Federal Democratic Republic of Ethiopia OCCUPATIONAL STANDARD



POWER GENERATION INSTALLATION AND MAINTENANCE- MECHANICAL

NTQF Level IV



Ministry of Education June 2012

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Introduction

Ethiopia has embarked on a process of reforming its TVET-System. Within the policies and strategies of the Ethiopian Government, technology transformation – by using international standards and international best practices as the basis, and, adopting, adapting and verifying them in the Ethiopian context – is a pivotal element. TVET is given an important role with regard to technology transfer. The new paradigm in the outcome-based TVET system is the orientation at the current and anticipated future demand of the economy and the labor market.

The Ethiopia Occupational Standards (EOS) is the core element of the Ethiopian National TVET-Strategy and an important factor within the context of the National TVET-Qualification Framework (NTQF). They are national Ethiopian standards, which define the occupational requirements and expected outcome related to a specific occupation without taking TVET delivery into account.

This document details the mandatory format, sequencing, wording and layout for the Ethiopia Occupational Standard which comprised of Units of Competence.

A Unit of Competence describes a distinct work activity. It is documented in a standard format that comprises:

- Occupational title and NTQF level
- Unit title
- Unit code
- Unit descriptor
- Elements and Performance criteria
- Variables and Range statement
- Evidence guide

Together all the parts of a Unit of Competence guide the assessor in determining whether the candidate is competent.

The ensuing sections of this EOS document comprise a description of the occupation with all the key components of a Unit of Competence:

- chart with an overview of all Units of Competence for the respective level (Unit of Competence Chart) including the Unit Codes and the Unit Titles
- contents of each Unit of Competence (competence standard)
- occupational map providing the technical and vocational education and training (TVET) providers with information and important requirements to consider when designing training programs for this standards and for the individual, a career path

UNIT OF COMPETENCE CHART

Occupational Standard: Power Generation Installation and Maintenance- Mechanical				
Occupational Code: EIS IMM				
NTQF Level IV				
EIS IMM4 01 0612 Monitor Compliance with OHS Policy and Procedures	EIS IMM4 02 0612 Install and Maintain Complex Mechanical Seals	EIS IMM4 03 0612 Maintain Complex Mechanical Valves		
EIS IMM4 04 0612 Maintain Complex Mechanical Pumps	EIS IMM4 05 0612 Install and Maintain Steam Turbine	EIS IMM4 06 0612 Conduct Complex Leveling and Alignment		
EIS IMM4 07 0612 Maintain Fluid Power Systems	EIS IMM4 08 0612 Install and Maintain Hydro Turbines	EIS IMM4 09 0612 Conduct Technical Inspection of Process Plant and Equipment		
EIS IMM4 10 0612 Conduct Performance Testing on Process Plant and Equipment	EIS IMM4 11 0612 Diagnose and Repair Faults in Complex Refrigeration/Air Conditioning Equipment	EIS IMM4 12 0612 Diagnose and Repair Faults in Mechanical Equipment		
EIS IMM4 13 0612 Install and Maintain Industrial Transmissions	EIS IMM4 14 0612 Perform Mechanical and Fabrication Drafting	EIS IMM4 15 0612 Conduct Condition Monitoring		
EIS IMM4 16 0612 Coordinate First Response Team Operation	EIS IMM4 17 0612 Conduct Welding Inspection/Supervision	EIS IMM4 18 0612 Tune Process Plant and Equipment		
EIS IMM4 19 0612 Monitor and Maintain Civil Assets	EIS IMM4 20 0612 Coordinate Permit to Work System	EIS IMM4 21 0612 Plan and Organize work		
EIS IMM4 22 0612 Migrate to New Technology	EIS IMM4 23 0612 Establish Quality Standards	EIS IMM4 24 0612 Develop Teams and Individuals		
EIS IMM4 25 0612 Utilize Specialized Communication Skills	EIS IMM4 26 0612 Manage and Maintain Small/Medium Business Operation	EIS IMM4 27 1012 Manage Continuous Improvement System		
Power Generation Installation and				

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Occupational Standard: Power Generation Installation and Maintenance- Mechanical Level IV		
Unit Title	Monitor Compliance with OHS Policy and Procedures	
Unit Code	EIS IMM4 01 0612	
Unit Descriptor	This unit deals with the skills and knowledge required to implement and monitor the organization's Occupational Health and Safety (OHS) policies, procedures and programs in the relevant work area to achieve and maintain Occupational Health and Safety standards.	
	This unit describes generic occupational health and safety competencies applicable for employees with supervisory responsibilities to be exhibited in the work area of responsibility. It involves application of relevant Occupational Health and Safety legislation and codes of practice, including duties and responsibilities of all parties under the general duty of care.	
	It requires the ability to implement and comply with workplace procedures in hazard identification and risk control, observation of others safe practices during work operations and conduct of participative arrangements for maintaining health and safety in the workplace.	

