

Code of Practice for the Performance of Aeronautical Engineering Work

R-02-COP-AER

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DEFINITIONS

In this Code, any word or expression defined in the Act has that meaning, unless the context dictates otherwise:

Act means the Engineering Profession Act, 46 of 2000.

Aeronautical Engineer means a Professional Engineer registered in terms of 18(1)(a)(i) of the Act who has experience specifically in the 11 practice areas of Aeronautical Engineering.

Aeronautical Engineering Practitioner means an engineering graduate from either Aeronautical or Mechanical Engineering who undertakes the Aeronautical Engineering Work in the capacity of Engineer, Technologist and Technician. These persons must be registered in terms of section 18(1)(a) or section 19(2)(b) of the Act to undertake the Aeronautical Engineering Work.

Aeronautical Engineering Specialist Work means Aeronautical Engineering Work that requires training, knowledge and experience outside the normal education curriculum and beyond that which is obtained in the general practice of the profession.

Aeronautical Engineering Work means Engineering Work identified in terms of section 26 of the Act, specifically in the discipline of Aeronautical Engineering.

Candidate means a person who is registered in terms of section 19(2)(b) of the Act.

Category of registration means the categories of registration provided for in section 18(1)(a) of the Act, i.e., Professional Engineers, Professional Engineering Technologists, Professional Certificated Engineers and Professional Engineering Technicians.

Code of Conduct means the code of conduct for registered persons in terms of Act.

Competent Person means a person who has the required knowledge, training, experience and, where applicable, qualifications specific to the work or task being performed, provided that, where appropriate, qualifications and training are registered in terms of the provisions of the National Qualification Framework Act, 67 of 2008, those qualifications and that training are regarded as the required qualifications.

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Discipline means the disciplines of engineering as recognised by ECSA.

ECSA Council means the Engineering Council of South Africa established in terms of section 2 of the Act.

Engineering Work means the work identified means the process of applying engineering and scientific principles, concepts, contextual and engineering knowledge to the research, planning, design, implementation and management of work in both the natural and built environments in terms of section 26 of the Act.

Flight Testing means a specialised branch of aeronautical engineering that focuses on developing specialised equipment required for testing of the aircraft performance and associated systems and sub-systems in flight.

Ground testing means a series of tests carried out on the aircraft systems and sub-systems on the ground before undergoing first flight.

Identification of Engineering Work means the Identification of Engineering Work as gazetted.

Overarching Code of Practice means the Overarching Code of Practice for the Performance of Engineering Work as gazetted.

Registered Person means a person registered with the Engineering Council of South Africa in terms of the Act under one of the categories referred to in section 18.

Risk means the effect of uncertainty on the objectives of a design; it is expressed in terms of a combination of the consequences of an event and the likelihood of occurrence.

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ABBREVIATIONS

CAD	Computer-aided design	
CAM	Computer-aided manufacturing	
CFD	Computational fluid dynamics	
СОР	Code of practice	
CPD	Continuing professional development	
DSTG	Discipline-specific Training Guide	
ECSA	Engineering Council of South Africa	
FEA	Finite element analysis	
НМІ	Human machine interface	
HUMS	Health and usage monitoring system	
NDT	Non-destructive testing	
Pr Eng	Professional Engineer	
Pr Tech Eng	Professional Engineering Technologist	
Pr Techni Eng	Professional Engineering Technician	
RCA	Root cause analysis	
SOP	Standard operating procedure	

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1. INTRODUCTION

This Code of Practice has been developed by the Engineering Council of South Africa (ECSA) to supplement the Code of Conduct for Registered Persons: Engineering Profession Act, 46 of 2000.

Section 27 of the Engineering Profession Act, 46 of 2000, empowers ECSA to draw up codes of practice in addition to codes of conduct and requires all registered persons to comply with such codes. While codes of conduct regulate behaviour, codes of practice regulate engineering practice.

The Code also details the ethical values and professional standards that ECSA expects all registered persons to adhere to as prescribed under the Code of Conduct for registered persons in terms of the Act.

Section 18(1) of the Act provides for the registration of professionals and candidates in four categories of registration: Professional Engineers, Professional Engineering Technologists, Professional Engineering Technicians, Professional Certificated Engineers, and registration in Specified Categories as prescribed by Council. Section 18(2) prohibits persons so registered from practising in a category other than that in which they are registered.

