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NOTE TO MEMBERS
#24 22 MAR 2017

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SUBJECT:
ENROUTE WAKE TURBULENCE
REVISED: 22 MAR 2017

CIRCULATION: PUBLIC – SHARE FREELY

Situation/Event

In January 2017, a Challenger 604 passed 1000 feet underneath an opposite direction Airbus 380, encountered wake turbulence, and lost control, rolling 3-5 times, engines flamed out, and lost 10,000 feet before recovering.The aircraft received damage beyond repair due to the G-forces, and was written off. There is now worldwide concern regarding the effects of A380 wake.

Existing wake guidance

A 2006 European study recommended a new category, **Super**, for the A380, due to its size. Behind an A380 on approach, you need 6nm in a heavy, 7nm in a medium, and 8nm in a light. For departures, 2 minutes is the minimum for all aircraft taking off behind an A380, increasing to 3 mins for light/medium, and 4 for intersection departures. The same study concluded that the A380 itself did not need any wake separation when following other aircraft, making it the only type to have this 'out'.

Enroute

No A380 wake guidance exists enroute (in fact, very little enroute wake turbulence guidance of any sort exists, which is why we are publishing this note) which is the phase of flight in which the above incident happened. We believe that will change. In the interim, full use of the SLOP offset procedure by all crews can mitigate risk. This will be of particular value to light and medium category aircraft potentially passing through A380 wake enroute.

SLOP – Standard Lateral Offset Procedure

SLOP allows an offset, usually 1 or 2nm to the right of track. First introduced as a NAT procedure in 2004, it's now mandatory there and allowed in many other FIR's. There are two reasons for SLOP. One is reducing collision risk, the other is avoiding wake turbulence, though until now that only really considered wake from traffic ahead.

Where can I SLOP?

The latest revision of ICAO Doc 4444 (Nov 2016) recommends that SLOP be authorised in **all enroute airspace on routes spaced by 6nm or more**. It is up to each country to implement this. This is still an ongoing process, so we'll list the special cases we know of here. Update us at intl.desk@fsbureau.org.

- **NAT Region** – since 2017, you **must SLOP**. Choose 1nm, 2nm (or centreline, but read below on why you shouldn't) Ref: NAT Doc 007, 2017.
- **The US** says crews "should" use SLOP in Oceanic Airspace. It does not mention domestic. Ref: AIP, 10NOV2016 ENR 7.4
- **China** is a special case and dictates their own offsets, though the AIP allows 1nm and 2nm also.

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- **Africa** ICAO recommended in 2010 that all FIR's allow SLOP throughout their airspace. We believe that all now do. Use together with the In Flight Broadcast Procedure (IFBP).
- **Australia** is also a special case. You may only offset in the OCA, and, if you're still on radar, then you need to tell ATC, both when starting the offset, or changing it. Within domestic CTA airspace, you must fly the route centreline. Ref: AIP ENR 2.2

Guidance

While the regulatory documents catch up, we offer the following guidance. We do this to help you form your own opinion. Make sure you do that, and not just rely on our say-so. **We might be wrong**.

We've based this guidance on: Flight Service Bureau opinion and research, SKYbrary documentation, existing Aviation Authority guidance, and an official Safety Information Bulletin from EASA that has been sighted but not yet been published. Check ad.easa.europa.eu. The FAA will likely follow suit.

Guidance for crews

SLOP

If you can, do it. It may not prevent all situations, especially crossing traffic, but if you're 2nm right of track you're a **lot less likely** to be directly underneath – or behind – another aircraft. Check that SLOP is allowed in the particular airspace you're in before you make the offset. Always SLOP **to the RIGHT**.

Centreline SLOP

Our recommendation is **not to fly the airway centreline** unless you absolutely have to – which will be because ATC mandates it (ie. no SLOP allowed), or because your aircraft can't (ie. It's old).

Althought SLOP is generally allowed 0nm, 1nm, or 2nm right of track, the 0nm offset is by definition **not an offset**. Flying centreline:
- **increases the risk of collision** with opposite direction traffic, either erroneously at the same level as you, or carrying out an emergency descent and not turning away from the centreline as they should.
- **increases the risk of wake turbulence** from opposite direction traffic also on the centreline.

