangement to the Memorandum of Understanding, the Exchange of Notes, and the Memorandum of Implementation for the Transfer of Japanese Military Technologies.

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## U.S. Workshare Is Expected to Be Approximately 40 Percent

The F-2 production agreements specify that U.S. industry is to receive approximately 40-percent workshare. If the Japanese fully implement the program,<sup>9</sup> the U.S. workshare will be an estimated \$4.1 billion over the life of the program. The agreements identify the contents of U.S. workshare and provide for a 40-percent workshare based on estimates of production costs at the time the agreements were signed.

A constant exchange rate of 110 yen to the dollar was used to avoid the effect of exchange rate fluctuations on the respective workshares. According to DOD officials, unlike during the development phase, U.S. workshare will not be recalculated throughout the program. These new provisions will change the method of verifying U.S. workshare from checking payments to U.S. companies to checking that U.S. companies have received contracts for the items that constitute U.S. workshare. The value of contracts and actual payments to U.S. companies will not be tracked.

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## Production Cost Estimates Provide Basis for U.S. Workshare

The production agreements provide that U.S. industry will receive approximately 40 percent of the total value of production over the life of the F-2 program. The total value of production for 130 aircraft consists of the flyaway aircraft costs plus initial spares, less certain agreed to deductions. The Japan Defense Agency estimates the total value of production will be about \$10.3 billion. This total does not include the purchase of follow-on spare parts, which Japan is expected to purchase from U.S. industry.

Actual program costs and U.S. revenue are likely to vary from current estimates. The 40-percent U.S. workshare is based on the Japan Defense Agency's estimates of total production costs, adjusted for inflation. The Japan Defense Agency obtained inputs from prime contractor Mitsubishi and other Japanese companies when developing its estimated production budget. These companies' estimates were based on the development phase experience and incorporated cost estimates from U.S. companies, according to DOD officials. U.S. Air Force officials estimated U.S. workshare by obtaining data from U.S. companies and extrapolating from experience with the F-16 program.

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<sup>9</sup>In constant 1996 dollars converted at an exchange rate of 110 yen to the dollar.

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## Production Phase Workshare Calculation Methodology Differs From the Development Phase

During the development phase, U.S. workshare was vulnerable to exchange rate fluctuations. If the yen appreciated against the dollar, thus requiring fewer yen to pay for each dollar, more work would be required for U.S. companies to achieve a 40-percent workshare.<sup>10</sup> Conversely, if the yen depreciated against the dollar, work would have to shift from U.S. to Japanese companies to maintain the 40/60 workshare split because more yen would be required to meet payments to U.S. companies.

The semi-annual workshare recalculations showed changes in the percentage of U.S. workshare as the development phase progressed. For example, in 1994, U.S. workshare was calculated to be 42.4 percent; 1 year later, U.S. workshare decreased to 40.7 percent as companies were paid at a lower yen/dollar rate. U.S. and Japanese officials attribute this change primarily to exchange rate fluctuations, which were significant during the development phase. From 1988 to 1995, the average annual exchange rate ranged between 145 yen to the dollar and 88 yen to the dollar.

During government-to-government negotiations for the production phase, workshare calculation methodology was a major issue. A constant exchange rate of 110 yen to the dollar was used to estimate the value of U.S. workshare. The constant exchange rate for the production phase will be useful not only in establishing U.S. workshare at the beginning of the program, but also in the event of changes during the course of the program. For example, if U.S. workshare were to be adjusted in response to changes in F-2 configuration items, the 110 yen to the dollar exchange rate would be used to factor in these adjustments to U.S. workshare.

The production phase negotiations also resulted in identification of the items that will constitute U.S. workshare. Our August 1995 report noted that U.S. program officials favored defining the elements that comprise production phase workshare to avoid delays, confusion, and subsequent disagreements.

In conjunction with the constant 110 yen to the dollar exchange rate, identification of the items to be produced by U.S. suppliers helps stabilize U.S. workshare for the life of the program. This will avoid the risk of shifting work from U.S. to Japanese companies, according to the DOD officials. Shifting work is not practical because of its potential impact on cost and schedule.

