Project Report

Power Systems Operators

National Training Framework

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Document Release

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Background

The Australian Energy Market Operator, (AEMO) has continued to work on the development of an appropriate framework to deliver the objectives of adopting standardised training for Power System Operators.

As a direction from the National Electricity Market Operations Committee (NEMOC), the Operations Training Working Group (OTWG) introduced the possibility of adopting a training framework. Aside from the NEMOC, issues with Power Systems Operator (PSO) knowledge and training have been raised at several forums, including the Control Room Operations Working Group (CROWG), with participants eager to see a training culture shift and the implementation of industry training standards via a National Training Framework[1].

AEMO has partnered with Thomson Bridge, a Registered Training Organisation (RTO), who has made significant developments in this area. Thomson Bridge is a national provider of Electricity Supply Industry (ESI) training, compliance, and electrical advisory services, improving essential electrical skills and safety leadership across transmission, distribution and rail networks, infrastructure, thermal and renewable generation, HV operations, control rooms and power-grid interface.

[1] *p1. National Training Framework – Courseware Development and Training Delivery Brief, Australian Energy Market Operator, 2021*

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Introduction

The transformation of the industry and the introduction of new technologies means the existing areas of accountability and interoperability within the network are breaking down. While some organisations have matured systems and procedures supported by training programs, some organisations do not.

Similarly, changing demographics of PSO cohorts, changes to traditional entry pathways, and the requirements of new network operators are redefining the training needs for PSO.

The Framework is designed to complement existing training options including various nationally recognised training packages. Where available, the Framework will develop content against nationally recognised training standards as a benchmark, so that where accredited certification is required the requirements can be met.

The Framework is specifically focused on power system operators across the spectrum of generation, transmission, and distribution. The Framework provides guidance on critical elements of skills and knowledge for PSO.

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Project Overview

AEMO will undertake a phased approach for the development of a National Training Framework. In collaboration with AEMO, Thomson Bridge have been engaged to undertake Phase 1. The phased approach is outlined as follows:

Phase 1

Collaboration and consultation to define a skills management and governance framework (the Framework) and the initial high level training needs analysis for the foundation suite of courses. Provision of the proposed Framework for industry review.

Subject to the outcomes of Phase 1:

Phase 2

Based on the training needs analysis, design and develop initial courseware, define delivery mechanisms, and conduct pilot programs with selected operators to validate and refine the approach.

Phase 3

Refine the overall approach for the management of the Framework including the design of an expanded suite of content, workplace performance and competency standards, content development and delivery modes, and program evaluation and improvement processes.

Phase 4

Implement the Framework including ongoing evaluation and continual refinement.

The timing of the project is currently projected as:

- Phase 1 was conducted over a 3 – 4 month period, allowing for initial consultation, follow up tasks and validation of findings.
- Phase 2 is subject to the requirements defined in Phase 1; however, it is envisaged that Phase 2 will take approximately 12 months.
- Phases 3 and 4 will be significantly dependent on the findings from Phases 1 and 2.

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Methodology and Findings

The methodology used in Phase 1 was to engage with industry widely to gather initial background on needs and requirements of a Framework. The organisations consulted are listed in **Appendix 1**. The statistics covering the initial interviews are described in Table 1.

Data Point	Statistics
Number of interviews conducted	21
Number of organisations consulted	19
Number of people interviewed	51
Amount of time spent in interviews	>32 hours

Table 1. *Initial Interview Statistics.*

In addition to interviews several relevant publications were reviewed including industry outlooks and skills forecasts for the UET and UEP sectors and the existing and proposed qualifications. Also, benchmarking against a like program was conducted using the North American Energy Reliability Commission (NERC) program and a sample vendor content offering. The documents reviewed are listed in Section 6, References.

Follow up interviews and validation through the dissemination of initial modelling in the Draft Report was the second part of Phase 1 to refine the final report.

Findings:

1. ESI Control Rooms are being impacted by Industry Transformation.
Distributed Energy Resources (DERs), such as battery energy storage and solar photovoltaics (PVs), are transforming the way electricity is produced and distributed.