Elements		Per	formance Criteria
1. Provide information to the work group about Occupational Health and Safety and the	Provide information to the work group	1.1	Relevant provisions of Occupational Health and Safety legislation and codes of practice are accurately and clearly explained to the work group
	1.2	Information on the organization's Occupational Health and Safety policies, procedures and programs is provided in a readily accessible manner and is accurately and clearly explained to the work group	
	policies, procedures and programs	1.3	Information about identified hazards and the outcome of risk assessment and risk control procedures is regularly provided and is accurately and clearly explained to the work group
		1.4	Where appropriate, the teams and individuals roles and responsibilities within the team are identified, and, where required, assist in the provision of on-the-job training
2. Imp mor part arra for t mar of C	Implement and monitor participative arrangements	2.1	Organizational procedures for consultation over Occupational Health and Safety issues are implemented and monitored to ensure that all members of the work group have the opportunity to contribute
	tor the management of OHS	2.2	Issues raised through consultation are dealt with and resolved promptly, or referred to the appropriate personnel for resolution in accordance with workplace procedures for issue resolution

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		2.3	The outo and Safe promptly	comes of consultation over Occupational ety issues are made known to the work g	Health jroup
3.	Implement and monitor the organization's procedures for identifying hazards and assessing risks	3.1	Existing and potential hazards in the work area are identified and reported so that risk assessment and risk control procedures can be applied		
4.	Implement and monitor the organization's	4.1	Work pro adheren accorda	ocedures to control risks are implemente ce to them by the work group is monitore nce with workplace procedures	ed and ed in
	procedures for controlling risks	4.2	Existing reported procedu	risk control measures are monitored and regularly in accordance with workplace res	d results
		4.3	Inadequa identified reported	acies in existing risk control measures a d in accordance with the hierarchy of cor to designated personnel	re htrol and
		4.4	Inadequa risk cont designat	acies in resource allocation for implement rol measures are identified and reported red personnel	ntation of to
5.	5. Implement the organization's procedures for		Workpla are imple prompt o	ce procedures for dealing with hazardou emented whenever necessary to ensure control action is taken	s events that
	dealing with hazardous	5.2	Hazardo in accoro	bus events are investigated to identify th dance with investigation procedures	eir cause
	events		Control r risks of h hierarch compete personn	measures to prevent recurrence, and min nazardous events, are implemented, bas y of control if within scope of responsibilit encies, or alternatively referred to design el for implementation	nimize ed on the ties and ated
6.	6. Implement and monitor the organization's procedures for providing Occupational Health and Safety training		Occupat identified Occupat and thos	ional Health and Safety training needs a d accurately, specifying gaps between ional Health and Safety competencies re se held by work group members	re equired
			Arranger Occupat and off-t relevant	ments are made for fulfilling identified ional Health and Safety training needs ir he-job training programs in consultation parties	n both on with
7.	Implement and monitor the organization's	7.1	1 Occupational Health and Safety records for work area are accurately and legibly completed in accordance with workplace requirements for Occupational Health and		area are with and
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procedure for maintaining		Safety records and legal requirements for the maintenance of records of occupational injury and disease
Occupational Health and Safety records	7.2	Aggregate information from the area's Occupational Health and Safety records is used to identify hazards and monitor risk control procedures within work area according to organizational procedures and within scope of responsibilities and competencies

Variable	Range
Hazardous events	May include but not limited to:
	 Include accidents, fires and emergencies such as chemical spills or bomb scare.
	 Procedures for dealing with emergency include evacuation, chemical containment and first aid procedures

Critical Aspects of CompetenceDemonstrates skills and knowledge in:• Evidence of understanding of hierarchy of control (the preferred order of risk control measures for most to least preferred, i.e. elimination, engineering controls, administrative controls and personal protective equipment) is required.• Evidence of understanding of the significance of other management systems and procedures for Occupational Health and Safety is required.• Evidence of knowledge of literacy levels and communication skills of work group members and consequent suitable communication techniques is required.• Dealing with an unplanned event by drawing on essential knowledge and AttitudesUnderpinning Knowledge and Attitudes• Relevant Occupational Health and Safety regulations • Relevant statutory legislation• Relevant enterprise/site safety procedures including identification of hazards and controlling of risks • Enterprise/site emergency procedures and techniques • Provision of occupational health and safety instruction to others • Maintenance of occupational health and safety regulations • Apply relevant statutory legislation	Evidence Guide		
Underpinning Knowledge and AttitudesDemonstrates knowledge of: • Relevant Occupational Health and Safety regulations • Relevant statutory legislation • Relevant enterprise/site safety procedures including identification of hazards and controlling of risks • Enterprise/site emergency procedures and techniques • Environmental legislation • Plant status • Participative arrangements including safety committees • Provision of occupational health and safety recordsUnderpinning SkillsDemonstrates skills to: • Apply relevant occupational health and safety regulations • Apply relevant statutory legislation	Critical Aspects of Competence	 Demonstrates skills and knowledge in: Evidence of understanding of hierarchy of control (the preferred order of risk control measures for most to least preferred, i.e. elimination, engineering controls, administrative controls and personal protective equipment) is required. Evidence of understanding of the significance of other management systems and procedures for Occupational Health and Safety is required. Evidence of knowledge of literacy levels and communication skills of work group members and consequent suitable communication techniques is required. Dealing with an unplanned event by drawing on essential knowledge and skills to provide appropriate solutions 	
Onderprinning Demonstrates skills to: Skills • Apply relevant occupational health and safety regulations • Apply relevant statutory legislation	Underpinning Knowledge and Attitudes	 incorporated in the holistic assessment Demonstrates knowledge of: Relevant Occupational Health and Safety regulations Relevant statutory legislation Relevant enterprise/site safety procedures including identification of hazards and controlling of risks Enterprise/site emergency procedures and techniques Environmental legislation Plant status Participative arrangements including safety committees Provision of occupational health and safety instruction to others Maintenance of occupational health and safety records 	
	Skills	 Demonstrates skills to: Apply relevant occupational health and safety regulations Apply relevant statutory legislation 	

