



**THE ZIMBABWE INSTITUTION
OF ENGINEERS**

**GENERAL REQUIREMENTS FOR
THE TRAINING OF
ENGINEERING GRADUATES**

(1999)

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**THE ZIMBABWE INSTITUTION OF ENGINEERS (ZIE)
STATEMENT ON THE GENERAL REQUIREMENTS FOR THE TRAINING AND
EXPERIENCE OF ENGINEERS FOR CORPORATE MEMBER STATUS**

We would like to thank the following sponsors for making it possible to put this publication into print:

**Eng John C Goldsmith
Institution of Civil Engineers (UK)**

1. INTRODUCTION.

The Council is the responsible body for the Institution on which all grades of member above student are represented.

- 1.1 To become a corporate member of the Zimbabwe Institution of Engineers (henceforth referred to as the Institution, a candidate must have completed satisfactorily:-
- a) education at degree level or equivalent
 - b) training in the practice of the chosen discipline
 - c) a period of responsible professional experience in an appropriate field of engineering (see Appendices)

1.2 This statement offers guidelines on the nature of training required. It is specific training programme which should be formulated by each employer to suit the particular needs of a graduate in a particular discipline or branch of engineering industry and profession.

2. DEFINITIONS.

Throughout this statement the following definitions are used:-

2.1 **Professional Engineer** (See Appendix "A" and "C-7")

2.2 **Corporate Member.**
A collective term which includes Fellow, Member and in some cases, Honorary Fellow

2.3 **The Trainee (Graduate)**
The trainee should be competent, at the conclusion of training, to undertake responsible professional duties called for in the Zimbabwe Institution of Engineers Act and the Engineers' Regulations which follow from it as required for admission to the grade of corporate member in the Institution. (see Appendix A).

2.4 **Graduate.**
A person undergoing training with a view to becoming a corporate member of the Institution.

2.5 **Supervising Engineer/Mentor.**
A corporate member of the Institution or other suitably qualified person approved by the Institution to supervise the graduate.

3. ACT & REGULATIONS REQUIREMENTS.

The requirements for acceptance as a corporate member are as follows:-

- a) must be not less than 25 years of age.
- b) must be normally engaged:-
 - (i) in the administration, design, execution or operation of professional engineering work; or

- (ii) as a lecturer in or teacher of a course or courses approved by the Council; or
 - (iii) in engineering research of a nature approved by the Council;
- and
- (i) is a Corporate Member of an Institution, Association or Society recognised by the Council; or
 - (ii) holds a university, college or school degree or diploma recognised by the Council or has been educated as a professional engineer for such period and has passed such examinations as may be prescribed by the Council,
- and
- d) has, in the case of an applicant having the qualifications referred to in sub-paragraph (ii) of paragraph [c], in addition completed such period, not being less than three years in the profession of engineering, satisfactory to the Council as will, when added to the period of technical training, amount to a total period of not less than seven years. For the purpose of this paragraph (d), the Council, or its appropriate sub-committee, may require an applicant to appear before it and additionally, or alternatively, undergo an examination conducted by it or on its behalf in order that the applicant may the better demonstrate possession of the requisite practical experience.

4. INTERPRETATION OF ACT AND REGULATION REQUIREMENTS.

- 4.1. In order to satisfy the above requirements, training may be carried out as part of an organised training scheme, as a trainee under an approved professional engineer or while fully employed under the supervision of an approved professional engineer.
- 4.2. The minimum training period required is two years after graduation provided that the applicant has been a graduate of the Institution in training for at least two years. Applicants not so recognised will also be considered but, in such cases, an extended period of training may be required. In assessing training the following factors will be taken into consideration. (See appendix B for additional information)
 - (a) the nature of training.
 - (b) the standard of training.
 - (c) advanced study during or before the training period.
 - (d) relevant pre-graduate experience.
- 4.3. Since documentary evidence of training and responsible experience will be required for admission to corporate membership, the Council envisages that new graduates will enrol as graduates and follow an approved training programme during the period of training and experience.

