DNOS.ME.01
FIRST DRAFT

DRAFT NATIONAL OCCUPATIONAL STANDARD FOR A MECHANICAL ENGINEER

*Disclaimer: this document is for Sector Review and Commenting **only**. It should **not** be used, or referred to, as a National Occupational Standard*

ZAMBIA QUALIFICATIONS AUTHORITY

APPROVING AUTHORITY

This National Occupational Standard has been prepared and published under the authority of the Zambia Qualifications Authority Board on [insert date when NOS was approved by the ZAQA Board].

ZAMBIA QUALIFICATIONS AUTHORITY

The Zambia Qualifications Authority Act No. 13 of 2011 was enacted by the Government of the Republic of Zambia to ***"provide for the development and implementation of a national qualifications framework; establish the Zambia Qualifications Authority; provide measures to ensure that standards and registered qualifications are internationally comparable; and provide for matters connected with, or incidental to the foregoing".*** Among other functions, ZAQA is responsible for ***determining national standards for any occupation***, through various sector specific National Occupational Standards Development Teams (NOSDTs).

REVISION OF NATIONAL OCCUPATIONAL STANDARDS

National Occupational Standards shall be revised every after **5 years**, or whenever necessary, by the issue of either amendments or of revised editions. It is important that users of National Occupational Standards (NOS) should ascertain that they are in possession of the latest amendments or editions.

NOS DEVELOPMENT TEAM RESPONSIBLE

This National Occupational Standard was prepared by the Manufacturing National Occupational Standards Development Team, upon which the following organisations were represented:

1. Bigtree Beverages Ltd
2. Copperbelt University
3. Evelyn Hone College
4. Lafarge Cement (Z) Plc
5. Lusaka Business and Technical College
6. Trade Kings Group
7. University of Zambia
8. Zambia Association of Manufacturers
9. Zambian Breweries Plc
10. Zambia Bureau of Standards
11. Zambia Qualifications Authority – Secretariat.

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FOREWORD

The Zambia Qualifications Authority (ZAQA) is a statutory body under the Ministry of Higher Education established by ZAQA Act No. 13 of 2011 to "***provide for the development and implementation of a national qualifications framework; provide measures to ensure that standards and registered qualifications are internationally comparable; and provide for matters connected with, or incidental to the foregoing***".

Among other functions, ZAQA is responsible for ***"determining national standards for any occupation"***, through various sector specific National Occupational Standards Development Teams (NOSDTs) of experts composed of representation from appropriate authorities, government departments, industry, academia, regulators, consumer associations and non-governmental organisations, etc.

This National Occupational Standard (NOS) has been developed by the Manufacturing National Occupational Standards Development Team in accordance with the procedures and guidelines of ZAQA. All users should ensure that they have the latest edition of this publication as National Occupational Standards are revised from time to time.

This NOS shall be used by, among others, industry, employers, quality assurance bodies, awarding and professional bodies and education and training institutions, as a benchmark to identify training needs, develop job profiles/descriptions, develop curricula and learning programmes, in various sectors where the occupation exists. In the Manufacturing sector, demonstration of competence against this NOS may be required in order to run a business or practice a craft or profession.

JUSTIFICATION

Good product designs coupled with proper operation and maintenance of equipment in a manufacturing environment not only enhance productivity and quality but also lower production costs.

A Mechanical Engineer is critical in the promotion of product quality, productivity and performance of equipment in the workplace. His/her role is to research, plan, develop, design, evaluate, manufacture, install, test, commission and maintain machines, machine components and systems in various fields of application.

This National Occupational Standard highlights core knowledge, skills, competences and personal attributes that Mechanical Engineers must possess to be successful in their jobs.

ACRONYMS AND ABBREVIATIONS

CAD	Computer Aided Design
CAM	Computer Aided Manufacturing
CS	Core Skill
DNOS	Draft National Occupational Standard
ME	Mechanical Engineer
MRP	Material Resources Planning
MSO	Mine Safety Officer
NOS	National Occupational Standard
NOSDT	National Occupational Standards Development Team
OK	Organisational Knowledge
PC	Performance Criteria
PS	Professional Skill
RK	Regulatory Knowledge
RPL	Recognition of Prior Learning
TK	Technical Knowledge
ZAQA	Zambia Qualifications Authority
ZQF	Zambia Qualifications Framework

GLOSSARY OF TERMS

For the purposes of this NOS, the following terms and definitions shall apply:

Core Skills/Generic Skills: are a group of skills that are key to learning and working in today's world. These skills are typically needed in any work environment. In the context of the NOS, these include communication related skills that are applicable to most job roles.

Function: is an activity necessary for achieving the key purpose of the sector, occupation, or area of work, which can be carried out by a person or a group of persons. Functions are identified through functional analysis and form the basis of NOS.

Job Title: defines a unique set of functions that together form a unique employment opportunity in an organisation.

Knowledge and Understanding: are statements which together specify the technical, generic, professional and organisational specific knowledge that an individual needs in order to perform to the required standard.

National Occupational Standards (NOS): are statements of the standards of performance individuals must achieve when carrying out functions in the workplace, together with specifications of the underpinning knowledge and understanding. They are precise descriptions of what an individual is expected to be able to do in his/her work role.

National Occupational Standards (NOS) Code: is a unique reference code that identifies a NOS.

National Occupational Standards Development Team (NOSDT): means an established group of national stakeholders/experts responsible for the development of National Occupational Standards within a specific economic sector or occupation.

Occupation: is a set of job roles, which perform similar/related set of functions in an industry.

Organisational Context: includes the way the organisation is structured and how it operates, including the extent of operative knowledge that managers have in their relevant areas of responsibility.

Performance Criteria: are statements that together specify the standard of performance required when carrying out a task.

Scope: is the set of statements specifying the range of variables that an individual may have to deal with in carrying out the function which have a critical impact on the quality of performance required.

Sector: is a conglomeration of different business operations having similar businesses and interests. It may also be defined as a distinct subset of the economy whose components share similar characteristics and interests.