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<sup>10</sup>For example, a \$100,000 contract would equal 13 million yen at an exchange of 130 yen to the dollar, whereas it would equal 11 million yen at an exchange rate of 110 yen to the dollar.

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### Production Workshare Monitoring Procedures Also Changed From the Development Phase

The removal of the effects of exchange rate fluctuations on workshare and identification of specific work to be performed by U.S. companies have resulted in changes to the methodology for verifying U.S. workshare from that used during the development phase. During development, U.S. workshare was recalculated and reported to the Technical Steering Committee twice each year by the Japan Defense Agency. The U.S. Air Force then verified the workshare data by contacting U.S. companies to determine the value of F-2 contract payments. According to one Air Force official, verifying U.S. workshare was time consuming and company reporting of Japanese payments for the purpose of verifying workshare is voluntary.

For the production phase, U.S. workshare will be monitored through verifying that Japan has awarded contracts to U.S. companies for the items agreed to in the production agreements, rather than through verifying actual payments. Monitoring implementation of the workshare agreement will be the responsibility of a joint production coordination group, the successor to the Technical Steering Committee. However, the exact responsibilities of this committee have yet to be determined.

DOD intends to ensure that agreed parts and items are indeed purchased from U.S. companies. The Air Force will periodically contact U.S. companies to verify that the contracts they receive for F-2 production are in fact consistent with the production agreements. However, the value of the contracts will not be tracked and a workshare percentage will not be calculated based on actual payments. As a result, the Air Force will not have the means to determine whether this approach in fact enabled U.S. companies to receive approximately 40 percent of the production work over the course of the program.

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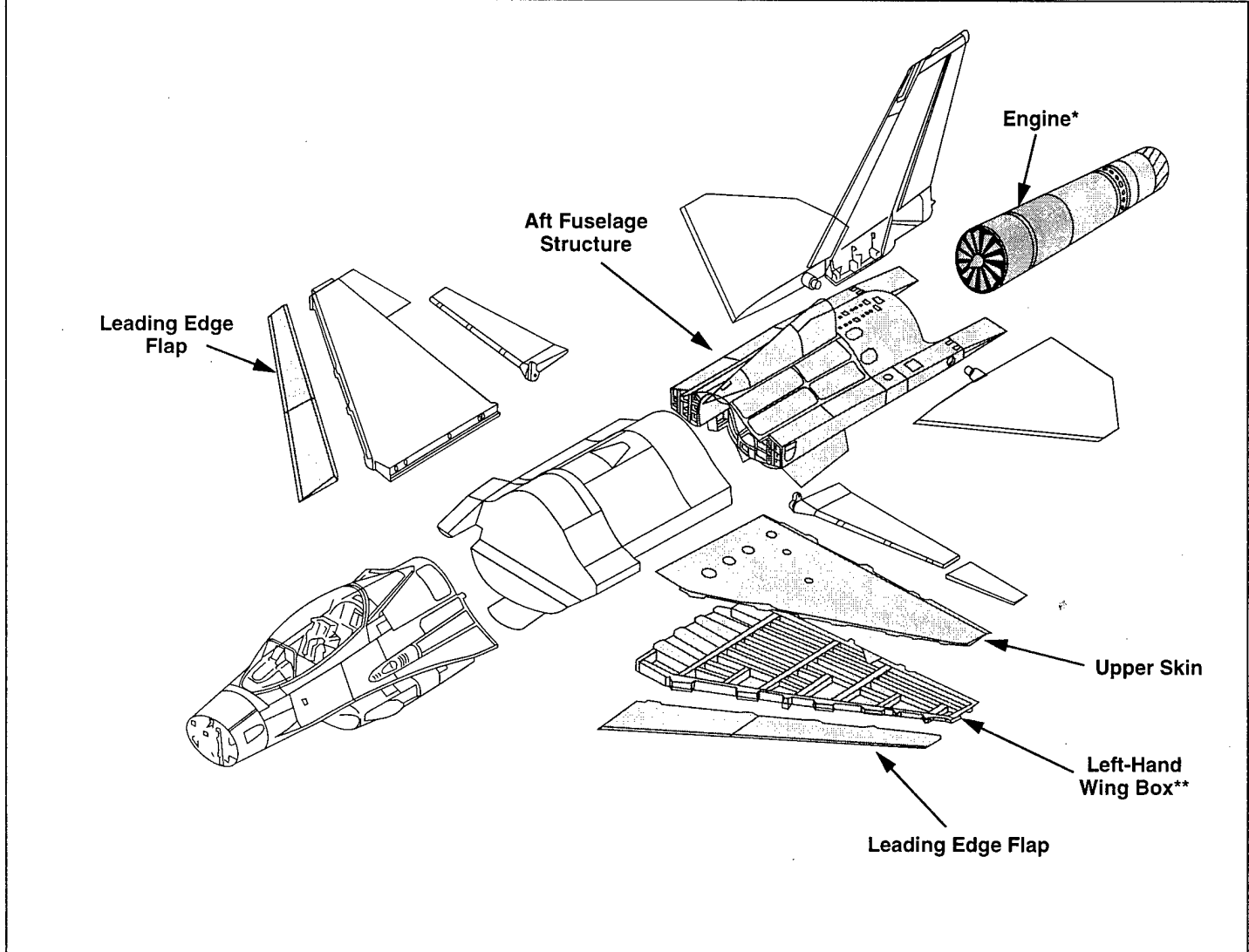
### U.S. Industry Expects Revenue of About \$4.1 Billion