In line with these requirements, this Code of Practice classifies Engineering Work in the sub-discipline of Aeronautical Engineering in terms of its complexity and stipulates the category of registration and the level of competence required for the execution of such work.

2. POLICY STATEMENT

This Code is a statement of good practice for the performance of Aeronautical Engineering Work by Registered Persons. It is applicable to the discipline of Aeronautical Engineering Profession. Section 27(3) of the Act requires Registered Persons to adhere to the requirements of this Code when they perform mechanical work.

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Furthermore:

- (a) It classifies Aeronautical Engineering Work according to the complexity of the problem, the nature of the environment, the methods employed, the risks involved and the consequences of failure.
- (b) It sets out the level of competence required from persons registered in any of the categories of registration provided for in Section 18(1) of the Act for the performance of Aeronautical Engineering Work of varying complexities.
- (c) This Code stipulates requirements for the practice of Aeronautical Engineering Work and provides a statement of recognised good practice.
- (d) Where a Code, Act or Policy is referenced, the latest version thereof applies.

3. PURPOSE

The purpose of this Code of Practice is to ensure that any person undertaking Aeronautical Engineering Work meets the prescribed requirements when practising and executing Aeronautical Engineering Work within the jurisdiction of the Act. This Code also sets appropriate levels of competence regulating the execution of Aeronautical Engineering Work and specifying technical standards and best practice. Among others, this Code of Practice ensures the following:

- (a) Registered persons apply their specialised knowledge within their competence and skill in accordance with all relevant legislation.
- (b) All Aeronautical Engineering Work is performed by a competent person and uniform competency and conduct standards apply to all registered persons.
- (c) Aeronautical Engineering Work is performed in accordance with generally accepted norms and standards of the Aeronautical Engineering profession.
- (d) Registered Persons apply their specialised knowledge and skill within their respective area of competence to ensure that engineering practice is appropriate, applicable, acceptable, affordable and sustainable.

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4. APPLICABLE LEGISLATIVE FRAMEWORK

Section 27 of the Act empowers the Council to draw up codes of practice in addition to codes of conduct and requires all registered persons to comply with such codes.

This Code should be read in conjunction with the following:

- Engineering Profession Act, 46 of 2000, as amended
- ECSA Code of Conduct, as amended
- Occupational Health and Safety Act, 85 of 1993, as amended
- ECSA Overarching Code of Practice for the performance of Engineering Work, as amended
- Identification of Engineering Work Regulations, as amended
- All other relevant and applicable legislation.

5. AERONAUTICAL ENGINEERING WORK

Aeronautical Engineering is that branch of engineering that deals with the design, development, build, testing, production and maintenance of all types of flight vehicles and related systems.

This type of engineering involves applied mathematics, physics, theory, knowledge and problem-solving skills to transform flight-related concepts into functioning aeronautical designs that are then built and operated.

Aeronautical Engineering Work requires a strong understanding of core areas that typically include scientific principles of flight mechanics, computational fluid dynamics, combustion and propulsion, aerospace structures, materials, mathematics and physics.

In addition, Aeronautical Engineering Professionals use tools such as computer-aided design (CAD), computer-aided manufacturing (CAM), finite element analysis (FEA), computational fluid dynamics (CFD), bespoke code, spreadsheets and first principles engineering tools and wind tunnel technologies.

Aeronautical Engineers are generally appointed in one or more of the following positions:

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

Aeronautical Engineering Technicians and Technologists are appointed in the roles similar to abovementioned positions at an appropriate level of complexity as prescribed in **R-05-AER-PT** and **R-05-AER-PN** respectively.

5.1 Range of Aeronautical Engineering problems and activities

For the purposes of this Code, engineering problems and activities are classified as complex, broadly defined, well-defined and specifically defined problems. The basis of the classification of engineering problems is given in the R-02-STA-PE/PT/PCE/PN and R-02-STA-SC documents, available on the ECSA website.

Aeronautical Engineering Work may, in terms of **Table 1**, be classified as work executed in one or more of the Fields/Areas in Column 2, involving one or more of the activities listed in Column 3 and making use of one or more of the Methods/Tools in Column 4. **Table 1** is a guideline and not an exhaustive list of Fields/Areas, Activities or Methods/Tools.