Sub Sector: is derived from a further breakdown based on the characteristics and interests of its components.

Technical Knowledge: is the specific knowledge needed to accomplish specific designated responsibilities.

Unit Title: gives a clear overall statement about what the incumbent should be able to do.

1. OVERVIEW

This is an introductory section providing a brief summary and specific information or commentary about the content of the NOS and the targeted sector and occupation to help the user judge whether it is relevant to them.

NOS Code	NOS.ME.01
Occupation	Mechanical Engineering
Job Title	Mechanical Engineer
Job Description	A mechanical Engineer plans, analyses, develops, designs, manufactures/builds, installs, tests and maintains mechanical devices and systems. He/she is responsible for adherence to applicable industry regulations.
Job Purpose	Mechanical Engineers work in a variety industries. In manufacturing industry a Mechanical Engineer is responsible for: • Creating designs and testing new products, tools, jigs and fixtures using such tools as Computer Aided Design (CAD); • Manufacturing products to required specifications, on time, and to budget using appropriate production methods and tools such as computer-aided manufacturing (CAM), and product lifecycle management; • Installation, testing and commissioning of machines and mechanical systems • Maintenance of production machinery, equipment, tools and systems. • Implementation and monitoring compliance to occupational health and safety standards and regulations • People management
ZQF Level	7
Sector	Manufacturing
Sub sectors	Agro-processing, textile, and leather industries, wood and wood products, paper and paper products, chemicals and chemical processing, Rubber and plastic products, non-metallic mineral products, Basic metal products, fabricated, formed and machined metal products, automotive, food and beverages.
Other Economic Sector(s) in which the Occupation is Practiced	Mining and mineral processing; chemical processing; pharmaceutical; aerospace; telecommunication; defence; agriculture; forestry; fishing and fish processing, energy, textile, health, construction, transport, education/training, tourism,

	water and sanitation, government ministries and agencies, etc.
Other Similar Jobs that can be performed by the Mechanical Engineer	Production Engineer/Manager, Design engineer/manager, Quality Officer/Manager, Project Engineer, Research Engineer, Maintenance Engineer/Manager, Tutor/Lecturer/Trainer or Training Manager, Transport Manager, Sales Engineer/Manager, Agricultural Engineer, Consultant, etc.
Minimum Educational Job Entry Qualification(s)	Bachelor's Degree in Mechanical Engineering, or equivalent
Practicing License Requirements (if any)	Membership with the Engineering Institution of Zambia (EIZ) and Practicing Licence from the Engineering Registration Board (EngRB).
Training/RPL	1. Awareness of the Industry Standards and Rules and Regulations and their application 2. Use of ICTs (Internet, Microsoft word, Excel, PowerPoint, email, Computer Software and Hardware necessary for the job, etc.). 3. 5S Workplace Organisation Method.
Minimum Job Entry Age	21
Prior Experience (Suggested)	Minimum of 1 year internship
Performance Criteria	As described in the Units under Section 4

2. SCOPE

This National Occupational Standard specifies the fundamental knowledge and understanding, skills and competences that Mechanical Engineers must possess to be successful in their jobs.

3. PERSONAL ATTRIBUTES (VALUES, ETHICS AND ATTITUDES)

This job requires an individual to possess ability to apply advanced mathematical principles and statistics to solve problems, experience using CAD and CAM software such as SolidWorks, AutoCAD, exceptional technical and problem-solving skills and reasoning ability, ability to communicate effectively and clearly, must be self-motivated and a great team worker. He/she must have ability to plan and prioritise, quality consciousness, occupational health and safety orientated, be physically fit, courteous and creative, as well as ability to use fingers, hands and feet with ease to complete the assigned task (dexterity).

4. UNITS AND ELEMENTS

This National Occupational Standard is divided into six (6) units representing the tasks that a jobholder should undertake in his/her day to day work. The unit

is further broken down into elements depicting the number of activities to be carried out for the successful execution of a particular task.

UNIT 1 [Conceptualising, designing and testing new products, components, processes and prototypes, tools, jigs and fixtures using such tools as Computer Aided Design (CAD)].

Unit No.	**01**
Unit Title	**Designing and testing new products, tools, jigs and fixtures**
Description	This unit is about demonstrating competence to conceptualise, design and test new products and prototypes, components processes, tools and fixtures
Scope	This unit covers the following: • Sketching and designing of products, tools, jigs and fixtures • Prototyping and testing • Process design
Performance Criteria (PC) w.r.t. the Scope	
Element	**Performance Criteria (PC)**
Sketching and designing of products, tools, jigs and fixtures	To be competent, the individual must be able to: PC1: Interpret product customer/market needs into a design brief PC2: Apply appropriate engineering concepts, processes, principles to achieve the design brief PC3: Generate designs that conform to client/market requirements PC4: Create a number of designs for client to choose from PC5: Organise the designs into suitable formats and with sufficient information to allow the client/superior to assess them PC7: Justify any variations from the design brief and give a suitable reason for them PC8: Diagnose faults and analyse engineering problems PC9: Provide design engineering solutions (sketch and design new products) PC10: Prepare work schedules and plans PC11: Prepare and maintain section/departmental staff competency skills matrix PC12: See to it that the designs comply with all relevant regulations, standards directives or codes of practice PC13: Seek suitable guidance and advice to support the design work PC14: Protect the designs as intellectual property in line with organisational policies and procedures PC15: Design and update records management and documentation systems PC16: Work safely at all times, complying with health and safety and other relevant regulations and guidelines
Prototyping, and testing	To be competent, the individual must be able to: PC17: Develop and test new products and prototypes PC18: Make the required modifications to the product according to the test results PC19: Prepare a test report on the results with recommendations for the manufacture of the tested product PC20: Work safely at all times, complying with health and safety and other relevant regulations and guidelines

