



Australian Government

Department of Education, Employment and Workplace Relations

MSL975016A Perform complex tests to measure engineering properties of materials

Revision Number: 1

MSL975016A Perform complex tests to measure engineering properties of materials

Modification History

Not applicable.

Unit Descriptor

Unit descriptor	<p>This unit of competency covers the ability to prepare test specimens and perform multi-stage mechanical tests on them. The unit requires personnel to create test conditions that suit the materials intended use, optimise measurement procedures and recognise critical measurement points during the tests.</p> <p>The unit also covers data analysis and troubleshooting procedures/equipment that have led to atypical data or results.</p>
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Application of the Unit

Application of the unit	<p>This unit of competency is applicable to laboratory personnel in the construction materials, mining and manufacturing industry sectors.</p> <p>Industry representatives have provided case studies to illustrate the practical application of this unit of competency and to show its relevance in a workplace setting, at the end of this unit of competency under the section 'This competency in practice'.</p>
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Licensing/Regulatory Information

Not applicable.

Pre-Requisites

Prerequisite units		
	<i>MSL974012A</i>	<i>Perform tests to determine the properties of construction materials</i>
		AND
	<i>MSL973010A</i>	<i>Conduct laboratory-based acceptance tests for construction materials</i>
		OR
	<i>MSL973001A</i>	<i>Perform basic tests</i>

Employability Skills Information

Employability skills	This unit contains employability skills.
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Elements and Performance Criteria Pre-Content

Elements describe the essential outcomes of a unit of competency.	Performance criteria describe the performance needed to demonstrate achievement of the element. Where bold italicised text is used, further information is detailed in the required skills and knowledge section and the range statement. Assessment of performance is to be consistent with the evidence guide.
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Elements and Performance Criteria

ELEMENT	PERFORMANCE CRITERIA
1. Interpret and schedule test requirements	1.1. Review test request and sample documentation to identify required test parameters and intended use of bulk material 1.2. Identify hazards and enterprise control measures associated with the sample, preparation/testing methods and equipment 1.3. Inspect samples, compare with specifications, record and report discrepancies 1.4. Liaise with client when samples and/or request forms do not comply with enterprise procedures 1.5. Match required parameters with suitable test methods, available equipment and instrument specifications 1.6. Plan parallel work sequences to optimise throughput of multiple sets of samples, as required
2. Prepare and measure test specimens	2.1. Prepare test specimens in accordance with test method 2.2. Conduct preliminary measurements to establish initial dimensions and conditions 2.3. Store test specimens and residual sample materials to maintain their integrity
3. Check equipment before use	3.1. Set up equipment/instruments in accordance with test method 3.2. Perform pre-use and safety checks in accordance with enterprise procedures and manufacturers specifications 3.3. Identify faulty or unsafe components and equipment and report to appropriate personnel 3.4. Check calibration status of equipment and quarantine out of calibration or faulty items
4. Test samples	4.1. Position and secure test specimen in test equipment/instrument 4.2. Conduct preliminary measurements to determine optimum test conditions and instrument settings 4.3. Perform each measurement stage in sequence, terminating each stage at the appropriate end point 4.4. Record all test measurements, observations and factors that may impact on quality of results 4.5. Remove test piece and conduct post-test measurements 4.6. Shut down equipment and store used test pieces in accordance with enterprise procedures

ELEMENT	PERFORMANCE CRITERIA
5. Process and analyse data	5.1. Confirm data is the result of valid measurements 5.2. Perform required calculations and ensure results are consistent with estimations and expectations 5.3. Record results with the appropriate accuracy, precision and units 5.4. Estimate and document uncertainty of measurement in accordance with enterprise procedures, if required 5.5. Analyse trends in data and/or results and report out of specification or atypical results promptly to appropriate personnel 5.6. Troubleshoot procedure or equipment problems which have led to atypical data or results
6. Maintain a safe work environment	6.1. Use established safe work practices to ensure personal safety and that of other laboratory personnel 6.2. Minimise the generation of wastes and environmental impact 6.3. Ensure the safe disposal of laboratory wastes 6.4. Clean, care for and store equipment and consumables in accordance with enterprise procedures
7. Maintain laboratory records	7.1. Enter approved data and results into laboratory information management system 7.2. Maintain security and confidentiality of enterprise information and laboratory data 7.3. Maintain equipment and calibration logs in accordance with enterprise procedures

Required Skills and Knowledge

REQUIRED SKILLS AND KNOWLEDGE

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

Required skills

Required skills include:

- interpreting client requests, complex tests and sample preparation methods accurately
- applying enterprise procedures
- planning work sequences involving multiple/parallel tasks
- interpreting safety information, such as material safety data sheets (MSDS) and working safely
- checking and using test equipment in accordance with enterprise procedures
- maintaining concentration and applying multi-stage test methods accurately
- estimating/calculating scientific quantities (e.g. total and effective stress, strain and pressure)
- using calibration charts
- interpreting significant features of data and graphs and making logical conclusions
- identifying atypical data, errors and unexpected results and tracing any obvious causes
- recording and presenting results accurately and legibly
- maintaining security, integrity and traceability of all samples/test pieces, data/results and technical records
- cleaning and maintaining equipment
- seeking advice from a supervisor
- communicating with clients or outside service technician
- demonstrating a professional approach and positive company/organisation image

Required knowledge

Required knowledge includes:

- complex test methods routinely used in job role, including:
 - purpose and principles of test
 - relationship between the engineering properties and uses of construction materials
 - key sample preparation stages
 - key treatment/measurement stages
 - calculation steps to give results in appropriate units and precision
 - expected values for sample type
 - sources of uncertainty and methods for their control
- principles and concepts underpinning the test method, such as:

REQUIRED SKILLS AND KNOWLEDGE

- stress, strain, pressure, total and effective stress, fatigue, creep, failure modes of materials, strength/consolidation of materials and permeability
- electrical safety concepts including voltage, current, resistance, conductors/insulators and AC/DC
- principles and concepts related to equipment/instrument operation including the function of key components and effects on test of modifying variables
- pre-use checks and operating procedures for test equipment/instruments routinely used in job role
- basic equipment/method troubleshooting procedures
- enterprise and/or legal traceability requirements for samples, test pieces, test data and results
- procedures for recording and reporting test results, calculations, test observations and unexpected or atypical results and equipment problems
- health, safety and environmental management requirements relevant to job role
- confidentiality requirements relevant to job role

Evidence Guide

EVIDENCE GUIDE	
<p>The Evidence Guide provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge, range statement and the Assessment Guidelines for the Training Package.</p>	
Overview of assessment	
Critical aspects for assessment and evidence required to demonstrate competency in this unit	<p>Assessors should ensure that candidates can:</p> <ul style="list-style-type: none"> • select test methods, operating parameters and test ranges to suit the material and its intended use • prepare and orient test pieces precisely • safely set up, start up and shut down equipment • maintain close attention to measurement procedures, accuracy and precision during lengthy complex tests • calculate/determine required engineering properties with appropriate accuracy, precision and units • recognise atypical data/results and trace artefacts and problems with procedures or equipment • record and report data/results in accordance with enterprise procedures • maintain security, integrity and traceability of all samples, test pieces and documentation.
Context of and specific resources for assessment	<p>This unit of competency is to be assessed in the workplace or simulated workplace environment. This unit of competency may be assessed with:</p> <ul style="list-style-type: none"> • <i>MSL925001A Analyse data and report results.</i> <p>Resources may include:</p> <ul style="list-style-type: none"> • engineering materials testing laboratory with appropriate test equipment, instruments and samples • SOPs and test methods.
Method of assessment	<p>The following assessment methods are suggested:</p> <ul style="list-style-type: none"> • review of results obtained by the candidate over a period of time to ensure accurate and consistent results are obtained within required timelines • inspection of testing records and workplace documentation completed by the candidate • observation of candidate conducting a range of complex tests on engineering materials • feedback from clients, peers and supervisors • oral or written questioning.

EVIDENCE GUIDE	
	<p>In all cases, practical assessment should be supported by questions to assess underpinning knowledge and those aspects of competency which are difficult to assess directly.</p> <p>Where applicable, reasonable adjustment must be made to work environments and training situations to accommodate ethnicity, age, gender, demographics and disability.</p> <p>Access must be provided to appropriate learning and/or assessment support when required.</p> <p>The language, literacy and numeracy demands of assessment should not be greater than those required to undertake the unit of competency in a work like environment.</p>
This competency in practice	<p>Industry representatives have provided the case study below to illustrate the practical application of this unit of competency and to show its relevance in a workplace setting.</p> <p>Construction materials</p> <p>A consulting company is investigating a possible dam site and needs to assess a particular soil in the foundation. They request a geotechnical testing authority to determine the permeability of the soil. A senior technician checks the client request and inspects the soil sample, noting that it is plastic, clay and fissured. He/she checks the dam design parameters and notes that the overburden pressure will be 500 kPa.</p> <p>The senior technician uses a triaxial permeability test using a constant head configuration. He/she trims a cylindrical test piece, determines the sample's bulk density and uses the trimmings to determine its moisture content. The test piece is mounted in a triaxial test cell and the equipment carefully de-aired. All pressure gauges, regulators and transducers are checked and the equipment is leak tested. A confining stress is applied and after allowing the sample to come to equilibrium, it is back saturated. The cell pressure is increased to 500 kPa and as the sample consolidates, the technician monitors the sample volume change and pore water pressure. A differential pressure is applied in stages and the water flow through the sample is optimised. After reaching a steady state the flow rate is monitored to determine the sample permeability.</p> <p>After taking sufficient readings to ensure a valid measurement, the senior technician prepares plots of</p>