The increasing focus on Hydropower, Solar and Wind generation represents significant shifts for the energy sector, and this will demand a pool of labour with a different skill profile than in the past.

With increasing interconnectedness and decentralised distribution models it is critical to have technical expertise at all levels to maintain the operations of these systems. To this end, workforce planning, and skills development needs to occur now if the industry is to fulfil future labour force needs[2].

Aside from the NEMOC, issues with PSO knowledge and training have been raised at several forums, including the Control Room Operations Working Group (CROWG), with participants eager to see a training culture shift and the implementation of industry training standards via a National Training Framework[3].

This finding was reinforced by comments in the interviews of industry during Phase 1 consultations.

2. National Training Packages only partially meet the industry needs.
The 2020 Annual Skills Forecast by Australian Industry Standards provides the following information on the training packages in the sector:

A review of 1,176 accredited courses and qualifications with enrolments listed in VOCSTATS yielded *no known current accredited courses or qualifications in the Transmission, Distribution and Rail field"*.*

The following UET qualifications have had no enrolments in the last four-year cycle.

- UET20519 Certificate II in National Broadband Network Cabling (Electricity Supply Industry Assets)
- UET60319 Advanced Diploma of ESI - Power Systems Operations*[4].

UET60319 was subsequently deleted from the national register and training requirements.

[2] *pp 2,3. Skills Forecast, Annual Update 2020 ESI Transmission, Distribution and Rail, Australian Industry Standards, 2020.*

[3] *p1. National Training Framework – Courseware Development and Training Delivery Brief, Australian Energy Market Operator, 2021.*

[4] *p6. Skills Forecast, Annual Update 2020 ESI Transmission, Distribution and Rail, Australian Industry Standards, 2020.*

Learners are undertaking in-house training versus the VET system due to some *nationally recognised qualifications not being suitable for industry requirements**. This has been addressed with current and future reviews of the Training Package[6].

The interviews emphasised the need for contextual training on the actual network, organisational procedures, and HMI.

**Italicized emphasis by author of this report.*

This finding was reinforced by comments in the interviews of industry during Phase 1 consultations. The use of accredited qualifications comments is detailed in Table 2.

Use of Advanced Diploma		
Focus Area	**Comments**	**Emphasis**
Accredited use	Accredited Adv Dip used as a recruitment prerequisite	2
	Accredited Adv Dip used in training	3
	Accredited Adv Dip partially used	2
	Accredited Adv Dip not used but some benchmarking	12

Table 2. *Use of Accredited Qualifications Comments.*

3. The entry pathways to control room operations are transforming.
While not specifically addressing control room operations the UET Skills Annual Report did highlight skill shortages, lack of diversity and changing pathways[7].

This finding was reinforced by comments in the interviews of industry during Phase 1 consultations.

[5] *UET60221 - Advanced Diploma of ESI - Power Systems, Australian Industry Standards, training.gov.au, accessed November 2021.*

[6] *p10. Skills Forecast, Annual Update 2020 ESI Transmission, Distribution and Rail, Australian Industry Standards, 2020.*

[7] *p11. Skills Forecast, Annual Update 2020 ESI Transmission, Distribution and Rail, Australian Industry Standards, 2020.*

4. There is scope for both nationally recognised (accredited) and non-nationally accredited (non-accredited) training options to be delivered across a PSO National Training Framework. Learners are undertaking in-house training over accredited VET system programs, to supplement the available nationally recognised qualifications. This has been considered with current and future reviews of the Training Package[8]. However, due to the specific requirements of control room operations, supplementary learnings will continue to be required.

This finding was reinforced by comments in the interviews of industry during Phase 1 consultations. Not all operators saw a need for all training to be accredited and there was a mix of use of nationally recognised training products. Comments from interviews are reflected in Table 3.

Use of Advanced Diploma		
Focus Area	**Comments**	**Emphasis**
Accreditation	Favour a non-accredited approach	15 comments
	Favour an accredited approach	8

Table 3. *Accreditation Comments.*

Most operators saw that any Framework would only provide core and common generic materials and that the business requirements, procedures, and processes would be delivered by the individual operators. No-one saw the Framework delivering all training for all operators. Comments from interviews are reflected in Table 4 Coverage.

