

NORTH ATLANTIC TREATY ORGANIZATION  
SCIENCE AND TECHNOLOGY ORGANIZATION



# SCI- 272 Task Group

## Flight Test Technical Team Overview

### Q1 2014 to Q1 2017

**Presented By: Mr Patrick Stoliker - USA**

**SCI- 272 is Open to NATO Members and PfP  
and is Unclassified**



## Mission of the NATO STO

- The mission of the NATO STO is to help position the Nations' and NATO's S&T investments as a strategic enabler of the knowledge and technology advantage for the defence and security posture of NATO Nations and partner Nations, by:
  - Conducting and promoting S&T activities that augment and leverage the capabilities and programmes of the Alliance, of the NATO Nations and the partner Nations, in support of NATO's objectives;
  - Contributing to NATO's ability to enable and influence security- and defence-related capability development and threat mitigation in NATO Nations and partner Nations, in accordance with NATO policies;
  - Supporting decision-making in the NATO Nations and NATO.



## SCI-272 Flight Test Technical Team (FT3) Mission

- Disseminate information through multiple means including the publication of AGARDographs on flight test technology derived from best practices which support the development of concepts and systems critical to NATO's technological and operational needs
- Enable advancements in flight test technologies to be discussed in open forums within the NATO community by identifying and distributing flight test training opportunities, and through proposing and facilitating symposia, short courses, lecture series, workshops, etc.
- Serve as the focal point for flight test subjects and issues for the SCI panel while ensuring vitality and continuity of the network of flight test experts within the NATO community.

## SCI-272 Membership and Links

### Participating Nations:

Canada  
France  
Germany  
Netherlands  
Spain  
Sweden  
Turkey  
United Kingdom  
United States of America

### Active Participants:

P. Stoliker (US) Chair

N. Alemdaroglu (TU)  
B. Ayet (FR)  
O. Brieger (DE)  
C. Buck (SW)  
D. Delsalle (FR)  
R. Exner (DE)  
H. Jentink (NE)  
U. Keller (SW)

P. Kissmann (CA)  
J. Martinez (ES)  
D. Moore (UK)  
D. Morley (UK)  
O. Nadar (TU)  
J. Orio (ES)

### Cooperating Organizations:

Society of Flight Test Engineers  
Society of Experimental Test Pilots  
Flight Test Safety Committee  
Royal Aeronautical Society



MINUTES of MEETING of FLIGHT MECHANICS PANEL FLIGHT TEST INSTRUMENTATION  
COMMITTEE (1 attachment)

Present: Prof. Doetsch  
Dr. Brünig

Date: 15 november 1968

General

Prof. Doetsch chaired this meeting, as agreed in the 33rd FMP business meeting (Oslo), in order to discuss the future status and task of the Committee in providing a survey of the present state of the art of flight test instrumentation.

The proceedings of the Flight Test Instrumentation Symposium in Montreal (Spring 1967) are now available but by its nature the involved material is not suitable for the above mentioned purpose.

For this reason it was decided already in the 32<sup>nd</sup> FMP business meeting (Amsterdam) that a series of Agardographs be edited, each of them covering a single subject or series of related subjects of flight test instrumentation.

The present task of the Committee will be to select subjects and authors for the Agardographs and to monitor the whole process of writing and editing.

## SCI-272 Activities

- The Team has engaged in a wide variety of activities relating to Flight Test. These have included :
  - AGARDographs
  - Training Courses
  - Symposia
  - Consultancy
  - Networking/Links to other Institutions
  - Workshops
  - Exploratory Teams
- For these activities The Team was awarded the RTO Scientific Achievement Award in 2008



# AGARDographs

- There are two series of AGARDographs
  - AG-160 Series on Flight Test Instrumentation Series
  - AG-300 Series on Flight Test Techniques
- Authors are recognized specialists and have broad experience in the field. By CSO financed fact finding travel they can broaden the scope of an AGARDograph with views from other specialists.





