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**Zulassungsanforderungen und Testprogramme für
den A 380**

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A380 Certification Process and Status (incl. Cert Test ex.)

Presented by

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Agenda

1. General Type Certification process
2. A380-800 aircraft master schedule and Type Certification planning
3. Main A380 Certification steps
 - a. Application letters & Teams nomination
 - b. Mandatory applicable requirements determination
 - c. Definition Familiarisation and establishment of the Special Conditions, Equivalent Level of Safety, Interpretative Materials and potential Exemptions through release of JAA/EASA CRIs and FAA IPs
 - d. Review and agreements on the acceptable means of compliance
 - e. Compliance Demonstration phase
4. A380 Major certification & development events: Flight Test results, Structural Static and fatigue tests, Emergency evacuation
5. Final Targets before Entry Into Service of 1st Production aeroplanes
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 - b. Validations by Foreign countries
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6. Post-Type Certifications activities: Individual Certification & Continued Airworthiness



Introduction (1)

- An Aircraft certification process is the process to achieve a Type certificate.
- The Type certificate allows to operate the Aircraft in the legal environment given by the relevant Airworthiness Authority.
- EASA (European Aviation Safety Agency) is the prime Authority for the European Aircraft Manufactures.
- A legal framework exists for the Airworthiness regulations.
 - ICAO recommendation
 - European law
 - Implementation regulation
 - Certification Specification
 - Advisory material



Introduction (2)

- Other Airworthiness Authorities exist (USA, Canada, Brazil, Russia, China,)
- Bilateral agreements regulate the relation between the different countries
- Close cooperation between Europe and the US
 - Regulations harmonised to a maximum (but differences exists) .
 - Important element of product acceptance (and marked penetration)
 - Type certification validation procedures regulate the acceptance of certificates.
- It is intended to achieve the EASA and FAA A380 type certificate at the same time

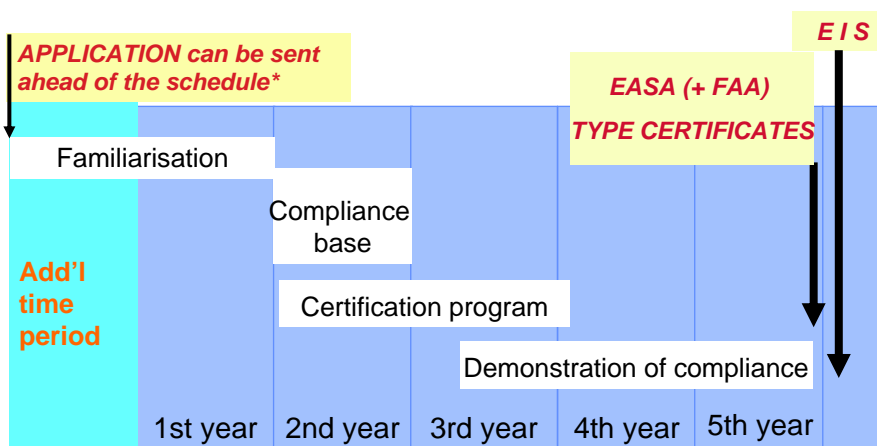


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Type certification: typical process



