**ICTOPN4115A Install and test a dense wavelength division multiplexing system**

### Unit descriptor
This unit describes the performance outcomes, skills and knowledge required to install dense wavelength division multiplexing (DWDM) equipment in optical networks.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of endorsement but users should confirm requirements with the relevant federal, state or territory authority.

### Employability skills
This unit contains employability skills.

### Prerequisite units

### Co-requisite units

### Application of the unit
Telecommunications technical staff who install long haul or metropolitan area DWDM equipment apply the skills and knowledge in this unit. They install the DWDM unit and circuit cards and inspect, clean, and install optical fibres, connectors and associated equipment and prepare the system for subsequent testing and commissioning.

### Competency field
Optical networks

### Unit sector
Telecommunications

### ELEMENT
Elements describe the essential outcomes of a unit of competency.

### PERFORMANCE CRITERIA
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.

<table>
<thead>
<tr>
<th>ELEMENT</th>
<th>PERFORMANCE CRITERIA</th>
</tr>
</thead>
</table>
| 1. Prepare to install DWDM units | 1.1. Determine the number of racks and DWDM units at each site by referring to installation documents  
1.2. Determine the DWDM unit and equipment positions within the individual racks  
1.3. Assemble equipment racks according to safe industry practice and manufacturer’s instructions  
1.4. Select tools and equipment  
1.5. Prepare patch panels with connectors according to installation plan |
| 2. Install DWDM units and associated cabling | 2.1. Install DWDM unit in the designated rack position in order to maintain the planned link budget margin  
2.2. Install patch panels and ancillary equipment and connections into equipment rack in preparation for commissioning procedures  
2.3. Insert circuit cards into specified slot locations in readiness for commissioning procedures, but do not seat cards into backplane nor lock into position at this stage  
2.4. Connect optical fibre cables between circuit cards, optical multiplexers, adjoining DWDM units and patch panels according to manufacturer’s specifications |
| 3. Test power connections and complete the | 3.1. Measure the main and redundant power supplies to verify the correct polarity of the ground and power connections  
3.2. Rectify any identified power wiring fault if applicable |
**ELEMENT** | **PERFORMANCE CRITERIA**
--- | ---
installation report | 3.3. Confirm that cooling fans, panel lights, indicator lights and alarms behave according to the manufacturer’s prescribed specifications when power is applied
 | 3.4. Complete the installation report and reinstate site

**REQUIRED SKILLS AND KNOWLEDGE**
This section describes the skills and knowledge required for this unit.

**Required skills**
- communication skills to liaise with internal and external personnel on technical and operational matters
- literacy skills to interpret technical documentation
- technical skills to:
  - assemble and secure standard telecommunications equipment rack, associated ironwork and optical fibre support ducting
  - clean optical fibre connector
  - examine optical fibre connector for contamination and assess whether cleaning is required
  - prepare and connect power and ground wires
  - use a digital multimeter to measure DC and AC voltage and to check continuity

**Required knowledge**
- DWDM principles of operation
- electrostatic discharge
- optical fibre connector types and characteristics
- optical fibre types and characteristics
- specific OHS requirements that impact on the safe inspection of optical connectors and the safe measurement of optical power from laser transmission systems

**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.

**Site** may include:
- optical add drop multiplexer (OADM) site
- terminal site.

**Equipment racks** may include:
- 19 inch type
- 23 inch type
- 535 mm (ETSI rack) type.

**Tools** may include:
- hand tools:
  - crimping tool
  - screwdrivers
  - wire cutters
  - wire stripping tool
- optical fibre connector cleaning cassette
- microscope or video fibre connector inspection instrument.

**Patch panels** may include:
- rack mounted
- wall mounted.

**Ancillary equipment and connections** may include:
- air filter
- alarm connections
- C/L band splitter tray
- cooling fan assembly
<table>
<thead>
<tr>
<th>RANGE STATEMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>• coupler tray</td>
</tr>
<tr>
<td>• craft terminal</td>
</tr>
<tr>
<td>• data communications connections</td>
</tr>
<tr>
<td>• equaliser tray</td>
</tr>
<tr>
<td>• Ethernet hub</td>
</tr>
<tr>
<td>• fibre management trays</td>
</tr>
<tr>
<td>• optical attenuators</td>
</tr>
<tr>
<td>• optical fibre patch cords</td>
</tr>
<tr>
<td>• optical multiplexer</td>
</tr>
<tr>
<td>• optical service channel tray</td>
</tr>
<tr>
<td>• telemetry connections</td>
</tr>
<tr>
<td>• variable optical attenuators</td>
</tr>
</tbody>
</table>

*Power wiring fault* may include:

<table>
<thead>
<tr>
<th>Power wiring fault may include:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• battery and ground wires are reversed to the DWDM unit</td>
</tr>
<tr>
<td>• battery wire is open or missing</td>
</tr>
<tr>
<td>• return wire is open or missing</td>
</tr>
</tbody>
</table>
## EVIDENCE GUIDE

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.

### Overview of assessment

<table>
<thead>
<tr>
<th>Critical aspects for assessment and evidence required to demonstrate competency in this unit</th>
<th>Evidence of the ability to:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• conduct installation of DWDM systems and associated cabling according to plans and specifications</td>
<td></td>
</tr>
<tr>
<td>• test power and ground connections</td>
<td></td>
</tr>
<tr>
<td>• complete installation reports.</td>
<td></td>
</tr>
</tbody>
</table>

### Context of and specific resources for assessment

Assessment must ensure:

| • suitable site for DWDM equipment installation |
| • access to tools and equipment required for installation |
| • a range of optical fibres to suit the installation. |

### Method of assessment

A range of assessment methods should be used to assess practical skills and knowledge. The following examples are appropriate for this unit:

| • direct observation of the candidate installing a DWDM unit from a DWDM system together with installation of optical fibre interconnecting cables |
| • review of DWDM installation report prepared by the candidate |
| • oral or written questioning of the candidate to assess knowledge of DWDM installation practices. |

### Guidance information for assessment

Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended, for example:

| • ICTTEN3056A Install telecommunications network equipment |
| • ICTBWN3088A Install optical fibre splitters in fibre distribution hubs. |

Aboriginal people and other people from a non-English speaking background may have second language issues.

Access must be provided to appropriate learning and assessment support when required.

Assessment processes and techniques must be culturally appropriate, and appropriate to the oral communication skill level, and language and literacy capacity of the candidate and the work being performed.

In all cases where practical assessment is used it will be combined with targeted questioning to assess required knowledge. Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.

Where applicable, physical resources should include equipment modified for people with special needs.
**ICTOPN4116A Use advanced optical test equipment**

**Unit descriptor**
This unit describes the performance outcomes, skills and knowledge required to test optical communication systems and components using advanced optical test equipment. It involves using the optical time domain reflectometer (OTDR), optical spectrum analyser (OSA) and optical return loss (ORL) test set for performance testing and link budget calculation.

Licensing, legislative, regulatory and certification requirements apply to working at heights. If an elevated work platform (EWP) is required, verify state or territory law requirements for a licence to operate an EWP. Users should confirm requirements with the relevant federal, state or territory authority.

If working at heights, achievement of the unit ‘CPCPCM2015A Work safely on roofs’ from the CPC08 Construction and Plumbing Services Integrated framework training Package fulfils this requirement.

**Employability skills**
This unit contains employability skills.

**Prerequisite units**

**Co-requisite units**

**Application of the unit**
Installation contractors, technical staff and field officers from telecommunications carriers or other private and public organisations, or regulatory authorities apply the skills and knowledge in this unit.

They combine technical skills with organisational and administrative skills to perform specialised testing of complex optical faults, optical network monitoring and link budget calculations on broadband passive optical network (PON), fibre to the x (FTTx) networks, hybrid fibre coaxial (HFC) networks and dense wavelength division multiplexing (DWDM) systems during installation, maintenance, commissioning and troubleshooting phases.

**Competency field**
Optical networks

**Unit sector**
Telecommunications

<table>
<thead>
<tr>
<th><strong>ELEMENT</strong></th>
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<td>Elements describe the essential outcomes of a unit of competency.</td>
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</tr>
</tbody>
</table>
| 1. Prepare to use advanced optical measuring instruments | 1.1. Obtain relevant legislation, codes, regulations and standards for compliance when conducting work  
1.2. Notify customer for site access, security arrangements and location details of optical system and test purpose  
1.3. Identify site hazards and notify appropriate personnel to make site safe  
1.4. Devise and implement risk control measures of hazards with handling of optical fibres and lasers in consultation |
## ELEMENT | PERFORMANCE CRITERIA
--- | ---
with appropriate personnel
1.5. Prepare a **testing plan** indicating the **type of measurement**, procedures and nominated **wavelength** and seek approval from customer
1.6. Select the appropriate **tools** and **test instruments** according to the required measurement and enterprise practice

2. Evaluate optical performance and link budget using advanced optical test equipment
2.1. Set up test instrument according to manufacturer’s instructions and occupational health and safety (OHS) and **environmental requirements**
2.2. Perform measurement using knowledge of appropriate testing techniques and advanced test equipment in a safe manner to evaluate the performance of optical system and component
2.3. Record test results and compare with standard test specifications from manufacturer’s and enterprise guidelines
2.4. Perform end-to-end measurements on an optical link to a customer and record test results and test points
2.5. Calculate the optical losses for a link budget figure of an optical link to determine if within operational margins as specified in manufacturer’s manual
2.6. Evaluate the test results and report on the functionality of the optical component or equipment and the performance of the optical link

3. Document measurement results
3.1. Document test results for future reference and make recommendations on optimising component and system performance
3.2. Clean worksite and make safe according to the enterprise requirements and to customer satisfaction
3.3. Notify appropriate personnel of job completion for sign off and present test documentations

### REQUIRED SKILLS AND KNOWLEDGE
This section describes the skills and knowledge required for this unit.

**Required skills**
- communication skills to liaise with customers and enterprise staff
- literacy skills to read and interpret work instructions and document work
- numeracy skills to gather and record data from measurements
- planning and organisational skills to plan prioritise and manage own work
- safety awareness skills to:
  - apply precautions and required action to minimise, control or eliminate hazards that may exist during work activities
  - select and use required personal protective equipment conforming to industry and OHS standards
  - work systematically with required attention to detail without injury to self or others, or damage to goods or equipment
- technical skills to:
  - clean an optical connector to an acceptable industry standard
  - safely inspect an optical connector for contamination and determine if cleaning is necessary
  - safely operate:
REQUIRED SKILLS AND KNOWLEDGE

- optical loss test set (OLTS)
- optical time domain reflectometer (OTDR)
- PON power meter

Required knowledge

- consequences of mating contaminated optical connectors
- decibels, dBm
- downstream and upstream signals
- DWDM metro and long haul system architecture
- measurement of DWDM signals
- measurement of gain and gain flatness of optical amplifier
- measurement of laser spectral stability, drift and unexpected variation in spectral transmission characteristics
- non-linear effects, four-wave mixing
- optical connector types
- optical signal to noise ratio (OSNR)
- optical spectrum limits, wavelengths used in various applications and International Telecommunications Union (ITU) grid
- optical transmitters and receivers
- ORL
- OTDR dead zones, dynamic range and launch cable
- reflectance
- safe handling procedures with optical fibres
- transmission system line rates:
  - optical Ethernet
  - optical transport network (OTN)
  - synchronous digital hierarchy (SDH)
- wavelength division multiplexing (WDM), coarse wavelength division multiplexing (CWDM) and DWDM principles and optical multiplexers

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.

Relevant legislation, codes, regulations and standards may include:

- appropriate licences:
  - crane
  - EWP
  - forklift
  - winch
- Australian Construction Industry Forum (ACIF) standards and codes
- AS Communications Cabling Manual (CCM) Volume 1
- AS/NZS 3000:2007
- AS/NZS 3080:2003
- AS/NZS 3084:2003
- AS/NZS 3085.1:2004
- AS/NZS IEC 61935.1:2006
- AS/NZS IEC 61935.2:2006
- AS/NZS ISO/IEC 15018:2005
### RANGE STATEMENT

- cabling security codes and regulations
- Environmental Protection Acts
- OHS

**Customer** may be:
- asset manager
- installation manager
- maintenance manager
- nominated customer representative
- outage manager
- project manager.

**Optical system** may contain:
- add-drop multiplexer
- Bragg filters
- DWDM system
- fibre hub
- HFC network
- optical amplifier
- optical line termination (OLT)
- optical links
- optical network termination (ONT)
- optical splitter.

**Hazards** may include:
- building debris
- earth potential rise
- glass fibre
- live power lines
- manual handling
- mud and water
- natural gas and other gas build up
- optical fibre cable may contain hazardous light
- radio frequency (RF) equipment emitting radiation
- remote power feeding services which operate at above telecommunications network voltage (TNV)
- vermin.

**Testing plan** may include:
- correct test set up
- recording and evaluation of measurements
- test layout
- test procedures
- test purpose
- test sites and location
- type of measurements
- use of appropriate test equipment.

**Type of measurement** may include:
- dedicated ORL test set:
  - optical power meter ORL
  - ORL versus wavelength.
  - OSA and ORL
  - PON splitter ORL
- OSA:
  - bandwidth of a device (multiplexer)
  - central wavelength and channel spacing
  - device flatness
**RANGE STATEMENT**

- DWDM channel uniformity
- insertion loss:
  - coupler
  - filter
  - optical splitter
  - WDM
- non-linear effects (four-wave mixing)
- optical power level:
  - at drop terminal
  - at optical transmitter
  - at patch panel
  - at the OLT
  - at the ONT
- optical signal to noise ratio (OSNR)
- ripple
- spectral purity of a source
- spectral stability and drift of a source

- **OTDR:**
  - break and fault location
  - certification of new cabling
  - characterisation of events in path
  - detailed event table
  - fibre attenuation
  - fibre attenuation rate
  - fibre attenuation uniformity
  - identification of ‘gainers’
  - identification of ‘ghost’ events
  - insertion loss of connectors and splices
  - macro-bend detection
  - ORL
  - segment length.

**Wavelength** may include:

- 850 nm
- 1310 nm
- 1490 nm
- 1550 nm.

