
**DRAFT NATIONAL OCCUPATIONAL STANDARD FOR
CHEMICAL ENGINEER**

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

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:

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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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DRAFT FOR SECTOR REVIEW AND COMMENTING

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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 organizations, 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

Chemical Engineers research, design, and develop chemical processes and equipment, oversee the operation and maintenance of industrial chemical, plastics, pharmaceutical, resource, pulp and paper, and food processing plants and perform duties related to chemical quality control, environmental protection and biochemical or biotechnical engineering. Chemical Engineers are employed in a wide range of manufacturing and processing industries, consulting firms, government, research and educational institutions.

With the foregoing in mind, every industry will require a Chemical Engineer to oversee the day to day operations and ensure desired production quality and quantity outcomes are achieved. Chemical Engineers are trained to understand industrial processes and apply this knowledge in problem solving, process evaluation and improvement.

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

ACRONYMS AND ABBREVIATIONS

BOM	Bill of Materials
CHE	Chemical Engineer
CS	Core Skill
DMAIC	Define, Measure, Analyze Improve and Control
DNOS	Draft National Occupational Standard
EIA	Environmental Impact Assessment
EP & PC	Environmental Protection and Pollution Control
FI	Focused Improvement
GLP	Good Laboratory Practices
GMP	Good Manufacturing Practices
ICT	Information and Communication Technology
ISO	International Organisation for Standardisation
IT	Information Technology
LRP	Labour Requirement Planning
MRP	Material Requirement Planning
MSDS	Material Safety Data Sheet
NOS	National Occupational Standard
NOSDT	National Occupational Standards Development Team
OK	Organizational Knowledge
PC	Performance Criteria
PMC	Performance Measurement and Control
PS	Professional Skill
P&ID	Piping and Instrumentation Diagram
PID	Product Information Document
PPE	Personal Protective Equipment
RK	Regulatory Knowledge
RPL	Recognition of Prior Learning
SOP	Standard Operating Procedure
SPC	Statistical Process Control
TK	Technical Knowledge
VM	Visual Management
ZAQA	Zambia Qualifications Authority
ZCSA	Zambia Compulsory Standards Agency
ZEMA	Zambia Environmental Management Agency
ZMA	Zambia Metrology Agency
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.

DRAFT FOR SECTOR REVIEW AND COMMENTING

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.CHE.01
Occupation	Chemical Engineering
Job Title	Biochemical/Chemical/Process/Process Control Engineer
Job Description	Chemical Engineers design and troubleshoot processes for the production of chemicals, fuels, foods, pharmaceuticals, and biologicals, etc. Their main responsibility in manufacturing plants is to maximise productivity and product quality while minimising costs.
Job Purpose	To design, operate and maintain chemical processing plants whilst ensuring cost effectiveness. They are also involved in chemical processing research and development and the development of guidelines and specifications for chemicals, materials and consumer goods.
ZQF Level	7
Sector	Manufacturing
Sub sector	Chemical process industries
Other Economic Sector(s) in which the Occupation is Practiced	Mining, Education, Government Institutions, etc.
Other Similar Jobs that can be performed by the Chemical Engineer	Production Manager, Process Manager, Process Improvement Manager, Manufacturing Development Officer, Quality Control Officer/Manager, Quality Assurance Officer/Manager, Utilities Engineer, Lecturer, Raw/Packaging Materials Officer, Packaging Manager/Officer, Metallurgist, Metallurgical/Plant Manager, Plant Controller, etc.
Minimum Educational Job Entry Qualification(s)	Bachelor's Degree in Chemical, Process or Biochemical 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 (Suggested)	1. Use of ICTs (Internet, Microsoft word, Excel, PowerPoint, Email, Computer Software and Hardware necessary for the job, etc.) 2. 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 Chemical Engineers must possess to be successful in their jobs.

3. PERSONAL ATTRIBUTES (VALUES, ETHICS AND ATTITUDES)

This job requires an individual to possess:

- Creativity
- Problem Solving Skills
- Analytical Skills
- Arithmetic and Statistical Skills
- Integrity
- Interpersonal Skills
- ICT Skills
- Commercial Awareness
- Attention to Detail
- Management Skills
- Project Management Skills, etc.

4. UNITS AND ELEMENTS

This National Occupational Standard is divided into seven (7) Units representing the tasks that a jobholder should undertake in his/her day to day work. Each 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 [This unit is about ensuring safety, health and environmental management].

