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Report to the Ranking Minority Member, Committee on National Security, House of Representatives

October 1997

THEATER MISSILE DEFENSE

Significant Technical Challenges Face the Airborne Laser Program

GAO/NSIAD-98-37

GAO

United States
General Accounting Office
Washington, D.C. 20548

National Security and
International Affairs Division

B-275849

October 23, 1997

The Honorable Ronald V. Dellums
Ranking Minority Member
Committee on National Security
House of Representatives

Dear Mr. Dellums:

As you requested, this report discusses our review of the status of the Airborne Laser (ABL) program. The Department of Defense (DOD) plans to develop the ABL as its primary program for intercepting theater ballistic missiles shortly after they have been launched—also known as the boost phase. The Air Force estimates the life-cycle cost of the ABL program to be about $11 billion. That estimate includes $1.3 billion for the program definition and risk reduction phase, $1.2 billion for the engineering and manufacturing development phase, $3.8 billion for the production phase, and $4.9 billion for 20 years of operations and support.

This report discusses (1) the way in which the ABL is expected to change theater missile defense, (2) assurances that the ABL will be able to operate effectively in the levels of optical turbulence that may be encountered in the geographical areas in which the system might be used, and (3) the technical challenges in developing an ABL system that will be compatible with the unique environment of an aircraft.

Background

Operation Desert Storm demonstrated that the U.S. military and other allied forces have limited capability against theater ballistic missiles. In fact, U.S. defensive capability is limited to weapons that defend against missiles nearing the end of their flight, such as the Patriot. No capability currently exists to destroy missiles in the boost phase. Consequently, DOD is expending considerable resources to develop the ABL's capability to intercept missiles in their boost phase. In simple terms, the ABL program will involve placing various components, including a powerful multimegawatt laser, a beam control system, and related equipment, in a Boeing 747-400 aircraft and ensuring that all the components work together to detect and destroy enemy missiles in their boost phase.

In November 1996, the Air Force awarded a 77-month program definition and risk reduction contract to the team of Boeing, TRW, and Lockheed Martin. Under the contract, Boeing is to produce and modify the 747-400 aircraft and integrate the laser and the beam control system with the aircraft, TRW will develop the multimegawatt Chemical Oxygen Iodine Laser (COIL) and ground support systems, and Lockheed Martin will develop the beam control system.

The various program components are in the early phases of design and testing. One prototype ABL will be produced and used in 2002 to shoot down a missile in its boost phase. If this demonstration is successful, the program will move into the engineering and manufacturing development phase in 2003. Production is scheduled to begin about 2005. Initial operational capability of three ABLs is scheduled for 2006; full operational capability of seven ABLs is scheduled for 2008.

Results in Brief

Although DOD has a long history with laser technologies, the ABL program is its first attempt to design, develop, and install a multimegawatt laser on an aircraft. The ABL is also expected to be DOD's first system to intercept missiles during the boost phase. To successfully destroy a missile in its boost phase, the ABL system would have to, within about 30 to 140 seconds, detect a missile shortly after it has been launched several hundred kilometers away, track the rising missile's path, and hold a concentrated laser beam on the missile until the beam's heat causes the missile's pressurized casing to fracture and then explode. This explosion would then cause a missile's warhead, along with any nuclear, chemical, or biological agents it may contain, to fall short of the intended target and possibly back on the aggressor's territory.

A key factor in determining whether the ABL will be able to successfully destroy a missile in its boost phase is the Air Force's ability to predict the levels of turbulence that the ABL is expected to encounter. An accurate prediction of those turbulence levels is needed to define the ABL's technical requirements for turbulence. To date, the Air Force has not shown that it can accurately predict the levels of turbulence the ABL is expected to encounter or that its technical requirements regarding turbulence are appropriate.

