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SOUTH AFRICAN QUALIFICATIONS AUTHORITY

NATIONAL QUALIFICATIONS FRAMEWORK

Established in terms of Act 58 of 1995

SOUTH AFRICAN QUALIFICATIONS AUTHORITY (SAQA)

In accordance with regulation 24(c) of the Standard Generating Bodies Regulations of 28 March 1998, the Standards Generating Body (SGB) for

Manufacturing, Engineering and Technology

publishes the following unit standards for public comment.

This notice contains the titles, fields, sub-fields, NQF levels, credits, and purpose of the qualification. The qualification can be accessed via the SAQA web site at **www.saqa.org.za**. Copies may also be obtained from the Directorate of Standards Setting and Development at the SAQA offices, Hatfield Forum West, 1067 Arcadia Street, Hatfield, Pretoria.

Comment on the unit standards should reach SAQA at the address ***below and no later than 15 Aug 2005.*** All correspondence should be marked **Standards Setting – SGB Engineering** and addressed to

The Director: Standards Setting and Development
SAQA
Attention: Mr. Eddie Brown
Postnet Suite 248
Private Bag X06
Waterkloof
0145
or faxed to 012 – 431-5144
e-mail: ebrown@saqa.co.za

DUGMORE MPHUTHING
ACTING DIRECTOR: STANDARDS SETTING AND DEVELOPMENT

SOUTH AFRICAN QUALIFICATIONS AUTHORITY

QUALIFICATION:

National Diploma: Engineering Technology

SAQA QUAL ID	QUALIFICATION TITLE		
49744	National Diploma: Engineering Technology		
SGB NAME		**NSB 06**	**PROVIDER NAME**
SGB Engineering		Manufacturing, Engineering and Technology	
QUAL TYPE		**FIELD**	**SUBFIELD**
National Certificate		Manufacturing, Engineering and Technology	Engineering and Related Design
ABET BAND	**MINIMUM CREDITS**	**NQF LEVEL**	**QUALIFICATION CLASS**
Undefined	360	Level 6	Regular-ELOAC

PURPOSE AND RATIONALE OF THE QUALIFICATION

Purpose:

The purpose of the qualification is to develop the necessary knowledge, understanding and skills required for learner's further learning towards becoming competent practising engineering technicians. It is intended to subsequently empower candidate-engineering technicians to demonstrate that they are capable of applying their acquired knowledge, understanding, skills, attitudes and values in the work environments in South Africa.

A person achieving this qualification will be able to:

> Competently apply an integration of theory, principles, proven techniques, practical experience and appropriate skills to well defined problems in the field of engineering while operating within the relevant standards and codes.
> Demonstrate a comprehensive general engineering knowledge, as well as systematic knowledge, of the main terms, procedures, principles and operations of one of the disciplines of engineering.
> Gather evidence from the relevant sources and journals using advanced retrieval skills, and organize, synthesize and present the information professionally in a mode appropriate to the audience.
> Apply the knowledge gained to new situations, both concrete and abstract, in the workplace/community.
> Identify, analyze, conduct and manage a project.
> Make independent decisions/judgments taking into account the relevant technical, economic, social and environmental factors.
> Work independently, as a member of a team, and as a team leader.
> Relate engineering activity to health, safety and environment, cultural, and economic sustainability.
> Meet the requirements for registration with the Engineering Council of South Africa as a Candidate Engineering Technician.
> Demonstrate the capacity to explore and exploit educational, entrepreneurial, and career opportunities and to develop him/herself professionally.

Rationale:

The Engineering profession contributes to the technological, socio-economic, built environment and environmental infrastructure of the country, facilitating socio-economic growth and sustainability. The target markets include both a traditional branch of engineering, and/or a significant industrial area. The qualification is the starting point of a career path in one of the areas of specialization, but is still generic enough to allow maximum mobility, based on recognition of prior learning, within the industry. Skills, knowledge, values and attitudes reflected in the qualification are building blocks for the development of candidate engineering technicians towards becoming competent engineering technicians.

The qualification is intended to:

> Promote the development of engineering knowledge and skills required to serve public and private needs.
> Release the potential of people.
> Provide opportunities for people to move up the value chain.
> Provide learners with life-long learning and articulation opportunities in the engineering profession.

RECOGNIZE PREVIOUS LEARNING?

