Education and Experience Guidelines for Flight Test Engineers

Technical Evaluation Report

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Flight testing has historically been conducted by teams composed of test pilots and flight test engineers (FTEs) working together to assess and evaluate aircraft and their associated systems. While the role of the test pilot as the person in control of the air vehicle is self-evident, the roles and responsibilities of FTEs have been less obvious and, in fact, are often quite varied and diverse based on the type of testing being conducted, the complexity of the system under test, and the risk level associated with the test. This diverse range of responsibilities mandates a similarly diverse range of educational backgrounds and experience needed to appropriately support the FTE role; experience and educational backgrounds that, heretofore, have neither been documented nor cataloged.

NATO/RTO sponsored a series of three forums consisting of an exploratory team meeting in Annapolis, Maryland in October 2008 and two Technical Specialist Workshops in September 2010 in Washington DC and London, England in an effort to canvas the aviation flight test community for their views on appropriate education and experience needed to perform FTE roles and to capture what some of those roles may be. Participants included academia, test pilot schools, professional societies, flight test centers, regulatory agencies, and industry.

Prior to these forums over three dozen preliminary questionnaires were distributed to selected members of the flight test community in the summer of 2008 to form the basis for an exploratory team review of the FTE education and experience level expectations for varying types of flight testing. Returned questionnaires showed that the majority of respondents preferred FTEs possessing undergraduate engineering degrees in one of three fields; aerospace engineering, mechanical engineering, or electrical engineering. Additional post-graduate education was of secondary interest to most with surveys citing either a Master's degree in an engineering science or a completion of a full test pilot school curriculum as the most applicable formal post-graduate education for an active FTE. A broad variety of project experience and on-the-job training coupled with specialty flight test courses (short courses offered by academia or test pilot schools for instance) were described as the most frequently used methods of gaining experience and knowledge while limited career growth opportunities within the field of flight testing were targeted as the biggest drain of experienced FTE talent. Though some test centers and industry partners developed training plans and targeted growth assignments for their FTE workforce, many others left FTEs career progression responsibilities to the individual employee, their supervisory chain, and some level of chance assignments to develop the skills deemed necessary for a fully functional FTE. The questionnaire is included as Appendix A and a summary of the results are included as Appendix B.

22 Individuals representing ten organizations participated in the full day exploratory team meeting at the US Naval Academy in Annapolis, Maryland on 21 October 2008. The top ten questionnaire results were used as the basis to frame the day's discussion, the outcome of which was to be a decision if the FTE topic held enough interest within the flight test community to rate further development and, if so, to recommend submittal of a formal Technical Activity Plan on the subject by the FT3.

The exploratory team effort produced spirited discussion of the flight test engineer background, tasking, and different roles supported by FTEs across the wide spectrum of industry and air vehicle applications. Commercial industry especially expressed a need to maintain the maximum flexibility possible in order to gain the most value from their workforce while maintaining enough agility within that workforce to get flight

testing completed in a safe and efficient manner. All attendees were in agreement that any FTE education and experience level discussions should be viewed as a set of recommended guidelines and "lessons learned" but not be construed as mandates in order to protect desired flexibility, meet unique demands of widely varying test programs, and so as to preserve the various flight test groups' organizational responsibility to manage their workforce and tasking. Findings of this exploratory team were compiled into a briefing provided to FT3 the following day at the Naval Air Warfare Center at Patuxent River, Maryland. Those findings showed a general consensus amongst the participants that further analysis and eventual documentation of the subject would be of value to the flight test community and the recommendation was made that additional effort should be undertaken by FT3 to support that end. This recommendation was accepted by FT3 and a TAP submitted to RTO for approval to proceed with a pair of Technical Specialist Workshops. This proposal was approved (SCI-204) and formal tasking received to complete the workshops in 2010.

In an effort to optimize the engagement of workshop participants, two separate technical specialist workshops were organized to be held in concert with ongoing flight test events in both North America and Europe. These events were the Society of Flight Test Engineers Annual Symposium in Washington DC and the European Flight Test Safety Workshop in West London, England. Meeting space was procured for a one day workshop at National Harbor, Maryland on 17 September 2010 and at Brunell University in London, England on 30 September 2010.

Both workshops featured presentations by leaders from academia, flight test centers, test pilot schools, professional societies, and the aviation industry with different attendees engaged at each workshop; 29 participants in total. The agendas for these two workshops are presented in Appendix C.