Coverage		
Focus Area	**Comments**	**Emphasis**
How much of training does the framework provide content for	Framework covers core and common aspects, but internal training required for specifics of the network and local application	19
	Framework covers all aspects of training required by individual operators	0
	Only local processes and no Framework	1

Table 4. *Coverage Comments.*

[8] *p6. Skills Forecast, Annual Update 2020 ESI Transmission, Distribution and Rail, Australian Industry Standards, 2020.*

Similarly, a modular 'pick and choose' option was preferred over a full curriculum although many people did say that having a framework for a full training approach with modular options would be good. Pathway comments are detailed in Table 5.

Focus Area	Comments	Emphasis
Pathway -modular	Provide a pathway that has modules that can be a 'pick and choose' option.	17 comments
Pathway -structured	Provide a pathway that is a structured curriculum.	7

Table 5. *Pathway Comments.*

This would also build on current non-accredited learning offered by the AEMO and enable vendors to build content against the Framework for both accredited and non-accredited options.
**Italicized emphasis by author of this report.*

5. There were several training needs expressed as being part of the Framework.
The foundational are summarised in Table 6:

Focus Area	Modules	Emphasis
Foundational (technical)	Emergency operations – network coordination	50 comments
	General knowledge of the network,	41
	Protection (fundamentals),	32
	Renewables (interaction and impacts in the network),	31
	Switching basics (understanding field operations)	24
	Markets	23
	Generation	22
	Voltage management	20
	Fault finding	18
	Constraints	15
	Load shedding	15
	Power flow	7
	Isolations	7
	Electrical fundamentals,	6
Foundational (non-technical)	Communications (protocols and terminology)	51 comments
	Human Factors - generally	10
	Fatigue	11
	Decision making	10
	Prioritising	5

Table 6. *Initial Foundational Training Needs.*

The suite of content is defined in **Appendix 2**.

6. Not all training requirements are addressed by any one program or package. A PSO National Training Framework can assist in informing Industry Skills Councils (ISC) as to changing needs for training products via OTWG and NEMOC inputs.

The ESI TDR ISC is proposing to review the Diploma of ESI Power Systems Operations as well as the Diploma and Advanced Diploma of ESI Power Systems and associated units of competency. This project will consider streamlining qualifications and ensure all materials are updated to align with current and future industry practices and emerging technologies[9].

As part of Phase 1 a gap analysis was conducted against training needs identified in the consultations and the current and proposed qualifications in ESI and benchmarked against the NERC model. The initial review of information on analysis against the fundamentals of the framework are detailed in Table 7.

Analysis	Focus areas	Potential Gaps of Existing Packages
PSO to UET60221	Network overviews, Renewables, Legislation, Communications and Human Factors	10
PSO to UEP50218	Network overviews, Legislation, Communications, Electrical Fundamentals and Human Factors	15
PSO to UET60221Y	Network overviews, Renewables, Legislation, Communications and Human Factors	9
PSO to NERC	NERC Sections 1 – 8 covered against PSO	0

Table 7. *Fundamental Gap analysis overview*

The results of the full gap and benchmarking analysis are summarised in **Appendix 3**.

[9] *p7. Industry Outlook, ESI Transmission, Distribution and Rail, Australian Industry Standards, 08 June 2021.*

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Framework Overview

The Framework is a dynamic document that is constantly updated by AEMO in consultation with industry to meet the needs of regulators, industry, and evolving technologies and processes.

The consultations determined the following high-level approach:

- The Framework is owned by industry through the OTWG of the NEMOC and managed by AEMO.
- The costs of accessing content of the Framework on an on-going basis are managed on a user-pays basis. The set-up costs for Phases 2 - 4 are to be borne by industry and or content vendors as part of the scope and industry engagement for each Phase, facilitated by AEMO and OTWG.
- The Framework would be a guidance document developed by industry for industry, that industry and entities such as industry reference committees, can use to develop, or benchmark, their learning and development models against.
- The Framework would be a single structure that consists of discrete modules that define the requirements for content development referencing nationally recognised packages where applicable.
- The Framework structure would consist of baseline modules covering fundamentals common across the industry with discrete pathways for PSO in generation, transmission, and distribution. The pathways are further divided into standard and advanced levels.
- The baseline modules will be progressive, from introductory level up to advanced, allowing the same modules to be used to achieve the appropriate level of understanding.