Unit No.	01
Unit Title	Ensure safety, health and environmental management
Description	This unit is about maintaining safety, health and environmental protection for the individual and the manufacturing plant
Scope	This unit covers the following: <ul style="list-style-type: none"> • Ensure all safety and health regulations are followed by the jobholder as well as other employees. • Ensure the operations of the establishment conform to the requirements for environmental protection.
Performance Criteria (PC) w.r.t. the Scope	
Element	Performance Criteria (PC)
Ensure all health and safety regulations are followed by the jobholder as well as other employees/ subordinates	To be competent, the individual must be able to: PC1. Implement the safety and health policies of the organisation PC2. Implement the environmental policies for the organisation PC3. Assess risk and possible safety hazards of all aspects of operations PC4. Guide other employees on the safe operation of machinery, tools and equipment and apply these in formulation of standard operating procedures (SOPs)
Ensure the operations of the establishment conform to the requirements for environmental protection	To be competent, the individual must be able to: PC5. Implement the environmental policies of the organisation PC6. Implement the environmental regulations of the organisation PC7. Guide other employees on the safe operations of equipment in relation to environmental protection and apply these in formulation of standard operating procedure(SOPs)
Knowledge and Understanding (K)	
A. Organisational Context (Knowledge of the company/ organisation and its processes)	The individual on the job must demonstrate knowledge and understanding of: OK1. Company policies on safety, health, environment and quality OK2. Company procedures and regulations on safety, health, environment and quality.
B. Technical Knowledge	The individual on the job must demonstrate knowledge and understanding of: TK1. Safety risk assessment TK2. Environmental risk assessment TK3. Tool box talk TK4. Material Safety Data Sheets (MSDS)
C. Regulatory context (Knowledge of Rules and Regulations)	The individual on the job must demonstrate knowledge and understanding of: RK1. Government regulatory requirements for safety and health (Factories Act) RK2. Government regulatory requirements for environmental protection (ZEMA guidelines, Environmental Management Act)

Skills (S)	
A. Core Skills/ Generic Skills	Reading Skills
	The individual on the job must be able to: CS1. Read and interpret internal/external documents related to safety, health and environmental management.
	Writing Skills
	The individual on the job must be able to: CS2. Prepare health, safety and environment SOPs.
B. Professional Skills	Oral Communication (Listening and Speaking skills)
	The individual on the job must be able to: CS3. Effectively communicate health safety and environmental information to his/her subordinates and other stakeholders.
	Plan and Organise
	The individual on the job must be able to: PS1. Plan and organise departmental health, safety and environmental awareness meetings. PS2. Carry out departmental safety, health and environmental risk assessments (in conjunction with the Safety Officer).
B. Professional Skills	Judgment and Critical Thinking
	The individual on the job must be able to: PS3. Determine the implications of failure to conform to desired health, safety and environmental regulations and impact on the employees and the company.
	Desire to Learn and Take Initiatives
	The individual on the job must be able to: PS4. Keep up-to-date with latest trends and changes in safety procedures and environmental management systems. PS5. Suggest and initiate improved ways to handle health, safety and environmental issues.
B. Professional Skills	Problem Solving and Decision Making
	The individual on the job must be able to: PS6. Identify and solve health, safety and environmental issues with minimum or no supervision. PS7. Make decisions in emergency situations.

UNIT 2 [This unit is about evaluating plant process technology and equipment and determine production specifications].

Unit No.	02
Unit Title	Production planning and plant process control
Description	This unit is about evaluating plant process technology and equipment and determine production specifications
Scope	This unit covers the following: <ul style="list-style-type: none"> Plant process technology and equipment Production planning.
Performance Criteria (PC) w.r.t. the Scope	
Element	Performance Criteria (PC)
Plant process technology and equipment	To be competent, the individual must be able to: <ul style="list-style-type: none"> PC1. Interpret plant/process flow PC2. Operate the individual processing units and equipment PC3. Identify, through trouble shooting, the bottlenecks and efficiency problems in the process. PC4. Identify plant process equipment failure and suggest solutions for repair and improvements PC5. Suggest plant process improvement ideas to increase production efficiencies and capacities. PC6. Identify new trends in processing and equipment and apply these to existing processes. PC7. Train subordinates and other individuals on the process. PC8. Formulate standard operating procedures for the plant process and equipment.
Production planning	To be competent, the individual must be able to: <ul style="list-style-type: none"> PC9. Develop an actionable and effective production plan PC10. Implement the production plan. PC11. Draft the bill of materials (BOM) for the production plan. PC12. Explain the production plan and bill of materials (BOM) to subordinates and other individuals/employees. PC13. Ensure all production materials are available and in the right quantities to satisfy the production plan. PC14. Make adjustments to the production plan and equipment to achieve desired targets. PC15. Forecast material requirements to fulfil future production plans. PC16. Supervise/coordinate manpower requirements. PC17. In conjunction with other engineers, technologists and other support services, plan and coordinate the resource requirements for the production plan, such as power and other utilities. PC18. Compile detailed production reports for internal and external use.
Knowledge and Understanding (K)	
A. Organisational Context (Knowledge of the company/	The individual on the job must demonstrate knowledge and understanding of: <ul style="list-style-type: none"> OK1. Company production reporting procedures. OK2. Company materials procurement procedures.

