



EUROPEAN AVIATION SAFETY AGENCY
AGENCE EUROPÉENNE DE LA SÉCURITÉ AÉRIENNE
EUROPÄISCHE AGENTUR FÜR FLUGSICHERHEIT

| 10TH ANNIVERSARY |

Flight test organisation

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Your safety is our mission.



Who is this course for?

➤ **DOATL: DOA Team Leaders**

You will learn about:

- How valid test results are achieved
- Safe operation of the test aircraft

Having taken this course, you will be able to properly assess flight test procedures and organisations performing flight tests

➤ **PCM: Product Certification Managers**

You will understand Part 21 core issues related to establishment and approval of flight conditions – as would be required from the DOA member holding the respective privilege.



Pre-requisite knowledge for this course

Assumed knowledge

- You already have a knowledge of the DOA expectations; i.e. that there is a general requirement for a manual describing the organisation and its procedures
- You understand how the organisations are expected to demonstrate compliance with DOA requirements



About this course

In this course we will:

Look at examples of best practice established for Flight Test Organizations

We will identify and detail those aspects of these best practices that are applicable to organizations that only occasionally perform flight tests

Through this, you will be able to better understand the reasoning behind the questionnaire provided in [WI.DOA.00147-001](#)

The training is divided into 3 parts:

- Part 1: Definition of a Flight Test Organisation
- Part 2: Associated Deliverables
- Part 3: Case studies



Definition of a flight test

What kind of flights could fall under the definition of a flight test, according to Part 21?

- ❖ The [GM to 21.A.701](#) provides useful information for identifying what is a flight test.
- ❖ Not all the cases listed in this GM should be qualified as a flight test. We are interested in 2 of these cases:

Development:

- ❖ Testing of new aircraft or modifications
- ❖ Testing of new concepts of airframe, engine, propeller and equipment
- ❖ Testing of new operating techniques

Demonstration of compliance with regulations or certification specifications:

- ❖ Certification flight testing for type certification, supplemental type certificates, changes to type certificates or ETSO authorisation





Regulatory requirements

What existing requirements are actually related to the flight test activity?

What forthcoming requirements could impact the flight test activity?



Part 21

- ❖ [21A.4\(a\)](#), [21A.20](#), [21A.33](#), [21A.35\(a\)](#), [21A.35\(b\)](#), [21A.55](#), [21A.239](#), [21A.243](#), [21A.245](#), [21A.251](#), [21A.257\(a\)](#), [21A.257\(b\)](#), [21A.263\(c\)](#), [21A.265](#), [21A.701](#), [21A.707](#), [21A.708](#), [21A.709](#), [21A.710](#), [21A.711](#), [21A.713](#), [21A.723](#), [21A.725](#), [21A.727](#), [21A.729](#) and related GMs and AMCs

Part FCL

- ❖ FCL.820 (Opt-out until 08/05/15)

Part 21 and Part SPO

- ❖ [Opinion 07/2013](#)
- ❖ TOR RMT.0348 and RMT.349 (2016?)



Safety aspects of flight testing



What are the safety issues related to flight test activity?

Is there a need to closer investigate how flight testing is addressed in DO?

safety of the design and...

... **operational risks** associated to the flight testing



Accidents related to Flight Testing:

No statistical data available that would indicate a higher than average accident rate on flight test activities but...

...when accidents occur, **organizational aspects** usually are a contributing factor





Elements of a flight test organisation

What are the key elements to consider during the assessment of a flight test organisation?



- ❖ **Aircraft** (without an aircraft, no flight test...)
- ❖ **Personnel** (we need ground and flight crew to perform the test)
- ❖ **Facilities**
- ❖ **Handbook and procedures**
- ❖ **Deliverables** (the purpose of the flight test is to collect information)





Aircraft in a flight test environment

What topics should be addressed before an aircraft used for flight test activity is declared ready for flight?



- ❖ **Configuration:** Basic configuration established at handover from production should be documented and configuration management process defined
- ❖ **Maintenance:** Maintenance Scheme must be available and associated responsibilities defined (delegated to production, to Part M or integrated in the DOA)
- ❖ **Flight Test Instrumentation:** Design and configuration should be controlled, calibration process should be defined
- ❖ **Safety equipment**





Elements of a flight test organisation

What are the key elements to consider during the assessment of a flight test organisation?



