En-route Wake Turbulence Encounters
BY: Steve Witowski, PRISM  Source: EASE Safety Information Bulletin

With the increase of the overall volume of air traffic and enhanced navigation precision, wake turbulence encounters in the en-route phase of flight above 10,000 feet (ft) mean sea level (MSL) have progressively become more frequent in the last few years.

Every flying aircraft generates turbulence in its wake. For a fixed-wing aircraft, this wake turbulence rolls-up into a pair of coherent, counter-rotating vortices that can persist for some minutes in the vicinity of the generating aircraft flight path, moving generally downward and laterally with the wind. This poses a potential hazard to the safe flight of another aircraft crossing or operating below the trajectory of the generating aircraft, and encountering these vortices. The trailing vortices' intensity and time to dissipate depends upon factors as the weight, size and speed of the aircraft, as well as prevailing atmospheric conditions. The relative size and weight of the generating aircraft in comparison to the affected aircraft is also a risk factor.
Wake turbulence encounters can occur during any phase of flight. Separation minima aim at preventing such encounters from inducing risk, but it must be noted that these provisions will not completely prevent wake encounters from occurring.

The basic effects of wake turbulence encounter on a following aircraft are induced roll, vertical acceleration (can be negative) and loss or gain of altitude. The greatest danger is typically the induced roll that can lead to a loss of control and possible injuries to cabin crew and passengers. En-route, the vortices evolves in altitudes at which the rate of decay leads to a typical persistence of 2-3 minutes, with a typical sink rate of about 400ft/min. Wakes will also be transported by wind.

Considering the high operating air speeds in cruise and the standard 1000 ft vertical separation in RVSM airspace, wake can be encountered up to 25 nautical miles (NM) behind the generating aircraft. The most significant encounters are reported within a distance of 15 NM. However, no specific horizontal wake turbulence separation minima are detailed within PANS-ATM for en-route flight, with States utilizing procedural or surveillance-based separation minima.

The encounters are mostly reported by pilots as sudden and unexpected events. The awareness of hazardous traffic configuration and risk factors is therefore of particular importance to anticipate, avoid and manage possible wake encounters.

In the en-route phase of flight, three major factors contribute to increase the likelihood of wake turbulence:

1. Crossing traffic situation: In the case that crossing traffic is climbing or descending in proximity (either the generating or following aircraft), the wake generated might cross the follower’s trajectory with minimum time for decay, so stronger wake turbulence might be encountered.

2. Thermal tropopause altitude: Wake vortex decays more slowly below the tropopause where there is therefore an increased risk of encountering severe wake turbulence.

3. Weight of the generating aircraft: Heavier aircraft types generate stronger wake vortices and are likely to induce more severe wake turbulence encounters, especially for smaller aircraft types.

The typical hazardous trajectory crossing configurations are the following. They are shown hereafter in a vertical plane, although the respective flight path might also be crossing on the horizontal plane. When crossing horizontally, the lower the crossing angle the higher the wake effect. See the examples as shown following.
Note: The variability in the generator aircraft rate of climb or descent makes it quite difficult to estimate exactly where the vortex is. Consequently, during the en-route phase of flight, pilots should expect possible wake encounters when other traffics in proximity appear to be on similar tracks ahead, crossing above your level, climbing or descending ahead through your flight path, while wind direction is likely to move the wake towards your trajectory.

In the future, appropriate system support functions to also inform and warn ATC of potentially hazardous wake encounters may be developed.

**Recommendation(s):**

As precautionary measures, operators and pilots should be aware that:

- Passengers should keep their seat belts fastened, even when the seat belt sign is off, unless moving around the cabin. This minimizes the risk of passenger injury in case of a turbulence encounter en-route (wake or atmospheric).
- When possible, condensation trails should be used to visualize wakes and estimate if their flight path brings them across.
- More attention should be given when flying below the tropopause altitude, as the likelihood of wake encounter increases. The tropopause altitude varies (between days,
between locations) and can be found on meteorological charts.

- Upwind lateral offset should be used if the risk of a wake encounter is suspected, when allowed by airspace regulations or via specific ATC approval. Also, a change of FL to cross “HEAVY” or “SUPER” traffics from above can be used when feasible and authorized by ATC.

**In case of a wake encounter, pilots should:**

- Be aware that experience has demonstrated that if the pilot reacts at the first roll motion, when in the core of the vortex, the roll motion could be potentially amplified by this initial piloting action.

- Be aware that some in-flight incidents have demonstrated that pilot inputs may exacerbate the unusual attitude condition with rapid roll control reversals carried out in an “out of phase” manner.