organisation and its processes)	OK3. Company human resource structure and hierarchy. OK4. Company human resource policies and procedures. OK5. Company maintenance policies and procedures.
B. Technical Knowledge	The individual on the job must demonstrate knowledge and understanding of: TK1. Flow diagrams TK2. Material Requirement Planning (MRP) TK3. Statistical Process Control (SPC) TK4. DMAIC Process Improvement Methodology TK5. 5S process improvement methodologies. TK6. Visual Management (VM) in the workplace. TK7. Focussed Improvement (FI) in the workplace. TK8. Performance Measurement and Control (PMC). TK9. Good Manufacturing Practices (GMP). TK10. Process unit operations TK11. Quality monitoring and control TK12. Drafting Standard Operating Procedures (SOPs) TK13. IT knowledge.
C. Regulatory context (Knowledge of Rules and Regulations)	The individual on the job must demonstrate knowledge and understanding of: RK1. Government regulatory requirements for production process emissions (ZEMA guidelines, Environmental Management Act). RK2. Government regulatory requirements for consumer product quantity, quality and safety (ZABS, ZMA, ZCSA). RK3. Government regulatory requirements for employee safety and compensation (Factories Act).
Skills (S)	
A. Core Skills/ Generic Skills	Reading Skills
	The individual on the job must be able to: CS1. Read and interpret internal/external documents related to production and maintenance. CS2. Read and interpret documents related to unit operations. CS3. Read and interpret related to process and equipment safety. CS4. Read and interpret process flow diagrams. CS5. Read and interpret standard operating procedures.
	Writing Skills
	The individual on the job must be able to: CS6. Generate production reports. CS7. Generate incident reports.
B. Professional Skills	Oral Communication (Listening and Speaking skills)
	The individual on the job must be able to: CS8. Effectively communicate process and equipment information to his/her subordinates and other stakeholders.
B. Professional Skills	Plan and Organise
	The individual on the job must be able to: PS1. Plan and organise maintenance and production meetings. PS2. Carry out Materials Requirement Planning (MRP). PS3. Plan and organise Labour Requirements (LRP).

	PS4. Plan for process monitoring and control.
	Judgment and Critical Thinking
	The individual on the job must be able to: PS5. Deal with process deviations and ensure quality of the desired end product. PS6. Analyse process conditions to anticipate any deviations and quickly rectify them with minimal disruption to the manufacturing process.
	Desire to Learn and Take Initiatives
	The individual on the job must be able to: PS7. Keep up-to-date with latest trends and changes in processing procedures and maintenance management systems. PS8. Be abreast with changes in raw materials requirements and suggests and initiates improved ways of processing to reduce on costs. PS9. Take the initiative to understand and lead change (change management)
	Problem Solving and Decision Making
	The individual on the job must be able to: PS10. Identify and solve process and equipment problems with minimum or no supervision. PS11. Handle process/production variables whilst maintaining desired end product quality. PS12. Provide input to all plant quality problem solving sessions/initiatives.

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UNIT 3 [This unit is about designing, overseeing the construction, modification, operation and maintenance of pilot plants, processing units or processing plants].

Unit No.	03
Unit Title	Design and test chemical processing and associated plants and equipment
Description	This unit is about designing, overseeing the construction, modification, operation and maintenance of pilot plants, processing units or processing plants
Scope	This unit covers the following: <ul style="list-style-type: none"> • Design of Chemical processing units or plants. • Oversee construction or modification of chemical processing units or plants. • Operation and maintenance of pilot plants, processing units or plants.
Performance Criteria (PC) w.r.t. the Scope	
Element	Performance Criteria (PC)
Design of chemical processing units or plants	To be competent, the individual must be able to: <p>PC1. Develop plant/process flow diagrams.</p> <p>PC2. Determine relationships between variables viz-a-viz temperature and pressure and their relationship to the raw materials, etc.</p> <p>PC3. Perform material and energy balances.</p> <p>PC4. Calculate and explain the cost implications of the design.</p> <p>PC5. Determine the physical and chemical characteristics of the raw materials as well as the construction materials.</p> <p>PC6. Integrate the auxiliary units like pumps into the process design.</p> <p>PC7. Draft PIDs for use both in construction and operations.</p>
Oversee construction or modification of chemical processing units or plants	To be competent, the individual must be able to: <p>PC8. Implement the PIDs as well as the flow sheets.</p> <p>PC9. Supervise/coordinate manpower requirements.</p> <p>PC10. In conjunction with other engineers, technologists, make modifications from original design to suit site considerations and cost implications.</p> <p>PC11. Forecast material requirements to fulfil commissioning and testing requirements.</p> <p>PC12. Generate progress reports outlining the milestones and challenges.</p> <p>PC13. Ensure strict adherence to agreed project timelines.</p> <p>PC14. Coordinate the construction of different parts/items/units and how they will be fitted together.</p> <p>PC15. Prepare contract documents and evaluate tenders for the process aspects of industrial construction</p>