Y

LEARNING ASSUMED TO BE IN PLACE

At the entry level, the learner is assumed to be proficient at NQF Level 4, or equivalent, in:

> Mathematics.
> Physical Science.
> English.

Recognition of prior learning:

Providers may make use of recognition of prior learning at intermediate levels but must take full responsibility for assuring that the exit level outcomes are fulfilled.

QUALIFICATION RULES

NQF level and assigned credits:

Knowledge profile of the successful learner:

The content of the programme when analysed by knowledge area shall not fall below the minimum credit values of the total actual credit for the programme specified for each knowledge area in Table 1. Knowledge areas are defined in Appendix A (Heading: 'Definition of Knowledge Areas') in the Qualification Notes.

Minimum curriculum content by knowledge area:

> Knowledge Area□
> Mathematical Sciences: 30 credits
> Basic Sciences: 20 credits
> Engineering Sciences: 90 credits
> Engineering Design: 20 credits
> Computing and IT: 30 credits
> Complementary Studies: 10 & <=40 credits
> Subtotal: 210 credits
> Discretionary to reach at least the minimum total: (150) credits
> Total: 360 credits

The discretionary component allows for flexibility in providing for the diverse needs of the different engineering disciplines. It shall be allocated to the six knowledge areas, to form a coherent, balanced programme.

Core and specialist requirements:

The allocation of credits shall result in a core of mathematics, basic sciences and fundamental engineering sciences that provides a viable platform for further studies and lifelong learning. The core enables development in a traditional discipline or in an emerging field. A programme shall contain engineering discipline specific learning outcomes at the exit level.

EXIT LEVEL OUTCOMES

1. Problem Solving.

Apply engineering principles to systematically diagnose and solve well-defined engineering problems.

Range: Problems are Stage 1 well-defined engineering problems having some or all of the following characteristics:

> Problem statement is concrete, requirements are complete and certain, but may require refinement.
> Problems may be unfamiliar, but occur in familiar contexts and are amenable to solution through established methods.
> Approach to solution involves standardized methods or codified best practice.
> Information is concrete & complete, requires checking and possible supplementation.
> Solutions are encompassed by standards, codes and documented procedures; judgment of outcome is needed.
> Involves imposing conflicting constraints within limitations of procedures.

Competency and Range:

1.1 Identify and define the problem.
1.2 Gather information relating to the problem.
1.3 Analyze the information relating to the problem.
1.4 Evaluate and select appropriate methodologies for the problem solution.
1.5 Synthesize potential solutions to the problem.
1.6 Evaluate and select the preferred solution.

2. Application of Scientific and Engineering Knowledge.

Demonstrate the application of mathematical, science and engineering knowledge in an engineering environment.

Range: Knowledge is characterized by some or all of the following:

> Coherent range of fundamental principles in mathematics, basic science and engineering science underlying a sub-discipline or recognised practice area.
> Coherent range of fundamental principles in engineering science and technology underlying an engineering sub-discipline or recognised practice area.
> Codified practical knowledge in recognised practice area.
> Professional communication, social impact, environmental impact, cost analysis, quality procedures.
> Use of codified engineering analysis methods and procedures, supported by established mathematical formulas, to perform technical calculations.

Competency and Range:

2.1 Demonstrate competence to use and integrate appropriate mathematical, basic science and engineering principles to solve engineering problems.
2.2 Demonstrate competence to use and apply appropriate measuring instruments and techniques to solve engineering problems.
2.3 Describe and perform the operation and maintenance of resources / processes / systems.
2.4 Plan, implement, report and improve on engineering processes.

3. Engineering Design.

Perform procedural design of well-defined components, systems, works, products or processes to meet desired needs within applicable standards, codes of practice and legislation.

Range: Design problems conform to the definition of Stage 1 well-defined engineering problems as indicated under exit level outcome 1.

Competency and Range:

3.1 Identify and analyse specific project objectives, and plan and formulate the criteria for an acceptable design solution.
3.2 Access, acquire and evaluate the relevant knowledge, information and resources.
3.3 Generate and analyse alternative solutions by applying appropriate engineering knowledge.
3.4 Select the optimal (preferred) solution based on technical, operational and economic criteria, and evaluate the impacts and benefits of the proposed design.
3.5 Implement the solution.
3.6 Communicate the design logic and information in the appropriate format.