**Tools** may include:

- alcohol swabs
- dry type cleaning cassette for optical connectors
- hand tools
- launch cable for OTDR
- lint-free dry wipes
- microscope for examining optical connector with:
  - integral safety infra-red filter
  - video microscope display
- optical connector adaptors
  - FC to LC
  - FC to SC
  - FC to ST
  - SC to ST
- optical fibre mandrel (single mode fibre low reflection termination)
- optical termination
- optical reference cable.
### RANGE STATEMENT

**Test instruments** may include:
- ORL test set
- OSA
- OTDR multimode
- OTDR single mode
- PON optimised OTDR.

**OHS and environmental requirements** may include:
- decommissioning and isolating worksite and lines prior to commencement
- identifying other services, including power and gas
- personal protective equipment:
  - earmuffs
  - gloves
  - head protection
  - masks
  - protective suits
  - safety boots
  - safety glasses
- safe working practices, such as the safe use and handling of:
  - chemicals
  - materials
  - tools and equipment
  - work platforms
- special access requirements
- environmental considerations:
  - clean-up protection
  - stormwater protection
  - waste management.
### EVIDENCE GUIDE

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<thead>
<tr>
<th>Overview of assessment</th>
<th>Evidence of the ability to:</th>
</tr>
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<tbody>
<tr>
<td>Critical aspects for assessment and evidence required to demonstrate competency in this unit</td>
<td>use OTDR, OSA and ORL advanced optical test equipment to:</td>
</tr>
<tr>
<td></td>
<td>◦ measure optical power level</td>
</tr>
<tr>
<td></td>
<td>◦ measure insertion loss of optical network</td>
</tr>
<tr>
<td></td>
<td>◦ measure end-to-end fibre loss (bi-directional)</td>
</tr>
<tr>
<td></td>
<td>◦ test and calculate optical link budget</td>
</tr>
<tr>
<td></td>
<td>◦ comply with all related OHS requirements and work practices.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Context of and specific resources for assessment</th>
<th>Assessment must ensure:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>sites on which optical measurements can be conducted</td>
</tr>
<tr>
<td></td>
<td>tools and equipment required for measurements</td>
</tr>
<tr>
<td></td>
<td>manufacturer’s documentation for test instruments and equipment under test.</td>
</tr>
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</table>

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<td>direct observation of the candidate performing optical measurements</td>
</tr>
<tr>
<td></td>
<td>review of a written report for the OTDR, the OSA and the ORL test set</td>
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<td></td>
<td>oral or written questioning to assess required knowledge.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Guidance information for assessment</th>
<th>Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended, for example:</th>
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<tbody>
<tr>
<td></td>
<td>ICTOPN5118A Plan and configure dense wavelength division multiplexing systems</td>
</tr>
<tr>
<td></td>
<td>ICTOPN5119A Perform acceptance and commissioning tests on optical network</td>
</tr>
<tr>
<td></td>
<td>ICTOPN5120A Plan for an optical system upgrade and cut over</td>
</tr>
<tr>
<td></td>
<td>ICTOPN5121A Test and commission a dense wavelength division multiplexing transmission system</td>
</tr>
<tr>
<td></td>
<td>ICTOPN5122A Test the performance of specialised optical devices</td>
</tr>
<tr>
<td></td>
<td>ICTOPN5123A Analyse and integrate specialised optical devices in the network.</td>
</tr>
</tbody>
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Aboriginal people and other people from a non-English speaking background may have second language issues.

Access must be provided to appropriate learning and assessment support when required.

Assessment processes and techniques must be culturally appropriate, and appropriate to the oral
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<td>Where applicable, physical resources should include equipment modified for people with special needs.</td>
</tr>
</tbody>
</table>
ICTOPN4117A Prepare activity plans and specifications for a fibre to the x installation

<table>
<thead>
<tr>
<th>Unit descriptor</th>
<th>This unit describes the performance outcomes, skills and knowledge required to prepare the activity plans and specifications required by field technical staff to deploy a fibre to the x (FTTx) installation for optical access networks.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planning</td>
<td>Planning involves provisioning underground and aerial cable work, construction of fibre enclosures and providing specification details for installation and construction teams.</td>
</tr>
<tr>
<td>Optical networks</td>
<td>Optical networks and FTTx are part of strategies by service providers using wave division multiplexing (WDM) to deliver very high speed broadband capacity through the Access Network for the National Broadband Network (NBN) initiative.</td>
</tr>
<tr>
<td>Licensing</td>
<td>No licensing, legislative, regulatory or certification requirements apply to this unit at the time of endorsement but users should confirm requirements with the relevant federal, state or territory authority.</td>
</tr>
</tbody>
</table>

Employability skills: This unit contains employability skills.

Prerequisite units:

Co-requisite units:

Application of the unit: Technical cable supervisors apply the skills and knowledge in this unit when planning the installation activities for the deployment of broadband Access Networks using optical technologies.

FTTx services can be underground or aerial and may include hybrid fibre coaxial (HFC) installations. Optical access networks with FTTx installations provide services in Next Generation Networks (NGN) using emerging technologies.

NGN services include internet protocol TV (IPTV), video on demand (VoD), interactive TV, mesh networks and cloud computing.

Competency field: Optical networks

Unit sector: Telecommunications

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</tr>
<tr>
<td>1. Prepare for FTTx planning tasks</td>
<td>1.1. Obtain relevant legislation, codes, regulations and standards for compliance when conducting work</td>
</tr>
<tr>
<td></td>
<td>1.2. Scope the work by obtaining project plan from appropriate personnel and arrange for site access to comply with security arrangements</td>
</tr>
<tr>
<td></td>
<td>1.3. Notify appropriate personnel of identified safety hazards at the work site</td>
</tr>
<tr>
<td>ELEMENT</td>
<td>PERFORMANCE CRITERIA</td>
</tr>
<tr>
<td>---------</td>
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</tr>
<tr>
<td>1.4.</td>
<td>Obtain <strong>tools and safety equipment</strong> and material to perform tasks safely and efficiently</td>
</tr>
<tr>
<td>1.5.</td>
<td>Select and use required protective equipment and make site safe and secure for installation work</td>
</tr>
<tr>
<td>1.6.</td>
<td>Identify and select <strong>plant and machinery</strong> for installation work activities</td>
</tr>
<tr>
<td>2.1.</td>
<td>Follow occupational health and safety (OHS) and environmental requirements for the given work and identify and avoid <strong>other services</strong></td>
</tr>
<tr>
<td>2.2.</td>
<td>Inspect proposed cable route visually according to cable plan and identify barriers to the cable installation</td>
</tr>
<tr>
<td>2.3.</td>
<td>Modify cable plan, if required, and notify appropriate personnel</td>
</tr>
<tr>
<td>2.4.</td>
<td>Prepare <strong>installation activities</strong> for FTTx provisioning according to project plan</td>
</tr>
<tr>
<td>2.5.</td>
<td>Prepare installation specifications according to safe work practices and manufacturer’s instructions to include <strong>optical fibre cable size</strong>, <strong>distribution area (DA)</strong>, <strong>distribution joint including lead-in multiport serving area (DLMSA)</strong>, <strong>enclosures</strong>, location of <strong>optical network terminations (ONT)</strong>, <strong>location and type of fibre distribution hub (FDH)</strong> and <strong>optical splitter</strong> provisioning</td>
</tr>
<tr>
<td>2.6.</td>
<td>Verify cable length from customer access network fibre centre to end user ONT is within 20 km operating limit</td>
</tr>
<tr>
<td>2.7.</td>
<td>Consult with appropriate personnel to confirm project scope, installation requirements and installation specifications according to project plan</td>
</tr>
<tr>
<td>3.1.</td>
<td>Complete and present updated planning activities documentation to authorised personnel</td>
</tr>
<tr>
<td>3.2.</td>
<td>Complete and provide updated specification documentation to vendors for supply of material and resources</td>
</tr>
<tr>
<td>3.3.</td>
<td>Submit documentation to appropriate person for approval and sign off</td>
</tr>
</tbody>
</table>

**REQUIRED SKILLS AND KNOWLEDGE**
This section describes the skills and knowledge required for this unit.

**Required skills**

- communication skills to:
  - interact with senior project staff and equipment vendors
  - work effectively within group
- literacy skills to:
  - prepare reports given a specific format
  - read and interpret technical and non-technical documentation
- numeracy skills to analyse and confirm installation requirements
- PC skills to carry out word processing and desktop research
- planning and organisational skills to:
  - make site access and equipment delivery arrangements
  - plan work activities according to project requirements and priorities
- problem solving skills to account for unexpected variations to requirements
- task management skills to work logically and systematically with required attention to detail
- technical skills to:
## REQUIRED SKILLS AND KNOWLEDGE

- prepare FTTx specifications
- prepare line drawings relevant to organisation
- record design specifications in centralised system relevant to organisation

### Required knowledge

- properties of passive optical devices including splitters and couplers
- FTTx installation equipment including tools and safety equipment
- FTTx specifications
- legislative privacy, safety and environmental requirements:
  - specific OHS requirements relating to handling of optical fibre and using laser optical sources
  - other personal safety issues
  - plant and equipment safety to be used in installation plans
  - options for green ICT installations
- manufacturer’s requirements for safe operation of equipment
- operation of optical transmitters and receivers
- organisational policy and procedures
- propagation of light in optical communication systems
- role of optical transmitters and receivers in optical communication systems
- concept of wavelength division multiplexing (WDM)
- site engineering
- typical issues and challenges that occur in preparing activity plans and on site
- workplace and industry environment

## 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.

### Relevant legislation, codes, regulations and standards may include:

- Australian Communications Industry Forum (ACIF) standards and codes
- AS Communications Cabling Manual (CCM) Volume 1
- AS/NZS 3000:2007
- AS/NZS 3080:2003
- AS/NZS 3084:2003
- AS/NZS 3085.1:2004
- AS/NZS IEC 61935.1:2006
- AS/NZS IEC 61935.2:2006
- AS/NZS ISO/IEC 15018:2005
- cabling security codes and regulations
- Environmental Protection Acts
- OHS
- road and traffic control legislation and codes

### Scope the work may include:

- cable:
  - route
  - types
  - supports
### RANGE STATEMENT

- distribution areas (DA)
- enclosures
- equipment required:
  - fibre hubs
  - optical splitters
- project type:
  - large residential
  - medium residential
  - standard residential or small business.

### Appropriate personnel may be:

- consultant
- project engineer
- project supervisor
- site supervisor.

### Safety hazards may refer to:

- access points that may contain:
  - hazardous light (non-visible laser)
  - radio frequency (RF) emission
- active lasers with no safety labels
- active optical fibres
- contact with remote power feed
- electrical supply that requires mandatory separation from communications cable
- exposed fibres
- unsafe support structures
- unsafe weather:
  - heavy rains
  - high winds
  - severe heat or cold
  - thunderstorms.

### Tools and safety equipment may include:

- personal protective equipment
- safety equipment
- test equipment:
  - local area network (LAN) Cat tester
  - network analyser
  - optical time domain reflectometer (OTDR)
  - passive optical network (PON) meter
- tools:
  - fibre cleaning kit
  - fibre splicer
  - labeller
  - screw drivers
  - spanners
  - tagging tool.

### Plant and machinery may include:

- back hoes
- bobcats
- cable hauling equipment
- cable lifters
- diggers
- elevated work platforms
- excavators
- jacks and trolleys
- tensioning equipment.
## RANGE STATEMENT

**OHS and environmental requirements** may relate to:

- identifying other services including power and gas personal protective equipment:
  - earmuffs
  - gloves:
    - leather
    - plastic
    - rubber
  - head protection
  - masks
  - protective suits
  - safety boots
  - safety glasses
- safe working practices, such as the safe use and handling of:
  - chemicals
  - materials
  - tools and equipment
- safety equipment:
  - flashing lights
  - safety barriers
  - warning signs and tapes
  - witches hats
- special access requirements
- environmental considerations:
  - clean-up protection
  - stormwater protection
  - waste management.

**Other services** may include:

- alarms
- electrical services
- fire sprinkler systems
- gas and water mains
- high voltage (HV) power
- other service provider networks.

**Installation activities** may include:

- aerial cable installation
- cable hauling
- cable terminations
- construction work for underground enclosures
- end-to-end testing of cable system
- excavation work
- installation of enclosures
- installation of FDH
- installation of optical devices
- marking out cable route and location of equipment
- site surveys.

**Optical fibre cable size** may include:

- 12F
- 24F
- 36F
- 48F
- 60F
- 72F.
<table>
<thead>
<tr>
<th>RANGE STATEMENT</th>
<th></th>
</tr>
</thead>
</table>
| **Distribution area (DA)** may include: | • expected type of buildings  
• number of service addresses  
• staging of development  
• types of service required. |
| **Distribution joint including lead-in multiport serving area (DLMSA)** may include: | • limit of 1 distribution joint including lead-in multiport (DLM) per pit  
• 4 or 6 way lead-in modules  
• avoid spurs and optimise cable hauling  
• reduce lead-in module tail lengths  
• 11 lead-ins per 12F tube.  
• lead-in cable lengths of 20, 40, 75 or 100 metres. |
| **Enclosures** may include: | • cabinet  
• FTTx cabinet  
• HFC housing  
• pit. |
| **Optical network terminations (ONT)** may include: | • standard residential or small business = 1  
• medium residential = 2 – 30  
• large residential = >30. |
| **Location and type of fibre distribution hub (FDH)** may include: | • location:  
  ◦ standard residential or small business, external FDH  
  ◦ medium residential, external FDH  
  ◦ large residential, internal FDH  
• type:  
  ◦ type 144 – 100 service addresses  
  ◦ type 288 – 220 service addresses  
  ◦ type 432 – 340 service addresses. |
| **Optical splitter** may include: | • 4 x 32 way  
• 8 x 32 way  
• 12 x 32 way. |
### EVIDENCE GUIDE

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.

<table>
<thead>
<tr>
<th>Overview of assessment</th>
<th>Evidence of the ability to:</th>
</tr>
</thead>
</table>
| Critical aspects for assessment and evidence required to demonstrate competency in this unit | • inspect proposed cable route visually  
• prepare installation activities for FTTx provisioning  
• prepare and document FTTx designs and specifications. |

<table>
<thead>
<tr>
<th>Context of and specific resources for assessment</th>
<th>Assessment must ensure:</th>
</tr>
</thead>
</table>
| Evidence of the ability to:                     | • sites on which FTTx installations may be designed and prepared  
• vendor product information and installation guides  
• relevant regulatory and equipment documentation that impact on installation activities. |

<table>
<thead>
<tr>
<th>Method of assessment</th>
<th>A range of assessment methods should be used to assess practical skills and knowledge. The following examples are appropriate for this unit:</th>
</tr>
</thead>
</table>
|                      | • direct observation of the candidate carrying out preparation and design for FTTx installation within an optical distribution network  
• review of FTTx designs and specifications completed by the candidate  
• oral and written questioning to assess required knowledge. |

<table>
<thead>
<tr>
<th>Guidance information for assessment</th>
<th>Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended, for example:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• ICTOPN4116A Use advanced optical test equipment.</td>
</tr>
</tbody>
</table>

Aboriginal people and other people from a non-English speaking background may have second language issues.

Access must be provided to appropriate learning and assessment support when required.

Assessment processes and techniques must be culturally appropriate, and appropriate to the oral communication skill level, and language and literacy capacity of the candidate and the work being performed.

In all cases where practical assessment is used it will be combined with targeted questioning to assess required knowledge. Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.