<p>Operation and maintenance of pilot plants, processing units or plants.</p>	<p>To be competent, the individual must be able to:</p> <p>PC16. Draw up process and quality monitoring and control checklists for use by operators/subordinates.</p> <p>PC17. In conjunction with other engineers, technologists, draw up maintenance plans and checklist to be used by artisans and operators.</p> <p>PC18. In conjunction with other engineers, technologists and subordinates, generate standard operating procedures for use by artisans and operators.</p> <p>PC19. Offer training to new employees on the operation and maintenance of the pilot plants, processing unit or plants.</p> <p>PC20. Incorporate and train subordinates on new trends in the operation of these units.</p> <p>PC21. In conjunction with other engineers and technologists, generate new ways to cut down on equipment failure and down time in order to improve efficiencies.</p>
<p>Knowledge and Understanding (K)</p>	
<p>A. Organisational Context (Knowledge of the company/ organisation and its processes)</p>	<p>The individual on the job must demonstrate knowledge and understanding of:</p> <p>OK1. Company construction and tender procedures.</p> <p>OK2. Company materials procurement procedures.</p> <p>OK3. Company human resource structure and hierarchy.</p> <p>OK4. Company human resource policies and procedures.</p> <p>OK5. Company maintenance policies and procedures</p>
<p>B. Technical Knowledge</p>	<p>The individual on the job must demonstrate knowledge and understanding of:</p> <p>TK1. PIDs and process flow diagrams.</p> <p>TK2. Material and energy balancing.</p> <p>TK3. Materials chemistry.</p> <p>TK4. Construction and design costing.</p> <p>TK5. Quality monitoring and Control.</p> <p>TK6. Process simulation and modelling.</p>
<p>C. Regulatory context (Knowledge of Rules and Regulations)</p>	<p>The individual on the job must demonstrate knowledge and understanding of:</p> <p>RK1. Government regulatory requirements for production process emissions (ZEMA guidelines, Environmental Management Act).</p> <p>RK2. Government regulatory requirements for consumer product quantity, quality and safety (ZABS, ZMA, ZCSA).</p> <p>RK3. Government regulatory requirements for employee safety and compensation (Factories Act).</p>
<p>Skills (S)</p>	
<p>A. Core Skills/ Generic Skills</p>	<p>Reading Skills</p> <p>The individual on the job must be able to:</p> <p>CS1. Read and interpret internal/external documents related to production and maintenance.</p> <p>CS2. Read and interpret documents related to unit operations.</p> <p>CS3. Read and interpret documents related to process and equipment safety.</p> <p>CS4. Read and interpret process flow diagrams and PIDs</p> <p>CS5. Read and interpret standard operating procedures.</p>

	<p>Writing Skills</p> <p>The individual on the job must be able to:</p> <ul style="list-style-type: none"> CS6. Generate production reports. CS7. Generate incident reports. CS8. Generate PIDs and process flow diagrams. CS9. Generate standard operating procedures. <p>Oral Communication (Listening and Speaking skills)</p> <p>The individual on the job must be able to:</p> <ul style="list-style-type: none"> CS10. Effectively communicate process and equipment information to his/her subordinates and other stakeholders.
<p>B. Professional Skills</p>	<p>Plan and Organise</p> <p>The individual on the job must be able to:</p> <ul style="list-style-type: none"> PS1. Plan and organise maintenance and production meetings. PS2. Carry out Materials Requirement Planning (MRP). PS3. Plan and organise Labour Requirements (LRP). PS4. Plan for process monitoring and control. PS5. Plan for the project life cycle. <p>Judgment and Critical Thinking</p> <p>The individual on the job must be able to:</p> <ul style="list-style-type: none"> PS6. Deal with process deviations and ensures to get the desired end product quality. PS7. Analyse process conditions to anticipate any deviations and quickly rectify with minimal disruption to process. PS8. Critically analyse all design and construction variables, and be able to change them to obtain desired end product. <p>Desire to Learn and Take Initiatives</p> <p>The individual on the job must be able to:</p> <ul style="list-style-type: none"> PS7. Keep up-to-date with latest trends and changes in processing procedures and maintenance management systems. PS8. Be abreast with changes in Raw materials requirements and suggests and initiates improved ways of processing to reduce on costs. PS9. Take the initiative to understand and lead change. (Change management) PS10. Be abreast with the latest versions of design and simulation software. <p>Problem Solving and Decision Making</p> <p>The individual on the job must be able to:</p> <ul style="list-style-type: none"> PS11. Identify and solve process and equipment problems with minimum or no supervision. PS12. Handle process/production variables whilst maintaining desired end product quality. PS13. Provide input to all plant quality problem solving sessions/initiatives. PS14. Offer alternatives when encountered with challenges during construction whilst achieving desired end product.

UNIT 4 [This unit is about supervising technicians, technologists, other engineers and contractors].

