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**REPUBLIC OF KENYA**

**NATIONAL OCCUPATIONAL STANDARDS**

**FOR**

**WATER ENGINEERING TECHNICIAN**

**LEVEL 6**

|  |  |
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|  |  |
| KENYA WATER INSTITUTE  P.O. BOX 60013-00200  NAIROBI | TVET CDACC  P.O. BOX 15745-00100  NAIROBI |

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# FOREWORD

The provision of quality education and training is fundamental to the Government’s overall strategy for social economic development. Quality education and training will contribute to achievement Kenya’s development blue print and sustainable development goals.

Reforms in the education sector are necessary for the achievement of Kenya Vision 2030 and meeting the provisions of the Constitution of Kenya 2010. The education sector had to be aligned to the Constitution and this resulted in the formulation of the Policy Framework for Reforming Education and Training. A key feature of this policy is the radical change in the design and delivery of the TVET training. The policy document requires that training in TVET shall be competency based, Curriculum development shall be industry led, certification shall be based on demonstration of competence and mode of delivery shall allow for multiple entry and exit in TVET programmes.

These reforms demand that Industry takes a leading role in Curriculum development to ensure the Curriculum addresses its competence needs. It is important to note that the water sector has undergone numerous reforms in the last decade that require new approach to training of personnel for the sector. It is against this background that these Occupational Standards were developed for the purpose of developing a competency-based Curriculum for Water Engineering Technology Level 6. These Occupational Standards will also be the basis for assessment of an individual for competence certification.

It is my conviction that these Occupational Standards will play a great role towards development of competent human resource for the Water sector’s growth and sustainable development.

**PRINCIPAL SECRETARY**

**MINISTRY OF WATER & SANITATION AND IRRIGATION**

# PREFACE

Kenya Vision 2030 aims to transform the country into a newly industrializing, “middle-income country providing a high-quality life to all its citizens by the year 2030”. Kenya intends to create a globally competitive and adaptive human resource base to meet the requirements of a rapidly industrializing economy through life-long education and training. TVET has a responsibility of facilitating the process of inculcating knowledge, skills and attitudes necessary for catapulting the nation to a globally competitive country, hence the paradigm shift to embrace Competency Based Education and Training (CBET).

The Technical and Vocational Education and Training Act No. 29 of 2013 on Reforming Education and Training in Kenya, emphasized the need to reform Curriculum development, assessment and certification. This called for shift to CBET to address the mismatch between skills acquired through training and skills needed by industry as well as increase the global competitiveness of Kenyan labour force.

Kenya Water Institute in conjunction with Water Sector Skills Advisory Committee (SSAC), Kenyatta University and Water Service Providers’ Association (WASPA), with guidance from TVET Curriculum Development, Assessment and Certification Council (TVET CDACC), has developed these occupational standards. These Occupational Standards will be the basis for development of competency-based Curriculum for Water Engineering, KNQF Level 6. These Standards will also be the basis for assessment of an individual for competence certification.

The Occupational Standards are designed and organized with clear performance criteria for each element of a unit of competency. These standards also outline the required knowledge and skills as well as evidence guide.

I am grateful to the KEWI Academic Board, Technical Teams, TVET CDACC, and Water SSAC, Experts drawn from Universities and Water Sector Institutions, and all other stakeholders who participated in the development of these occupational standards.

**CHAIRPERSON,**

**KENYA WATER INSTITUTE GOVERNING COUNCIL**

# ACKNOWLEDGMENT

These Occupational Standards were developed through combined effort of various stakeholders from private and public organizations. I am sincerely thankful to the management of these organizations for allowing their staff to participate in this course. I wish to acknowledge the invaluable contribution of industry players who provided inputs towards the development of these Standards.

I thank TVET Curriculum Development, Assessment and Certification Council (TVET CDACC) for providing guidance on the development of these Standards. My gratitude goes to the Water Sector Skills Advisory Committee (SSAC) members for their contribution to the development of these Standards. I thank all the individuals and organizations who participated in the validation of these Standards.

My gratitude also goes to Kenya Water Institute Academic Board and Technical Teams for who cooperated with TVET CDACC and key sector institutions in the development of these Standards.

I acknowledge all institutions which in one way or another contributed to the success of development of these Standards.

**CHAIRPERSON**

**WATER SECTOR SKILLS ADVISORY COMMITTEE**

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|  |  |
| --- | --- |
| ABBREVIATIONS AND ACRONYMS | |
| AP | Arithmetic Progression |
| CAD | Computer Aided Design |
| CDACC | Curriculum Development, Assessment and Certification Council |
| EMCA | Environmental Management Coordination Act |
| EMS | Environmental Management Systems |
| GHS | Globally Harmonized System |
| GIS | Geographical Information Systems |
| GPS  GPRS  HDPE | Global Positioning System  General Packet Radio Services  High-Density Polyethylene |
| ICT | Information Communication Technology |
| IWRM | Integrated Water Resources Management |
| KEWI | Kenya Water Institute |
| NEMA  NRW | National Environmental Management Authority  Non- Revenue Water |
| OS | Operating Systems |
| OSH | Occupational Safety and Health |
| PC | Personal Computer |
| PPE | Personal Protective Equipment |
| SMART | Specific, Measurable, Achievable, Results-focused, time-bound |
| SSAC | Sector Skills Advisory Committee |
| TV | Television |
| TVET | Technical Vocational Education and Training |
| UV-VIS  UPVC | Ultraviolet Visible  Unplasticized Polyvinyl Chloride |
| WASPA | Water Service Providers Association |
| WASREB | Water Services Regulatory Board |
| WET | Water Engineering Technician |
| WHSA | Water Harvesting Storage Authority |
| WSP | Water Service Providers |
| WSTF | Water Services Trust Fund |

# KEY TO UNIT CODE

**WAT/ OS/ WET/ BC/ 01/ 6/A**

Industry or sector

Occupational Standards

Occupational area

Type of competency

Competency number

Competency level

Control version

# OVERVIEW

Water Engineering Technician Level 6 Occupational Standards consists of competencies that an individual must achieve to enable him/her provide water supply services. It entails designing, constructing water supply infrastructure and operating and maintaining waters supply systems.

The qualification consists of the following basic, common and core competencies:

**Basic Units of Competency**

|  |  |
| --- | --- |
| **Unit Code** | **Unit Title** |
| WAT/OS/WET/BC/01/6/A | Demonstrate Communication Skills |
| WAT/OS/WET/BC/02/6/A | Demonstrate Digital Literacy |
| WAT/OS/WET/BC/03/6/A | Demonstrate Entrepreneurial Skills |
| WAT/OS/WET/BC/04/6/A | Demonstrate Employability Skills |
| WAT/OS/WET/BC/05/6/A | Demonstrate Environmental Literacy |
| WAT/OS/WET/BC/06/6/A | Demonstrate Occupational Safety and Health Practices |

**Common Units of Competency**

|  |  |
| --- | --- |
| **Unit Code** | **Unit Title** |
| WAT/OS/WET/CC/01/6/A | Apply Water Quality Principles |
| WAT/OS/WET /CC/02/6/A | Apply Engineering Mathematics |
| WAT/OS/WET /CC/03/6/A | Apply Workshop Technology |
| WAT/OS/WET/CC/04/6/A | Apply Physics Principles |
| WAT/OS/WET/CC/05/6/A | Apply Technical Drawings and Computer Aided Design Principles |
| WAT/OS/WET/CC/06/6/A | Apply Water Technology Principles |
| WAT/OS/WET/CC/07/6/A | Apply Water Management Principles |

**Core Units of Competency**

|  |  |
| --- | --- |
| **Unit Code** | **Unit Title** |
| WAT/OS/WET/CR/01/6/A | Design Water Supply Infrastructure |
| WAT/OS/WET/CR/02/6/A | Construct Water Supply infrastructure |
| WAT/OS/WET/CR/03/6/A | Operate and Maintain Water supply Systems |
| WAT/OS/WET/CR/04/6/A | Manage Non- Revenue Water |

# BASIC UNITS OF COMPETENCY

## DEMONSTRATE COMMUNICATION SKILLS

**UNIT CODE:** WAT/OS/WET/CC/01/6/A

**UNIT DESCRIPTION**

This unit covers the competencies required to demonstrate communication skills. It involves meeting communication needs of clients and colleagues, developing communication strategies, establishing and maintaining communication pathways, conducting interviews, facilitating group discussion and representing the organization.

**ELEMENTS AND PERFORMANCE CRITERIA**

|  |  |
| --- | --- |
| **ELEMENT**  These describe the key outcomes which make up workplace function | **PERFORMANCE CRITERIA**  These are assessable statements which specify the required level of performance for each of the elements.  ***Bold and italicized terms are elaborated in the Range*** |
| 1. Meet communication needs of clients and colleagues | 1. Specific communication needs of clients and colleagues are identified and met based on workplace requirements 2. Different communication approaches are identified and applied according to clients’ needs 3. Conflict is identified and addressed as per the standards of the organization |
| 1. Develop communication strategies | * 1. Strategies for effective internal and external dissemination of information are developed as per organization’s requirements   2. Special communication needs are considered in developing strategies according workplace procedures   3. ***Communication strategies*** are analyzed, evaluated and revised based the workplace needs |
| 1. Establish and maintain communication pathways | * 1. Pathways of communication are established as per organization policy   2. Pathways are maintained and reviewed according to organization procedures |
| 1. Promote use of communication strategies | * 1. Information is provided to all areas of the organization as per strategy requirements   2. Effective communication techniques are articulated and modeled according work requirements   3. Personnel are given guidance about adapting communication strategies as per organization procedures |
| 1. Conduct interview | 1. A range of appropriate communication strategies are employed in ***interview situations*** based on the workplace requirements 2. Records of interviews are made and maintained in accordance with organizational procedures 3. Effective questioning, listening and nonverbal communication techniques are used as per needs |
| 1. Facilitate group discussion | 1. Mechanisms to enhance ***effective group interaction*** are identified and implemented according to workplace requirements 2. Strategies to encourage group participation are identified and used as per organizations’ procedures 3. Meetings objectives and agenda are set and followed based on workplace requirements 4. Relevant information is provided and feedback obtained according to set protocols 5. Evaluation of group communication strategies is undertaken in accordance with workplace guidelines 6. Specific communication needs of individuals are identified and addressed as per individual needs |
| 1. Represent the organization | 1. 7Relevant presentation are researched and presented based on internal or external communication forums requirements 2. Presentation is delivered in a clear and sequential manner as per the predetermined time 3. Presentation is made as per appropriate media 4. Difference views are respected based on workplace procedures 5. Written communication is done as per organizational standards 6. Inquiries are responded according to organizational standard |

**RANGE**

This section provides work environment and conditions to which the performance criteria apply. It allows for different work environment and situations that will affect performance.

|  |  |
| --- | --- |
| **Variable** | **Range** |
| 1. Communication strategies may include but not limited to: | * Language switch * Comprehension check * Repetition * Asking confirmation * Paraphrase * Clarification request * Translation * Restructuring * Approximation * Generalization |
| 1. Effective group interaction may include but not limited to: | * Identifying and evaluating what is occurring within an interaction in a nonjudgmental way * Using active listening * Making decision about appropriate words, behavior * Putting together response which is culturally appropriate * Expressing an individual perspective * Expressing own philosophy, ideology and background and exploring impact with relevance to communication |
| 1. Situations may include but not limited to: | * Establishing rapport * Eliciting facts and information * Facilitating resolution of issues * Developing action plans * Diffusing potentially difficult situations |

**REQUIRED SKILLS AND KNOWLEDGE**

This section describes the skills and knowledge required for this unit of competency.

**Required Skills**

The individual needs to demonstrate the following skills:

* Communication
* Active listening
* Interpretation
* Negotiation
* Writing

**Required Knowledge**

The individual needs to demonstrate knowledge of:

* Communication process
* Dynamics of groups
* Styles of group leadership
* Key elements of communications strategy

**EVIDENCE GUIDE**

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge and range.

|  |  |
| --- | --- |
| 1. Critical aspects of Competency | Assessment requires evidence that the candidate:   1. Developed communication strategies to meet the organization requirements and applied in the workplace 2. Established and maintained communication pathways for effective communication in the workplace 3. Used communication strategies involving exchanges of complex oral information |
| 1. Resource Implications | The following resources should be provided:   1. Access to relevant workplace or appropriately simulated environment where assessment can take place 2. Materials relevant to the proposed activity or tasks |
| 1. Methods of Assessment | Competency in this unit may be assessed through:   1. Direct observation 2. Oral questioning 3. Written texts |
| 1. Context of Assessment | Competency may be assessed:   1. On-the-job 2. Off-the –job 3. During Industrial attachment |
| 1. Guidance information for assessment | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. |

## DEMONSTRATE DIGITAL LITERACY

**UNIT CODE:** WAT/OS/WET/CC/02/6/A

**UNIT DESCRIPTION**

This unit describes competencies required to demonstrate digital literacy. It involves, identifying computer software and hardware, applying security measures to data, hardware, and software in automated environment, applying computer software in solving task, applying internet and email in communication at workplace, applying desktop publishing in official assignments and preparing presentation packages.

