# Proposed Definition of the Term "En Route" in "En Route Aircraft Noise."

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**The Need for a Precise, Formal, Definition.**

The current FAA-NASA Symposium affords perhaps the first opportunity for scientists, technicians, and regulators to examine the problem of en route aircraft noise in a formal, dedicated, setting. Whereas the general meaning of the term "en route" might be intuitively understood, it is suggested that a precise formal definition of the term "en route" would be opportune from the outset, especially since the scientific and technical investigation of the problem of noise immissions on the ground from aircraft in flight away from the airspace of an airport may conceivably lead to administrative, regulatory, and legal consequences that would mandatorily require a precise definition of the term "en route."

**The Reason for the Proposed Definition.**

At this time, certification requirements for aircraft noise under the provisions of ICAO Annex 16 and the U.S. Federal Aviation Regulations Part 36 (FAR 36), Ref. 2, specifically relate to the final approach of aircraft to an airport and the initial climbout from the airport. Both regulations establish precise points at which the concepts set forth in the said regulations begin and end.

More specifically, on approach to an airport, the outermost point of the airport-related airspace is the measurement point **H**, the vertical projection of which, **N**, is a point of the extended runway centerline situated at a distance of 6,562 feet (2,000 meters) from the runway threshold **O** (Ref. 2, Section A36.11(c). For all practical purposes, the flight segment interceding between point **H** and the runway threshold is one of stabilized approach of the aircraft in its final landing configuration, except for a short segment involved in the incipient level-off of the aircraft.

In takeoff, the most distant point considered in the noise certification of aircraft is the noise-measurement station **K** situated at a distance of 21,325 feet (6,500 meters) from the beginning point of the takeoff roll, point **A** (Ref. 1, Section A36.11(b). As a practical matter, the climb with reduced propulsive thrust continues, until the aircraft has attained an altitude of 3,000 feet, at which point maximum climb thrust is restored. That point, designated **F**, can be regarded as the end of the takeoff climb.

**Definition of the Term "Airport" in "Airport-Related Aircraft Noise".**

The bounds of noise emissions at the source and noise immissions on the ground ascribable to the "*airport operation*" of the aircraft range from point **H** inbound to point **F** outbound.

**Definition of the Term "En Route" in "En Route Aircraft Noise."**

The term "*en route*" in "*en route aircraft noise*," it is proposed, should encompass the operation of aircraft from point **F** outbound to point **H** inbound per Ref. 1, Section A36, 11(b) and 11(c).

For the purpose of detailed topical analysis of noise immissions from aircraft in en route flight, the following segments of a flightpath may be regarded as portions of the "*en route flight*" of an aircraft, as illustrated in Fig. 1 for the en route descent on final approach and in Fig. 2 for the en route transition from takeoff climb to cruise, plus the cruise flight itself.

**I. Cruising Flight.**

The definition of "*en route cruise flight*" might be that of prolonged flight at a uniform flight level and changes in flight level from time to time. On long flights, stepwise increases and decreases in flight altitude occur in response to decreasing fuel weight aboard an aircraft and to the exigencies of air traffic control. Such changes in flight level might pose individual en route noise problems.

**II. Transition from Cruise to Landing.**

Noise immissions on the ground are directly affected by the two principal phases of the en route descent from cruising-flight level to the runway, namely, the initial descent from cruise and the final approach (**Fig. 1**).

**II-a. Initial Descent from Cruise.**

On termination of a cruise, an aircraft is cleared to descend.

The profile descent begins with the aircraft in its clean configuration and at airspeeds that correspond to the optimal utilization of the kinetic energy of the aircraft and, hence, minimal consumption of energy.

That phase of the descent terminates in a leveling off at a 10,000-foot altitude to reduce the true airspeed to 250 knots.

The next phase comprises a slowdown to initial approach altitude, usually approximately 230 knots, and alignment with a final glidepath.

**II-b. Final Approach.**

On final approach, beginning at a point approximately 9 to 10 nautical miles (n.mi.) from touchdown. landing flaps are extended in steps, and the landing gear is deployed.

In many noise-sensitive areas, the extension of flaps and landing gear is delayed until the aircraft has crossed the ILS Outer Marker (at a distance of approximately 6 n.mi from touchdown and at an altitude of 1.700 feet).

The functional difference between the initial descent from cruise and the final approach, so far as noise on the ground is concerned, derives from the aerodynamic noise of the airframe with flaps and landing gear extended and the need for the application of engine power to maintain a steady descent against the increased aerodynamic drag of the airframe.

**III.Transition from Takeoff Climb to Cruise.**

On departure, noise immissions on the ground are directly affected by the two principal phases of the climb from point **F** of thrust restoration at 3,000 feet altitude to cruising level (**Fig. 2**).