Unit No.	04
Unit Title	Supervising
Description	This unit is about supervising technicians, technologists, other engineers and contractors
Scope	This unit covers the following: <ul style="list-style-type: none"> • Supervising technicians, technologists and other engineers • Supervising contractors
Performance Criteria (PC) w.r.t. the Scope	
Element	Performance Criteria (PC)
Supervising technicians, technologists and other engineers	To be competent, the individual must be able to: PC1. Plan and schedule workloads. PC2. Plan and forecast for manpower requirements. PC3. Manage day to day activities for technicians, technologists and other engineers. PC4. Involve the technicians in decision making. PC5. Prepare contingency plans to deal with unforeseen changes in staffing levels.
Supervising Contractors	To be competent, the individual must be able to: PC6. Interpret all construction and process drawings. PC7. Supervise/coordinate manpower requirements. PC8. Provide relevant process/plant data to contractors. PC9. Carry out cost analysis of the project and ensure all falls in budget. PC10. Apply the principles of project management. PC11. Ensure strict adherence to agreed project time lines. PC12. Coordinate cross-functional teams in the construction of different parts/items/units and how they will be fitted together. PC13. Prepare contract documents and evaluate tenders for the process aspects of industrial construction. PC14. Use the scope and contract documents in supervising contractors.
Knowledge and Understanding (K)	
A. Organisational Context (Knowledge of the company/ organisation and its processes)	The individual on the job must demonstrate knowledge and understanding of: OK1. Company construction and tender procedures. OK2. Company human resource structure and hierarchy. OK3. Company human resource policies and procedures.
B. Technical Knowledge	The individual on the job must demonstrate knowledge and understanding of: TK1. DMAIC Process Improvement Methodology TK2. 5S Process improvement Methodologies. TK3. Visual Management (VM) in the workplace. TK4. Focussed Improvement (FI) in the workplace. TK5. Performance Measurement and Control (PMC). TK6. Good Manufacturing Practices (GMP).

	<p>TK7. Quality monitoring and control TK8. Drafting Standard Operating Procedures (SOPs) TK9. IT knowledge. TK10. Human resource management. TK11. Project management.</p>
C. Regulatory context (Knowledge of Rules and Regulations)	<p>The individual on the job must demonstrate knowledge and understanding of: RK1. Government regulatory requirements for construction. RK2. Government regulatory requirements for employee safety and compensation (Factories Act).</p>
Skills (S)	
A. Core Skills/ Generic Skills	Reading Skills
	<p>The individual on the job must be able to: CS1. Read and interpret internal/external documents related to Construction and project management. CS2. Read and interpret documents related to human resource management.</p>
	Writing Skills
	<p>The individual on the job must be able to: CS3. Prepare manpower schedules. CS4. Prepare progress reports. CS5. Prepare technical reports.</p>
	Oral Communication (Listening and Speaking skills)
	<p>The individual on the job must be able to: CS6. Effectively communicate technical and non-technical information to his/her subordinates and other stake holders.</p>
B. Professional Skills	Plan and Organise
	<p>The individual on the job must be able to: PS1. Plan and organise communication meetings for internal/external stakeholders. PS2. Plan and organise Labour Requirements (LRP)</p>
	Judgment and Critical Thinking
	<p>The individual on the job must be able to: PS3. Effectively deal with different personalities of the technicians, technologists and other engineers. PS4. Effectively deal with different personalities of the contractors. PS5. Effectively communicate any changes to program/ processes/personnel and still obtain desired input from subordinates.</p>
	Desire to Learn and Take Initiatives
	<p>The individual on the job must be able to: PS6. Demonstrate leadership by going beyond the call of duty and inspire subordinates. PS7. Be abreast with changes in the industry and share the best practices learned with his technicians, technologists and other engineers. PS8. Take the initiative to understand and lead change (change management).</p>

	Problem Solving and Decision Making
	<p>The individual on the job must be able to:</p> <ul style="list-style-type: none">PS9. Make correct decisions in a timely manner whilst considering the cost implications.PS10. Effectively use problem solving methodologies to handle any issues so as to avoid bias.

DRAFT FOR SECTOR REVIEW AND COMMENTING

UNIT 5 [This unit is about establishing and conducting quality control programs, operating procedures and control strategies to ensure consistency and adherence to standards for Raw materials, Products and Waste products or emissions].