## Flight Test Techniques



## Flight Test Instrumentation





## Volumes in the AGARD Instrumentation Series, AGARDograph 160

1. Basic Principles of Flight Test Instrumentation Engineering  
Issue 1: Edited by A. Pool and D. Bosman 1974  
Issue 2: Edited by R. Borek and A. Pool 1994
2. In-Flight Temperature Measurements by F. Trenkle and M. Reinhardt 1973
3. The Measurements of Fuel Flow by J.T. France 1972
4. The Measurements of Engine Rotation Speed by M. Vedrunes 1973
5. Magnetic Recording of Flight Test Data by G.E. Bennett 1974
6. Open and Closed Loop Accelerometers by I. McLaren 1974
7. Strain Gauge Measurements on Aircraft by E. Kottkamp, H. Wilhelm and D. Kohl 1976
8. Linear and Angular Position Measurement of Aircraft Components by J.C. van der Linden and H.A. Mensink 1977
9. Aeroelastic Flight Test Techniques and Instrumentation by J.W.G. van Nunen and G. Piazzoli 1979
10. Helicopter Flight Test Instrumentation by K.R. Ferrell 1980
11. Pressure and Flow Measurement by W. Wuest 1980

**Volumes in the AGARD Instrumentation Series, AGARDograph 160 (continued)**

12. Aircraft Flight Test Data Processing – A Review of the State of the Art by L.J. Smith and N.O. Matthews 1980
13. Practical Aspects of Instrumentation System Installation by R.W. Borek 1981
14. The Analysis of Random Data by D.A. Williams 1981
15. Gyroscopic Instruments and Their Application to Flight Testing by B. Stieler and H. Winter 1982
16. Trajectory Measurements for Take-off and Landing Test and Other Short-Range Applications by P. de Benque D'Agut, H. Riebeek and A. Pool 1985
17. Analogue Signal Conditioning for Flight Test Instrumentation by D.W. Veatch and R.K. Bogue 1986
18. Microprocessor Applications in Airborne Flight Test Instrumentation by M.J. Prickett 1987
19. Digital Signal Conditioning for Flight Test by G.A. Bever 1991
20. Optical Air Flow Measurements in Flight by R.K. Bogue and H.W. Jentink 2003
21. Differential Global Positioning System (DGPS) for Flight Testing by R. Sabatini and G.B. Palmerini 2008
22. Application of Fiber Optic Instrumentation by L. Richards, A.R. Parker Jr., W.L. Ko, A. Piazza and P. Chan 2012



## Volumes in the AGARD and RTO Flight Test Techniques Series

AG237 Guide to In-Flight Thrust Measurement of Turbojets and Fan Engines by the MIDAP Study Group (UK) 1979

**The remaining volumes are published as a sequence of Volume Numbers of AGARDograph 300.**

1. Calibration of Air-Data Systems and Flow Direction Sensors by J.A. Lawford and K.R. Nippres 1988
2. Identification of Dynamic Systems by R.E. Maine and K.W. Iliff 1988
3. Identification of Dynamic Systems – Applications to Aircraft  
Part 1: The Output Error Approach by R.E. Maine and K.W. Iliff 1986  
Part 2: Nonlinear Analysis and Manoeuvre Design by J.A. Mulder, J.K. Sridhar and J.H. Breeman 1994
4. Determination of Antenna Patterns and Radar Reflection Characteristics of Aircraft by H. Bothe and D. McDonald 1986
5. Store Separation Flight Testing by R.J. Arnold and C.S. Epstein 1986
6. Developmental Airdrop Testing Techniques and Devices by H.J. Hunter 1987
7. Air-to-Air Radar Flight Testing by R.E. Scott 1992
8. Flight Testing under Extreme Environmental Conditions by C.L. Henrickson 1988
9. Aircraft Exterior Noise Measurement and Analysis Techniques by H. Heller 1991
10. Weapon Delivery Analysis and Ballistic Flight Testing by R.J. Arnold and J.B. Knight 1992