The turbulence that the ABL will encounter is referred to as optical turbulence. This type of turbulence can be measured either optically or non-optically. Optical measurements are taken by transmitting laser beams from one aircraft to instruments on board another aircraft at various altitudes and distances. Non-optical measurements of turbulence are taken by radar or by temperature probes mounted on balloons or on an aircraft's exterior. The Air Force has taken both optical and non-optical measurements for the ABL program. However, because the ABL is an optical weapon system, only optical measurements of turbulence can measure the turbulence that will actually be encountered by the ABL laser beam along its path. The Air Force has no plans to take additional optical measurements. Instead, it plans to take additional non-optical measurements to predict the severity of optical turbulence the ABL will encounter. Therefore, to ensure that the non-optical measurements can be validly applied to the ABL program, the Air Force must determine whether the non-optical measurements can be correlated to optical measurements. A senior-level ABL oversight team has expressed concern about the absence of such a correlation. In response, the Air Force has indicated that it plans to determine, in late 1997, whether a correlation exists between optical and non-optical measurements.

Until the Air Force can verify that its predicted levels of optical turbulence are valid, it will not be able to validate the ABL's design specification for overcoming turbulence. The Air Force has established a design specification for the ABL that is based on Air Force modeling techniques. However, data collected by the program office indicate that the levels of turbulence the ABL may encounter could be four times greater than the levels in which the system is being designed to operate. According to DOD officials, if the higher levels of optical turbulence are encountered, the effective range of the ABL system would decrease, and the risk that the ABL system would be underdesigned for its intended mission would increase. DOD officials also indicated that a more realistic design may not be achievable using current state-of-the-art technology.

In addition to the challenges posed by turbulence, developing and integrating a laser weapon system into an aircraft pose many technical challenges for the Air Force. The Air Force must build a new laser that is able to contend with size and weight restrictions, motion and vibrations, and other factors unique to an aircraft environment and yet be powerful enough to sustain a killing force over a range of at least 500 kilometers. Also, the Air Force must create a beam control system that must compensate for the optical turbulence in which the system is operating and control the direction and size of the laser beam. The beam control system will consist of complex software programs, moving telescopes, and sophisticated mirrors. To date, the Air Force has not demonstrated how well a beam control system of such complexity can operate on an aircraft. Because these challenges will not be resolved for several years, it is too early to accurately predict whether the ABL program will evolve into a viable missile defense system.

