How The Present Separation Standards Were Created

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Separation Standards – Restricted to Single Runway Landings

In the interest of time, only single runway landing separation standards will be addressed.

Will refer to US standards.
Similar discussions could address:

- Takeoffs
- Closely spaced parallel runways
- Intersecting runways
- RVSM
- Special Procedures (e.g., LDA, B-707/DC-8)
- Rotorcraft

Separation Standards – Up to 1970

3 nmi separation between aircraft during IMC

- Radar operating limits
- Runway occupancy limitations

1969 – Introduction of B-747

Jan. 1970 – GENOT issued. Restricted airspace behind B-747 and C-5A

- To 60 degrees either side
- 2000 feet below
- Distance of 10 nmi

Separation Standards – 1970 to 1972

FAA – NASA – Boeing 1970 Flight Test Program

- Terminal/En route area: B-737 and F-86 behind B-747 and B-707
- Near ground: ARCO tower, Idaho, using B-747, C-5A, B-707, DC-8-63, DC-8-50, B-727, DC-9 and LearJet
- Terminal area: CV-990 behind C-5A, B-747 and B-707

March 1970 – Wake Turbulence IFR Separation Distances

Behind Heavies (> 300,000 lbs.)

4 nm: for Large (12,500 – 300,000 lbs.)

5 nm: for Small (< 12,500 lbs.)

Separation Standards - Criteria

The 1970 flight tests noted that both horizontal and vertical separations were needed. Three components were introduced:

- Aircraft Categories (wingspans of aircraft noted to be important, but maximum certificated takeoff weight selected as the most workable parameter)
- ATC Procedures (separation distances)
- Piloting Procedures (such as flying at or above the leader aircraft flight path).

Separation Standards – 1972 to 1975

May 1972: DC-9 crashed on final approach behind a DC-10

July 1972 Wake Turbulence IFR Separation Distances

	Leader			
Follower	>300,000 lbs	DC-10/L-1011	12,500 - 300,000 lbs	<12,500 lbs
B-747/C-5A	--	--	--	--
DC-10/L-1011	--	5	--	--
>300,000 lbs	--	5	--	--
12,500 – 300,000	5	5	--	--
<12,500	5	5	--	--

Separation Standards – 1975 to 1986

Late 1971, FAA Air Traffic asked Volpe Center to examine the adequacy of the then current separation standards.

31R, JFK, June 1973 – Nov. 1973, >14,000 landings
22L, DEN, August 1973 – Nov. 1973, >7,000 landings

Standards shown to be conservative for commercial airlines, but concern for small aircraft. About 15 Small aircraft accidents per year due to wake vortices.

Separation Standards – 1975 to 1986

November 1975 Wake Turbulence IFR Separation Standards

	Leader		
Follower	>300,000 lbs	12,500 – 300,000 lbs	>12,500 lbs
>300,000 lbs	4	--	--
12,500 to 300,000 lbs	5	--	--
<12,500 lbs	6	4	--

Separation Standards – 1975 to 1986

British began incident reporting system primarily at Heathrow

Additional vortex data collection at LHR, JFK and ORD

28R, LHR, May 1974 – June 1975, ~13,000 landings
31R, JFK, Nov. 1973 – Jan. 1977, ~4,700 landings
14R/27R/32L, ORD, July 1976 – Sept. 1977, >21,000 landings

Separation Standards – 1986 to 1994

In 1986, FAA allowed the separation distance to be reduced to 2.5 nmi inside the final approach fix (providing runway occupancy < 50 sec demonstrated – not a wake standard).

1986 Wake Turbulence IFR Separation Standards

	Leader		
Follower	>300,000 lbs	12,500 – 300,000 lbs	<12,500 lbs
>300,000 lbs	4	3/2.5	3/2.5
12,500 to 300,000 lbs	5	3/2.5	3/2.5
<12,500 lbs	6	4	3/2.5

Separation Standards – 1994 to 1996

Two accidents involved Citation and Westwind landing behind the B-757.

NTSB special investigation (Feb. 1994).

1994 Wake Turbulence IFR Separation Distances

	Leader			
Follower	>300,000 lbs	B-757	12,500 – 300,000 lbs	<12,500 lbs
>300,000 lbs	4	4	--	--
B-757	5	4	--	--
12,500 to 300,000 lbs	5	4	--	--
<12,500 lbs	6	4	4	--

Separation Standards – 1996 to Present

Small Category: <41,000 lbs
Large Category: 41,000 to 255,000 lbs
Heavy Category: >255,000 lbs
and the B-757 category remained.

Separation Standards

No accidents in US while IMC operations in effect and appropriate procedures followed.

Useful References

- FAA–Flight Standards Service, A Compilation of Working Papers Concerning the Wake Turbulence Tests, 30 April 1970.
- FAA-EM-75-6, Vortex-Related Accidents Over the Ten Year Period 1964 – 1973, April 1975.
- CAA Paper 91015, United Kingdom Civil Aviation Wake Vortex Database: Analysis of Incidents Reported Between 1982 and 1990, August 1991.
- NTSB/SIR-94-01, Safety Issues Related to Wake Vortex Encounters During Visual Approach to Land, Feb. 1994.
- Wake Turbulence Industry Team, Science of Separation Distances Subcommittee Final Recommendations, 9 June 1995.