* To allow first discussions with AA on the most important certification items



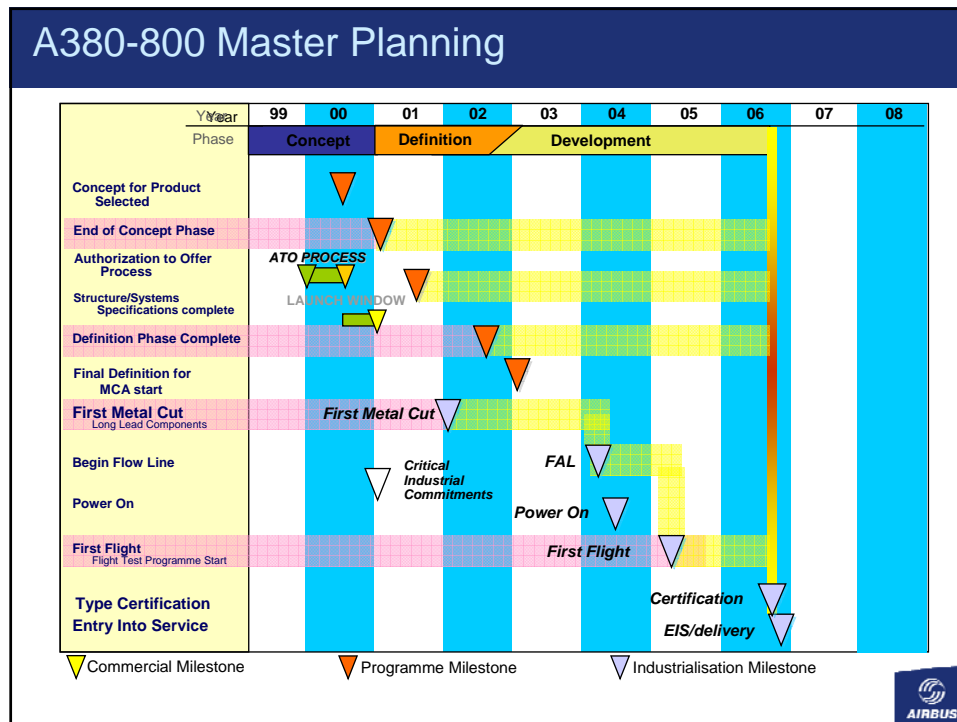
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Reminder: Airlines commitment status

<p>159 firm orders & commitments from 16 Customers</p> <p>132 A380 27 A380F</p>		EA	10 A380
			5 A380
		EA	41 A380 2 A380F
			4 A380
		EA	10 A380F
			5 A380 5 A380F
			5 A380
			5 A380
		RR	15 A380
		RR	6 A380
			2 A380
		RR	12 A380
		RR	10 A380
			6 A380
			10 A380F
		RR	6 A380



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A380 Global Certification status summary

- **First certification activities** started as early as **1998**, with the European Airworthiness Authorities (JAA) to initiate talks on most important aspects
- **Official reference date** (for mandatory requirements) by **Dec 20, 2001**
- **EASA/JAA and FAA Certification bases** (including Special Conditions, Interpretative Material, etc) have been agreed and frozen, **mostly in 2002**, with some complements in **2003** [and with similar approach for FAA]
- **Means of Compliance:** most MOC related to all applicable requirements agreed by **end of 2003**
- **Compliance demonstration phase:** **2004, 2005 and part of 2006** totally devoted to the corresponding tasks (analysis, laboratory/ground/flight tests, inspections,...)
- **Blocking points:** **none identified**, but some specific technical items still need further discussions
- **EASA/JAA & FAA Type Certificates for 1st A380 model:** Target is by **October 2006**

A380 Type Certification Process is on track



A380-800 Type Certification Bases

- For the A380-800 pax version, due to the reference dates for JAA & FAA Certifications, the applicable mandatory requirements are those of :
 - **JAR 25 change 15** mandatory
 - **FAR 25** up to and including **amdt 25-98** mandatory
- Airbus has, on a voluntary basis, elected to comply to:
 - **24** JAR-25 future rules (NPAs)
 - **7** additional FAR-25 amendments [including amdt **25.106** for Design for Security) and **5** FAR-25 future rules (NPRMs)
- External Noise regulations include, upon Airbus initiative, most recent and stringent **Chapter/Stage 4**
- Airbus has also requested two exemptions against FAR 25 sections:
 - 16g resistance for pilot seats (**part of 25.562**)
 - Duration of pax exposure to cabin depressurisation (**25.841a post amdt 25.87**)



A380 Type Certification specific subjects

- Special consideration given during Certification Specialist meetings on:
 - Features linked to the size or weight of the aircraft, like:
 - double deck crashworthiness
 - cabin overall arrangement and management
 - cabin evacuation
 - general fire protection
 - New or novel technologies implemented in the design, like:
 - electricity variable frequency generation
 - 5000 psi Hydraulic generation
 - Integrated Modular Avionics
 - use of GLARE and of Laser Beam Welded structures