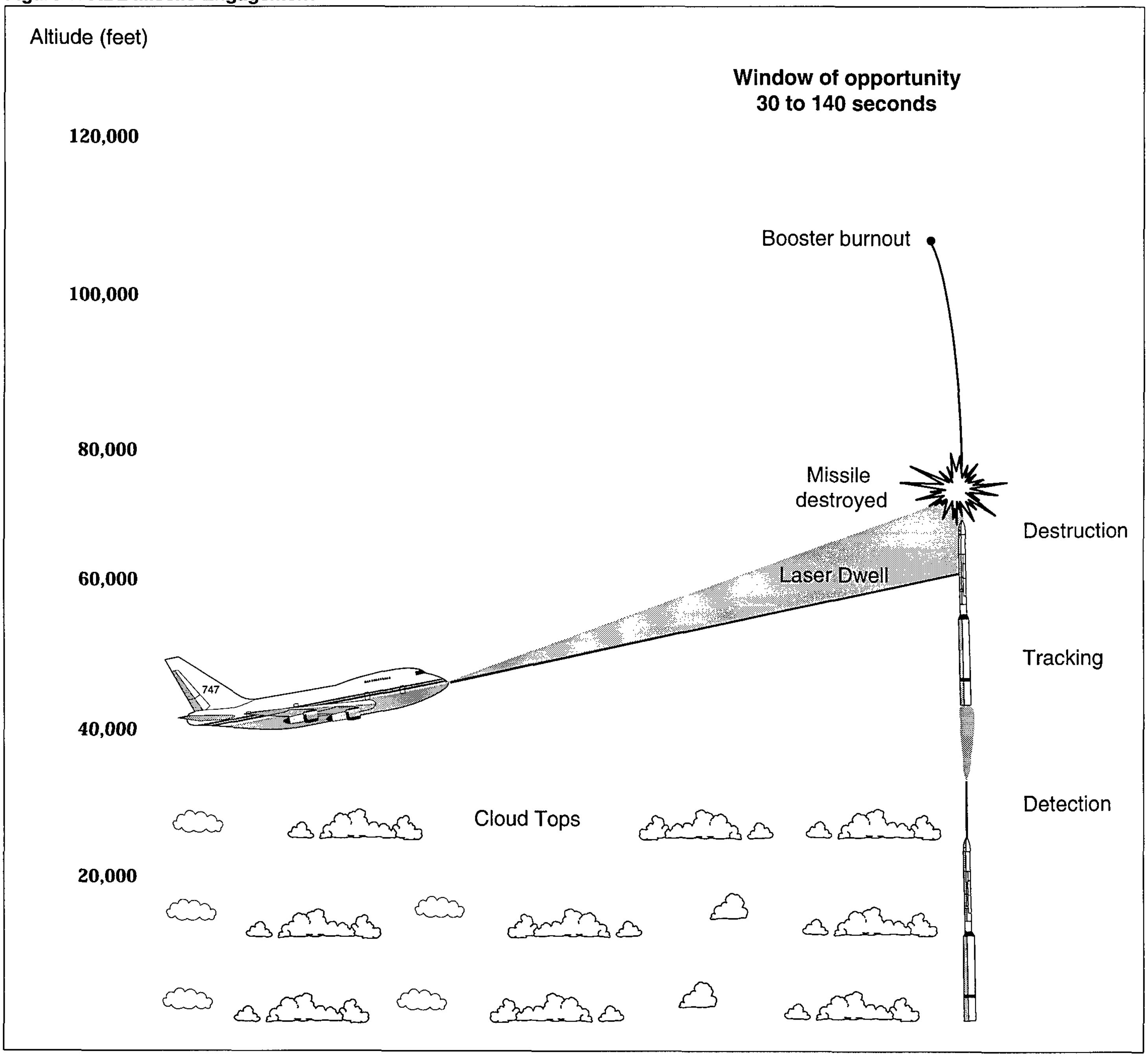
The ABL Is a New Weapon Concept

The ABL is a complex laser weapon system that is expected to detect an enemy missile shortly after its launch, track the missile's path, and destroy the missile by holding a concentrated laser beam on it until the beam's heat causes the pressurized missile casing to crack, in turn causing the missile to explode and the warhead to fall to earth well short of its intended target.

The ABL's opportunity to shoot down a missile lasts only from the time the missile has cleared the cloud tops until its booster burns out.[1] That interval can range from 30 to 140 seconds, depending on missile type. During that interval, the ABL is expected to detect, track, and destroy the missile, as shown in figure 1.

[1]The missile's booster is under pressure only while it is burning. This pressure causes the missile to explode after heat from the laser fractures the casing.

Figure 1: ABL Missile Engagement



The first step—detection—is to begin when the ABL's infrared search sensor detects a burst of heat that could be fire from a missile's booster.[2] Because clouds block the view of the infrared search sensor, the sensor cannot detect this burst of heat until the missile has broken through the cloud tops—assumed to be at about 38,500 feet. The sensor detects the heat burst about 2 seconds after the missile has cleared the cloud tops. (In the absence of clouds, detection can occur earlier.) The ABL would then use information from the sensor to verify that the heat burst is the plume of a missile in its boost phase and would then move the telescope located in the nose of the aircraft toward the coordinates identified by the infrared sensor.

The second step—tracking—is to be performed sequentially and with increasing precision by several ABL devices. The first of these tracking devices, the acquisition sensor, is to take control of the telescope, center the plume in the telescope's field of view, and hand off that information to the next device, the plume tracker.