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Personnel in a flight test organisation

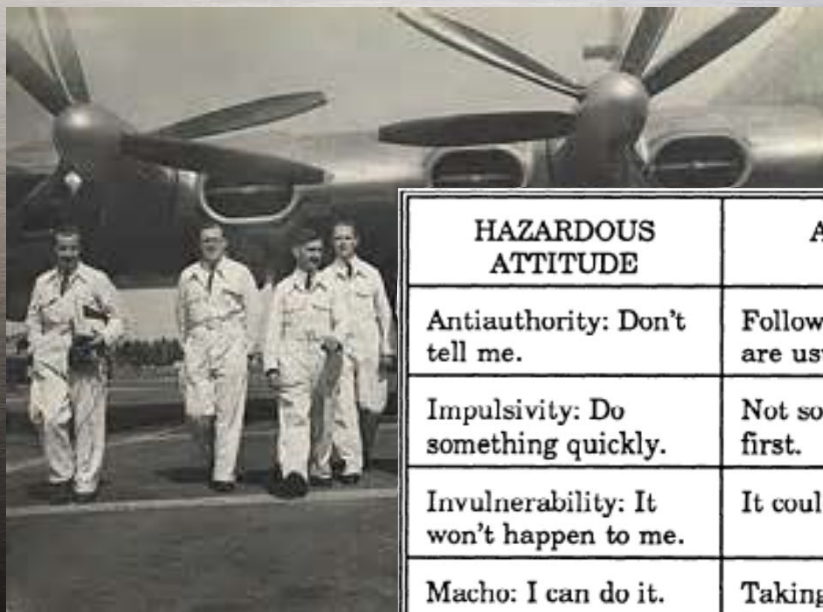
Who are the people required in a flight test organisation?

- ❖ Test pilots
- ❖ Flight Test Engineers
- ❖ Designers
- ❖ Mechanics
- ❖ Certifying staff
- ❖ Safety officer





What needs to be defined by the FTO concerning 'test pilots' and 'flight test engineers'?



HAZARDOUS ATTITUDE	ANTIDOTE
Antiauthority: Don't tell me.	Follow the rules. They are usually right.
Impulsivity: Do something quickly.	Not so fast. Think first.
Invulnerability: It won't happen to me.	It could happen to me.
Macho: I can do it.	Taking chances is foolish.
Resignation: What's the use?	I'm not helpless. I can make a difference.

- ❖ Qualification requirements
 - ❖ Licences
 - ❖ Ratings
 - ❖ Skills
 - ❖ Recency
 - ❖ (recurrent) training
 - ❖ Experience
 - ❖ Behaviour
- ❖ Authorizations (eventually time limited?)
- ❖ Validity check of licences, medical etc.
- ❖ Flight time limitation policy
- ❖ CRM





Elements of a flight test organisation

What are the key elements to consider during the assessment of a flight test organisation?



- ❖ **Aircraft** (without an aircraft, no flight test...) ✓
- ❖ **Personnel** (we need ground and flight crew to perform the test) ✓
- ❖ **Facilities**
- ❖ **Handbook and procedures**
- ❖ **Deliverables** (the purpose of the flight test is to collect information)



Facilities

What should be considered as part of flight test “facilities”?



- ❖ **Airfield:** suitability, location, length of runway, ATC, airspace...
- ❖ **Hangar:** environmental protection, security of the test aircraft..
- ❖ **Rescue and safety equipment:** parachutes (serviceability), fire extinguishers, life vest, survival kit, flight suits oxygen...
- ❖ **Rescue services** (with trained people)
- ❖ **Ground control, communication, telemetry**





Elements of a flight test organisation

What are the key elements to consider during the assessment of a flight test organisation?