Table 1: Aeronautical Engineering Work

Number (Column 1)	Field/Area (Column 2)	Activities (Column 3)	Methods/Tools (Column 4)
1	Aircraft Design	Conceptual designPreliminary designDetailed design	 Brainstorming First principles engineering methods CAD CAM CFD FEA
2	Aircraft Structure	Fabrications	• CAD

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Number (Column 1)	Field/Area (Column 2)	Activities (Column 3)	Methods/Tools (Column 4)
		Re-engineeringRepairsModifications	CAMFirst principles analysisNDTFabrication toolsFEA
3	Aircraft Propulsion Systems	 Design Re-engineering Upgrade and optimisation Repairs Manufacture Modifications 	 CAD CAM FEA CFD NDT First principles analysis Heat transfer analysis Rotor dynamics Materials selection and development Manufacturing simulations
4	Aerodynamics	Aircraft designAirfoil selectionDrag reduction	Wind tunnel testingCFDFirst principles analysis
5	Avionics	 Automation of avionics control Re-engineer obsolete systems Software optimisation and upgrade Fabrication 	 Analysis of control response Ergonomic analysis Flight and ground testing Simulators Hardware in the loop ground test
6	Aeroelasticity	Flutter analysis and testing	 Structural response analysis Ground vibration testing Wind tunnel testing Flight testing
7	Stability and Control	Control optimisation	Wind tunnel testing

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Number (Column 1)	Field/Area (Column 2)	Activities (Column 3)	Methods/Tools (Column 4)
		 Wings and winglets re-engineering Structural re-design Stabilisation of hydraulic control 	Flight testingHardware in the loopSimulators
8	Aircraft systems (hydraulic, pneumatic and avionics)	 Response time optimisation Automate auxiliary hydraulic and pneumatic control systems 	Flight testingGround testingTest bench systems
9	Wind-tunnel testing	 Aerodynamic characterisation Measurement of aerodynamic coefficients Airflow optimisation Flow visualisation Flutter testing Force and pressure measurements Aerodynamic damping tests 	 Wind tunnels Balances Various visualisation techniques, including tufts, oil flow, particle image velocimetry etc Various Static and dynamic force measurement Dynamic test rigs
10	Flight Test Engineering	Testing CriteriaGround TestingFlight Testing	 Ground and flight test techniques. Data analysis techniques Software programs for data reduction: Matlab, MS Excel, Python, etc.
11	Aircraft Performance Monitoring	 Fuel consumption or efficiency Flight hours Rate of incident Flight data monitoring Health and usage monitoring system (HUMS) 	Performance software Human machine interface (HMI)

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Number (Column 1)	Field/Area (Column 2)	Activities (Column 3)	Methods/Tools (Column 4)
12	Airport/Airfield management	 Scheduling and logistics Maintenance of runways, Lighting and other airfield components and systems. Equipment operations and maintenance 	Airport management software Terminal management Software for the maintenance and monitoring of assets, buildings, electrical grids, environmental systems.
13	Certification and System Safety Programmes	 Ground testing Flight testing	 Ground and flight test techniques. Data analysis techniques Software programs for data reduction: Matlab, MS Excel, Python, etc.
14	Flight operations and technical support	Scheduling and maintenance logistics	Scheduling software
15	Research and Development	Any of the above activities performed for the purposes of generating new, local or international knowledge and innovation	All the above
16	Academic Teaching and Learning	 Generation of course material Lecturing of related aeronautical topics Supervision of student research projects 	Lectures and supervision of activities listed above

5.2 Aeronautical Engineering sub-disciplines

The Aeronautical Engineering sub-disciplines ECSA recognises are provided in the Discipline-specific Training Guides R-05-AER-PE, R-05-AER-PT and R-05-AER-PN for each category of registration. These can be found on the ECSA website.

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5.3 Categories of registration

Aeronautical Engineering professionals' category of registration is determined by the Council in terms of Section 18(1) of the Act. The categories of registration include:

- Professional Engineer (Pr.Eng) registered in terms of Section 18(1)(a)(i) of the Act
- Professional Engineering Technologist (Pr.Tech Eng) registered in terms of Section 18(1)(a)(ii) of the Act
- Professional Engineering Technician (Pr.Techni Eng) registered in terms of Section 18(1)(a)(iv) of the Act
- Specified Category Practitioner registered in terms of Section 18(1)(c) of the Act
- A candidate registered in terms of Section 18(1)(b) of the Act.

