ENGINEERING COUNCIL OF SOUTH AFRICA *Standards and Procedures System*			
Discipline-specific Training Guideline for Candidate Engineers in Aeronautical Engineering			
Status: Approved by Registration Committee for Professional Engineers			
Document : R-05-AER-PE	**Rev-1**	**12 March 2013**	

Background: ECSA Registration System Documents

The documents that define the Engineering Council of South Africa (ECSA) system for registration in professional categories are shown in Figure 1 which also locates the current document.

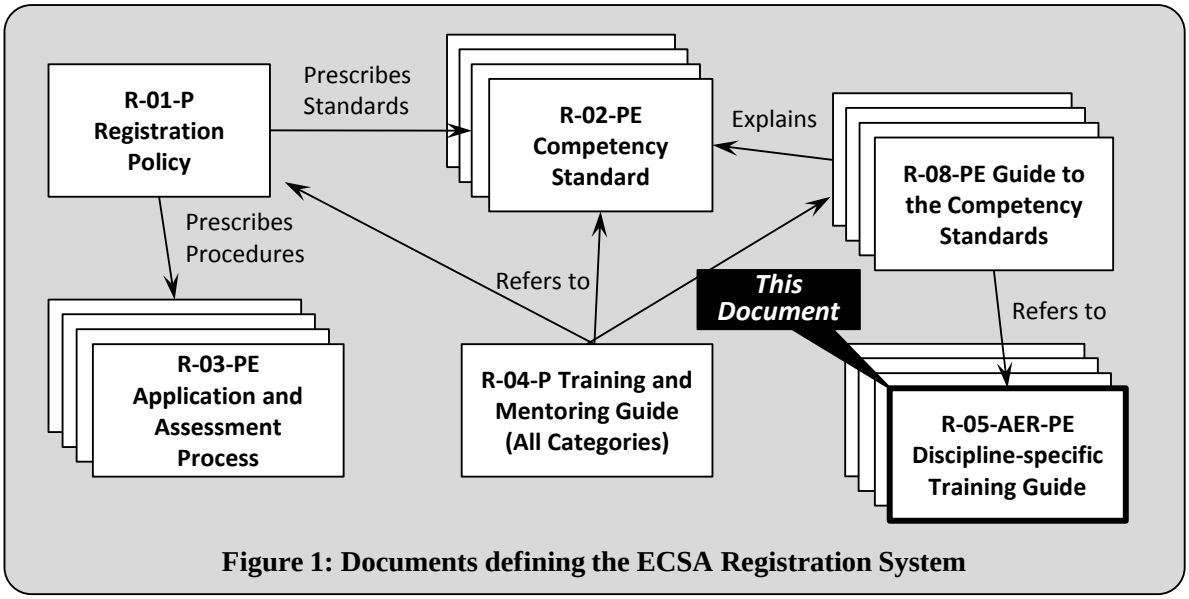

Figure 1: Documents defining the ECSA Registration System

1. Purpose

All persons applying for registration as Professional Engineers are expected to demonstrate the competencies specified in document R-02-PE at the prescribed level, irrespective of the trainee's discipline, through work performed by the applicant at the prescribed level of responsibility.

This document supplements the generic *Training and Mentoring Guide* (R-04-P) and the *Guide to the Competency Standards for Professional Engineers* (R-08-PE). In document R-04-P attention is drawn to the following sections:

- 7.3.2 Duration of training and period working at level required for registration
- 7.3.3 Principles of planning training and experience
- 7.3.4 Progression of Training programme
- 7.3.5 Documenting Training and Experience
- 7.4 Demonstrating responsibility

The second document R-08-P provides both a high-level and outcome-by-outcome understanding of the competency standards as an essential basis for this discipline specific training guide.

This Guide, as well as documents R-04-P and R-08-PE, are subordinate to the Policy on Registration (R-01-P), the Competency Standard (R-02-PE) and the application process definition (R-03-PE).

2. Audience

This guide is specifically for engineers who have studied aeronautical engineering and practice as aeronautical engineers. It is also applicable to engineers who studied in other disciplines, but whose work is primarily in the aeronautical field and who wish to be assessed for professional registration based on their work in an aeronautical environment. The Guide is intended to support a programme of training and experience incorporating good practice elements. See footnote regarding Marine Engineering and Naval Architecture[1].

This guide applies to persons who have:

1. Completed the education requirements by obtaining either an accredited BEng-type qualification, or a Washington-Accord Recognised qualification or through evaluation/assessment;
2. Registered as Candidate Engineers;
3. Embarked on a process of acceptable training under a registered Commitment and Undertaking (C&U) with a mentor guiding the professional development process at each stage;

This guide is written for the recent graduate who is training and gaining experience toward registration. Mature applicants for registration may apply the guide retrospectively to identify possible gaps in their development.

