
Wake Turbulence Safety Training Aid - Video Script
*Wake Turbulence Avoidance - A Pilot and
Air Traffic Controller Briefing*

3-D

The data in this appendix is provided for training purposes only and should not be used for any other purpose.

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WAKE TURBULENCE AVOIDANCE

TRT: 24:27

- | | |
|--|---|
| 1. MS of flight deck of a (Large) aircraft. Pilot begins to request clearance to go VFR. | “Washington approach, Pinnacle 452, we have the airport in sight.” |
| 2. MS of controller granting VFR request. | “Pinnacle 452, Washington approach cleared for a visual approach runway 34 right, contact Washington tower 1-1-9er.0” |
| 3. MS of flight deck large aircraft. | “Pinnacle 452 cleared visual 34 right.” |
| 4. MS of flight deck of a (Smaller) corporate jet. The pilot requests permission for VFR approach. | “Washington approach, November 2-6-1-2-4 approaching the mall.” |
| 5. MS of controller talking to (Smaller) aircraft. | “Citation 2-6-1-2-4, Washington approach, traffic 1 O’clock, 5 miles westbound, Boeing 7-57 descending through 5000 for runway 3-4 right. "Do you have that traffic in sight?” |
| 6. MS of (Smaller) aircraft flight deck with pilots. | “Did he say 7-5-7...?” “Yeah, there it is!”
“Affirmative Washington, I have the 7-5-7 in sight.” |

- 7. Over-shoulder of controller with radar screen
- 8. CU controller's face.
- 9. MS of (Large) flight deck and pilots. Cut to a CU of the glideslope indicator which is indicating a 1.5 dots high. And the airspeed indicator showing 140 knots.
- 10. MS of tower controller.
- 11. CU of glideslope indicator on glideslope.
- 12. CU airspeed indicator at 175 knots.
- 13. MS flight deck smaller aircraft

“Citation 1-2-4, you are 4 miles behind the Boeing 7-57, caution wake turbulence. Follow that traffic. Cleared visual approach runway 3-4 right. Contact Washington tower 1-1-9er.0.”

Ambient sound of engines slowing down and communication between pilots and tower.

“Pinnacle 452, can you accept 34L, following traffic 34 right.”

“Roger Washington, 3-4 left, no problem.”

14. CU exterior of large aircraft landing.

Ambient sound of tires hitting pavement, reverse thrusters, flaps and gear.

15. CU of smaller flight deck and pilot. Suddenly, pilot is turning yoke back and forth to recover from uncontrolled roll.

“OH...”

16. CU glideslope indicator out of control

17. MS smaller aircraft flight deck with pilots struggling for control. Fade to black.

Dramatic stingers

18. CU of newspaper headlines:
“Four Injured In Wake Turbulence Encounter”

Title over:

....too close

....below flightpath

....light winds.

19. Graphic of text comes up:

AVOID WAKE TURBULENCE.
This takes cooperation and awareness among pilots and air traffic controllers.

20. Scenes of early 70's flights. Passengers in terminals, inside airlines, assortment of wide-body airplanes.

21. Scenes of modern airports with mixed traffic.

22. WS of modern wide-bodied aircraft.

23. Small airport with mixed traffic.

24. WS of wide-body jet in flight with wake turbulence smoke.

Transitional Music

The introduction of wide-body airplanes in the 70s was instrumental in satisfying the public's desire for traveling. In order to safely avoid the wake turbulence associated with these aircraft, separation standards were developed that established aircraft weight categories and distances. At that time, aircraft were easily categorized: wide-bodies, B-727, B-737, DC-9, and others.

As the aircraft within the categories increased in number and size, the potential for wake-turbulence encounters increased as well.

Today there is almost a continuum of aircraft sizes as manufacturers develop the "airplane family" concept of new transport and corporate aircraft.