Where applicable, physical resources should include equipment modified for people with special needs.
ICTOPN5118A Plan and configure dense wavelength division multiplexing systems

Unit descriptor
This unit describes the performance outcomes, skills and knowledge required to prepare the activity plans and specifications required by field technical staff to deploy a dense wavelength division multiplexing (DWDM) optical network suitable for a metropolitan area network (MAN) or long haul applications.

It involves provisioning DWDM fibre and power cabling work, provisioning of splicing cabinets and patch panels, and providing specification details for installation and construction teams.

DWDMs use optical multiplexing techniques to increase the carrying capacity of a fibre network by transmitting multiple optical wavelengths each carrying high speed data stream over a single fibre. DWDM systems offer up to 128 wavelengths, with each wavelength carrying up to 100 Gbps.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of endorsement but users should confirm requirements with the relevant federal, state or territory authority.

Employability skills
This unit contains employability skills.

Prerequisite units

Co-requisite units

Application of the unit
Technical officers and supervisors apply the skills and knowledge in this unit when planning installation activities for the deployment of high capacity networks using optical technologies.

Optical networks using DWDM provide services in Next Generation Networks (NGN) using emerging technologies.

NGN services include internet protocol TV (IPTV), video on demand (VoD), interactive TV and cloud computing.

Competency field
Optical networks

Unit sector
Telecommunications

ELEMENT
Elements describe the essential outcomes of a unit of competency.

PERFORMANCE CRITERIA
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.

1. Prepare for DWDM planning activities
   1.1. Obtain relevant legislation, codes, regulations and standards for compliance when conducting work
   1.2. Scope the work by obtaining project plan from appropriate personnel and arrange for site access to comply with security arrangements
   1.3. Notify appropriate personnel of identified safety hazards at the work site

2. Plan DWDM
   2.1. Follow occupational health and safety (OHS) and
### ELEMENT | PERFORMANCE CRITERIA
--- | ---
**installation activities and develop specifications** | *environmental requirements* for the given work and identify and avoid *other services*
2.2. Identify *tools, safety equipment, plant and machinery* for installation work activities
2.3. Conduct physical inspections of proposed DWDM sites and verify that backbone dark fibre is accessible and available according to cabling plan
2.4. Verify proposed backbone and customer fibre cable routes to the splicing cabinet and fibre patch panel and identify barriers to the cable installation
2.5. Verify proposed power cabling route from distribution board and circuit breakers and identify barriers to the cable installation
2.6. Modify cable plan if required and notify appropriate personnel
2.7. Prepare *fibre installation specifications* and *power cable and grounding specifications* according to cabling plan and safe work practices and manufacturer’s instructions
2.8. Verify proposed location of *associated hardware* racks, cabinets and ironwork and confirm access to enterprise local area network (LAN)

3. Prepare DWDM shelf configuration and specifications according to customer requirements | 3.1. Prepare a *configuration document* including configuration plans and specifications for the installation team
3.2. Specify location of DWDM shelves or racks and the shelf interconnection fibre cabling layout according to cabling plan
3.3. Specify the individual DWDM units and circuit card types required to suit customer requirements

4. Plan preliminary optical tests | 4.1. Verify backbone fibres at patch panel and conduct bidirectional *optical time domain reflectometer (OTDR) test* and record measurement results and OTDR images
4.2. Conduct bidirectional *optical loss test set (OLTS) measurement* of insertion loss on backbone fibres from patch panel to patch panel at adjacent sites and record measurement results

5. Complete documentation and obtain sign off | 5.1. Provide results of optical measurements to design team
5.2. Complete and provide updated specification documentation to installation team
5.3. Submit documentation to appropriate person for approval and sign off

### REQUIRED SKILLS AND KNOWLEDGE
This section describes the skills and knowledge required for this unit.

**Required skills**
- analytical skills to:
  - analyse specific customer requirements
  - evaluate different types of technical data
  - identify details relating to the project from the approved network plan
- communication skills to discuss project brief with enterprise design and installation personnel, vendors, customers and contractors
- literacy skills to:
REQUIRED SKILLS AND KNOWLEDGE

- interpret technical documentation
- write reports, project briefs in required formats

Numeracy skills to:
- interpret results and evaluate different types of technical data
- analyse site survey data

Planning skills to:
- consider current, new technology, facilities and features when developing options
- plan, prioritise and monitor own work and that of others

Problem solving skills to address specific customer requirements

Research skills to:
- analyse impacts on planning processes
- obtain and study information relating to new technology or technology features
- obtain geographical site information
- study relevant legislation and associated operational codes
- technical skills to identify barriers to plan realisation and interpret test results

Required knowledge

- configuration of DWDM shelf
- DWDM principles of operation
- electrostatic discharge
- features and operating requirements of test equipment:
  - hand-held optical power meter
  - optical spectrum analyser
  - OTDR
  - transmission test set
- functions of optical add drop multiplexer
- internet protocol (IP) addressing, subnet mask, dynamic host configuration protocol (DHCP) and default gateway
- International Telecommunications Union (ITU) wavelength grid for DWDM
- optical fibre connector types and characteristics
- optical fibre types and characteristics
- path protection and protection switching
- physical optical loopbacks and software loopbacks
- protocols used on optical DWDM systems
- ring topologies and linear network topologies
- specific OHS requirements that impact on the safe inspection of optical connectors and the safe measurement of optical power from laser transmission systems

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.

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### RANGE STATEMENT

- AS/NZS IEC 61935.2:2006
- AS/NZS ISO/IEC 15018:2005
- cabling security codes and regulations
- Environmental Protection Acts
- OHS
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### Scope the work may include:

- cable route
- cable supports
- cable types
- distribution areas (DA)
- enclosures
- equipment required
- fibre hubs
- optical splitters
- project type:
  - large residential
  - medium residential
  - small business
  - standard residential.

### Appropriate personnel may be:

- consultant
- planning engineer
- project engineer
- project supervisor
- site supervisor.

### Safety hazards may refer to:

- access points that may contain:
  - hazardous light (non-visible laser)
  - radio frequency (RF) emission
- active lasers without safety labels
- active optical fibres
- contact with remote power feed
- electrical supply that requires mandatory separation from communications cable
- exposed fibres
- unsafe support structures
- unsafe weather:
  - heavy rains
  - high winds
  - severe heat or cold
  - thunderstorms.

### OHS and environmental requirements may relate to:

- identifying other services, including power and gas
- personal protective equipment
  - earmuffs
  - gloves
  - head protection
  - masks
  - protective suits
  - safety boots.
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**Other services** may include:

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- other service provider networks.

**Tools, safety equipment** may include:

- personal protective equipment
- test equipment:
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  - OTDR
  - passive optical network (PON) meter
- tools:
  - fibre cleaning kit
  - fibre splicer
  - labeller
  - screw drivers
  - spanners
  - tagging tool.

**Plant and machinery** may include:

- back hoes
- bobcats
- cable hauling equipment
- cable lifters
- diggers
- elevated work platforms (EWP)
- excavators
- jacks and trolleys
- tensioning equipment.

**Fibre installation specifications** may include:

- connector types
- fibre management system
- identification label
- patch cord type
- splicing cabinet location.

**Power cable and grounding specifications** may include:

- cable colour code
- cable termination lug type.
### RANGE STATEMENT

- cable wire gauge
- identification label
- overhead route
- under floor cable route.

**Associated hardware** may include:

- cabinets
- equipment racks:
  - 19 inch
  - 23 inch
  - 535 mm
  - European Telecommunications Standards Institute (ETSI) compliant
- fibre distribution troughing
- ironwork
- LAN hubs and routers
- rectifier cabinet.

**Configuration document** may include:

- circuit card locations
- contents of each shelf
- filler card locations.

**Optical time domain reflectometer (OTDR) test** may include:

- bidirectional ‘footprint’ test:
  - at 1310 nm
  - at 1550 nm
  - at 1625 nm
- fibre loss
- splice losses and their locations.

**Optical loss test set (OLTS) measurement** may include fibre insertion loss from:

- **A to B at:**
  - 1310 nm
  - 1550 nm
  - 1625 nm
- **B to A at:**
  - 1310 nm
  - 1550 nm
  - 1625 nm.
**EVIDENCE GUIDE**

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<td></td>
<td>• develop installation specifications</td>
</tr>
<tr>
<td></td>
<td>• prepare DWDM shelf configuration and specifications</td>
</tr>
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<td>• plan preliminary optical tests.</td>
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<td>• sites on which testing, installation and configuring of a DWDM system may be conducted</td>
</tr>
<tr>
<td></td>
<td>• use of test equipment currently used in industry</td>
</tr>
<tr>
<td></td>
<td>• manufacturer’s technical documentation</td>
</tr>
<tr>
<td></td>
<td>• relevant regulations and specifications.</td>
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</table>

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<td></td>
<td>• direct observation of the candidate undertaking DWDM planning tasks</td>
</tr>
<tr>
<td></td>
<td>• review of data gathered, reports and project plans prepared by the candidate</td>
</tr>
<tr>
<td></td>
<td>• oral or written questioning to assess knowledge of planning and configuring of DWDM systems.</td>
</tr>
</tbody>
</table>

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<tr>
<th>Guidance information for assessment</th>
<th>Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended, for example:</th>
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<tr>
<td></td>
<td>• ICTOPN5121A Test and commission a dense wavelength division multiplexing transmission system.</td>
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<td></td>
<td>Aboriginal people and other people from a non-English speaking background may have second language issues.</td>
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<td>Where applicable, physical resources should include equipment modified for people with special needs.</td>
</tr>
<tr>
<td><strong>ICTOPN5119A</strong></td>
<td><strong>Perform acceptance and commissioning tests on optical network</strong></td>
</tr>
<tr>
<td>-----------------</td>
<td>---------------------------------------------------------------</td>
</tr>
<tr>
<td>Unit descriptor</td>
<td>This unit describes the performance outcomes, skills and knowledge required to conduct acceptance tests and commissioning tests on optical networks, including the optical portion of broadband hybrid fibre coaxial (HFC) networks, fibre to the x (FTTx) passive optical networks (PONs) and metropolitan and long haul dense wavelength division multiplexing (DWDM) networks. It ensures readiness of the new system through the application of appropriate inspections and tests to confirm compliance and specified performance. No licensing, legislative, regulatory or certification requirements apply to this unit at the time of endorsement but users should confirm requirements with the relevant federal, state or territory authority.</td>
</tr>
<tr>
<td>Employability skills</td>
<td>This unit contains employability skills.</td>
</tr>
<tr>
<td>Prerequisite units</td>
<td></td>
</tr>
<tr>
<td>Co-requisite units</td>
<td></td>
</tr>
<tr>
<td>Application of the unit</td>
<td>Technicians who install and maintain optical network equipment in access networks apply the skills and knowledge in this unit to provide services in Next Generation Networks (NGN) using emerging technologies. This unit applies to experienced field officers, technicians or technical supervisors working for telecommunications carriers, contractors or other service providers. NGN services include internet protocol TV (IPTV), video on demand (VoD), interactive TV, mesh networks and cloud computing.</td>
</tr>
<tr>
<td>Competency field</td>
<td>Optical networks</td>
</tr>
<tr>
<td>Unit sector</td>
<td>Telecommunications</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>ELEMENT</strong></th>
<th><strong>PERFORMANCE CRITERIA</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Elements describe the essential outcomes of a unit of competency.</td>
<td>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.</td>
</tr>
<tr>
<td>1. Prepare to conduct acceptance tests</td>
<td>1.1. Obtain <em>installation and commissioning documents</em> and planning specifications from <em>appropriate personnel</em> to ensure the installed <em>optical network</em> is as planned and specified 1.2. Conduct visual inspection of new installation and verify compliance of the system against <em>relevant legislation, codes, regulations and standards</em> and accepted industry practice</td>
</tr>
</tbody>
</table>
ICTOPN5119A Perform acceptance and commissioning tests on optical network

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<tr>
<th>ELEMENT</th>
<th>PERFORMANCE CRITERIA</th>
</tr>
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<tbody>
<tr>
<td>1.3. Select and obtain required <strong>test equipment</strong> for suitability of acceptance testing</td>
<td></td>
</tr>
<tr>
<td>1.4. Prepare acceptance schedule and <strong>test criteria</strong> in consultation with appropriate personnel</td>
<td></td>
</tr>
<tr>
<td>2. Conduct acceptance testing</td>
<td>2.1. Conduct and evaluate <strong>performance tests</strong> to ensure measurements meet with predetermined specifications and approved operating margins</td>
</tr>
<tr>
<td></td>
<td>2.2. Verify performance levels to be within tolerance specifications set in manufacturer’s instructions</td>
</tr>
<tr>
<td></td>
<td>2.3. Test <strong>protection mechanisms</strong> to ensure performance criteria meets the specified standard</td>
</tr>
<tr>
<td></td>
<td>2.4. Test <strong>alarms</strong> for satisfactory operation and refer identified problems to appropriate personnel for remedial action</td>
</tr>
<tr>
<td></td>
<td>2.5. Record all acceptance test procedures and results</td>
</tr>
<tr>
<td>3. Complete administrative tasks</td>
<td>3.1. Complete acceptance documentation including recommendations</td>
</tr>
<tr>
<td></td>
<td>3.2. Notify appropriate personnel and obtain sign off</td>
</tr>
</tbody>
</table>

**REQUIRED SKILLS AND KNOWLEDGE**

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

**Required skills**

- analytical skills to interpret test equipment settings and readings
- communication skills to:
  - liaise with customers and technical staff to ensure requirements are known and can be met within timeframes
  - prepare reports and technical documentation
- literacy skills to interpret technical specifications, standards documents and related documentation
- numeracy skills to make calculations and necessary calibration changes
- planning and organisation skills to develop activity plans to undertake inspections and tests in efficient manner
- safety awareness skills to:
  - apply precautions and required action to minimise, control or eliminate hazards that may exist during work activities
  - work systematically with required attention to detail without injury to self or others, or damage to goods or equipment
- technical skills to correctly handle, connect and calibrate test equipment

**Required knowledge**

- cabling, terminations and supporting structures that may be encountered in the system under inspection
- common performance levels and standards
- electrical and optical properties to be measured
- occupational health and safety (OHS) issues appropriate to the environment under inspection
- overview of typical network topologies, switching, routing and transmission techniques
- transmission type and signals that may be encountered
- various test equipment types suitable for tests to be made
**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.