**ELEMENTS AND PERFORMANCE CRITERIA**

|  |  |
| --- | --- |
| **ELEMENT**  These describe the key outcomes which make up workplace function | **PERFORMANCE CRITERIA**  These are assessable statements which specify the required level of performance for each of the elements.  ***Bold and italicized terms are elaborated in the Range*** |
| 1. Identify appropriate computer software and hardware | * 1. Concepts of ICT are determined in accordance with computer equipment   2. Classifications of computers are determined in accordance with manufacturers specification   3. Appropriate computer software is identified according to manufacturer’s specification   4. Appropriate computer hardware is identified according to manufacturer’s specification   5. Functions and commands of operating system are determined in accordance with manufacturer’s specification |
| 1. Apply security measures to data, hardware, software in automated environment | * 1. ***Data security and privacy are classified*** in accordance with the prevailing technology   2. ***Security threats*** reidentified ***and control measures*** are applied in accordance with laws governing protection of ICT   3. Computer threats and crimes are detected in accordance to Information Management security guidelines   4. Protection against computer crimes is undertaken in accordance with laws governing protection of ICT |
| 1. Apply computer software in solving tasks | * 1. ***Word processing concepts*** are applied in resolving workplace tasks, report writing and documentation as per the job requirements   2. ***Word processing utilities*** are applied in accordance with workplace procedures   3. Worksheet layout is prepared in accordance with work procedures   4. Worksheet is built and data manipulated in the worksheet in accordance with workplace procedures   5. Continuous data manipulated on worksheet is undertaken in accordance with work requirements   6. Database design and manipulation is undertaken in accordance with office procedures   7. Data sorting, indexing, storage, retrieval and security is provided in accordance with workplace procedures |
| 1. Apply internet and email in communication at workplace | * 1. Electronic mail addresses are opened and applied in workplace communication in accordance with office policy   2. Office internet functions are defined and executed in accordance with office procedures   3. ***Network configuration*** is determined in accordance with office operations procedures   4. Official World Wide Web is installed and managed according to workplace procedures |
| 1. Apply Desktop publishing in official assignments | * 1. Desktop publishing functions and tools are identified in accordance with manufactures specifications   2. Desktop publishing tools are developed in accordance with work requirements   3. Desktop publishing tools are applied in accordance with workplace requirements   4. Typeset work is enhanced in accordance with workplace standards |
| 1. Prepare presentation packages | * 1. Types of presentation packages are identified in accordance with office requirements   2. Slides are created and formulated in accordance with workplace procedures   3. Slides are edited and run-in accordance with work procedures   4. Slides and handouts are printed according to work requirements |

**RANGE**

This section provides work environments and conditions to which the performance criteria apply. It allows for different work environments and situations that will affect performance.

|  |  |
| --- | --- |
| **Variable** | **Range** |
| 1. Appropriate computer hardware may include but not limited to: | Collection of physical parts of a computer system such as:   * Computer case, monitor, keyboard, and mouse * All the parts inside the computer case, such as the hard disk drive, motherboard and video card |
| 1. Data security and privacy may include but not limited to: | * Confidentiality of data * Cloud computing * Integrity -but-curious data surfing |
| 1. Security and control measures may include but not limited to: | * Counter measures against cyber terrorism * Risk reduction * Cyber threat issues * Risk management * Pass-wording |
| 1. Security threats may include but not limited to: | * Cyber terrorism * Hacking |

**REQUIRED SKILLS AND KNOWLEDGE**

This section describes the skills and knowledge required for this unit of competency.

**Required Skills**

The individual needs to demonstrate the following skills:

* Analytical skills
* Interpretation
* Typing
* Communication
* Computing (applying fundamental operations such as addition, subtraction, division and multiplication)
* Using calculator
* Basic ICT skills

**Required Knowledge**

The individual needs to demonstrate knowledge of:

* Software concept
* Functions of computer software and hardware
* Data security and privacy
* Computer security threats and control measures
* Technology underlying cyber-attacks and networks
* Cyber terrorism
* Computer crimes
* Detection and protection of computer crimes
* Laws governing protection of ICT
* Word processing;
* Functions and concepts of word processing.
* Documents and tables creation and manipulations
* Mail merging
* Word processing utilities
* Spread sheets;
* Meaning, formulae, function and charts, uses and layout
* Data formulation, manipulation and application to cells
* Database;
* Database design, data manipulation, sorting, indexing, storage retrieval and security
* Desktop publishing;
* Designing and developing desktop publishing tools
* Manipulation of desktop publishing tools
* Enhancement of typeset work and printing documents
* Presentation Packages;
* Types of presentation Packages
* Creating, formulating, running, editing, printing and presenting slides and handouts
* Networking and Internet;
* Computer networking and internet.
* Electronic mail and world wide web
* Emerging trends and issues in ICT;
* Identify and integrate emerging trends and issues in ICT
* Challenges posed by emerging trends and issues

**EVIDENCE** **GUIDE**

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge and range.

|  |  |
| --- | --- |
| 1. Critical Aspects of Competency | Assessment requires evidence that the candidate:   * 1. Identified and controlled security threats   2. Detected and protected computer crimes   3. Applied word processing in office tasks   4. Designed, prepared work sheet and applied data to the cells in accordance to workplace procedures   5. Opened electronic mail for office communication as per workplace procedure   6. Installed internet and World Wide Web for office tasks in accordance with office procedures   7. Integrated emerging issues in computer ICT applications   8. Applied laws governing protection of ICT |
| 1. Resource Implications | The following resources should be provided:   * 1. Access to relevant workplace where assessment can take place   2. Appropriately simulated environment where assessment can take place |
| 1. Methods of Assessment | Competency may be assessed through:   * 1. Observation   2. Oral questioning   3. Written test   4. Portfolio of Evidence   5. Interview   6. Third party report |
| 1. Context of Assessment | Competency may be assessed:   1. On-the-job 2. Off-the –job 3. During Industrial attachment |
| 1. Guidance information for assessment | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. |

## DEMONSTRATE ENTREPRENEURIAL SKILLS

**UNIT CODE :** WAT/OS/WET/CC/03/6/A

**UNIT DESCRIPTION**

This unit covers the competencies required to demonstrate understanding of entrepreneurship. It involves demonstrating understanding of an entrepreneur, entrepreneurship, and self-employment, identifying entrepreneurship opportunities, creating entrepreneurial awareness, applying entrepreneurial motivation, developing business innovative strategies and developing business plan.

**ELEMENTS AND PERFORMANCE CRITERIA**

|  |  |
| --- | --- |
| **ELEMENT** | **PERFORMANCE CRITERIA** |
| 1. Demonstrate understanding of an Entrepreneur | 1. Entrepreneurs and Business persons are distinguished as per principles of entrepreneurship 2. ***Types of entrepreneurs*** are identified as per principles of entrepreneurship 3. Ways of becoming an Entrepreneur are identified as per principles of Entrepreneurship 4. ***Characteristics of Entrepreneurs*** are identified as per principles of Entrepreneurship 5. Factors affecting Entrepreneurship development are explored as per principles of Entrepreneurship |
| 1. Demonstrate understanding of Entrepreneurship and self-employment | 1. Entrepreneurship and self-employment are distinguished as per principles of entrepreneurship 2. Importance of self-employment is analysed based on business procedures and strategies 3. ***Requirements for entry into self-employment*** are identified according to business procedures and strategies 4. Role of an Entrepreneur in business is determined according to business procedures and strategies 5. Contributions of Entrepreneurs to National development are identified as per business procedures and strategies 6. Entrepreneurship culture in Kenya is explored as per business procedures and strategies 7. Born or made Entrepreneurs are distinguished as per entrepreneurial traits |
| 1. Identify Entrepreneurship opportunities | 1. Sources of business ideas are identified as per business procedures and strategies 2. Business ideas and opportunities are generated as per business procedures and strategies 3. Business life cycle is analysed as per business procedures and strategies 4. Legal aspects of business are identified as per procedures and strategies 5. Product demand is assessed as per market strategies 6. Types of ***business environment*** are identified and evaluated as per business procedures 7. Factors to consider when evaluating business environment are explored based on business procedure and strategies 8. Technology in business is incorporated as per best practice |
| 1. Create entrepreneurial awareness | 1. ***Forms of businesses*** are explored as per business procedures and strategies 2. Sources of business finance are identified as per business procedures and strategies 3. Factors in selecting source of business finance are identified as per business procedures and strategies 4. ***Governing policies*** on Small Scale Enterprises (SSEs) are determined as per business procedures and strategies 5. Problems of starting and operating SSEs are explored as per business procedures and strategies |
| 1. Apply entrepreneurial motivation | 1. ***Internal and external motivation*** factors are determined in accordance with motivational theories 2. Self-assessment is carried out as per entrepreneurial orientation 3. Effective communications are carried out in accordance with communication principles 4. Entrepreneurial motivation is applied as per motivational theories |
| 1. Develop innovative business strategies | 1. Business innovation strategies are determined in accordance with the organization strategies 2. Creativity in business development is demonstrated in accordance with business strategies 3. ***Innovative business strategies*** are developed as per business principles 4. Linkages with other entrepreneurs are created as per best practice 5. ICT is incorporated in business growth and development as per best practice |
| 1. Develop Business Plan | 1. Identified Business is described as per business procedures and strategies 2. Marketing plan is developed as per business plan format 3. Organizational/Management plan is prepared in accordance with business plan format 4. Production/operation plan in accordance with business plan format 5. Financial plan is prepared in accordance with the business plan format 6. Executive summary is prepared in accordance with business plan format 7. Business plan is presented as per best practice |

**RANGE**

This section provides work environment and conditions to which the performance criteria apply. It allows for different work environment and situations that will affect performance.

|  |  |
| --- | --- |
| **Variable** | **Range** |
| 1. Types of entrepreneurs may include but not limited to: | * Innovators * Imitators * Craft * Opportunistic * Speculators |
| 1. Characteristics of Entrepreneurs may include but not limited to: | * Creative * Innovative * Planner * Risk taker * Networker * Confident * Flexible * Persistent * Patient * Independent * Future oriented * Goal oriented |
| 1. Requirements for entry into self-employment may include but not limited to | * Technical skills * Management skills * Entrepreneurial skills * Resources * Infrastructure |
| 1. Internal and external motivation may include but not limited to: | * Interest * Passion * Freedom * Prestige * Rewards * Punishment * Enabling environment * Government policies |
| 1. Business environment may include but not limited to: | * External * Internal * Intermediate |
| 1. Forms of businesses may include but not limited to: | * Sole proprietorship * Partnership * Limited companies * Cooperatives |
| 1. Governing policies may include but not limited to: | * Increasing scope for finance * Promoting cooperation between entrepreneurs and private sector * Reducing regulatory burden on entrepreneurs * Developing IT tools for entrepreneurs |
| 1. Innovative business strategies may include but not limited to: | * New products * New methods of production * New markets * New sources of supplies * Change in industrialization |

**REQUIRED SKILLS AND KNOWLEDGE**

This section describes the skills and knowledge required for this unit of competency.

**Required Skills**

The individual needs to demonstrate the following skills:

* Analytical
* Management
* Problem-solving
* Root-cause analysis
* Communication

**Required Knowledge**

The individual needs to demonstrate knowledge of:

* Decision making
* Business communication
* Change management
* Competition
* Risk
* Net working
* Time management
* Leadership
* Factors affecting entrepreneurship development
* Principles of Entrepreneurship
* Features and benefits of common operational practices, e. g., continuous improvement (kaizen), waste elimination,
* Conflict resolution
* Health, safety and environment (HSE) principles and requirements
* Customer care strategies
* Basic financial management
* Business strategic planning
* Impact of change on individuals, groups and industries
* Government and regulatory processes
* Local and international market trends
* Product promotion strategies
* Market and feasibility studies
* Government and regulatory processes
* Local and international business environment
* Relevant developments in other industries
* Regional/ County business expansion strategies

**EVIDENCE GUIDE**

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge and range.

|  |  |
| --- | --- |
| 1. Critical Aspects of Competency | 1. Assessment requires evidence that the candidate: 2. Distinguished entrepreneurs and businesspersons correctly 3. Identified ways of becoming an entrepreneur appropriately 4. Explored factors affecting entrepreneurship development appropriately 5. Analysed importance of self-employment accurately 6. Identified requirements for entry into self-employment correctly 7. Identified sources of business ideas correctly 8. GeneratedBusiness ideas and opportunities correctly 9. Analysed business life cycle accurately 10. Identified legal aspects of business correctly 11. Assessed product demand accurately 12. Determined Internal and external motivation factors appropriately 13. Carried out communications effectively 14. Identified sources of business finance correctly 15. Determined Governing policy on small scale enterprise appropriately 16. Explored problems of starting and operating SSEs effectively 17. Developed Marketing, Organizational/Management, Production/Operation and Financial plans correctly 18. Prepared executive summary correctly 19. Determined business innovative strategies appropriately 20. Presented business plan effectively |
| 1. Resource Implications | The following resources should be provided:   1. Access to relevant workplace where assessment can take place 2. Appropriately simulated environment where assessment can take place |
| 1. Methods of Assessment | 1. Written tests 2. Oral questions 3. Third party report 4. Interviews 5. Portfolio of Evidence |
| 1. Context of Assessment | Competency may be assessed   1. On-the-job 2. Off-the –job 3. During Industrial attachment |
| 1. Guidance information for assessment | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. |

## DEMONSTRATE EMPLOYABILITY SKILLS

**UNIT CODE:** WAT/OS/WET/CC/04/6/A

**UNIT DESCRIPTON**

This unit covers competencies required to demonstrate employability skills. It involves conducting self-management, demonstrating interpersonal communication, critical safe work habits, leading a workplace team, planning and organizing work, maintaining professional growth and development, demonstrating workplace learning, problem solving skills and managing ethical performance.