- Be aware that if the autopilot is engaged, intentional disconnection can complicate the scenario, and the autopilot will, in most cases, facilitate the recovery.

- Try to avoid large rudder deflections that can create important lateral accelerations, which could then generate very large forces on the vertical stabilizer that may exceed the structural resistance. Although some recent aircraft types are protected by fly-by-wire systems, typically, the use of the rudder does not reduce the severity of the encounter nor does it improve the ease of recovery.

- Make use of specific guidance in the AOM (Aircraft Operating Manual) for their specific type(s)/fleet, where available.
The Cockpit Checklist

BY: Steve Witowski, PRISM

How did the cockpit checklist come into practice? Indications of its origin point to October 30, 1935, at Wright Air Field in Dayton, Ohio, where the U.S. Army Air Corps was evaluating the Boeing Corporation's Model 299, a new prototype bomber. Boeing's plane could carry five times as many bombs as the Army had requested; it could fly faster than previous bombers, and almost twice as far. It seemed to be the perfect choice.

A newspaperman who had glimpsed the plane called it the "flying fortress," and the name stuck.

A small crowd of Army brass and manufacturing executives watched as the Model 299 test plane taxied onto the runway that day. It was sleek and impressive, with a hundred-and-three-foot wingspan and four engines jutting out from the wings, rather than the usual two. Power was applied, the plane roared ahead, lifted off smoothly and climbed sharply to three hundred feet. Then it stalled, turned on one wing and crashed in a fiery explosion. Two of the five crew members died, including the test pilot, Major Ployer P. Hill (thus Hill AFB, Ogden, UT).

The subsequent investigation revealed that nothing mechanical had gone wrong, and pointed to human error. Substantially more complex than previous aircraft, the new plane required the pilot to attend to the four engines, a retractable landing gear, a new wing flaps design, electric trim tabs that needed adjustment to maintain control at different airspeeds, and constant-speed propellers whose pitch had to be regulated with hydraulic controls, among other features. In the midst of managing all this, Major Hill had forgotten to release a new locking mechanism on the elevator and rudder controls.

The “flying fortress” was then deemed “too much airplane for one man to fly,” and the Army Air Corps declared a smaller bomber design the winner. Still, the Army purchased a few Model 299 aircraft from Boeing as test planes, and some insiders remained convinced that the aircraft was a viable bomber. So a group of test pilots got together and considered what to do.

They could have required Model 299 pilots to undergo more training, but it was hard to imagine having more experience and expertise than Major Hill, who had been the U.S. Army Air Corps’ Chief of Flight Testing. Instead, they came up with an ingeniously simple approach: they created a pilot’s checklist, with step-by-step checks for takeoff, flight, landing, and taxiing. In the early years of flight, getting an aircraft into the air might have been nerve-racking, but it was hardly complex. Using a checklist for takeoff would no more have occurred to a pilot than to a driver backing a car out of the garage. But operating this new plane was too complicated to be left solely to memory.
With the checklist in hand, the pilots went on to fly the Model 299 a total of 18 million miles without one accident. The Army ultimately ordered almost thirteen thousand of the aircraft, which it dubbed the B-17 Flying Fortress.

In today's aviation world, operating with a cockpit checklist is ubiquitous, and every aircraft has significant nuance and complexity. How do these checklists interact with the intricate systems involved in aviation, ever increasing task demands, and information overload experienced by pilots? The human brain has limitations.

Do the circumstances in the following ASRS report sound familiar?

“.. As we started the taxi, I called for the taxi checklist, but became confused about the route and queried the first officer to help me clear up the discrepancy. We discussed the route and continued the taxi... We were cleared for takeoff from runway 1, but the flight attendant call chime wasn't working. I had called for the Before Takeoff checklist, but this was interrupted by the communications glitch. .. On takeoff, rotation and liftoff were sluggish. At 100-150 ft as I continued to rotate, we got the stick shaker. The first officer noticed the no flap condition and placed the flaps to 5. (No takeoff warning horn-discovered popped circuit breaker back at the gate).”

The effects of concurrent task demands on human performance are a growing concern, especially in routine operations. Real world reports consistently associate these demands with vulnerability to error often characterized by inadvertent omissions of intended actions by skilled and experienced pilots. From a NASA study: Many pilots stated that at one time or another they had seen a checklist item in the improper status, yet they perceived it as being in the correct status and replied accordingly. For example, the flap handle is at the zero degree slot (physical stimulus), but the pilot perceives its location on the 5 degree position, and calls “flaps—5,” because he expects it to be there. This incorrect reply is based on numerous similar checks in which the flap handle was always in the proper setting during this stage in the checklist. Often, this phenomenon is coupled with unfavorable psychological and physical conditions such as time pressure, high workload, fatigue, noise, etc. The result is a human failure.
Have you ever had the experience of driving along a familiar route, and suddenly realizing that you have traveled some distance without being aware of it? Your brain can cease to consciously process information for a significant length of time. A highly practiced skill can be executed without conscious perception. Do you think flying can fall into this category? You bet it can. Checklist procedures can become an automatic routine, “running” the checklist with the reply done from memory, and not based on the actual state or position of the item.