3. Persons not Registered as a Candidate or not Training under a C&U

All applicants for registration must present the same evidence of competence and be assessed against the same standards, irrespective of the development path followed. Application for registration as a Professional Engineer is permitted without being registered as a Candidate Engineer and without training under a C&U. Mentorship and adequate supervision are, however, key factors in effective development to the level required for registration. A C&U indicates that the company is committed to mentorship and supervision.

If the trainee's employer has no C&U, the trainee should establish the level of mentorship and supervision the employer is able to provide. In the absence of an internal mentor, the services of an external mentor should be secured. The Voluntary Association for the discipline should be consulted for assistance in locating an external mentor. A mentor should be in place at all stages of the development process.

Any applicant who has not enjoyed mentorship is advised to request an experienced mentor (internal or external) to act as an application adviser while they prepare their application for registration.
The guide may be applied in the case of a person moving into a candidacy programme at a later stage that is at a level below that required for registration (see section 7).

[1] Because of the small number of candidates in the field of Marine Engineering and Naval Architecture, the Aeronautical Engineering Professional Advisory Committee will evaluate applications in this field. ECSA does not have discipline-specific training guideline in Marine Engineering and Naval Architecture. Candidates and their mentors may make use of the guidelines given in this document with the appropriate transpositions of subject matter.

4. Aeronautical Engineer (OFO 214403)

An *Aeronautical Engineer* performs and supervises engineering work concerned with the design, development, manufacture, operation and maintenance of aircraft and spacecraft of all types based on the engineering sciences underlying flight dynamics, aerospace structures and propulsion systems.

Practising *Aeronautical Engineers* generally concentrate in one or more of the following areas:

- Aeronautical Design Engineer
- Aeronautical Systems Engineer
- Aeronautical Certification Engineer
- Aeronautical Flight Test Engineer
- Aeronautical Research Engineer or Academic

5. Training Implications of Industry Structure

Many engineers in the aerospace industry, particularly those working in a highly technical environment, tend to become specialists. Those working in areas such as manufacture, maintenance and project management tend to be generalists. Specialists, through their interaction on projects with persons from other specialist areas, should as a consequence also gain practical experience also outside their specialist area.

Those aeronautical engineers whose training has been more general should demonstrate that they have acceptable experience in a number of specialist areas (typically 5) for a minimum period of three years. Specialist aeronautical engineers, however, should demonstrate that they have had in-depth experience, of typically five years, in at least one area of aerospace engineering and acceptable experience in a number of other areas.

Typical aerospace specialist areas are:

- Aircraft design
- Aircraft structures
- Aircraft propulsion systems
- Aerodynamics
- Avionics
- Aero-elasticity
- Stability and control
- Aircraft systems including hydraulic, pneumatic and avionic systems
- Wind tunnel testing
- Flight testing
- Aircraft performance monitoring
- Airport/Airfield management
- Certification and system safety programmes

Because of the complex nature of aeronautical systems, any given product or system will usually have components designed by engineers in many of the specialist areas. Work done by any engineer in the field may frequently cross the boundaries between disciplines and specialist areas or at least will be influenced by interfaces with other disciplines.

Because of the complex nature and long life cycles of aeronautical systems, Candidate Engineers are expected typically to have gained in depth experience in at least one of the lifecycle phases (such as development, design, manufacturing or operation & maintenance) of aeronautical systems. Even though it is not required that all Candidate Engineers have had in depth design experience, it is required that all Candidates must have demonstrated their ability to solve complex aeronautical problems, as explained in document R-08-PE. Solving such problems would typically require the application of aeronautical engineering sciences and the application of engineering judgement.

Since the aeronautical industry routinely involves significant risks, it is a highly regulated industry. All Candidate Engineers are, therefore, expected to have gained exposure to the regulatory aspects relevant to the work they have been involved in. Candidates are further expected to have demonstrated making sound judgements to address and mitigate risks in an aeronautical environment, and thereby not unnecessarily endanger users of their systems or the general public. Such considerations of risks should particularly include situations where technologies (such as materials and control systems) are rapidly developing and the software used for design and operations is increasingly complex.

Candidates are expected to demonstrate appreciation that practising as a professional engineer is a life-long process of learning and improvement. Candidates are, therefore, expected to show how, during their training period, they improved their abilities to make sound judgements and manage risks in the presence of rapidly developing technologies.