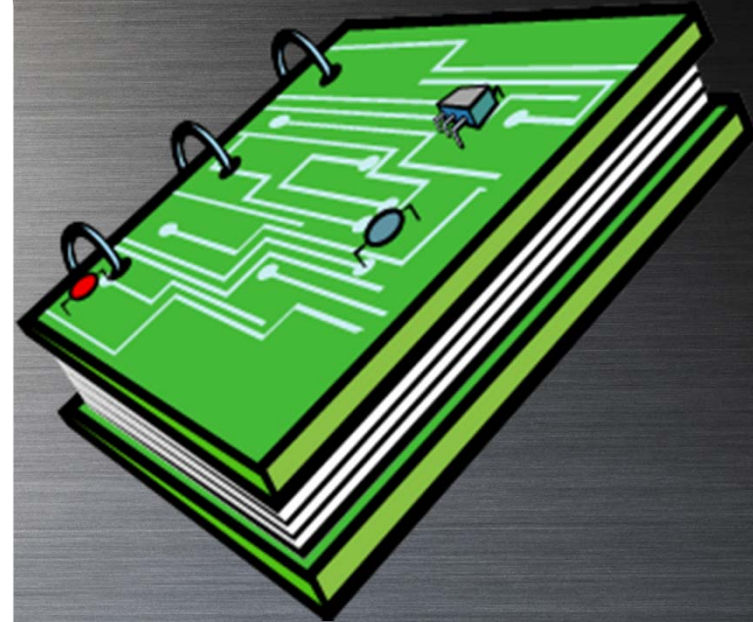
- ❖ **Aircraft** (without an aircraft, no flight test...) ✓
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- ❖ **Facilities** ✓
- ❖ **Handbook and procedures**
- ❖ **Deliverables** (the purpose of the flight test is to collect information)



Handbook and procedures

Organisations performing flight tests in order to demonstrate regulatory compliance are required to document all activity in a **Flight Test Organisation Manual (FTOM)**

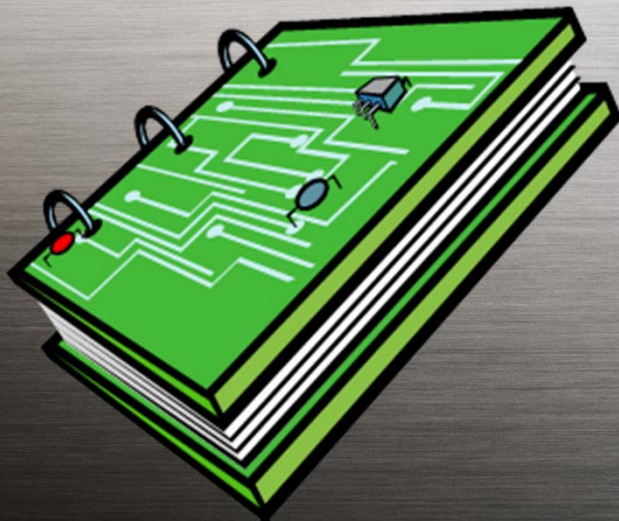
The FTOM should provide **general information** about principles adopted by the organisation and the management of the flight test activity.





Handbook and procedures

What subjects should the FTOM cover?



- ❖ Organizational structure and position within the DO
- ❖ Competences requirement and nomination process versus Categories of flights
- ❖ Facilities requirements
- ❖ Management and calibration of test equipment
- ❖ Configuration management of the test aircraft
- ❖ Maintenance of test aircraft (arrangements with CAMO and Part 145)
- ❖ Arrangements with suppliers (e.g. pilots, flight test engineers, and suppliers of flight test instrumentation)
- ❖ Flight Test Procedure
- ❖ SOP





Elements of a flight test organisation

What are the key elements to consider during the assessment of a flight test organisation?



- ❖ **Aircraft** (without an aircraft, no flight test...) ✓
- ❖ **Personnel** (we need ground and flight crew to perform the test) ✓
- ❖ **Facilities** ✓
- ❖ **Handbook and procedures** ✓
- ❖ **Deliverables** (the purpose of the flight test is to collect information)



Deliverables

What are the deliverables which could be associated to a flight test process?



- ❖ FTOM
- ❖ Flight test Programme
- ❖ Flight test report
- ❖ Flight Test Order
- ❖ Flight Test Card
- ❖ Techlog
- ❖ Briefing/Debriefing minutes
- ❖ Training records
- ❖ Safety analysis
- ❖ Flight conditions
- ❖ Permit to fly



Flight Test Programme – Flight Test Plan

Specific to the **project**, covering development and certification flights, the flight test Programme should document:



- ❖ Sequence and planning of flights (with phases if needed)
- ❖ Reference to the applicable requirements (certification flights)
- ❖ Method of test flight
- ❖ Safety provisions (analysis, emergency devices, airspace...)
- ❖ Design Limitations
- ❖ Ground and flight crew
- ❖ Facilities information
- ❖ Test aircraft configuration versus target configuration
- ❖ Flight test instrumentation
- ❖ Maintenance of the test aircraft





Flight Test Programme

Additional requirements
of the Flight Test
Programme:

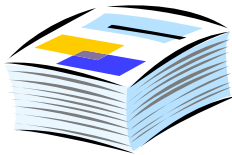


A matrix in appendix showing the reference of a flight in compared against the certification requirement could be used as a compliance check list for the certification process.