5. ELEMENTS OF TRAINING.

- 5.1. The purpose of training is to acquaint the trainee with as wide a range of engineering and management as possible while, at the same time, demonstrating how available techniques, both practical and analytical, can best be applied in practical situations. Above all it must aim to develop judgment and critical abilities so that in later life the trainee will be better able to undertake engineering projects

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- with due regard to technical, ethical, economic, financial, commercial, social other relevant practices.
- 5.2. Following a period of induction and basic training, the training elements concerned shall include:

5.2.1. *Problem Solving.*

Work requiring the solution of problems in connection with engineering tasks, projects, involving judgment in: problem identification and formulation; first selecting and effective use of relevant information; analysis of factors affecting possible solutions; relevant engineering and scientific principles; practical economic, social and statutory requirements and constraints; checking of conclusions; creative synthesis of possible solutions; deciding on the so to adopt (even when only limited information is available e.g. the preparatory conceptual plan or a process design).

5.2.2 *Planning, design, communication*

Work on the development of the proposed solution to a communicable form for those who have to execute it, e.g. estimating by means of plans, designs specifications, reports, or other means of communication.

5.2.2. *Execution.*

Work on the execution of tasks or projects, e.g. construction, manufacture, operation or maintenance, involving the effective management of (work) materials, machines, money and method with due regard for their interaction.

5.2.4. *Responsibilities.*

The work shall involve progressively greater responsibilities until the trainee capable of accepting professional responsibility in making and executing engineering decisions and of demonstrating this ability.

- 5.3. Throughout training, the graduate should be made aware of:
 - (a) The code of conduct for an engineer;
 - (b) The need to make provision to ensure safety and reliability;
 - (c) Responsibilities to employer, colleagues, subordinates, other engineers & the community at large;
 - (d) The importance and relevance of theoretical knowledge for design, manufacture, construction, marketing, operation and maintenance of particular products or services with which the employing organisation concerned;
 - (e) The general problems affecting an industrial organisation, such as:
 - (i) The financial, economic and commercial limitations;
 - (ii) Limitations imposed by the qualities of the workers and materials that are available;
 - (iii) The operational and maintenance requirements that may affect engineering decisions.

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(iv) Environmental factors.

(f) The need to understand the views or opinions of others and to promote good personal relationships at all levels within an organisation;

(g) The importance of good industrial relations, safety, health and welfare not only of employees but in the general public interest;

(h) The need to exercise sound judgement and to accept responsibility for it;

(i) The need to develop abilities to best advantage of the trainee.

(j) The importance of adequate managerial control mechanisms designed to ensure that actual performance is compared with planned performance and, where necessary, appropriate action is initiated.

5.4 Throughout training, the graduate must, wherever possible, obtain practical knowledge and experience by participating in useful hands-on work rather than by only observing the work of others.

5.5 Throughout training the graduate should be brought to realise that, although academic knowledge, industrial training and experience may enable the trainee to work as a professional engineer, development will demand continuing specialised education and further experience in order to keep abreast of technological developments. Supporting general education should also be continuous to enable the trainee to apply a particular engineering speciality, or in management, new developments and techniques in other branches of technology, sciences, economics and sociology

6. FORMULATION OF TRAINING PROGRAMMES

6.1 A training programme should, as far as possible be made up of well defined tasks by which each trainee can be assessed by their performance of each task. It is particularly important that each trainee should be able to assess the degree of their success at each stage of the programme. The need to measure individual performance does not preclude the inclusion in a training programme of group projects, and indeed, they may well serve as a useful introduction to the type of teamwork which is required of most professional engineers throughout their careers.

6.2 In formulating a training programme, the following considerations should be taken into account:

(a) the training requirements for each particular branch of engineering as set out in the appendices;

(b) the scope and contents of the academic courses which the trainee has completed or is following;

(c) industrial training already undertaken by the trainee;

(d) the attainment of the trainee;

(e) the expected later employment of the trainee;

(f) the need for an engineer to have a broad rather than a narrow view of the chosen profession – thus the need for exposure to training outside the

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confines of a particular discipline.

Training should emphasise the complementary nature of theory and It should also be interesting, challenging and relevant to the future the trainee, and furthermore should stretch intellectual powers.

6.3 The Zimbabwe Institution of Engineers' Diploma in Engineering Management (Dip. E.M.) satisfies the training requirements set out in Para 6.2.(a) to (f) and may be followed as an alternative route towards the achievement of membership. The Diploma is a modular programme based on the existing courses offered by the Institution. Candidates accumulate sufficient credit assignments, projects or a practical activity to the satisfaction of the Board of Engineering Management.

6.4 It is important that, during the final period of training, the trainee should work of an engineering nature for which the trainee is held responsible, for a limited degree.

6.5 Some aspects of training are considered to be key elements for a particular of engineering and have been emphasised in the appendices. When trainee's current employer is unable to provide such training, the facilities of organisations or establishments should be used.