4. Communication

Communicate technical, supervisory and general management information effectively, both orally and in writing, using appropriate language and terminology, structure, style and graphical support.

Range: Communicate technical information, interpret instructions; issue clear oral and written instructions; receive reports, present technical/project progress information using defined formats.

Competency and Range:

4.1 Generate and assemble appropriate data and information, using available resources.
4.2 Interpret technical data.
 > Range: Technical books, periodicals, data packs and quality manuals.
4.3 Apply graphical techniques to present the information effectively.
 > Range: Line graphs, histograms, pie charts, bar charts.
4.4 Generate, construct and assemble technical documents.
 > Range: Pre-defined weekly and monthly technical reports, project progress reports, specifications.
4.5 Communicate interactively with individuals and with peers.
 > Range: Meetings.
4.6 Generate, construct, assemble and deliver a technical presentation.
 > Range: To a peer-group audience. Project progress reports, product/service overviews, technical reports.

5. Engineering Management.

Apply self-management principles and concepts relating to the development of projects and/or operations within an engineering environment.

Competency and Range:

5.1 Apply entrepreneurial principles to product / service / process development or operations.
 > Range: Simple product, service, process
5.2 Practice self-management principles.
 > Range: General process operations, product development, service delivery.

6. Application of Complementary Knowledge.

Demonstrate a critical awareness of the impact of engineering activity on the social, industrial and physical environment, and of the need to act professionally within own limits of competence.

Range: The combination of social, workplace and physical environmental factors must be appropriate to the discipline or other designation of the qualification. Evidence may include case studies typical of engineering practice situations in which the graduate is likely to participate.

Competency and Range:

6.1 Relate engineering activity to environmental, cultural and safety issues.
6.2 Exhibit awareness of the need for professionalism.

ASSOCIATED ASSESSMENT CRITERIA

1.1

> A well-defined engineering problem/desired outcome is identified.
> The factors/variables influencing the problem are identified.
> Criteria against which a solution can be measured are identified.
> A clear description of the problem and its localized effect is provided.
> The relevant assumptions, premises and constraints are identified and recorded.

1.2

> Information relating to the problem is gathered.
> Appropriate data collection methods are applied.
> Statistical methods are applied to information sampling.

> Facts and evidence are distinguished from assumptions and inferences.

1.3

> Available information is assessed for accuracy and relevance.
> Appropriate tools of analysis are chosen.
> Mathematics, basic science, engineering science and practical experience are applied as required.
> Relevant information is presented in a methodical and logical format comprehensible to peers/co-workers and team leaders.

1.4

> Appropriate solution methodologies are evaluated.
> Appropriate tools and techniques are identified to remedy the problem.
> The preferred solution methodology is stated and justified.
> The solution methodology takes workplace safety into account.

1.5

> Engineering judgement is applied in the process.
> Fundamental engineering principles are applied when necessary.
> Mathematics, basic science, engineering science and practical experience are applied as required.
> Appropriate assistance is obtained when required.
> Potential/relevant solutions are proposed.

1.6

> The potential solutions are tested for technical, economic and operational feasibility.
> The preferred solution is articulated in a logical and methodical manner.
   > Range: Oral, written.
> The system is tested to ensure that the problem has been solved.
> The preferred solution appropriately addresses the premises, assumptions, constraints and desired outcomes.

2.1

> The correct approach to solving the problem is chosen and justified using given criteria.
> The problem is described using appropriate mathematical, basic science and engineering principles.
> The solution to the engineering problem is demonstrated.
> The solution is validated against the desired outcome.
> The relevant assumptions, premises and constraints are identified and recorded.

2.2

> Appropriate measuring instruments are chosen and justified.
> Calibration of the measuring instrument is validated.
> Valid measuring techniques are correctly applied.
> The observations are correctly recorded, analysed and evaluated.
> The preferred solution appropriately addresses the premises, assumptions, constraints and desired outcomes.

2.3

> The operation of equipment and components / products / processes / systems is described and explained, both practically and theoretically.
> Equipment is successfully operated against specified requirements.
   > Range: Performed under supervision.
> An appropriate maintenance strategy is chosen and performed.