In assessing the suitability of a Candidate, the cross-disciplinary nature of their work will be examined, as well as the degree to which they have been able to work effectively in such contexts. The degree to which they have demonstrated that they are able to know their own limits and call in the help of specialists, for example, illustrates their ability. Candidates must demonstrate that they also know enough about other disciplines/specialist areas influencing their work to properly understand and manage the risks arising from those influences.

6. Good Practice in Training in Aeronautical Engineering

In order to assist Candidates in gaining the necessary training and experience/exposure, the following guidelines are given of the type of activities that should be engaged in during the time prior to registration.
These guidelines are illustrative and candidates will not be expected to do all of the suggested training activities before registration, but should do many of them to ensure that adequate experience is obtained.

6.1 Aeronautical Design Engineers

Aeronautical design engineers are those involved with the design of aircraft or aircraft systems. These would be engineers performing actual design, such as preliminary design, performance predictions, aerodynamic design, structural design, power plant trade-off studies, control system design, etc. These are activities in which products/systems are designed to meet particular needs/specifications/standards.

The following types of activities are recommended for training of Aeronautical Design Engineers:

Type of Experience	Specific Activities
Problem/Requirements Definition	• Formulation of User Requirement Statements (URS) • Generate performance specifications (Specs) • Qualification/verification matrix design *(Use Standards/Specifications/Handbooks to guide in preparation of above documents.)*
Project Planning (for design)	• Resource Planning (computing/drafting/manufacturing, etc.) • Timescales, Critical Path, identification of bottlenecks/critical milestones, etc.
Examination of Alternatives	• Literature Study • Identifying potential techniques/technologies/materials • Generation of concepts • Elimination of unsuitable alternatives • Preliminary performance prediction
Trade-off Studies	• Using decision making tools to select between viable alternatives • Examining impacts of alternatives on ability to meet URS/Specs • Negotiate with customers wrt requirement trade-offs and reformulation of URS/Specs
Detailed Design	• Material selection • Aerofoil & high lift devices selection • Selection of components/sub-systems • Structural/aerodynamic/mechanical design • Performance prediction • Stress analysis • Aerodynamic analysis • Stability and control analysis and design • Hazard and Operability (HAZOP) studies • Failure Modes Effects and Criticality Analysis (FMECA) • Updating of specifications • Maintenance requirements design
Design Documentation	• Generation of drawings • Generation of design reports • Updating of documents/specifications as design progresses • Configuration control
Supervision of Production	• Design of processes/tests • Handling of engineering queries/concessions/deviations • Design & implementation of quality control methods • Handling of materials • Handling of scrap/reworkable items, etc
Verification Testing	• Qualification/verification test planning • Qualification/verification testing • Test report writing • Commissioning of plants/equipment
Product Support	• Support during production testing • Support during operational testing & evaluation • Management of upgrades/repairs

6.2 Aeronautical System Engineers

Aeronautical system engineers are those involved with the specification, in-service management and fleet engineering of aircraft or aircraft systems. These would typically be engineers in organisations who operate fleets of aircraft and who are responsible to ensure continued airworthiness of the fleet and addressing obsolescence issues. These engineers operate subject to regulations and regulating bodies such as the Civil Aviation Authority.

The following types of activities are recommended for training of Aeronautical System Engineers:

Type of Experience	**Specific Activities**
Maintaining Airworthiness	• Identification & implementation of relevant Service Bulletins • Implementation of Airworthiness Directives • Implementation of Ageing Aircraft Programmes • Health and Utilisation Monitoring • Failure Reporting and Corrective Action (eg FMECA/FRACAS)
Maintenance Optimisation	• Staggering (Fleet Utilisation & Maintenance Scheduling) • Negotiation with Original Equipment Manufacturers to adapt ervicing for fleet specific requirements • Trend monitoring and maintenance adaptation • Engineering management of suppliers and sub-contractors
Fleet Optimisation	• Fleet redesign and adaptation • Route planning for optimal fleet utilisation
Maintaining Fleet Currency	• Aircraft Configuration Currency Analysis • Trade-off studies between cost and return of upgrades/retrofits vs fleet replacements • Aircraft Configuration Control
Acquisition/Procurement Projects	• Requirements definition for new products & systems • Integration of new weapons/equipment on existing aircraft • Design review activities • Selection and implementation of upgrades (typically such as would be covered under Supplemental Type Certificates) • Management of flight test and other acceptance testing activities • Oversight of suppliers during development activities (eg weapons development) • Monitoring compliance with Certification Compliance Matrixes • Commissioning of ground systems and support equipment (simulators, new maintenance equipment, etc)

6.3 Certification Engineers

Certification engineers are those involved with ensuring that aircraft systems meet the requirements of Airworthiness Regulations. These would typically be engineers employed by the Civil Aviation Authority or within companies requesting certification of their products and whose responsibility it is to ensure compliance with certification requirements.