Visually spotting the wake

Remember that the wake and the contrail are not always, and in fact unlikely to be, in the same place. **The contrail comes from the engines, and the wake comes from the wings**. While it may move away from the centerline in the same direction as the wake, the contrail will sit at altitude, while the wake drifts down, and, usually, the wake is invisible. NASA says it drifts down at, on average, 350 fpm, and settles about 1000ft below the flight path. Wake vortex decay is much slower below the tropopause.

Just passed one – what now?

Each situation will require your judgement, but if you've just gone directly under an opposite direction A380 – or any any aircraft much heavier than yourself:

- **First, consider the wind**. The danger point is roughly 15-20nm after the crossing point, as this is when the wake will have drifted down 1000 feet. In stronger winds, the wake may have drifted well away from the centreline. A turn away may not be necessary.
- If you're in SLOP approved airspace, you **don't need a clearance** from ATC to turn away from the track you're on. Turn, if possible into wind – for example from offset R1 to R2. No need to inform ATC (except for Australia).

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- If you're in SLOP unapproved airspace, or you're not sure, consider talking to ATC and getting a **clearance to turn into wind**.
- Switch on the seatbelt sign and secure the cabin.
- Check TCAS below and see what's underneath you, just in case you do encounter an upset.

Flying out of a wake upset

From the FAA "Pilot and Air Traffic Controller Guide to Wake Turbulence":

An encounter with wake turbulence usually results in induced rolling or pitch moments; however, in rare instances an encounter could cause structural damage to the aircraft. In more than one instance, pilots have described an encounter to be like "hitting a wall". The dynamic forces of the vortex can exceed the roll or pitch capability of the aircraft to overcome these forces.

During test programs, the wake was approached from all directions to evaluate the effect of encounter direction on response. One item common to all encounters, was that without a concerted effort by the pilot the aircraft would be expelled from the wake.

Counter control is usually effective and induced roll is minimal in cases where the wingspan and ailerons of the encountering aircraft extend beyond the rotational flow field of the vortex. It is more difficult for aircraft with short wingspan (relative to the generating aircraft) to counter the imposed roll induced by the vortex flow.

Pilots of short span aircraft, even of the high performance type, must be especially alert to wake-turbulence encounters.

The following is from an advance copy of an upcoming EASA SIB on Enroute Wake Turbulence (not yet released)

- It has been demonstrated during flight tests that if the pilot reacts at the first roll motion, when in the core of the vortex, the roll motion could be amplified by this initial piloting action. The result can be a final bank angle greater than if the pilot would not have moved the controls.

- 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.

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

Guidance for controllers

We expect specific guidance to be issued by EASA, the FAA, and eventually individual Aviation Authorities and ATC agencies.

The following is again from an advance copy of an upcoming EASA SIB on Enroute Wake Turbulence (not yet released)

- Make use of the wake turbulence category (WTC) indication in the surveillance label and/or the flight progress strip (whether electronic or paper), and observe closely separated aeroplanes that are at the opposite extremes of the WTC spectrum

- As the best practice, provide traffic information, advising "CAUTION WAKE TURBULENCE", when you identify that a 'HEAVY' or 'SUPER HEAVY' wake category traffic is climbing or descending within 15 NM of another following traffic;

- Manage en-route traffic crossings such as, when possible while preserving safe tactical management of overall traffic in the sector, avoiding to instruct climb or descent to 'HEAVY' or 'SUPER HEAVY' traffic within 15 NM distance from another following traffic;

- If at all possible, avoid vectoring an aeroplane (particularly if it is LIGHT or MEDIUM category) through the wake of a HEAVY or SUPER HEAVY aeroplane where wake turbulence may exist.

In the interim, as an enroute ATCO, consider the following. As with crew guidance, this is for you to think about, but **make up your own mind** if this suits your airspace and operation. We refer to the A380 here, but consider it also for any heavy aircraft where something a good deal smaller will come close.