Process design	To be competent, the individual must be able to: PC21: Lead on making improvements to processes and procedures PC22: Design suitable product processes with clear flow diagrams, technical data and other information PC23: Utilise customer requirements and the design specification for new process or processes PC24: Recommend improvements to existing or new manufacturing processes PC25: Monitor machine performance and capacity utilisation in order to determine and optimise timelines PC26: Work safely at all times, complying with health and safety and other relevant regulations and guidelines
Knowledge and Understanding (K)	
A. Organisation-al Context (Knowledge of the company/ organisation and its processes)	The individual on the job must demonstrate knowledge and understanding of: OK1: Legislation, regulations, policies, standards, and procedures followed in the company relevant to own employment and performance conditions OK2. Organisation culture and typical customer profile OK3. Company's service level agreements and policies OK4. Company's code of conduct OK5. Organisation pricing and discount policy OK6. Organisation policy on documentation, reporting, etc.
B. Technical Knowledge	The individual on the job must demonstrate knowledge and understanding of: TK1. Sketching and design tools and methods TK2: Selection of suitable design software/package and the factors that must be considered TK3: How to prepare the design brief/specification and the different types of design briefs that could be required TK4: How to address any variations from the design brief TK5: Types and level of detail to be included in a design TK6: Approaches in attaining different types of designs TK7: Design formats that are most suitable to meet specific needs TK8: The minimum number of different designs that are necessary to provide a client/company with options TK9: How to present designs to the client/supervisor TK10: Standard practices for prototyping, testing methods and tools TK11: Production processes and technologies TK12. Intellectual property rights and protection TK13: Installation techniques and procedures TK14. Maintenance techniques and procedures TK15: Types of materials, material selection and treatment TK16: How and where to obtain information on regulations, standards, procedures, etc. TK17: How to obtain and interpret drawings, charts, specifications and documents TK18: How to prepare bills of materials, product costing and

	budgeting
C. Regulatory context (Knowledge of Rules and Regulations)	The individual on the job must demonstrate knowledge and understanding of RK1. Applicable national laws regulating the engineering profession RK2: National laws regulating the manufacturing industry; RK3: Environmental Management Act No 12 of 2011 RK4: Occupational Health and Safety Act 36 of 2010 RK5. Other applicable National and International Standards
Skills (S)	
A. Core Skills/ Generic Skills	**Reading Skills**
	The individual on the job must be able to: CS1. Read and analyse the available data about the product, processes, components, tools, fixtures CS2: Interpret sketches and drawings CS3: Examine equipment manuals and process documents to understand the equipment and processes better CS4. Read internal information sent by supervisor/other teams
	Writing Skills
	The individual on the job must be able to: CS5. Note down observations (if any) CS6. Prepare requisitions to procurement/stores for materials, tools and equipment, etc. CS7: Prepare technical and other reports
	Oral Communication (Listening and Speaking skills)
	The individual on the job must be able to: CS8. Discuss task lists, schedules and activities CS9. Effectively communicate with superiors, colleagues, subordinates and regulators CS10. Attentively listen and comprehend the information given by various sources CS11. Effectively delegate tasks to other staff
B. Professional Skills	**Plan and Organise**
	The individual on the job must be able to: PS1. Use Computer Aided Design PS2: Plan and organise the work order and flow of jobs PS3. Organise all processes, equipment, manuals so that sorting out/accessing information is easy; PS4: Collect, store and disseminate up to date information
	Judgment and Critical Thinking
	The individual on the job must be able to: PS5. Use common sense and make judgments in day to day activities PS6. Use reasoning skills to identify and resolve basic problems PS7. Use intuition to detect any potential problems which could arise during operations
	Desire to Learn and Take Initiatives
	The individual on the job must be able to: PS8. Follow instructions and work on areas of improvement identified

	PS9. Complete assigned tasks with minimum supervision PS10. Complete jobs within timelines and budget and quality norms PS11. Be open to other ideas and information PS12. Keep up-to-date with latest trends and changes in industry and the profession
	Problem Solving and Decision Making
	The individual on the job must be able to: PS13. Detect problems in day to day tasks PS14. Discuss possible solutions to address problems with subordinates and the supervisor PS15. Make decisions in emergency situations in the absence of the supervisor (as per the authority matrix defined by the organisation).

UNIT 2 [This Unit is about accomplishing the manufacturing process to produce products of required specification, output, on time and to budget using appropriate production methods and tools such as computer-aided manufacturing (CAM)].

Unit No.	**02**
Unit Title	**Manufacturing products, tools, jigs and fixtures to required specifications.**
Description	This unit is about demonstrating competence to plan, manufacture and accomplish the production process in the most judicious and economical way using tools such as computer-aided manufacturing (CAM), and product lifecycle management;
Scope	This unit covers the following: • Production planning • Product Manufacturing • Total Quality Management • Assembly of components, subassemblies and final assemblies • Product testing
Performance Criteria (PC) w.r.t. the Scope	
Element	**Performance Criteria (PC)**
Production planning	To be competent, the individual must be able to: PC1: Determine the work (product specifications, output, budget, time) required from the job and discuss the same with the supervisor and subordinates PC2: Plan for production and ensure that schedules, plans , material requirements (using MRP), processes and budget are understood by the production team; PC3: Evaluate and assemble a team of skilled technical staff; PC4: Deploy suitable machinery, equipment and materials PC5: Determine appropriate product/process sketches or blueprints to be used PC6: Examine machine performance and capacity utilisation in order to determine and optimise timelines PC7: Record and report impact of improvement activities PC8: Work safely at all times, complying with health and safety and other relevant regulations and guidelines
Product Manufacturing	To be competent, the individual must be able to: PC9: Lead product manufacturing PC10: Establish product requirements and discuss the same with the supervisor and subordinates; PC11: Determine types of materials, select materials and heat treatment processes and procedures PC12: Manufacture products according to specifications, quantities and timelines PC13: Manage and supervise the production team; PC14: Implement total quality management principles PC15: Accurately record and document production data; PC16: Put in place a methodical way of improving production activities e.g. quality circles PC17: Apply the use of Computer Aided Manufacturing (CAM)