<table>
<thead>
<tr>
<th>Installation and commissioning documents may include:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• agreed modifications to original design plan</td>
</tr>
<tr>
<td>• commissioning test results</td>
</tr>
<tr>
<td>• preliminary test results</td>
</tr>
<tr>
<td>• recommendations from commissioning procedures.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Appropriate personnel may include:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• network manager</td>
</tr>
<tr>
<td>• planning manager</td>
</tr>
<tr>
<td>• project manager</td>
</tr>
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<thead>
<tr>
<th>Optical network may include:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• 10 Gbps ethernet local area network (LAN) services over the emerging global standard called optical transport network (OTN)</td>
</tr>
<tr>
<td>• DWDM long haul system</td>
</tr>
<tr>
<td>• DWDM metro system</td>
</tr>
<tr>
<td>• gigabit Ethernet</td>
</tr>
<tr>
<td>• optical portion of HFC network.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Relevant legislation, codes, regulations and standards include:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Australian Communications Industry Forum (ACIF) standards and codes</td>
</tr>
<tr>
<td>• Australian Communications and Media Authority (ACMA) technical standards</td>
</tr>
<tr>
<td>• International Standards ISO 9000 and 9001</td>
</tr>
<tr>
<td>• ITU Standards</td>
</tr>
<tr>
<td>• OHS</td>
</tr>
<tr>
<td>• Privacy Act</td>
</tr>
<tr>
<td>• private property law.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Test equipment may include:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• advanced network tester – synchronous optical network (SONET)/synchronous digital hierarchy (SDH)</td>
</tr>
<tr>
<td>• optical power meters</td>
</tr>
<tr>
<td>• optical return loss test set</td>
</tr>
<tr>
<td>• optical spectrum analyser</td>
</tr>
<tr>
<td>• optical time domain reflectometer (OTDR)</td>
</tr>
<tr>
<td>• protocol analyser</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Test criteria may include:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• 24 – 72 hours test duration</td>
</tr>
<tr>
<td>• live traffic tests</td>
</tr>
<tr>
<td>• test environment</td>
</tr>
<tr>
<td>• test margins and errors</td>
</tr>
<tr>
<td>• testing at highest data rate:</td>
</tr>
<tr>
<td>◦ 10 Gbps</td>
</tr>
<tr>
<td>◦ 40 Gbps</td>
</tr>
<tr>
<td>◦ 100 GBps</td>
</tr>
<tr>
<td>• topology:</td>
</tr>
<tr>
<td>◦ point to point link</td>
</tr>
<tr>
<td>◦ protected ring</td>
</tr>
<tr>
<td>• normal and extreme load tests</td>
</tr>
<tr>
<td>• using installed optical fibre during test.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Performance tests may include:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• end-to-end bit error rate (BER) test:</td>
</tr>
<tr>
<td>◦ stressful pseudo random binary sequence (PRBS) pattern</td>
</tr>
<tr>
<td>• forward error correction (FEC) testing</td>
</tr>
</tbody>
</table>
### RANGE STATEMENT

- G.709 testing
- receive interface specification:
  - received optical power
- stability tests
- transmit interface specification:
  - optical output power.

<table>
<thead>
<tr>
<th>Protection mechanisms may include:</th>
<th>1:1 protection</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1+1 protection</td>
</tr>
<tr>
<td></td>
<td>optical channel path protection</td>
</tr>
<tr>
<td></td>
<td>path protection</td>
</tr>
<tr>
<td></td>
<td>wavelength protection.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Alarms may include:</th>
<th>audible alarms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>on-screen display and monitoring systems</td>
</tr>
<tr>
<td></td>
<td>visual indicators.</td>
</tr>
</tbody>
</table>
## EVIDENCE GUIDE

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.

<table>
<thead>
<tr>
<th>Overview of assessment</th>
<th>Critical aspects for assessment and evidence required to demonstrate competency in this unit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Evidence of the ability to:</td>
</tr>
<tr>
<td></td>
<td>• verify ‘as built’ installation against installation plans</td>
</tr>
<tr>
<td></td>
<td>• undertake acceptance and commissioning tests and analysis against specified performance criteria</td>
</tr>
<tr>
<td></td>
<td>• complete report, including acceptance test procedures, results and recommendations</td>
</tr>
<tr>
<td></td>
<td>• comply with all related OHS requirements and work practices.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Context of and specific resources for assessment</th>
<th>Assessment must ensure:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• sites on which acceptance tests may be conducted</td>
</tr>
<tr>
<td></td>
<td>• use of testing equipment currently used in industry</td>
</tr>
<tr>
<td></td>
<td>• relevant regulatory and equipment documentation.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Method of assessment</th>
<th>A range of assessment methods should be used to assess practical skills and knowledge. The following examples are appropriate for this unit:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• direct observation of the candidate undertaking acceptance tests</td>
</tr>
<tr>
<td></td>
<td>• oral or written questioning to assess knowledge of tests and inspections types of systems and applications</td>
</tr>
<tr>
<td></td>
<td>• review of completed acceptance documentation for systems and equipment prepared by the candidate, including recommendations.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Guidance information for assessment</th>
<th>Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended, for example:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• ICTTEN5059A Commission telecommunications network equipment</td>
</tr>
<tr>
<td></td>
<td>• ICTTEN5092A Undertake outage management.</td>
</tr>
<tr>
<td></td>
<td>Aboriginal people and other people from a non-English speaking background may have second language issues.</td>
</tr>
<tr>
<td></td>
<td>Access must be provided to appropriate learning and assessment support when required.</td>
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<td></td>
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<td></td>
<td>Where applicable, physical resources should include</td>
</tr>
<tr>
<td>EVIDENCE GUIDE</td>
<td>equipment modified for people with special needs.</td>
</tr>
</tbody>
</table>
ICTOPN5120A Plan for an optical system upgrade and cut over

**Unit descriptor**

This unit describes the performance outcomes, skills and knowledge required to plan the activities of a major upgrade of optical systems from specifications provided by the planning and design section. Major upgrades in enterprise networks or telecommunications service provider’s networks involve cut over activities to integrate additional work into existing network.

The exponential growth of internet protocol (IP) traffic is driving IP optical integration, in particular the convergence of IP and dense wavelength division multiplexing (DWDM) networks in Next Generation Networks (NGN), necessitating regular system upgrades.

No licensing, legislative, regulatory or certification requirements apply to this unit at the time of endorsement but users should confirm requirements with the relevant federal, state or territory authority.

**Employability skills**

This unit contains employability skills.

**Prerequisite units**

- 

**Co-requisite units**

- 

**Application of the unit**

Field officers, technicians or technical supervisors from carriers, contractors or other service providers whose work involves upgrading optical systems and equipment in enterprise networks and service providers’ core and access networks apply the skills and knowledge in this unit.

They are involved in maintenance, upgrades and cut overs of emerging technologies in IP based telecommunications networks.

Relevant jobs roles include a supervisor in charge of installation and maintenance teams responsible for the new installations and upgrades of telecommunications networks.

**Competency field**

Optical networks

**Unit sector**

Telecommunications

---

**ELEMENT**

Elements describe the essential outcomes of a unit of competency.

**PERFORMANCE CRITERIA**

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.

1. **Gather information to prepare upgrade activity plan**

   1.1. Obtain **relevant legislation, codes, regulations and standards** for compliance when conducting work
   1.2. Obtain design specifications from the planning and design section to determine the scope and **nature of the upgrade**
   1.3. Analyse the design specification and design plan and determine the accuracy of the design plan to site installation and requirements with **customer**
   1.4. Determine the **network equipment** types and obtain installation details from manufacturer
ELEMENT | PERFORMANCE CRITERIA
--- | ---
2. Prepare upgrade activity plans | 1.5. Prepare an equipment and component list and source vendors for procurement
 | 2.1. Prepare a detailed **installation plan** of the upgrade for the installer
 | 2.2. Prepare a detailed **installation procedure** to carry out the upgrade to minimise impact to the customer
 | 2.3. Prepare pre-installation **optical tests** on existing equipment to determine benchmarks and performance levels prior to the upgrade
 | 2.4. Prepare post-installation optical tests on upgrade to ensure upgraded system is achieving the desired results
 | 2.5. Prepare monitoring schedule to progressively assess the **progress of the upgrade**
 | 2.6. Prepare **contingency plan** for backing out if upgrade is not progressing according to schedule and disruptions to customer are excessive
 | 2.7. Prepare cut over procedures

3. Complete documentation | 3.1. Update and produce **documentation** for submission
 | 3.2. Submit planning activity document to planning and design section for approval

**REQUIRED SKILLS AND KNOWLEDGE**
This section describes the skills and knowledge required for this unit.

**Required skills**
- analytical skills to evaluate impact of upgrades on customer, equipment and systems
- communication skills to provide advice and guidance and liaise with other technical staff on operational matters
- literacy skills to:
  - prepare:
    - installation plans
    - installation procedures
    - pre-installation tests
    - post-installation tests
    - contingency plans
    - cut over plan
  - read and interpret:
    - enterprise procedures, manuals and specifications
    - technical data, technical and non-technical information from a range of sources
    - test results
- numeracy skills to interpret technical data
- PC skills to monitor installed software
- planning and organisational skills to plan and prioritise own work
- problem solving skills to:
  - deal with unexpected situations on the basis of safety and specified work outcomes
  - prepare upgrade plan
  - troubleshoot common equipment and network problems
- safety awareness skills to:
  - apply precautions and required action to minimise, control or eliminate hazards
  - follow enterprise occupational health and safety (OHS) procedures
  - work systematically with required attention to detail without injury to self or others, or damage to goods or equipment
- technical skills to:
REQUIRED SKILLS AND KNOWLEDGE

◦ analyse the impact of applications on traffic flow in the network
◦ determine customer requirements and an upgrade plan
◦ determine the impact of upgrading hardware and software on network functionality
◦ identify the technical requirements, constraints and manageability issues for a given customer network requirement
◦ implement upgrade of equipment and software
◦ use test equipment and monitoring tools
◦ use tools and equipment to assemble and disassemble equipment

Required knowledge

• alarms
• backup systems
• computer knowledge
• escalation and outage procedures
• network management systems
• overview knowledge of telecommunications networks and equipment
• telecommunications monitoring tools
• telecommunications test equipment and test setups
• telecommunications wiring practices
• upgrade and post-upgrade routines

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.

Relevant legislation, codes, regulations and standards may include:

• Australian Communications Industry Forum (ACIF) standards and codes
• AS Communications Cabling Manual (CCM) Volume 1
• AS/NZS 3000:2007
• AS/NZS 3080:2003
• AS/NZS 3084:2003
• AS/NZS 3085.1:2004
• AS/NZS IEC 61935.1:2006
• AS/NZS IEC 61935.2:2006
• AS/NZS ISO/IEC 14763.3:2007
• AS/NZS ISO/IEC 15018:2005
• AS/NZS ISO/IEC 24702:2007
• cabling security codes and regulations
• Environmental Protection Acts
• OHS Acts

Nature of upgrade work may include:

• commission of new system
• installation of new additional equipment
• installation of new software
• integration of new equipment into existing system
• provision of temporary service
• removal of redundant equipment
• test on new system.

Upgrade may include:

• introducing dispersion compensation devices
### RANGE STATEMENT

- moving to 40 Gbps technology
- network capacity upgrade:
  - additional optical fibres to be added
  - additional DWDM wavelength channels and associated hardware to be added
  - increase data rate by changing transmitter and receiver cards
  - replace optical fibre with a type more suited towards 40 Gbps
- upgrading from erbium doped fibre amplifiers (EDFA) to Raman optical amplifiers
- upgrading laser transmitter power.

#### Customer may be:

- asset manager
- contractor
- network planner
- nominated customer representative
- project manager
- service provider.

#### Network equipment may include:

- asynchronous transfer mode (ATM) switch
- dispersion compensation devices
- enclosures
- hubs
- optical add drop multiplexer (OADM)
- optical amplifier
- optical filters
- optical splitters
- patch panels
- regenerator
- synchronous digital hierarchy (SDH) multiplexers
- transponder shelf.

#### Installation plan may include:

- cable trays
- detailed drawings and equipment layout
- detailed list of equipment and types
- earthing specifications
- equipment locations
- equipment mounting details
- interconnecting cabling between racks
- monitoring equipment
- power feeds
- rack positions
- testing procedures
- tools.

#### Installation procedures may include:

- setup procedures
- monitoring progress according to plan
- notification of network operations centre (NOC)
- sourcing hardware and software
- upgrade activity:
  - installing optical equipment
  - post-upgrade testing
  - pre-update testing
  - shutdown installation
### RANGE STATEMENT

<table>
<thead>
<tr>
<th><strong>Optical tests</strong> may include:</th>
<th>• rectifying faults.</th>
</tr>
</thead>
<tbody>
<tr>
<td>• bit error rate test (BERT)</td>
<td>• default settings</td>
</tr>
<tr>
<td>• functional test</td>
<td>• optical power levels</td>
</tr>
<tr>
<td>• optical return loss</td>
<td>• optical signal to noise ratio (OSNR)</td>
</tr>
<tr>
<td>• performance tests.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Progress of upgrade</strong> may include:</th>
<th>• rate of deliverables against project timeline</th>
</tr>
</thead>
<tbody>
<tr>
<td>• risk management</td>
<td>• timing.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Contingency plan</strong> may:</th>
<th>• be developed as part of the upgrade planning and design</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• be escalated and referred to more specialist team</td>
</tr>
<tr>
<td></td>
<td>• invoke partial upgrade to be continued at later stage</td>
</tr>
<tr>
<td></td>
<td>• invoke reversion procedure to pre-update condition.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Documentation</strong> may include:</th>
<th>• configuration details</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• implementation and testing procedures</td>
</tr>
<tr>
<td></td>
<td>• network impact statement</td>
</tr>
<tr>
<td></td>
<td>• software test results</td>
</tr>
<tr>
<td></td>
<td>• system updates</td>
</tr>
<tr>
<td></td>
<td>• test results and recommendations</td>
</tr>
<tr>
<td></td>
<td>• upgrade details</td>
</tr>
<tr>
<td></td>
<td>• vendor, equipment and enterprise specific details.</td>
</tr>
</tbody>
</table>
## EVIDENCE GUIDE
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<tr>
<th>Overview of assessment</th>
<th>Evidence of the ability to:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Critical aspects for assessment and evidence required to demonstrate competency in this unit</strong></td>
<td>• prepare an upgrade plan incorporating the essential activities listed:</td>
</tr>
<tr>
<td></td>
<td>◦ detailed installation plan and installation procedures</td>
</tr>
<tr>
<td></td>
<td>◦ pre-installation and post-installation tests</td>
</tr>
<tr>
<td></td>
<td>◦ monitoring schedule to assess progress of the upgrade</td>
</tr>
<tr>
<td></td>
<td>◦ contingency plan.</td>
</tr>
</tbody>
</table>

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<thead>
<tr>
<th>Context of and specific resources for assessment</th>
<th>Assessment must ensure:</th>
</tr>
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<tbody>
<tr>
<td><strong>Overview of assessment</strong></td>
<td>• site where upgrade and cut over may be planned</td>
</tr>
<tr>
<td></td>
<td>• use of equipment, software, test and monitoring equipment currently used in industry</td>
</tr>
<tr>
<td></td>
<td>• relevant regulatory, equipment, enterprise and vendor documentation that impacts on work activities.</td>
</tr>
</tbody>
</table>

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<th>Method of assessment</th>
<th>A range of assessment methods should be used to assess practical skills and knowledge. The following examples are appropriate for this unit:</th>
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<td><strong>Overview of assessment</strong></td>
<td>• direct observation of the candidate performing upgrade</td>
</tr>
<tr>
<td></td>
<td>• direct observation of the candidate performing tests and monitoring alarms</td>
</tr>
<tr>
<td></td>
<td>• review of documents prepared by the candidate providing upgrade plan and assessing impact of upgrade taking into consideration customer feedback</td>
</tr>
<tr>
<td></td>
<td>• oral or written questioning to assess knowledge of upgrade, testing and monitoring procedures.</td>
</tr>
</tbody>
</table>

<table>
<thead>
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<th>Guidance information for assessment</th>
<th>Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended, for example:</th>
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<tbody>
<tr>
<td><strong>Overview of assessment</strong></td>
<td>• ICTTEN4073A Cut over customer premises equipment major upgrades</td>
</tr>
<tr>
<td></td>
<td>• ICTTEN4076A Complete equipment and software upgrades</td>
</tr>
<tr>
<td></td>
<td>• ICTTEN4086A Undertake routine maintenance of the telecommunications network</td>
</tr>
<tr>
<td></td>
<td>• ICTTEN5061A Cut over new and replacement network equipment.</td>
</tr>
</tbody>
</table>

Aboriginal people and other people from a non-English speaking background may have second language issues.