- Any content developed aligned to the Framework can be used as a pick and choose model, with Completion Certificates or Statements of Attainment given for each module, or as a curriculum based training program, requiring learners to complete all modules in the relevant stream, or provide evidence for RPL.
- Where a nationally recognised qualification is required the relevant packaging rules and package requirements must be met. The content of the Framework may not fully align with packaging rules, but the intent is that where content does align it can be used against the requirements of a unit of competency. The Framework will specify the requirements for training elements, assessment and refresher periods for individual modules including alignment to nationally recognised training requirements, where applicable.
- The Framework will allow for internal training within organisations for procedural and context components.
- The Framework will specify the modality and delivery streams recommended for individual modules.
- AEMO will oversee a delivery management system for the purpose of deploying content, enrolment, and attendance management, recording and reporting, and certification issue.
- The Framework modules will be aligned to nationally recognised training, where applicable. Where content is not readily aligned to nationally recognised training non-accredited modules can be deployed.
- Use of the Framework modules against nationally recognised training for the attainment of units of competency or qualifications within the Australian Qualifications Framework (AQF), is optional.
- Where nationally recognised training for the attainment of units of competency or qualifications within the AQF is required, the relevant legislation and standards must be applied.
- Certificates of completion for modules under the Framework are approved by NEMOC and AEMO and may be issued as recognition of completion of specified modules. These certificates are proof of attendance and completion and are not part of the AQF.
- Industry, Consultants and RTO can develop and deliver content against the Framework. Where any certification is required, the training and assessment entity must be duly authorised to issue nationally recognised training for AQF certificates or by NEMOC and AEMO for non-accredited certificates of completion.

The initial Framework design is depicted in **Image 1** on the following page.

POWER SYSTEMS OPERATOR NATIONAL TRAINING FRAMEWORK

	All		
Fundamental	1.1 Australian Networks and Elements of Electrical Power Systems. 1.2 Renewables and Emerging Technologies. 1.3 Communication Technologies. 1.4. Legislation and Regulation Overview. 1.5. Electrical Fundamentals - DC. 1.6. Electrical Fundamentals - AC. 1.7. Electrical Fundamentals – Use drawings, schedules, codes, and specifications 1.8. Electrical Fundamentals - Electromagnetics	1.9. Electrical Fundamentals - basic electrical computational problems. 1.10. Electrical Fundamentals - Provide engineering solutions to problems in complex polyphase power circuits. 1.11. Electrical Fundamentals – Electrical measurements 1.12. Protection Fundamentals 1.13. Switching Fundamentals 1.14. Management and coordination of work parties and field operators 1.15. Voltage Control and Reactive Power	1.16. Reliability Operating Limits and Reliability 1.17. Power Control and the Energy Market 1.18. Emergency Operations 1.19. Resource and Demand Balancing 1.20. Human Factors – Effective Communications 1.21. Human Factors – Fatigue and Fatigue Management 1.22. Human Factors – Human Machine Interface 1.23. Human Factors – Decision making and degradation factors
	Transmission	**Distribution**	**Generation**
Standard	2.1 System Ride Through 2.2 Power System Disturbance and Contingency Response 2.3 Coordination 2.4 Power System Stability 2.5 Fault Finding and Management 2.6 Monitor and control field staff 2.7 Respond to protection operations 2.8 Develop switching programs 2.9 Operate and monitor system SCADA	3.1 System Ride Through 3.2 Power System Disturbance and Contingency Response 3.3 Coordination 3.4 Power System Stability 3.5 Fault Finding and Management 3.6 Transmission Operations 3.7 Monitor and control field staff 3.8 Respond to protection operations 3.9 Develop switching programs 3.10 Operate and monitor system SCADA	4.1 System Ride Through 4.2 Power System Disturbance and Contingency Response 4.3 Coordination 4.4 Energy Market Services 4.5 Fault Finding and Management 4.6 Monitor and control operations staff 4.7 Respond to protection operations 4.8 Operate and monitor generation system **Thermal | Wind | Solar | Hydro**
Advanced	5.1 Synchrophases 5.2 Transmission Planning 5.3 Facilities Design, Connections and Maintenance 5.4 Power System Simulation 5.5 Power System Restoration 5.6 Cyber Infrastructure and Security 5.7 Respond to complex protection operations 5.8 Lead and coordinate a control room 5.9 Transmission Congestion	6.1 Power System Simulation 6.2 Power System Restoration 6.3 Cyber Infrastructure and Security 6.4 Respond to complex protection operations 6.5 Lead and coordinate a control room 6.6 Design and interface of Distributed Energy Resources on the Distribution Network 7.1 Transmission Congestion	7.2 Power System Restoration 7.3 Cyber Infrastructure and Security 7.4 Respond to complex protection operations 7.5 Lead and coordinate a control room