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	Apply relevant enterprise/site safety procedures
	• Apply enterprise /site emergency procedures and techniques
	Apply enterprise recording procedures
	 Locate and/or identify relevant plant and equipment
	Identify plant status
	Communicate effectively.
Resources	Access is required to real or appropriately simulated situations,
Implication	including work areas, materials and equipment, and to
	information on workplace practices and OHS practices.
Methods of	Competence may be assessed through:
Assessment	 Interview / Written Test
	 Observation / Demonstration with Oral Questioning
Context of	Competence may be assessed in the work place or in a
Assessment	simulated work place setting

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Occupational Standard: Power Generation Installation and Maintenance- Mechanical Level IV				
Unit Title	Install and Maintain Complex Mechanical Seals			
Unit Code	EIS IMM4 02 0612			
Unit Descriptor	This unit deals with the skills and knowledge required to undertake all work associated with the installation and maintenance of complex mechanical seals and which may involve fault finding, diagnosis and repairs.			

Elements		Performance Criteria			
1. Plan and prepare for t work	the	1.1	Work re orders o appropr	equirements are identified from request/v or equivalent and clarified/confirmed with riate parties or by site inspection	vork 1
		1.2	Occupa requirer practice requirer applied	tional Health and Safety standards, state ments, relevant Ethiopian standards, coo e, manufacturers" specifications, environ ments and enterprise procedures are ide and monitored throughout the work proc	utory les of mental entified, cedure
		1.3	Resoure obtaine specific	ces required to satisfy the work plan are d and inspected for compliance with the ations	identified, job
		1.4	Relevar interpre	nt plans, drawings and texts are selected ted in accordance with the work plan	and
		1.5	Correct are dete with the	size, type and quantity of materials/com ermined, obtained and inspected for com job specifications	ponents opliance
		1.6	Work is prioritizi for the r accorda	planned in detail including sequencing a ing and considerations made, where app maintenance of plant security and capac ance with system/site requirements	and propriate, ity in
		1.7	Coordination requirements, including requests for isolations where appropriate, are resolved with others involved, affected or required by the work		
		1.8	Potential hazards are identified and prevention and/or control measures are selected in accordance with the work plan and site procedures		
		1.9	9 Work area is prepared in accordance with work requirements and site procedures		
		1.10	1.10 Where appropriate, the teams and individuals roles and responsibilities within the team are identified and, where required, assist in the provision of on-the-job training		
2. Remove seals for maintenance		2.1	Require accorda	ed isolations are confirmed where approance with site requirements	priate, in
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	2.2	Seals a	re identified in accordance with the work	k plan
	2.3	Seals ar replacer	e removed in a manner which will assis nent in accordance with the work plan	t in
	2.4	Seals ar	e inspected for abnormalities in accorda	ance with
3. Maintain complex seals	3.1	<i>Mainter</i> manufac	nance is performed in accordance with cturers specifications and site procedure	es
	3.2	Seal ass enginee accorda	semblies are dismantled using appropria ring principles and technical procedures nce with the job plan and site requireme	ate s in ents
	3.3	Compor produce the job p	nent parts are clearly marked and sketch d as required for identification in accord plan and site requirements	nes ance with
	3.4	Compor precise equipme and site	nent wear and clearances are determine measuring techniques and appropriate t ent in accordance with manufacturer spe requirements	ed using test ecifications
	3.5	Compor and/or a specifica	nents found to be faulty are repaired, rep adjusted to conform with manufacturer ations and site requirements	blaced
	3.6	New cor required accordir requiren	mponents are inspected for compliance I specifications and prepared for re asse ng to manufacturer specifications /site nents	to mbly
	3.7	Compor accordir requiren	nent parts are refitted to seal assemblies ng to manufacturer specifications /site nents	3
	3.8	Modifica with site	tions/alterations are undertaken in acco requirements	ordance
4. Replace/install complex seals	4.1	<i>Site</i> is prepared for seal replacement in accordance with the work plan		
	4.2	Seals are replaced in accordance with the work plan and manufacturer specifications		
	4.3	All fastenings are torque in accordance with manufacturer specifications and site requirements		
4.4 Machinery/plant is test run, monitored and adjust required in accordance with manufacturer specification and site requirements		sted as fications		
5. Complete the work	5.1	Work is completed and appropriate personnel notified in accordance with site/enterprise requirements		
	5.2	Work ar secured	ea is cleared of waste, cleaned, restored in accordance with site/enterprise proc	d and edures
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5.3	Plant, <i>tools and equipment</i> are maintained and stored in accordance with site/enterprise procedures
5.4	<i>Work completion details</i> are finalized in accordance with site/enterprise procedures

Variable	Range
Complex/	May include but not limited to:
specialized seals	• Generator hydrogen seals, double acting mechanical seals, floating seals and turbine labyrinth glands.
Test equipment	May include but not limited to:
	 Feeler gauge, dial gauge, bearing blue, micrometers, flexi gauge, leads and go/no-go gauges.
	 Details of maintenance may be clarified by diagnosis and work place inspection.
Tools and	May include but not limited to:
equipment	 micrometers, vernier, dial test indicators, slip gauges, hand tools, customized mandrels, digital height gauges, internal micrometers, oxyacetylene gear, depth gauges, air grinders, jigs and fixtures, customized spanners, electronic internal micrometers, appropriate lifting devices, heated oil
Maintenance	Dath and induction heaters.
Maintenance	 Repair, inspection, modification, overhaul, lubrication, servicing and test running.
Work completion	May include but not limited to:
details	 Plant/maintenance records, job cards, check sheets, on device labeling updates and reporting/documenting equipment defects.
Work site	May include but not limited to:
environment	 Affected by nearby plant or processes, e.g. chemical, heat, dust, noise, gas and oil.
Isolations	May refer to:
	electrical/mechanical or other associated processes