2.4

> A problem associated with a typical engineering process is identified and possible improvements suggested.
> Modifications to components / products / processes / systems are identified, planned, and performed in

line with appropriate engineering strategies.
> The candidate makes a significant contribution both as an individual, and as a member of a team.
> Continuous improvements to the system / process are applied.

3.1

> The problem / design is contextualised, and the implications of the design are described.
> The candidate's role within the multidisciplinary / team project is identified and outlined, including his/her relationship / line function to the team leader / supervisor.
> The scope of the project / design is identified and defined.
> Internal and external factors influencing the design including codes of practice and legislation are identified.
> A strategy and critical path to solve the problem is formulated.
> The relevant assumptions, premises and constraints are identified and recorded.

3.2

> Available information (knowledge and data) is assessed for accuracy and completeness.
> New information that is required is identified.
> Relevant sources of information are identified (library, internet, scientific data banks, etc).
> Relevant data and information are collected, collated and analysed.
> Relevant information is presented in a logical and methodical manner.

3.3

> Standard methodologies / correlations are used to generate solutions.
> Solutions are analysed and evaluated to test their feasibility and their potential integration into larger system/s.

3.4

> Solutions are evaluated using defined criteria, and are ranked according to appropriateness and preferability.
> Range: Costs, benefits, advantages, limitations.
> The selection of the preferred solution relative to other solutions is justified.
> The preferred solution is further evaluated in terms of economic, social and environmental impacts.
> The preferred solution / design is subjected to some basic optimisation evaluations.
> The preferred solution appropriately addresses the premises, assumptions, constraints and desired outcomes.

3.5

> An implementation strategy and plan is outlined.
> The responsibilities of team members are recognised / delegated and documented for the successful implementation of the solution.
> The implemented solution is evaluated against the initial design criteria specifications.

3.6

> The design is presented in an acceptable technical report format.
> The content is selected and arranged in a logical manner and graphics are integrated appropriately.
> Correlations / methodologies used are clearly stated, justified and referenced.
> All assumptions are stated and justified.
> Technical and professional vocabulary is used throughout the report.

4.1

> An appropriate search methodology is used to gather data and information.
> Data and information is clustered into themes/sub-themes.
> Sources of information are listed, identifying the various concepts/ideas obtained from each source.
> Reference lists are compiled and displayed according to a standard convention.

4.2

> Technical, supervisory and general management data and categories are created and selected to organize information pertaining to the documents.
> Information is correctly transferred from one form into another.
> A computer is effectively used to process, produce and present data.
> Valid conclusions are drawn from technical, supervisory and general management data.

4.3

> Data/information that could best be displayed graphically is identified.
> Graphical tools within the selected software package(s) are used to produce an effective graphical presentation of the data.

4.4

> An appropriate type of workplace document for the purpose is chosen and justified against selected criteria.
> The structure, style and language are appropriate to the document type.
> Tables, figures and other graphical techniques are appropriately integrated.
> Task-and readership-appropriate style, register and vocabulary are assessed against given criteria.

4.5

> Ideas are presented clearly.
> Ideas from other individuals are encouraged.
> Listening skills are demonstrated.
> Effective and confident participation in discussions is demonstrated.
> A comprehensive report on the outcome of discussions, including the views of all participants is presented orally and/or in writing.

4.6

> The needs and knowledge of a simulated audience are identified and information is pitched at the appropriate level.
> An appropriate presentation format is chosen according to the occasion.
> Presentation slides and handout documentation are produced using effective layouts and formats.
> A variety of effective verbal presentation techniques are used with confidence.
> The verbal presentation is integrated with the visual aids / electronic media to communicate the information effectively.

5.1

> Relevant entrepreneurial criteria contributing to a successful project in a specialised field are identified.
> A prototype / innovation / systems improvement is conceptualised.
  > Range: Technical and economic feasibility.
> Elements contributing to the business plan are identified and presented.
> The viability of the prototype / innovation / systems improvement is assessed.
  > Range: technical, social or environmental.
> The relevant assumptions, premises and constraints are identified and recorded.

5.2

> Self-management principles are described and justified.
> Self-management principles are applied to a project, process or operation.
> Performance measures/benchmarks are identified.
> Quality assurance issues are identified and integrated.
> Safety assurance issues are identified and integrated.
> Projects, processes and/or operations are monitored and controlled.