Airports of various sizes are handling increased air traffic that includes everything from heavy wide-bodies to small business and recreational aircraft. Along with this increased mix of aircraft comes an increased concern about wake turbulence.

Wake turbulence, being a natural by-product of powered flight, is generated by the lift created by the aircraft wings and helicopter rotor systems.

25. Animation of vortex formation showing movement and direction of flow behind aircraft. Model rotates to show size of vortices.

It develops when air rolls up off the wingtips forming 2 counter-rotating vortices.

26. Wide-body aircraft approached vortex tower with smoke, turbulence develops.

Title over: Size, weight, speed, wing configuration.

The strength and effect of a trailing vortex is predominantly determined by the size, weight, speed, and wing configuration of the aircraft producing it. The strongest and potentially most dangerous wake turbulence is produced when the aircraft is heavy and flying slowly.

27. Animation of aircraft approaching from left to right and illustrating rate of vortices diminishment.

The vortices from larger aircraft sink initially at about 300 to 500 feet per minute to a maximum of 900 feet below the flightpath of the generating aircraft. Vortex strength diminishes with time and is affected by atmospheric conditions and contact with the ground.

28. Animation illustrating vortices movement over ground.

In calm wind, as the vortices sink close to the ground, they tend to move laterally over the ground at approximately 2 to 5 knots.

29. Animation illustrating effect of ambient wind on vortices.

The vortices are strongly influenced by ambient wind. A strong enough wind will dissipate the turbulence. A light crosswind will decrease the lateral movement of the upwind vortex and increase the movement of the downwind vortex.

30. Animation illustrating effect of tailwinds on vortices. **A tailwind condition can move the vortices forward into the touchdown area. One of the most hazardous situations is a light quartering tailwind.**
31. WS of active runway, aircraft landing. **The location and strength of wake turbulence still remains fairly difficult to determine and usually invisible to both the pilot and controller.**
32. CU pilot in aircraft, title over: Wake Turbulence Avoidance Procedures. **There are, however, some basic recommended procedures which can be used to assist pilots in avoiding the preceding aircraft's wake. Your aircraft's performance and capability should be considered when applying these procedures.**
33. Animation shows landing behind a larger aircraft on the same runway. **When landing behind a larger aircraft on the same runway, stay at or above its flightpath, noting its touchdown point and landing beyond it.**
34. Animation shows a landing behind a larger aircraft on a parallel runway closer than 2500 feet with wind drifts. **In the case of parallel runways closer than 2500 feet, landing behind a larger aircraft requires the pilots to be aware of possible wind drift towards their runway. Stay at or above the larger aircraft's flightpath and note its touchdown.**
35. Animation shows landing behind a larger aircraft on a crossing runway. **If you are landing behind a larger aircraft on crossing runways, cross above the larger aircraft's flightpath.**
36. Animation shows landing behind a larger aircraft departing on the same runway. **If the larger aircraft is departing on the same runway, note its rotation point and land well prior to that point.**

37. Animation shows landing behind a larger aircraft departing on a crossing runway. Larger aircraft rotates after intersection.

Here, the larger aircraft is departing on a crossing runway. Note the rotation point. If it is past the intersection, continue your approach and land prior to the intersection.

38. Animation shows landing behind a larger aircraft departing on a crossing runway, rotating before the intersection of two runways.

If it rotates prior to the intersection, avoid flying below the larger aircraft's flightpath. Abandon the approach unless you can land well before the intersection.

39. Long shot of aircraft waiting as other aircraft takes off.

Be alert for any critical take-off situation which could lead to a vortex encounter. In take-off situations, note the departing aircraft's rotation point and rotate prior to it. Be sure to evaluate aircraft performance and determine if it is possible. If necessary, or there is any doubt, delay the takeoff.

40. Animation shows departing behind a larger aircraft (departed) on a single runway. The lead aircraft's flightpath is visible.

After takeoff, continue your climb above and upwind of the larger aircraft's climb path until turning clear of its wake. Avoid any headings which will place you behind the preceding aircraft's path.