Each presentation provided an overview of FTE roles within the specific domain of the presenter's organization as well as their preferences for educational backgrounds and in-house policies for flight test related training and skills development. In general, these viewpoints aligned with the results of the exploratory team meeting in that all presenters preferred a "classic" undergraduate engineering degree in Aerospace, Electrical, or Mechanical Engineering combined with on-the-job skills development gained through work assignments, program experience, and available courses in test specific subjects such as instrumentation, data reduction, and flight test techniques. The expectation was that 3-5 years of work experience was the average required for an FTE to be considered and expected to function at the journeyman's level in performing a flight test role without direct oversight and supervision. More complex or higher risk FTE responsibilities demanded more proven experience and education with the major test centers opting for test pilot school graduates for these roles while industry relied upon senior FTE's who had built a solid reputation within the company on a succession of projects.

The academic discussions revealed that few undergraduate institutions offered coursework specifically addressing flight testing subjects mainly due to a lack of aircraft access to support such courses and also liability concerns associated with students participating in any actual flights. Those that did offer specific flight test coursework mostly focused on graduate level (Master's Degree) level offerings mainly based on the narrow application of the subject matter and the higher costs of any associated lab or flight time. Increased use of remote controlled aircraft or unmanned air vehicles (UAV) was touted as a step towards addressing this void with an associated reduced risk to participants, lower costs, and a rapidly increasing academic interest promoted by intercollegiate flight competitions and heavy current social interest in UAV activities.

All four NATO nation test pilot schools provide FTE specific flight test education with up to 50% of some school's classes composed of flight test engineers (as opposed to pilots). These schools were the US Air Force Test Pilot School and Empire Test Pilot School (UK while the remaining two schools, US Naval Test Pilot School and the French Test Pilot School (EPNER), were still primarily pilot focused in their long course, Each of the schools offered some forms of short course training modules specifically intended to

support FTE education over and above their primary long courses. The principle shortfalls associated with all of the test pilot programs were high costs of education, especially for any coursework involving flight, very limited FTE throughput, and the predominantly military nature of the programs which inhibited industry participation.

Industry presentations, along with those from government flight test centers, involved some level of internal training program aimed at developing and improving FTE skills. Some programs were mandatory and highly structured with dedicated employee time managed and applied to participating in the training while others featured self-help or after-hours programs that, while not mandatory, were key ingredients to a successful engineer's professional development and career progression. Most of these programs were not obviously transferrable to other companies or sites as they tended to dwell on specific test processes in use by the provider and were highly focused on maximizing the efficiency of training so as to get the most return on the company's in-house investment of time, talent, and financial resources.

The two primary professional societies closely engaged with flight test activities, the Society of Flight Test Engineers (SFTE) and the Society of Experimental Test Pilots (SETP), were both represented by their presidents with each providing strong opinions that the FTE and test pilot team was the most valued part of a successful flight test program and that the roles and responsibilities of these positions overlapped in many areas thus demanding a high level of integration and cooperation so as to work effectively. Both societies also expressed doubts and concerns about regulatory mandates of experience levels and training as the population of FTEs and pilots was so broad and varied as were the types of flight test programs supported that regulation could prove to be overly restrictive or inappropriate.

Regulatory presentations were not available from either the FAA or EASA but input was provided after the workshops in the form of a briefing on emerging test pilot and FTE licensing requirements under consideration from EASA for European civil aircraft certification. These requirements cited specific educational and currency minimums with a phased in schedule of compliance beginning with company developed and tracked training programs for their employees actively engaged as flight test engineers. This "active engagement" was defined to only include, at least initially, those who would actively fly onboard the test aircraft during the conduct of flight testing. Expansion of these requirements into non-flying FTE roles or into the military sector of flight testing was not addressed nor was any plan for transferrable education and skills credentials between European companies until the full implementation of the licensing approach. It is anticipated that this aspect of EASA regulation will continue to be defined and developed as experience with licensing FTE's builds. As of the time of the workshops, the FAA was not considering any similar approach and no additional regulatory initiatives that would apply to any purely military testing.

Releasability concerns and processes limited the ability to compile and further distribute the workshop presentations and these minutes will serve to close out the FT3 effort for this topic (SCI-204). The workshops were timely events that served as outstanding forums to help exchange opinions on the FTE subject and promoted a better definition of baseline skills, knowledge, and abilities needed to function as a successful FTE. It is not anticipated that further development of the subject is needed in NATO and no follow on activity is recommended.