**ELEMENTS AND PERFORMANCE CRITERIA**

|  |  |
| --- | --- |
| **ELEMENT**  These describe the key outcomes which make up workplace function. | **PERFORMANCE CRITERIA**  These are assessable statements which specify the required level of performance for each of the elements.  ***Bold and italicized terms are elaborated in the Range*** |
| 1. Conduct self-management | 1. Personal vision, mission and goals are formulated based on potential and in relation to organization objectives 2. Emotional intelligence is demonstrated as per workplace requirements. 3. Individual performance is evaluated and monitored according to the agreed targets. 4. Assertiveness is developed and maintained based on the requirements of the job. 5. Accountability and responsibility for own actions are demonstrated based on workplace instructions. 6. Self-esteem and a positive self-image are developed and maintained based on values. 7. Time management, attendance and punctuality are observed as per the organization policy. 8. Goals are managed as per the organization’s objective 9. Self-strengths and weaknesses are identified based on personal objectives |
| 1. Demonstrate interpersonal communication | 1. Writing skills are demonstrated as per communication policy 2. Negotiation and persuasion skills are demonstrated as per communication policy 3. Internal and external stakeholders’ needs are identified and interpreted as per the communication policy 4. Communication networks are established based on workplace policy 5. Information is shared as per communication policy |
| 1. Demonstrate critical safe work habits | * 1. Stress is managed in accordance with workplace policy.   2. Punctuality and time consciousness is demonstrated in line with workplace policy.   3. Personal objectives are integrated with organization goals based on organization’s strategic plan.   4. ***Resources*** are utilized in accordance with workplace policy.   5. Work priorities are set in accordance to workplace goals and objectives.   6. Leisure time is recognized and utilized in line with personal objectives.   7. ***Drugs and substances of abuse*** are identified and avoided based on workplace policy.   8. HIV and AIDS prevention awareness is demonstrated in line with workplace policy.   9. Safety consciousness is demonstrated in the workplace based on organization safety policy.   10. ***Emerging issues*** are identified and dealt with in accordance with organization policy. |
| 1. Lead a workplace team | 1. Performance targets for the ***team*** are set based on organization’s objectives 2. Duties are assigned in accordance with the organization policy. 3. ***Forms of communication*** in a team are established according to organization’s policy. 4. Team performance is evaluated based on set targets as per workplace policy. 5. Conflicts are resolved between team members in line with organization policy. 6. Gender related issues are identified and mainstreamed in accordance workplace policy. 7. Human rights and fundamental freedoms are identified and respected as Constitution of Kenya 2010. 8. Healthy relationships are developed and maintained in line with workplace. |
| 1. Plan and organize work | 1. Work plans are prepared based on activities and budget. 2. Assigned tasks are interpreted and expectations identified as per the workplace instructions. 3. Task occupational safety and health requirements are identified and observed regulations. 4. Work resources are identified, mobilized, allocated and utilized based on organization work plans. 5. Work activities are monitored and evaluated in line with work plans and workplace policy. 6. Work plans are reviewed based on target and available resources. |
| 1. Maintain professional growth and development | * 1. Personal training needs are identified and assessed in line with the requirements of the job.   2. ***Training and career opportunities*** are identified and utilized based on job requirements.   3. Resources for training are mobilized and allocated based organizations and individual skills needs.   4. Licensees and certifications relevant to job and career are obtained and renewed as per policy.   5. Work priorities and personal commitments are balanced and managed based on requirements of the job and personal objectives.   6. Recognitions are sought as proof of career advancement in line with professional requirements. |
| 1. Demonstrate workplace learning | * 1. Learning opportunities are sought and managed based on job requirement and organization policy.   2. Improvement in performance is demonstrated based on courses attended.   3. Application of learning is demonstrated in both technical and non-technical aspects based on requirements of the job   4. Time and effort is invested in learning new skills based on job requirements   5. Initiative is taken to create more effective and efficient processes and procedures in line with workplace policy.   6. New systems are developed and maintained in accordance with the requirements of the job.   7. Awareness of personal role in workplace ***innovation*** is demonstrated based on requirements of the job. |
| 1. Demonstrate problem solving skills | * 1. Creative, innovative and practical solutions are developed based on the problem   2. Independence and initiative in identifying and solving problems is demonstrated based on requirements of the job.   3. Team problems are solved as per the workplace guidelines   4. Problem solving strategies are applied as per the workplace guidelines   5. Problems are analyzed and assumptions tested as per the context of data and circumstances |
| 1. Manage ethical performance | * 1. Policies and guidelines are observed as per the workplace requirements   2. Self-worth and professionalism is exercised in line with personal goals and organizational policies   3. Code of conduct is observed as per the workplace requirements   4. Integrity is demonstrated as per legal requirement |

**RANGE**

This section provides work environment and conditions to which the performance criteria apply. It allows for different work environment and situations that will affect performance.

|  |  |
| --- | --- |
| **Variable** | **Range** |
| 1. Drug and substance abuse may include but not limited to: | Commonly abused   * Alcohol * Tobacco * Miraa * Over-the-counter drugs * Cocaine * Bhang * Glue |
| 1. Feedback may include but not limited to: | * Verbal * Written * Informal * Formal |
| 1. Relationships may include but not limited to: | * Man/Woman * Trainer/trainee * Employee/employer * Client/service provider * Husband/wife * Boy/girl * Parent/child * Sibling relationships |
| 1. Forms of communication may include but not limited to: | * Written * Visual * Verbal * Non verbal * Formal and informal |
| 1. Team may include but not limited to: | * Small work group * Staff in a section/department * Inter-agency group |
| 1. Personal growth may include but not limited to: | * Growth in the job * Career mobility * Gains and exposure the job gives * Net workings * Benefits that accrue to the individual as a result of noteworthy performance |
| 1. Personal objectives may include but not limited to: | * Long term * Short term * Broad * Specific |
| 1. Trainings and career opportunities may includes but not limited to | * Participation in training programs * Serving as Resource Persons in conferences and workshops |
| 1. Resource may include may but not limited to: | * Human * Financial * Technology |
| 1. Innovation may include but not limited to: | * New ideas * Original ideas * Different ideas * Methods/procedures * Processes * New tools |
| 1. Emerging issues may include but not limited to: | * Terrorism * Social media * National cohesion * Open offices |
| 1. Range of media for learning may include but not limited to: | * Mentoring * peer support and networking * IT and courses |

**REQUIRED SKILLS AND KNOWLEDGE**

This section describes the skills and knowledge required for this unit of competency.

**Required Skills**

The individual needs to demonstrate the following skills:

* Interpersonal
* Communication
* Critical thinking
* Organizational
* Negotiation
* Monitoring
* Evaluation
* Record keeping
* Problem solving
* Decision Making
* Resource utilization
* Resource mobilization

**Required Knowledge**

The individual needs to demonstrate knowledge of:

* Work values and ethics
* Company policies
* Company operations, procedures and standards
* Occupational Health and safety procedures
* Fundamental rights at work
* Workplace communication
* Concept of time
* Time management
* Decision making
* Types of resources
* Work planning
* Organizing work
* Monitoring and evaluation
* Record keeping
* Gender mainstreaming
* HIV and AIDS
* Drug and substance abuse
* Professional growth and development
* Technology in the workplace
* Innovation
* Emerging issues

**EVIDENCE GUIDE**

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge and range.

|  |  |
| --- | --- |
| 1. Critical aspects of Competency | Assessment requires evidence that the candidate:   * 1. Conducted self-management   2. Demonstrated interpersonal communication   3. Demonstrated critical safe work habits   4. Demonstrated the ability to lead a workplace team   5. Planned and organized work   6. Maintained professional growth and development   7. Demonstrated workplace learning   8. Demonstrated problem solving skills   9. Demonstrated the ability to manage performance ethically |
| 1. Resource Implications | The following resources should be provided:   1. Access to relevant workplace where assessment can take place 2. Appropriately simulated environment where assessment can take place |
| 1. Methods of Assessment | Competency in this unit may be assessed through:   1. Observation 2. Oral questioning 3. Written test 4. Portfolio of Evidence 5. Interview 6. Third party report |
| 1. Context of Assessment | Competency may be assessed:   1. On-the-job 2. Off-the –job 3. During Industrial attachment |
| 1. Guidance information for assessment | | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. |

## DEMONSTRATE ENVIRONMENTAL LITERACY

**UNIT CODE:** WAT/OS/WET/CC/05/6/A

**UNIT DESCRIPTION**

This unit specifies the competencies required to demonstrate environmental literacy. It involves, controlling environmental hazard and environmental pollution, demonstrating sustainable resource use, evaluating current practices in relation to resource usage, identifying environmental legislations/conventions for environmental concerns, implementing specific environmental programs, monitoring activities on environmental protection/Programs , analyzing resource use and developing resource conservation plans

**ELEMENTS AND PERFORMANCE CRITERIA**

|  |  |
| --- | --- |
| **ELEMENT**  These describe the key outcomes which make up workplace function. | **PERFORMANCE CRITERIA**  These are assessable statements which specify the required level of performance for each of the elements.  ***Bold and italicized terms are elaborated in the Range*** |
| 1. Control environmental hazard | 1. Storage methods for environmentally hazardous materials are strictly followed according to environmental regulations and OSHS. 2. Disposal methods of hazardous wastes are followed according to environmental regulations and OSHS. 3. ***PPE*** is used according to OSHS. |
| 1. Control environmental Pollution | * 1. Environmental pollution ***control measures*** are implemented in accordance with international protocols.   2. Procedures for solid waste management are observed according Environmental Management and Coordination Act 1999   3. Methods for minimizing noise pollution is complied with based on Noise and Excessive Vibration Pollution and Control Regulations, 2009 |
| 1. Demonstrate sustainable resource use | * 1. Methods for minimizing wastage are complied with based on organizational waste management guide   2. Waste management procedures are employed following principles of 3Rs (Reduce, Reuse, Recycle)   3. Methods for economizing and reducing resource consumption are practiced as per the Constitution of Kenya 2010 Article 69 . |
| 1. Evaluate current practices in relation to resource usage | * 1. Information on resource efficiency systems and procedures are collected and provided as per work groups/sector   2. Current resource usage is measured and recorded as per work group   3. Current purchasing strategies are analyzed and recorded according to industry procedures.   4. Current work processes to access information and data is analyzed following enterprise protocol. |
| 1. Identify environmental legislations/conventions for environmental concerns | 1. Environmental legislations/conventions and local ordinances are identified according to the different environmental aspects/impact 2. Industrial standard/environmental practices are described according to the different environmental concerns |
| 1. Implement specific environmental programs | 1. Programs/Activities are identified according to organizations policies and guidelines. 2. Individual roles/responsibilities are determined and performed based on the activities identified. 3. Problems/constraints encountered are resolved in accordance with organizations’ policies and guidelines 4. Stakeholders are consulted based on company guidelines |
| 1. Monitor activities on Environmental protection/Programs | 1. Activities are periodically monitored and Evaluated according to the objectives of the environmental program 2. Feedback from stakeholders are gathered and considered in Proposing enhancements to the program based on consultations 3. Data gathered are analyzed based on Evaluation requirements 4. Recommendations are submitted based on the findings 5. Management support systems are set/established to sustain and enhance the program 6. Environmental incidents are monitored and reported to 7. concerned/proper authorities |
| 1. Analyze resource use | 1. All resource consuming processes are Identified as per the organizational work plan 2. Quantity and nature of resource consumed is determined based on processes 3. Resource flow is analyzed as per different parts of the process. 4. Wastes are classified according to NEMA regulations on waste management. |
| 1. Develop resource Conservation plans | 9.1. Efficiency of use/conversion of resources is determined according to industry protocol.  9.2. Causes of low efficiency of use of resources are Determined based on industry protocol.  9.3. Plans for increasing the efficiency of resource use are developed based on findings. |

**RANGE**

This section provides work environments and conditions to which the performance criteria apply. It allows for different work environments and situations that will affect performance.

|  |  |
| --- | --- |
| **Variable** | **Range** |
| 1. PPE may include but not limited to | * + Mask   + Gloves   + Goggles   + Safety hat   + Overall * Hearing protector |
| 1. Control measures may include but not limited to | * Methods for minimizing or stopping spread and ingestion of airborne particles * Methods for minimizing or stopping spread and ingestion of gases and fumes * Methods for minimizing or stopping spread and ingestion of liquid wastes |

**REQUIRED SKILLS AND KNOWLEDGE**

This section describes the skills and knowledge required for this unit of competency.

**Required Skills**

The individual needs to demonstrate the following skills:

* Measuring
* Recording
* Analytical
* Monitoring
* Communication
* Writing

**Required Knowledge**

The individual needs to demonstrate knowledge of:

* PPEs
* Environmental regulations
* OSHS
* Pollution
* Waste management
* Principle of 3Rs
* Types of resources
* Techniques in measuring current usage of resources
* Environmental hazards
* Regulatory requirements

**EVIDENCE GUIDE**

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge and range.

|  |  |
| --- | --- |
| 1. Critical Aspects of Competency | Assessment requires evidence that the candidate:   * 1. Controlled environmental hazard   2. Controlled environmental pollution   3. Demonstrated sustainable resource use   4. Evaluated current practices in relation to resource usage   5. Demonstrated knowledge of environmental legislations and local ordinances according to the different environmental issues /concerns.   6. Described industrial standard environmental practices according to the different environmental issues/concerns.   7. Resolved problems/ constraints encountered based on management standard procedures   8. Implemented and monitored environmental practices on a periodic basis as per company guidelines   9. Recommended solutions for the improvement of the program   10. Monitored and reported to proper authorities any environmental incidents |
| 1. Resource Implications | The following resources should be provided:   * + Workplace with storage facilities   + Tools, materials and equipment relevant to the tasks (e.g. Cleaning tools, cleaning materials, trash bags)   + PPE, manuals and references   + Legislation, policies, procedures, protocols and local ordinances relating to environmental protection   + Case studies/scenarios relating to environmental Protection |
| 1. Methods of Assessment | Competency in this unit may be assessed through:   * + Observation   + Oral questioning   + Written test   + Portfolio of Evidence   + Interview   + Third party report |
| 1. Context of Assessment | Competency may be assessed   1. On-the-job 2. Off-the –job 3. During Industrial attachment |
| 1. Guidance information for assessment | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. |

## DEMONSTRATE OCCUPATIONAL SAFETY AND HEALTH PRACTICES

**UNIT CODE:** WAT/OS/WET/CC/06/6/A

**UNIT DESCRIPTION**

This unit specifies the competencies required to demonstrate occupational health and safety practices. It involves identifying workplace hazards and risks, identifying and implementing appropriate control measures to hazards and risks and implementing OSH programs, procedures and policies/guidelines.