41. MS of flight deck with pilots.

42. Animation shows departing (Large) aircraft and its rotation point and another aircraft waiting for takeoff at intersection.

In the case of an intersection takeoff on the same runway or parallel runways, be alert to adjacent large aircraft, particularly upwind of your position. Avoid subsequent headings which will cause you to cross below a large aircraft's path.

43. WS aircraft in flight.
44. Animation shows a runway with a large aircraft making a low, missed approach. Wake turbulence is illustrated as it settles across the runway. Wind is illustrated as being light, quartering. Aircraft (Small) waits for takeoff.
45. Animation shows an aircraft (Small) being overtaken by an aircraft (Large). We then see the aircraft (Small) adjust its course.
46. LS aircraft on approach, zoom out to show CU of controller in tower.
47. CU radar screen with controller's reflection in screen.
48. CG graphic over still frame of air traffic controller.
- Type of approaches available (IFR VFR).
 Mix of traffic (turbojet, propeller, helicopter).
 Traffic density.
 Wake turbulence separation.
 Noise abatement procedures.

In the case of an aircraft making a low, missed approach or touch-and-go, wake turbulence may exist along the runway and in your flightpath, especially if a light quartering wind exists. Leave an interval of at least 2 minutes before executing a takeoff AFTER A HEAVY AIRCRAFT.

If you are en route VFR, and you observe a large aircraft above, on the same track, avoid the area below and behind its path by adjusting your position laterally, preferably upwind.

The other key player directly involved with avoiding wake turbulence is the air traffic controller. Air traffic controllers are required to provide radar and wake turbulence separation or visual separation until the pilot accepts visual separation or a visual approach.

The primary considerations that affect the controller's ability to control traffic safely, orderly, and expeditiously are: the types of approaches available, (Instrument Flight Rules or Visual Flight Rules), the mix of traffic (jet, propeller, or helicopter), traffic density, wake-turbulence separation, and noise abatement requirements.

49. Long shots of stacked aircraft on approach, takeoff, and taxiing.

50. CU controllers and radar screen.

51. CU of radar screen. We hear the pilot and controller on the radio. The pilot is requesting VFR approach.

Title over: Air Traffic Considerations for Visual Separation or Visual Approach.

52. Animation of smaller aircraft upwind of a larger aircraft. Show crosswind and direction. Show small aircraft landing on parallel runway with large aircraft. Show the vortices of the large aircraft, wind direction, moving vortices, and the small aircraft.

Traffic density is the major factor in the amount of airplanes that can be safely, orderly, and expeditiously landed or departed. The busiest airports schedule takeoffs and landings based on weather conditions. Visual conditions and visual separation allow air traffic control to handle more aircraft within the traffic control system. Air traffic controllers can gain more flexibility in handling aircraft still under IFR control by clearing aircraft to maintain visual separation or a visual approach.

There are several factors a controller should consider before clearing an aircraft to maintain visual separation or for a visual approach when wake turbulence separation must be applied.

An aircraft upwind from a larger aircraft is unlikely to encounter any wake turbulence. However, it is not always possible or practical to have a smaller aircraft follow a larger aircraft on the upwind side.

53. Animation of the large aircraft making a steep descent. Show a very suburban area in the background to convey a noise abatement situation. As the large aircraft descends, show a small aircraft descending at a normal rate and eventually ending up below the glidepath of the large aircraft. Show vortices rolling behind the large aircraft and slowly drifting toward the runway into the path of small aircraft.

54. Animation of a large aircraft on regular glidepath. Show a small, fast jet coming in behind the large aircraft. Show vortices from the large aircraft rolling off and eventually coming in front of the small aircraft's glidepath.

55. Animation of intersecting runways. Show a large jet aircraft taking off on and a small jet on approach to an intersecting runway. Rolling vortices are falling off of the large aircraft and descending to same flightpath as the small jet aircraft on approach.