5.4 Overlaps

The Aeronautical Engineering Practitioners must comply with respective legal requirements and the requirements of this Code of Practice when performing Aeronautical Engineering Work.

Persons registered in a particular discipline may perform Engineering Work in a different discipline if their knowledge, training, experience and applicable qualifications specifically render them competent to perform such work. Specifically in this Code, Aeronautical Engineering Practitioners must work with other engineering disciplines to ensure that confusion is minimised regarding which engineering discipline should perform certain tasks, as per Paragraph 7.3 of the **Overarching Code of Practice for Performance of Engineering Work**.

6. AERONAUTICAL ENGINEERING COMPETENCY REQUIREMENTS

The Core Competencies Required to Perform Identified Engineering work can be found in the gazetted "Identification of Engineering Work"; the General Requirements and Requirements for Registered Persons are listed in the "Overarching Code of Practice".

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6.1 General requirements

- (a) Any person who performs Aeronautical Engineering Work must be registered with ECSA in the appropriate professional registration category and must comply with the Act, as well as any requirement contemplated in the Act.
- (b) All Aeronautical Engineering Work must be carried out by a competent Aeronautical Engineering Registered Person who is qualified by virtue of knowledge, training, experience and applicable qualifications to perform such work.
- (c) All Registered Persons must confine their performance of Aeronautical Engineering Work to the areas in which they are competent, subject to the provisions of (b) above.
- (d) All Registered Persons must undertake continuing professional development (CPD) or independent learning activities sufficient to maintain and extend their competence in line with current good practice in the industry.
- (e) Registered Persons' competence and the nature of the work they are competent to perform should be assessed in terms of the criteria applicable to them.

6.2 Criteria for assessment of competency

The criteria for assessing competency are defined in the ECSA Competency Standard for Registration in Professional Categories as **PE/PT/PN** (**R-02-STA-PE/PT/PN**) and **R-02-STA-SC**.

6.3 Competence levels

Engineers' competency level varies depending on their level of education, experience and specialised skills. Generally, there are three levels of engineering competency, as listed in the Table 2 below.

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Table 2: Engineering competency levels

Competency Level	Description	Responsibility	Experience & Registration	Risk Level
Junior	Refers to recently graduated or Candidate Technicians, Technologists and Engineers. They are typically assigned routine tasks and require close supervision from more experienced Technicians, Technologists or Engineers.	Juniors are responsible for executing tasks assigned by their supervisors. They are expected to learn the basics of engineering design, analysis and testing.	0–3 yearsCandidate	Low
Senior	Seniors have several years (at least 5 years) of experience in their field and have demonstrated proficiency in their work. They are capable of managing complex projects and providing technical guidance to junior engineers.	Senior engineering practitioners are responsible for overseeing projects from conception to completion. They are expected to analyse data, provide solutions to problems and ensure that projects are completed within budget and on time.	 5–10 years Pr.Eng Pr.Tech Eng Pr.Techni Eng 	Medium
Competent	These are the most experienced engineering practitioners in a company or project team. They have extensive knowledge of their field and are responsible for managing large-scale projects.	Competent engineering practitioners are responsible for managing teams of engineers, developing project timelines and budgets, and overseeing the design and implementation of complex systems.	 More than 10 years Pr.Eng Pr.Tech. Eng Pr.Techni. Eng 	High

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6.4 Risk analysis

Aeronautical Engineers must perform thorough risk analyses, which are crucial elements of the design process to ensure the safety of aircraft and passengers. Risk mitigation must include the structured process of:

- identifying potential hazards
- assessing their likelihood and severity
- implementing measures to reduce or eliminate them.

This process includes performing safety analyses, developing safety requirements and designing safety-critical systems. Impact mitigation involves designing aircraft systems and structures to withstand potential impacts, such as bird strikes or lightning strikes. This process includes performing impact analyses, designing structures and systems with sufficient strength and redundancy and implementing safety measures such as fire suppression and emergency response procedures.