6.1

> A problem in a workplace process is identified and possible improvements applied.
> Pertinent social issues, safety and environmental laws and regulations are identified.
> Potential hazards and their consequences are identified.
> The potential impact of engineering activity on social and environmental issues is critically evaluated.

> Relevant environmental management and safety principles are applied and justified.
> The relevant assumptions, premises and constraints are identified and recorded.

6.2

> Reasons for maintaining continued competence and for keeping abreast of up-to-date tools and techniques are listed.
> The system of professional development is described.
> The boundaries of competence in problem solving and design are discerned.
> Decision-making is limited to area of current competence.
> Judgement is displayed in decision- making during problem solving and design.
> The design or solution of a problem is justified in terms of ethical considerations.
> The learner accepts responsibility for own actions.

Integrated assessment:

Providers of programmes shall in the quality assurance process demonstrate that an effective integrated assessment strategy is used. Clearly identified components of assessment must address summative assessment of the exit level outcomes. Evidence should be derived from major work or multiple instances of limited scale work.

INTERNATIONAL COMPARABILITY

International comparability of the whole qualification standard is ensured through the Dublin Accord. The standards are comparable with those for qualifications in engineering in countries having comparable engineering education systems to South Africa, namely, Canada, Ireland and the United Kingdom. Comparability is audited by mutual visits.

ARTICULATION OPTIONS

The exit level outcomes ensure that a graduate of a programme meeting these standards would meet requirements for entry to a number of programmes including:

> A 480 Credit Qualification in Engineering Technology.
> A learnership programme leading to the qualification required for registration as a Professional Engineering Technician/Competent Engineering Practitioner.

MODERATION OPTIONS

The following criteria should be applied by the relevant ETQA:

> Appropriate qualification in the field of engineering at one level higher than the level of the qualification.
> Appropriate experience and understanding of assessment theory, processes and practices.
> Good interpersonal skills and ability to balance the conflicting requirements of:
  > Maintaining national standards
  > The interests of the learner
  > The need for transformation and redressing the legacies of the past
  > The cultural background and language of the learner.
> Registration as an assessor with a relevant ETQA.
> Any other criteria required by a relevant ETQA.

CRITERIA FOR THE REGISTRATION OF ASSESSORS

N/A

NOTES

Appendix A

Definition of Knowledge Areas

Basic Sciences

> Physics (including mechanics), chemistry, earth sciences and the biological sciences which focus on understanding the physical world, as applicable in each engineering disciplinary context.

Complementary Studies

> Those disciplines outside of engineering sciences, basic sciences and mathematics which:

> Are essential to the practice of engineering, including engineering economics, the impact of technology on society and effective communication; and
> Broaden the student's perspective in the humanities and social sciences in order to understand the world in which engineering is practised.

Computing and Information Technologies

> The use of computers, networking and software to support engineering activity, and as an engineering activity in itself, as appropriate to the discipline.

Engineering Design and Synthesis

> The creative, iterative and often open-ended process of conceiving and developing components, systems and processes. Design requires the integration of engineering, basic and mathematical sciences, working under constraints, taking into account economic, health and safety, social and environmental factors, codes of practice and applicable laws.

Engineering Sciences

> These are rooted in the mathematical and physical sciences, and where applicable, in other basic sciences, but extend knowledge and develop models and methods in order to lead to engineering applications and solve engineering problems.

Mathematical Sciences

> This is an umbrella term embracing the techniques of mathematics, numerical analysis and statistics cast in an appropriate mathematical formalism.

Appendix C

Consistency of Exit Level Outcomes with Critical Cross-field Outcomes

SAQA Critical Cross-Field Outcomes:

> Identifying and solving problems in which responses display that responsible decisions using critical thinking have been made.
> Equivalent Exit Level Outcome: 1, 2, 3, 6

> Working effectively with others as a member of a team, group, organisation and community.
> Equivalent Exit Level Outcome: 2, 3, 4, 6

> Organising and managing oneself and one's activities responsibly and effectively.
> Equivalent Exit Level Outcome: 3, 5, 6

> Collecting, analysing, organising and critically evaluating information.
> Equivalent Exit Level Outcome: 1, 2, 3, 4

> Communicating effectively using visual, mathematical and/or language skills.
> Equivalent Exit Level Outcome: 1, 2, 3, 4, 6