**Volumes in the AGARD Flight Test Technique Series, AGARDograph 300 (continued)**

11. The Testing of Fixed Wing Tanker & Receiver Aircraft to Establish Their Air-to-Air Refuelling Capabilities by J. Bradley and K. Emerson 1992
12. The Principles of Flight Test Assessment of Flight-Safety-Critical Systems in Helicopters by J.D.L. Gregory 1994
13. Reliability and Maintainability Flight Test Techniques by J.M. Howell 1994
14. Introduction to Flight Test Engineering  
Issue 1: Edited by F. Stoliker 1995  
Issue 2: Edited by F. Stoliker and G. Bever 2005
15. Introduction to Avionics Flight Test by J.M. Clifton 1996
16. Introduction to Airborne Early Warning Radar Flight Test by J.M. Clifton and F.W. Lee 1999
17. Electronic Warfare Test and Evaluation† by H. Banks and R. McQuillan 2000
18. Flight Testing of Radio Navigation Systems by H. Bothe and H.J. Hotop 2000
19. Simulation in Support of Flight Testing by D. Hines 2000
20. Logistics Test and Evaluation in Flight Testing by M. Bourcier 2001
21. Flying Qualities Flight Testing of Digital Flight Control Systems by F. Webster and T.D. Smith 2001
22. Helicopter/Ship Qualification Testing by D. Carico, R. Fang, R.S. Finch, W.P. Geyer Jr., Cdr. (Ret.) H.W. Krijns and K. Long 2002



**Volumes in the AGARD Flight Test Technique Series, AGARDograph 300 (continued)**

23. Flight Test Measurement Techniques for Laminar Flow by D. Fisher, K.H. Horstmann and H. Riedel 2003
24. Precision Airdrop by M.R. Wuest and R.J. Benney 2005
25. Flight Testing of Night Vision Systems in Rotorcraft by G. Craig, T. Macuda, S. Jennings, G. Ramphal and A. Stewart 2007
26. Airborne Laser Systems Testing and Analysis by R. Sabatini and M.A. Richardson 2010
27. Unique Aspects of Flight Testing Unmanned Aircraft Systems by A.E. Pontzer, M.D. Lower and J.R. Miller 2010
28. Electronic Warfare Test and Evaluation by M. Welch and M. Pywell 2012

## Current FT3 AGARDographs

- The Team has one volume on the verge of publication
  - SCI-244, Aircraft Store Compatibility, Integration, and Separation Testing.
  - The champion was a Turkish member
- The Team has a number of new AGARDographs in preparation
  - SCI-236 Flight Test Safety Management, the champion is a British member
  - SCI-245 Reduced Friction Runways, the champion is a Canadian member
  - SCI-255 High Altitude Helicopter Testing, the champion is an American member
  - SCI-266, Application of the IRIG 106 Digital Recorder Standards for Flight Test, the champion is a Dutch member
- The team has compiled a watch list of potential topics
  - Para Drop
  - Structural Loads Testing
  - Data Links
  - Flow measurement Techniques
  - Advanced Vision Systems and Cockpit Displays



## FT3 Training Courses

- In recent years the Team has managed the delivery of a Training Course on Store Integration Flight Test, SCI-154
- This was prepared and presented by a British Team Member
- This was delivered at a number of sites
  - INTA Torrejon Spain
  - FMV Malmen Sweden
  - BAE Systems Warton UK
- Course attendees were from Spain, Sweden, UK, Turkey and Canada

## FT3 Proposed Lecture Series

- A product of our last meeting was a TAP for a Lecture Series on Store Separation Trajectory Prediction
- The lecture series will be championed by a Turkish member and will feature German, American and Turkish lecturers
- The lecture series will cover
  - The computational Fluid Dynamics tools used to predict aerodynamics of a store in close proximity to an aircraft
  - The wind tunnel test techniques and measurement systems for determining aerodynamic forces
  - Correlation of CFD and wind tunnel test results with flight test results
- The plan is to deliver the lecture series to at least three host countries