U.S. workshare, currently expected to be about \$4.1 billion over the life of the program,<sup>11</sup> is represented by the flow of revenue to U.S. companies, rather than the percentage of actual work performed. Thus, U.S. workshare will include parts and components manufactured in the United States as well as royalties and licensing fees paid by Japan to U.S. companies. Royalties and licensing fees account for about 5.2 percent of the \$4.1 billion U.S. workshare. Figure 2 shows the major components of U.S. workshare.

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<sup>11</sup>In constant 1996 dollars converted at an exchange rate of 110 yen to the dollar.

Figure 2: Major Components of U.S. Workshare



Notes: \* Phased-in licensing arrangement  
\*\* 8 of every 10 left-hand wings

Source: Defense Security Assistance Agency.

Lockheed Martin Tactical Aircraft Systems and General Electric Aircraft Engines are expected to receive about 70 percent of the U.S. workshare

(excluding initial spare parts the two companies will produce). About 200 other U.S. companies will also receive F-2 contracts directly from Japan, as specified in the production agreements. Lockheed Martin will produce 80 percent of the left-hand wings, as well as the aft fuselage, leading edge flaps, avionics support equipment, and stores management set.<sup>12</sup> The percentage of left-hand wings Lockheed Martin will produce is an increase over the 57 percent produced during the development phase.

General Electric is entering into a licensed production arrangement with Japanese engine manufacturer Ishikawajima-Harima Heavy Industries. General Electric will allow Ishikawajima-Harima to produce up to 76 percent of the engine under license in a phased arrangement. Over the life of the program, Ishikawajima-Harima's licensed production of the engine will average 60 percent. However, in accordance with U.S. restrictions on transfers of leading edge technologies, critical engine technologies are not being licensed to Japan as part of this program.<sup>13</sup>

Workshare will be accounted for by contracts awarded to the major subcontractors, such as Lockheed Martin and General Electric, and to the 200 or so smaller U.S. companies that will contract directly with Japan. We have identified several parts and components that will be procured from third countries; however, these parts account for less than 1 percent of U.S. workshare. For example, Lockheed will buy airframe harnesses from Mexico at an estimated total cost of \$6 million, or about 0.15 percent of U.S. workshare. Similarly, General Electric will purchase certain parts from its subcontractors in Canada, the Netherlands, and Turkey at an estimated total cost of about \$19 million, or about 0.5 percent of U.S. workshare. These are parts that U.S. contractors typically buy from third countries to build these engines for the U.S. Air Force.

## Transfers of Technology From Japan Improve but Some Unresolved Issues Remain

Transfers of technology from Japan to the United States have been in accordance with the development agreements but some issues remain unresolved. In 1993, Japan requested that 12 items be recategorized as Japanese indigenous technologies. The United States is to receive free and automatic flowback of F-2 technologies that are derived from U.S. technical data. In 1994, the United States agreed to reclassify 4 of the 12 items as non-derived or Japanese indigenous technologies. However, as

<sup>12</sup>The stores management set is a computer system that contains weapon delivery software. This system interacts and communicates with all weapon systems on the aircraft.