The following types of activities are recommended for training of Certification Engineers:

Type of Experience	Specific Activities
Compliance Testing	• Consultation with clients and other aviation authorities wrt airworthiness requirements and regulations. • Setting up Compliance Matrixes • Oversight of flight test and other acceptance testing activities • Oversight of suppliers during development activities (eg weapons development)
Systems Background	• Training in systems on one or more aircraft types • Troubleshooting & fault analysis • Use of design specifications during design or certification planning • Floor level exposure to all aspects of aircraft maintenance • Participation in software development and certification
System Safety Analysis	• Training in and application of the system safety process • Application of fault tree, HAZOP, FMEA / FMECA and equivalent safety procedures
Organisational Audits	• Advising organisations in creating and implementing their Manuals of Procedures • Quality systems and special process audits • Periodic auditing of approved manufacturing and maintenance organisations
Monitoring Compliance with Airworthiness Directives, etc	• Ensuring approved organisations and fleet operators implement applicable Airworthiness Directives • Auditing/monitoring correct implementation of Service Bulletins/ Ageing Aircraft Programmes
Accident Investigations	• Serving as part of accident investigation teams • Overseeing accident investigations • Review & analysis previous accident investigation reports for similarities/trends • Writing accident investigation reports
Generation of Regulations	• Review existing regulations • Generate or update regulations

6.4 Flight Test Engineers

Flight Test engineering is a specialist field requiring first an engineering degree and then additional training as Flight Test Engineer at one of the Test Pilot/Engineer schools. Flight Testing forms part of product development as well as verification testing towards certification of aircraft and systems.

The following types of activities are recommended for training of Flight Test Engineers:

Type of Experience	Specific Activities
Flight Testing and Ground Testing	• Determination of relevant and necessary tests • Compilation of Test Objectives and Test Plans • Development of new testing techniques & equipment • Modifications to test aircraft • Performance testing and data analysis • Flutter Clearance testing and data analysis • Cockpit evaluation

Client Liaison	• Negotiations wrt flight testing • Writing of Flight Test Reports • Presentation of test results

6.5 Research Engineers and Engineering Academics

Research Engineers and Academics are those employed by universities and research organisations. Their focus is on development of new knowledge/techniques/technologies and in teaching students.

The following types of activities are recommended for training of Aeronautical Research Engineers and Academics Engineers:

Type of Experience	**Specific Activities**
Teaching	• Reading in applicable fields of knowledge • Curriculum development • Selection and development of teaching materials • Compilation of lecture notes • Compilation of examination papers • Demonstration of application of theory in practice • Serve as supervisor for student projects
Study & Research	• Literature study • Obtaining higher qualifications • Advancement of the current state of the art of technology • Theoretical research/development of analytical techniques • Practical/experimental research • Participating in international collaborative research
Laboratory/experimental work	• Experimentation • Design and building of laboratories • Experimental equipment design/construction • Experiment design • Development of new manufacturing techniques • Development of Non-Destructive Testing techniques • Ground vibration testing • Wind-tunnel testing • Material/structural testing
Conferences, Symposia, etc	• Publishing papers (peer-review journals and international conferences) • Public peaking, etc
Consulting	• Consulting to industry in solving real problems encountered in engineering practice • Design of products/components/systems for clients

7. Moving into or Changing Candidacy Programmes

This Guide assumes that the candidate enters a programme after graduation and continues with the programme until ready to submit an application for registration. It also assumes that the candidate is supervised and mentored by persons who meet the requirements in document R-04-P section 7.2. In the case of a person changing from one candidacy programme to another or moving into a candidacy programme from a less structure environment, it is essential that the following steps be completed:

- The candidate must complete the Training and Experience Summary (TES) and Training and Experience Reports (TER) for the previous programme or unstructured experience. In the latter case it is important to reconstruct the experience as accurately as possible. The TERs must be signed off.
- On entering the new programme, the mentor and supervisor should review the candidate's development in the light of the past experience and opportunities and requirements of the new programme and plan at least the next phase of the candidate's programme.

Revision History

Version	Date	Revised/Approved by	Nature of Revision
Rev 0: Concept A	15 Nov 2011	PAC Aero	Initial compilation of DSTG
Rev 0: Concept B		JIC	Working document for 23 July 2012 Workshop
Rev 0: Concept C	23 July 2012	PAC Aero	Product of 23 July Workshop
Rev 0: Concept D	29 Oct 2012	JIC for submission to Reg Committee	Sections 1-3 put in standard form
Rev 0: Concept E	15 Jan 2013	To Reg Committee	Minor amendments
Rev 1	12 Mar 2013	Registration Committee for Professional Engineers	