The plume tracker, having taken control of the telescope, is to track and determine the shape of the missile plume and use this information to estimate the location of the missile's body and project a beam from the track illuminator laser to light up the nose cone of the missile. The plume tracker is then to hand its information, and control of the telescope, to the final tracking device, the fine tracker.

The fine tracker is to measure the effects of turbulence and determine the aimpoint for the beacon laser and, ultimately, for the COIL laser. The reflected light from the illuminator laser provides information that is to be used to operate a sophisticated mirror system (known as a fast-steering mirror) that helps to compensate for optical turbulence by stabilizing the COIL beam on the target. The reflected light from the beacon laser provides information that is to be used to operate deformable mirrors that will further compensate for turbulence by shaping the COIL beam.[3] With the illuminator and beacon lasers still operating, the fine tracker is to determine the aimpoint for the COIL laser. The COIL laser is to be brought to full power and focused on the aimpoint.

[2]Even though the ABL's surveillance system will be the primary means for detecting missiles, the ABL will also have the capability to accept missile detection information from other DOD sensor systems.

[3]A deformable mirror is a flexible reflective surface mounted to an array of actuators, or pistons, that can rapidly (up to 1,000 times per second) alter the shape of the mirror. In effect, the mirror's shape is altered to predistort an outgoing laser beam, which is then refocused by the turbulence through which the beam travels on its way to the target.

At this point, the final step in the sequence—missile destruction—is to begin. During this final step, a lethal laser beam is held on the missile. The length of time that the beam must dwell on the missile will depend on turbulence levels and the missile type, hardness, range, and altitude. Throughout the lethal dwell, the illuminator and beacon lasers are to continue to operate, providing the information to operate the fast-steering and deformable mirrors. Under the intense heat of the laser beam, which is focused on an area about the size of a basketball, the missile's pressurized casing fractures, and then explodes, destroying the missile.

The ABL is expected to operate from a central base in the United States and be available to be deployed worldwide. The program calls for a seven-aircraft fleet, with five aircraft to be available for operational duty at any given time. The other two aircraft are to be undergoing modifications or down for maintenance or repair. When the ABLs are deployed, two aircraft are to fly, in figure-eight patterns, above the clouds at about 40,000 feet. Through in-flight refueling, which is to occur between 25,000 and 35,000 feet, and rotation of aircraft, two ABLs will always be on patrol, thus ensuring 24-hour coverage of potential missile launch sites within the theater of operations. The ABLs are intended to operate about 90 kilometers behind the front line of friendly troops but could move forward once air superiority has been established in the theater of operations. When on patrol, the ABLs are to be provided the same sort of fighter and/or surface-to-air missile protection provided to other high-value air assets, such as the Airborne Warning and Control System and the Joint Surveillance Target Attack Radar System.

ABL's Operational Effectiveness Is Currently Unknown

A key factor in determining whether the ABL will be able to successfully destroy a missile in its boost phase is the Air Force's ability to predict the levels of turbulence that the ABL is expected to encounter. Those levels are needed to define the ABL's technical requirements for turbulence. To date, the Air Force has not shown that it can accurately predict the levels of turbulence the ABL is expected to encounter or that its technical requirements regarding turbulence is appropriate.

Correlation Between Non-Optical and Optical Turbulence Measurements Is Needed

The type of turbulence that the ABL will encounter is referred to as optical turbulence. It is caused by temperature variations in the atmosphere. These variations distort and reduce the intensity of the laser beam. Optical turbulence can be measured either optically on non-optically. Optical measurements are taken by transmitting laser beams from one aircraft to instruments on board another aircraft at various altitudes and distances. Non-optical measurements of turbulence are taken by radar or by temperature probes mounted on balloons or on an aircraft's exterior.

The Air Force's ABL program office has not determined whether non-optical measurements of turbulence can be mathematically correlated with optical measurements. Without demonstrating that such a correlation exists, the program office cannot ensure that the non-optical measurements of turbulence that it is collecting are useful in predicting the turbulence likely to be encountered by the ABL's laser beam.