Access must be provided to appropriate learning and assessment support when required.

Assessment processes and techniques must be culturally appropriate, and appropriate to the oral.
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</table>
ICTOPN5121A Test and commission a dense wavelength division multiplexing transmission system

<table>
<thead>
<tr>
<th>ICTOPN5121A</th>
<th>Test and commission a dense wavelength division multiplexing transmission system</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit descriptor</td>
<td>This unit describes the performance outcomes, skills and knowledge required to test and commission optical transmission systems using dense wavelength division multiplexing (DWDM) technology.</td>
</tr>
<tr>
<td></td>
<td>No licensing, legislative, regulatory or certification requirements apply to this unit at the time of endorsement but users should confirm requirements with the relevant federal, state or territory authority.</td>
</tr>
<tr>
<td>Employability skills</td>
<td>This unit contains employability skills.</td>
</tr>
<tr>
<td>Prerequisite units</td>
<td></td>
</tr>
<tr>
<td>Co-requisite units</td>
<td></td>
</tr>
<tr>
<td>Application of the unit</td>
<td>Technical staff working with telecommunications carriers, service providers, public utilities and broadcasting companies apply the skills and knowledge in this unit. They combine technical optical communications skills with broader organisational and administrative skills to test and commission DWDM systems in a range of commercial contexts and environments.</td>
</tr>
<tr>
<td>Competency field</td>
<td>Optical networks</td>
</tr>
<tr>
<td>Unit sector</td>
<td>Telecommunications</td>
</tr>
</tbody>
</table>

**ELEMENT**

Elements describe the essential outcomes of a unit of competency.

**PERFORMANCE CRITERIA**

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.

1. **Prepare to commission DWDM transmission system**
   1.1. Implement hazard risk control measures
   1.2. Review system specifications and technical data by identifying system operating parameters
   1.3. Obtain and check tools and test equipment needed for the work
   1.4. Verify all necessary equipment is installed, and circuit cards and filler cards are correctly located and seated
   1.5. Check that interconnecting fibres to optical multiplexers and shelves are intact and correctly routed
   1.6. Establish communication between computer and **DWDM shelf**
   1.7. Upload latest software release to each DWDM shelf in the network

2. **Commission DWDM transmission system**
   2.1. Connect an **optical test set** and a physical **optical loopback** to the system, and select **protocol** compatible with the DWDM hardware
   2.2. Check the status of the connection and that test set data is passing correctly
ICTOPN5121A Test and commission a dense wavelength division multiplexing transmission system

<table>
<thead>
<tr>
<th>ELEMENT</th>
<th>PERFORMANCE CRITERIA</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.3. Monitor quality of received signal by setting performance monitoring (PM) features and retrieve PM counts</td>
<td></td>
</tr>
<tr>
<td>2.4. Verify that no errors are counted by the test set during a long term stability test while customer input signal is set to the worst case (minimum) power level</td>
<td></td>
</tr>
<tr>
<td>2.5. Verify that no alarms are generated during the long term stability test period</td>
<td></td>
</tr>
<tr>
<td>2.6. Dispose of antistatic packaging to minimise environmental impact</td>
<td></td>
</tr>
</tbody>
</table>

3. Complete test and commissioning documentation

3.1. Finalise documentation on commissioning test results

3.2. Present results to appropriate person according to established procedures

**REQUIRED SKILLS AND KNOWLEDGE**

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

**Required skills**

- Communication skills to:
  - liaise with internal and external personnel on technical and operational matters
  - relate to work associates, supervisors, team members and clients
- Literacy skills to:
  - interpret technical documentation, such as equipment manuals, specifications and service orders
  - write reports using standard formats
- Numeracy skills to interpret results and evaluate different types of technical data
- Planning and organisational skills to plan, prioritise and monitor own work and that of others
- Problem solving and contingency management skills to:
  - adapt testing procedures to requirements of particular situations
  - modify activities depending on operational contingencies, risk situations and environments
- Safety awareness skills to:
  - apply precautions and required action to minimise, control or eliminate hazards that may exist during work activities especially when dealing with infra-red laser light
  - select and use required personal protective equipment conforming to industry and occupational health and safety (OHS) standards
  - work systematically with required attention to detail without injury to self or others, or damage to goods or equipment
- Technical skills to:
  - backup and restore
  - clean optical fibre connector
  - examine optical fibre connector for contamination and assess whether cleaning is required
  - install software
  - measure optical power using handheld optical power meter
  - measurement of DC and AC voltages
  - setup internet protocol (IP) addresses and subnet masks

**Required knowledge**

- Alarms
- DWDM principles of operation
- Electrostatic discharge precaution
- Features and operating requirements of test equipment including:
  - hand-held optical power meter
**REQUIRED SKILLS AND KNOWLEDGE**

- transmission test set
- optical spectrum analyser
- functions of optical add drop multiplexer
- IP addressing, subnet mask, dynamic host configuration protocol (DHCP) and default gateway
- International Telecommunications Union (ITU) wavelength grid for DWDM
- optical fibre connector types and characteristics
- optical fibre types and characteristics
- path protection and protection switching
- physical optical loopbacks and software loopbacks
- protocols used on optical DWDM systems
- ring topologies and linear network topologies
- specific OHS requirements that impact on the safe inspection of optical connectors and the safe measurement of optical power from laser transmission systems

**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.

**DWDM shelf** maybe part of:
- long haul system
- metropolitan area (metro) system.

**Optical test set** may include:
- Acterna/JDSU ANT-20 advanced network tester
- synchronous digital hierarchy (SDH)/synchronous optical network (SONET) analyser
- SDH/SONET STM-1/4/16 or OC-3/12/48 transmission test set – bit error rate test (BERT)

**Optical loopback** may include:
- fibre optic patchcord connecting transmit and receive ports via inline variable optical attenuator (VOA)
- short fibre optic patchcord connecting transmit and receive ports with fixed attenuator at receive port input if required.

**Protocol** may include:
- D1 video 270 Mbps
- ESCON 200 Mbps.
- fast Ethernet
- fibre channel
- gigabit Ethernet
- SDH:
  - STM-1
  - STM-4
  - STM-16
  - STM-64
- SONET:
  - OC-3
  - OC-12
  - OC-48
  - OC-192.

**Performance monitoring features** may include:
- equipment performance monitoring:
  - threshold crossing alerts
- SDH:
<table>
<thead>
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<th></th>
</tr>
</thead>
<tbody>
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<tr>
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<td></td>
</tr>
<tr>
<td>◦ severely errored seconds (SES)</td>
<td></td>
</tr>
<tr>
<td>◦ out-of-frame seconds (OFS)</td>
<td></td>
</tr>
<tr>
<td>◦ SONET:</td>
<td></td>
</tr>
<tr>
<td>◦ coding violation (CV)</td>
<td></td>
</tr>
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</tr>
<tr>
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<td></td>
</tr>
</tbody>
</table>

**Long term stability test** may refer to:
- 24 hour period
- 48 hour period
- 72 hour period.

**Appropriate person** may include:
- customer
- network administrator
- network planner
- project manager
- supervisor.
### EVIDENCE GUIDE

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.

<table>
<thead>
<tr>
<th>Overview of assessment</th>
<th>Evidence of the ability to:</th>
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<td>Critical aspects for assessment and evidence required to demonstrate competency in this unit</td>
<td>plan and coordinate commissioning</td>
</tr>
<tr>
<td></td>
<td>test and commission DWDM transmission system</td>
</tr>
<tr>
<td></td>
<td>complete test and commissioning documentation</td>
</tr>
<tr>
<td></td>
<td>comply with all related OHS requirements and work practices.</td>
</tr>
</tbody>
</table>

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<tr>
<th>Context of and specific resources for assessment</th>
<th>Assessment must ensure:</th>
</tr>
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<td></td>
<td>access to sites on which testing and commissioning a DWDM transmission system may be conducted</td>
</tr>
<tr>
<td></td>
<td>use of test equipment currently used in industry</td>
</tr>
<tr>
<td></td>
<td>manufacturer’s technical documentation.</td>
</tr>
</tbody>
</table>

<table>
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<tr>
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</tr>
<tr>
<td></td>
<td>review of test and commissioning documentation completed by the candidate</td>
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<td></td>
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</tr>
<tr>
<td></td>
<td>ICTOPN5119A Perform acceptance and commissioning test on optical network</td>
</tr>
<tr>
<td></td>
<td>ICTOPN5120A Plan for an optical system upgrade and cut over</td>
</tr>
<tr>
<td></td>
<td>ICTOPN5122A Test the performance of specialised optical devices</td>
</tr>
<tr>
<td></td>
<td>ICTOPN5123A Analyse and integrate specialised optical devices in the network.</td>
</tr>
</tbody>
</table>

Aboriginal people and other people from a non-English speaking background may have second language issues.

Access must be provided to appropriate learning and assessment support when required.

Assessment processes and techniques must be culturally appropriate, and appropriate to the oral communication skill level, and language and literacy capacity of the candidate and the work being performed.

In all cases where practical assessment is used it will be combined with targeted questioning to assess required knowledge. Questioning techniques should not...
ICTOPN5121A Test and commission a dense wavelength division multiplexing transmission system

<table>
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<tr>
<th>EVIDENCE GUIDE</th>
<th>require language, literacy and numeracy skills beyond those required in this unit of competency. Where applicable, physical resources should include equipment modified for people with special needs.</th>
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</thead>
</table>

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ICT10 Integrated telecommunications Training Package  Page 6
### ICTOPN5122A Test the performance of specialised optical devices

<table>
<thead>
<tr>
<th>ICTOPN5122A</th>
<th>Test the performance of specialised optical devices</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Unit descriptor</strong></td>
<td>This unit describes the performance outcomes, skills and knowledge required to test the performance of specialised optical devices for integration into existing optical networks. The integration of specialised optical devices into existing networks may be required as part of an upgrade for higher bandwidths required by services and applications of Next Generation Networks (NGN). No licensing, legislative, regulatory or certification requirements apply to this unit at the time of endorsement but users should confirm requirements with the relevant federal, state or territory authority.</td>
</tr>
<tr>
<td><strong>Employability skills</strong></td>
<td>This unit contains employability skills.</td>
</tr>
<tr>
<td><strong>Prerequisite units</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Co-requisite units</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Application of the unit</strong></td>
<td>Technical staff from telecommunications carriers, service providers or other private and public organisations who have experience in optical transmission apply the skills and knowledge in this unit. They combine this technical expertise with a range of analytical, research and planning skills to develop integration solutions for particular business needs. Relevant job roles include design and planning of networks using emerging technology.</td>
</tr>
<tr>
<td><strong>Competency field</strong></td>
<td>Optical networks</td>
</tr>
<tr>
<td><strong>Unit sector</strong></td>
<td>Telecommunications</td>
</tr>
</tbody>
</table>

#### ELEMENT
Elements describe the essential outcomes of a unit of competency.

#### PERFORMANCE CRITERIA
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.

1. Prepare to test specialised optical devices
   1.1. Obtain relevant legislation, codes, regulations and standards and follow occupational health and safety (OHS) and environmental requirements for the given work
   1.2. Work safely according to relevant safety legislation and company work practices identifying hazards and using personal protective equipment
   1.3. Determine the type of optical device using the design plan from appropriate person and obtain manufacturer’s specifications for testing
   1.4. Determine the test procedures and test equipment required to evaluate suitability of the optical device

2. Test the specialised optical device
   2.1. Set up the test layout according to safe industry practice and connect the specialised optical device into the test set-up
ELEMENT | PERFORMANCE CRITERIA
--- | ---
2.2. Undertake a **test regime** to determine the performance characteristics of the specialised optical device
2.3. Analyse the test results to determine the suitability and compatibility of the optical device for integration into the network

3. Document the performance of the specialised optical device
3.1. Prepare an evaluation report with recommendations on the suitability of the specialised optical device
3.2. Present test results and evaluation report to appropriate person with copies filed for later reference according to organisation’s policies

**REQUIRED SKILLS AND KNOWLEDGE**
This section describes the skills and knowledge required for this unit.

**Required skills**
- analytical skills to interpret test results
- communication skills to:
  - liaise with internal and external personnel on technical and operational matters
  - relate to work associates, supervisors, team members and clients
- literacy skills to:
  - interpret technical documentation, such as equipment manuals, specifications and service orders
  - write reports using standard formats
- numeracy skills to interpret results and evaluate different types of technical data
- planning and organisational skills to plan, prioritise and monitor own work and that of others
- problem solving and contingency management skills to:
  - adapt testing procedures to requirements of particular situations
  - modify activities depending on operational contingencies, risk situations and environments
- safety awareness skills to:
  - apply precautions and required action to minimise, control or eliminate hazards that may exist during work activities especially when dealing with infra-red laser light
  - select and use required personal protective equipment conforming to industry and OHS standards
  - work systematically with required attention to detail without injury to self or others, or damage to goods or equipment
- technical skills to:
  - backup and restore
  - clean optical fibre connector
  - examine optical fibre connector for contamination and assess whether cleaning is required
  - install software
  - measure optical power using hand-held optical power meter
  - measure DC and AC voltages
  - select and use appropriate test equipment
  - setup internet protocol (IP) addresses and subnet masks

**Required knowledge**
- amplified spontaneous emission (ASE)
- attenuation characteristics of optical fibres
- dense wavelength division multiplexing (DWDM) principles of operation
- features and operating requirements of test equipment including:
  - hand-held optical power meter
## REQUIRED SKILLS AND KNOWLEDGE

- optical spectrum analyser
- transmission test set
- dispersion characteristics of various fibres
- dispersion compensation devices
- electrostatic discharge precaution
- functions of optical add drop multiplexer (OADM) and reconfigurable optical add-drop multiplexer (ROADM)
- gain equalisation
- International Telecommunications Union (ITU) wavelength grid for DWDM
- measurement of dispersion
- optical amplifier operation
- optical fibre connector types and characteristics
- optical fibre types and characteristics
- optical return loss (ORL)
- path protection and protection switching
- polarisation dependent loss (PDL)
- protocols used on optical DWDM systems
- reflectance
- ring topologies and linear network topologies
- specific OHS requirements that impact on the safe inspection of optical connectors and the safe measurement of optical power from laser transmission systems
- tunable laser sources and their characteristics

## 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.

### Relevant legislation, codes, regulations and standards

- Australian Communications Industry Forum (ACIF) standards and codes
- AS Communications Cabling Manual (CCM)
- Australian building codes and regulations
- compliance with appropriate Australian Communications and Media Authority (ACMA) technical standard requirements for underground, aerial, Category 5 or Category 6, 6A, 7 or 7A, and unshielded twisted pairs (UTP)
- Environmental Protection Acts
- fire regulations
- Institute of Electrical and Electronics Engineers (IEEE) standards
- OHS
- relevant international standards

### OHS and environmental requirements

- decommissioning and isolating worksite and lines prior to commencement
- flashing lights
- gas and other hazard detection equipment
- identifying other services, including power and gas
- safety barriers
### RANGE STATEMENT

- safety equipment
- safe working practices such as the safe use and handling of:
  - asbestos
  - chemicals
  - materials
  - tools and equipment
  - work platforms
- special access requirements
- suitable light and ventilation
- trench guards
- warning signs and tapes
- witches hats
- environmental considerations:
  - clean-up protection
  - stormwater protection
  - waste management
  - noise, dust and clean-up management.