	if necessary PC 18: Offer technical advice and guidance as required PC19: Work safely at all times, complying with health and safety and other relevant regulations and guidelines
Total Quality Management	To be competent, the individual must be able to: PC20: Interpret product and process specifications; PC21: Deploy Total Quality Management systems and techniques PC22: Design and implement quality improvement plans and training PC23: Collect, document and disseminate data on product quality and improvements to the supervisor and subordinates PC24: Prepare quality improvement reports PC25: Work safely at all times, complying with health and safety and other relevant regulations and guidelines
Assembly of components into subassemblies and final assemblies	To be competent, the individual must be able to: PC26: Assemble components into finished products PC27: Test sub and final assemblies PC28: Prepare test reports PC29: Carry product modifications and improvements PC30: Install and commission machines and systems PC31: Work safely at all times, complying with health and safety and other relevant regulations and guidelines
Product testing	To be competent, the individual must be able to: PC32: Test and document results PC33: Standardise machine output and calibrate; PC34: Prepare maintenance and operating manuals PC35: Declare products ready for use PC36: Work safely at all times, complying with health and safety and other relevant regulations and guidelines
Knowledge and Understanding (K)	
A. Organisation-al Context (Knowledge of the company/ organisation and its processes)	The individual on the job must demonstrate knowledge and understanding of: OK1: Legislation, standards, policies, and procedures followed in the company relevant to own employment and performance conditions OK2. Organisation culture and typical customer profile OK3. Company's service level agreements and policies OK4. Company's code of conduct OK5. Organisation pricing and discount policy OK6. Organisation policy on documentation, reporting, etc.
B. Technical Knowledge	The individual on the job must demonstrate knowledge and understanding of: TK1. Analytical tools and methods TK2. Production tools and methods (e.g. CAM) TK3. Prioritising own and team's workload to ensure that targets are met TK4: Interpreting drawings, charts, specifications, information, data, reports, manuals and other documents needed to understand the requirements of the production task TK5: Keeping up-to-date data and information such as

	drawings, specifications, manufacturers' manuals and other documents needed in the facility TK6: Operating principles and processes of the manufacturing machines and equipment in use TK7: The need for regular monitoring of departmental budgets and the implications for the company TK8: How to communicate effectively, listen, question, support and mentor others to work towards production targets TK9: Using decision making and creativity techniques (such as brainstorming, to generate ideas for improvement) TK10: How to identify training needs and to access training and developmental programmes TK11: Risks and hazards associated with the work, such as handling oils, misuse of tools, using damaged or badly maintained tools and equipment, and how to minimise the risks TK12. Prototyping and testing methods and tools TK13. Installation and commissioning techniques TK14. Diagnostic and preventive maintenance techniques TK15: Movement of materials, components or finished goods TK16. Business improvement activities TK17: Engineering safety audits or risk assessments TK18: Quality control/quality assurance
C. Regulatory context (Knowledge of Rules and Regulations)	The individual on the job must demonstrate knowledge and understanding of: RK1. Applicable national laws regulating the engineering profession RK2: National laws regulating the manufacturing industry RK3: Environmental Management Act No 12 of 2011 RK4: Occupational Health and Safety Act 36 of 2010 RK5. Applicable National and International Standards
Skills (S)	
A. Core Skills/ Generic Skills	**Reading Skills**
	The individual on the job must be able to: CS1. Read and analyse the available data about the products, processes, components, tools and fixtures CS2: Read and interpret sketches and drawings CS3: Read and understand equipment manuals and process documents
	Writing Skills
	The individual on the job must be able to CS4. Note down observations (if any) CS5. Prepare requisitions to procurement/stores on the requirement of materials, tools and equipment, etc. CS6: Prepare technical and other reports
	Oral Communication (Listening and Speaking skills)
	The individual on the job must be able to: CS7. Discuss task lists, schedules and activities CS8. Effectively communicate with superiors, colleagues, subordinates and regulators CS9. Attentively listen and comprehend the information given

	by various sources
B. Professional Skills	**Plan and Organise**
	The individual on the job must be able to: PS1. Plan and organise the work order and jobs PS2. Organise all process, manuals so that sorting out/accessing information is easy; PS3: Collect and keep up to date production and other information
	Judgment and Critical Thinking
	The individual on the job must be able to: PS4 Use common sense and make judgments in day to day activities PS5. Use reasoning skills to identify and resolve basic problems PS6. Use intuition to detect any potential problems which could arise during operations
	Desire to Learn and Take Initiatives
	The individual on the job must be able to: PS7. Follow instructions and work on areas of improvement identified PS8. Complete assigned tasks with minimum supervision PS9. Complete jobs within timelines and budget and quality norms PS10. Be open to other ideas and information PS11. Keep up-to-date with latest trends and changes in industry and the profession.
	Problem Solving and Decision Making
	The individual on the job must be able to: PS12. Detect problems in day to day tasks PS13. Discuss possible solutions to address problems with subordinates and the supervisor PS14. Make decisions in emergency situations in the absence of the supervisor (as per the authority matrix defined by the organisation)

UNIT 3 [This Unit is about carrying out installation, testing, modification and commissioning of machines and mechanical systems].