A380 Type Certification specific subjects

- Other considerations introduced during Certification Specialist meetings:
 - New rules or evolutions of existing ones issued or to be published soon from various Task Forces or Working Groups, like:
 - full impact study for “Sustained Engine Imbalance”
 - improved criteria for fire resistance of materials used for linings and electrical wiring
 - impact of loss of thrust control
 - In-flight engine restart
 - fuel tank system safety
 - ICAO design for security
 - use of SAE ARP 4754 & 4761 recommendations for complex systems, introducing a more structured approach for demonstrating compliance with aircraft safety objectives



Beyond basic mandatory rules

- The Familiarisation phase has allowed JAA/EASA & FAA
 - getting clear and detailed knowledge of the aircraft definition
 - determining (as for each aircraft programme, and in accordance with JAR / IR / FAR 21) which JAR/FAR 25 requirements had to be replaced or complemented, because of the specificities of the aircraft
- This has led, for European Authorities to issuance of
 - **141 CRIs**, including around **40 Special Conditions** and close to 100 “Interpretative Materials”
- The US Authorities have issued
 - **102 Issue Papers**, with around **30 Special Conditions** [smaller numbers than from EASA due to the application of the “Validation Principles”, preventing duplication of similar work each time possible]



Determination of the Means of Compliance

- Once all applicable requirements were frozen, meetings per ATA chapters (that is per Systems or for Structure) have allowed to agree on which way the A380-800 has to be demonstrated as compliant with each rule related to each system of part of the structure
- For each applicable requirement paragraph, Airbus got acceptance, by **end of 2003**, of JAA/EASA & FAA on the proposed Means of Compliance, selected, for each case, among:

-- MoC 0: statement	-- MoC 5: ground tests
-- MoC 1: description	-- MoC 6: flight tests
-- MoC 2: analysis	-- MoC 7: inspection
-- MoC 3: safety analysis	-- MoC 8: simulator tests
-- MoC 4: laboratory tests	-- MoC 9: external proof



Compliance Demonstration phase

- It started during 2004, with the descriptive documents and the first analyses, went on across 2005 and will cover all 2006 until the Type Certificate (Oct 2006)
- Main activities status is described in next charts and include:
 - the Structural tests
 - the Systems tests
 - the Flight tests, covering
 - Load measurements to validate the models used for the test cells
 - Systems functioning
 - Performances and Handling Qualities



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A380 Major Static Test: Status

- Progress
 - 11 out of 12 Ultimate Load cases completed.
- Test results
 - FEM validation and non linear analysis validation are good.
 - Some local plastic deformations, as expected, were seen but complying with certification requirements and with no impact for serial aircraft.
- Forward outlook
 - Preparation of last Ultimate Load case (**Maximum Wing bending**); test to be performed in January 2006