The Certification flight test Programme should be kept up to date. Initial issue and subsequent revisions should be accepted by EASA.



Documents structure



Flight test Programme
Specific to the **project**, shows sequence of flights



Flight test order
One **per flight**, show sequence of test points



Flight test Card
One per **test point**





Flight Test Order



The flight test order is an **order** given by **someone having the appropriate authority** to the test pilot and flight test engineer to perform a predefined **sequence of tasks**, called “test points”.

Who is able to issue the order should be defined in the Handbook



Flight Test Order

What does a flight test order contain ?



- ❖ The crew
- ❖ Communication information
- ❖ The required facilities and airspace
- ❖ The required and actual weather conditions
- ❖ Weight and balance
- ❖ The aircraft configuration (directly or indirectly)
- ❖ The limitations applicable to the flight
- ❖ Emergency procedures
- ❖ Test points, with test method and mean used for the recording (FTI, FTE, [Cooper Harper](#))
- ❖ that an operational safety analysis has been performed for all test points. Conditions that could lead to interrupt the flight should be clearly identified
- ❖ [the flight profile](#)

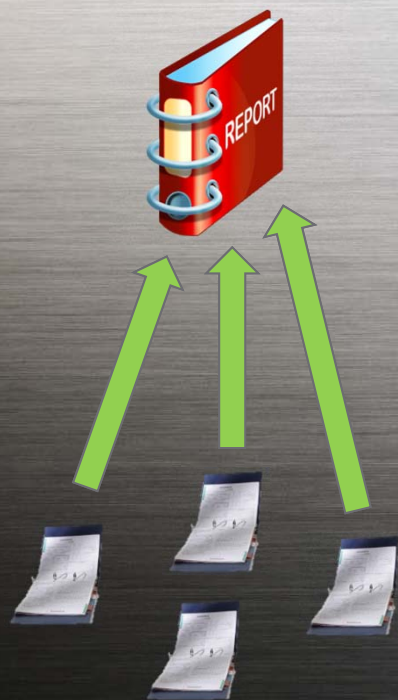




Flight test cards

What is a flight test card?

Why can a flight test card not replace a flight test order?



- ❖ Flight Test cards can be used as input data, to prepare the Flight Test Order, and/or to record data, collected from the Flight Test Instrumentation or the notes recorded by the test pilot or the flight test engineer.
- ❖ Flight Test Cards, when used, are specific to a test point. They are standalone documents and cannot replace the Flight Test Order, which is defining the sequence of test points.
- ❖ A compilation of filled Flight Test Cards can be used to build a flight test report.





Safety of the design & associated limitations

Could you give examples of limitations triggered by the result of a safety assessment of the design?



- ❖ Structure: An aircraft for which the static test has been performed up to limit load only, normally operated up to 3,8g could be limited to 2,7 g
- ❖ Structure: No full ground test performed for the flutter assessment. VD and associated speeds limited
- ❖ System: Landing Gear retraction system actuators not fully qualified, first flight performed with LG extended





Safety of the design & associated limitations

Who are the actors participating to the preparation of the safety analysis document?

Who should check this document?

Does this document need to be updated?

- ❖ Obviously, experts for each technical domain impacted by the project should participate
- ❖ Part 21 requires an independent check of the safety substantiation (not a CVE role)
- ❖ This document needs to be updated, in order to substantiate new limitations, or lift/amend existing ones





Safety of the flight test operations

At what stage should the safety of the operation be assessed?

Who are the actors ?

What are the elements and the output of this activity?

Where should the evidence of this activity be recorded?



- ❖ Safety of the operations should be assessed before each flight
- ❖ The Test Pilot, the Flight Test Engineer and possibly a safety officer should participate to the assessment
- ❖ **Each test point** should be analysed and associated risk identified and classified. Risk should be mitigated by appropriate limitation (altitude, safety equipment, chase aircraft). No flight should be performed if the risk after mitigation is classified as catastrophic
- ❖ The result of the analysis should be visible in the flight test order





Technical logbook (Techlog)

The **technical logbook** is an essential deliverable for flight test operations. What should a **Techlog** be used for?