Image 1. *PSO National Training Framework.*

The details of proposed Framework are described in **Appendix 4**.

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Appendix 1
Organisations Consulted

There were 21 interviews conducted in the initial consultation phase across 19 Organisations in all States and the ACT and NT, involving 51 people. Roles of interviewees were predominantly a mix of Control Room Managers, Senior Controllers/Team Leads, Controllers, and Trainers.

The organisations consulted during Phase 1 were:

State	NPS	Service
NSW	Ausgrid	Distribution
ACT	Evoenergy	Distribution
NSW	Transgrid	Transmission
NSW	Endeavour Energy	Distribution
NSW	Essential Energy	Distribution
QLD	Powerlink	Transmission
QLD	Energy Queensland	Distribution
SA	ElectraNet	Transmission
TAS	TasNetworks	Transmission/Distribution
VIC	AusNet Services	Transmission/Distribution
VIC	Jemena	Distribution
VIC	United Energy/Powercor/CitiPower	Distribution
NT	Power and Water	Transmission/Distribution
WA	Western Power	Transmission/Distribution
QLD	CS Energy	Generation
AUST	AGL Energy	Generation
AUST	BayWa R.E.	Generation

In addition, there were briefings conducted with the Steering Committee which consists of 24 people representing a variety of organisations including generators, distribution, and transmission, and industry bodies including the Clean Energy Council and Energy Networks Australia.

AEMO also provided updates to the OTWG and NEMOC, prior to the commencement of the project, during, and at the close of Phase 1.

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Appendix 2
Suite of Fundamentals

The following courses are defined as fundamentals. The fundamentals are required skills that all operators would possess or obtain as part of the framework.

NOTE: *This report references national training products that are in draft and under review. Once final versions are published on the national register a review will be undertaken to define impacts and update the Framework accordingly.*

Module	1.1 Australian Networks and Elements of Electrical Power Systems
Description	This course is focused on introduction to the Australian network operations and elements of electrical power systems. It covers the following: • The Australian Networks and Regulators • Basic operation of generators and transformers. • Transmission and distribution networks in Australia • Generators in Australia • AEMO • State interconnectors • National Electricity Market (NEM) in Australia • Electricity Statement of Opportunities (ESOO) • Integrated System Plan (ISP) • Loss Factors • Ancillary Services
Target Audience	The audience for this course is: • Managers; • Site operators
Baseline	Non-accredited / some alignment with **UETDRSO003**
Pre-requisites	Nil
Modality	Digital
Delivery mode	Online, Virtual Classroom; Face-to-Face
Recognition	Certificate of Completion
Assessment	Theory
Refresher	Nil