## FT3 Symposia

- The Team has been instrumental in delivering a number of Symposia on Flight Test Topics in recent years.
- The Team has a new Symposium in the Planning Phase
- This is targeted for May 2015 in Canada
- The topic is SCI-269 The Flight Testing of Unmanned Aircraft Systems
- It is being led by one of our Turkish members
- Abstracts are due in November with selections by the end of the year

## FT3 Consultancy

- Consultancy has been provided both internal to the team and to external parties
- Of these the most significant has been a mission to the Turkish Air Force Technology and Weapons System Development Directorate at Eskisehir to advise on aspects of Flight Test Planning and Management and Flight Test Instrumentation.
- These were supported by American, Canadian and Dutch Team Members.



## FT3 Networking and Links

- Through its Team Members and their Contacts the Team has an established network that spans the International Flight Test Community
- The links encompass :-
  - Government Flight Test Centres
  - Industry Flight Test Centres
  - Academia
  - Professional Institutions
- The Kevin Bacon Game says that anyone in the World is only five people away from anyone else. Via FT3's Network the Flight Test Community might better that.

## FT3 Workshops

- The Team has run one workshop recently
- This was an Exploratory Team on the Education and Experience Requirements for Flight Test Engineers SCI 204
- Sessions took place in both the US and the UK
- This was managed and reported by a US Team Member



## SCI-272 Current Activity

### Recent Meetings/Events:

- **Bi Annually - The Task Group convenes against SCI 272 to discuss the management of its deliverables and to develop ideas for future work.**
  - **Spring 2013, hosted by the United States**
  - **Fall 2013, hosted by the Netherlands**
  - **Spring 2014, hosted by France**
  - **Fall 2014, hosted by Spain**
  - **Spring 2015, hosted by Canada in conjunction with the SCI panel meeting/symposium**
- **Future activities are proposed and managed as specific SCI Activities in their own right.**

## SCI-272 Current Activity

### Current Portfolio:

- The current portfolio comprises **AGARDOgraphs, a Symposium and a proposed Specialist Workshop**
  - SCI-236 Flight Test Safety Management
  - SCI-245 Reduced Friction Runways
  - SCI-255 High Altitude Helicopter Testing
  - SCI-266, Application of the IRIG 106 Digital Recorder Standards for Flight Test

### Near Term Plan to Completion:

- **2014-2017 Business Meetings Continue**
- **Q2 2014 Publication AG SCI 244 on Store Compatibility Flight Test**
- **Q2 2014 Publication Report closing SCI 204 Flight Test Specialist Workshop**
- **Q2 2015 Symposium on UAS testing**
- **Q3 2015 Publication AG SCI 236 on Flight Test Safety Management**



## SCI- 272 Future

### Challenges/Issues:

- Maintaining delivery schedules when utilising unfunded voluntary contributors
- Rebuilding the Membership, particularly from the United States, following the retirement of existing team members
- Securing travel funds in constrained budget environments for member participation
- Retaining relevance as NATO membership, partnerships, and responsibilities evolve
- Archiving sufficient flight test instrumentation and flight test technique knowledge and lessons learned as the interval between significant development programs grows

## SCI- 272 Future

### Prospective Follow-On Activities:

- The team has compiled a watch list of 17 potential AGARDograph topics in both the Instrumentation and test Technique series.
- As papers are collected for the 2015 Symposium, we will assess the need/value of follow-on Specialists Meetings or Workshops
  - May be classified as required
- Submitted a TAP for a Lecture Series on Store Separation Trajectory Prediction