Both risk and impact mitigation require a thorough understanding of aircraft systems, their failure modes and their potential interactions with other systems. Aeronautical engineers use advanced computer simulations, testing and analysis techniques to identify potential risks and impacts and design aircraft systems to mitigate them.

6.5 Risk levels

Aeronautical has three risk levels: low, medium and high. These risk levels are determined by the potential consequences of a failure or error in the system.

Table 3: Risk Levels

Risk Level	Scenario	Example	Impact
Low	Refers to scenarios where the consequences of a failure are minor, such as a small decrease in performance or a minor inconvenience.	A minor malfunction in an aircraft's entertainment system would be considered low risk.	 No media coverage. Defect can be resolved without impacting operation.

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Risk Level	Scenario	Example	Impact
Medium	The consequences of a failure are more significant, such as an interruption in service or a loss of function.	A malfunction in the landing gear of an aircraft would be considered a medium risk.	 Trigger investigation by local aviation authority. Defect impact operation of specific fleet or type for short period of time. Minor penalty imposed by aviation authority. Local media coverage.
High	The consequences of a failure are severe, such as a loss of life or catastrophic damage to the system	An engine failure just after rotation or anywhere during flight would be considered high risk.	 Grounding of airline or fleet for extended period. Substantial impact to national and regional aviation industry. Hefty fines and penalty imposed. International media coverage.

It is critical to identify and assess the risk level of each situation to ensure appropriate safety measures are in place and to minimize the potential consequences of failures or errors in the system.

7. AERONAUTICAL ENGINEERING GOOD PRACTICE

7.1 General good practice

All work carried out or services rendered must be performed:

- in accordance with accepted norms and standards of Aeronautical Engineering
- in an ethical and responsible manner in accordance with the ECSA Code of Conduct
- within the area of competency with honesty, fidelity and integrity
- in accordance with all applicable legislation, Acts and standards

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Prior to taking a role in Aeronautical Engineering, Aeronautical Engineering Registered Persons must ensure that they possess the competencies required to undertake the work.

Prior to undertaking any task, Aeronautical Engineering Registered Persons must ascertain and document:

- the purpose of the activities
- the approach to be used in executing the activities
- the performance requirements for the activities
- any statutory, regulatory or other requirements that may pertain to the activities.

The Aeronautical Engineering Registered Person must consider the likely variation in input parameters and the accuracy of the models or methods used in the execution of all engineering analyses.

All calculations must be independently checked, either by another suitably qualified registered person or by alternative calculation methods.

Prior to approving any work or signing any completion certificate, Aeronautical Engineering Registered Persons must ensure sufficient detailed checks or inspections to warrant such approval. Where the checks or inspections were limited in any way or carried out by a third party, the approval must be qualified accordingly.

7.2 Health, safety and environment

All Aeronautical Engineering Work must be done in accordance with the following:

- Occupational Health and Safety Act, as amended
- National Environmental Management Act, as amended
- Any other applicable legislation.

Cognisance must be taken of health and safety requirements from planning to completion of work.

The environmental impact of all Aeronautical Engineering Work should be assessed, and appropriate measures taken to minimise such impacts or to remediate areas so impacted.

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Aeronautical Engineering Registered Person must involve relevant expertise when identified impacts are outside their area of expertise.

The client must be notified immediately of any condition that is observed that may compromise the health and safety of persons or the environment.

7.3 Ethical considerations

Registered Persons must comply with the ECSA Code of Conduct.

Cognisance should be taken of any potential social and cultural impacts of the Aeronautical Engineering Work on the communities within which work is conducted.

The client must be notified immediately of any condition that is observed that may result in social or cultural impacts.

7.4 Standards and codes of practice

All Aeronautical Engineering Work must be done in accordance with accepted norms and standards. Any deviation from such norms and standards must be clearly stated.

7.5 Aeronautical Engineering data

Sufficient quantitative or qualitative data is required for all Aeronautical Engineering tasks. Aeronautical Engineering Registered Persons should ensure that the data used is adequate for the intended purpose. Where this is not the case, additional data should be obtained or the work should be based on parameter values selected such that the occurrence of less favourable values is unlikely.

Data analysis should be presented in sufficient detail to allow independent assessment of the data.