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- **Crossing A380 traffic**. The wake will trail downwards, at about 400 feet per minute. Traffic passing **1000' below and behind** will be in its wake if it reaches the crossing point around 2 minutes later. Consider a small vector left or right to change the point of the cross. Remember that the wind will push the wake away a little. In this case you can judge it better than the crew.

- **Opposite Direction A380 traffic**. Especially if the traffic below is much smaller, there is danger of an upset if the pass is exact. Strong wind will push the wake off the centreline. Consider informing the crew, and maybe offer a turn in advance should they decide they want it, traffic permitting.

SLOP Rules and References

ICAO Doc 4444 PANS-ATM, 2016 16th Edition

November 2016

Remember that ICAO issues the standards; each country has to implement them through the AIP, or AIC.

Excerpt from Doc 4444, 16.5

Definition: SLOP are approved procedures that allow aircraft to fly on a parallel track **to the right of the centre line** relative to the direction of flight to mitigate the lateral overlap probability due to increased navigation accuracy, and wake turbulence encounters.

16.5.2 Strategic lateral offsets shall be authorized only in en-route airspace as follows:

a) where the lateral separation minima or spacing between route centre lines is **23 NM** or more, offsets to the right of the centre line relative to the direction of flight in tenths of a nautical mile up to a maximum of **2 NM**; and
b) where the lateral separation minima or spacing between route centre lines is **6 NM** or more and less than **23 NM**, offsets to the right of the centre line relative to the direction of flight in tenths of a nautical mile up to a maximum of **0.5 NM**.

16.5.3 The routes or airspace where application of strategic lateral offsets is authorized, and the procedures to be followed by pilots, shall be promulgated in aeronautical information publications (AIPs).

16.5.4 The decision to apply a strategic lateral offset shall be the responsibility of the flight crew. The flight crew shall only apply strategic lateral offsets in airspace where such offsets have been authorized by the appropriate ATS authority and when the aircraft is equipped with automatic offset tracking capability.
Note 1.— Pilots may contact other aircraft on the inter-pilot air-to-air frequency 123.45 MHz to coordinate offsets.
Note 2.— The strategic lateral offset procedure has been designed to include offsets to mitigate the effects of wake turbulence of preceding aircraft. If wake turbulence needs to be avoided, an offset to the right and within the limits specified in 16.5.2 may be used.
Note 3.— Pilots are not required to inform ATC that a strategic lateral offset is being applied.

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NAT Doc 007
January 2017

8.5.2 **SLOP**
This procedure provides for offsets within the following guidelines:
a) along a route or track there will be three positions that an aircraft may fly: centreline or one or two miles right (*Note: SLOP provisions as specified in ICAO PANS-ATM Doc.4444 were amended 13 November 2014 to include the use of "micro-offsets of 0.1 Nms for those aircraft with this FMS capabilty. Appropriate guidance for the use of this amended procedure in the North Atlantic is under study and hence pending*);
b)offsets will not exceed 2 NM right of centreline; and
c)offsets **left** of centreline must not be made.

Further References

- **FAA Pilot and Controller Wake Turbulence Guide**
https://www.faa.gov/training_testing/training/media/wake/04SEC2.PDF
- **FAA AC-90-23G Wake Turbulence**
https://www.faa.gov/documentLibrary/media/Advisory_Circular/AC_90-23G.pdf
- **Current A380 wake guidance**
http://www.skybrary.aero/index.php/Airbus_A380_Wake_Vortex_Guidance
- **ICAO Circular 331 - SLOP**
- **Aviation Herald: A380 vs CL604 incident**
http://avherald.com/h?article=4a5e80f3
- **ICAO Doc 4444 – November 2016**
http://flightservicebureau.org/2016-16th-edition-icao-doc-4444/
- **ICAO NAT Doc 007 – January 2017**
http://flightservicebureau.org/2017-edition-nat-doc-007-north-atlantic-airspace-and-operations-manual/
- **This is what an A380 looks like when it's coming to get you**
http://flightservicebureau.org/this-is-what-an-airbus-380-looks-like-when-its-coming-to-get-you/

Feedback and Input

We greatly appreciate commentary and information to allow us to keep this information current. Write to: pubs@fsbureau.org

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