## SCI-236-AG – Safety & Risk Management in Flight Testing



**Team Leader(s):** Dennis Morley

**Contributing NATO Members:** US, UK, TU, NE, FR, DE

**Contributing Partner Nations:** SW

**Coordination Efforts:** Flight Test Safety Committee, Society of Experimental Test Pilots, Society of Flight Test Engineers

**Start-End:** January 2011-Dec 2015

**Related activity:**

### Objectives:

- Document the current best practices in Flight Test Safety Management that will act as a Guideline for future military and civilian flight test activities.
- Gather a collection of short papers by a wide variety of Civil and Military flight test organizations
- Provide analysis on commonalities, differences, and novel practices and approaches

### Topics/themes:

- Safety Assessment
- Hazard Identification
- Risk Mitigation
- Test Plan Approval
- Monitoring and Oversight

### Deliverables and Exploitation:

- Unlimited Release AGARDograph in the Flight Test Techniques series
- Emphasize the best practice in safety and risk mitigation
- Safe conduct of testing
- Reduction of mishaps

## SCI-244-AG – Aircraft Stores Compatibility, Integration, and Test



**Team Leader(s):** Orhan Nadar (TU)

**Contributing NATO Members:** US, UK, CA, FR

**Contributing Partner Nations:** SW

**Coordination Efforts:** Society of Flight Test Engineers

**Start-End:** January 2012-December 2014

**Related activity:**

### Objectives:

- Provide definitive documentation on the requirements for safely integrating external stores onto aircraft and validating capabilities to be provided to the warfighter

### Topics/themes:

- Gross effects on aircraft performance
  - Degraded flying qualities
  - Aerodynamics effects
- Aeroelastic effects
- Separation
- Flow field effects
- High speed, high g, steep dive angle separation
- Accuracy

### Deliverables and Exploitation:

- Unlimited Release AGARDograph in the Flight Test Techniques series
- Improve commonality across the NATO nations in the development and integration of capabilities into aircraft
- Emphasize the best practices in safety and risk mitigation
- Maximize NATO capabilities in aircraft capabilities



## SCI-245-AG – Reduced Friction Runway Surface Flight Testing



**Team Leader(s):** Paull Kissmann (CA)

**Contributing NATO Members:** US, UK, DE, FR

**Contributing Partner Nations:** SW

**Coordination Efforts:** Society of Flight Test Engineers

**Start-End:** January 2012-Dec 2014

**Related activity:**

### Objectives:

- Document the best practices for flight testing on reduce friction runway surfaces.

### Topics/themes:

- Runway State
- Common runway friction indices and Descriptive Reports
- Friction Measurement Devices
- Application of measurement devices to aircraft performance
- Analytical methods for aircraft performance and handling qualities – stopping
- Flight test practices for contaminated surface flight test
- Application for runway friction information/operational impact
- Current commercial systems

### Deliverables and Exploitation:

- Unlimited Release AGARDograph in the Flight Test Techniques series
- Commonality in the understanding of reduced friction surfaces
- Improved aircraft capabilities in degraded weather conditions
- Improve commonality across the NATO nations in the development and integration of capabilities into aircraft
- Emphasize the best practice in safety and risk mitigation

## SCI-255-AG – High Altitude Rotary Wing Flight Testing



**Team Leader(s):** J. McCue (US)

**Contributing NATO Members:** US, UK, DE, FR

**Contributing Partner Nations:** SW

**Coordination Efforts:** Society of Flight Test Engineers

**Start-End:** January 2012-Dec 2014

**Related activity:**

### Objectives:

- Discuss the importance of rigorous, all-encompassing research into

### Topics/themes:

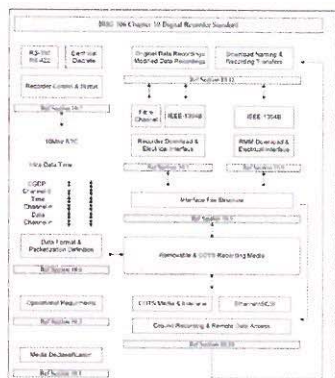
- Rotary Wing performance at high altitudes
  - Blade aerodynamics
  - Engine performance
- Aircrew physiological requirements
- Helicopter handling qualities in thin air
- Mechanical systems operations at cold temperatures and high altitudes
- Test site considerations
- High altitude emergency planning