Appendix A – Flight Test Engineer Qualification Guidelines Questionnaire

Appendix B – Flight Test Engineer Qualification Guidelines Questionnaire Summary Results

Appendix C – Flight Test Engineer Qualification and Experience Guidelines Workshop Agendas

Appendix A – SCI-204 Flight Test Engineer Qualification Guidelines Questionnaire

Name, phone number, and email address for the person responding to this questionnaire:

_____

_____

_____

Organization: _____

Involvement in Flight Testing:

_____

1. Do you have Flight Test Engineers in your organization: (yes/no) If so, how many? _____

2. Is Flight Test Engineering a recognized skill within your organization or an Ad Hoc assignment?

_____

3. What types of undergraduate education are appropriate for FTEs?

a. Aerospace Engineering (Required/Preferred/Desired/Needed/Helpful/Not Required/1nadequate)

b. Mechanical Engineering (Required/Preferred/Desired/Needed/Helpful/Not Required/Inadequate)

c. Electrical Engineering (Required/Preferred/Desired/Needed/Helpful/Not Required/Inadequate)

d. Civil Engineering (Required/Preferred/Desired/Needed/Helpful/Not Required/inadequate)

e Any engineer degree (Required/Preferred/Desired/Needed/Helpful/Not Required/Inadequate)

f. Physics degree (Required/Preferred/Desired/Needed/Helpful/Not Required/Inadequate)

g. Mathematics degree (Required/Preferred/Desired/Needed/Helpful/Not Required/Inadequate) h)

h. Any Calculus based science degree (Required/Preferred/Desired/Needed/Helpful/Not Required/Inadequate)

i. No University Degree _____

j. Other _____

4. What types of graduate education are appropriate for FTEs?

a. Master's degree in Engineering (Required/Preferred/Desired/Needed/Helpful/Not Required)

b. Test Pilot School Short Courses (Required/Preferred/Desired/Needed/Helpful/Not Required)

c. Test Pilot School Long Course (Required/Preferred/Desired/Needed/Helpful/Not Required)

d. Other _____

e. None _____

5. What types of On-The-Job Training are needed for an FTE?

a. Mentoring by experienced FTE
(Required/Preferred/Desired/Needed/Helpful/Not Required

b. Formal training on instrumentation systems (Required/Preferred/Desired/Needed/Helpful/Not Required)

c. Technical writing (Required/Preferred/Desired/Needed/Helpful/Not Required)

d. Aircraft specific training ("NATOPS")(Required/Preferred/Desired/Needed/Helpful/Not Required)

e. Flight training/flight experience (Required/Preferred/Desired/Needed/Helpful/Not Required)

f. Series of progressive assignments(Required/Preferred/Desired/Needed/Helpful/Not Required)

g. Professional society membership (Required/Preferred/Desired/Needed/Helpful/Not Required)

h. Other _____

6. Are your FTEs determined by their role/function on team (job title)? (yes/no)

7. Are your FTEs determined based on prior experience level (team role instead of sole title)? (yes/no)

8. Are your FTE's a mixture of both 6 and 7? (yes/no)

9. How many years of experience should an engineer have before he/she is labeled an FTE?

10. What should your experienced FTEs have to do to maintain their skill set as they mature or is experience by itself enough to remain knowledgeable? _____

_____

11. How do you define flight test? _____

12. Does ALL flight testing require the involvement of an FTE? (yes/no)

13. If not, what types of flight testing do not? _____

_____

14. What duties should an FTE be responsible/lead for in a flight test event:

a. Overall test management (yes/no)

b. Establishing the test matrix (yes/no)

c. Establishing the instrumentation parameters (yes/no)

d. Writing the overall test plan (yes/no)

e. Writing the test cards (yes/no)

f. Briefing management on the flight test approach and plan (yes/no)

g. Conducting the individual flight briefs (yes/no)

h. Real time monitoring of the test flights-on the ground (yes/no) -in the aircraft (yes/no)

i. Controlling the test flight/test point progression/prioritization (yes/no)

j. Post flight data retrieval and analysis (yes/no)

k. Final assessment of test data and resulting conclusions (yes/no)

l. Post-test briefings to management (yes/no)

m. Data archiving (yes/no)

n. Report writing (yes/no)

15. Which of the above duties should the FTE share equally with the test pilot:
a, b, c, d, e, f, g, h, I, j, k, I, m, n, all, none

16. Which of the above duties are the top three (most important) FTE duties:
a, b, c, d, e, f, g, h, I, j, k, I, m, n

17. Which of the above duties are the least important FTE duties.
a, b, c, d, e, f, g, h, I, j, k, I, m, n

18. What other duty/task is an important FTE flight test responsibility

_____

_____

19. Should FTE's remain completely engaged in flight testing or have responsibilities outside of the flight test arena as well (yes/no)

20. Should FTE's be co-located with test pilots (yes/no) or with larger engineering groups (yes/no)

21. Is some official certification necessary for FTE's (yes/no/eventually)

22. Should there be qualification standards established for flight test engineers to perform varying levels of tasks (yes/no/eventually)

