



**Australian Government**

# **ICTRFN7182B Produce a radio link budget**

**Release 1**

## ICTRFN7182B Produce a radio link budget

### Modification History

| Release   | Comments                                                                                                                                                                                      |
|-----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Release 2 | <p>This version first released with <i>ICT10 Integrated Telecommunications Training Package Version 3.0</i>.</p> <p>References to other units updated.</p> <p>Outcomes deemed equivalent.</p> |
| Release 1 | <p>This version first released with <i>ICT10 Integrated Telecommunications Training Package Version 1.0</i>.</p>                                                                              |

### Unit Descriptor

This unit describes the performance outcomes, skills and knowledge required to analyse the technical performance of fixed and mobile radio systems and to plan and calculate link budgets.

### Application of the Unit

Telecommunications engineers apply the skills and knowledge in this unit as part of their work with radio systems for a telecommunications service provider.

The job role includes responsibility for establishing the layout of the digital radio system to minimise transmission loss and optimise the system performance.

### Licensing/Regulatory Information

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.

### Pre-Requisites

Not applicable.

## Employability Skills Information

This unit contains employability skills.

### Elements and Performance Criteria Pre-Content

| Element                                                                  | Performance Criteria                                                                                                                                                                                                                                                                                                    |
|--------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Elements describe the essential outcomes of a unit of competency.</i> | <i>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.</i> |

### Elements and Performance Criteria

|                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|----------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Analyse suitability of radio systems            | <p>1.1 Analyse the spectral efficiency of <b>functional elements</b> of mobile <b>radio systems</b> for determining optimal frequency utilisation</p> <p>1.2 Analyse the features of radio systems to evaluate the effectiveness of a particular application</p> <p>1.3 Compare the features and specifications of antennas used in radio systems to assist with radio link budget</p> <p>1.4 Report on the suitability of radio systems, including recommendations to improve network performance</p> |
| 2. Calculate a radio link budget                   | <p>2.1 Calculate <b>path loss</b> using <b>variables</b> in appropriate propagation models for a power link budget</p> <p>2.2 Evaluate the power link budget against allowable power margins specifications</p> <p>2.3 Evaluate <b>modulation types</b> and spectral efficiency</p> <p>2.4 Confirm radio power link budget achieves <b>specified reliability</b></p>                                                                                                                                   |
| 3. Complete evaluation and planning documentations | <p>3.1 Complete an evaluation report on performance of radio systems with recommendations on improvements to the system</p> <p>3.2 Document the processes carried out to determine the optimal power link budget for a radio system</p>                                                                                                                                                                                                                                                                |

## Required Skills and Knowledge

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

### Required skills

- analytical skills to review complex information to make judgements
- communication skills to work effectively within a group and present information
- information technology skills for word processing and desktop research
- literacy skills to prepare reports given a specific format
- numeracy skills to:
  - calculate link budgets
  - gather and record data from measurements
- research skills to gather data and information
- technical skills to operate test equipment.
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### Required knowledge

- HF, VHF, UHF and microwave receiving techniques
- modulation methods:
  - AM
  - FM
  - digital formats
- multiplexing systems
- operation of transmitters and receivers
- organisational policy and procedures
- personal safety issues
- propagation methods
- radio communications systems
- radio frequency (RF) losses
- RF technologies
- workplace and industry environment.

## 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.*

|                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|-----------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Overview of assessment</b>                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>Critical aspects for assessment and evidence required to demonstrate competency in this unit</b> | <p>Evidence of the ability to:</p> <ul style="list-style-type: none"> <li>analyse the signal degradation characteristics of radio paths and calculate power budgets for various distances and antenna heights versus transmitted power</li> <li>research the constraints imposed by mobile phone frequency allocations and simulate carrier to interference radiation patterns around a cell site</li> <li>complete evaluation report on radio system performance and document processes used to determine power link budget.</li> </ul> |
| <b>Context of and specific resources for assessment</b>                                             | <p>Assessment must ensure:</p> <ul style="list-style-type: none"> <li>telecommunications operations site</li> <li>mobile telephony devices and equipment</li> <li>networked computers and relevant software.</li> </ul>                                                                                                                                                                                                                                                                                                                  |
| <b>Method of assessment</b>                                                                         | <p>A range of assessment methods should be used to assess practical skills and knowledge. The following examples are appropriate for this unit:</p> <ul style="list-style-type: none"> <li>oral or written questioning to assess required knowledge</li> <li>review of link budget reports completed by the candidate for different communication scenarios</li> <li>direct observation of the candidate analysing radio systems and calculating link budgets.</li> </ul>                                                                |
| <b>Guidance information for assessment</b>                                                          | <p>Holistic assessment with other units relevant to the industry sector, workplaces and job role is recommended, for example:</p> <ul style="list-style-type: none"> <li>ICTPMG7145B Undertake a telecommunications project</li> <li>ICTTEN7193B Plan a transmission network.</li> </ul> <p>Aboriginal people and other people from a non-English</p>                                                                                                                                                                                    |

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|  | <p>speaking background may have second language issues.</p> <p>Access must be provided to appropriate learning and assessment support when required.</p> <p>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.</p> <p>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.</p> <p>Where applicable, physical resources should include equipment modified for people with special needs.</p> |
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## 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.*

|                                         |                                                                                                                                                                                                                                                                                                                                                    |
|-----------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Functional elements</b> may include: | <ul style="list-style-type: none"> <li>• code division multiple access (CDMA)</li> <li>• frequency division multiple access (FDMA)</li> <li>• time division multiple access (TDMA)</li> <li>• wideband code division multiple access (WCDMA).</li> </ul>                                                                                           |
| <b>Radio systems</b> may include:       | <ul style="list-style-type: none"> <li>• 3G</li> <li>• 4G</li> <li>• CDMA</li> <li>• GPRS</li> <li>• Global system for mobiles (GSM)</li> <li>• trunked</li> <li>• WCDMA</li> <li>• worldwide interoperability for microwave access (WiMAX).</li> </ul>                                                                                            |
| <b>Path loss</b> refers to:             | <ul style="list-style-type: none"> <li>• received power to transmitted power ratio and may depend on:             <ul style="list-style-type: none"> <li>• antenna height</li> <li>• atmospheric absorption</li> <li>• distance</li> <li>• rain</li> <li>• reflection coefficient.</li> </ul> </li> </ul>                                          |
| <b>Variables</b> may include:           | <ul style="list-style-type: none"> <li>• clutter factor</li> <li>• Doppler effect on mobile transmission</li> <li>• frequency</li> <li>• Fresnel distance and absorption</li> <li>• K factor</li> <li>• point-to-multipoint</li> <li>• point-to-point</li> <li>• Raleigh fading and counter measures</li> <li>• reflection coefficient.</li> </ul> |
| <b>Modulation types</b> may include:    | <ul style="list-style-type: none"> <li>• FM</li> <li>• AM</li> <li>• orthogonal frequency division multiplex (OFDM)</li> <li>• COFDM</li> </ul>                                                                                                                                                                                                    |

|                                                  |                                                                                                                                                              |
|--------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                  | <ul style="list-style-type: none"><li>• quaternary phase shift keying (QPSK)</li><li>• 16 quadrature amplitude modulation (QAM)</li><li>• 256 QAM.</li></ul> |
| <b><i>Specified reliability</i></b> may include: | <ul style="list-style-type: none"><li>• drop outs</li><li>• outage time</li><li>• power margin</li><li>• signal fading.</li></ul>                            |

## Unit Sector(s)

Telecommunications - Radio frequency networks