Unit No.	**03**
Unit Title	**Installation and commissioning of machines and mechanical systems**
Description	This unit is about demonstrating competence to carry out installation, testing and commissioning of machines and systems
Scope	This unit covers the following: • Planning • Installation • Testing • Commissioning
Performance Criteria (PC) w.r.t. the Scope	
Element	**Performance Criteria (PC)**
Planning	To be competent, the individual must be able to: PC1: Prepare bill of material and equipment requirements PC2: Determine number and type of technical staff for the installation PC3: Determine budget and timelines for the job PC4: Assess suitability of location and develop machine layout plan PC5: Prepare and arrange for power (with right voltage and water PC6: Plan that appropriate hand, power and lifting tools are in place PC7: Plan for adequate ventilation PC8: Work safely at all times, complying with health and safety and other relevant regulations and guidelines
Installation	To be competent, the individual must be able to: PC9: Assemble and install the machine/system PC10: Confirm that all mounting are firmly secured and torqued up if necessary PC11: Confirm that all other components of the machines are securely tightened PC12: Check water connection for possible leakages PC13: Connect power to the machine/system PC14: Check that all running parts have power supply PC15: Energise the machine/system PC16: Provide for adequate signage on all components and systems PC17: Work safely at all times, complying with health and safety and other relevant regulations and guidelines
Testing	To be competent, the individual must be able to: PC18: Test the installation PC19: Observe and monitor the main performance parameters e.g. temperature, pressure, output, etc. PC20: Make necessary adjustments or modifications to standardise the machines PC21: Continue testing until your get the pre-set results

	PC22: Prepare operating and maintenance manuals PC23: Work safely at all times, complying with health and safety and other relevant regulations and guidelines.
Commissioning	To be competent, the individual must be able to: PC24: Arrange for the commission PC25: Commission the installation PC26: Issue commission certificate PC27: Work safely at all times, complying with health and safety and other relevant regulations and guidelines
Knowledge and Understanding (K)	
A. Organisation-al Context (Knowledge of the company/ organisation and its processes)	The individual on the job must demonstrate knowledge and understanding of: OK1: Legislation, standards, policies, and procedures followed in the company OK2: Company policy pertaining to manufactured components OK3. Organisation culture and typical customer profile OK4. Company's service level agreements and policies OK5. Company's code of conduct OK6. Organisation pricing, discount policy OK7. Organisation policy on documentation, reporting, etc.
B. Technical Knowledge	The individual on the job must demonstrate knowledge and understanding of: TK1. Site layout TK2: Planning and installation techniques TK3: Testing methods and tools TK4. Preparation of operating and maintenance manuals TK5. Maintenance schedules for the machine/component TK6: Selection of suitable fittings for the machine TK7: Preparation of bills of materials and costing TK8: Commissioning technique, standards, procedures and guidelines TK9: Assessing training needs for the would be users of the installation TK10: Providing training to users
C. Regulatory context (Knowledge of Rules and Regulations)	The individual on the job must demonstrate knowledge and understanding of: RK1. Applicable national laws regulating the engineering profession RK2. National laws regulating the manufacturing industry; RK3. Environmental Management Act No 12 of 2011 RK4. Occupational Health and Safety Act 36 of 2010 RK5. Other applicable National and International Standards
Skills (S)	
A. Core Skills/ Generic Skills	**Reading Skills** The individual on the job must be able to: CS1. Read and analyse the available data about machines for installation and commissioning CS2: Read and interpret sketches and drawings CS3: Read equipment manuals and process documents to understand the equipment and processes better CS4. Read internal information sent by supervisor/other teams

	Writing Skills
	The individual on the job must be able to: CS5. Note down observations (if any) CS6. Prepare requisitions to procurement/stores on the requirement of materials, tools and equipment, etc. CS7. Prepare instruction manuals CS8. Prepare technical reports
	Oral Communication (Listening and Speaking skills)
	The individual on the job must be able to: CS9. Discuss task lists, schedules and activities CS10. Effectively communicate with superiors, colleagues, subordinates and regulators CS11. Attentively listen and comprehend the information given by various sources CS12. Delegate tasks to other staff
B. Professional Skills	**Plan and Organise**
	The individual on the job must be able to: PS1. Logically plan and organise the work order/schedule and flow of work activities PS2. Organise all processes, manuals so that sorting out/accessing information is easy PS3: Collect and keep up to date records
	Judgment and Critical Thinking
	The individual on the job must be able to: PS4. Use common sense and make judgments in day to day activities PS5. Use reasoning skills to identify and resolve basic problems PS6. Use intuition to detect any potential problems which could arise during operations
	Desire to Learn and Take Initiatives
	The individual on the job must be able to: PS7. Follow instructions and work on areas of improvement identified PS8. Complete assigned tasks with minimum supervision PS9. Complete jobs within timelines and budget and quality norms PS10. Be open to other ideas and information PS11. Keep up-to-date with latest trends and changes in industry and the profession
	Problem Solving and Decision Making
	The individual on the job must be able to: PS12. Detect problems in day to day tasks PS13. Discuss possible solutions to address problems with subordinates and the supervisor PS14. Make decisions in emergency situations in the absence of the supervisor (as per the authority matrix defined by the organisation)

UNIT 4 [This Unit is about maintenance of production machinery, equipment and systems].

Unit No.	**04**
Unit Title	**Maintenance of manufacturing machinery, equipment and systems.**
Description	This unit is about demonstrating competence to implement maintenance tasks and activities in accordance with approved procedures
Scope	This unit covers the following: • Planning • Preventive maintenance • Diagnosis and repair
Performance Criteria (PC) w.r.t. the Scope	
Element	**Performance Criteria (PC)**
Planning	To be competent, the individual must be able to: PC1: Prepare maintenance schedules of all machinery and equipment PC2: Evaluate sensory information from the machines(sight, sound, smell) and if necessary short circuit the maintenance PC3: Maintain a good stock of service parts to reduce on down time of equipment PC4: Requisition and procure materials, spares and tools PC5: Work safely at all times, complying with health and safety and other relevant regulations and guidelines
Preventive maintenance	To be competent, the individual must be able to: PC6: Prepare a comprehensive preventive maintenance schedule for the plant PC7: Influence decision to shut down the plant for preventive maintenance PC8: Maintain equipment according to the preventive maintenance schedule PC9: Test the machinery and equipment PC10: Calibrate/align if necessary PC11: Work safely at all times, complying with health and safety and other relevant regulations and guidelines
Diagnosis and repair	To be competent, the individual must be able to: PC12: Evaluate various types of information available for fault diagnosis, such as operator reports, monitoring equipment, sensory information, machinery history records and condition of end product PC13: Use a range of fault diagnostic equipment to investigate the problem, such as measuring devices, torque and run-out devices PC14: Apply appropriate methods and techniques to remove and replace the required components; PC15: Promptly rectify the fault. PC16: Test the machinery, equipment or component