7.6 Reporting

During the planning of an activity, Aeronautical Engineering Registered Persons should ascertain the purpose for which the activity is required and the nature of the proposed

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activity. Aeronautical Engineering Registered Persons must ensure that the proposed activity is capable of yielding the information required for that purpose.

Aeronautical Engineering Registered Persons should advise the client of the effect of any restrictions placed on the activity that are likely to adversely affect the accuracy or adequacy of the data obtained. This information may be presented as a single report or in two separate reports: a factual report and an interpretive report. All assumptions must be clearly documented together with the reason for the specific assumption.

7.7 Quality and risk management

Aeronautical Engineering Registered Persons must implement quality and risk management systems covering all aspects of their work, appropriate to the nature and size of the work.

Quality and risk management systems must be reviewed regularly. Compliance with the quality and risk management systems should be audited at least annually. Organisations undertaking Engineering Work should consider external certification, such as ISO 9001, ISO 45001 and ISO 14001.

8. ADMINISTRATION

- (a) The Council is responsible for the administration of this Code, including its publication, maintenance and distribution.
- (b) The Council must ensure that this Code and all amendments thereto are available on the ECSA website and must upon request, provide a copy thereof.
- (c) The Council must take all reasonable steps to introduce this Code to the general public.

9. INTERPRETATION AND COMPLIANCE

9.1 Interpretation

(a) The word "must" indicates a peremptory provision.

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(b) The word "should" indicates a provision directive or informative in character, requiring substantial compliance only.

9.2 Compliance

Failure to comply with a peremptory provision of this Code constitutes improper conduct in terms of the Act. Failure to comply with a directive or informative provision of this Code may constitute improper conduct in terms of the Act if its consequences are significant.

10. FURTHER INFORMATION

Further insights and information can be found in the following publications:

- Engineering Council of South Africa Code of Conduct
- Engineering Council of South Africa Overarching Code of Practice for the performance of Engineering Work.

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REVISION HISTORY

Revision no.	Revision date	Revision details	Approved by
Rev A	16 January 2023	New Document	RPS & Working Group
Rev B	02 March 2023	Incorporation of comments received from Broader Consultation	RPS & Working Group
Rev C	11 May 2023	Presentation before Steering Committee	Code of Practice Steering Committee
Rev D	24 May 2023	Updates to include additional information relating to Risk, Overlaps and Competencies	RPS & Working Group
Rev E	19 June 2023	Updates to incorporate comments from Steering Committee.	RPS & Working Group
Rev F	20 June 2023	Recommendation for approval	Code of Practice Steering Committee
Rev.0	10 July 2023	Approval	RPSC
Rev.0	22 August 2023	Ratification	Council

The Code of Practice for:

Aeronautical Engineering

Revision 0 dated 22 August 2023 consisting of 24 pages have been reviewed for adequacy by the Business Unit Manager and is approved by the Executive: Research, Policy and Standards (**RPS**).

ADUL 1.	25 March 2024
Business Unit Manager	Date
	2024/04/05
Executive: RPS	Date

This definitive version of this policy is available on our website.

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REFERENCES

- [1] Engineering Council of South Africa. Rules of Conduct for Registered Persons Engineering Profession Act, 2000. Board Notice 256 of 2013. Government Gazette No. 37123 of 13 December 2013.
- [2] Engineering Qualifications in the Higher Education Qualifications Sub-Framework E-23 P.
- [3] Identification of Engineering Work Regulations, No. 44333, Government Gazette, 26 March 2021.
- [4] Overarching Code of Practice for the Performance of Engineering Work, No. 44333, Government Gazette, 26 March 2021.
- [5] Framework for development of ECSA Codes of Practice Revision 1: 29 January 2019.
- [6] **R-02-COP-ELE:** Electrical Engineering Code of Practice
- [7] R-02-COP-IND: Industrial Engineering Code of Practice
- [8] **R-02-COP-MEC:** Mechanical Engineering Code of Practice
- [9] **R-05-AER-PE**: Discipline-specific Training Guide for Registration as a Professional Engineer in Aeronautical Engineering (Section 6).
- [10] **R-02-STA-PE/PT/PCE/PN**: Competency Standard for Registration in Professional Categories as **PE/PT/PCE/PN**.