Concern about turbulence measurements was expressed by a DOD oversight office nearly 1 year ago. In November 1996, during its milestone 1 review of the ABL program,[4] the Defense Acquisition Board directed the program office to develop a plan for gathering additional data on optical turbulence and present that plan to a senior-level ABL oversight team for approval. The Board also asked the program office to "demonstrate a quantifiable understanding of the range and range variability due to optical turbulence and assess operational implications." This requirement was one of several that the Air Force has been asked to meet before being granted the authority to proceed with development of the ABL. That authority-to-proceed decision is scheduled for June 1998.

In February 1997, the program office presented to the oversight team a plan for gathering only non-optical data. The oversight team accepted the plan but noted concern that the plan was based on a "fundamental assumption" of a correlation between non-optical and optical measurements. If that assumption does not prove to be accurate, according to the oversight team, the program office will have to develop a new plan to gather more relevant (i.e., optical rather than non-optical) measurements. Accordingly, the oversight team required that the program office include in its data-gathering plan a statement agreeing to demonstrate the correlation between the non-optical and optical measurements. Program officials said they plan to demonstrate that correlation in the summer of 1997.

To establish that a correlation exists, the program office plans to use optical and non-optical turbulence measurements taken during a 1995 Air Force project known as Airborne Laser Extended Atmospheric Characterization Experiment (ABLE ACE). Optical measurements were made by transmitting two laser beams from one aircraft to instruments aboard

[4]This review is the point in time at which a new acquisition program is approved.

another aircraft at distances from 13 to 198 kilometers and at altitudes from 39,000 to 46,000 feet. These measurements provided the data used to calculate the average turbulence strengths encountered by the beams over these distances.

The ABLE ACE project also took non-optical measurements of turbulence using temperature probes mounted on the exterior of one of the aircraft. Rather than taking measurements over the path of a laser beam between two aircraft, as with the optical measurements, the probes measured temperature variations of the air as the aircraft flew its route.

Opinions vary within DOD about whether a correlation between optical and non-optical turbulence measurements can be established. Some atmospheric experts, who are members of the program office's Working Group on Atmospheric Characterization, criticized the program office's plan for collecting additional atmospheric data because it did not include additional optical measurements. Minutes from a Working Group meeting indicated that some of these experts believed that "current scientific understanding is far too immature" to predict optical effects from non-optical point measurements. In contrast, the chief scientist for the ABL program said it would be surprising if the two measurements were not directly related; he added that evaluations at specific points in the ABLE ACE tests have already indicated a relationship. According to the chief scientist, it would be prudent for the program office to continue to collect non-optical data while it completes its in-depth analysis of the ABLE ACE data.

According to a DOD headquarters official, because the ABL is an optical weapon, gathering non-optical data without first establishing their correlation to optical data is risky. The official concluded that, if the program office cannot establish this correlation, turbulence data will have to be gathered through optical means.

Technical Requirements for Overcoming Turbulence May Be Understated

The ABL program office also has not shown that the turbulence levels in which the ABL is being designed to operate are realistic. Available optical data on optical turbulence indicate that the turbulence the ABL may encounter could be four times greater than the design specifications. These higher levels of optical turbulence would decrease the effective range of the ABL system.

The ABL program office set the ABL's design specifications for optical turbulence at a level twice that, according to a model, the ABL would likely encounter at its operational altitude. This model was based on research carried out in 1984 for the ground based laser/free electron laser program, in which non-optical measurements were taken by 12 balloon flights at the White Sands Missile Range in New Mexico. Each of the 12 flights took temperature measurements at various altitudes. These measurements were then used to develop a turbulence model that the program office refers to as "clear 1 night."