<sup>13</sup>The engine licensed production rate for the Japanese side is approximately 60 percent on average through the F-2 production period, and reaching up to 76 percent at the end of the F-2 production period.

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our August 1995 report indicated; while this issue is unresolved, the United States is not receiving free and automatic access to these technologies.<sup>14</sup>

We also stated in our August 1995 report that the U.S. Department of Commerce wanted to develop opportunities for U.S. companies interested in Japanese FS-X technology by organizing industry visits to Japan to examine non-derived technologies. Since then, the Commerce Department and DOD have sponsored 17 U.S. government and industry visits. Industry participants reported that they generally benefited from learning about Japanese methods and also from making contacts with Japanese companies; however, DOD officials and industry participants indicate that there is limited interest in those technologies.

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### Japan Limits U.S. Access to Certain Technologies Pending Resolution of Reclassification Request

The F-2 development phase agreements provide for flowback of technologies to the United States that are essentially developed from U.S. technical data. These so-called “derived” technologies are those based in whole or in part upon U.S. technical data provided to Japan as part of this agreement. The provision entitles the United States to receive all the technical data and know-how required to replicate the item on a free and automatic basis.

The United States also has access to Japanese indigenous or “non-derived” technologies. Japan is to provide technical outlines on non-derived technologies with sufficient information to enable the United States to determine their value and usefulness. Those in the United States who wish to use the technology can obtain it through a licensing agreement from the originating Japanese company.

The production phase agreements contain similar provisions regarding flowback of derived technologies and access to non-derived technologies.

The development agreements identified four major F-2 components—the active phased array radar, the integrated electronic warfare system, the inertial reference/navigation system, and the mission computer—as Japanese indigenous or non-derived technologies. There is also a provision granting Japan the option to request a change in technology classification from derived to non-derived, provided it can demonstrate that the technology was developed with insignificant or no U.S. input. In 1993, the United States agreed to reclassify radar absorbing material to non-derived

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<sup>14</sup>Further details on this case have been classified by DOD and excluded from this report.

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status, increasing the number of recognized Japanese indigenous or non-derived technologies to five.

Japan later submitted 12 items as candidates for reclassification to non-derived status. The U.S. government evaluated the 12 to determine if Japan developed them with minimal or insignificant U.S. input, as Japan claimed. In 1994, the U.S. government told Japan that the United States would agree to reclassify 4 of the 12 items. Reclassification of the remaining eight items remains unresolved. However, as we stated in our August 1995 report, the United States was not receiving automatic flowback of these technologies because the Japan Defense Agency was reluctant to transfer candidate technologies before the U.S. evaluation was complete. Japan believes that these technologies are not essentially developed from U.S. technology. On the other hand, U.S. officials contend that all F-2 technology is derived until classified otherwise and that Japan is obligated to transfer data until classification negotiations end. At the time of this review, the United States and Japan had not resolved the classification status of the remaining eight technologies.

According to program officials, Japan has generally complied with the flowback provisions for derived technologies and U.S. officials told us that about 40,000 technical documents have been transferred to date. Generally, compliance with the memorandum of understanding's requirement to submit outlines of non-derived items has been satisfactory. For example, in the February 1996 working subcommittee meeting, Japan provided technical outlines of the four items that were recategorized from derived to non-derived status and included updates of the original five non-derived items.

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### U.S. Access to Wing Technology Data Improves

The co-cured composite technology used by both countries to produce the F-2 wings, including materials, process specifications, and tooling was designed by Mitsubishi and transferred to Lockheed Martin. For the development phase, Lockheed fabricated five left-hand wing box assemblies using Japanese materials and processing techniques.

The F-2 wings differ from the traditional F-16 aluminum wings in several respects, but the most significant feature is the use of co-curing technology whereby composite parts are bonded together without conventional metal fasteners. In terms of performance, the significantly lighter F-2 wings are expected to be more durable, provide higher strength, and reduce flutter problems.