Another consideration controllers need to make is the flightpath of the preceding aircraft compared to the flightpath of the following aircraft. A steep descent of larger aircraft could create a hazard for smaller aircraft following on a normal descent to the same runway. As you can see, at some time, the smaller aircraft would be below the flightpath of a larger jet. When practical, air traffic controllers should advise the following aircraft of the leader's steep descent.

Faster aircraft following slower aircraft can create a serious wake-turbulence problem by easily getting too close. The separation distance provides time for the wake turbulence to dissipate as well as descend.

Intersecting runways can also create a hazard when a small aircraft is cleared to land on a runway where the flightpath will take it through the flightpath of a larger aircraft that was landing or departing on a different runway.

56. Interior approach tower Seattle-Tacoma International Airport. On-camera is Tom Davidson, Air Traffic Manager.

Title Over: Tom Davidson
Air Traffic Manager

Slow zoom-in to CU of Davidson

The best method for avoiding wake turbulence is both pilot and controller awareness. Controllers must know where wake turbulence could occur and how it will affect other following aircraft. Crosswinds, steep descents, different airspeeds, and crossing runways are just some of the factors controllers should consider.

Pilots also have to be aware of where potential hazards exist. Sometimes giving a cautionary wake-turbulence advisory is not enough. The pilots need to know if the aircraft they are following is on a steeper than normal descent, is flying slower than they are, or if it is landing on another runway. If there is a potential for a wake-turbulence hazard, the controller needs to inform the pilots of it and allow the pilots to adjust their flight-path accordingly.

Conversely, it is the pilot's responsibility to keep air traffic controllers informed of flight profiles outside of the normal operation.

When it's operationally beneficial, air traffic control may authorize the pilot to conduct a visual approach to an airport or to follow another aircraft in VFR weather conditions. The pilot must have the airport or the preceding aircraft in sight before the clearance is granted.

57. MS of flight deck. Aircraft is VMC.

58. Color Graphic illustration of urban airport with variety of aircraft

59. Shots of flight deck and pilot.

Title over: Pilot Techniques for Visually Maintaining Separation

60. Shot of runway while on approach.

Title over: Normal VASI for Wide-Body Aircraft

The pilot is solely responsible for avoiding wake turbulence. The task of maintaining proper visual relationship with the lead aircraft in order to remain at or above its flightpath becomes greater and more complicated when aircraft of different sizes and speeds, approaching from various altitudes and directions are involved.

Changing from an instrument approach to a visual approach and landing, when conditions permit, is routinely accomplished. The pilot's situational awareness up until the time of transition from IMC to VMC is usually limited to information received from radio communications. While ATC will issue information and cautionary instructions, the pilot must be prepared to determine the traffic situation and apply proper avoidance procedures.

In order for pilots to avoid wake turbulence by staying on or above the flightpath of the leader aircraft, trailing pilots must make some assumptions on where the leader has flown since there is no available visual reference to indicate this.

The use of visual glideslope indicators such as VASI or PAPI or instrument precision approach aids will assist in establishing and maintaining a normal approach flightpath.

61. CU ILS glideslope.
62. Superimpose glideslope indicator with MS flight deck with pilots.
63. MS different flight deck (nighttime)
64. Color graphic showing 3-degree flight path equals 300 feet per nautical mile traveled.
65. CU pilot at controls.
66. Animation showing leader aircraft with line drawn to runway touchdown point.
67. Animation of line running from following aircraft through the leader aircraft and to the runway end.
- When available to the pilot, the ILS glideslope can assist in determining the flightpath of a leader aircraft. However, it is not foolproof. In fact, the leader aircraft may have flown above the glideslope for wake-turbulence avoidance or other reasons.**
- If external aids are not available and obstacles are not a factor, a descent rate of 300 feet per nautical mile traveled approximates a 3-degree flightpath. The aircraft should be stabilized on a flightpath as early as possible, but not later than 500 feet above the ground.**
- One way to determine the flightpath the leader aircraft has flown is to line up the leader aircraft with the anticipated or normal runway touchdown point. Visualize an extension of the line between those two points. This technique assumes the leader has flown a consistent flightpath and is using a normal touchdown point.**
- While following an aircraft, extending an imaginary line from your aircraft through the leader to the runway should end at the normal runway touchdown point. If it ends at a point down the runway, the trailing aircraft is probably below the flightpath of the leader. If the line extension is prior to the touchdown point, as in an overrun, the trailing aircraft is probably above the leader flightpath.**