**ELEMENTS AND PERFORMANCE CRITERIA**

|  |  |
| --- | --- |
| **ELEMENT**  These describe the key outcomes which make up workplace function. | **PERFORMANCE CRITERIA**  These are assessable statements which specify the required level of performance for each of the elements.  ***Bold and italicized terms are elaborated in the Range*** |
| 1. Identify workplace hazards and risk | 1.1 ***Hazards*** in the workplace are identified ***based their indicators***  1.2 Risks and hazards are evaluated based on legal requirements.  1.3 ***OSH concerns*** raised by workers are addressed as per legal requirements. |
| 1. Control OSH hazards | 2.1 Hazard prevention ***and control measures*** are implemented as per legal requirement.  2.2 Risk assessment is conductedand a risk matrix developed based on likely impact.  2.3 ***Contingency measures***, including ***emergency procedures*** during workplace ***incidents and emergencies*** are recognized and established in accordance with organization procedures. |
| 1. Implement OSH programs | 3.1 Company OSH program are identified, evaluated and reviewed based on legal requirements.  3.2 Company OSH programs are implemented as per legal requirements.  3.3 Workers are capacity built on OSH standards and procedures as per legal requirements  3.4 ***OSH-related records*** are maintained as per legal requirements. |

**RANGE**

This section provides work environments and conditions to which the performance criteria apply. It allows for different work environments and situations that will affect performance.

|  |  |
| --- | --- |
| **Variable** | **Range** |
| 1. Hazards may include but not limited to: | * Physical hazards – impact, illumination, pressure, noise, * vibration, extreme temperature, radiation * Biological hazards- bacteria, viruses, plants, parasites, mites, molds, fungi, insects * Chemical hazards – dusts, fibers, mists, fumes, smoke, gasses, vapors * Ergonomics * Psychological factors – over exertion/ excessive force,   awkward/static positions, fatigue, direct pressure,   * varying metabolic cycles * Physiological factors – monotony, personal relationship, work out cycle * Safety hazards (unsafe workplace condition) –confined space, excavations, falling objects, gas leaks, electrical, poor storage of materials and waste, spillage, waste and debris * Unsafe workers’ act (Smoking in off-limited areas, Substance and alcohol abuse at work) |
| 1. Indicators may include but not limited to: | * Increased of incidents of accidents, injuries * Increased occurrence of sickness or health complaints/ symptoms * Common complaints of workers related to OSH * High absenteeism for work-related reasons |
| 1. OSH concerns may include but not limited to: | * Workers’ experience/observance on presence of work hazards * Unsafe/unhealthy administrative arrangements (prolonged work hours, no break time, constant overtime, scheduling of tasks) * Reasons for compliance/non-compliance to use of PPEs or other OSH procedures/policies/guidelines |
| 1. Safety gears /PPE (Personal Protective Equipment) may include but not limited to: | * Arm/Hand guard, gloves * Eye protection (goggles, shield) * Hearing protection (ear muffs, ear plugs) * Hair Net/cap/bonnet * Hard hat * Face protection (mask, shield) * Apron/Gown/coverall/jump suit * Anti-static suits * High-visibility reflective vest |
| 1. Appropriate risk controls   may include but not limited to: | * Appropriate risk controls in order of impact are as follows: * Eliminate the hazard altogether (i.e., get rid of the dangerous machine) * Isolate the hazard from anyone who could be harmed (i.e., keep the machine in a closed room and operate it remotely; barricade an unsafe area off) * Substitute the hazard with a safer alternative (i.e., replace the machine with a safer one) * Use administrative controls to reduce the risk (i.e., train workers how to use equipment safely; train workers about the risks of harassment; issue signage) * Use engineering controls to reduce the risk (i.e., attach guards to the machine to protect users) * Use personal protective equipment (i.e., wear * gloves and goggles when using the machine) |
| 1. Contingency measures may include but not limited to: | * Evacuation * Isolation * Decontamination * (Calling designed) emergency personnel |
| 1. Incidents and emergencies may include but not limited to: | * Chemical spills * Equipment/vehicle accidents * Explosion * Fire * Gas leak * Injury to personnel * Structural collapse * Toxic and/or flammable vapors emission. |
| 1. OSH-related Records may include but not limited to: | * Medical/Health records * Incident/accident reports * Sickness notifications/sick leave application * OSH-related trainings obtained |

**REQUIRED SKILLS AND KNOWLEDGE**

This section describes the skills and knowledge required for this unit of competency.

**Required Skills**

The individual needs to demonstrate the following skills:

* Communication
* Interpersonal
* Presentation
* Risk assessment
* Evaluation
* Critical thinking
* Problem solving
* Negotiation

**Required Knowledge**

The individual needs to demonstrate knowledge of:

* General OSH Principles
* Occupational hazards/risks recognition
* OSH organizations providing services on OSH evaluation and/or work environment measurements (WEM)
* National OSH regulations; company OSH policies and protocols
* Systematic gathering of OSH issues and concerns
* General OSH principles
* National OSH regulations
* Company OSH and recording protocols, procedures and policies/guidelines
* Training and/or counseling methodologies and strategies

**EVIDENCE GUIDE**

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge and range.

|  |  |
| --- | --- |
| 1. Critical Aspects of Competency | Assessment requires evidence that the candidate:   1. Identified hazards in the workplace based their indicators 2. Evaluated workplace hazards based on legal requirements. 3. Addressed OSH concerns raised by workers as per legal requirements. 4. Implemented hazard prevention and control measures as per legal requirement. 5. Conducted risk assessment as per legal requirement. 6. Developed risk matrix based on likely impact. 7. Recognized and established contingency measures in accordance with organization procedures. 8. Identified, evaluated and reviewed company OSH program based on legal requirements. 9. Implemented company OSH programs as per legal requirements. 10. Capacity built workers on OSH standards and procedures as per legal requirements 11. Maintained OSH-related records as per legal requirements. |
| 1. Resource Implications | The following resources should be provided:   1. Access to relevant workplace where assessment can take place 2. Appropriately simulated environment where assessment can take place |
| 1. Methods of Assessment | Competency in this unit may be assessed through:   1. Observation 2. Oral questioning 3. Written test 4. Portfolio of Evidence 5. Interview 6. Third party report |
| 1. Context of Assessment | Competency may be assessed:   1. On-the-job 2. Off-the –job 3. During Industrial attachment |
| 1. Guidance information for assessment | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. |

# COMMON UNITS OF COMPETENCY

## APPLY WATER QUALITY PRINCIPLES

**UNIT CODE:** WAT/OS/WET/CC/01/6/A

**UNIT DESCRIPTION**

This unit covers the competencies required to apply chemistry and biology principles. It involves applying inorganic chemistry principles, organic chemistry principles, physical chemistry principles, water chemistry principles and biology principles. It also involves analyzing physical and chemical substances and micro-biological organisms in water and wastewater.

This standard applies in water sector.

**ELEMENTS AND PERFORMANCE CRITERIA**

|  |  |
| --- | --- |
| **ELEMENTS**  These describe the **key outcomes** which make up **workplace function.** | **PERFORMANCE CRITERIA**  These are **assessable** statements which specify the required level of performance for each of the elements.  ***Bold and italicized terms are elaborated in the Range.*** |
| * + 1. Apply inorganic chemistry principles | 1. Structure of atoms are illustrated based on Bohr’s atomic model 2. Electron arrangement of the first 30 elements of the periodic table are illustrated based on ***quantum numbers*** and ***electronic configuration rules*** 3. The periodic table is analyzed based on groups, periods and ***blocks*** 4. Acid-base properties of ***compounds of period three*** elements are analyzed based on dissolution and hydrolysis 5. ***Chemical bonds*** are identified based on their properties 6. ***Chemical structures*** of substances are represented based on ***chemical bonding*** 7. ***Hazardous chemicals*** are identified based on globally harmonized system of classification and labeling of chemical 8. ***Units of concentrations*** are determined based on ***physical states*** 9. ***Chemical reactions*** are illustrated based on stoichiometric principles 10. ***Chemical reagents*** and ***solutions*** are prepared based on standard procedures 11. Chemical safety is observed based on good Laboratory Practice |
| * + 1. Apply Organic Chemistry Principles | 1. Organic compounds are classified based on functional groups. 2. Plastics are identified based on plastics identification code 3. Aerobic and anaerobic processes in water treatment are identified based on biochemical principles |
| * + 1. Apply Physical Chemistry Principles | 1. Corrosion is illustrated using electrochemical principles. 2. Calculations involving redox reactions are performed based on electrochemical series. 3. Problems on gases are solved based on kinetic theory and gas laws. 4. Solubility of substances compared based on solubility product. 5. Salts are classified based on their interactions with water. 6. Solutions are prepared based on user requirements. 7. Unknown concentrations are determined based on stoichiometric principles. 8. Calculations involving chemical kinetics in aqueous medium are performed as per the rate law. 9. Calculations involving chemical equilibria are performed based on Le Chatelier’s principle. 10. Enthalpy of reactions determined based on thermochemistry principles. 11. Calculations involving thermal equilibria carried out are based on laws of thermodynamics. |
| * + 1. Apply Water Chemistry Principles | 1. Chemical bonding and structure of water is illustrated based on Bohr’s atomic model 2. ***Unique Properties of water*** are identified based on characteristics of similar compounds 3. Levelling effect of water is illustrated based on chemical equilibria 4. Buffering capacity of water is illustrated based on the carbonate system 5. Solubility of ***substances*** in water is determined based on solubility rules 6. Water pollution is evaluated based on ***type of pollutants*** 7. Water treatment methods are evaluated based on ***processes*** involved 8. Wastewater treatment methods are evaluated based on ***processes*** involved |
| * + 1. Apply chemical water quality principles | 1. Physicochemical parameters of water quality are identified based on KEBS standards and NEMA regulations 2. Chemical parameters of water quality are identified based on KEBS water quality standards and NEMA effluent discharge regulations 3. Water and effluents for physical/chemical analysis are sampled based on standard operating procedures 4. Physicochemical parameters of water quality are determined based on job requirements. 5. Chemical parameters of water quality are determined based on job requirements. 6. Physical and chemical water quality test reports are interpreted based on job requirements 7. Laboratory safety is observed in accordance with GLP |
| * + 1. Apply Microbiology Principles | 1. ***Living organisms*** classified based on the ***5 kingdom system*** 2. Cells of organisms are classified based on ***structure*** 3. ***Microorganisms*** are classified based on their **ecological niche** 4. ***Water related infections*** are identified based on causative agents 5. Aquatic ecosystems are maintained based on principles of ecology 6. General biosafety is observed in accordance with GLP |
| * + 1. Apply microbial water quality principles | * 1. Microbiological limits of water quality are identified in accordance with on national standards and regulations   2. Water and effluents for microbial analysis are sampled based on standard operating procedures   3. Microbial parameters of water quality are determined using light and **microbiology techniques**   4. Microbiological water quality reports are interpreted based on national water quality standards and regulations. |

**RANGE**

This section provides work environments and conditions to which the performance criteria apply. It allows for different work environments and situations that will affect performance.

|  |  |
| --- | --- |
| **Variable** | **Range** |
| 1. Quantum numbers may include but is not limited to: | * Principal quantum * Angular momentum quantum number * Magnetic quantum number * Electron spin quantum number |
| 1. Electronic Configuration rules may include but is not limited to: | * Main shell rule (2n2 ) * Sub-shell rules * Hund’s rule * Pauli Exclusion Principle * Aufbau Principle |
| 1. Units of concentration may include but is not limited to: | * equivalent weight * Normality * Percentage |
| 1. Chemical reactions may include but `is not limited to: | * Precipitation * Acid-base neutralization * Redox * Displacement reactions as redox reactions |
| 1. Toxic effects may include but is not limited to: | * Chronic * acute |
| 1. Structure may include but is not limited to: | * Acellular * Cellular * Prokaryotic * Eukaryotic |
| 1. Ecological niche may include but is not limited to: | * Habitat * Role |

**REQUIRED SKILLS AND KNOWLEDGE**

This section describes the skills and knowledge required for this unit of competency.

**Required Skills**

The individual needs to demonstrate the following skills:

* Communication
* Analytical
* Organizing
* Decision making
* Planning
* Problem solving
* Supervising
* Time management
* Instrumentation
* Standard operating procedures
* Water sampling
* Water quality testing
* Solutions preparation
* Titration
* GLP
* Report writing

**Required Knowledge**

* Stoichiometry
* Pathogens
* Chemical kinetics and chemical equilibria
* MSDS
* GHS
* SOPs

**EVIDENCE GUIDE**

This provides advice on assessment and must be read in conjunction with the performance criteria, required knowledge and understanding and range.

|  |  |
| --- | --- |
| 1. Critical aspects of Competency | Assessment requires evidence that the candidate:   1. Determined acid-base properties of compounds based on 2. Identified hazardous chemicals based on globally harmonized system of classification and labeling of chemicals 3. Observed general biosafety based on good laboratory practice 4. Prepared chemical solutions based on SOPs. 5. Classified plastics and polymers based on plastics identification code 6. Identified aerobic and anaerobic processes in water quality testing and wastewater treatment based on biochemical principles 7. Determined solubility of substances in water is based on solubility rules 8. . Identified unique properties of water based on characteristics of similar compounds 9. Illustrated levelling effect of water based on chemical equilibria 10. Classified microorganisms based on their pathogenic effects. 11. Conducted water quality tests based on job requirements 12. Preserved aquatic ecosystems based on principles of ecology 13. Observed safety based on GLP |
| 1. Resource Implications | The following resources should be provided:   1. Periodic table 2. Chemicals and reagents 3. Analytical balances 4. Water quality test kits 5. Microscopes 6. Autoclave 7. Water bath 8. Basic laboratory installations |
| 1. Methods of Assessment | Competency may be assessed through:   1. Written tests 2. Observation 3. Oral questioning |
| 1. Context of Assessment | Assessment may be done:   1. On–the–job 2. Off-the –job 3. Industrial attachment |
| 1. Guidance information for assessment | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. |

## APPLY ENGINEERING MATHEMATICS

**UNIT CODE:** WAT/CU/WET/CC/02/6/A

**UNIT DESCRIPTION:**

This unit describes the competencies required to apply engineering mathematics. It involves applying algebra, trigonometry and hyperbolic functions, complex numbers, co-ordinate geometry and carrying out binomial expansion. It also involves applying calculus, solving ordinary differential equations; carrying out mensuration, power series, statistics, numerical methods, vector theory and matrices.

This standard applies in water sector.