Checklist performance is also affected by the way individuals interact as a crew. The crew must have a positive attitude about checklist use and standardization, and not consider it a nuisance. Poor crew coordination and loose role structures will lead to omissions and mistakes, and the result may be an incident or an accident. What about a rushed crew, attempting to make that rapidly approaching takeoff time? Again, from research: Another psychological factor that influences checklist performance is the relationship between the speed of performing the checklist and the quality (accuracy) of the check. Laboratory research showed a very definable relationship between response-time and error-rate. Therefore, if the pilot scans the appropriate panel(s) rapidly because of time pressure, the accuracy of his perception will suffer and the probability of error will increase.

The checklist is a primary interface between human and machine. When considering human factors, the combined effect of expectations and experience turns the brain’s pattern-analyzing mechanism into a double-edged sword. On one hand, this ability makes the user flexible and faster in responding to multiple conditions. On the other hand, it can lead to a disastrous mistake when the information is collected quickly or without sufficient attention, and is incorrectly perceived to match the expected condition. The unique interaction between checklists, humans, machines, and the operational environment makes the cockpit checklist a true human factors issue. Unfortunately, the human factors aspects are sometimes ignored.
Factors That May Affect Use of Normal Checklists (Flight Safety Foundation)

The following factors are often cited in discussing the partial omission or complete omission of a normal checklist:

- Out-of-phase timing whenever a factor (such as tailwind or a subsystem malfunction) modifies the time scale of the approach or the occurrence of a trigger event for the initiation of a normal checklist;
- Interruptions;
- Distractions;
- Task saturation;
- Incorrect management of priorities;
- Reduced attention (tunnel vision) in abnormal conditions or high workload conditions;
- Inadequate CRM;
- Overreliance on memory;
- Less-than-optimum checklist content, task sharing and/or format; and
- Possible inadequate emphasis on use of normal checklists during transition training and recurrent training.
Safety Promotion

Described as the fourth pillar of safety management, safety promotion connects the system to the participating employees. It relies upon effective communication to meet its objective of appropriate levels of awareness, information dissemination, and a knowledgeable workforce.

External information and other news plays an important part in safety promotion. Accident reports from the National Transportation Safety Board (NTSB) and other nation’s aviation safety investigation agencies provide valuable feedback describing accident causal factors. Feedback of this sort, when communicated effectively, can raise awareness and “open eyes” when an employee considers similar events could happen to them. Other sources, like this newsletter for example, also help in the safety promotion effort by bringing forward topics and generating thought and discussion.

Although external information plays an important role in safety promotion, it mustn’t be the sole focus. Internal information from the safety management system (SMS) itself is critical to successful safety promotion. Your operation’s SMS generates a plethora of relevant information and data, and employees deserve meaningful feedback. Creating this feedback is one of the crucial responsibilities of a safety manager. Employees participating in the SMS deserve to know how the SMS improves the operation’s risk management.

Pick an appropriate periodicity and create a straightforward summary of significant information from the SMS. The summary should contain simple counts, descriptions of actions, and any ongoing analysis. The following provides a short example:

**Safety Report Submissions**

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**Significant Corrective Actions from Safety Reports**

- SOP change to fueling aircraft (AUG 2017)
- New training requirements for aircraft towing (OCT 2017)

**Safety Performance Indicator Trends and Analysis (3 Months)**

- **Upticks**
  - Navigation error. Analysis: increase in number of flights into KTEB
  - Fatigue related error. Analysis: increase in international flights
- **Downticks**
Quote of the Month

“Step with care and great tact, and remember that life’s a great balancing act.”

BY: Dr. Seuss

Maintain balance in all things. Although this approach sounds more pertinent to ancient philosophies, can’t we see the importance of balance in today’s aviation operations? Deviations often occur when balance is lost. Influencers such as pressure, task overload, CRM, communication and situational awareness and many others can create imbalance and result in a tumbling effect of sorts, helping things spin just beyond control. “Then those things ran about with big bumps, jumps, and kicks and with hops and big thumps and all kinds of bad tricks.” Whenever things are not going well, doesn’t it feel like that? Stay in balance, and intervene quickly when recognizing factors begin to create a negative tide and bounce you astray.