The clear 1 night model shows the average turbulence levels found at various altitudes. The ABL is being designed to operate at about 40,000 feet, so the turbulence expected at that level became the starting point for setting the design specifications. To ensure that the ABL would operate effectively at the intended ranges, for design purposes, the program office doubled the turbulence levels indicated by its clear 1 night model. The program office estimated that the ABL could be expected to encounter turbulence at or below that level 85 percent of the time. This estimate was based on the turbulence measured by 63 balloon flights made at various locations in the United States during the 1980s.

When the ABL design specifications were established, the program office had very little data on turbulence. However, more recent data, accumulated during the ABLE ACE program, indicated that turbulence levels in many areas were much greater than those the ABL is being designed to handle. According to DOD officials, if such higher levels of turbulence are encountered, the effective range of the ABL system would decrease, and the risk that the ABL system would be underdesigned for its intended mission would increase. DOD officials also indicated that a more realistic design may not be achievable using current state-of-the-art technology.

ABLE ACE took optical measurements in various parts of the world, including airspace over the United States, Japan, and Korea. According to the program office and Office of the Secretary of Defense (OSD) analyses of optical measurements taken during seven ABLE ACE missions, overall turbulence levels exceeded the design specifications 50 percent of the time. For the two ABLE ACE missions flown over Korea, the measurements indicated turbulence of up to four times the design specifications. Additionally, according to officials in OSD, ABLE ACE data were biased toward benign, low-turbulent, nighttime conditions. According to these officials, turbulence levels may be greater in the daytime.

Developing and Integrating ABL Components Pose Many Technical Challenges

Developing and integrating a weapon-level laser, a beam control system, and the many associated components and software systems into an aircraft are unprecedented challenges for DOD. Although DOD has integrated a weapon-level laser and beam control system on the ground at White Sands Missile Range, it has not done so in an aircraft environment. Therefore, it has not had to contend with size and weight restrictions, motion and vibrations, and other factors unique to an aircraft environment.

The COIL is in the early development stage. The Air Force must build the laser to be able to contend with size and weight restrictions, motion and vibrations, and other factors unique to an aircraft environment, yet be powerful enough to sustain a killing force over a range of at least 500 kilometers. It is to be constructed in a configuration that links modules together to produce a single high-energy beam. The laser being developed for the program definition and risk reduction phase will have six modules. The laser to be developed for the engineering and manufacturing development phase of the program will have 14 modules. To date, one developmental module has been constructed and tested. Although this developmental module exceeded its energy output requirements, it is too heavy and too large to meet integration requirements. The module currently weighs about 5,535 pounds and must be reduced to about 2,777 pounds. The module's width must also be reduced by about one-third. To accomplish these reductions, many components of the module may have to be built of advanced materials, such as composites.

The ABL aircraft, a Boeing 747-400 Freighter, will require many modifications to allow integration of the laser, beam control system, and other components. A significant modification is the installation of the beam control turret in the nose of the aircraft. The beam control turret is to be used for acquisition, tracking, and pointing actions used in destroying a missile. Consequently, the location of the turret is critical to the success of the ABL. Issues associated with the turret include the decreased aircraft performance resulting from the additional drag on the aircraft; the interaction of the laser beam with the atmosphere next to the turret, which can cause the laser beam to lose intensity; and vibrations from the operation of the aircraft that affect the accuracy of pointing the beam control turret. The contractor has conducted wind tunnel tests of these expected effects for three different turret locations and found that installing the turret in the nose of the aircraft would cause the fewest negative effects. However, the operational effectiveness of the beam control turret will not be known until it undergoes additional testing in 2002 in an operationally realistic environment.

The laser exhaust system is another critical modification. The system must prevent the hot corrosive laser exhaust from damaging the bottom of the aircraft and other structural components made of conventional aluminum. The exhaust created by the laser will reach about 500 degrees Fahrenheit when it is ejected through the laser exhaust system on the bottom of the aircraft. This exhaust system must also undergo additional testing on the aircraft in 2002 to determine its operational effectiveness.