Unit No.	05
Unit Title	Establishing quality control programs and strategies
Description	This unit is about establishing and implementing quality control programs, operating procedures and control strategies to ensure consistency and adherence to standards for raw materials, products and waste products or emissions.
Scope	This unit covers the following: <ul style="list-style-type: none"> Establishing and implementing quality control programs Establishing operating procedures and control strategies
Performance Criteria (PC) w.r.t. the Scope	
Element	Performance Criteria (PC)
Establishing and implementing quality control programs	To be competent, the individual must be able to: PC1. Map out the whole Process Value Chain. PC2. Determine raw materials quality characteristics. PC3. Determine product quality characteristics. PC4. Perform a hazard analysis across the value chain. PC5. Identify the Critical Control Points PC6. Establish critical limits. PC7. Establish monitoring of critical limits. PC8. Establish control measures if deviation occurs. PC9. Establish documentation for monitoring. PC10. Establish verification procedures.
Establishing operating procedures and control strategies	To be competent, the individual must be able to: PC11. Determine the operating principles of the units/processes. PC10. Determine the safety considerations of the unit or process. PC11. Determine the quality considerations of the unit or process and the impact on the final product. PC12. Coordinate with other stakeholders that have an input in the development of the operating procedures.
Knowledge and Understanding (K)	
A. Organisational Context (Knowledge of the company/ organisation and its processes)	The individual on the job must demonstrate knowledge and understanding of: OK1. Company's value chain operations. OK2. Company's quality assurance and control policies. OK3. Company's vision, mission and strategic plan.
B. Technical Knowledge	The individual on the job must demonstrate knowledge and understanding of: TK1. Quality assurance and control. TK2. Formulation of SOPs. TK3. Process/unit operating principles.

<p>C. Regulatory context (Knowledge of Rules and Regulations)</p>	<p>The individual on the job must demonstrate knowledge and understanding of:</p> <p>RK1. Government regulatory requirements for production process emissions (ZEMA guidelines, Environmental Management Act).</p> <p>RK2. Government regulatory requirements for consumer product quantity, quality and safety (ZABS, ZMA, ZCSA).</p>
<p>Skills (S)</p>	
<p>A. Core Skills/ Generic Skills</p>	<p>Reading Skills</p> <p>The individual on the job must be able to:</p> <p>CS1. Read and interpret internal/external documents related to process/unit operations</p> <p>CS2. Read and interpret documents related quality assurance and control.</p> <p>Writing Skills</p> <p>The individual on the job must be able to:</p> <p>CS3. Generate quality assurance and control reports.</p> <p>CS4. Generate progress reports.</p> <p>CS5. Generate technical reports.</p> <p>Oral Communication (Listening and Speaking skills)</p> <p>The individual on the job must be able to:</p> <p>CS6. Effectively communicate quality assurance and control information to other stake holders.</p>
<p>B. Professional Skills</p>	<p>Plan and Organise</p> <p>The individual on the job must be able to:</p> <p>PS1. Plan and organise quality communication meetings for internal/external stakeholders.</p> <p>PS2. Generate and compile all quality assurance and control documents and present them logically to all stakeholders.</p> <p>Judgment and Critical Thinking</p> <p>The individual on the job must be able to:</p> <p>PS3. Employ practicality in generating the quality assurance and documents.</p> <p>PS4. Consider all cost activities related to the quality plans and ensure all that they are budgeted for.</p> <p>Desire to Learn and Take Initiatives</p> <p>The individual on the job must be able to:</p> <p>PS5. Suggest alternative processes in the value chain that may save costs.</p> <p>PS6. Be abreast with changes in the industry and share the best practices learned and apply them in the day to day activities.</p> <p>PS7. Takes the initiative to understand and lead change (change management).</p> <p>Problem Solving and Decision Making</p> <p>The individual on the job must be able to:</p> <p>PS8. Make correct decisions in a timely manner whilst considering the cost implications.</p> <p>PS10. Effectively use decision making and problem solving methodologies to handle issues as part of the day to day activities.</p>

UNIT 6 [This unit is about conducting research into the development or improvement of chemical engineering processes, reactions and materials].

Unit No.	06
Unit Title	Conducting research into the development or improvement of chemical engineering processes, reactions and materials.
Description	This unit is about Conducting research into the development or improvement of chemical engineering processes, reactions and materials
Scope	This unit covers the following: <ul style="list-style-type: none"> Conducting research into development or improvement of chemical engineering processes, reactions and materials.
Performance Criteria (PC) w.r.t. the Scope	
Element	Performance Criteria (PC)
Conducting research into development or improvement of chemical engineering processes, reactions and materials.	To be competent, the individual must be able to: PC1. Use basic laboratory equipment. PC2. Apply Good Laboratory Practices (GLPs). PC3. Operate and maintain pilot plants. PC4. Formulate new products or processes using principles of chemistry. PC5. Apply the principles of energy and material balancing. PC6. Perform basic analytical procedures to test the efficacy of a new product. PC7. Supervise the initial production of the new products or processes. PC8. Carry out a cost benefit analysis of the new product or process. PC9. Forecast raw material requirements for products moving from pilot to large scale production. PC10. Generate quality control limits for materials and processes moving from pilot to large scale production. PC11. Use the pilot plants to help make modification to existing products or processes.
Knowledge and Understanding (K)	
A. Organisational Context (Knowledge of the company/ organisation and its processes)	The individual on the job must demonstrate knowledge and understanding of: OK1. Company quality assurance and control policies. OK2. Company vision, mission and strategic plan. OK3. Company policies on safety, health, environmental management and quality.
B. Technical Knowledge	The individual on the job must demonstrate knowledge and understanding of: TK1. PIDs and process flow diagrams TK2. Material and energy balancing TK3. Materials/analytical chemistry TK4. Construction and design Costing TK5. Quality monitoring and control TK6. Process simulation and modelling. TK7. Research methods