7. SUPERVISION OF TRAINING

7.1 A training programme should normally be monitored by a Professional Engineer from the appropriate discipline who would preferably be a corporate member of the Institution holding a responsible position within the organisation providing training.

Although the trainee may be under the control of a training officer with instructions from people in various departments, it is essential that there is direct guidance from a Supervising Engineer/Mentor irrespective of the method whereby the trainee aims to satisfy the requirements. The progress of the trainee should be regularly assessed. Reports should be produced on work carried out. The Supervising Engineer/Mentor should be readily accessible to the trainee for discussion on technical and professional matters and should ensure that the trainee is benefiting from the training programme and discuss its development frequent intervals.

It is the duty of the Supervising Engineer/Mentor to ensure that during the course of the training period, the trainee is made aware of matters outlined in Paragraph 7.2.

7.2 The trainee must maintain a record of training authenticated by the Supervising Engineer/Mentor. To facilitate this, the Institution has produced a "Diary of Training and Experience" available from the Chief Executive. A satisfactory report by the Supervising Engineer/Mentor based on this record may be accepted as documentary evidence that the training requirements have been satisfactorily fulfilled.

8. RESPONSIBILITY OF EMPLOYERS.

It is recommended that an employer of engineers in training should, as a matter of policy, draw up a general training programme formulated along the lines given in the General Requirements. 5

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This programme would be submitted to the Institution for comment and guidance and thereafter the Institution's acceptance of the programme in principle obtained. Such acceptance will be subject to the trainee complying with this statement of policy and guidelines. The employer is expected to ensure that the trainee is always under the general guidance (not necessarily direct supervision) of a recognised Supervising Engineer/Mentor as per Para 7.1.

9. **PROFESSIONAL EXPERIENCE AND RESPONSIBILITY UNDER GUIDANCE
SUBSEQUENT TO TRAINING.**

Upon completion of the formal training programme, which normally takes two years, and before a candidate can be considered for corporate membership, experience is required in a position of responsibility as a professional engineer (see Para 4.2). At the completion of the training programme, the trainee should be able to exercise judgment and undertake responsibility in a professional capacity under the guidance of a professionally qualified Engineer acceptable to the Institution. Subsequently, as experience is gained, the degree of responsibility will normally be increased progressively but, it is important that, from the outset, the work regarded as constituting responsible experience must be professional in character and must involve some responsibility for the management of people and resources.

PROFESSIONAL ENGINEER

The following definition of a professional engineer has been adopted by the Engineering Societies of Western Europe and the USA (EUSEC):-

A professional engineer is competent by virtue of fundamental education and training in the scientific method and outlook to the analysis and solution of engineering problems. An engineer is able to assume personal responsibility for the development and application of engineering science and knowledge, notably in one or more of the following fields:- design, construction, manufacturing, superintending, managing and in the education of an Engineer. Work is predominantly intellectual and varied, and not of a routine physical nature. It requires the exercise of original thought and judgment and the supervision of the technical and administrative work of others.

Education will have been such as to make the Engineer capable of closely and continuously following progress in the branch of engineering science by consulting newly published information on a world-wide basis, assimilating such information and applying it independently. An individual is placed in a position to make contributions to the development of engineering science or its applications.

Education and training will have been such that a broad and general appreciation of engineering sciences will have been acquired as well as a thorough insight into the subjects studied. In due time, the Engineer will be able to give authoritative technical advice and assume responsibility for the direction of important tasks within the sphere of his or her science and experience.

TRAINING FACTORS : ADDITIONAL INFORMATION (See Para 4.2)

1. **NATURE OF TRAINING**
The training shall include all the elements of engineering work set out in Para. 5 and follow the guidelines set out Appendix "C"
2. **STANDARD OF TRAINING.**
Before accepting a candidate as a corporate member, the Council has to be satisfied that the applicant's training included all the required elements at an acceptable level and that the applicant was sufficiently diligent so that, at the end of the period, the candidate is capable of accepting professional responsibility in making and executing engineering decisions in a sufficient variety of work in the applicant's branch of engineering.
3. **RECOGNITION OF ADVANCED STUDY.**
The prescribed period may be reduced in the case of applicants who are holders of a Master's or Doctor's degree from a university recognised by the Council.

Accelerated training shall include all the elements normally required but with less time spent on the various aspects. It is considered that holders of advanced degrees should be capable of obtaining the requisite training in a shorter time than normally required. However, this will have to be demonstrated to the Council or its appropriate sub-committee in each case.