**ELEMENTS AND PERFORMANCE CRITERIA**

| **ELEMENT**  These describe the **key outcomes** which make up **workplace function**. | **PERFORMANCE CRITERIA**  These are **assessable** statements which specify the required level of performance for each of the elements.  ***Bold and italicized terms are elaborated in the Range.*** |
| --- | --- |
| * 1. Apply Algebra | 1. Calculations involving Indices are performed as per the concept 2. Calculations involving Logarithms are performed as per the concept 3. Scientific calculator is used in solving mathematical problems in line with manufacturer’s manual 4. Simultaneous equations are performed as per the rules 5. Quadratic equations are calculated as per the concept |
| * 1. Apply Trigonometry and hyperbolic functions | 1. Calculations are performed using trigonometric rules 2. Calculations are performed using hyperbolic functions |
| * 1. Apply complex numbers | 1. Complex numbers are represented using Arg and diagrams 2. Operations involving complex numbers are performed 3. Calculations involving complex numbers are performed using De Moivre’s theorem |
| * 1. Apply Coordinate Geometry | 1. Polar equations are calculated using coordinate geometry 2. Graphs of given polar equations are drawn using the Cartesian plane 3. Normal and tangents are determined using coordinate geometry |
| * 1. Carry out Binomial Expansion | 1. Roots of numbers are determined using binomial theorem 2. Errors of small changes are determined using binomial theorem |
| * 1. Apply Calculus | * 1. Derivatives of functions are determined using Differentiation   2. Derivatives of hyperbolic functions are determined using Differentiation   3. Derivatives of inverse trigonometric functions are determined using Differentiation   4. Rate of change and small change are determined using Differentiation.   5. Calculation involving stationery points of functions of two variables are performed using differentiation.   6. Integrals of algebraic functions are determined using integration   7. Integrals of trigonometric functions are determined using integration   8. Integrals of logarithmic functions are determined using integration   9. Integrals of hyperbolic and inverse functions are determined using integration |
| * 1. Solve Ordinary differential equations | * 1. First order and second order differential equations are solved using the method of undetermined coefficients   7.2 First order and second order differential equations are solved from given boundary conditions |
| * 1. Carry out Mensuration | * 1. Perimeter and areas of figures are obtained   2. Volume and of Surface area of solids are obtained   3. Area of irregular figures are obtained   4. Areas and volumes are obtained using Pappus theorem |
| * 1. Apply Power Series | * 1. Power series are obtained using Taylor’s Theorem   2. Power series are obtained using McLaurin’s ‘s theorem |
| * 1. Apply Statistics | * 1. Mean, median ,mode and Standard deviation are obtained from given data   2. Calculations are performed based on Laws of probability   3. Calculation involving *probability distributions* , mathematical expectation sampling distributions are performed   4. Sampling distribution methods are applied in data analysis   5. Calculations involving use of standard normal table, sampling distribution, T-distribution and Estimation are done   6. Confidence intervals are determined |
| * 1. Apply Numerical methods | * 1. Roots of polynomials are obtained using iterative *numerical methods*   2. Interpolation and extrapolation are performed using numerical methods |
| * 1. Apply Vector theory | * 1. Vectors and scalar quantities are obtained in two and three dimensions   2. *Operations* on vectors are performed   3. Position of vectors is obtained   4. Resolution of vectors is done |
| * 1. Apply Matrices | * 1. Determinant and inverse of 3x3 matrix are obtained   2. Solutions of simultaneous equations are obtained   3. Calculation involving Eigen values and Eigen vectors are performed |

**RANGE**

This section provides work environments and conditions to which the performance criteria apply. It allows for different work environments and situations that will affect performance.

|  |  |
| --- | --- |
| **Variable** | **Range** |
| 1. Operations may include but not limited to: | * + Addition   + Subtraction |
| 1. Hyperbolic functions may include but not limited to: | * + Sinh x   + Cosh x   + Cosec x   + Coth x   + Tanh x   + Sech x |
| 1. Probability Distributions may include but not limited to: | * + Binomial   + Poisson   + Normal |
| 1. Numerical Methods may include but not limited to: | * + Newton Raphson   + Gregory Newton |

**REQUIRED SKILLS AND KNOWLEDGE**

This section describes the skills and knowledge required for this unit of competency.

**Required Skills**

The individual needs to demonstrate the following skills:

1. Analytical
2. Communication
3. Logical thinking
4. Problem solving
5. Drawing
6. Sketching
7. Interpersonal
8. Organization

**Required knowledge**

The individual needs to demonstrate knowledge of:

1. Mensuration
2. Vector operations
3. Matrix operations
4. Calculus
5. Statistics
6. Ordinary differential equations
7. Power series
8. Complex numbers
9. Algebra
10. Trigonometry and hyperbolic functions
11. Coordinate Geometry
12. Binomial Expansion
13. Numerical methods

**EVIDENCE GUIDE**

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge and range.

|  |  |
| --- | --- |
| 1. Critical aspects of Competency | Assessment requires evidence that the candidate:   1. Applied algebra correctly. 2. Applied Trigonometry and hyperbolic functions correctly. 3. Applied complex numbers correctly. 4. Applied Calculus correctly. 5. Solved Ordinary differential equations correctly. 6. Carried out mensuration correctly. 7. Applied Power Series correctly. 8. Applied Vector theory correctly. 9. Applied Matrix correctly. 10. Applied Numerical methods correctly. 11. Applied statistics correctly. 12. Applied binomial expansion correctly. 13. Applied co-ordinate geometry correctly. |
| 1. Resource Implications | The following resources should be provided:   * 1. Access to relevant workplace or appropriately simulated environment where assessment can take place   2. Measuring equipment   3. Materials relevant to the proposed activity or tasks |
| 1. Methods of Assessment | Competency in this unit may be assessed through:   * 1. Written tests   2. Observation   3. Oral Questioning |
| 1. Context of Assessment | Competency may be assessed:   * 1. On-the –job   2. Off-the-job   3. Industrial attachment |
| 1. Guidance information for assessment | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. |

## APPLY WORKSHOP TECHNOLOGY

**UNIT CODE:** WAT/OS/WET/CC/03/6/A

**UNIT DESCRIPTION**

This unit describes the competence required to apply workshop technology. It involves applying workshop safety measures, identifying engineering materials, performing masonry tasks, carpentry tasks, general electrical tasks and mechanical tasks. It also involves managing workshop wastes.

**ELEMENTS AND PERFORMANCE CRITERIA**

| **ELEMENT**  These describe the **key outcomes** which make up **workplace function.** | **PERFORMANCE CRITERIA**  These are **assessable** statements which specify the required level of performance for each of the elements.  ***(Bold and italicized terms are elaborated in the Range)*** |
| --- | --- |
| 1. Apply workshop safety measures | 1. Personal Protective Equipment (PPE) are used based on manufacturer’s instructions, Nature of hazard and legal requirements. 2. Safety measures are observed based on workshop safety rules and regulations 3. Safety provisions are implemented based on National OSH guidelines 4. First Aid is administered based on standard operation procedures |
| 1. Identify Engineering Materials for workshop operations | 1. Engineering materials are classified based on Crystalline structure and chemical make up 2. Properties of engineering materials are identified based on conventional standards 3. Engineering Materials are selected based on workshop operations and engineering service conditions 4. Construction materials are selected based on workshop operations and engineering service conditions |
| 1. Perform masonry tasks | 1. Masonry hand and machine tools are identified selected based on job requirement 2. Materials and supplies for masonry works are identified and selected based job requirements. 3. Masonry tools are used as per manufacturer’s specifications 4. Masonry tasks are performed based on instructions. 5. Masonry machines and equipment are troubleshot and reported based on SOPs.   Masonry tools are maintained as per manufacturer’s specifications |
| 1. Perform carpentry tasks | 1. Carpentry hand tools and machines are identified and selected based job requirements. 2. Materials and supplies for carpentry works are identified and selected as per job requirements 3. Carpentry hand tools and machines are used as per manufacturer’s specifications 4. Carpentry tasks are performed based on instructions 5. Carpentry machines and equipment are troubleshoot and reported based on SOPs. 6. Carpentry tools are maintained as per manufacturer’s specifications |
| 1. Perform general electrical tasks | 1. Electric and electronic circuits are interpreted as per principles of flow of charge. 2. Electrical and electronic instruments are identified based on job requirements 3. Electrical and electronic measurements are conducted based job requirements 4. Errors in electrical measurement are analyzed based on IEE guidelines 5. Circuits diagrams are interpreted as per electric codes and symbols 6. Materials and supplies are identified selected based on job requirement 7. Electrical tools are used as per manufacturer’s specifications 8. Electrical and electronic installations are conducted as per manufacturers’ manuals 9. Electrical machines and equipment are troubleshot and reported based on SOPs. 10. Electrical tools are maintained as per manufacturer’s specifications |
| 1. Perform plumbing tasks | 1. Plumbing hand and machine tools are identified selected based on job requirement 2. Materials and supplies for plumbing works are identified and selected based job requirements. 3. Plumbing tools are used as per manufacturer’s specifications 4. Plumbing tasks are performed based on instructions. 5. Plumping machines and equipment are troubleshoot and reported based on SOPs. 6. Plumbing tools are maintained as per manufacturer’s specifications |
| 1. Perform general welding tasks | 1. Welding hand and machine tools are identified selected based on job requirements 2. Materials and supplies for welding works are identified and selected based job requirements. 3. Welding tools are used as per manufacturer’s specifications 4. Welding tasks are performed based on instructions. 5. Welding machines and equipment are troubleshoot and reported based on SOPs. 6. Welding tools are maintained as per manufacturer’s specifications |
| 1. Perform mechanical tasks | 1. Mechanical hand and machine tools are identified selected based on job requirement 2. Materials and supplies for mechanical works are identified and selected based job requirements. 3. Welding mechanical tools are used as per manufacturer’s specifications 4. Mechanical tasks are performed based on instructions. 5. Mechanical machines and equipment are troubleshot and reported based on SOPs 6. Mechanical tools are maintained as per manufacturer’s specifications 7. Fluid pumping terms and units are interpreted according to fluid machine principles 8. Pumps are selected based on job requirements 9. Fluid pumping calculations are performed based on fluid flow principles and laws 10. Pump performance parameters are interpreted based on fluid machine principles 11. Pumping sets are operated in accordance with SOPs 12. Pump maintenance schedules are prepared based on manufacturer’s instructions. 13. Maintenance tasks for pumping systems are conducted based on SOPs. |
| 1. Manage workshop wastes | 1. Workshop is cleaned and waste managed and disposed as per workplace policy and legal requirements 2. Recyclable supplies are cleaned and stored as per workplace policy and legal requirement. 3. Non-Recyclable supplies are cleaned and stored as per workplace policy and legal requirement. |

**REQUIRED KNOWLEDGE**

* Communication
* Analytical
* Tools and equipment
* Safety regulations
* Mathematics
* Electrical installation
* Electric Power supply
* Engine operations
* Motor operations
* Plumbing
* Water pump operation
* Masonry
* Mortar mixing
* General welding
* Firefighting
* Electric Circuit interpretation

**SKILLS**

* Critical thinking
* Problem solving
* Firefighting
* Quality control
* Circuit interpretation

**EVIDENCE GUIDE**

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge and range.

|  |  |
| --- | --- |
| * + 1. Critical Aspects of Competency | Assessment requires evidence that the candidate:   * 1. Used Personal Protective Equipment (PPE) based on manufacturer’s instructions, Nature of hazard and legal requirements.   2. Observed Safety measures based on workshop safety rules and regulations   3. Implemented Safety provisions based on DoSHs guidelines   4. Selected Engineering Materials based on workshop operations and engineering service conditions   5. Selected Construction materials based on workshop operations and engineering service conditions   6. Used masonry tools as per manufacturer’s specifications   7. Performed Masonry tasks based on work instructions.   8. Troubleshot and reported masonry machines and equipment based on SOPs.   9. Performed Carpentry tasks based on instructions   10. Troubleshot and reported Carpentry machines and equipment based on SOPs.   11. Used electrical tools as per manufacturer’s specifications   12. Performed Electrical tasks based on instructions.   13. Troubleshot and reported Electrical machines and equipment based on SOPs.   14. Performed plumbing tasks based on instructions.   15. Troubleshot and reported plumping machines and equipment based on sops.   16. Performed welding tasks based on work instructions.   17. Troubleshot and reported Welding machines and equipment based on SOPs.   18. Performed mechanical tasks based on instructions.   19. Troubleshot and reported mechanical machines and equipment based on SOPs.   20. Handled non-Recyclable supplies as per workplace policy and legal requirement. |
| * + 1. Resource Implications | The following resources should be provided:   * 1. Working tools and equipment   2. Electrical appliances   3. Training Workshops   4. Plumbing materials   5. Masonry materials |
| * + 1. Methods of Assessment | Competency may be assessed through:   * 1. Written text   2. Interview   3. Observation |
| * + 1. Context of Assessment | Competency may be assessed   1. on the job, 2. off the job 3. during industrial Attachment. |
| * + 1. Guidance information for assessment | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. |

## APPLY PHYSICS PRINCIPLES

**UNIT CODE:** WAT/OS/WET/CC/04/6/A

**UNIT DESCRIPTION**

This unit describes the competence required to apply principles. It involves performing measurements of physical quantities, applying principles of classical mechanics, heat transfer, waves and oscillations, as well as density and pressure principle. It also entails applying electromagnetic induction principles.

This standard applies in water sector.