### Hazards may include:

- activating equipment without notifying other staff who may be working remotely on the network
- cleaning alcohol, epoxy resins and other solvents and chemicals may be carcinogenic, cause allergies or be dangerous to health in other ways
- environmental hazards:
  - air pollution
  - damage to natural or heritage precincts
  - dangerous gases
  - ground water contamination
  - heavy or noxious metals pollution
  - noise
  - petrochemical spillage
  - release of hydrochlorofluorocarbons (HCFC)
- flammable cleaning chemicals fluids and solvents
- fibre offcut damage to eyes and skin
- health hazards:
  - dangerous or harmful substances
  - handling of optic fibres and lasers
  - risk of infection
  - risk of sustained injury from repetitive tasks
- inhalation of fibre offcuts and particles from vacuum cleaning of worksite
- laser damage to eyes.

### Personal protective equipment may include:

- inspection microscope with integral laser safety filter
- safety glasses
- video microscope.

### Optical device may include:

- Bragg grating
- coupler
- dispersion compensation device (DCD)
- DWDM multiplexer
- erbium doped fibre amplifier (EDFA)
- gain equaliser
| RANGE STATEMENT | • Raman amplifier  
| • ROADM. |

**Appropriate person** may include:
• network engineer  
• project engineer  
• project manager.

**Specifications** may include:
• bandwidth  
• insertion loss  
• operating wavelength  
• ORL  
• ripple.

**Test equipment** may include:
• broadband amplified spontaneous emissions (ASE) source  
• optical spectrum analyser  
• PDL controller  
• PDL meter  
• power meter  
• tunable laser source  
• variable attenuator.

**Test regime** may include:
• bandwidth  
• central wavelength and channel spacing  
• channel uniformity  
• insertion loss  
• ORL  
• PDL  
• ripple.
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<td>- analyse test results</td>
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<td>- report and make recommendations on suitability for integration</td>
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<td>-------------</td>
<td>-------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Unit descriptor</strong></td>
<td>This unit describes the performance outcomes, skills and knowledge required to analyse and integrate specialised optical devices into existing optical networks to support the higher bandwidths associated with Next Generation Networks (NGN). Carriers and service providers regularly upgrade existing infrastructures and extend the length of their networks’ optical links due to expansion of NGN services such as voice, data and video. Performance testing of specialised optical devices is covered in a separate unit ICTOPN5122A Test the performance of specialised optical devices. No licensing, legislative, regulatory or certification requirements apply to this unit at the time of endorsement but users should confirm requirements with the relevant federal, state or territory authority.</td>
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<td>1. Analyse specialised optical device and prepare for integration in the network</td>
<td>1.1. Obtain relevant legislation, codes, regulations and standards and follow occupational health and safety (OHS) and environmental requirements for the project work 1.2. Work safely according to relevant safety legislation and company work practices identifying hazards and using personal protective equipment 1.3. Obtain plans and drawings of existing optical network from appropriate person and review potential locations for suitability of integrating additional hardware</td>
</tr>
</tbody>
</table>
### ELEMENT | PERFORMANCE CRITERIA
--- | ---
1.4. Analyse and evaluate a range of integration options using device specifications which satisfy the customer’s network requirements
1.5. Prepare and submit the business case for adopting the recommended integration solution
1.6. Prepare design plan with interconnection details to existing system and installation options and seek approval to proceed from customer
1.7. Undertake an impact risk assessment of the hardware integration with the network operations centre (NOC) and prepare for contingencies using contingency plan

2. Integrate the specialised optical device in the network
2.1. Install and integrate specialised optical devices into existing network according to design plan
2.2. Test the network and evaluate the results to verify optical network performance with the integrated specialised optical devices in operation

3. Document the integration of the specialised optical device in dense wavelength division multiplexing (DWDM) network
3.1. Produce an updated design plan and submit to customer with copies filed for later reference according to organisation’s policies
3.2. Prepare an evaluation report on the performance of the network with specialised optical devices with recommendations for future enhancements
3.3. Notify NOC of job completion and obtain sign off from appropriate person

### REQUIRED SKILLS AND KNOWLEDGE
This section describes the skills and knowledge required for this unit.

**Required skills**

- analytical skills to evaluate technical information and develop integration options
- communication skills to:
  - liaise with internal and external personnel on technical and operational matters
  - relate to work associates, supervisors, team members and clients
- literacy skills to:
  - interpret technical documentation, such as equipment manuals, specifications and service orders
  - write reports using standard formats
- numeracy skills to interpret results and evaluate different types of technical data
- planning and organisational skills to plan, prioritise and monitor own work and that of others
- problem solving and contingency management skills to:
  - adapt testing procedures to requirements of particular situations
  - modify activities depending on operational contingencies, risk situations and environments
- safety awareness skills to:
  - apply precautions and required action to minimise, control or eliminate hazards that may exist during work activities especially when dealing with infra-red laser light
  - select and use required personal protective equipment conforming to industry and OHS standards
  - work systematically with required attention to detail without injury to self or others, or damage to goods or equipment
- technical skills to:
  - backup and restore
  - clean optical fibre connector
**REQUIRED SKILLS AND KNOWLEDGE**

- examine optical fibre connector for contamination and assess whether cleaning is required
- install software
- measure optical power using handheld optical power meter
- measure DC and AC voltages
- select and use appropriate test equipment
- setup internet protocol (IP) addresses and subnet masks

**Required knowledge**

- attenuation characteristics of optical fibres
- DWDM principles of operation
- features and operating requirements of test equipment, including:
  - hand-held optical power meter
  - optical spectrum analyser
  - transmission test set
- dispersion characteristics of optical fibres
- dispersion compensation devices
- electrostatic discharge precaution
- functions of optical add drop multiplexer (OADM) and reconfigurable optical add-drop multiplexer (ROADM)
- gain equalisation
- International Telecommunications Union (ITU) wavelength grid for DWDM
- measurement of dispersion
- optical amplifier operation
- optical fibre connector types and characteristics
- optical fibre types and characteristics
- optical return loss (ORL)
- path protection and protection switching
- protocols used on optical DWDM systems
- reflectance
- ring topologies and linear network topologies
- specific OHS requirements that impact on the safe inspection of optical connectors and the safe measurement of optical power from laser transmission systems
- tunable laser sources and their characteristics

**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.

**Relevant legislation, codes, regulations and standards** may include:

- Australian Communications Industry Forum (ACIF) standards and codes
- AS Communications Cabling Manual (CCM) Volume 1
- Australian building codes and regulations
- compliance with appropriate Australian Communications and Media Authority (ACMA) technical standard requirements for underground, aerial, Category 5 or Category 6, 6A, 7 or 7A, and unshielded twisted pairs (UTP)
- Environmental Protection Acts
- fire regulations
### RANGE STATEMENT

- Institute of Electrical and Electronics Engineers (IEEE) standards
- OHS
- relevant international standards

### OHS and environmental requirements may relate to:

- decommissioning and isolating work site and lines prior to commencement
- flashing lights
- gas and other hazard detection equipment
- identifying other services, including power and gas
- safety barriers
- safety equipment
- safe working practices, such as the safe use and handling of:
  - asbestos
  - chemicals
  - materials
  - tools and equipment
  - work platforms
- special access requirements
- suitable light and ventilation
- trench guards
- warning signs and tapes
- witches hats
- environmental considerations:
  - clean-up protection
  - noise, dust and clean-up management
  - stormwater protection
  - waste management.

### Hazards may include:

- activating equipment without notifying other staff who may be working remotely on the network
- cleaning alcohol, epoxy resins and other solvents and chemicals may be carcinogenic, cause allergies or be dangerous to health in other ways
- environmental hazards:
  - air pollution
  - damage to natural or heritage precincts
  - dangerous gases
  - ground water contamination
  - heavy or noxious metals pollution
  - noise
  - petrochemical spillage
  - release of hydrochlorofluorocarbons (HCFC)
- flammable cleaning chemicals fluids and solvents
- fibre offcut damage to eyes and skin
- health hazards:
  - dangerous or harmful substances
  - handling of optic fibres and lasers
  - risk of infection
  - risk of sustained injury from repetitive tasks
## RANGE STATEMENT

| **Personal protective equipment** may include: | • inspection microscope with integral laser safety filter  
• safety glasses  
• video microscope. |
| **Optical network** may include: | • coarse wavelength division multiplexing (CWDM)  
• DWDM  
• Hybrid fibre coaxial (HFC). |
| **Appropriate person** may include: | • customer  
• network manager  
• project engineer  
• project manager. |
| **Specifications** may include: | • bandwidth  
• insertion loss  
• operating wavelength  
• optical return loss (ORL)  
• ripple. |
| **Installation options** may include: | • location at intermediate location  
• location at OADM site  
• location at terminal site  
• location underground. |
| **Specialised optical devices** may include: | • Bragg grating  
• coupler  
• dispersion compensation device (DCD)  
• DWDM multiplexer  
• erbium doped fibre amplifier (EDFA)  
• gain equaliser  
• Raman amplifier  
• ROADM. |
| **Verify optical network performance** may include: | • stability test  
• bit error ratio test (BERT). |
### EVIDENCE GUIDE

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.

#### Overview of assessment

<table>
<thead>
<tr>
<th>Critical aspects for assessment and evidence required to demonstrate competency in this unit</th>
<th>Evidence of the ability to:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• analyse a specialised optical device and prepare a design to integrate it with a network</td>
</tr>
<tr>
<td></td>
<td>• integrate and test the device</td>
</tr>
<tr>
<td></td>
<td>• document the integration to the network and recommend enhancements</td>
</tr>
<tr>
<td></td>
<td>• comply with all related OHS requirements and work practices.</td>
</tr>
</tbody>
</table>

#### Context of and specific resources for assessment

<table>
<thead>
<tr>
<th>Assessment must ensure:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• sites on which specialised optical device can be integrated</td>
</tr>
<tr>
<td>• use of test equipment currently used in industry</td>
</tr>
<tr>
<td>• manufacturer’s technical documentation, legislation, codes and standards.</td>
</tr>
</tbody>
</table>

#### Method of assessment

<table>
<thead>
<tr>
<th>A range of assessment methods should be used to assess practical skills and knowledge. The following examples are appropriate for this unit:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• direct observation of the candidate performing integration</td>
</tr>
<tr>
<td>• review of test documentation and reports completed by the candidate</td>
</tr>
<tr>
<td>• oral or written questioning to assess required knowledge and skill.</td>
</tr>
</tbody>
</table>

#### Guidance information for assessment

<table>
<thead>
<tr>
<th>Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended, for example:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• ICTOPN5118A Plan and configure dense wavelength division multiplexing systems</td>
</tr>
<tr>
<td>• ICTOPN5119A Perform acceptance and commissioning test on optical network</td>
</tr>
<tr>
<td>• ICTOPN5120A Plan for an optical system upgrade and cut over</td>
</tr>
<tr>
<td>• ICTOPN5122A Test the performance of specialised optical devices.</td>
</tr>
</tbody>
</table>

Aboriginal people and other people from a non-English speaking background may have second language issues.

Access must be provided to appropriate learning and assessment support when required.

Assessment processes and techniques must be culturally appropriate, and appropriate to the oral communication skill level, and language and literacy capacity of the candidate and the work being performed.