Appropriate research work will be considered as engineering work.
4. **PRE-GRADUATION EXPERIENCE.**
Engineering work other than course work or prescribed vacation training, performed prior to passing a recognised examination may be taken partially into account.

Normally credit for not more than twelve months of such work will be considered, and then only if the nature of the work and the level of responsibility was that expected of an engineer in training.

GENERAL GUIDELINES FOR GRADUATE ENGINEER TRAINING FOR SOME TYPICAL DISCIPLINES*(which can be extended if and when required upon request)*

4. **INTRODUCTION.**
The training in each discipline will differ in detail according to the type of industry organisation with which the trainee is associated. However, a considerable part of the training will be common to all the fields of a chosen discipline and the difference will be one of emphasis rather than of basic approach. However, the standards applicable to the relevant industry, considerations of safety to workers and the requirements of the public and environmental considerations are paramount in every case.

The following notes are for the guidance of graduates undergoing training and the Supervising Engineers/Mentors responsible for overseeing such training. Mentoring is accepted as the most popular and effective method of developing trainees. This also assists the Membership Sub-Committee of the Council so that it can be involved in understanding what is meant by 'the need to have practical (often hands-on) training and experience', together with the 'ability to accept responsibility'.
5. **INDUCTION. (Up to 2 weeks).**
During this period the trainee is provided with information on the organisation, employment conditions, pay procedures, sickness and holiday leave, medical procedures and is generally assisted with adapting to the new life such as in an industrial environment and/or commercial environment. During this period the Supervising Engineer/Mentor is introduced to the trainee who is then given details of the whole programme.
6. **PRACTICAL TRAINING (12 weeks)**
If the candidate had not completed the 'hands-on' workshop training similar to the University of Zimbabwe degree syllabi, the trainee will be required to spend weeks on practical work (including hand and machine tools) associated with the applicable discipline. This period should foster an initial appreciation of the discipline, semi-skilled and skilled artisans / craftsmen / journeymen as members of the engineering team.

Such training should be supplemented by lectures and courses on the appropriate theoretical aspects.
7. **GENERAL ENGINEERING TRAINING / SITE EXPERIENCE. (approx. 50 weeks)**
As an engineer is one of a team, this period should allow him to develop the team and develop an understanding of how others will work with the trainee and later on carrying out the engineering tasks of the departments in which the trainee is subsequently employed. The trainee will also be given an appreciation of the service departments of the organisation such as stores, personnel, administration, accounts etc. operate and how the engineer relates to them.

Specifically the graduate will acquire knowledge of:-

Equipment/works specification and performance capability. Documentation, data preparation, storage and dissemination. Procurement, installation, commissioning, operation & maintenance procedures for engineering items. Company organisation including finance and management. Statutory legal requirements.

The content of this portion of the programme and the specific areas of knowledge in which the trainee will receive instruction should be made clear when a training programme is submitted to the Institution for approval.

2. DIRECTED OBJECTIVE TRAINING / SITE EXPERIENCE. (approx. 40 weeks)

In this final phase the training is directed towards preparing the trainee for the first staff appointment. During this time the trainee will be given specific tasks to carry out under decreasing supervision to stimulate interest and establish confidence.

At all stages of the training, the trainee would be expected to submit short monthly reports which would be discussed with and commented upon by his immediate Supervisor and Engineering Monitor before being placed on his personal record. These reports would be in addition to any special project or investigation reports and all reports will be used as the basis for assessing any application.

In addition the trainee must keep a "Diary of Engineering Trainee and Experience" which provides a key to be used for the identification of the training elements covered.

During directed objective training the trainee needs to be given realistic assignments, which are not too specialised and which would vary with the needs and type of organisation employing the trainee. Project work, both individual and as part of a team, can be very suitable.

It is important to bear in mind at this stage that responsibility is vital to the trainee's development as a start is made in the assumption of duties that will eventually lead to a position of full responsibility.

Formal training conditions in terms of supervision, maintenance of written records and instruction must still be applied during this period.

3. TOPICS RELEVANT TO SPECIFIC DISCIPLINES.

The word 'training' is often misunderstood – many believe that it simply refers to 'courses'. In respect of Graduates of the Institution, it means much more, with the commencement of a period of two years of structured training leading to a further period of responsible experience to enable the trainee to produce convincing evidence that the candidate is worthy of consideration for corporate membership. The emphasis is on 'on the job / at the coal face' learning, even 'experiential learning', 'continued improvement' and, of course 'continual professional development (CPD)'.