	PC17: Calibrate/align if necessary PC18: Seek guidance from the relevant people if unable to solve particular problems PC19: Work safely at all times, complying with health and safety and other relevant regulations and guidelines
Knowledge and Understanding (K)	
A. Organisation-al Context (Knowledge of the company/ organisation and its processes)	The individual on the job must demonstrate knowledge and understanding of: OK1: Legislation, standards, policies, and procedures followed in the company OK2: Company policy pertaining to manufactured components OK3. Organisation culture and typical customer profile OK4. Company's service level agreements and policies OK5. Company's code of conduct OK6. Organisation pricing, discount policy OK7: Organisational policy on waste disposal and management OK7. Organisation policy on documentation, reporting, etc.
B. Technical Knowledge	The individual on the job must demonstrate knowledge and understanding of: TK1. Hazards involved in carrying out maintenance activities on engineering equipment and systems (e.g. handling oils, greases, stored energy/force, live electrical components, process controller interface, misuse of tools, using damaged or badly maintained tools and equipment, not following laid-down maintenance procedures), and how to minimise them TK2: System isolation procedures or permit-to-work procedure that applies TK3: Interpreting drawings, specifications, manufacturers' manuals and other documents needed in maintenance; TK4: Procedures for sourcing drawings, job instructions, related specifications, replacement parts, materials and other consumables necessary for the maintenance activities TK5: Principles of how machines function, operation sequence, the working purpose of individual units/components and how they interact TK6. Testing methods and tools and testing and alignment, calibration of machines TK7: Techniques and tools used to dismantle and reassemble electrical/electronic equipment, fluid power and process control instrumentation equipment TK8: Deploying monitoring devices and test measurements to check inputs and outputs TK9: Methods of checking and ensuring that components are fit for purpose and how to identify defects and wear characteristics; and the need to replace them TK10: Procedures to be followed for investigating the faults, and how to deal with intermittent faults PC11: Occupational health and safety and other relevant regulations and guidelines

C. Regulatory context (Knowledge of Rules and Regulations)	The individual on the job must demonstrate knowledge and understanding of: RK1. Applicable national laws regulating the engineering profession RK2: National laws regulating the manufacturing industry; RK3: Environmental Management Act No 12 of 2011 RK4: Occupational Health and Safety Act 36 of 2010 RK3. Other applicable National and International Standards
Skills (S)	
A. Core Skills/ Generic Skills	**Reading Skills**
	The individual on the job must be able to: CS1. Read and analyse the equipment operating manuals CS2: Read and interpret sketches and drawings CS3: Examine equipment manuals and process documents to understand the equipment and processes better CS4. Read and analyse internal information sent by supervisor/other teams
	Writing Skills
	The individual on the job must be able to: CS5. Note down observations (if any) CS6. Prepare requisitions to procurement/stores on the requirement of materials, tools and equipment, etc. CS7: Prepare maintenance documentation and/or reports CS8. Prepare instruction manuals
	Oral Communication (Listening and Speaking skills)
	The individual on the job must be able to: CS9. Discuss task lists, schedules and activities CS10. Effectively communicate with superiors, colleagues, subordinates and regulators CS11. Attentively listen and comprehend the information given by various sources CS12. Delegate tasks to other staff
B. Professional Skills	**Plan and Organise**
	The individual on the job must be able to: PS1. Logically plan and organise the work order/schedule and flow and jobs PS2. Organise all process, manuals so that sorting out/accessing information is easy PS3: Collect and keep up to date records
	Judgment and Critical Thinking
	The individual on the job must be able to: PS4. Use common sense and make judgments in day to day activities PS5. Use reasoning skills to identify and resolve basic problems PS6. Use intuition to detect any potential problems which could arise during operations
	Desire to Learn and Take Initiatives
	The individual on the job must be able to: PS7. Follow instructions and work on areas of improvement identified

	PS8. Complete assigned tasks with minimum supervision PS9. Complete jobs within timelines and budget and quality norms PS10. Be open to other ideas and information PS11. Keep up-to-date with latest trends and changes in industry and the profession
	Problem Solving and Decision Making
	The individual on the job must be able to: PS12. Detect problems in day to day tasks PS13. Discuss possible solutions to address problems with subordinates and the supervisor PS14. Make decisions in emergency situations in the absence of the supervisor (as per the authority matrix defined by the organisation)

UNIT 5 [This Unit is about implementing and monitoring compliance to quality and occupational health and safety standards and regulations].

Unit No.	**05**
Unit Title	**Implement and monitor occupational health and safety standards and regulations**
Description	This unit is about demonstrating competence to implement and monitor compliance to occupational health and safety standards and regulations
Scope	This unit covers the following: • Planning • Implementation • Monitoring
Performance Criteria (PC) w.r.t. the Scope	
Element	**Performance Criteria (PC)**
Planning	To be competent, the individual must be able to: PC1: Interpret occupational health and safety regulations and standards PC2: Determine types of occupational health and safety information requirements PC3: Determine types of occupational health and safety equipment requirements PC4: Source appropriate occupational health and safety information PC5: Source appropriate occupational health and safety equipment PC6: Assess staff training needs in occupational health and safety PC7: Prepare or organise suitable training for staff, PC8: Work safely at all times, complying with health and safety and other relevant regulations and guidelines
Implementation	To be competent, the individual must be able to: PC9: Provide comprehensive staff induction programme PC10: Apply appropriate health and safety precautions, regulations and standards PC11: Review implementation of occupational health and safety standards and regulations PC12: Work safely at all times, complying with health and safety and other relevant regulations and guidelines
Monitoring	To be competent, the individual must be able to: PC13: Regularly and systematically monitor compliance to occupational health and safety, e.g. importance of staff wearing protective clothing and other appropriate safety equipment PC14: Record and document and evaluate data on regulatory compliance to health and safety regulations and standards PC15: Work safely at all times, complying with health and safety and other relevant regulations and guidelines