In all cases where practical assessment is used it will be combined with targeted questioning to assess...
<p>| EVIDENCE GUIDE | required knowledge. Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency. Where applicable, physical resources should include equipment modified for people with special needs. |</p>
<table>
<thead>
<tr>
<th>ICTOPN6124A</th>
<th>Manage optical ethernet transmission</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Unit descriptor</strong></td>
<td>This unit describes the performance outcomes, skills and knowledge required to manage an ethernet optical transmission system. It includes analysis of fault conditions that may occur.</td>
</tr>
<tr>
<td></td>
<td>No licensing, legislative, regulatory or certification requirements apply to this unit at the time of endorsement but users should confirm requirements with the relevant federal, state or territory authority.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Employability skills</th>
<th>This unit contains employability skills.</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Prerequisite units</th>
<th></th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Co-requisite units</th>
<th></th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Application of the unit</th>
<th>Field officers working with carrier telecommunications networks using optical technologies apply the skills and knowledge in this unit.</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Competency field</th>
<th>Optical networks</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Unit sector</th>
<th>Telecommunications</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th><strong>ELEMENT</strong></th>
<th><strong>PERFORMANCE CRITERIA</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Elements describe the essential outcomes of a unit of competency.</td>
<td>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.</td>
</tr>
</tbody>
</table>

1. **Plan to test optical ethernet link**
   - 1.1. Make worksite safe by identifying existing and potential site hazards
   - 1.2. Determine the technical environment and network components
   - 1.3. Report on infrastructure to ensure that link is designed to meet performance requirements

2. **Specify architecture requirements**
   - 2.1. Follow site specific safety requirements and enterprise occupational health and safety (OHS) procedures
   - 2.2. Determine architecture components
   - 2.3. Determine functions and framework for the system to operate across network boundaries, taking into account performance criteria

3. **Manage optical ethernet link**
   - 3.1. Conduct work in the context of appropriate tests
   - 3.2. Analyse test results
   - 3.3. Provide a report on test results and compare with expected outcomes
   - 3.4. Document test results and refer to the appropriate person

<table>
<thead>
<tr>
<th><strong>REQUIRED SKILLS AND KNOWLEDGE</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>This section describes the skills and knowledge required for this unit.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Required skills</th>
<th></th>
</tr>
</thead>
</table>

- analytical skills to identify and rectify faults in Ethernet transmission
- communication skills to:
  - liaise with internal and external personnel on technical and operational matters
  - relate to work associates, supervisors, team members and clients
- literacy skills to:
### REQUIRED SKILLS AND KNOWLEDGE

- interpret technical documentation, such as equipment manuals, specifications and service orders
- write reports using standard formats
- research skills to gather data, observation and analysis of transmission issues
- technical skills to conduct tests and operate test equipment

#### Required knowledge

- **ethernet:**
  - applications of ethernet in optical systems
  - architecture of ethernet systems
  - operation of ethernet within a telecommunications environment
  - organisational policy and procedures
  - testing techniques
- familiarity with workplace and industry environment
- specific OHS requirements relating to:
  - handling of optical fibre
  - personal safety issues
  - use of laser light sources

### 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.

**Hazards** may include:
- optical cable:
  - hazardous laser light.

**Technical environment** may include:
- Ethernet frame structure
- medium access control
- physical media.

**Architecture components** may include:
- entire fibres
- Lambda
- time division multiplexing
- waveband.

**Functions** may include:
- bandwidth profile parameters
- class-of-service labels
- network service parameters
- service attributes
- service performance parameters.

**Framework** may include:
- auto-negotiation
- physical coding sub-layer
- physical medium attachment
- physical medium dependent.

**Appropriate tests** may include:
- approval and acceptance tests:
  - 1000BASE-T PMA
  - 1000BASE-X PCS
  - auto-negotiation
  - electrical interfaces
  - ethernet testing suite
  - flow control test
  - jitter measurements
  - media access control (MAC) layer
  - operating wavelength
<table>
<thead>
<tr>
<th>RANGE STATEMENT</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>◦ optical interfaces</td>
</tr>
<tr>
<td></td>
<td>◦ phase fluctuation and jitter</td>
</tr>
<tr>
<td></td>
<td>◦ physical interface</td>
</tr>
<tr>
<td></td>
<td>◦ physical-layer interoperability</td>
</tr>
<tr>
<td></td>
<td>• media tests:</td>
</tr>
<tr>
<td></td>
<td>◦ advanced cable testing</td>
</tr>
<tr>
<td></td>
<td>◦ characteristic impedance</td>
</tr>
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<td></td>
<td>◦ crosstalk</td>
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<tr>
<td></td>
<td>◦ delay</td>
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<tr>
<td></td>
<td>◦ insertion loss or attenuation</td>
</tr>
<tr>
<td></td>
<td>◦ media categories</td>
</tr>
<tr>
<td></td>
<td>◦ return loss</td>
</tr>
<tr>
<td></td>
<td>◦ wiremap</td>
</tr>
<tr>
<td></td>
<td>• performance tests:</td>
</tr>
<tr>
<td></td>
<td>◦ back-to-back frames</td>
</tr>
<tr>
<td></td>
<td>◦ frame loss ratio</td>
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<tr>
<td></td>
<td>◦ latency</td>
</tr>
<tr>
<td></td>
<td>◦ reset</td>
</tr>
<tr>
<td></td>
<td>◦ RFC 2544 Test</td>
</tr>
<tr>
<td></td>
<td>◦ system recovery</td>
</tr>
<tr>
<td></td>
<td>◦ throughput</td>
</tr>
<tr>
<td></td>
<td>◦ traffic generation</td>
</tr>
</tbody>
</table>

**Appropriate person** may include:
- authorised business representative
- client
- supervisor.
## EVIDENCE GUIDE

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.

### Overview of assessment

<table>
<thead>
<tr>
<th>Critical aspects for assessment and evidence required to demonstrate competency in this unit</th>
<th>Evidence of the ability to:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• plan to test an optical ethernet link</td>
</tr>
<tr>
<td></td>
<td>• select and perform a testing regime on ethernet optical transmissions</td>
</tr>
<tr>
<td></td>
<td>• analyse and document test results</td>
</tr>
<tr>
<td></td>
<td>• comply with all related OHS requirements and work practices.</td>
</tr>
</tbody>
</table>

### Context of and specific resources for assessment

Assessment must ensure:

- a telecommunications operations site with ethernet optical transmission system
- test equipment currently used in industry.

### Method of assessment

A range of assessment methods should be used to assess practical skills and knowledge. The following examples are appropriate for this unit:

- oral or written questioning of the candidate
- direct observation of the candidate carrying out relevant measurements within an ethernet optical communication system
- evaluation of written report prepared by the candidate outlining architecture components, testing regime and analysis of test results.

### Guidance information for assessment

Holistic assessment with other units relevant to the industry sector, workplaces and job role is recommended, for example:

- ICTOPN4116A Use advanced optical test equipment
- ICTOPN6129A Analyse optical transmission systems.

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Access must be provided to appropriate learning and assessment support when required.

Assessment processes and techniques must be culturally appropriate, and appropriate to the oral communication skill level, and language and literacy capacity of the candidate and the work being performed.

In all cases where practical assessment is used it will be combined with targeted questioning to assess required knowledge. Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.

Where applicable, physical resources should include equipment modified for people with special needs.
<p>| EVIDENCE GUIDE |  |</p>
<table>
<thead>
<tr>
<th>ICTOPN6125A</th>
<th>Manage dense wavelength division multiplexing transmission system</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Unit descriptor</strong></td>
<td>This unit describes the performance outcomes, skills and knowledge required to manage a dense wavelength division multiplexing (DWDM) transmission system using graphical user interface (GUI) management software. Network management software provides a single point of access to the fault, performance, security and administrative functions of network management. Alarms are displayed and performance data and statistics are visible, allowing network degradation to be detected before actual failure occurs. No licensing, legislative, regulatory or certification requirements apply to this unit at the time of endorsement but users should confirm requirements with the relevant federal, state or territory authority.</td>
</tr>
<tr>
<td><strong>Employability skills</strong></td>
<td>This unit contains employability skills.</td>
</tr>
<tr>
<td><strong>Prerequisite units</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Co-requisite units</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Application of the unit</strong></td>
<td>Technical staff in telecommunications who work with DWDM optical transmission systems where network management is implemented apply the skills and knowledge in this unit. The network management operations are often carried out at a central Network Operations Centre (NOC).</td>
</tr>
<tr>
<td><strong>Competency field</strong></td>
<td>Optical networks</td>
</tr>
<tr>
<td><strong>Unit sector</strong></td>
<td>Telecommunications</td>
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</tbody>
</table>

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</tr>
</tbody>
</table>
| 1. Prepare to manage transmission system | 1.1. Determine **networking issues** and requirements from **appropriate person**  
1.2. Install network management software according to vendor instructions, including access, security and administration  
1.3. Create a customised representation of the enterprise’s **network topology**  
1.4. Set and configure thresholds for performance monitoring  
1.5. Prepare a plan to integrate the DWDM management system into a broader network management system where applicable |
| 2. Manage transmission system | 2.1. **Manage the network** using appropriate communications links  
2.2. Monitor the network for faults and performance and produce a fault and performance report |
| 3. Use network management to report on the overall state of | 3.1. Analyse performance monitoring data and alarm data  
3.2. Prepare a report and make recommendations based on the analysis |
## ELEMENT
**transmission system**

### PERFORMANCE CRITERIA
3.3. Report on network degradation over a period of time

## REQUIRED SKILLS AND KNOWLEDGE
This section describes the skills and knowledge required for this unit.

### Required skills
- Analytical skills to identify and rectify faults in DWDM transmission system
- Communication skills to:
  - liaise with internal and external personnel on technical and operational matters
  - relate to work associates, supervisors, team members and clients
- Information technology skills particularly interoperability between management systems
- Literacy skills to:
  - interpret technical documentation, such as equipment manuals, specifications and service orders
  - write reports using standard formats
- Problem solving skills to resolve software inoperability problems
- Research skills to gather data, observe and analyse transmission issues
- Technical skills to operate test equipment

### Required knowledge
- Familiarity with workplace and industry environment
- Optical communications principles
- DWDM technology
- Simple network management protocol (SNMP)
- Organisational policy and procedures

## 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.

### Networking issues may include:
- access
- administration
- protocols:
  - SNMP
- security
- transaction language 1 (TL1).

### Appropriate person may include:
- network administrator
- network planner
- project manager.

### Network topology may include:
- background maps
- communications links between network elements or groups
- groups of elements
- nested groups of elements
- physical shapes.

### Manage the network may include:
- acknowledging or clearing alarms
- determining alarm severity
- determining overall network status
- integrated with external management system
- locally
- managing connections
- managing protection
| RANGE STATEMENT | • monitoring the network for faults  
|                | • monitoring the performance of network elements  
|                | • performing software download and upgrade  
|                | • producing equipment inventory at a given site  
|                | • remotely  
|                | • stand alone management  
|                | • viewing historical event logs and alarm data  
|                | • viewing performance parameters and thresholds  
|                | • viewing real time active alarm data.  
| Network degradation may include: | • decreasing received optical power level  
|                | • decreasing transmit optical power level. |
### EVIDENCE GUIDE

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.

<table>
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<tr>
<th>Overview of assessment</th>
<th>Evidence of the ability to:</th>
</tr>
</thead>
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<tr>
<td>Critical aspects for assessment and evidence required to demonstrate competency in this unit</td>
<td>• monitor the network for faults and performance and produce a fault and performance report</td>
</tr>
<tr>
<td></td>
<td>• analyse performance monitoring and alarm data and prepare a report with recommendations based on this analysis.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Context of and specific resources for assessment</th>
<th>Assessment must ensure:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assessment must ensure:</td>
<td>• access to sites on which DWDM equipment and associated network management can be operated</td>
</tr>
<tr>
<td></td>
<td>• access to DWDM system and test equipment currently used in industry</td>
</tr>
<tr>
<td></td>
<td>• access to relevant equipment manuals, software manuals and other procedural documentation.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Method of assessment</th>
<th>A range of assessment methods should be used to assess practical skills and knowledge. The following examples are appropriate for this unit:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• direct observation of the candidate using transmission system manuals and specifications to manage the network and analyse test results</td>
</tr>
<tr>
<td></td>
<td>• evaluation of measurement results and reports produced by the candidate.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Guidance information for assessment</th>
<th>Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended, for example:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• ICTOPN5121A Test and commission a dense wavelength division multiplexing transmission system</td>
</tr>
<tr>
<td></td>
<td>• ICTOPN6124A Manage optical ethernet transmission</td>
</tr>
<tr>
<td></td>
<td>• ICTOPN6128A Design a dense wavelength division multiplexing system.</td>
</tr>
</tbody>
</table>

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Access must be provided to appropriate learning and assessment support when required.

Assessment processes and techniques must be culturally appropriate, and appropriate to the oral communication skill level, and language and literacy capacity of the candidate and the work being performed.

In all cases where practical assessment is used it will be combined with targeted questioning to assess required knowledge. Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.
| EVIDENCE GUIDE | Where applicable, physical resources should include equipment modified for people with special needs. |
### Employability skills

This unit contains employability skills.

### Prerequisite units

<table>
<thead>
<tr>
<th>Co-requisite units</th>
<th></th>
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</tbody>
</table>

### Application of the unit

Technical officers and supervisors apply the skills and knowledge in this unit when designing DWDM systems for the deployment of high capacity networks using optical technologies.

Optical networks using DWDM provide services in Next Generation Networks (NGN) using emerging technologies.

NGN services include internet protocol TV (IPTV), video on demand (VoD), interactive TV and cloud computing.

### Competency field

Optical networks

### Unit sector

Telecommunications

### ELEMENT

Elements describe the essential outcomes of a unit of competency.

### PERFORMANCE CRITERIA

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.

<table>
<thead>
<tr>
<th>ELEMENT</th>
<th>PERFORMANCE CRITERIA</th>
</tr>
</thead>
</table>
| 1. Prepare to produce a DWDM system design | 1.1. Obtain the planning document from appropriate person and determine site details  
1.2. Obtain the service type and the number of channels required between customer traffic sources and destinations and the type of protection required  
1.3. Obtain specifications of the optical fibre between sites  
1.4. Determine the fibre loss between sites |
| 2. Calculate link budget for each wavelength path | 2.1. Use vendor’s engineering design rules, specifications and data to calculate link budget and link margin for each DWDM wavelength and path  
2.2. Evaluate link budget and assess the calculated margin and |
## ELEMENT | PERFORMANCE CRITERIA
---|---
| 3. Prepare detailed configuration documents for the DWDM system | 3.1. Outline the **detailed requirements** of the DWDM system for **configuration document**  
3.2. Prepare a configuration document according to the customer’s traffic needs  
3.3. Prepare an internet protocol (IP) **address allocation** for all DWDM shelves and associated routers and gateways  
3.4. Submit documentation to appropriate person for approval and sign off
| 4. Investigate upgrade options using emerging technologies | 4.1. Investigate the option of using a reconfigurable optical add-drop multiplexer (ROADM) and make recommendations outlining the benefits  
4.2. Investigate the feasibility of a future upgrade up to 100 Gbps system using optical transport network (OTN)-DWDM technology

### REQUIRED SKILLS AND KNOWLEDGE

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

**Required skills**

- analytical skills to identify details relating to the project from the approved network plan  
- communication skills to discuss project brief with enterprise design and installation personnel, vendors, customers and contractors  
- literacy skills to:  
  - write project briefs and interpret results and evaluate different types of technical data  
  - interpret technical documentation and write reports in required formats  
- numeracy skills to:  
  - interpret results and evaluate different types of technical data  
  - analyse site survey data  
- planning skills to:  
  - consider current, new technology, facilities and features when developing options  
  - plan, prioritise and monitor own work and that of others  
- problem solving skills to address and analyse specific customer requirements  
- research skills to:  
  - analyse impacts on planning processes  
  - obtain and study information relating to emerging DWDM technologies  
  - obtain geographical site information  
  - study relevant legislation and associated operational codes  
  - technical skills to identify barriers to plan realisation and evaluate emerging DWDM technologies

**Required knowledge**

- configuration of DWDM shelf  
- DWDM principles of operation  
- electrostatic discharge
REQUARED SKILLS AND KNOWLEDGE

- features and operating requirements of test equipment including:
  - optical time domain reflectometer (OTDR)
  - hand-held optical power meter
  - transmission test set
  - optical spectrum analyser
- functions of optical add drop multiplexer (OADM)
- functions of reconfigurable optical add drop multiplexer (ROADM)
- IP addressing, subnet mask, dynamic host configuration protocol (DHCP) and default gateway
- International Telecommunications Union (ITU) wavelength grid for DWDM
- laser stability
- dispersion compensation devices
- link budget calculations and link margins
- optical fibre connector types and characteristics
- optical fibre types and characteristics
- path protection and protection switching
- physical optical loopbacks and software loopbacks
- traditional protocols and emerging OTN technologies used on optical DWDM systems
- ring topologies and linear network topologies
- specific occupational health and safety (OHS) requirements that impact on the safe inspection of optical connectors and the safe measurement of optical power from laser transmission systems

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.