- ❖ Any change in aircraft configuration, like implementation of changes, installation or removal of flight test instrumentation, installation or change in ballast configuration...
- ❖ Maintenance tasks performed on the test aircraft
- ❖ Snags reported by the crew





Technical logbook (Techlog)

Who should sign the Techlog?



- ❖ The maintenance or production certifying staff appointed by the DOA to attest the work performed on the aircraft.
- ❖ The FTE or/and test pilot for acceptance.



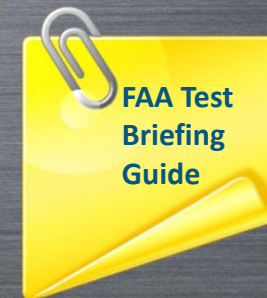


Briefing & debriefing

What should be discussed during the briefing?



- ❖ Review of the techlog (aircraft condition)
- ❖ Review of the flight test order (showing limitations)
- ❖ Weather condition
- ❖ Crew condition



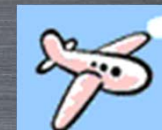


Briefing & debriefing

What should be discussed during the debriefing?



- ❖ Snags recorded during the flights
- ❖ Configuration to be prepared before next flight





Briefing & debriefing

Briefing and debriefing are key activities during flight test operations. It is important to record evidence of these activities. What documents could be used for this purpose?

- ❖ Specific minutes
- ❖ Flight test order (if all participants identified)
- ❖ Techlog





Flight Test Report

Could you identify, among all deliverables identified so far, what are the elements which could be used to compile a flight test report?

- ❖ Flight test Programme
- ❖ Flight test cards
- ❖ Data collected from the FTI

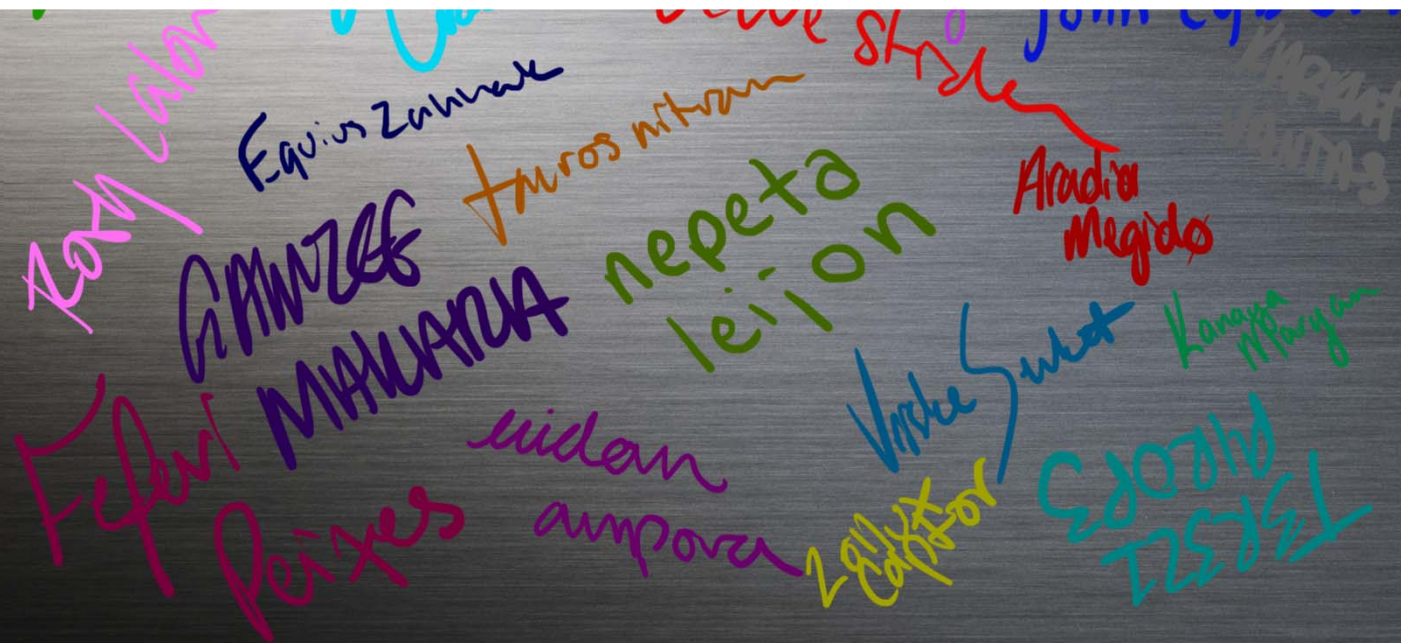




Flight Test Report

How many CVE should sign a flight test report (used as compliance document)?