	TK8.Data analysis
C. Regulatory context (Knowledge of Rules and Regulations)	The individual on the job must demonstrate knowledge and understanding of: RK1. Government regulatory requirements for production process emissions (ZEMA guidelines, Environmental Management Act). RK2. Government regulatory requirements for consumer product quantity, quality and safety (ZABS, ZMA, ZCSA).
Skills (S)	
A. Core Skills/ Generic Skills	Reading Skills
	The individual on the job must be able to: CS1.Read and interpret laboratory manuals and SOPs. CS2. Read and interpret documents related quality assurance and control. CS3. Read and interpret Material Safety Data Sheets (MSDS). CS4. Read and interpret product information documents. CS5. Read and interpret processes flow diagrams.
	Writing Skills
	The individual on the job must be able to: CS6. Prepare laboratory manuals and SOPs. CS7. Prepare Product Information Documents (PIDs). CS8. Prepare technical reports. CS9. Prepare quality assurance and control documents. CS10. Draw flowcharts and Piping and Instrumentation Diagrams(P&IDs)
	Oral Communication (Listening and Speaking skills)
	The individual on the job must be able to: CS11.Effectively communicate research and design information to other stake holders.
B. Professional Skills	Plan and Organise
	The individual on the job must be able to: PS1.Plan and organise for all required data and materials to be used during the research and development process.
	Judgment and Critical Thinking
	The individual on the job must be able to: PS2. Visualise and explain the full scale version of any new product or process. PS3.Modify initial designs with respect to cost and material/ resource availability.
	Desire to Learn and Take Initiatives
	The individual on the job must be able to: PS4. Follow latest trends and changes in processing/design procedures and maintenance management systems. PS5. Be abreast with changes in raw materials requirements and suggest and initiate improved ways of processing to enhance product quality and reduce on costs. PS6.Take the initiative to understand and lead change (change management). PS7.Be abreast with the latest versions of design and simulation software.

	Problem Solving and Decision Making
	<p>The individual on the job must be able to:</p> <ul style="list-style-type: none">PS8. Make correct decisions in a timely manner whilst considering the cost implications.PS9. Effectively use decision making and problem solving methodologies to handle issues as part of the day to day activities.

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UNIT 7 [This unit is about working in an administrative capacity, for example, in the development of guidelines and specifications for the handling of dangerous chemicals, environmental protection, or setting standards for foods, materials and consumer goods].

Unit No.	07
Unit Title	Developing Guidelines and Specifications for Chemicals, Materials and Consumer Goods
Description	This unit is about working in an administrative capacity, for example, in the development of guidelines and specifications for the handling of dangerous chemicals, environmental protection, or setting standards for foods, materials and consumer goods.
Scope	This unit covers the following: <ul style="list-style-type: none"> • Development of guidelines and specifications for the handling of dangerous chemicals. • Development of guidelines for environmental protection. • Development of standards for foods, materials and consumer goods.
Performance Criteria (PC) w.r.t. the Scope	
Element	Performance Criteria (PC)
Development of guidelines and specifications for the handling of dangerous chemicals	To be competent, the individual must be able to: PC1. Apply the principles of industrial chemistry. PC2. Apply the safety requirements pertaining to handling of chemicals. PC3. Carry out research and perform laboratory experiments to validate specifications. PC4. Perform laboratory experiments to develop chemical specifications. PC5. Perform laboratory experiments to develop safety guidelines. PC6. Generate Materials Safety Data Sheets (MSDS). PC7. Carry out industrial dangerous chemicals handling audits.
Development of guidelines for environmental protection	PC8. Perform laboratory experiments to check effects of pollutants on living organisms/ecosystem. PC9. Generate, apply and interpret Environmental Impact Assessments (EIA). PC10. Carry out laboratory experiments to determine pollutant limits that become fatal and dangerous to living organisms PC11. Interpret Materials Safety Data Sheets (MSDS). PC12. Carry out environmental/emissions assessment audits.
Development of standards for foods, materials and consumer goods	PC13. Carry out materials, consumer goods and food safety audits. PC14. Perform laboratory experiments to test/validate specifications of materials, foods and consumer goods. PC15. Interpret the production processes involved in producing a type of food substance, material or consumer good. PC16. Apply the principles of industrial chemistry. PC17. Interpret Materials Safety Data Sheets (MSDS).