Civilisation's advancement has inevitably led to specialisation in many fields, not least of which is 'engineering'. Not only is it divided into separate disciplines, but these in turn, are sub-divided into many facets/divisions/branches in which the trainee may wish, or be obliged to contribute. However, some knowledge of other divisions is an advantage for 'cross pollination' within the chosen discipline.

These divisions are already apparent in secondary & tertiary education where the last few years of study (education), students are obliged to choose, for only four courses of study from about ten distinctive specialisms. Thus it is surprising that renewable energy and protection of the environment are being taught within courses in most disciplines.

For the above reasons, the list of post-graduate training subjects for each discipline within a specific discipline is very wide and could depend upon the employer's requirements. These are listed below for all the disciplines common in Zimbabwe. Disciplines (and topics) not listed will be considered on an ad hoc basis when such emerge from the country.

Some topics overlap two or more disciplines. Further topics can be added to it appropriate to various individuals. e.g. aeronautical and marine engineering disciplines and topics are given in alphabetical order.

Agriculture.

Any aspect of engineering concerned with the production, harvesting, handling or processing of products produced by agriculture, forestry or related activities, for example but not limited to:-

Agricultural Chemicals; Agronomy; Animal Husbandry; Dams; Mechanical plant harvesting; Pest control; Pumping; Soil Preparation; Soil types; Rural renewable Tractive power.

Chemical.

Agricultural Chemicals; Bulk medicines; Corrosion; Explosives; Fossil fuels; Lubricants; Materials (as in Civil); Nuclear energy; Physics; Protective Coatings; Renewable energy

Civil.

Bills of Quantity; Building Services; Cementation; Civil engineering quantities; Administration; Contract Documentation Dams; Fluid mechanics; Geology; Hydraulics; Materials – cost, storage, quality & characteristics; Power stations; Renewable Energy; Roads; Railways; Sanitation – sewage; Site investigations & reports; Structures; Surveying; Water – public health; Water resources

Electrical.

Acoustics; Component manufacture; Computers & Software; Control systems welding; Electro magnetics; Electronics; Fibre optics; Fitting & machining; Inst Machines; Measurements; Micro processors; Microwave; Networks; Nuclear Power supplies – installation, commissioning, testing & maintenance; Power Renewable Energy; Telecommunications; Winding; Wiring.

Mechanical.

Automobiles; Construction & assembly; Control systems; Dynamics; Fitting & Gas turbines; Heat transfer; Hoisting; Hydraulics; Industrial systems; Internal combustion engines; Manufacturing technology; Measurements; Nuclear Energy; Power Renewable energy; Solid mechanics; Strength of Materials; Tools – hand & machine; Transportation – air, marine, rail, road & off-road; Tribology; Welding – gas & arc; Winding; Wire ropes.

Metallurgical.

Ceramics; Chemical laboratory; Corrosion; Crushing & screening; Equipment design for reduction works; Ferrous tramp removal; Fossil fuels; Guillotining (cutting); Heat & mass transfer; Heat treatment; Hydro metallurgy; Materials & composites; Materials handling; Mineral processing; Mining; Nuclear energy; Ores & resources; Plant layout; Power supply; Physical metallurgy; Pressing; Pyro metallurgy; Renewable energy; Rolling; Waste dumps.

Mining.

Air conditioning, fans, refrigeration & ventilation; Applied geology; Cementation; Compressed air; Crushing & screening Design & application of underground and open pit (surface mining) equipment; Economic use of power; Engineering materials; Explosives; Filtration; Geo mechanics – rock mechanics; Hydro mining; Materials handling; Metallurgy; Mine design & planning; Mineral dressing; Mining law; Mine services; Operations research & process control; Power supply; Pumping – clean water & mud; Rail & off-road transport; Rehabilitation of mine dumps & old workings; Renewable energy; Rock drilling; Safety equipment; Strength of materials; Surveying; Winches, winders, wire ropes & scrapers.

1. PROFESSIONAL OUTLOOK.

- 1.1. This is a measure of a person's character and can, at best, be only a subjective appreciation of the candidate's general behaviour and ability to be a credit in all ways to the profession. A professional engineer must be a mature person, able to communicate in good English both in speech and writing.
- 1.2. The candidate should have an understanding of current affairs on a national and international level and be conversant with the rudiments and possible effects of engineering works on the environment and society in general.