STATEMENT OF NEAL A. BLAKE, DEPUTY ASSOCIATE ADMINISTRATOR FOR ENGINEERING, FEDERAL AVIATION ADMINISTRATION, BEFORE THE HOUSE COMMITTEE ON SCIENCE AND TECHNOLOGY, SUBCOMMITTEE ON INVESTIGATIONS AND OVERSIGHT, CONCERNING THE MICROWAVE LANDING SYSTEM AND THE TRAFFIC ALERT AND COLLISION AVOIDANCE SYSTEM. NOVEMBER 23, 1985.

Mr. Chairman and Members of the Subcommittee:

I welcome the opportunity to appear before the Subcommittee today to discuss two key programs of the Federal Aviation Administration concerning the Microwave Landing System (MLS) and the Traffic Alert and Collision Avoidance System (TCAS). I would like to take a few moments now to respond briefly to the issues you raised in your letter of invitation to the FAA concerning these programs, and will be prepared following my statement to respond to specific questions you may have.

I would like to first discuss the FAA's MLS program. The MLS is a precision landing aid which will eventually replace the Instrument Landing System (ILS). The MLS and ILS assist pilots in approaching and landing at a given runway by emitting a "signal" or radio beam which is monitored by equipment carried on board the aircraft. The aircraft then flies along the path made by the signal down to the runway. The primary distinctions between MLS and ILS are in four key areas: the quality of the navigation signal emitted to the airspace user; requirements for siting the equipment at an airport; frequency spectrum and number of available channels; and reliability of the

system. In each of these areas, MLS offers substantial improvements over ILS.

With MLS, there is only one signal quality standard. That standard is equivalent to the standard for ILS Category III which is the most sophisticated category of approach aid that permits a pilot to land at an airport under the most adverse visibility conditions. The severity of weather in which operations are permitted declines with Category II systems and even more so with Category I. The initial ILS installation at a location will typically meet only Category I signal standards. Efforts to achieve ILS Category II or III signal quality can lead to the need for site improvement or unique antenna or antenna feed systems, which require additional costs both in time and money. We expect MLS to reduce the cost of providing Category II/III capability, which is a key benefit over ILS, and that it will enable more locations to qualify for Category II/III service. Clearly, increases in operations under Category II or III conditions will have a capacity enhancing effect. Moreover, the more locations there are offering Category II or III service, the more commonplace the operations become, reducing the costs to the users for special training and related equipment.

Insofar as criteria for "siting" or locating a MLS or ILS at an airport are concerned, critical areas are the areas immediately

in front of and to the sides of each guidance antenna for an MLS or ILS. Since the guidance antennas, either ILS or MLS, must be located within prescribed limits determined by the runway to be instrumented, critical areas associated with each antenna will sometimes include runways and taxiways. In that penetration of a critical area by a moving or parked aircraft may cause interference with the guidance signal being used by an aircraft on approach to the runway, aircraft movement on the ground must be restricted in the critical areas. This restriction can limit the movement of aircraft on taxiways to the point where airport capacity is reduced. With MLS, these critical areas are smaller than the ILS. In addition, since MLS does not require smooth terrain in front of the elevation antenna, more siting flexibility is available to enable the selection of antenna location to avoid having runways and taxiways penetrate the critical area. Both of these features should help in reducing restrictions that may limit airport capacity.

Improved signal reliability is available with the MLS because its signal is less susceptible to interference from conditions such as deep snow, rising and falling tides, growing vegetation, or changing weather conditions. In addition, the digital signal used by MLS has a higher tolerance for signal variations; uses integrated circuitry to allow more economical signal processing; and utilizes special processing circuits in the receiver to

provide increased immunity from signal perturbations. Further, with MLS, to reduce the effects of signal-reflecting objects near the transmitting antennas, the antenna's characteristics can be modified and the scan controlled so that the effects are minimized. This flexibility that ILS does not possess makes the MLS more adaptable to the runway environment and improves availability during adverse weather, avoiding flight disruptions which otherwise might occur.