Knowledge and Understanding (K)	
A. Organisation-al Context (Knowledge of the company/ organisation and its processes)	The individual on the job must demonstrate knowledge and understanding of: OK1: Legislation, standards, policies, and procedures followed in the company OK2: Company policy pertaining to manufactured components OK3. Organisation culture and typical customer profile OK4. Company's service level agreements and policies OK5. Company's code of conduct OK6. Organisation pricing and discount policy OK7: Organisational policy on waste disposal and management OK7. Organisation policy on documentation, reporting, etc.
B. Technical Knowledge	The individual on the job must demonstrate knowledge and understanding of: TK1. Occupational health and safety regulations, standards and guidelines TK2. Key health and safety equipment required for the facility, e.g. fire extinguishers, water hydrants, first aid box, etc. TK3. Imparting knowledge to others TK4: Safety equipment/technique to use for specific types of hazards/risks TK5: Application of first aid
C. Regulatory context (Knowledge of Rules and Regulations)	The individual on the job must demonstrate knowledge and understanding of: RK1. Applicable national laws regulating the engineering profession RK2: National laws regulating the manufacturing industry RK3: Environmental Management Act No 12 of 2011 RK4: Occupational Health and Safety Act 36 of 2010 RK5. Other applicable National and International Standards
Skills (S)	
A. Core Skills/ Generic Skills	**Reading Skills** The individual on the job must be able to: CS1. Read and analyse the available data about the occupational health and safety; CS2: Read and interpret and adhere to safety precautions displayed on machines and equipment ketches and drawings CS3: Read equipment manuals and process documents to understand operational hazards and risks. CS4. Read internal information on health and safety sent by supervisor/other teams **Writing Skills** The individual on the job must be able to: CS5. Note down observations (if any) CS6. Prepare requisitions to procurement/stores on the requirement of health and safety materials, and equipment, etc. CS7: Note down and display emergency numbers in the work place CS8: Prepare training notes and presentations

	Oral Communication (Listening and Speaking skills)
	The individual on the job must be able to: CS9. Discuss task lists, schedules and activities CS10. Effectively communicate with superiors, colleagues, subordinates and regulators CS11. Attentively listen and comprehend the information given by various sources; CS12. Make presentations CS13. Delegate tasks to other staff
B. Professional Skills	**Plan and Organise**
	The individual on the job must be able to: PS1. Logically plan and organise the work order/schedule PS2. Organise all process, manuals so that sorting out/accessing information is easy; PS3: Collect and keep up to date records
	Judgment and Critical Thinking
	The individual on the job must be able to: PS4. Use common sense and make judgments in day to day activities PS5. Use reasoning skills to identify and resolve basic problems PS6. Use intuition to detect any potential problems which could arise during operations
	Desire to Learn and Take Initiatives
	The individual on the job must be able to: PS7. Follow instructions and work on areas of improvement identified PS8. Complete assigned tasks with minimum supervision PS9. Complete jobs within timelines and budget and quality norms PS10. Be open to other ideas and information PS11. Keep up-to-date with latest trends and changes in industry and the profession
	Problem Solving and Decision Making
	The individual on the job must be able to: PS12. Detect problems in day to day tasks PS13. Discuss possible solutions to address problems with subordinates and the supervisor PS14. Make decisions in emergency situations in the absence of the supervisor (as per the authority matrix defined by the organisation)

UNIT 6 [This Unit is about supervision and management of technical staff; artisans, technicians, technologists and other engineers].

Unit No.	**06**
Unit Title	**People management**
Description	This unit is about demonstrating competence to supervise and manage artisans, technicians, technologists and other engineers.
Scope	This unit covers the following: • Departmental skills needs assessment • Job allocation • Supervision and performance management
Performance Criteria (PC) w.r.t. the Scope	
Element	**Performance Criteria (PC)**
Skills needs assessment	To be competent, the individual must be able to: PC1: Comprehensive staff induction programme PC2: Carry out a skills audit of staff, PC3: Identify and recommend appropriate training for staff
Job allocation	To be competent, the individual must be able to: PC4: Allocate jobs according to staff abilities PC5: Assemble task teams around highly skilled staff and facilitate team work PC6: Accommodate ideas from both subordinates and superiors.
Supervision and performance management	To be competent, the individual must be able to: PC7: Supervise and manage subordinates; PC8: Provide timely feedback to superiors and subordinates PC9: Carry out activities in the specified sequence and in an agreed timescale PC10. Coach and mentor subordinates PC11. Motivate and provide incentives for outstanding performance.
Knowledge and Understanding (K)	
A. Organisation-al Context (Knowledge of the company/ organisation and its processes)	The individual on the job must demonstrate knowledge and understanding of: OK1: Legislation, standards, policies, and procedures followed in the company OK2: Company policy pertaining to manufactured components OK3. Organisation culture and typical customer profile OK4. Company's service level agreements and policies OK5. Company's code of conduct OK6. Organisation pricing, discount policy OK7: Organisational policy on waste disposal and management OK7. Organisation policy on documentation, reporting, etc.
B. Technical Knowledge	The individual on the job must demonstrate knowledge and understanding of: TK1. Serving as a reliable link between subordinates and management TK2: Team work and staff motivation TK3: Staff welfare TK4. Prioritise health and safety of staff under his/her supervision TK5: Imparting knowledge to others