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In our August 1995 report, we stated that Lockheed was not at that time receiving all of the wing data necessary to apply the composites technology to other programs. The U.S. contractor and DOD program officials have recently indicated that technology transfers from Japan have been successful and continue to be effective and that Lockheed is generally satisfied with the transfer of Japanese technology. Lockheed officials indicated that Lockheed now has had sufficient access to Japan's ground tests and that they expect to have access to the Japanese government's flight testing data as government-led flight testing increases.

Other DOD contractors, however, were unable to obtain access to the wing technology until September 1995 when DOD and the Japan Defense Agency agreed to grant DOD and DOD contractors access to the co-cured composite wing technology.

In terms of potential application to other programs, Lockheed officials explained that some of the F-2 tooling techniques are of interest to them. In January 1996, for example, Lockheed Martin announced that the company had combined technology derived from the F-2 program with its own manufacturing processes to manufacture a composite bulkhead. The bulkhead is to be used in demonstration tests for the Joint Advanced Strike Technology program for potential cost-saving manufacturing options.

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### Technology Visits to Evaluate F-2 Technologies Result in Limited U.S. Government and Industry Interest

Throughout the development phase of the program, DOD's F-16 program office, in coordination with the Commerce Department, conducted a series of technology visits to observe and evaluate Japanese technology. As a result of these visits, the program office prepared Technology Assessment Reports for inclusion in Defense Technical Information Center's (DTIC) database. This database can be accessed by U.S. firms interested in learning about the technologies.<sup>15</sup>

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<sup>15</sup>The DTIC provides scientific technical information principally to DOD. DTIC's resources are intended primarily for federal government agencies and their contractors. DOD contractors who are registered DTIC users and are interested in F-2 technical abstracts can access technical abstracts sorted in the following categories: air vehicle, airframe, landing gear, propulsion, fuel, environmental control, crew, flight control, hydraulic, armament, weapons delivery, avionics, electrical, instrumentation, operational software, inertial reference/navigation system, integrated electronic warfare system, mission computer, active phased array radar, and radar-absorbing material.

Technology visits were conducted for the five technologies reclassified to non-derived,<sup>16</sup> and plans are currently underway to determine whether to review the four additional technologies recategorized to non-derived status in December of 1994. Table 1 summarizes the technology visits conducted and the level of participation by U.S. industry.

**Table 1: Summary of Technology Visits**

| Technology                           | Date of visits                               | Number of U.S. companies attending |
|--------------------------------------|--|------------------------------------|
| Active phased array radar            | May 1991<br>July 1993<br>November 1994       | 14                                 |
| Mission computer                     | November 1991<br>May 1993                    | DOD only                           |
| Integrated electronic warfare system | July 1993<br>September 1994<br>December 1995 | 10                                 |
| Inertial reference/navigation system | November 1994<br>September 1994              | DOD only                           |
| Radar-absorbing materials            | June 1995                                    | DOD only                           |
| Co-cured composite wing (symposium)  | March 1996                                   | 13                                 |

Key objectives of the technology visits were to allow DOD to evaluate technologies of interest for its own potential use and to introduce U.S. companies to the F-2 technologies. It would then be up to the individual firms to decide whether or not to enter into contractual or licensing arrangements with individual Japanese companies.

#### Active Phased Array Radar System

To evaluate the F-2's active phased array radar system, the U.S. Air Force acquired five transmit/receive modules to test and evaluate at its Wright Laboratory. The radar was of interest to DOD because it incorporates new technologies; however, some officials believe that U.S. radar technology being developed for the F-22 is a generation ahead of Japanese technology. Although there is limited commercial application for a fire control radar, some of its parts could be of interest to U.S. companies and at least one U.S. company expressed interest. In general, the U.S. industry participants were favorably impressed with the level of access to active phased array radar technology during the visit but found that the technology was not

<sup>16</sup>As of February 1996, the program office did not plan additional future visits for the technologies described above, but expected that as the development phase reaches completion and test results become available, the United States would consider additional technology visits.

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quite as advanced as expected. Also, industry participants observed that the approaches used by Japanese industry to package and seal the radar modules are not a low-cost approach by U.S. industry standards.