EVIDENCE GUIDE	
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	permeability and time and reports the steady state values. After completing the test, he/she shuts down the equipment in the recommended sequence, cleans and restores all items. He/she then removes the test piece and determines the after-test moisture content.
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Range Statement

RANGE STATEMENT

The range statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold italicised wording, if used in the performance criteria, is detailed below. Essential operating conditions that may be present with training and assessment (depending on the work situation, needs of the candidate, accessibility of the item, and local industry and regional contexts) may also be included.

Codes of practice

Where reference is made to industry codes of practice, and/or Australian/international standards, it is expected the latest version will be used

Standards, codes, procedures and/or enterprise requirements

Standards, codes, procedures and/or enterprise requirements may include:

- Australian and international standards, such as:
 - AS ISO/IEC 17025 General requirements for the competence of testing and calibration laboratories
 - AS 1289 Methods of testing soils for engineering
 - AS 1012 Methods of testing concrete
 - AS 2981 Methods of sampling and testing asphalt
 - DIN 19683 series - Soil testing in agricultural hydrology - Physical laboratory tests
 - ISO/IEC Guide 98-3:2008 Uncertainty of measurement - Part 3 Guide to the expression of uncertainty in measurement (GUM)
- National Association of Testing Authorities (NATA) supplementary requirements for the relevant field of testing
- NATA technical notes and guides
- MSDS
- standard operating procedures (SOPs)
- quality manuals, equipment and procedures manuals
- equipment startup, operation and shutdown procedures
- calibration and maintenance schedules
- enterprise recording and reporting procedures

RANGE STATEMENT	
	<ul style="list-style-type: none">• production and laboratory schedules• material, production and product specifications

RANGE STATEMENT	
Preparation of samples	<p>Preparation of samples may include:</p> <ul style="list-style-type: none"> • moisture conditioning and compaction of soil • trimming to required size and shape • orientation of test pieces • polishing • curing concrete test pieces
Test methods and procedures	<p>Test methods and procedures may include:</p> <ul style="list-style-type: none"> • consolidation of soil (e.g. one-dimensional and triaxial) • shear testing of soil and rock (e.g. total stress, effective stress, direct stress and triaxial stress) • permeability of soil, rock and concrete (e.g. falling head and constant head) • California Bearing Ratio (CBR) (4 point) • fatigue and creep of metals, polymers and concrete • wheel tracking in asphalt • stiffness and creep of asphalt
Hazards	<p>Hazards may include:</p> <ul style="list-style-type: none"> • microbiological organisms and agents associated with soil • chemicals, such as acids and solvents • sharps and hand tools • flammable liquids and gases • cryogenics, such as dry ice and liquid nitrogen • fluids under pressure such as steam and industrial gases and hydraulics • disturbance or interruption of services • crushing, entanglement and cuts associated with moving machinery or falling objects
Hazard control measures	<p>Hazard control measures may include:</p> <ul style="list-style-type: none"> • ensuring access to service shut-off points • recognising and observing hazard warnings and safety signs • labelling of samples, hazardous materials and equipment • machinery guards • handling and storage for hazardous materials and equipment in accordance with labelling,

RANGE STATEMENT	
	<p>MSDS and manufacturer's instructions</p> <ul style="list-style-type: none"> • identifying and reporting operating problems or equipment malfunctions • cleaning equipment and work areas regularly using enterprise procedures • using personal protective clothing and equipment, such as hard hats, hearing protection, gloves, safety glasses, coveralls and safety boots • following established manual handling procedures • reporting abnormal emissions, discharges and airborne contaminants such as noise, light, solids, liquids, water/waste water, gases, smoke, vapour, fumes, odour and particulates to appropriate personnel
Occupational health and safety (OHS) and environmental management requirements	<p>OHS and environmental management requirements:</p> <ul style="list-style-type: none"> • all operations must comply with enterprise OHS and environmental management requirements, which may be imposed through state/territory or federal legislation - these requirements must not be compromised at any time • all operations assume the potentially hazardous nature of samples and require standard precautions to be applied • where relevant, users should access and apply current industry understanding of infection control issued by the National Health and Medical Research Council (NHMRC) and State and Territory Departments of Health

Unit Sector(s)

Unit sector	Testing
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Competency field

Competency field	
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Co-requisite units

Co-requisite units		