### Deliverables and Exploitation:

- Unlimited Release AGARDograph in the Flight Test Technique series
- Flight testing of rotary wing aircraft is not well documented
- Recent NATO experience has necessitated the use of rotary wing aircraft in more extreme environments



## SCI-266-AG – Application of Digital Data Recorder Standards for Flight Test



**Team Leader(s):** Johan Klijn (NL)  
**Contributing NATO Members:** US, UK, DE, FR  
**Contributing Partner Nations:** SW  
**Coordination Efforts:** Society of Flight Test Engineers  
**Start-End:** January 2012-Dec 2014  
**Related activity:**

### Objectives:

- Develop a common NATO approach to data acquisition and data processing using this standard

### Topics/themes:

- IRIG 106 Chapter 10 compatible recording of (multiple) data streams
- Synchronization of data, data recorders, data retrieval and processing
- Examples of flight test programs

### Deliverables and Exploitation:

- Unlimited Release AGARDograph in the Flight Test Instrumentation series
- Improve commonality across the NATO nations in the development and integration of capabilities into aircraft
- Enhance awareness in a new field of Flight Test Instrumentation

## SCI-269-SY – Flight Testing of Unmanned Aerial Systems



**Team Leader(s):** Nafiz Alemdaroglu (TU)  
**Contributing NATO Members:** US, UK, DE, FR, CA, NL, ES  
**Contributing Partner Nations:** SW  
**Coordination Efforts:** Applied Vehicle Technology Panel  
**Start-End:** January 2014-Dec 2015  
**Related activity:**

### **Objectives:** Integrated NATO approach for flight test of UAS **Topics/themes:**

Procedures and practices of Flight Testing of UAS  
 UAS programs and lessons learned from Flight Testing  
 Issues related to testing of UAS such as Risk Management  
 Civilian usage of UAS  
 Airworthiness, Configuration Control  
 Range Clearance, Flight Termination Systems  
 Qualification and competency of Flight Test Personnel  
 Test planning, Ground Testing, Modelling and Simulation, System Integration, Data Link and Control  
 Flight Testing for different Concepts of Operations, Flying qualities and performance  
 Flight Test Instrumentation  
 Payload and Weapon systems  
 Operational suitability and interoperability with Manned Systems, flight in segregated/non-segregated air-space, flight testing in support of Integration of UAS in civilian airspace.

### **Deliverables and Exploitation:**

- TAP prepared for SCI panel
- Call for Papers delivered to CSO
- Conference proceedings will be published following the Symposium
- Symposium interchange will be used to define further workshops and Specialist Meetings



## SCI-204-ET Education and Experience Levels for Flight Test Engineers



**Team Leader(s):** Rusty Lowry (US)  
**Contributing NATO Members:** UK, DE, FR, TU, NE, CA, ES  
**Contributing Partner Nations:** SW  
**Coordination Efforts:** Society of Flight Test Engineers, Society of Experimental Test Pilots  
**Start-End:** January 2007-May 2014  
**Related activity:**

### Objectives:

- Investigate the issue of Flight Test Engineer qualifications

### Topics/themes:

- Canvas the flight test community for views on the appropriate education and experience to support the FTE role
- Surveys identified preference go undergraduate engineering degree
- Full test pilot curriculum most applicable for a full-time FTE
- On the job training with specialty short courses
- Value of regulatory requirements

### Deliverables and Exploitation:

- Exploratory Team Meeting in Maryland, October 2008
- Technical Specialist workshop in Washington, DC, September 2010
- Technical Specialist workshop in London, UK, September 2010
- Summary Report, May 2014
- Conclusion is that further development and involvement is not needed by NATO