**ELEMENTS AND PERFORMANCE CRITERIA**

|  |  |
| --- | --- |
| **ELEMENTS**  These describe the **key outcomes** which make up **workplace function.** | **PERFORMANCE CRITERIA**  These are **assessable** statements which specify the required level of performance for each of the elements.  ***Bold and italicized terms are elaborated in the Range.*** |
| 1. Perform measurements of physical quantities   . | * 1. ***Basic quantities and derived* quantities** are identified based on the SI units   2. Inter conversion of units is performed in accordance with appropriate systems of measurement   3. Dimensional analysis is performed in accordance to units of measurement   4. Measurements are performed using suitable **instruments** in accordance with appropriate units |
| 1. Apply principles of forces | * 1. ***Forces*** and their effects are identified in accordance to work place tasks   2. Moment of a force and its SI unit is determined in accordance with work place tasks   3. Forces are resolved in accordance with workplace tasks   4. Resultant forces are determined as per reference   5. The principle of moments is applied to solve problems as per reference   6. Centre of gravity of objects is determined in accordance to moments   7. Laws of friction are applied as per reference   8. Effects of friction are identified based on experiments   9. Benefits of reducing friction are described as applied to maintaining machines   10. Tools and equipment are operated based on standard operating procedures (SOPs) |
| 1. Apply principles of classical mechanics | * 1. Laws of linear *motion* are applied as per job requirements.   3.2 Parameters of motion are calculated based on the laws of motion.   * 1. Force formula is derived in accordance with laws of motion   2. Motion under gravity is determined in accordance to the laws of motion   3. Motion graphs are drawn based on parameters of motion.   4. Forms of energy and energy transformations are identified based on reference   5. Sources of energy are identified based on the forms of energy   6. Problems on work, energy and power are solved based on standard formulas. |
| 1. Apply principles of heat transfer | * 1. Modes of heat transfer are identified based on the type of material   2. Heat transfer is applied based on the modes   3. Thermal expansion is identified based on the type of materials   4. Thermal expansion is applied based on the type of materials |
| 1. Apply principles of waves and oscillations | * 1. Laws of reflection and refraction are applied to determine distance, size objects and refractive indices based on the type of material   2. Properties of waves are applied based on the effects of resonance to structures   3. Propagation of sound is applied to perform calculations based on relation amplitude , wavelength, frequency, and distance analyzed |
| 1. Apply principles of density and pressure | * 1. Laws and principles appropriate to fluid pressure are applied in accordance with reference   2. Atmospheric and fluid pressures are determined using pressure simple gauging instruments. |
| 1. Apply Principles of Electromagnetic Induction | * 1. Concepts and terminology in electromagnetic induction are explained based on electromagnetic principles.   2. Identify magnetic parameters as per relevant laws of magnetism.   3. Magnetic properties of materials are determined in accordance with the orientation of the magnetic dipole orientation.   4. Induced e.m.f. and current are identified as coupled based on Faraday’s laws of electromagnetic induction.   5. Lenz’s law is explained based on the direction of the induced e.m.f.   6. Applications of electromagnetic inductionare demonstrated based on the requirements of water laboratory. |

**RANGE**

This section provides work environments and conditions to which the performance criteria apply. It allows for different work environments and situations that will affect performance.

|  |  |
| --- | --- |
| **Variable** | **Range** |
| 1. Motion may include but is not limited to: | * Linear * projectile |
| 1. Forms of energy may include but is not limited to: | * Kinetic * Potential |
| 1. Types of waves may include but is not limited to: | * Transverse * Longitudinal |
| 1. Forms of waves may include but is not limited to: | * Mechanical * Electromagnetic |

**REQUIRED SKILLS AND KNOWLEDGE**

This section describes the skills and knowledge required for this unit of competency.

**Required skills**

The individual needs to demonstrate the following skills:

**Generic skills**

* Communication
* Analytical
* Organizing
* Decision making
* Planning
* Problem solving
* Supervising
* Time management

**Technical skills**:

* Measurement
* Instrumentation
* Calibration
* Report writing

**Required Knowledge**

* States of matter
* Laws of motion
* Optics
* Waves

**EVIDENCE GUIDE**

This provides advice on assessment and must be read in conjunction with the performance criteria, required knowledge and understanding and range.

|  |  |
| --- | --- |
| * + 1. Critical aspects of Competency | **Assessment requires evidence that the candidate:**   1. Performed measurement of the physical quantities based on standard procedures. 2. Operated and maintained optical equipment based on SOPs 3. Operated and maintained hydraulic machines based on job requirements. 4. Identified modes of heat transfer in according to the transmission media. 5. Quantity of heat is determined based on enthalpy. 6. Temperature changes are illustrated based on latent heat. 7. Illustrated change in physical state based on latent heat 8. Demonstrated optical properties of light based on principles of optics. 9. Constituents of electromagnetic spectrum are identified based on wavelength. 10. Wave-particle nature of light is evaluated based on de Broglie’s hypothesis. 11. Linear propagation of light is demonstrated based on pinhole camera. 12. Evaluated pressure in fluids based on Pascal’s law. 13. Evaluated fluid flow based on Bernoulli’s Principle. 14. Operated Hydraulic machines based on Pascal’s law 15. Interpreted simple electric circuits based on the path of flow of charge. 16. Interpreted R-L-C circuits as per the symbols. 17. Selected materials for work based on their magnetic properties |
| * + 1. Resource Implications | The following resources **should** be provided:   1. Analytical balances 2. Micrometer screw gauge 3. Vernier calipers 4. Meter rules 5. Simple machines 6. Glass prisms 7. Lenses 8. Plane and curved mirrors 9. Optical bench |
| * + 1. Methods of Assessment | Competency may be assessed through:   * 1. Written tests   2. Observations   3. Interviews   4. Third party reports |
| * + 1. Context of Assessment | Assessment may be done: -   * 1. On–the–job   2. Off-the –job   3. Industrial attachment |
| * + 1. Guidance information for assessment | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. |

## APPLY TECHNICAL DRAWINGS AND COMPUTER AIDED DESIGN PRINCIPLES

**UNIT CODE:** WAT/OS/WET/CC/05/6/A

**UNIT DESCRIPTION**

This unit covers the competencies required to apply technical drawing and computer aided design principles. It involves using and maintaining drawing equipment and materials, producing plane geometry drawings, solid geometry drawings, 3D drawings, and working drawings it also involves applying CAD packages in producing working drawings.

This standard applies in water sector.

**ELEMENTS AND PERFORMANCE CRITERIA**

|  |  |
| --- | --- |
| **ELEMENT**  These describe the **key outcomes** which make up **workplace function** | **PERFORMANCE CRITERIA**  These are **assessable** statements which specify the required level of performance for each of the elements.  ***(Bold and italicised terms are elaborated in the Range)*** |
| 1. Use and maintain drawing equipment and materials | 1. Drawing equipment are identified and gathered according to task requirements 2. Drawing materials are identified and gathered according to task requirements 3. Drawing equipment are used and maintained as per manufacturer’s instructions 4. Drawing materials are used as per workplace procedures 5. Symbols and abbreviations are identified and their meaning interpreted according to standard drawing conventions |
| 1. Produce plane geometry drawings | 1. Different types of lines used in drawing and their meanings are identified according to standard drawing conventions 2. Lettering is done in accordance with BS308. 3. Different types of scales are constructed and interpreted according to standard conventions 4. Different types of angles are constructed according to standard conventions. 5. Different types of ***geometric forms*** are constructed according to standard conventions |
| 1. Produce solid geometry drawings | 1. Drawings of patterns are interpreted according to standard conventions 2. Surface developments are produced using standard conventions 3. True shapes, plans and elevations are developed in accordance with standard conventions 4. Freehand sketching is done based on standard format. |
| 1. Produce 3D drawings | 1. First and third angle orthographic drawings are interpreted and produced in accordance with the standard conventions 2. Orthographic elevations are dimensioned in accordance with standard conventions 3. Isometric drawings are interpreted and produced in accordance with standard conventions |
| 1. Produce working drawings | 1. Suitable scales are identified and interpreted according to standard conventions 2. Plans, elevations and section drawings are produced according to standard conventions. 3. Cross sections and profiles of water structures are produced according to standard conventions 4. Dimensioning is done to working drawings according to standard |
| 1. Apply CAD packages | 1. CAD packages are selected according to task requirements 2. CAD packages are applied in production of drawings |

**Range**

This section provides work environments and conditions to which the performance criteria apply. It allows for different work environments and situations that will affect performance.

| **Variable** | **Range** |
| --- | --- |
| 1.Geometric forms may include but not limited to: | * Circles * Triangles * Rectangles * Parallelogram * Polygons * Pyramids * conic sections * prisms * loci |
| 2. Solid geometry may include but not limited to: | * Cubes * Cuboids * Pyramids * Cones * Cylinders * Truncated cones * Pyramids * Cylinders * interpenetration |

**REQUIRED SKILLS AND KNOWLEDGE**

This section describes the skills and knowledge required for this unit of competency.

**Required skills**

The individual needs to demonstrate the following skills:

* Communication
* Critical thinking
* Drawing
* Interpretation
* Drawing equipment handling
* Analysis and synthesis
* Inter personal

**Required knowledge**

The individual needs to demonstrate knowledge of:

* Drawing equipment and materials
* Freehand sketching
* Lettering
* Geometrical constructions
* Types of drawings
* Types of lines
* Isometric drawing conventions, features, characteristics, components
* Orthographic drawing conventions, features, characteristics, components
* Sketches and drawings of simple patterns

EVIDENCE GUIDE

This provides advice on assessment and must be read in conjunction with the performance criteria, required knowledge and understanding and range.

|  |  |
| --- | --- |
| 1. Critical Aspects of Competency | Assessment requires evidence that the candidate:   * 1. Used and maintained Drawing equipment as per manufacturer’s instructions   2. Used Drawing materials as per workplace procedures   3. Constructed different types of scales and interpreted according to standard conventions.   4. Constructed Different types of angles according to standard conventions.   5. Constructed Different types of geometric forms according to standard conventions   6. Interpreted Drawings of patterns according to standard conventions   7. Produced Surface developments using standard conventions   8. Developed True shapes, plans and elevations in accordance with standard conventions   9. Interpreted First and third angle orthographic drawings and produced in accordance with the standard conventions   10. Dimensioned Orthographic elevations in accordance with standard conventions   11. Interpreted and produced isometric drawings are in accordance with standard conventions   12. Applied CAD packages in production of drawings |
| 1. Resource Implications | Resources the same as that of workplace are advised to be applied.   1. Drawing room 2. Drawing equipment and materials 3. Computers 4. CAD packages |
| 1. Methods of Assessment | Competency may be assessed through:   1. Practical tests 2. Observation |
| 1. Context of Assessment | Competency may be assessed   * 1. On the job   2. Off the job   3. During Industrial Attachment |
| 1. Guidance information for assessment | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. |

## APPLY WATER TECHNOLOGY PRINCIPLES

**UNIT CODE:** WAT/OS/WLT/CC/06/6/A

**UNIT DESCRIPTION**

This unit describes the competence required to apply water technology principles. It involves applying basic water supply principles, principles of wastewater collection and treatment. It also involves applying basic hydraulics and irrigation and drainage principles.

This standard applies in the water sector.

**ELEMENTS AND PERFORMANCE CRITERIA**

| **ELEMENT** | **PERFORMANCE CRITERIA**  ***(Bold and italicized terms are elaborated in the Range)*** |
| --- | --- |
| 1. Apply basic water supply principles | 1. Water demand is calculated based on use. 2. Sources of water are established based on demand and particular use. 3. Water treatment technologies are employed based on water quality. 4. Water pipes and appurtenances are assessed based on the design 5. Water supply symbols are interpreted based on international standards 6. Water distribution systems are evaluated based on design 7. Water storage structures are evaluated based on water system 8. Work safety is observed based on code of practice |
| 1. Apply basic hydraulic principles | 1. ***Properties of fluids*** are identified based on standards 2. ***Tools and equipment*** are identified based on fluid properties 3. ***Hydraulic principles*** are applied based on the types of fluids |
| 1. Apply basic wastewater collection and treatment principles | * 1. Wastewater is characterized based on source.   2. Industrial wastewater sources are characterizedbased on wastewater characteristics   3. Sewer system layout is sketched based on sewerage design manual   4. Sewerage systems are selected based on best practice.   5. Sewer appurtenances are identified based on sewer code.   6. Wastewater treatment processes are selected based on wastewater characteristics.   7. Wastewater symbols and coding are interpreted based on international standards.   8. Wastewater recycling and reuse applications are utilized based on national policy.   9. Sludge treatment processes are identified based on characteristics.   10. Work safety is observed according to code of practice. |
| 1. Apply basic irrigation and drainage principles | * 1. Crop water requirement is determined based on agronomic requirements.   2. Quality of irrigation water is analyzed based on national standards.   3. Irrigation methods are evaluatedbased on the type of crop, type of soil, resources available, quantity and quality of water   4. Work safety is observed based on code of practice |

**Range**

This section provides work environments and conditions to which the performance criteria apply. It allows for different work environments and situations that will affect performance.

|  |  |
| --- | --- |
| **Variable** | **Range** |
| 1. Water treatment techniques may include but is not limited to: | * Household * Membrane filtration * Conventional processes |
| 1. Properties of fluids may include but not limited to | * Viscosity * Density * Mass * Volume * Compressibility * Pressure * Surface tension * Specific gravity * Specific weight |
| 1. Tools, equipment and facilities for hydraulics may include but not limited to | * Manometers * Venturimeters * Pitot tubes * Orifice meter * Orifices * V-notches * Weirs * Channels * Hydraulic bench |
| 1. Hydraulics principles may include but not limited to | * Hydrostatics * Hydrodynamics * Pipe flow * Open channel flow |
| 1. Effluent discharge Regulations may include but is not limited to: | * Public sewers * Environment |
| 1. Sewerage systems may include but is not limited to: | * Separate * Combined * Partially separate |
| 1. Wastewater treatment processes may include but is not limited to: | * Conventional: * Physical * Biological * Sludge treatment * Advanced: * Carbon adsorption * Ion exchange * Membrane processes * Chemical methods * Biological methods * Land treatment systems |
| 1. Wastewater recycling and reuse applications may include but not limited to: | * Direct reuse * Indirect potable reuse * Direct potable reuse * Planned reuse * Reclaimed wastewater * Unplanned reuse * Agricultural irrigation * Land scape irrigation * Industrial recycling and reuse * Ground water recharge * Non potable urban reuse * Potable reuse |
| 1. Sludge treatment processes may include but not limited to: | * Thickening * Stabilization * Digestion * Conditioning * Disinfection * Dewatering * Drying |
| 1. Industrial wastewater sources may include but not limited to: | * Processing: * Food * Textiles * Tannery * Manufacturing: * Paper * Detergents and cosmetics * Agrochemicals |
| 1. Irrigation methods may include but is not limited to: | * Surface methods * Subsurface methods * Overhead methods |

**REQUIRED SKILLS AND KNOWLEDGE**

This section describes the skills and knowledge required for this unit of competency