Evidence Guid	le				
Critical Aspects Competence	s of Demonstrate • Occupation legislation, enterprise/ • Preparatio • Removal to procedures • Installation • Completion • Dealing wi knowledge	 Demonstrates skills and knowledge in: Occupational Health and Safety legislation, statutory legislation, enterprise/site safety procedures and enterprise/site emergency procedures Preparation and planning of work Removal techniques maintenance techniques and procedures Installation techniques and procedures Completion of work procedures Dealing with an unplanned event by drawing on essential knowledge and skills to provide appropriate solutions 			
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Underpinning	Demonstrates knowledge of:
Knowledge and	Occupational Health and Safety
Attitudes	Complex mechanical seals
	Precision measuring equipment
	 Seals and gaskets (types and materials)
	Bearings (anti-friction and plain)
	Quality assurance/guality control
	Specialized tools and jigs
	 Leveling and aligning principles
	Rigging and lifting techniques
	 Relevant materials and components
	 Technical drawings and data
	 Data recording techniques
	 Hand and portable power tools
	 Diagnostic and testing techniques
	 Relevant plant and systems
	 Isolation procedures
	Heating techniques
	Communication principle
Underninning	Demonstrates skills to:
Skills	Apply Occupational Health and Safety standards
	 Identify and use measuring equipment
	Apply sealing principles
	 Manufacture and install seals and daskets
	 Install bearings (anti-friction and plain)
	 Use technical drawings and data
	 Identify and select materials and components
	 Use hand and portable power tools
	 Apply diagnostic and testing techniques
	 Apply diagnostic and testing testing techniques Apply dismantling and reassembling techniques
	 Apply distributing and reassering techniques Apply installation and maintenance procedures
	 Apply installation and maintenance procedures Apply data analysis techniques
	Recognize worn/damaged components
	Communicate effectively
Resources	Access is required to real or appropriately simulated situations
Implication	including work areas materials and equipment and to
mphoadon	information on workplace practices and OHS practices.
Methods of	Competence may be assessed through:
Assessment	Interview / Written Test
	Observation / Demonstration with Oral Questioning
Context of	Competence may be assessed in the work place or in a
Assessment	simulated work place setting

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Occupational Standard: Power Generation Installation and Maintenance- Mechanical Level IV				
Unit Title	Maintain Complex Mechanical Valves			
Unit Code	EIS IMM4 03 0612			
Unit Descriptor	This unit deals with the skills and knowledge required to undertake the fault finding, diagnosis, repair and/or overhaul of complex mechanical valves, but excluding associated servo or actuating units.			