#### Mission Computer

According to program officials, the F-2's mission computer is very similar in capability to the F-16's.

#### Integrated Electronic Warfare System

Although the U.S. visitors found the technology visit informative, they found that additional detailed data was required before a complete technology assessment could be made. Some participants commented that although details of the Japanese program were provided, there was insufficient detail for U.S. companies to make a commercial decision. Moreover, the overall quality of the system will be determined during the test phase.

#### Inertial Reference/Navigation System

The F-2's inertial reference/navigation system does not use any significant advances in technology beyond those employed on the F-16. Moreover, the F-16 is also being equipped with the global positioning system, also used by commercial airlines. The F-2 will not use the global positioning system and its navigation system does not provide capabilities beyond that available in U.S. systems. Therefore, neither U.S. government nor industry officials expressed interest in this technology.

#### Radar-Absorbing Materials

A small government team conducted a technology visit in June 1995 to discuss radar-absorbing materials. The government officials found that the visit was informative and responsive to U.S. requests for information, but did not see the technology as advanced as U.S. technology in this area. Nevertheless, officials indicate that more information on the electrical performance data of the radar-absorbing material—not available at the time of the visit—will be needed in order to determine whether the material would be valuable for U.S. industry.

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### Co-cured Composite Wing

A symposium was held in March 1996 to provide an overview to U.S. industry participants of the wing in terms of materials, design, processes, fabrication, and assembly. DOD and Commerce officials told us that the participating companies have not indicated any further interest in obtaining technical documents. The general consensus among industry participants and U.S. Air Force officials is that it is extremely costly to produce the wing structure by the co-curing process. Lockheed Martin, however, has stated that the use of tooling techniques from the F-2 program has contributed to reducing the cost of manufacturing the composite bulkhead materials for the Joint Advanced Strike Technology program.

### New Non-derived Technologies

According to program officials, of the four new non-derived technologies—the digital flight control computer software, airborne video tape recorder, cockpit television sensor, UHF/VHF radio—the most likely candidate for a technology visit is the digital flight control software. The F-2 uses a tri-redundant architecture with an analog back-up mode, while the F-16 uses a quad-redundant architecture with a digital back-up mode. With regard to the cockpit television sensor and the UHF/VHF radio, program officials stated that the U.S. Air Force would not have an interest because there is little technical innovation. The airborne video tape recorder currently used in the Air Force's F-16s is acquired from Japan, obviating the need for additional evaluation of this system.

In addition to the systems-specific technology visits, the program office conducted two other technical visits. First, in January 1996, an avionics integration technology visit was conducted at Mitsubishi to review software development and hardware integration processes. Second, a structures test meeting was conducted at Japan's Technology Research and Development Institute structural test facility in April 1996. The visit was part of an ongoing structural test dialogue between F-16 and F-2 structural engineers.

## Japanese Aerospace Industry Gains From F-2 Program but Continues to Be Constrained by Export Restrictions

U.S. program officials and industry experts indicate that Japan will continue to gain experience and capability from the F-2 program, although less capability than if it had pursued indigenous development. Specifically, DOD officials believe that the F-2 program will significantly enhance Japan's systems integration capability—that is, incorporating subsystems and technologies into the airframe.

However, Japanese industry will not gain significant new capability in engine production. Because of the terms of the engine licensed production agreement, Japanese industry will not be modifying the General Electric F110-129 engine for the F-2. Instead, it will produce increasingly more parts along the course of the program. According to program officials, the engine technology that will be released to Japan for this program is roughly equivalent to technical data previously obtained from the United States as part of the licensed production of the F-15J program. Moreover, in accordance with U.S. restrictions on transfers of U.S. leading edge technologies, critical engine technology is not being licensed to Japan.

Although the F-2 program will enhance Japan's military aircraft capability, exports of military technology continue to be constrained by the country's long-standing restrictions on exports of military weapon systems and exclusively military technology. In 1967 Japan adopted its Three Principles on arms exports, which, in effect, banned arms exports. These principles were reaffirmed in 1976 and 1981. In 1983, Japan signed a bilateral agreement with the United States to allow, on a limited basis, the transfer of Japanese military technology to the United States. The agreement recognized the imbalance of technology flows between the two countries and permits the transfer of Japanese military technology to the United States on a case-by-case basis. The agreement also reaffirmed Japan's policy that, in principle, dual-use technology can freely flow between the two countries. Japanese technologies transferred to the United States for the F-2 program are subject to this agreement.