68. MS flight deck (nighttime)

69. CU of ILS glideslope indicator.

70. CU pilot

71. Color graphic of different aircraft pitches.

72. CU of pilot.
CU of ILS localizer.

73. WS of flight deck of following aircraft.

74. MS of tower controller giving separation distances and air-speed differential. We hear the conversation between controller and pilot.

When ILS approaches are being used in VMC, consideration may be made by the pilot of the trailing aircraft to fly at or above the ILS glideslope. This assumes the leader aircraft is positioned on the glideslope. However, this assumption is not always valid. Pilots should be cautious of leader aircraft intercepting the glideslope from above.

A nose-high pitch attitude of the leader aircraft should not be used as an indicator of flightpath because pitch attitudes vary among aircraft types and manufacturers.

During crosswind conditions, pilots may consider flying offset on the upwind side of the localizer centerline as a means of avoiding the leader's wake turbulence. This assumes the leader is flying on the localizer course.

Pilots may also establish longitudinal separation from a leader aircraft so as to allow time for the wake turbulence to move or dissipate. Judging in-flight distances is not always easy to do.

Air traffic controllers are willing to provide separation distance information to pilots. They can also provide airspeed differential between aircraft, if applicable.

75. MS flight deck.
76. Animation of leader aircraft passing a point; Indicate timing reference at point.
77. LS of aircraft landing showing tire smoking and trailing aircraft visible in background.
78. MS inside flight deck.
- Title over: Aircraft Performance In-flight Visibility Coordination with ATC. Other Traffic in the Pattern
79. MS on flight deck.
80. CU airspeed indicator decreasing.
81. MS flight deck.
- One technique available is for the trailing pilot to start timing the leader aircraft when it or its shadow passes a recognizable geographical reference point. Radio call points can also be used for timing references. After determining the amount of time it takes for the trailing aircraft to pass over the same point, convert that time into distance.**
- Most heavy and large aircraft produce some smoke from tires during touchdown on landing. Pilots of trailing aircraft, upon observing the smoke, can estimate their own position from touchdown as well as determining a point to land beyond. Knowing the distance from the runway to an instrument final approach fix or an available landmark can be helpful in determining relative distances.**
- There are multiple ways to increase separation distances while following an aircraft on final approach. Several factors should be considered, however, before implementing these techniques—aircraft performance, in-flight visibility, coordination with ATC, and other traffic in the pattern that are taking off or preparing to take off.**
- Airspeed reduction is an obvious choice of most pilots for increasing separation. But, it is usually limited to small changes because of aircraft performance or ATC restrictions.**
- Pilots must not reduce airspeed below the aircraft's minimum safe operating speed. Be aware that recovery from an inadvertent wake-turbulence encounter is more difficult at slower speeds.**

82. Interior of flight deck of plane performing a turn.

Performing “S” turns is another way to gain separation. Flying a 360-degree turn will greatly increase the distance from the leader, but the impact on other aircraft may preclude its use.

83. MS flight deck

The decision to abort the approach or landing and go around is always an alternative for avoiding wake turbulence.