Elements	Performance Criteria			
1. Plan and prepare for work	1.1 Work requirements are identified from request/work orders or equivalent and clarified/confirmed with appropriate parties or by site inspection			
	1.2 Occupational Health and Safety standards, statutory requirements, relevant Ethiopian standards, codes of practice, manufacturer specifications, environmental requirements and enterprise procedures are identified, applied and monitored throughout the work procedure			
	 Resources required to satisfy the work plan are identified, obtained and inspected for compliance with the job specifications 			
	1.4 Relevant plans, drawings and texts are selected and interpreted in accordance with the work plan			
	1.5 Correct size, type and quantity of materials/components are determined, obtained and inspected for compliance with the job specifications			
	1.6 Work is planned in detail including sequencing and prioritizing and considerations made, where appropriate, for the maintenance of plant security and capacity in accordance with system/site requirements			
	1.7 Coordination requirements, including requests for isolations where appropriate, are resolved with others involved, affected or required by the work			
	1.8 Potential hazards are identified and prevention and/or control measures are selected in accordance with the work plan and site procedures			
	1.9 Work area is prepared in accordance with work requirements and site procedures			
	1.10 Where appropriate, the teams and individuals roles and responsibilities within the team are identified and, where required, assist in the provision of the on-the-job training			
2. Remove valves for	2.1 Required isolations are confirmed where appropriate, in accordance with site requirements			
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maintenance	2.2	Valve is o	disconnected in accordance with the wor	rk plan
	2.3	Valve is r replacem	emoved in a manner which will assist in ent in accordance with the work plan.	
	2.4	Valve is i work plan	nspected for abnormalities in accordanc	e with the
3. Perform valve maintenance	3.1	<i>Maintena</i> manufact	ance is performed in accordance with urer specifications and the work plan	
	3.2	Valve is c relevant s	dismantled, clearly marked for identifications with the vertice of the second ance with the vertice of the second ance with the second ance with the second ance with the second ance with the second and se	ion and vork plan
	3.3	Compone in accord	ents are correlated in preparation for re-a ance with manufacturer's drawings/man	assembly uals
	3.4	New com manufact	ponents are inspected to ensure complia urer specifications	ance with
	3.5	Dimensio <i>measurii</i> manufact	nal inspection is performed with precisi ng devices to ensure compliance with urer specifications and site requirements	6 6
	3.6	Compone with man	ents are reassembled for testing in accor ufacturer specifications and site requirer	dance nents
	3.7	Modificati manufact	ions/alterations are undertaken in accord urer specifications and site requirements	dance with s
	3.8	Compone in accord requireme	ents are leveled, aligned, coupled and co ance with manufacturer specifications an ents.	onnected nd site
	3.9	Valves ar required i and the w	e pressure tested, monitored and adjust in accordance with manufacturer specific ork plan	ed if cations
4. Replace/install valves	4.1	Site is protection of the work	epared for valve replacement in accorda plan	ince with
	4.2	Valve is r manufact	eplaced in accordance with the work pla urer specifications	in and
	4.3	Valve is c manufact	connected in accordance with the work p urer specifications	lan and
	4.4	Final job relinquish	inspection is completed and any permits red in accordance with the work plan	•
5. Complete the work	5.1	Work is c accordan	completed and appropriate personnel notified in the with site/enterprise requirements	
5.2		<i>Work area</i> is cleared of waste, cleaned, restored and secured in accordance with site/enterprise procedures		
	5.3 Plant, tools and equipment are maintained and sto accordance with site/enterprise procedures		ored in	
	5.4	Work con site/enter	<i>mpletion details</i> are finalized in accorda prise procedures	ance with
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Variable	Range			
Complex valves	May include but not limited to:			
-	• Double seated pressure and flow control valves, boiler safety			
	valves, and valves whose actuators are an integral part of the			
	valve and so must be part of any maintenance to the valve.			
Precision	May include but not limited to:			
measuring	 Inside/outside micrometers, vernier, engineer's rule, dial 			
devices	gauges, depth gauges and feeler gauges.			
Testing	May include but not limited to:			
	 Pressure testing (hydraulic and vacuum), blue check and 			
	non-destructive testing.			
Valve may	May include but not limited to:			
control solutions	 gases solids and fluids and chemicals such as caustic soda, 			
	chlorine, ammonia, sulphuric acid, sodium hypochlorite,			
	hydrazine, diethylamine, citric acid, hydrofluoric acid,			
	ammonium molydate, trisodium phosphate, hydrogen,			
	nitrogen, carbon dioxide, water, fly-ash, siurry, compressed			
	air, brine, oil, steam (superneated and saturated), hydrogen,			
Dotoilo of	propane and carbon dioxide.			
Details Of	May include but not infined to.			
Maintenance	Clarined by diagnosis and workplace inspection May include but not limited to:			
Maintenance	May include but not infined to.			
	 Repair, inspection, mounication, overnau, idontation, sonvicing tost running scaling machining idontifying and 			
	replacing defective components and valve packing			
Valve drives	May include but not limited to:			
	 electrical, mechanical, pneumatic, hydraulic or manual 			
Work completion	May include but not limited to:			
details	 Plant and maintenance records, job cards, check sheets, on 			
	device labeling updates and reporting and/or documenting			
	equipment defects.			
Work site	May be affected by but not limited to:			
environment	• Nearby plant or processes, e.g. chemical, heat, dust, noise,			
	gas and oil, Isolations can refer to electrical/mechanical or			
	other associated processes.			

Evidence Guide	
Critical Aspects of Competence	 Demonstrates skills and knowledge in: Knowledge and application of relevant sections of Occupational Health and Safety legislation, statutory legislation, enterprise/site safety procedures and enterprise/site emergency procedures Preparation and planning of work removal techniques Maintenance techniques and procedures Installation techniques and procedures Completion of work procedures