Integrating the beam control system with the aircraft also poses a challenge for the Air Force. The Air Force must create a beam control system, consisting of complex software programs, moving telescopes, and sophisticated mirrors, that will compensate for the optical turbulence in which the system is operating and control the direction and size of the laser beam. In addition, the beam control system must be able to tolerate the various kinds of motions and vibrations that will be encountered in an aircraft environment. In deciding the on-board location of the beam control system's components, the Air Force used data gathered by an extensive study of aircraft vibrations on the 747-400 Freighter. The beam control components are expected to be located in those areas of the aircraft that experience less intense vibrations and, to the extent possible, be shielded from vibrations and other aircraft motion. To date, the Air Force has not demonstrated how well a beam control system of such complexity can operate on an aircraft. The contractor has modeled the ABL's beam control system on a brassboard but has not tested it on board an aircraft.[5]

Conclusions and Recommendations

The ABL program is a revolutionary weapon system concept. Although DOD has a long history with laser technologies, the ABL is its first attempt to design, develop, and install a multimegawatt laser on an aircraft. As such, the concept faces a number of technological challenges. A fundamental challenge is for the Air Force to accurately and reliably predict the level of optical turbulence that the ABL will encounter and then design the system to operate effectively in that turbulence. The Air Force will not have

[5]A brassboard is an experimental device (or group of devices) used to determine feasibility and develop technical and operational data. It may resemble the end item but is not intended for use as the end item.

resolved that challenge until it has demonstrated whether there is a reliable correlation between its non-optical and optical turbulence measurements, or, should such a correlation not exist, gather additional optical data, which may delay the ABL program. Whether relevant and reliable data are confirmed through correlation or by additional optical measurements, the data are critical in assessing the appropriateness of the design specifications for turbulence. If the specifications need to be set higher, that should be done as soon as possible.

Therefore, we recommend that the Secretary of Defense direct the Secretary of the Air Force to take the following actions:

- Demonstrate as quickly as possible, but no later than the time when DOD decides whether to grant the ABL program the authority to proceed (currently scheduled for June 1998), the existence of a correlation between the optical and non-optical turbulence data. If a correlation between optical and non-optical data cannot be established, the Air Force should be required to gather additional optical data to accurately predict the turbulence levels the ABL may encounter, before being given the authority to proceed with the program as planned.
- Validate the appropriateness of the design specification for turbulence based on reliable data that are either derived from a correlation between optical and non-optical data or obtained through the collection of additional optical data.

Agency Comments

DOD concurred with both of our recommendations. DOD's comments are reprinted in appendix I. DOD also provided technical comments that we incorporated in this report where appropriate.

Scope and Methodology

We reviewed and analyzed DOD, Air Force, ABL program office, and contractor documents and studies regarding various aspects of the ABL program. We discussed the ABL program with officials of the Office of the Under Secretary of Defense (Comptroller); the Office of the Under Secretary of Defense (Acquisition and Technology); the Air Combat Command; the ABL program office; the Air Force's Phillips Laboratory; and the ABL Contractor team of Boeing, TRW, and Lockheed Martin. We also discussed selected aspects of the ABL program with a consultant to the ABL program office.

We conducted our review from September 1996 to August 1997 in accordance with generally accepted government auditing standards.

We are sending copies of this report to the congressional committees that have jurisdiction over the matters discussed and to the Secretary of Defense; the Secretary of the Air Force; and the Director, Office of Management and Budget. We will make copies available to others on request.

Please contact me at (202) 512-4841 if you or your staff have questions concerning this report. Major contributors to this report were Steven Kuhta, Ted Baird, Suzanne MacFarlane, and Rich Horiuchi.