MLS also offers further benefits in terms of efficiency improvements and improved traffic flow. These can be further divided into near-term and long-term benefits. The near-term benefits are derived from the ability to install systems at locations where it was not previously feasible, either economically or technically, to provide precision guidance systems. These are near-term benefits that result from having Instrument Flight Rules (IFR) procedures available where needed. In the long-term, benefits are available because we can design an optimum procedure to either improve the efficiency of the air traffic system and thereby reduce flight time, or increase capacity by providing guidance that will reduce or eliminate airspace conflicts. These benefits are possible because MLS can provide a very precise "curved" signal to be followed on approach to the runway whereas ILS provides only a "straight line" approach to a runway. Furthermore, the

availability of back azimuth guidance from MLS provides benefits by allowing the development of precision missed approach and departure procedures that improve the overall efficiency of the air traffic system.

In terms of our implementation plan for MLS, the United States is following a plan consistent with the International Civil Aviation Organization's transition plan for worldwide replacement of ILS by the year 2000. Under that plan, the ILS will continue to be available through the year 1998 as a parallel system to MLS. The United States' MLS plan estimates installation of 1,250 systems, which is the projected number of runways expected to qualify for precision landing capability. The first contract for MLS ground equipment was awarded in January 1984, to the Hazeltine Corporation. The contract provides for the delivery of ground equipment and installation of MLS at 178 locations. The contract deliveries begin in late 1986, and are to be completed by mid-1988. Our plans currently call for the second contract for MLS procurement to be awarded in September 1987, and the third and final contract to be awarded in December 1991. We plan for the first MLS to be commissioned in October 1986, and the last of the MLS's under the third contract to be commissioned in December 1998.

We estimate that the total cost of MLS implementation will be about $2.0 billion in 1981 dollars. $1.1 billion of this cost

is for 1,250 ground systems to be funded under the FAA's Facility and Equipment Program; $0.9 billion in cost of avionics would be borne by aviation users.

I would like to turn now to the FAA's effort to develop the Traffic Alert and Collision Avoidance System (TCAS). The FAA and the aviation community have been searching for a workable collision avoidance system since the late 1950's. It has long been recognized that a practical collision avoidance system, which works independently of and as a back-up to the air traffic control system, would provide an added margin of safety to airspace users. To achieve that objective, however, has not been easy. In fact, it has proven to be one of the most complex R&D efforts which we and the aviation community have dealt with over the years. For example, work in the late 1960's and early 1970's concentrated on investigating the merits of three potential Airborne Collision Avoidance Systems (ACAS). Under this program, an aircraft equipped with an ACAS would have been protected only from another aircraft carrying an ACAS. Therefore, the protection afforded by ACAS was limited until significant numbers of aircraft were equipped with ACAS. An alternative approach sponsored by the FAA in 1974 considered the feasibility of a Beacon Collision Avoidance System (BCAS) which would offer protection from all aircraft equipped with radar

transponders. Since the vast majority of the aircraft in the U.S. are equipped with transponders, protection afforded to a BCAS-equipped aircraft would be substantial from day one.

The feasibility of BCAS was established in 1976, and, after lengthy consultation with the users in which they stated a clear preference for BCAS over ACAS, FAA concentrated its efforts on the development of BCAS. From 1976 to 1981, FAA's primary efforts were devoted to improving the threat evaluation and maneuver selection logic and in improving hardware/software techniques concerned with surveillance, threat detection, and threat tracking.

In 1981, the FAA's efforts were expanded based on an aircraft collision concept called Traffic Alert and Collision Avoidance System (TCAS). This concept builds on previous efforts in the BCAS program by adding upgraded air-to-air communications techniques and providing a range of collision avoidance equipment alternatives that can provide some degree of collision protection for the full spectrum of airspace users. In addition, the TCAS equipment will operate independent of ground equipment.

There are three versions of TCAS: TCAS I, TCAS II, and TCAS III. TCAS I is a system which generates traffic advisories only. TCAS II will generate traffic advisories <u>and</u> resolution

advisories. Resolution advisories tell a pilot what maneuver to undertake to avoid another aircraft. In the case of TCAS II, only up or down maneuvers (or maneuvers in the vertical plane) will be provided by the equipment. TCAS III will generate both traffic advisories and resolution advisories, which can be in the vertical or horizontal plane. In other words, TCAS III can advise a pilot to turn left or right or up or down. The TCAS II system is furthest along in the development cycle.