Japan's decreasing military procurement budget has led some industry representatives to consider asking the Japanese government to relax its ban on exporting military systems and components to the United States. For example, in 1995, the defense production committee of Keidanren, Japan's largest industry association, released a statement alluding to a desire to relax Japan's restrictions on military exports to the United States. Nonetheless, some experts believe that the long-term goal of Japan's defense industry is to export subcomponents to support U.S. programs

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such as the F-22 aircraft, but that public sentiment will likely prevent the Japanese government from relaxing the ban.

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## Recommendation

Current plans for monitoring implementation of the production agreements do not provide a means to determine whether U.S. companies actually receive approximately 40 percent of the F-2 production work by the end of the program. Therefore, we recommend that the Secretary of Defense direct the Defense Security Assistance Agency, as the lead U.S. agency for the F-2 program, to collect sufficient data to determine the value of production work received by U.S. companies at the end of the program. This can be accomplished by collecting data from Lockheed Martin, General Electric, and a selection of the smaller contractors involved in this program. Collection of such data will allow the Defense Security Assistance Agency to assess the soundness of the production phase approach to workshare allocation and tracking for use in future cooperative programs.

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## Agency Comments

DOD and the Departments of State and Commerce provided comments on a draft of the classified version of this report. DOD said it fully concurred with the draft report. (See app. I.) In addition, DOD provided minor technical comments that we have incorporated in the text as appropriate. The Commerce Department stated that it generally agreed with the report's findings and conclusions. (See app. II.) The Department of State orally concurred with the report.

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## Scope and Methodology

To examine the status of the F-2 program, we reviewed documentation and interviewed officials from the Office of the Secretary of Defense for International Security Affairs, the Office of the Deputy Under Secretary of the Air Force for International Affairs, the F-16 program office at Wright-Patterson Air Force Base, the Defense Security Assistance Agency, and the Defense Technology Security Administration. We also interviewed officials at the Departments of Commerce and State.

To examine the terms of the U.S. workshare, we reviewed the memorandum of understanding for the production phase and compared it to the memorandum of understanding for the development phase. We also compared and contrasted other development phase implementing agreements and similar production phase documents. We sought and obtained production phase cost estimates from General Electric and from

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Lockheed Martin. We reviewed and analyzed the methods DOD used to calculate U.S. workshare.

To assess the status of technology flowback from Japan to the United States and whether those technologies were of interest to the U.S. government and industry, we reviewed minutes of Technical Steering Committee meetings, summaries of technology visits, and summaries of participants' comments. We interviewed cognizant program officials to obtain their overall impressions of the visits and of the technologies observed. Additionally, to examine the status of Japan's request for recategorization, we obtained and analyzed documents describing criteria for each reviewer's conclusions. We also interviewed officials to confirm our interpretation of those documents.

We conducted our review between March 1996 and December 1996 in accordance with generally accepted government auditing standards.

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We plan no further distribution of this report until 10 days from its issue date. At that time we will send copies of the report to other interested congressional committees and to the Secretaries of State, Commerce, and Defense. Upon request, copies may also be made available to others.

This report was prepared under the guidance of Katherine V. Schinasi, who can be reached at (202) 512-4841 if you or your staff have any questions. Other major contributors to this report were Karen S. Zuckerstein, M. Cristina Gobin, and Paula J. Haurilesko.



Henry L. Hinton, Jr.  
Assistant Comptroller General

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## Abbreviations

|      |                                       |
|------|---------------------------------------|
| DOD  | Department of Defense                 |
| DTIC | Defense Technology Information Center |



# Comments From the Department of Defense



DEFENSE SECURITY ASSISTANCE AGENCY

WASHINGTON, DC 20301-2800

15 JUN 1996

In reply refer to:  
I-005079/96

Ms. Katherine V. Schinasi  
Associate Director  
Defense Acquisition Issues  
National Security and International Affairs Division  
U.S. General Accounting Office  
Washington, D.C. 20548

Dear Ms. Schinasi:

This is the Department of Defense (DoD) response to General Accounting Office (GAO) draft report "U.S.-JAPAN FIGHTER: F-2 Coproduction Report Signed," (GAO Code 707164), OSD Case 1251-X.