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knowledge and Attitudes knowledge and Pwarting equipment constrates knowledge of: Valve operating and seating arrangements Attitudes Valve operating and seating arrangements Hydraulic and pneumatic principles Attitudes Hydraulic and pneumatic principles Measuring equipment Glands, seals and gaskets Bearings Occupational Health and Safety standards Ouality assurance/quality control Specialized tools and jigs Eveling and aligning Rigging and lifting equipment Valve materials and components Eveling and aligning Rigging and lifting equipment Valve materials and components Eveling and aligning Pata recording techniques Hand and portable power tools Diagnostic and testing techniques Protective coatings Protective coatings Plant and systems Blow down duration and valve lift Communication principles Underpinning Demonstrates skills to: Skills Level and align Use technical drawings and data Identify and use precision measuring equipment Manufacture and install seals and gaskets Apply dismartling and assembly techniques Skills Level and align Use technical drawings and		Dealing with an unplanned event by drawing on essential				
Underpinning Knowledge and Attitudes Demonstrates knowledge of: Valve operating and seating arrangements Hydraulic and pneumatic principles Measuring equipment Glands, seals and gaskets Bearings Occupational Health and Safety standards Quality assurance/quality control Specialized tools and igs Leveling and aligning Rigging and lifting equipment Valve materials and components Technical drawings and data Data recording techniques Hand and portable power tools Diagnostic and testing techniques Protective coatings Plant and systems Blow down duration and valve lift Communication principles Underpinning Skills Identify and use precision measuring equipment Manufacture and install seals and gaskets Apply dismantling and assembly techniques Select, manufacture and use specialized tools and jigs Level and align Use technical drawings and data Identify and select materials and components Apply diagnostic and testing techniques and rectify faults Apply diagnostic and testing techniques Apply diagnostic and testing techniques and rectify faults Apply diagnostic an		knowledge and skills to provide appropriate solutions				
Knowledge and Attitudes • Valve operating and seating arrangements • Hydraulic and pneumatic principles • Measuring equipment • Glands, seals and gaskets • Bearings • Occupational Health and Safety standards • Quality assurance/quality control • Specialized tools and jigs • Leveling and aligning • Rigging and lifting equipment • Valve materials and components • Technical drawings and data • Data recording techniques • Hand and portable power tools • Diagnostic and testing techniques • Protective coatings • Plant and systems • Blow down duration and valve lift • Communication principles Underpinning Skills Underpinning Skills • Identify and use precision measuring equipment • Manufacture and use specialized tools and jigs • Level and align • Use technical drawings and data • Identify and select materials and components • Manufacture and use specialized tools and jigs • Level and align • Use technical drawings and data • Identify and	Underpinning	Demonstrates knowledge of:				
Attitudes Hydraulic and pneumatic principles Measuring equipment Glands, seals and gaskets Bearings Occupational Health and Safety standards Quality assurance/quality control Specialized tools and jigs Leveling and aligning Rigging and lifting equipment Valve materials and components Technical drawings and data Data recording techniques Hand and portable power tools Diagnostic and testing techniques Protective coatings Plant and systems Blow down duration and valve lift Communication principles Underpinning Demonstrates skills to: Identify and use precision measuring equipment Manufacture and install seals and gaskets Apply diagnostic and testing techniques Select, manufacture and use specialized tools and jigs Level and align Use technical drawings and data Identify and select materials and components Use technical drawings and data Identify and select materials and components Use technical drawings and data Identify and select materials and components Use toxino and portable power tools Apply diagnostic and testing techniques Apply data analysis techniques and	Knowledge and	Valve operating and seating arrangements				
Measuring equipment Glands, seals and gaskets Bearings Occupational Health and Safety standards Quality assurance/quality control Specialized tools and jigs Leveling and aligning Rigging and lifting equipment Valve materials and components Technical drawings and data Data recording techniques Hand and portable power tools Diagnostic and testing techniques Protective coatings Plant and systems Blow down duration and valve lift Communication principles Underpinning Skills Demonstrates skills to: Select, manufacture and use specialized tools and jigs Level and align Use technical drawings and data Data recording techniques Select, manufacture and use specialized tools and jigs Level and align Use technical drawings and data dentify and use precision measuring equipment Manufacture and install seals and gaskets Apply dismantling and assembly techniques Select, manufacture and use specialized tools and jigs Level and align Use technical drawings and data Identify and select materials and components Use hand and portable power tools Apply protective coatings Interpret and apply valve operational techniques Apply diffective maintenance procedures Apply diffective maintenance procedures Apply diffective maintenance procedures Apply deflective materials and equipment, and to information on workplace practices and OHS practices. Methods of Assessment Competence may be assessed through: Access is required to real or appropriately simulated situations, information on workplace practices and OHS practices. Methods of Assessment Maintenance Procedures Selection / Demonstration with Oral Questioning Competence may be assessed in the work place or in a simulated work place setting Maintenance. Mechanic Competition	Attitudes	Hydraulic and pneumatic principles				
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Occupational Standard: Power Generation Installation and Maintenance- Mechanical Level IV				
Unit Title	Maintain Complex Mechanical Pumps			
Unit Code	EIS IMM4 04 0612			
Unit Descriptor	This unit deals with the skills and knowledge required to undertake the installation and maintenance of multi-stage centrifugal pumps, axial flow compressors, fans and blowers.			

Elements	Per	formance Criteria
1. Plan and prepare for the work	1.1	Work requirements are identified from request/work orders or equivalent and clarified/confirmed with appropriate parties or by site inspection
	1.2	Occupational Health and Safety standards, statutory requirements, relevant Ethiopian standards, codes of practice, manufacturer specifications, environmental requirements and enterprise procedures are identified, applied and monitored throughout the work procedure
	1.3	Resources required to satisfy the work plan are identified, obtained and inspected for compliance with the job specifications
	1.4	Relevant plans, drawings and texts are selected and interpreted in accordance with the work plan
	1.5	Correct size, type and quantity of <i>materials</i> /components are determined, obtained and inspected for compliance with the job specifications
	1.6	Work is planned in detail including sequencing and prioritizing and considerations made, where appropriate, for the maintenance of plant security and capacity in accordance with system/site requirements
	1.7	Co-ordination requirements, including requests for isolations where appropriate, are resolved with others involved, affected or required by the work
	1.8	Potential hazards are identified and prevention and/or control measures are selected in accordance with the work plan and site procedures
	1.9	Work area is prepared in accordance with work requirements and site procedures
	1.1	Where appropriate, the teams and individuals roles and responsibilities within the team are identified and, where required, assist in the provision of on-the-job training
2. Remove pumps for	2.1	Required <i>isolations</i> are confirmed, where appropriate, in accordance with site requirements
maintenance	2.2	Pump is disconnected in accordance with the work plan