> Using science and technology effectively and critically, showing responsibility toward the environment and health of others.
> Equivalent Exit Level Outcome: 1, 2, 3, 5, 6

> Demonstrating an understanding of the world as a set of related systems by recognising that problem contexts do not exist in isolation.
> Equivalent Exit Level Outcome: 1, 2, 3, 6

> Contributing to the full personal development of each learner and the social and economic development of society at large, by making it an underlying intention of the programme of learning to make an individual

aware of:

> Reflecting on and exploring a variety of strategies to learn more effectively.
> > Equivalent Exit Level Outcome: 2, 6
> Participating as responsible citizens in the life of local, national and global communities.
> > Equivalent Exit Level Outcome: 2, 3, 6
> Being culturally and aesthetically sensitive across a range of contexts.
> > Equivalent Exit Level Outcome: 3, 4, 5, 6
> Exploring education and career opportunities.
> > Equivalent Exit Level Outcome: 5, 6
> Developing entrepreneurial opportunities.
> > Equivalent Exit Level Outcome: 5, 6

Appendix D

Calculation of SAQA Credits and Allocation to Knowledge Area

The method of calculation assumes that certain activities are scheduled on a regular weekly basis while others can only be quantified as a total activity over the duration of a course or module. This calculation makes the following assumptions:

> Classroom or other scheduled contact activity generates notional hours of the student's own time for each hour of scheduled contact. The total is given by a multiplier (see third column of table below) applied to the contact time.

> One week of full time activity accounts for assessments in a semester.

> Assigned work generates only the notional hours judged to be necessary for completion of the work and is not multiplied.

Define for each course or module identified in the rules for the technology qualification:

Type of Activity:
□□
> L = number of lectures per week□□
> T = number of tutorial per week□□
> P = total practical periods□□
> X = total other contact periods□□
> A = total assignment non-contact hours□□
> D = total no of days of workplace-based learning□□
> W = number of weeks the course lasts (actual + 2 week per semester for assessment, if applicable to the course or module)

Time Unit in hours:

> TL = duration of a lecture period
> TT = duration of a tutorial period
> TP = duration of an institution-based practical period
> TX = duration of other period
> TA = 1 hour
> TD = duration of work-based learning per day

Contact time multiplier:

> ML=total work per lecture period
> MT=total work per tutorial period
> MP=total work per practical period
> MX=total work per other period
> MD=total workplace-based learning per period.

The credit for the course is calculated using the formula:

> C = {W(LTL ML + TTT MT) + PTP MP + XTX MX + ATA + DTDMD}/10

The resulting credit for a course or value may be divided between more than one knowledge area. In allocating the credit for a course to multiple knowledge areas, only new knowledge or skills in a particular area may be counted. Knowledge and skills developed in other courses and used in the course in question shall not be counted. Such knowledge is classified by the nature of the area in which it is applied. In summary, no knowledge is counted more than once as being new.

MD may differ for different activities e.g. the factor for work-based learning component in which the learner develops skills which integrate theoretical knowledge with actual practice in a working environment will differ from the factor for a related assignment and project work which enhances learner understanding of the work environment and/or new learning.

All learning that is assigned credits must satisfy the following criteria:

> The competencies to be achieved and contributions to knowledge areas are clearly defined and documented.
> The learning is quality assured by the provider.
> A student's performance is assessed against defined outcomes.
> Evidence of the assessment process is presented in the accreditation evaluation.

Qualifiers:

The qualification may have a disciplinary or cross-disciplinary qualifier (discipline, branch, option or endorsement) defined in the provider's rules for the technology qualification and reflected on the academic transcript and technology qualification certificate, subject to the following:

> The designation must contain the word "Engineering". The qualifier may contain one or more combinations of the following descriptors: Chemical, Civil, Computer, Electrical, Electro-mechanical, Industrial, Mechanical, Metallurgical and Mining. Designations are not restricted to this list.
> The qualifier must clearly indicate the nature and purpose of programme.
> The fundamental engineering science content must be consistent with the qualifier.
> The target market indicated by the qualifier may be a traditional branch of engineering or a substantial industry area.
> In the case of a provider offering programmes with minor differences in content, only one programme should be accredited.

UNIT STANDARDS
(Note: A blank space after this line means that the qualification is not based on Unit Standards.)