23. Should there be educational/training guidelines established for general application to flight test engineers (yes/no/eventually)

24. Should civil aviation and military aviation require the same FTE skill set (yes/no)- If not, what differences are there _____

_____

25. Is flight test engineering really a unique discipline by itself or simply a subtask of a more general engineering function _____

_____

26. Should flight test engineering be taught as an undergraduate course of study (yes/no)- should it be a graduate course of study (yes/no)

27. If certification is needed, what body should be the certifying agency:

a. Professional society such as SFTE (yes/no)

b. National government agency such as the FAA for the USA (yes/no)

c. International agency such as FAI (yes/no)

d. Individual military for each country (yes/no)

e. NATO

f. Other _____

28. If certification is not needed, should mandatory training requirements be imposed for self-application by individual flight test organizations (yes/no)

29. Should suggested training guidelines be published instead of mandatory rules for use by the international community (yes/no)

30. How should such FTE training guidelines be transmitted

a. Written text such as an Agardograph (yes/no)

b. Stand-alone symposium (yes/no)

c. Presentation at professional symposium such as SFTE (yes/no)

d. Regulatory guidance such as FAA or JAR documentation (yes/no)

e. Web based site (yes/no)

f. Other _____

What other comments or inputs do you have for Flight Test Engineering that should be considered?

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_____

Thank you for your time in filling out this questionnaire. Please feel free to contact any FT3 Committee member with additional comments or send them to wilson.lowry@navy.mil

Appendix B – SCI-204 Exploratory Team Questionnaire Summary Results

Twenty two questionnaires were received from eight countries representing input from military, civil academia, and professional societies directly associated with flight testing. General answers to the 30 questions revealed that aeronautical, mechanical, and electrical engineering undergraduate degrees were overwhelmingly preferred for aspiring FTEs with Test Pilot School types of specialized short courses utilized for formal training. This training was coupled with two-five years of practical experience including flight monitoring, test card preparation, flight conduct control and direction, and detailed test planning and reporting to achieve a mature "journeyman" level of FTE performance.

The questionnaire responses endorsed further definition of FTE roles, responsibilities, and educational guidelines but did not endorse certification at that time. Limited career progression opportunities within the field of flight test engineering was cited as a retention problem as was transference of specific FTE skills from one site to another because of unique test center instrumentation, range, and test approval processes.

Questionnaire and exploratory team results promoted continuation of SCI-204 workshops to further identify FTE experience level and education issues.

Appendix C – SCI-204 Workshop Agendas

Program Overview:

One-day technical specialist workshops open to NATO/PFP Nations.

Technical Presentations from:

- Professional Societies (Society of Flight Test Engineers, Society of Experimental Test Pilots)
- Academia (Undergraduate Aeronautical, Flight Test Curricula)
- Test Pilot Schools
- Test Centers (US Navy, US Air Force, Boscombe Down)
- Industry (Civil, Military)
- Regulatory (EASA, FAA)

Wrap-up Session

Two Separate Workshops:

- North America – Washington DC
- Europe – London

Workshops held concurrent with SFTE Symposium and Flight Test Safety Workshop to enhance attendance and participation

SCI-204 North American Workshop
Washington DC
17 September 2010

0800	Welcome and Introduction	Mr. Rusty Lowry (Flight Test Technical Team – FT3)
0815	Academic	Dr Chuck Hall (NC State University)
0845	Test Pilot School	LtCol Tim Jorris (USAF Test Pilot School)
0930	Industry	Mr. Al Lawless (Hondajet)
1000	Flight Test Center	Ms. Leslie Taylor (US Naval Air Systems Command)
1030	Professional Society	Mr. Pete Donath (Society of Flight Test Engineers)
1115	Question and Answer Panel	ALL
1145	Wrap Up	Mr. Rusty Lowry (FT3)

SCI-204 European Workshop
West London, England
30 September 2010

0900	Introduction and SCI-204 Update	Mr. Rusty Lowry (FT3)
0930	Academic	Dr Guy Gratton (Brunel University)
1000	Test Pilot School	Mr. Rusty Lowry (US Naval Test Pilot School)
1030	Industry	Mr. Dennis Morley (BAE Systems) Mr. Christian Buck (Saab) Serdar Cora (Turkish Aerospace Industries)
1200	Test Center	Mr. Pat Svatek (US Naval Air Systems Command)
1230	Professional Society	Mr. Billie Flynn (Society of Experimental Test Pilots)
1245	Questions and Wrap Up	Mr. Rusty Lowry (FT3)
1300	Brunel University Tour	