Appropriate person may include:

- consultant
- planning engineer
- project engineer
- project supervisor
- site supervisor.

Site details may include:

- location of network sites
- number of network sites
- optical fibre path distance between sites
- straight line distance between sites
- type of site:
  - OADM
  - ROADM
  - terminal.

Service type may include:

- interface requirements
- protocol and bit rate:
  - digital video broadcasting - asynchronous serial interface (DVB-ASI)
  - enterprise system connection (ESCON)
  - ethernet
    - fast ethernet 100 Mbps
    - 1 GbE
    - 10 GbE
  - fibre channel
<table>
<thead>
<tr>
<th>RANGE STATEMENT</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>◦ OTN</td>
<td></td>
</tr>
<tr>
<td>◦ synchronous digital hierarchy (SDH)</td>
<td></td>
</tr>
<tr>
<td>◦ synchronous optical networking (SONET)</td>
<td></td>
</tr>
<tr>
<td>- STM-1 155 Mbps</td>
<td></td>
</tr>
<tr>
<td>- STM-4 622 Mbps</td>
<td></td>
</tr>
<tr>
<td>- STM-16 2.48 Gbps</td>
<td></td>
</tr>
<tr>
<td>- STM-64 10 Gbps</td>
<td></td>
</tr>
<tr>
<td>- STM-256 40 Gbps</td>
<td></td>
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<tr>
<td>◦ 100 Gbps</td>
<td></td>
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<tr>
<td>◦ HD-SDI</td>
<td></td>
</tr>
<tr>
<td>◦ SD-SDI</td>
<td></td>
</tr>
</tbody>
</table>

Protection may include:
- equipment protection
- path protection.

Specifications may include:
- chromatic dispersion \((\text{ps/nm}*\text{km})\)
- cladding diameter
- core diameter
- end-to-end attenuation or dB loss per km at nominated wavelength
- fibre type
  ◦ non-zero dispersion shifted fibre (NZDSF) ITU-T G.655
  ◦ non-dispersion shifted fibre (NDSF) ITU-T G.652 also known as standard single mode fibre ‘SMF’
  ◦ dispersion-shifted fibre (DSF) ITU-T G.653
  ◦ 1550-nm loss-minimised fibre (ITU-T G.654)
  ◦ ITU-T G.656
  ◦ LEAF fibre
- number of fusion splices
- polarisation mode dispersion
- refractive index profile of core.

Optical fibre may include:
- existing fibre
- fibre optimised for DWDM system
- new fibre.

Detailed requirements may include:
- actual wavelengths specified
- chirp parameter
- dispersion compensation devices
- maximum allowable span length
- optical amplifier
- optical signal to noise ratio (OSNR)
- receiver threshold
- transmit laser:
  ◦ maximum power
  ◦ minimum power
  ◦ stability
  ◦ type.

Configuration document may include:
- channel configuration information
- fixed optical attenuators
- protection details
- slot positions and circuit card type
- type and quantity of circuit cards.
RANGE STATEMENT

<table>
<thead>
<tr>
<th><strong>IP address allocation</strong> may include:</th>
<th>default gateway IP address</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>shelf IP addresses</td>
</tr>
<tr>
<td></td>
<td>subnet mask.</td>
</tr>
</tbody>
</table>
### EVIDENCE GUIDE

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.

<table>
<thead>
<tr>
<th>Overview of assessment</th>
<th>Evidence of the ability to:</th>
</tr>
</thead>
</table>
| Critical aspects for assessment and evidence required to demonstrate competency in this unit | • determine the fibre loss between sites  
• calculate link budget and link margin  
• prepare DWDM shelf configuration and specifications  
• produce a configuration document  
• investigate an emerging DWDM technology. |

<table>
<thead>
<tr>
<th>Context of and specific resources for assessment</th>
<th>Assessment must ensure:</th>
</tr>
</thead>
</table>
| | • sites on which design of a DWDM system may be conducted  
• manufacturer’s technical documentation, relevant regulations and specifications. |

<table>
<thead>
<tr>
<th>Method of assessment</th>
<th>A range of assessment methods should be used to assess practical skills and knowledge. The following examples are appropriate for this unit:</th>
</tr>
</thead>
</table>
| | • direct observation of the candidate undertaking DWDM calculations  
• review of data gathered, reports and project plans prepared by the candidate  
• oral or written questioning to assess knowledge of design and configuring of DWDM systems. |

<table>
<thead>
<tr>
<th>Guidance information for assessment</th>
<th>Holistic assessment with other units relevant to the industry sector, workplace and job role is recommended, for example:</th>
</tr>
</thead>
</table>
| | • ICTOPN6125A Manage dense wavelength division multiplexing transmission system  
• ICTOPN6129A Analyse optical transmission systems. |

Aboriginal people and other people from a non-English speaking background may have second language issues.

Access must be provided to appropriate learning and assessment support when required.

Assessment processes and techniques must be culturally appropriate, and appropriate to the oral communication skill level, and language and literacy capacity of the candidate and the work being performed.

In all cases where practical assessment is used it will be combined with targeted questioning to assess required knowledge. Questioning techniques should not require language, literacy and numeracy skills beyond those required in this unit of competency.

Where applicable, physical resources should include equipment modified for people with special needs.
<table>
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<th>EVIDENCE GUIDE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>


**ICTOPN6129A Analyse optical transmission systems**

| **Unit descriptor** | This unit describes the performance outcomes, skills and knowledge required to analyse optical transmission systems deployed by service providers in core and access networks. Network service providers adapt their existing optical networks to meet the demand for higher bandwidths for Next Generation Networks (NGN). Upgrading to 128 channels at transmission rates of up to 100 Gbit/s has a significant effect on the network’s tolerance to optical impairments, such as noise level, chromatic dispersion and polarisation mode dispersion (PMD). Before an existing network is upgraded, its characteristics must be characterised and verified to ensure it will support the new modulation requirements of the equipment. No licensing, legislative, regulatory or certification requirements apply to this unit at the time of endorsement but users should confirm requirements with the relevant federal, state or territory authority. |
| **Employability skills** | This unit contains employability skills. |
| **Prerequisite units** | |
| **Co-requisite units** | |
| **Application of the unit** | Experienced technical staff from telecommunications carriers, service providers or other private and public organisations who have experience in the optical transmission area apply the skills and knowledge in this unit. |
| **Competency field** | Optical networks |
| **Unit sector** | Telecommunications |

<table>
<thead>
<tr>
<th><strong>ELEMENT</strong></th>
<th><strong>PERFORMANCE CRITERIA</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Elements describe the essential outcomes of a unit of competency.</td>
<td>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.</td>
</tr>
<tr>
<td>1. Prepare to conduct characterisation tests on existing optical network</td>
<td>1.1. Obtain <em>relevant legislation, codes, regulations and standards relevant legislation, codes, regulations and standards</em> and follow occupational health and safety <em>(OHS) and environmental requirements</em> for the given work 1.2. Identify <em>hazards</em> and work safely according to relevant safety legislation and company work practices using <em>personal protective equipment</em> 1.3. Construct <em>test procedures</em> for each test to be conducted 1.4. Notify customer and arrange for site access</td>
</tr>
<tr>
<td>2. Conduct link characterisation tests and analyse existing optical network</td>
<td>2.1. Perform <em>optical tests</em> to characterise the existing fibre link 2.2. Analyse the results of the optical tests, and determine the extent and nature of future upgrades based on the tests</td>
</tr>
<tr>
<td>3. Document the analysis of optical network with</td>
<td>3.1. Produce final drawings and plans of proposed upgrade requirements for optical transmission and submit to project</td>
</tr>
<tr>
<td>ELEMENT</td>
<td>PERFORMANCE CRITERIA</td>
</tr>
<tr>
<td>---------</td>
<td>----------------------</td>
</tr>
<tr>
<td>recommendations</td>
<td>manager according to enterprise policy</td>
</tr>
<tr>
<td>3.2. Prepare a report on the measured performance of the network and recommendations on future upgrades</td>
<td></td>
</tr>
</tbody>
</table>

### REQUIRED SKILLS AND KNOWLEDGE

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

#### Required skills

- **communication skills to:**
  - liaise with internal and external personnel on technical and operational matters
  - relate to work associates, supervisors, team members and clients
- **literacy skills to:**
  - interpret technical documentation, such as equipment manuals, specifications and service orders
  - write reports using standard formats
- **numeracy skills to interpret results and evaluate different types of technical data**
- **planning and organisational skills to plan, prioritise and monitor own work and that of others**
- **problem solving and contingency management skills to:**
  - adapt testing procedures to requirements of particular situations
  - modify activities depending on operational contingencies, risk situations and environments
- **safety awareness skills to:**
  - apply precautions and required action to minimise, control or eliminate hazards that may exist during work activities especially when dealing with infra-red laser light
  - select and use required personal protective equipment conforming to industry and OHS standards
  - work systematically with required attention to detail without injury to self or others, or damage to goods or equipment
- **technical skills to:**
  - backup and restore
  - clean optical fibre connector
  - examine optical fibre connector for contamination and assess whether cleaning is required
  - install software
  - measure DC and AC voltages
  - measure optical power using handheld optical power meter
  - select and use appropriate test equipment
  - setup IP addresses and subnet masks

#### Required knowledge

- attenuation characteristics of optical fibres
- chromatic dispersion (CD) test
- dense wavelength division multiplexing (DWDM) principles of operation
- dispersion
- dispersion characteristics of various fibres
- dispersion compensation devices
- electrostatic discharge precaution
- features and operating requirements of test equipment including:
  - hand-held optical power meter
  - optical spectrum analyser
  - transmission test set
- functions of optical add drop multiplexer (OADM) and reconfigurable optical add-drop multiplexer (ROADM)
### REQUIRED SKILLS AND KNOWLEDGE

- gain equalisation
- insertion loss test
- International Telecommunications Union (ITU) wavelength grid for DWDM
- measurement of dispersion
- methods to reduce dispersion
- optical amplifier operation
- optical fibre connector types and characteristics
- optical fibre types and characteristics
- optical return loss (ORL) test
- optical signal to noise ratio (OSNR) test
- optical time domain reflectometer (OTDR) test
- path protection and protection switching
- performance qualification of 40 Gbit/s and 100 Gbit/s transceivers
- polarisation mode dispersion (PMD) test
- protocols used on optical DWDM systems
- reflectance
- ring topologies and linear network topologies
- specific OHS requirements that impact on the safe inspection of optical connectors and the safe measurement of optical power from laser transmission systems

### 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.

**Relevant legislation, codes, regulations and standards** may include:

- Australian Communications Industry Forum (ACIF) standards and codes
- AS Communications Cabling Manual (CCM) Volume 1
- Australian building codes and regulations
- compliance with appropriate Australian Communications and Media Authority (ACMA) technical standard requirements for underground, aerial, Category 5 or Category 6, 6A, 7 or 7A, and unshielded twisted pairs (UTP)
- Environmental Protection Acts
- fire regulations
- International Electrotechnical Commission (IEC):
  - IEC 61282-3 Technical report on calculation of PMD
  - IEC 61290-1 Gain of optical amplifiers
  - IEC 61290-2 Power measurements on optical amplifiers
  - IEC 61291 Generic specs for optical amplifiers
  - IEC 61291-4 Performance template for multi-channel optical amplifiers
  - IEC 61941 Standard on PMD measurement for single mode optical fibre
- OHS
- relevant international standards
**RANGE STATEMENT**

**OHS and environmental requirements** may relate to:

- decommissioning and isolating worksite and lines prior to commencement
- flashing lights
- gas and other hazard detection equipment
- identifying other services, including power and gas
- safe working practices, such as the safe use and handling of:
  - asbestos
  - chemicals
  - materials
  - tools and equipment
  - work platforms
- safety barriers
- safety equipment
- special access requirements
- suitable light and ventilation
- trench guards
- warning signs and tapes
- witches hats
- environmental considerations:
  - clean-up protection
  - noise, dust and clean-up management
  - stormwater protection
  - waste management.

**Hazards** may include:

- infra-red laser light at transmitter ports and fibres
- needle stick injuries from fractured optical fibres.

**Personal protective equipment** may include:

- dust protection
- earmuffs
- eye protection
- gloves
- hard hats
- personal reflecting jackets
- safety boots
- safety glasses
- traffic signs
- warning signs and tapes.

**Test procedures** may include:

- expected measurement results
- test conditions
- test instrument settings
- test instruments required
- test setup.

**Optical tests** may include:

- tests:
  - CD
  - non-linearity (four wave mixing)
  - optical loss test set (OLTS)
  - ORL
  - OSNR
  - OTDR testing from both ends
  - PMD
- wavelength:
  - 1310 nm
<table>
<thead>
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<th></th>
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<tbody>
<tr>
<td>◦ 1550 nm</td>
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<tr>
<td>◦ 1625 nm</td>
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</tr>
<tr>
<td>------------------------</td>
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<tr>
<td>Critical aspects for assessment and evidence required to demonstrate competency in this unit</td>
<td>• conduct four of the following measurements:</td>
</tr>
<tr>
<td></td>
<td>◦ OTDR testing from both ends</td>
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<td>◦ OLTS loss test</td>
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<td>◦ OSNR</td>
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<tr>
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<td>• analyse complex optical measurement results</td>
</tr>
<tr>
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<td>• recommend the most appropriate upgrades for the existing system.</td>
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</tbody>
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<tr>
<td></td>
<td>• use of test equipment currently used in industry</td>
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<td>• test equipment and manufacturer’s technical documentation.</td>
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<td>• oral or written questioning to assess knowledge of test and commissioning procedures.</td>
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<td>• ICTOPN5118A Plan and configure dense wavelength division multiplexing systems</td>
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<tr>
<td></td>
<td>• ICTOPN5119A Perform acceptance test and commission an optical network</td>
</tr>
<tr>
<td></td>
<td>• ICTOPN5120A Plan for an optical system upgrade and cut over</td>
</tr>
<tr>
<td></td>
<td>• ICTOPN5122A Test the performance of specialised optical devices.</td>
</tr>
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**EVIDENCE GUIDE**

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