Module	1.2 Renewables and Emerging Technologies
Description	This course is focused on introduction to the renewables and emerging technologies. It covers the following: • Solar generation including roof top • Wind generation • Hydro generation including pumped hydro • Batteries. • Network impacts
Target Audience	The audience for this course is: • Managers; • Site operators
Baseline	Non-accredited
Pre-requisites	Nil
Modality	Digital
Delivery mode	Online, Virtual Classroom; Face-to-Face
Recognition	Certificate of Completion
Assessment	Theory
Refresher	Nil

Module	1.3 Communication Technologies
Description	This course is focused on introduction to the relevant communication processes and technologies that apply for network operations. It covers the following: • Control Room Communications • Communication systems and processes
Target Audience	The audience for this course is: • Control room operators; • Managers; • Site operators
Baseline	Non-accredited
Pre-requisites	Nil
Modality	Digital
Delivery mode	Online, Virtual Classroom; Face-to-Face
Recognition	Certificate of Completion
Assessment	Theory
Refresher	Nil

Module	1.4 Legislation and Regulation Overview
Description	This course is focused on an introduction to the relevant legislation and regulations that apply for network operations across various jurisdictions. It covers the following: • State and Federal Legislation • Regulations • Regulators
Target Audience	The audience for this course is: • Control room operators; • Managers
Baseline	Non-accredited
Pre-requisites	Nil
Modality	Digital
Delivery mode	Online, Virtual Classroom; Face-to-Face
Recognition	Certificate of Completion
Assessment	Theory
Refresher	Nil

Module	1.5 Electrical Fundamentals - DC
Description	This course is focused on solving problems in direct current circuits. It covers the following: • Identification of d.c. electrical circuits • Determine an electrical d.c. circuit problem • Complete work and document problem-solving activities
Target Audience	The audience for this course is all control room operators.
Baseline	**UEEEL0019** Solve problems in direct current (d.c.) machines.
Pre-requisites	**UEECD0044** Solve problems in multiple path circuits **UEECD0046** Solve problems in single path circuits
Modality	Digital
Delivery Mode	This course is delivered using a blended model: • Theory (may be online) • Simulation • Practical application (may be done remotely using virtual classroom)
Recognition	State of Attainment and Certificate of Completion
Assessment	Theory and Practical
Refresher	Nil

Module	1.6 Electrical Fundamentals - AC
Description	This course is focused on solving problems in low voltage alternating current circuits. This course covers the following: • Identify low voltage (LV) a.c. circuit problem • Solve LV a.c. circuit problems • Complete work and document problem-solving activities
Target Audience	The audience for this course is all control room operators.
Baseline	**UEEEL0020** Solve problems in low voltage a.c. circuits
Pre-requisites	**UEECD0044** Solve problems in multiple path circuits **UEECD0046** Solve problems in single path circuits
Modality	Digital
Delivery Mode	This course is delivered using a blended model: • Theory (may be online) • Simulation • Practical application (may be done remotely using virtual classroom)
Recognition	Statement of Attainment and Certificate of Completion
Assessment	Theory and Practical
Refresher	Nil

Module	1.7 Use of drawings, schedules, codes, and specifications
Description	This course is focused on operators using drawings, diagrams, schedules, standards, codes, and specifications. This course covers the following: • Prepare to use drawings, diagrams, schedules, and manuals • Use drawings, diagrams, schedules, and manuals to obtain job information. • Use drawings, diagrams, schedules, and manuals to convey information and ideas • Comply with industry standards, codes of practice and specifications
Target Audience	The audience for this course is all control room operators.
Baseline	**UEECD0051** Use drawings, diagrams, schedules, standards, codes, and specifications.
Pre-requisites	**UEECD0007** Apply work health and safety regulations, codes, and practices in the workplace.
Modality	Digital
Delivery Mode	This course is delivered using a blended model: • Theory (may be online) • Simulation • Practical application (may be done remotely using virtual classroom)
Recognition	Statement of Attainment and Certificate of Completion
Assessment	Theory
Refresher	Nil