Sincerely yours,

Louis J. Rodrigues
Director, Defense Acquisitions Issues

Comments From the Department of Defense

OFFICE OF THE UNDER SECRETARY OF DEFENSE

3000 DEFENSE PENTAGON
WASHINGTON, DC 20301-3000

ACQUISITION AND TECHNOLOGY

03 OCT 1997

Mr. Louis J. Rodrigues
Director, Defense Acquisitions Issues
National Security and International Affairs Division
U.S. General Accounting Office
Washington, D.C. 20548

Dear Mr. Rodrigues:

This is the Department of Defense (DoD) response to the General Accounting Office (GAO) draft report, "THEATER MISSILE DEFENSE: Significant Technical Challenges Face the Airborne Laser Program", dated August 27, 1997, (GAO Code 707210), OSD Case 1451. The Department concurs on both recommendations.

The DoD detailed comments in response to the recommendations are provided in the enclosure. Detailed technical comments for accuracy and clarification were provided separately.

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

Sincerely,

George R. Schneiter
Director
Strategic and Tactical Systems

Enclosure

GAO DRAFT REPORT -- DATED AUGUST 27, 1997
(GAO CODE 707210) OSD CASE 1451

"THEATER MISSILE DEFENSE: SIGNIFICANT TECHNICAL CHALLENGES FACE THE AIRBORNE LASER PROGRAM"

DOD COMMENTS ON THE GAO RECOMMENDATIONS

- RECOMMENDATION 1: The GAO recommended that the Secretary of Defense direct the Air Force to demonstrate as quickly as possible, but no later than the time when DOD decides whether to grant the Airborne Laser (ABL) program the authority to proceed with major commitment toward the purchase of the first 747-400F aircraft (currently scheduled for June, 1998), the existence of a correlation between the optical and non-optical turbulence data. If a correlation between optical and non-optical data cannot be established, the GAO recommended that the Air Force be required to gather additional optical data to accurately predict the turbulence levels the ABL may encounter, before being given the authority to proceed with the program as planned. (p. 16/GAO Draft Report)

Now on p. 13.

DOD RESPONSE: Concur. Atmospheric turbulence will affect the performance of the ABL. The Air Force set up the Atmospheric Characterization Working Group (ACWG) to help define issues related to atmospheric turbulence and its effect on ABL performance. After the first two ACWG meetings the ABL Program Office developed an Atmospheric Data Collection Plan, which was briefed to the Overarching Integrated Product Team (OIPT) in February 1997, and was approved. The OIPT report noted that a key assumption in the plan was that there was a correlation between optical and non-optical data. At the most recent ACWG, held on September 11, 1997, the Air Force and OSD, after conducting independent analyses, showed correlation between optical data and non-optical data from the Airborne Laser Extended Atmospheric Characterization Experiment (ABLE ACE), which is the only experiment to date in which both optical data and non-optical data were collected simultaneously. The Air Force and OSD will discuss these efforts in the upcoming Integrating Integrated Product Team (IIPT) and OIPT meetings. Further, the program must demonstrate a quantifiable understanding of the range and range variability due to atmospheric turbulence and assess implications for performance and operational concepts in order to receive approval to proceed at the decision point currently scheduled for June 1998. This decision will be made by the Air Force Service Acquisition Executive with the advice of the OIPT and the consent of the Defense Acquisition Executive.

- RECOMMENDATION 2: The GAO also recommended that the Secretary of Defense direct the Secretary of the Air Force to validate the appropriateness of the design specification for turbulence based on reliable data that are either derived from a correlation between optical and non-optical data or obtained through the collection of additional optical data. (p. 16/GAO Draft Report)

Now on p. 13.

DOD RESPONSE: Concur. The Air Force plans to validate the design specification and both the Air Force and OSD will estimate system performance based on data gathered throughout the Air Force data collection efforts. This will combine the current Air Force atmospheric data collection effort, which gathers data in two theaters of interest in all four seasons of the year, with data collected in earlier atmospheric collection campaigns to generate a data base showing expected turbulence variations in the atmosphere. This data base can then be used to update ABL's design specifications for turbulence variations and to predict ABL's system performance and operational effectiveness. The current data collection efforts, including the four-season collections in each theater, are on schedule and will be completed prior to the authority to proceed decision point currently scheduled for June 1998.

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