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	2.3	Pump is removed in a manner which will assist in replacement in accordance with the work plan	
	2.4	Pump is inspected for abnormalities in accordance with the work plan	
3. Maintain pumps	3.1	<i>Maintenance</i> is performed in accordance with manufacturer specifications and site procedures	
	3.2	Pump is dismantled for maintenance in accordance with manufacturer specifications and site procedures	
	3.3	Sketches are made, data noted and components marked for identification and/or re- assembly in accordance with job requirements and site procedures	
	3.4	New components are obtained and inspected for compliance with manufacturer specifications	
	3.5	Dimensional inspection is performed with precision measuring devices to ensure compliance with specifications and results recorded in accordance with job requirements and site procedures	
	3.6	Pump is reassembled applying appropriate principles and techniques in accordance with manufacturer specifications and site requirements	
	3.7	Modifications/alterations are undertaken in accordance with site requirements	
4. Replace/install pumps	4.1	Site is prepared for pump replacement in accordance with the work plan	
	4.2	Pump is replaced in accordance with the work plan and manufacturer specifications	
	4.3	Pump is leveled, aligned, coupled and connected in accordance with the work plan	
	4.4	All fastening are torque in accordance with manufacturer specifications and site requirements	
	4.5	Machinery/plant and pump are test run, monitored and adjusted as required in accordance with manufacturer specifications and site requirements	
5. Complete the work	5.1	Work is completed and appropriate personnel notified in accordance with site/enterprise requirements	
	5.2	<i>Work area</i> is cleared of waste, cleaned, restored and secured in accordance with site/enterprise procedures	
	5.3	<i>Plant, tools</i> and <i>equipment</i> are maintained and stored in accordance with site/enterprise procedures	
	5.4	<i>Work completion details</i> are finalized in accordance with site/enterprise procedures	

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Variable	Range
Materials	May include but not limited to:
	Liquid nitrogen.
Isolations	May include but not limited to:
13010113	 can refer to electrical/mechanical or other associated
	processes
Complex pumps	May include but not limited to:
	Multistage boiler feed pumps and circulation pumps, gas
	turbine compressors, multistage hydrogen compressors.
Pump drives	May include but not limited to:
	 electrical, internal combustion, hydraulic, pneumatic or steam
Details of	May include but not limited to:
maintenance	Be clarified by diagnosis and workplace inspection.
Maintenance	May include but not limited to:
	Repair, inspection, modification, lubrication, servicing, test
	running, identifying and replacing defective components.
Tools	May include but not limited to:
	• Micrometers, verniers, dial test indicators, slip gauges, hand
	tools, hydraulic spanners, customized mandrels, digital
	height gauges, internal micrometers, depth gauges, air
	grinders, jigs and fixtures, customized spanners, thermal
	thermometers, expectively again and appropriate lifting
	devices.
Plant and	May include but not limited to:
equipment	Include jigs for dismantling and oxyacetylene heating
	equipment.
Work site	May include but not limited to:
environment may	• Be affected by nearby plant or processes e.g. chemical,
Morte completion	neat, dust, noise and oli.
details	Niay include but not inflited to:
	 Frank and maintenance records, job cards, check sheets, on device labeling undates and reporting and/or decumenting

Evidence Guide	
Critical Aspects of Competence	 Demonstrates skills and knowledge in: The knowledge and application of relevant sections of: Occupational Health and Safety legislation Statutory legislation Enterprise/site safety procedures Enterprise/site emergency procedures Preparation and planning of work Removal techniques Maintenance techniques and procedures

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	 Installation techniques and procedures
	Completion of work procedures
	 Dealing with an unplanned event by drawing on essential
	knowledge and skills to provide appropriate solutions
Underpinning	Demonstrates knowledge of:
Knowledge and	 Pumps and compressors
Attitudes	 Precision measuring equipment
	Seals and gaskets
	Bearings (anti-friction)
	White metal and tilting pad bearings
	Occupational Health and Safety standards
	Quality assurance/quality control
	 Specialized tools and jigs
	Advanced balancing, leveling and alignment techniques
	Rigging and lifting equipment
	Materials and components of pumps
	Fluid dynamics
	Torque techniques
	Technical drawings and data
	Data recording techniques
	Hand and portable power tools
	 Diagnostic and testing techniques
	Protective coatings
	Heating techniques
	Defined tolerances and fits
	Isolation procedures
	Insulation materials
	Complex/multistage pumps, compressors
	Communication principles
Underpinning	Demonstrates skills to:
Skills	Identify and use precision measuring equipment
	Manufacture and install seals and gaskets
	Apply fluid dynamics principles
	 Install bearings (anti-friction and plain)
	Use specialized tools and jigs
	Apply advanced level and alignment techniques
	 Use technical drawings and data Identify and calent materials and components
	Identify and select materials and components Apply data applying techniques
	 Apply data analysis techniques Identify and apply correct targue techniques
	 Identify and apply correct torque techniques Use hand and portable hand tools
	 Ose fiand and portable fiand tools Apply diagnostic and tosting tochniques
	 Apply diagnostic and resting rechniques Use heat application equipment
	 Apply dismantling and reassembling techniques
	Work to defined tolerances
	Apply Occupational Health and Safety procedures
	 Recognize worn/damaged components
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	Apply effective maintenance procedures			
	 Install white metal and tilting pad bearings 			
	Communicate effectively.			
Resources	Access is required to real or appropriately simulated situations,			
Implication	including work areas, materials and equipment, and to			
	information on workplace practices and OHS practices.			
Methods of	Competence may be assessed through:			
Assessment	 Interview / Written Test 			
	 Observation / Demonstration with Oral Questioning 			
Context of	Competence may be assessed in the work place or in a			
Assessment	simulated work place setting			

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Occupational Standard: Power Generation Installation and Maintenance- Mechanical Level IV		
Unit Title	Install and Maintain Steam Turbine	
Unit Code	EIS IMM4 05 0612	
Unit Descriptor	This unit deals with the skills and knowledge required to install HP, IP, LP, and SFPT, cylinders, rotors and steam units.	