A380 Major Static Test: wing bending at Limit Load



A380 Major Fatigue Test: Status

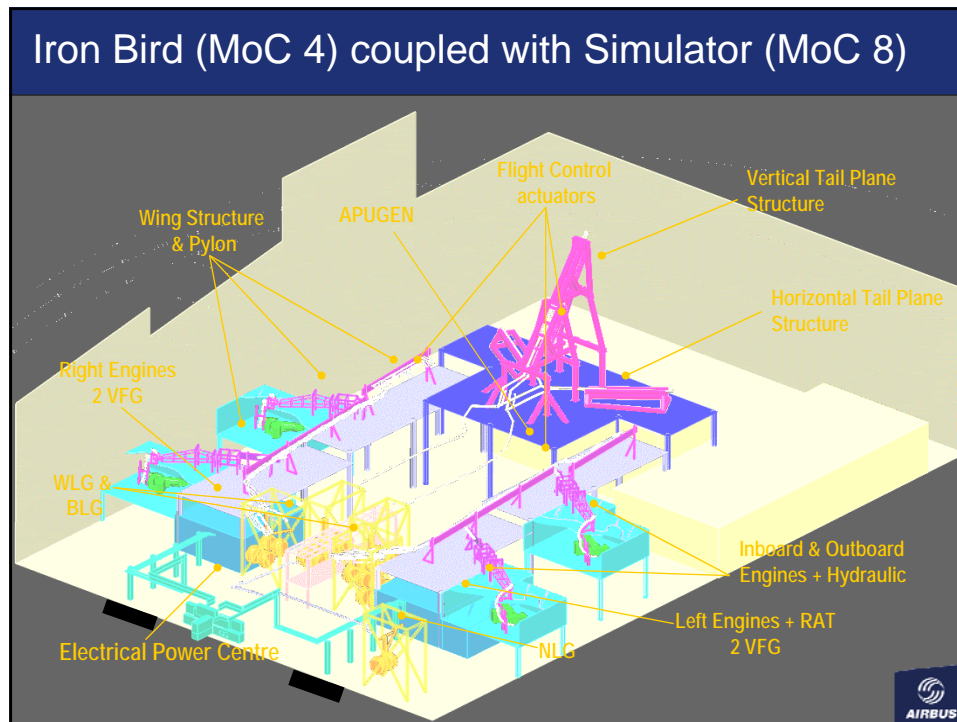
- Progress
 - Test Started 1 Sept 2005.
 - Test on-going beyond TC date
- Test results.
 - No fatigue damages found to date.
- Forward outlook.
 - First B inspection (3,800 simulated flights) done
 - Intent is to reach 5,000 cycles at time of Entry Into Service of the 1st production aircraft, so that a large flight cycle amount is demonstrated at that time
 - Test will continue until demonstration of the Design Service Goals is obtained



Lab tests for Systems

- All components of each system are qualified, either at Vendors or at Airbus or both
- Most of the systems are tested on specifically developed test benches
- A global aircraft test bench, called Iron Bird, representative of the installation on the aircraft, is used:
 - to check the integration of the Systems into the complete aircraft
 - to identify, before the first flights, the potential snags or anomalies, during what is called "virtual first flight"
 - to check, in the aircraft environment, the behaviour of upgraded components and pieces of equipment before flying them on aircraft





A380 Flight testing

- From 27 April to end of December 2005
 - **more than 150 flights** (using, basically, 2 development aircraft)
 - around **720 flight hours**
 - more than **250 flight cycles**
- **Achievements**
 - Initial evaluation
 - Flight envelope opening
 - Anemometric calibration
 - Preliminary cruise performance evaluation
 - Le Bourget & Dubai Airshows plus Asia/Australia tour
 - Aerodynamic configuration choice
 - All flutter tests completed
 - Landing gear loads measurements
 - Aerodynamic identification for simulators
 - Wake vortex measurements

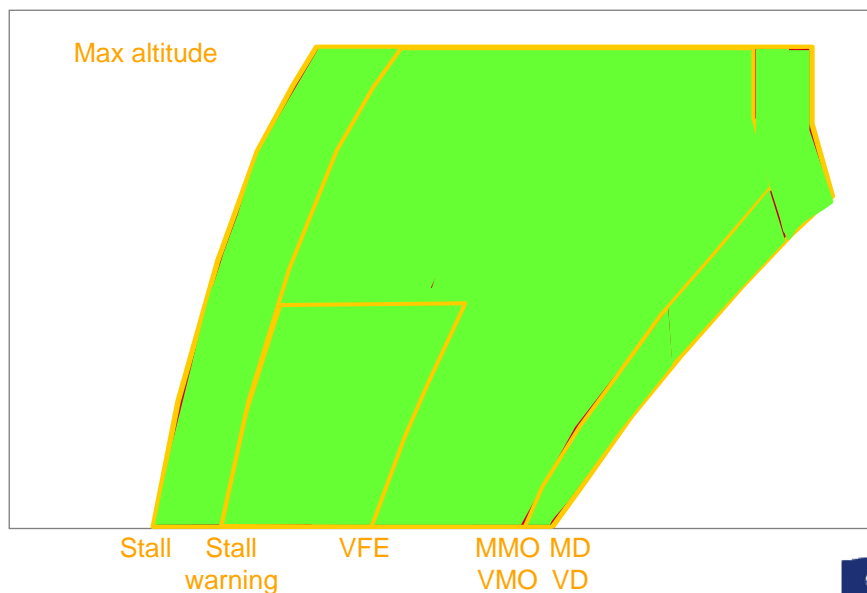
General evaluation & flight envelope opening