C. Regulatory context (Knowledge of Rules and Regulations)	The individual on the job must demonstrate knowledge and understanding of: RK1. Applicable national laws regulating the engineering profession RK2: National laws regulating the manufacturing industry; RK 3: Environmental Management Act No 12 of 2011 RK 4: Occupational Health and Safety Act 36 of 2010 RK3. Other applicable National and International Standards
Skills (S)	
A. Core Skills/ Generic Skills	**Reading Skills**
	The individual on the job must be able to: CS1. Read and analyse the available data about staff skills and qualifications CS2: Read and interpret conditions of service CS3: Read and interpret code of conduct CS4. Read internal information sent by supervisor/other teams
	Writing Skills
	The individual on the job must be able to: CS5. Note down observations (if any) CS6. Prepare work instructions CS7: Prepare training notes and presentations CS8: Prepare reports
	Oral Communication (Listening and Speaking skills)
	The individual on the job must be able to: CS9. Discuss task lists, schedules and activities CS10. Effectively communicate with superiors, colleagues, subordinates and regulators CS11. Attentively listen and comprehend the information given by various sources CS12. Make presentations CS13. Delegate tasks to other staff
B. Professional Skills	**Plan and Organise**
	The individual on the job must be able to: PS1. Logically plan and organise the work order/schedule and flow and jobs PS2. Organise all process, manuals so that sorting out/accessing information is easy PS3: Collect and keep-up-to date records
	Judgment and Critical Thinking
	The individual on the job must be able to: PS4. Use common sense and make judgments in day to day activities PS5. Use reasoning skills to identify and resolve basic problems PS6. Use intuition to detect any potential problems which could arise during operations
	Desire to Learn and Take Initiatives
	The individual on the job must be able to: PS7. Follow instructions and work on areas of improvement identified PS8. Complete assigned tasks with minimum supervision

	PS9. Complete jobs within timelines and budget and quality norms PS10. Be open to other ideas and information PS11. Keep up-to-date with latest trends and changes in industry and the profession.
	Problem Solving and Decision Making
	The individual on the job must be able to: PS12. Detect problems in day to day tasks PS13. discuss possible solutions to address problems with subordinates and the supervisor PS14. Make decisions in emergency situations in the absence of the supervisor (as per the authority matrix defined by the organisation)

5. EQUIPMENT, TOOLS AND CONSUMABLE MATERIALS

These include, but not limited to:

Equipment and Tools:
Design and Prototyping equipment and tools, computer software applications, Machine shop equipment and tools, Fabrication shop equipment and tools, Electrical equipment, Maintenance equipment and tools, Testing equipment and tools, Personal protective equipment, etc.

Raw Materials and Consumables:
Textile, Leather, Wood, Paper, Chemicals, Rubber, Plastics, Non-metallic minerals, Basic metals, Lubricants, Composites, Spare parts and components, etc.

6. DILEMMAS/CHALLENGES AND COMPLEXITIES FOR A JOB HOLDER

Mechanical engineers face challenges such as obsolete and/or inappropriate equipment and tools, budgetary constraints, inadequate product costing skills, poor technical skill base, bureaucracy in procurement procedures, lack of appreciation of preventive maintenance by non-engineering management staff, labour intensive nature of the work, rapid change of technology and materials, lack of personal protective equipment, climate change, cyber warfare, inconsistence in company and government policies and regulations, etc.

6.1 Alternative Choices (Solutions) to Dilemmas and Complexities

Solutions to challenges include: selecting and procuring appropriate equipment and tools for the job; supporting capacity building through training; identifying and utilising suitable adaptation and mitigation measure against the effect of climate change; utilising appropriate cyber security measures to protect against cyber warfare; include engineering professionals in management teams, deployment of automation where feasible, provision of personal protective

equipment, participate in lobbying and formulation of policies, allocation of adequate financial resources, etc.

7. WORKING CONDITIONS/ENVIRONMENT

Mechanical Engineers work with a variety of machinery, toxic substances and volatile materials, their work environment is susceptible to fires, explosions, structural failures and equipment malfunctions. Working conditions include cold, hot and wet conditions, climbing heights, stand/walk for long hours, lifting materials, working in day or night shifts, areas that are noisy and dusty, areas with limited lighting and ventilation, etc.

8. PARTIES INVOLVED/INTERACTING WITH THE JOB HOLDER OR TRAINEE

8.1 Internal/Within the Organisation

Management, supervisors, subordinates and other section members, etc.

8.2 External/Outside the Organisation

Government regulators, professional bodies, clients, suppliers, fellow engineers from other companies, labour unions, clients, students/interns, etc.

9. PHYSICAL DEMANDS ON THE BODY

- Physique to sustain strenuous conditions;
- Be able to walk and stand for long periods of time;
- Bend, stretch, twist, or reach out;
- Be able to lift relatively heavy materials, tools and equipment;
- Be able to use fingers, hands and feet with ease to complete the assigned task (dexterity);
- Etc.

ANNEX A
Criteria for Assessments based on this NOS

A.1 Guidelines for Assessment

A.1.1 Criteria for assessment for curricula and learning programmes based on this NOS will be created by curricula and programmes developers. Each Performance Criteria (PC) will be assigned marks proportional to its importance in the NOS. Curricula and programmes developers will also lay down proportion of marks for theory and practical skills for each performance criteria, giving more weight to practical skills.

There shall be allocated the 'Total Mark', which will be the sum of all marks in each Unit, distributed across the number of PCs in that particular Unit. The 'out of' mark will be the mark allocated to each PC, which will be shared between theory and skills practical assessments.

A.1.2 Individual awarding/assessment bodies or institutions and other users of the NOS will create unique question papers for the theory part and evaluations for skill practical part for their respective candidates.

ANNEX B
NOS Version Control

This Annex gives details necessary for the tracking of the NOS versions based on the number of revisions.

NOS Code	DNOS.ME.01		
ZQF Level	7	**Version Number**	01
Sector	Manufacturing	**Date of Approval**	
Sub Sector	Agro-processing, textile, and leather industries, wood and wood products, paper and paper products, Chemicals and chemical processing, Rubber and plastic products, Non-metallic mineral products, Basic metal products, Fabricated, formed and machined metal products, automotive; food and beverages.	**Date of Last Review**	N/A
Occupation	Mechanical Engineering	**Date of Next Review**	