Elements	Performance Criteria			
1. Plan and prepare for the work	1.1 Work re or equiv	equirements are identified from request/w valent and clarified/confirmed with approp or by site inspection	ork orders priate	
	1.2 Occupa requirer practice requirer applied	tional Health and Safety standards, statuments, relevant Ethiopian standards, code e, manufacturer specifications, environments and enterprise procedures are ider and monitored throughout the work proce	tory es of ental ntified, edure	
	1.3 Resource obtaine specific	ces required to satisfy the work plan are i d and inspected for compliance with the j ations	dentified, ob	
	1.4 Relevar interpre	nt plans, drawings and texts are selected ted in accordance with the work plan	and	
	1.5 Correct are dete with the	size, type and quantity of materials/comp ermined, obtained and inspected for com gob specifications	oonents pliance	
	1.6 Work is prioritizi for the r accorda	planned in detail including sequencing a ing and considerations made, where app maintenance of plant security and capacit ance with system/site requirements	nd ropriate, ty in	
	1.7 Co-ordi isolation involved	nation requirements, including requests f ns where appropriate, are resolved with c d, affected or required by the work	or ithers	
	1.8 Potentia control plan an	al hazards are identified and prevention a measures are selected in accordance wit d site procedures	nd/or h the work	
	1.9 Work ar requirer	rea is prepared in accordance with work ments and site procedures		
	1.10 Where a response required	appropriate, the teams and individuals ro sibilities within the team are identified and d, assist in the provision of on-the-job trai	les and I, where ning	
2. Disassemble turbine	2.1 Require accorda	ed <i>isolations</i> are confirmed where appropance with enterprise/site procedures	priate in	
	2.2 Turbine specific	is disassembled in accordance with mar ations and work requirements	ufacturer	
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	2.3	Turbine components are removed in appropriate priority in accordance with manufacturer's specification and work requirements
	2.4	Disassembly is carried out in a manner that will facilitate assembly in accordance with the work plan
	2.5	Components are measured and clearances taken to determine conformity to manufacturer's limits, and to ensure assembly is in accordance with manufacturer specifications
	2.6	Measurements and clearances are recorded in accordance with manufacturer specifications and work requirements.
3. Inspect turbine components	3.1	Components are cleaned and inspected in accordance with the work plan
	3.2	Faults are identified and recorded in accordance with the work plan
	3.3	New components are inspected for compliance to manufacturer specifications and work requirements
	3.4	Components are prepared for assembly in accordance with the work plan
4. Repair turbine/	4.1	Repairs are carried out in accordance with the work plan
components	4.2	Repairs are tested and results analyzed to ensure conformance to specifications and in accordance with the work plan
	4.3	Data from testing is recorded in accordance with the work plan and enterprise/site procedures
5. Reassemble turbine	5.1	Site is prepared for re-assembly of turbine in accordance with the work plan and site procedures
	5.2	Components are refitted in accordance with the work plan and manufacturers specifications
	5.3	Turbine is assembled in accordance with the work plan and manufacturer specifications
	5.4	Turbine is test run and operating characteristics are monitored to ensure compliance with manufacturer specifications and enterprise requirements
6. Complete the work	6.1	Work is completed and appropriate personnel notified in accordance with site/enterprise requirements
	6.2	<i>Work area</i> is cleared of waste, cleaned, restored and secured in accordance with site/enterprise procedures
	6.3	Plant, tools and <i>equipment</i> are maintained and stored in accordance with site/enterprise procedures
	6.4	<i>Work completion details</i> are finalized in accordance with site/enterprise procedures
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Variable	Range		
Isolations	can refer to :		
	electrical/mechanical or other associated processes		
Assembly	May entail :		
	complex/advanced leveling and aligning procedures		
Components	May include but not limited to:		
	White metal bearings, tilting pad bearings, lubrication		
	system components, governor system components, cooling		
	systems components, transmissions and couplings.		
Test equipment	May include but not limited to:		
	 optical fiber scope, gas analyzers, pressure recorders and vibration monitors 		
Work site	May be affected :		
environment	 by nearby plant or processes, e.g. chemical, heat, dust, noise, gas and oil 		
Work completion	May include but not limited to:		
details	 Plant and maintenance records, job cards, check sheets, on device labeling updates and reporting and/or documenting equipment defects. 		

Evidence Guide			
Critical Aspects of Competence	 Demonstrates skills and knowledge in: The knowledge and application of relevant sections of: Occupational Health and Safety legislation Statutory legislation Enterprise/site safety procedures Enterprise/site emergency procedures Preparation and planning of work Disassembly techniques Inspection and fault diagnosis techniques and procedures Repair and maintenance techniques and procedures Re-assembly techniques Completion of work procedures Dealing with an unplanned event by drawing on essential knowledge and skills to provide appropriate solutions 		
Underpinning Knowledge and Attitudes	 Demonstrates knowledge of: Occupational Health and Safety standards Related plant and equipment Hand and portable power tools Precision measuring equipment Rigging and lifting equipment Specialized tools and jigs Advanced leveling and aligning techniques Technical drawings and data Diagnostic and testing techniques Gaskets and seals Bearings (white metal and pad tilting) 		

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