TCAS II is now in the user evaluation phase of development. Engineering development has been completed. The principal focus of this TCAS II effort is in the certification and installation of TCAS II equipment in airline aircraft for operational evaluation of the system. Currently, two projects are underway for this purpose. A prototype TCAS II unit will be flown in a Piedmont B-727 aircraft. We are currently involved within the FAA in certificating the TCAS II unit for use by Piedmont. One significant element of this certification process has centered around the need to demonstrate fully the software integrity of the TCAS II unit which, as you might imagine, has not proven to be a simple task given the extraordinary complexity of this system. TCAS must be able to rapidly process and assimilate vast amounts of technical data and then unerringly provide the pilot with the digested results of its analysis of that data. We expect certification within the next few months provided

Piedmont resolves outstanding issues in a timely manner. Following certification, an 8-month flight evaluation will begin.

The other TCAS II project is known as the Limited Installation Program (LIP). Sixteen TCAS II commercial quality units will be manufactured by Allied Bendix and Sperry Dalmo Victor (SDV). Two Bendix units will be flown on United DC-8 and B-737 aircraft. Three SDV units will be flown on Republic DC-9's and two SDV units will be flown on Piedmont B-727 aircraft. Two units will be provided by each manufacturer to the FAA with the remaining units kept as spares. At this time, the LIP contracts have been awarded, and the designs are nearly complete for both contractors. We expect the first airline flight to commence in early 1987. User evaluation should be completed in March 1988.

The TCAS III program has also been making steady progress in the past year, during which a number of flight tests of the experimental system were made in the vicinity of the FAA Technical Center. In addition, a series of test flights were conducted in the Los Angeles Basin area to determine operational characteristics in the highest air traffic density. As a result of these flight tests and supporting computer simulation analyses, the performance of the first generation TCAS III logic is being assessed. The data obtained in the next series of flight tests with the upgraded logic will provide the

engineering basis for the specification of TCAS III characteristics in the Minimum Operational Performance Standards (MOPS).

Insofar as TCAS I is concerned, in accordance with the recommendations of the Radio Technical Commission for Aeronautics (RTCA), a working group was formed to develop Minimum Operational Performance Standards (MOPS) for TCAS I. This group is in the process of drafting the operational requirements section of the MOPS for TCAS I. The application of TCAS I techniques to helicopter operations has been recently demonstrated at Lincoln Laboratory in flight tests. A TCAS engineering unit was used to provide Pilot Warning Indication (PWI). The bearing accuracy obtained was less than available from fixed wing aircraft but was generally found adequate for PWI operations. Additional helicopter tests have begun at the FAA Technical Center and are scheduled for completion in early 1986. The data obtained in the rotorcraft tests will be combined with data previously obtained for fixed wing aircraft to provide the basis for the TCAS I MOPS engineering requirements.

We estimate that the cost of the TCAS program, through its projected completion in FY 1988, will be about $42 million. At the present time, it is not feasible to determine the cost of TCAS equipment. Instead, our program envisions price goals for

the TCAS equipment. For TCAS I, the price goal ranges from $4,000 to $15,000; for TCAS II, $50,000 to $60,000; and for TCAS III, $70,000 to $90,000.

At this time, we have no specific regulatory plans concerning TCAS. I would note, however, that a recent regulation we have promulgated will complement the introduction of TCAS. That regulation concerns the use of transponders. The FAA recently issued a rule which requires pilots operating aircraft with functioning transponders to turn them on during flight. Since TCAS protection is provided from other aircraft with transponders, this rule, although not promulgated for TCAS, will help afford greater future protection to TCAS-equipped aircraft.

In closing, Mr. Chairman, I would reiterate that the FAA believes that both MLS and TCAS will afford significant benefits to the traveling public, and we are committed to the timely completion of these key programs.

That completes my prepared statement. I would be pleased to respond to questions you may have at this time.