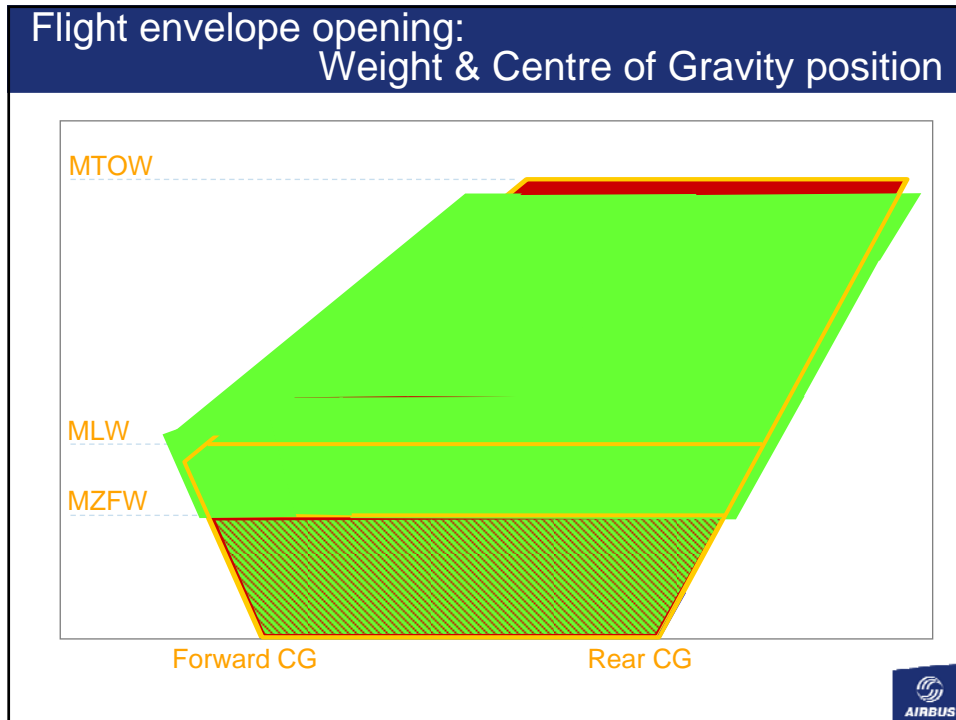
- Test objectives
 - Check of the aircraft behaviour
 - Direct and normal flight control law
 - Effect of speed, Mach number, altitude, aircraft weight and centre of gravity position
 - All flight phases, from take-off to landing.
 - Check of the adequate functioning of the various aircraft systems during the various flight phases
- Main results
 - Excellent aircraft behaviour
 - Control laws, and auto flight already very mature
 - Aircraft behaviour close to simulator
 - Successful autoland on flight 17, 35 days only after first flight
 - Major systems working as intended during normal operations.
 - Early safety checks carried out flawlessly
 - Landing gear gravity extension
 - Ram air turbine extension and functioning
 - Engine relight



Flight envelope opening:

Speed and altitude





Performance Aerodynamic configuration freeze

- Test objectives
 - Preliminary identification of the low speed performance
 - Evaluation of several slat / flap configurations to support freezing of final settings
 - Data gathered for all potential slat and flap settings
 - Take-off performance
 - Climb performance with AEO and OEI
 - Stalls
 - VMU's
- Results