The DoD fully concurs with the draft report. Needed technical changes have been provided separately.

The DoD appreciates the opportunity to comment on the draft report.

Sincerely,

A handwritten signature in cursive script that reads "Thomas G. Rhame".

Thomas G. Rhame  
Lieutenant General, USA  
Director

# Comments From the Department of Commerce



**UNITED STATES DEPARTMENT OF COMMERCE**  
The Under Secretary for Export Administration  
Washington, D.C. 20230

December 5, 1996

Ms. Katherine V. Schinasi  
Associate Director  
Defense Acquisitions Issues  
U.S. General Accounting Office  
Washington, DC 20548

Dear Ms. Schinasi:

Thank you for the opportunity to review and comment on your draft report on the U.S.-Japan Fighter Aircraft Program (GAO code 707164). We generally agree with the report's findings and conclusions. We will continue to work with the Department of Defense to seek opportunities for U.S. industry under the U.S.-Japan Fighter Aircraft Program.

Sincerely,

A handwritten signature in black ink, appearing to read "W. A. Reinsch".

William A. Reinsch





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# Related GAO Products

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U.S.-Japan Cooperative Development: Progress on the FS-X Program Enhances Japanese Aerospace Capabilities (GAO/NSIAD-95-145, Aug. 11, 1995).

Asian Aeronautics: Technology Acquisition Drives Industry Development (GAO/NSIAD-94-140, May 4, 1994).

Foreign Technology: Collection and Dissemination of Japanese Information Can Be Improved (GAO/NSIAD-93-251, Sept. 30, 1993).

Competitiveness Issues: The Business Environment in the United States, Japan, and Germany (GAO/GGD-93-124, Aug. 9, 1993).

High Technology Competitiveness: Trends in U.S. and Foreign Performance (GAO/NSIAD-92-236, Sept. 16, 1992).

Technology Transfer: Japanese Firms Involved in F-15 Coproduction and Civil Aircraft Programs (GAO/NSIAD-92-178, June 10, 1992).

Defense Technology Base: Risks of Foreign Dependencies for Military Unique Critical Technologies (GAO/NSIAD-92-231, June 5, 1992).

U.S.-Japan Codevelopment: Update of the FS-X Program (GAO/NSIAD-92-165, June 5, 1992).

Foreign Technology: Federal Processes for Collection and Dissemination (GAO/NSIAD-92-101, Mar. 23, 1992).

Aerospace Plane Technology: Research and Development Efforts in Japan and Australia (GAO/NSIAD-92-5, Oct. 4, 1991).

Commercialization of Technology by Japanese Companies (GAO/T-NSIAD-91-32, Apr. 30, 1991).

U.S.-Japan Codevelopment: Review of the FS-X Program (GAO/NSIAD-90-77BR, Feb. 6, 1990).

Investment in Foreign Aerospace Vehicle Research and Technological Development Efforts (GAO/T-NSIAD-89-43, Aug. 2, 1989).

U.S.-Japan FS-X Codevelopment Program (GAO/T-NSIAD-89-32, May 16, 1989).

U.S.-Japan FS-X Codevelopment Program (GAO/T-NSIAD-89-31, May 11, 1989).

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**Related GAO Products**

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U.S. Military Aircraft Coproduction With Japan (GAO/T-NSIAD-89-6, Feb. 23, 1989).

Support for Development of Electronics and Materials Technologies by the Governments of the United States, Japan, West Germany, France, and the United Kingdom (GAO/RCED-85-63, Sept. 9, 1985).

Industrial Policy: Case Studies in the Japanese Experience (GAO/ID-83-11, Oct. 20, 1982).

Industrial Policy: Japan's Flexible Approach (GAO/ID-82-32, June 23, 1982).

U.S. Military Coproduction Programs Assist Japan in Developing Its Civil Aircraft Industry (GAO/ID-82-23, Mar. 18, 1982).