**Required Knowledge**

* Tools and equipment
* Safety regulations
* Mathematics
* Water cycle
* Water pipes
* Plumbing
* Water pump operation
* Pipe fitting

**Skills**

* Communication
* Analytical
* Critical thinking
* Problem solving
* Firefighting
* Quality control
* Circuit interpretation

**EVIDENCE GUIDE**

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge and range.

|  |  |
| --- | --- |
| 1. Critical Aspects of Competency | Assessment requires evidence that the candidate:   1. Calculated water demand based on the particular water use 2. Established sources of water based on the water demand and particular use 3. Employed water treatment technologies based water quality 4. Identified water pipes and appurtenances based on design 5. Interpreted water supply symbols based on international standards. 6. Interpreted water distribution systems based on the design. 7. Developed water storage structures based on water system 8. appliedhydraulic principles based on the types of fluids 9. Selected sewer system layout based on sewerage design manual 10. Characterized wastewater based on effluent discharge regulations 11. Selected wastewater treatment processes based on wastewater characteristics 12. Interpreted wastewater symbols based on international standards. 13. Interpreted wastewater colour codes based on international standards. 14. Determined crop water requirements based on agronomic requirements. 15. Analyzed quality of irrigation water based on national regulations 16. Applied irrigation methods based on the crop requirements 17. Determined method of drainage based on crop water requirement, type of soil, quantity and quality of water. 18. Observed work safety according to code of practice |
| 1. Resource Implications | The following resources should be provided:   1. Water distribution system models 2. Population forecasting charts 3. Water supply symbols charts 4. Wastewater symbols chart 5. Wastewater pipes 6. Plumbing supplies and equipment 7. Water quality laboratory supplies and equipment 8. Soil water, plant relationship chart 9. Drainage models 10. PPE |
| 1. Methods of Assessment | Competency may be assessed through:   1. Written tests 2. Interviews 3. Observations |
| 1. Context of Assessment | Assessment may be done: -   * 1. On–the–job   2. Off-the –job   3. Industrial attachment |
| 1. Guidance information for assessment | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. |

## APPLY WATER MANAGEMENT PRINCIPLES

**UNIT CODE:** WAT/OS/WLT/CC/07/6/A

**UNIT DESCRIPTION**

This unit describes the competencies required to apply water management principles. It involves applying hydrology, hydrogeology as well as soil and water conservation, remote sensing and GIS principles. It also entails applying water policy and legislation as well integrated water resources management principles.

This standard applies in the water sector.

**ELEMENTS AND PERFORMANCE CRITERIA**

|  |  |
| --- | --- |
| **ELEMENT**  These describe the key outcomes which make up workplace function. | **PERFORMANCE CRITERIA**  These are assessable statements which specify the required level of performance for each of the elements.  ***Bold and italicized terms are elaborated in the Range.*** |
| 1. Apply hydrology principles | 1. Identify hydrological processes based on hydrological cycle. 2. ***Hydrological measurements***are conducted based on job requirements. 3. Safety in hydrometry is observed based on OSH. |
| 1. Apply hydrogeology principles | 1. Identify hydrogeological processes based on geophysical principles. 2. ***Geological formations***are identified based on geochemistry principles. 3. Hydrogeological reports are interpreted based on hydrogeological surveys. |
| 1. Apply soil and water conservation principles | 1. Water and soil status is evaluated based on work environment. 2. Soil erosion is controlled based on best practices. 3. Water conservation practices are demonstrated based on environment. |
| 1. Apply remote sensing and GIS principles | 1. ***Remote sensing and GIS tools*** are identified based on job requirements 2. Remote sensing and GIS data is collected based on SOPs. 3. Remote sensing and GIS data is interpreted based on work requirements. |
| 1. Apply water policy and legislation | 1. Water resources are managed in accordance with national water policy. 2. Water and sanitation services are provided in accordance with legislative and regulatory framework. |
| 1. Applied integrated water resources management principles | 1. Principles of IWRM are identifiedas per Dublin Statements. 2. IWRM practices are demonstrated based on work environment. |

**RANGE**

This section provides work environments and conditions to which the performance criteria apply. It allows for different work environments and situations that will affect performance.

|  |  |
| --- | --- |
| **Variable** | **Range** |
| 1. Hydrological data may include but not limited to: | * Rainfall * Humidity * evaporation * Temperature |
| 1. Geological formations may include but not limited to: | * Rocks * Aquifers |
| 1. Remote sensing and GIS tools may include but not limited to: | * Hardware * Software |
| 1. Remote sensing and GIS data may include but not limited to: | * Water quality * land cover |
| 1. Water laws may include but not limited to: | * National * Regional |

**REQUIRED SKILLS AND KNOWLEDGE**

This section describes the skills and knowledge required for this unit of competency.

**Required Skills**

The individual needs to demonstrate the following skills:

* Communication
* Analytical
* Logical thinking
* Problem solving
* Measurement
* Data analysis
* Record keeping
* Organizing
* Decision making
* Planning
* Supervising
* Time management
* Reporting
* Instrumentation
* Remote sensing
* GIS

**Required knowledge**

The individual needs to demonstrate knowledge of:

* + Water Act
  + Water law
  + Legislation
  + Hydrogeology basics
  + National water and sanitation policy
  + Community development
  + Gender mainstreaming
  + GPS
  + OSH

**EVIDENCE GUIDE**

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge and range.

|  |  |
| --- | --- |
| 1. Critical aspects of Competency | Assessment requires that the candidate:   1. Identified hydrological processes based on the hydrological cycle. 2. Conducted hydrological measurements based on job requirements. 3. Observed safety in hydrometry based on OSH. 4. Identified geological formations based on geochemistry principles. 5. Interpreted Hydrogeological reports are based on hydrogeological surveys. 6. Collected remote sensing and GIS data based on SOPs. 7. is interpreted remote sensing and GIS data based on work requirements 8. Demonstrated soil and water conservation practices based national policy. 9. Performed work in accordance in accordance with the national legal and regulatory framework. 10. Utilized water resources and services in accordance with IWRM principles. |
| 1. Resource Implications | The following resources should be provided:   1. Basic Meteorological measuring equipment 2. GPS receivers 3. Maps 4. Computers 5. Software |
| 1. Methods of Assessment | Competency in this unit may be assessed through:   1. Observation 2. Oral Questioning 3. Written tests 4. Third party reports |
| 1. Context of Assessment | Competency may be assessed through:   1. On–the–job 2. Off-the –job 3. Industrial attachment |
| 1. Guidance information for assessment | Holistic assessment with other units relevant to the water sector, workplace and job role is recommended. |

# CORE UNITS OF COMPETENCY

# 

## DESIGN WATER SUPPLY INFRASTRUCTURE

**UNIT CODE:** WAT/OS/WET/CR/01/6/A

**UNIT DESCRIPTION**

This unit covers the competencies required to design water supply infrastructure. It involves conducting feasibility study and site survey for water supply design infrastructure, collecting water supply infrastructure design data, determining water supply infrastructure design data and calculating of water supply infrastructure design parameters. It also entails drawing water supply infrastructure units and preparing water supply infrastructure design reports.

This standard applies in Water Industry.

**ELEMENTS AND PERFORMANCE CRITERIA**

|  |  |
| --- | --- |
| **ELEMENT**  These describe the **key outcomes** which make up **workplace function** | **PERFORMANCE CRITERIA**  These are **assessable** statements which specify the required level of performance for each of the elements.  ***Bold and italicized terms are elaborated in the Range*** |
| * 1. Conduct feasibility study | 1. Desktop study is conducted based on job requirement. 2. Reconnaissance survey is conducted based on desktop study. 3. Feasibility report is prepared based on reconnaissance survey. |
| * 1. Conduct site survey for water supply design infrastructure | 1. ***Survey tools and equipment*** are identified based on the site conditions and required data. 2. Site survey is carried out based on job requirements. 3. Survey report is prepared based on SOPs. |
| * 1. Collect water supply infrastructure design data | 1. ***Tools and equipment for design data collection*** are prepared based on information required. 2. Design datais collected based on SOPs. |
| * 1. Determine water supply infrastructure design parameters | 1. Design data is analyzed organized based on SOPs. 2. Design data is presented based on SOPs. 3. Water supply infrastructure ***design parameters*** are calculated based on design codes. |
| * 1. Analyze structural elements for water supply infrastructure | 1. ***Properties of materials*** are identified based on job requirements 2. ***Section properties*** of elements are analyzed based on the materials 3. ***Structural elements*** are analyzed based on materials and loadings 4. Structural elements are designed based on design codes 5. Structural drawings are produced based on the design |
| * 1. Draw water supply infrastructure units | 1. ***Drawing tools and equipment*** are determined based on job requirements. 2. ***Water supply infrastructure units*** are drawn based on the design parameters. 3. Water supply infrastructure drawings are submitted for approval as per legal requirements. |
| * 1. Prepare water supply infrastructure design report | 1. Bill of quantities is prepared based on the design. 2. Design report is compiled prepared as per statutory regulation 3. Design report is submitted as per statutory regulations. |

**RANGE**

This section provides work environments and conditions to which the performance criteria apply. It allows for different work environments and situations that will affect performance.

|  |  |
| --- | --- |
| Variables | Range |
| 1. Water supply infrastructure may include but not limited to: | * Intake works * Treatment works * Storage works * Distribution systems |
| 1. Design parameters may include but not limited to: | **Tunnels and channels**   * Cross-sectional area * Slope * Wetted perimeter * Depth * Diameter * Width * Discharge * Velocity * Loads on tunnels   **Dams**   * Reservoir capacity * Embankment height * Crest width * Bottom width * Slope * Spillway discharge * Outlet pipeline diameter * Freeboard * Forces and failure modes |
| 1. Surveying tools and equipment may include but not limited to: | * GIS software * Theodolite * Dumpy level * Total station * Levelling staff * Booking sheet |
| 1. Drawing tools and equipment may include but not limited to: | * CAD Software * Pencils * Ruler * T-square * Scale rule * Eraser * Set square * Drawing board |
| 1. Tools for design data collection may include but not limited to: | * Stop watch * Checklists * Questionnaires * Stationery * Sampling equipment |
| 1. Properties of material may include but not limited to | * Stress * Strain * Elasticity * Plasticity * Stiffness * Young’s modulus |
| 1. Section properties of materials may include but not limited to | * Centroids * Centre of gravity * 1st moment of area * 2nd moment of area * Section modulus * Radius of gyration |
| 1. Structural elements may include but not limited to | * Reinforced concrete structures * Timber structures * Steel structures |

**REQUIRED SKILLS AND KNOWLEDGE**

This section describes the skills and knowledge required for this unit of competency.

**Required Skills**

The individual needs to demonstrate the following skills:

**Generic skills:**

* Communication
* Analytical
* Organizing
* Decision making
* Planning
* Record keeping
* Problem solving
* First aid
* Supervising
* Organizing
* Time management
* Supervision

**Technical Skills:**

* Analysis
* Reporting
* Trouble shooting
* Data logging
* Surveying
* Design
* Soil analysis
* Hydraulics
* Measurement
* Technical drawing
* CAD
* GIS

**Required Knowledge**

The individual needs to demonstrate knowledge of:

* Technical specifications
* Statutory regulations
* OSH
* Quality Assurance
* Wastewater treatment technologies
* Basic statistics
* EIA

**EVIDENCE GUIDE**

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills, knowledge and range.

|  |  |
| --- | --- |
| * + 1. Critical Aspects of Competency | Assessment requires evidence that the candidate:   1. Conducted desktop study based on job requirement. 2. Conducted reconnaissance survey is based on desktop study. 3. Prepared feasibility report based on reconnaissance survey. 4. Mapped area based on feasibility study 5. Collected data based on SOPs. 6. Calculated design parameters in accordance with water supply design manual. 7. Prepared design drawings based on calculated parameters. 8. Prepared bill of quantities based on the design drawings 9. Prepared design report based on job requirement |
| * + 1. Resource Implications | The following resources should be provided:  **Laboratory**   1. Soil 2. Survey 3. Hydrology 4. Water quality 5. Computer 6. Software |
| * + 1. Methods of Assessment | Competency may be assessed through:   1. Written assessment 2. Presentation 3. Oral interview 4. Observation 5. Third party report |
| * + 1. Context of Assessment | Competency may be assessed:   1. On the job 2. Off the job 3. In work placement |
| * + 1. Guidance information for assessment | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended |

## CONSTRUCT WATER SUPPLY INFRASTRUCTURE

**UNIT CODE:** WAT/OS/WET/CR/02/6/A

**UNIT DESCRIPTION**

This unit covers the competencies required to construct water supply infrastructure. It involves analysing properties, organizing the construction site, prepare construction schedule and constructing the water supply infrastructure.

This standard applies in water industry.