Tufting campaign - In flight



VMU: July 13th and 14th, 2005

- Test objectives
 - Measure VMU in configurations (slat/flap) 23/26 and 23/29
 - Flap settings (26° and 29°) were candidates for CONF 3
 - VMU's were required to identify the optimum flap deflection
 - Measure VMU's in the already selected T/O configurations
- Test conditions
 - Istres Air Base
 - GW/CG = 540 t/ 35% (FWD CG limit)
 - Trim = Nominal for FWD CG limit
 - Geometry limitation demonstrated in all configurations

VMU: July 13th and 14th, 2005



VMU: July 13th and 14th, 2005



Slats / Flaps configurations

- Optimised slats/flaps configurations :

Conf	Slats(°) / Flaps(°)
1	20/00
1+F	20/08
2	20/17
3	23/26
Full	23/32



Aerodynamic configuration : results

- CLmax better than expected
 - Approach speed lower than expected by ~4 kt
 - Vref = 138 kt at MLW
 - Take-off V_{MU} limited
- Take-off performances on target
- Airbrakes deflections being finalised



Landing Gear Loads Measurements (June 25th, 2005)

- Test objectives
 - ▶ Measure loads on Landing Gear
 - During towing and pushback
 - At operational (60° max) and extreme (72°) nose wheel angles
 - BLG Steering: ON and OFF

- Test conditions
 - ▶ Gross Weight = 546 t
 - ▶ Steering Angle = 60° (max operational) and 72°
 - ▶ Temperature = 32°C



On-going now

- Structural identification
 - ▶ Loads
- Handling Qualities development continuation
- Autoland development
- Systems development
 - ▶ Fuel
 - ▶ Electrics / RAT
 - ▶ Air conditioning
 - ▶ Others...



A380 Cabin Evacuation Tests

- **Principle:**

- › a single evacuation test from both decks at the same time with **853 pax (315 on UD + 538 on MD)** configuration [plus 18 Cabin Crew and 2 Cockpit Crew members]
- › complemented with “stair migration” test (from UD to MD)

- Airbus has been working for months on the organisation and the logistic of that test
- Recent FAR amdt 25.117 (issued to minimise injury risk for testers) used as guideline to determine the most appropriate test conditions, allowing good safety of the test participants (UD slides pre-deployed before test start and low light level instead of “dark of night”); all various test conditions and pass/fail criteria agreed with Authorities
- Evacuation test will also meet specific conditions to comply with FAR 121 and will take place by **end March / beg. April 2006**



Evacuation Demonstration

Test at Hamburg



Hangar 221



- Evacuation test planned with witnessing of all involved national Certification Authorities



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Final Certification tasks to be performed before EIS

- Last steps to EASA & FAA Type Certificates
 - Completion of all compliance demonstration documents (**around beg. of Aug. 06**)
 - EASA Type Board Meeting (**beg. Sept. 06**)
 - Type Certificates (**Oct. 06**)
- Validation by customer countries (when not part of European Union or not USA)
 - Prepared by common Workshops and bilateral meetings since 4 years
 - Sequence adapted to delivery order
 - 1st validation with CAA Singapore before 1st a/c to SIA (**end 06**)
- Approval of all modifications implemented on the 1st Production aircraft (including all Airline options)



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Reminder: Post-Type Certifications activities

- **Individual Aircraft Certification**
 - At the delivery of each Production aircraft, an individual Certificate for Export has to be produced
 - All specific changes implemented on each aircraft have to be approved as a prerequisite to its delivery
- **Continued Airworthiness**
 - On A380, like on each other programme, since the moment aircraft are operated by Airlines, in-service incidents may happen that are, in some cases, impacting directly or indirectly the Airworthiness of the aircraft
 - Such incidents have to be covered by specific processes that include inquiries related to their causes, research of issue fixing and plans to implement those fixes on aircraft
- For both Airworthiness functions, dedicated A380 teams are being deployed **across 2006** so that they are fully operational when first aircraft are used in commercial service



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