**III-a. Initial Climb to 10,000 feet altitude.**

Having attained a clean configuration, a "*quiet*" zero-flap maneuvering and climbing airspeed, $V_{ZF}$, and an altitude of 3,000 feet, full climb power is restored and the aircraft accelerates to an airspeed of 250 knots to meet the requirements of air traffic control, until a specified altitude, namely (in the United States and some other countries) 10,000 feet, is attained. At some airports other intermediate airspeed limitations are established, for example, at the Zurich International Airport, where a maximum airspeed of 210 knots is specified for altitudes of up to 3,500 feet).

**III-b. Climb from 10,000 feet Altitude or Other Altitude Without an Airspeed Restriction to Optimal Climbing Airspeed to the Intended Initial Cruise Level.**

Exiting from the 10,000-foot level (in the U.S.), the aircraft is accelerated to the "optimal-climb" airspeed, that is, that airspeed at which the time or distance rate of total-energy gain is greatest and the Euler-Lagrange derivative of the total-energy gain versus time goes to zero (Ref. 2).

**Conclusion.**

I submit that the foregoing five flight segments, with their differing airframe configurations, engine thrusts, and airspeed management,

should form the basis for the differential consideration of the noise immissions perceived on the ground underneath or near the aforedefined segments of the flightpath in en route flight, from the end of the initial climb from an airport after takeoff until the final approach to an airport.

**References.**


1. Code of Federal Regulations, Title 14, 14CFR Part 36, *Noise Standards: Aircraft Type and Airworthiness Certification.* (FAR 36).

2.. Garbell, Maurice A. *Optimum Climbing Techniques for High-Performance Aircraft.* Garbell Aeronautical Series No. 8. Garbell Research Foundation, San Francisco, California. 1953.


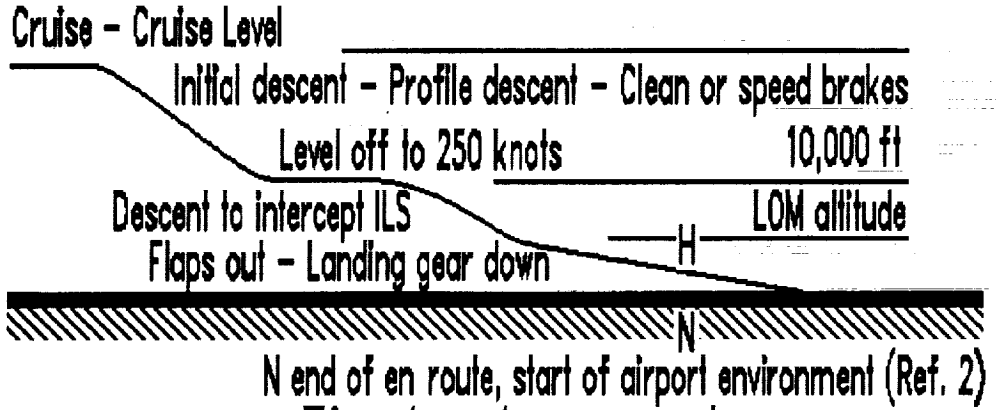


Fig.1. Approach

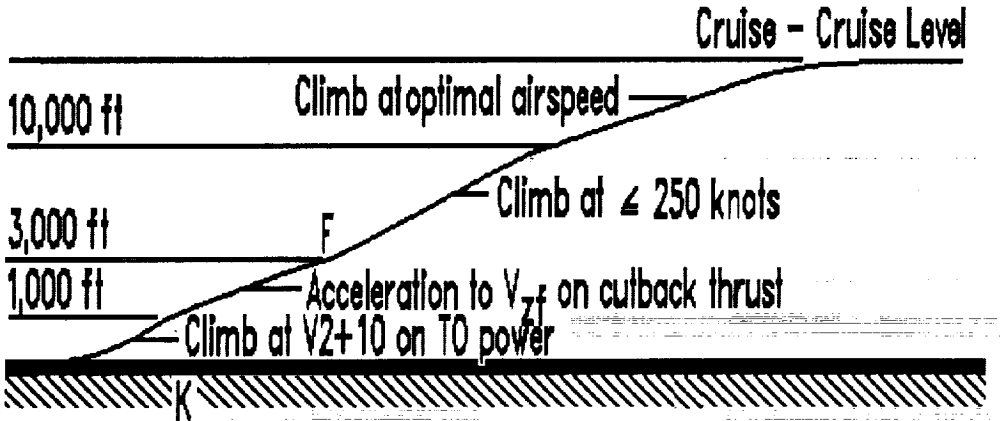


Fig. 2. Takeoff