Knowledge and Understanding (K)	
A. Organisational Context (Knowledge of the company/ organisation and its processes)	The individual on the job must demonstrate knowledge and understanding of: OK1. Country/company legal requirements for production and importation of materials, foods and consumer goods. OK2. Country/company legal requirements for emissions and environmental protection. OK3. Country/company safety, health and environmental management regulations.
B. Technical Knowledge	The individual on the job must demonstrate knowledge and understanding of: TK1. International food safety standards. TK2. Materials/analytical chemistry TK3. Materials, consumer goods and food safety audit procedures. TK4. Environmental impact assessments and audits TK5. Process flow diagrams TK6. ISO standards pertaining to materials, consumer goods and food safety. TK7. ISO standards on environmental management.
C. Regulatory context (Knowledge of Rules and Regulations)	The individual on the job must demonstrate knowledge and understanding of: RK1. Government regulatory requirements for production process emissions (ZEMA guidelines, Environmental Management Act). RK2. Government regulatory requirements for consumer product quantity, quality and safety (ZABS, ZMA, ZCSA).
Skills (S)	
A. Core Skills/ Generic Skills	Reading Skills
	The individual on the job must be able to: CS1. Read and interpret laboratory manuals and SOPs. CS2. Read and interpret documents related environmental impact assessments and audits. CS3. Read and interpret material safety data sheets.(MSDS) CS4. Read and interpret product information documents. CS5. Read and interpret processes flow diagrams. CS6. Read and interpret documents related to audit of materials, consumer goods and food safety.
	Writing Skills
	The individual on the job must be able to: CS7.Prepare laboratory manuals and SOPs. CS8.Prepare Product Information Documents (PIDs). CS9. Generate technical reports such as Environmental Impact Assessments (EIAs). CS10.Prepare audit reports. CS11. Prepare Material Safety Data Sheets (MSDS).
A. Core Skills/ Generic Skills	Oral Communication (Listening and Speaking skills)
	The individual on the job must be able to: CS12. Effectively communicate audit, safety information, government regulations, material and chemical specifications to all stakeholders.

B. Professional Skills	Plan and Organise
	The individual on the job must be able to: PS1. Plan and organise for all required data and materials to be used during development of standards and guidelines. PS2. Plan and organise audit documents, procedures and meetings.
	Judgment and Critical Thinking
	The individual on the job must be able to: PS3. Interpret and apply international standards in the local context.
	Desire to Learn and Take Initiatives
	The individual on the job must be able to: PS4. Keep up-to-date with trends and changes in international standards of materials, food processing and consumer goods PS5. Be abreast with changes in pollution limits and regulations, and in auditing and assessment procedures. PS6. Take the initiative to understand and lead change (change management). PS7. Be abreast with the development of new local industries and be proactive in development of standards. PS8. Proactively make amendments to existing local standards and guidelines to align with international standards.
Problem Solving and Decision Making	
The individual on the job must be able to: PS9. Make correct decisions in a timely manner whilst considering the cost implications. PS10. Effectively use decision making and problem solving methodologies to handle issues as part of the day to day activities.	

5. EQUIPMENT, TOOLS AND CONSUMABLE MATERIALS

These include, but not limited to: Computer with appropriate software and hardware; Personal Protective Equipment (PPE); Laboratory analytical instruments and equipment; Laboratory glassware; Respiratory apparatus; Lifting apparatus; Chemicals and reagents; Different types of stationery; and Temperature/pressure monitoring instruments.

6. DILEMMAS/CHALLENGES AND COMPLEXITIES FOR A JOB HOLDER

Dilemmas associated with the job of a chemical engineer include working in dangerous areas and with hazardous machinery/equipment, working in confined areas, long working hours, exposure to chemical, physical and biological hazards, pressure from supervisors and colleagues, tight timelines for completing tasks, pressure from government regulators, working in extreme weather such as hot and cold conditions, working in noisy, wet and dusty environments, etc.

6.1 Alternative Choices (Solutions) to Dilemmas and Complexities

Solutions to dilemmas include wearing Personal Protective Equipment (PPE) and ensuring their availability and use by other employees, exercising regularly to maintain physical fitness, participating in workplace safety sensitisation and awareness meetings/training sessions, planning daily tasks, reading and researching on new ways to handle work stress, adhering to company's safety and standard operating procedures at all times, consulting extensively within and outside one's department/team on safety and other issues.

7. WORKING CONDITIONS/ENVIRONMENT

Working conditions include working in cold, hot and wet conditions, at heights, stand/walk for long hours, working in laboratory environment and in shifts, areas that are noisy and dusty, areas with limited lighting and ventilation, handling chemicals, working in confined spaces and explosives environment, etc.

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

8.1 Internal/Within the Organisation

Supervisors, trainers, safety team/section members, other colleagues, etc.

8.2 External/Outside the Organisation

Government regulators, trainers, suppliers of equipment/tools/consumables, fellow Chemical Engineers from other companies, labour unions/occupational health and safety associations, 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 programs based on this NOS will be created by curricula and program developers. Each Performance Criteria (PC) will be assigned marks proportional to its importance in the NOS. Curricula and programs 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.CHE.01		
ZQF Level	7	Version Number	01
Sector	Manufacturing	Date of Approval	
Sub Sector	Chemical process industries	Date of Last Review	N/A
Occupation	Chemical Engineering	Date of Next Review	

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