**ELEMENTS AND PERFORMANCE CRITERIA**

|  |  |
| --- | --- |
| **ELEMENT**  These describe the **key outcomes** which make up **workplace function** | **PERFORMANCE CRITERIA**  These are **assessable** statements which specify the required level of performance for each of the elements.  ***Bold and italicized terms are elaborated in the Range*** |
| 1. Analyze soil properties | 1. ***Soil analysis tools, supplies and materials*** are identified and gathered based on available resources and the tests to be conducted 2. Engineering properties of soils are identified based on the soils classification 3. Properties of soils are analyzed based on the standard procedures 4. Soil analysis report is prepared based on the results. |
| 1. Prepare construction schedule | 1. Engineering drawings are interpreted based on the engineering codes 2. ***Construction activities*** are identified based on scope of work 3. Project management timelines are prepared based on project specifications |
| 1. Organize the construction Site | 1. Site is cleared and secured based on the contract document. 2. Human resources, construction plant and equipment are identified and mobilized based on the contract document 3. ***Site infrastructures*** are put in place based on contract document and legal requirements. |
| 1. Construct the water supply infrastructure units | 1. ***Construction materials and tools*** are sourced and mobilized based on the bill of quantities 2. Infrastructure is set out based on the engineering drawings. 3. ***Water supply infrastructure units*** are constructed based on the design drawings 4. Labor payments are done based on the progress report and attendance. 5. As-built drawings are prepared and submitted based on the actual construction 6. Payment certificate is prepared based on progress report. 7. Completion certificate is prepared based on the legal requirements |

**RANGE**

This section provides work environments and conditions to which the performance criteria apply. It allows for different work environments and situations that will affect performance.

|  |  |
| --- | --- |
| **Variables** | **Range** |
| 1. Soil analysis tools, supplies and materials may include but is not limited to: | * Sieve analysis * PI index * Odometer tests * Cassagrande * Cone penetrometer * Sand replacement * Moisture content * California Bearing Ratio * Proctor * Triaxial test |
| 1. Construction activities of water supply infrastructure may include but not limited to: | * Excavation * Concrete works * Compaction * Pipe laying and jointing * Timbering to trenches * Backfilling * Alignment * Formwork * Well casing/lining |
| 1. Site infrastructures may include but not limited to: | * Site office * Site store * Ablution block * Fence * Signage/safety signs * Hoarding |
| 1. Materials and supplies required for water supply infrastructure construction may include but not limited to: | * Materials and supplies * Coarse aggregate * Fine aggregate * Cement * Water * Steel bars * Timber * Iron sheets * Conduits/ Pipes * Steel-sheets * Dumb-proof course * Paints and varnishes * Celling boards * Wire-mesh * Construction stones and blocks * Nails * Filter blanket * Filter media * Valves * Pipes and pipe fittings |
| 1. Construction of water supply infrastructure may include but not limited to: | * Treatment works * Pipelines * Intakes * Electromechanical works * Retention structures * Storage structures * Open channels |
| 1. Tools and equipment required for construction of water supply infrastructure may include but not limited to: | * Diestocks * Pipe wrenches * Excavators * Adjustable spanners * Plumbing vice * Rollers * Graders * Clamping vice * Hammers * Hack saws * Pipe reamers * Concrete mixers * Spirit level * Threading machines * Vibrators * Compactor * Personal protective equipment * Computer software * Plump bob * Tape measures * Water level |

**REQUIRED SKILLS AND KNOWLEDGE**

This section describes the skills and knowledge required for this unit of competency.

**Required Skills**

The individual needs to demonstrate the following skills:

* Communication
* Analytical
* Organizing
* Decision making
* Planning
* Reporting
* Record keeping
* Problem solving
* First aid
* Performance appraising
* Supervising
* Trouble shooting
* Time management
* Data logging
* Technical drawing
* Computer Aided drawing
* Excavation

**Required Knowledge**

The individual needs to demonstrate knowledge of:

* Construction plant and equipment
* Site organization
* Excavation
* Construction materials
* Construction management
* Contract document development
* Technical specifications
* Measurement and costing
* Project planning
* Construction of water supply infrastructure
* Statutory regulations

**EVIDENCE GUIDE**

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge and range.

|  |  |
| --- | --- |
| * 1. Critical aspects of competency | Assessment requires evidence that the candidate:   1. Analyzed properties of soils based on the standard procedures 2. Prepared soil analysis report based on the results. 3. Prepared project management timelines based on project specifications 4. Constructed site infrastructures based on contract document and legal requirements. 5. Constructed water supply infrastructure units based on the design drawings 6. Prepared Completion certificate based on the legal requirements |
| * 1. Resource Implications | The following resources should be provided:   1. Adequately equipped concrete lab 2. Adequately equipped soils laboratory 3. Survey Equipment 4. Construction tools and equipment 5. Adequately equipped timber workshop 6. Plumbing and pipe fitting workshop 7. Electromechanically workshop 8. Diestocks 9. Pipe wrenches 10. Adjustable spanners 11. Clamping vice 12. Hammers 13. Hack saws 14. Spirit level 15. Vibrators 16. Personal protective equipment 17. Computer software 18. Course aggregates 19. Fine aggregates 20. Cement 21. Water 22. Pipes 23. Appurtenances 24. Steel bars 25. Timber 26. Formwork 27. Iron sheets 28. Conduits 29. Steel-sheets 30. Dumb-proof course 31. Paints and varnishes 32. Wire-mesh 33. Construction stones and blocks 34. Nails 35. Filter blanket 36. Filter media |
| * 1. Methods of Assessment | Competency may be assessed through:   * 1. Observation   2. Written tests   3. Third party reports |
| * 1. Context of Assessment | Competency may be assessed:   * 1. On the job   2. Off the job   3. In work placement (attachment)   Off the job assessment must be undertaken in a closely simulated workplace environment |
| * 1. Guidance information for assessment | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended |

## OPERATE AND MAINTAIN WATER SUPPLY INFRASTRUCTURE

**UNIT CODE:** WAT/OS/WET/CR/03/6/A

**UNIT DESCRIPTION**

This unit covers the competencies required to operate and maintain water supply infrastructure. It involves preparing operation and maintenance schedules, operating water supply system maintaining water supply systems, Operate and maintain point of use treatment units and operate and maintain community water supply schemes.

This standard applies in water industry.

**ELEMENTS AND PERFORMANCE CRITERIA**

|  |  |
| --- | --- |
| **ELEMENT**  These describe the **key outcomes** which make up **workplace function** | **PERFORMANCE CRITERIA**  These are **assessable** statements which specify the required level of performance for each of the elements.  ***Bold and italicized terms are elaborated in the Range*** |
| 1. Prepare operation and maintenance schedules | * 1. Operation and maintenance tasks are identified based on the water supply system   2. Required ***operation and maintenance resources*** are determined based on tasks   3. Operation and maintenance manual is prepared based on Standard Operating Procedures   4. Operation and maintenance schedule is prepared based on operation and maintenance manual |
| 1. Operate and maintain water supply system | * 1. Routine operation is carried out based on operation and maintenance manual.   2. Routine maintenance is carried out based on maintenance schedule   3. Machine service and calibration is carried out based on manufactures specification   4. Operation and maintenance reports are prepared based on operation and maintenance manual |
| 1. Operate and maintain point of use treatment units | * 1. Tools and equipment required for maintenance of point of use treatment units are identified and acquired based on the water distribution system   2. ***Point of use treatment units*** are monitored and inspected based on the design specifications   3. Point of use treatment units monitoring report are prepared based on best practices.   4. Appropriate rehabilitation is conducted based on monitoring report findings. |
| 1. Operate and maintain community water supply schemes | 1. ***Community level operations*** are identified depending on the community needs 2. Community level operations are scheduled based on the identified local capacity 3. Operations are initiated and conducted within the community based on schedule 4. Operations are maintained within the community based on community agreements |

**RANGE**

This section provides work environments and conditions to which the performance criteria apply. It allows for different work environments and situations that will affect performance.

|  |  |
| --- | --- |
| **Variables** | **Range** |
| 1. Operation and maintenance resourcesmay include and not limited to: | * Human resource * Tools and equipment * Vehicle and machinery |
| 1. Point of use treatment units may include and not limited to: | * Particulate filters * Reverse osmosis * Ion exchange * Adsorption filters |
| 1. Community level operation and maintenance may include and not limited to | * Springs * Shallow wells * Pans * Sand dams |

**REQUIRED SKILLS AND KNOWLEDGE**

This section describes the skills and knowledge required for this unit of competency.

**Required Skills**

The individual needs to demonstrate the following skills:

* Communication
* Analytical
* Organizing
* Decision making
* Planning
* Reporting
* Record keeping
* Problem solving
* First aid
* Performance appraising
* Supervising
* Trouble shooting
* Time management
* Data logging
* Technical drawing
* Computer Aided drawing

**Required Knowledge**

The individual needs to demonstrate knowledge of:

* Operation and maintenance of water supply infrastructure
* Water quality test
* Water quality standards
* Electromechanical equipment and machines
* Dam monitoring operation and maintenance
* Quality management system
* Plant operation and maintenance
* Statistics
* Metering
* Zoning concept
* Pressure management
* Leak detection and repair
* Water balance

**EVIDENCE GUIDE**

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge and range.

|  |  |
| --- | --- |
| * 1. Critical Aspects of Competency | Assessment requires evidence that the candidate:   1. Identified operation and maintenance tasks based on the water supply system 2. Determined operation and maintenance resources based on tasks 3. Prepared operation and maintenance manual based on Standard Operating Procedures 4. Prepared operation and maintenance schedule based on operation and maintenance manual 5. Carried out routine operation based on operation and maintenance manual 6. Carried out routine maintenance based on maintenance schedule 7. Carried out machine service and calibration based on manufactures specification 8. Prepared operation and maintenance reports based on operation and maintenance manual 9. Computed Water balance based on non-revenue water manual |
| * 1. Resource Implications | The following resources should be provided:   * 1. Construction tools and equipment   2. Construction material and supplies   3. Water supply system models   4. Laboratories * Survey * Soil * Water quality   1. Workshops * Construction * Plumbing and Pipework |
| * 1. Methods of Assessment | Competency may be assessed through:   * 1. Written assessment   2. Presentation   3. Oral interview   4. Observation   5. Construction reports   6. Practical assessment |
| * 1. Context of Assessment | Competency may be assessed:   * 1. On the job   2. Off the job   3. In work placement (attachment)   Off the job assessment must be undertaken in a closely simulated workplace environment |
| * 1. Guidance information for assessment | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended |

## MANAGE NON-REVENUE WATER

**UNIT CODE:** WAT/OS/WET/CR/04/6/A

**UNIT DESCRIPTION**

This unit covers the competencies required to manage non-revenue water. It involves analysis of water balance, management of technical losses (physical losses), management of commercial losses and management of customer service connections.

This standard applies in water industry.

**ELEMENTS AND PERFORMANCE CRITERIA**

|  |  |
| --- | --- |
| **ELEMENT**  These describe the **key outcomes** which make up **workplace function** | **PERFORMANCE CRITERIA**  These are **assessable** statements which specify the required level of performance for each of the elements.  ***Bold and italicized terms are elaborated in the Range*** |
| 1. Analyze water balance | 1. ***Tools and equipment*** for collecting data are prepared based on area of coverage 2. System input and output data is obtained based on needs assessment 3. Water balance is computed based on non-revenue water manual |
| 1. Manage technical losses(physical losses) | 1. ***Tools and equipment for collecting data*** for technical losses management are identified and sourced based on area of coverage 2. Distribution system is mapped based on the area of coverage 3. Points of technical losses are identified and mapped based on the area of coverage 4. Causes of technical losses are identified based on the non-revenue water management manual 5. Technical losses are managed based on the causes identified |
| 1. Manage commercial losses | 1. ***Tools and equipment for collecting data*** for commercial losses management are prepared based on area of coverage 2. Points of commercial losses are identified and mapped based on the area of coverage 3. Causes of commercial losses are identified based on the coverage area 4. Commercial losses are managed based on the causes identified |
| 1. Manage customer service connections | 1. Connection tools, equipment, material and labour are identified and sourced based on the reconnaissance report 2. Water pipeline is connected based on the connection schedule 3. The connection is updated in the system based on the executed works 4. The meter is identified and sourced based the connection requirement 5. The meter is tested based on specification in the contract document 6. The meter is installed based on the pipe size and customer classification |

**RANGE**

This section provides work environments and conditions to which the performance criteria apply. It allows for different work environments and situations that will affect performance.

|  |  |
| --- | --- |
| Variables | Range |
| 1. Tools and equipment used for collecting non-revenue water data and management may include but not limited to: | * Mattocks * Jembes * Spades * Personal protective equipment * Toolbox * Stop watch * Measuring cylinder * Thread tapes * Measuring tapes * Vanier caliper * Stationery * Meter reading tools (geo-referenced phones ) * Computer software * Vehicles * GPS * Fusing machine * Gas flame lamp * Welding machines * Cutting/grinding machine * Cutting disc * Excavator * Grinding disc * Dewatering pump * Meter testing benches * Leak detectors * Computers * Software * Meters * GPS * Flow Meters * Smart Meters |
| 1. Materials used for non-revenue water management may include but not limited to: | Materials   * Pipe fittings * Meter fittings * Hemp |

**REQUIRED SKILLS AND KNOWLEDGE**

This section describes the skills and knowledge required for this unit of competency.

**Required Skills**

The individual needs to demonstrate the following skills:

* Communication
* Analytical
* Organizing
* Decision making
* Planning
* Reporting
* Record keeping
* Problem solving
* First aid
* Performance appraising
* Supervising
* Trouble shooting
* Time management
* Data logging
* Technical drawing
* Computer Aided drawing

**Required Knowledge**

The individual needs to demonstrate knowledge of:

* Metering
* Water balance
* Leak detection and repair
* Pressure management
* Zoning
* Geographic information system
* Data capture
* Non-revenue water management
* Customer care relations
* Pipes(types, repairs and maintenance)
* Plumbing and pipefitting

**EVIDENCE GUIDE**

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge and range.

|  |  |
| --- | --- |
| * 1. Critical Aspects of Competency | Assessment requires evidence that the candidate:   1. Obtained system input and output data based on needs assessment 2. Computed water balance based on non-revenue water manual 3. Mapped distribution system based on the area of coverage 4. Managed technical losses based on the causes identified 5. Managed commercial losses based on the causes identified 6. installed water meter based on the pipe size and customer classification |
| * 1. Resource Implications | The following resources should be provided:   * 1. Mattocks   2. Jembes   3. Spades   4. Spanners   5. Toolbox   6. Thread tapes   7. Hack saw   8. Measurement tapes   9. Computer software   10. Personal protective equipment   11. Vehicle   12. Fusing machine   13. Gas flame lamp   14. Welding machines   15. Cutting/grinding machine   16. Cutting disc   17. GPS   18. Meter   19. Pipes   20. Pipe fittings   21. Pipe adhesives   22. Thread tape   23. Hemp |
| * 1. Methods of Assessment | Competency may be assessed through:   * 1. Written assessment   2. presentation   3. Oral interview   4. Observation   5. Practical assessment |
| * 1. Context of Assessment | Competency may be assessed:   * 1. On the job   2. Off the job   3. In work placement (attachment)   Off the job assessment must be undertaken in a closely simulated workplace environment |
| * 1. Guidance information for assessment | Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended. |