As many as technical domain impacted by the project, e.g. performances, handling qualities, avionic, structure (flutter)... They can sign the report but can also sign directly at flight test card level.





Flight Conditions

Would you feel comfortable in approving flight conditions if all what we have presented here was properly implemented by the DOA?



Yes...

Flight conditions can be approved for one flight only (Airbus system), for a series of flights or even a flight test campaign if they are associated with procedures, tools and deliverables ensuring that configuration, maintenance and safety of the aircraft is properly managed.





Permit to fly

Flight conditions have an “approver”. Permit to fly as well, but on top the approver, what is the important role associated to the PtF?

The Permit to fly holder





Permit to fly

Permit to fly has a validity period, but not the flight conditions, why?



The aircraft cannot fly only with flight conditions. They must be associated with a Permit to Fly. The Flight conditions are controlled via the permit and the obligation of the holder to check that the aircraft is conform to the configuration defined in the latest approved FC. If not, the permit is automatically invalidated.





Permit to fly

For PtF issued by DO under 21.A.263(c)(7) privilege why should the DOA holder send a copy of the PtF to the competent authority within 72 hours?

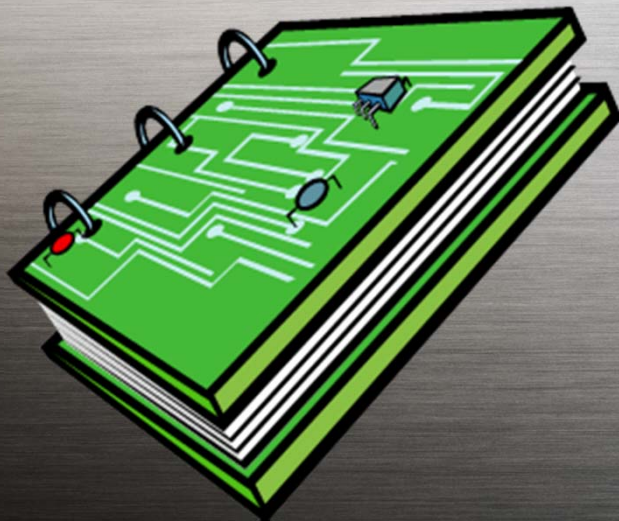
To be sure that national operational / airspace / flight crew requirements are properly considered.





Handbook and procedures

What subjects should the FTOM cover?



- ❖ Organizational structure and position within the DO
- ❖ Competences requirement and nomination process versus Categories of flights
- ❖ Facilities requirements
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- ❖ Arrangements with suppliers (e.g. pilots, flight test engineers, and suppliers of flight test instrumentation)
- ❖ Flight Test Procedure
- ❖ SOP
- ❖ Safety analysis process
- ❖ Flight Conditions and Permit to Fly process





Case study 1: Aerospool Flight Test Operations Manual

- Could you identify the contents that have been addressed in the first part of our training session?
- Could you identify the missing elements, if any?
- Could you assess the quality of the FTOM (Strengths and weaknesses)?

Time allocated: 30 minutes





Case study 2:

STC case, flight test plan and FC approved by EASA

- Could you check the proposed flight conditions and supporting substantiations and report if some elements are missing?
- Could you assess the definition of the aircraft configuration?
- Could you assess the quality of the Test Plan and the Test Report?

Time allocated: 30 minutes





Case study 3: TC case, Tecnam P2008 flight test programme

- Could you review the attached flight test programme and report if some elements are missing?
- Could you assess the quality of this document?

Time allocated: 30 minutes





Case study 4: Flight Test Orders comparison

- ▶ Could you review and compare the two Flight Test Orders, one used for the A380 by Airbus and one used for the ME-262 by Cassidian?

Time allocated: 30 minutes



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Books and Documents:

- Breaking the Mishap Chain
- Gulfstream G650 Accident Report
- Airbus A320 Accident Report
- FAA Order 4040.26B - Aircraft Certification Service Flight Test Risk Management Program

Websites:

- Flight Test Safety Committee



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