84. WS interior flight deck, we hear radio communication between another aircraft and the ATC.

Listening to all radio communications (not just those directed at you) can be helpful in providing information that can improve wake turbulence situational awareness. Prior to entering a visual pattern or initiating an instrument approach, radio communications between ATC and other airplanes can alert pilots on where they may fit in the landing sequence or what type aircraft they may follow.

70. Continuation of visual.

Takeoff and landing clearances for other aircraft provide pilots information that can be useful for spacing considerations as well as anticipating the location of generated wake turbulence. In other words, don't overlook any information that can aid your planning and flying an approach, takeoff, landing, or go-around.

85. On camera; Paul Smith, Sr.
Manager AT Services.

Title over: NATIONAL
BUSINESS AIRCRAFT AS-
SOCIATION, INC.

The number of aircraft continues to increase each year for reasons that reach from the desire for greater recreational use to responding to commercial requirements. As this number has increased, so has the necessary support or infrastructure.

86. WS airport activity

We have evolved from few pilots to many pilots, from few air traffic controllers to many air traffic controllers. This situation, coupled with high air traffic density, creates an environment that requires pilots and air traffic controllers to cooperate in order to safely and efficiently conduct flight operations.

Air traffic controllers should understand that many times the pilot's situational awareness is limited to information provided by air traffic until the pilot enters visual conditions. This means initially that it may be difficult for us to visually detect whether we may be overtaking the leader aircraft or where we are relative to the leader's flightpath.

87. CU Paul Smith.

We as pilots can assist air traffic in several ways.

88. Flight deck scenes

One way is to understand that controllers are continually challenged in sequencing arrivals with departures, planning for different aircraft with different performance characteristics, and applying wake turbulence separation criteria.

89. More of Paul Smith.

If we initiate an unusual request or make a change in our flight operations from what is normally expected by air traffic, it will probably increase an already high workload for most controllers at major airports. Timely, precise, and disciplined radio communications with air traffic improves the flow of vital information.

90. Return to original situation with a heavy aircraft being followed by small corporate jet. We hear the same communication between ATC and heavy aircraft and ATC and small aircraft.

Now let's review the reenactment of the wake turbulence encounter you watched at the beginning of this video and see where increased awareness might have prevented the incident.

91. Return to opening shot 757 (Large) flight deck. We hear some ambient noise, radio talk, etc. Then camera shows CU of glideslope/airspeed. Then picture freezes for teaching point.

The leader aircraft is coming in high and slow because its descent was delayed. Although not typically a problem, it contributes to the situation which arises.

92. Return to opening shot of (Smaller) flight deck.

Title over: Below Leader's Overtaking Airspeed

The "CITATION" should have been aware of the location of the 7-5-7's flightpath and that the CITATION'S current flightpath would be below the flightpath of the 7-5-7. The pilots lacked sufficient situational awareness of the possibilities.

93. MS tower controller talking to 757.

Title over: Smaller Aircraft
Positioned to the Downwind
Runway

Putting the 7-5-7 on the left runway with a trailing CITATION on the right positioned the CITATION downwind from the 7-5-7. Light winds enabled the wake turbulence from the 7-5-7 to drift to the right.

94. MS ATC.

Title over: Insufficient Communication

Additionally, if the controller had been aware that there was potential for reduced separation upon landing, and of the 7-5-7's higher approach path, he could have warned the CITATION of its closure with the 7-5-7. And, he could have given important information regarding the 7-5-7's flightpath by advising the following aircraft that the leader aircraft was higher. For example: "Your traffic departed the outer marker at 3000 feet."

95. Montage of aircrafts landing, pilots flying, air traffic controllers controlling.

Closing music

96. Same montage of aircraft landing, pilots flying, air traffic controllers controlling

Off camera narrator as music fades down.

Wake turbulence is one of many factors that pilots and air traffic controllers must overcome to fly safely. It takes cooperation, awareness, AND the understanding of each other's requirements to safely avoid wake turbulence.

Music up and out

FADE TO BLACK

FADE UP TO DISCLAIMER

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