Module	1.8 Electromagnetics
Description	This course is focused on operators solving problems in electromagnetic devices and related circuits. This course covers the following: • Prepare to work on electromagnetic devices and circuits. • Solve electromagnetic devices/circuit problems. • Complete work and document problem solving activities.
Target Audience	The audience for this course is all control room operators.
Baseline	**UEEEL0021** Solve problems in magnetic and electromagnetic devices
Pre-requisites	**UEECD0044** Solve problems in multiple path circuits **UEECD0046** Solve problems in single path circuits
Modality	Digital
Delivery Mode	This course is delivered using a blended model: a. Theory (may be online) b. Simulation c. Practical application
Recognition	Certificate of Completion
Assessment	Theory and Practical
Refresher	Nil

Module	1.9 Solve basic electrical computational problems
Description	This course is focused on operators providing solutions to basic engineering computational problems. This course covers the following: • Provide computational solutions to engineering problems • Complete work and documentation.
Target Audience	The audience for this course is all control room operators.
Baseline	**UEECD0039** Provide solutions to basic engineering computational problems
Pre-requisites	**UEECD0007** Apply work health and safety regulations, codes, and practices in the workplace
Modality	Digital
Delivery Mode	This course is delivered using a blended model: • Theory (may be online) • Simulation • Practical application (may be done remotely using virtual classroom)
Recognition	Statement of Attainment and Certificate of Completion
Assessment	Theory and Practical
Refresher	Nil

Module	1.10 Provide engineering solutions to problems in complex polyphase power circuits
Description	This course is focused on operators providing solutions to basic engineering computational problems. This course covers the following: • Prepare to provide engineering solutions to problems in complex polyphase power circuits. • Provide engineering solutions to problems in complex polyphase power circuits • Prepare to solve problems in complex multiple path circuits • Solve problems in complex multiple path circuits • Complete work and document solutions for problem solving activities.
Target Audience	The audience for this course is all control room operators.
Baseline	**UEEEL0062** Provide engineering solutions to problems in complex polyphase power circuits **UEECD0036** Provide engineering solutions for problems in complex multiple path circuits
Pre-requisites	**UEECD0036** Provide engineering solutions for problems in complex multiple path circuits **UEEEL0020** Solve problems in low voltage a.c. circuits
Modality	Digital
Delivery Mode	This course is delivered using a blended model: • Theory (may be online) • Simulation • Practical application (may be done remotely using virtual classroom)
Recognition	Statement of Attainment and Certificate of Completion
Assessment	Theory and Practical
Refresher	Nil

Module	1.11 Electrical Measurement
Description	This course is focused on introduction to electrical measurement. It covers the following: • Basic mathematical calculations • Instrument transformers • Transducers • Undertaking electrical measurements • Interpreting electrical measurements
Target Audience	The audience for this course is all control room operators.
Baseline	Non-accredited – potentially some crossover with UETDRTS027
Pre-requisites	Nil
Modality	Digital
Delivery Mode	This course is delivered using a blended model: • Theory (may be online) • Simulation • Practical application (may be done remotely using virtual classroom)
Recognition	Certificate of Completion
Assessment	Theory and Practical
Refresher	Nil

Module	1.12 Protection Fundamentals
Description	This course is focused on operators understanding protection fundamentals. This course covers the following: • Network protections • Relays • Isolation processes during faults • Protection testing and calibration overview
Target Audience	The audience for this course is: • Control room operators; • Managers; • Site operators
Baseline	**UETDRSO010Y** Respond to protection operations
Pre-requisites	**UEECD0007** Apply work health and safety regulations, codes and practices in the workplace **UEECD0036** Provide engineering solutions for problems in complex multiple path circuits **UEECD0039** Provide solutions to basic engineering computational problems **UEECD0044** Solve problems in multiple path circuits **UEECD0046** Solve problems in single path circuits **UEECD0051** Use drawings, diagrams, schedules, standards, codes and specifications **UEEEL0020** Solve problems in low voltage a.c. circuits **UEEEL0021** Solve problems in magnetic and electromagnetic devices **UEEEL0062** Provide engineering solutions to problems in complex polyphase power circuits **UETDREL005** Work safely in the vicinity of live electrical apparatus **UETDRIS005Y** Implement and monitor environmental requirements **UETDRIS006Y** Implement and monitor organisational WHS/OHS policies, procedures and programs
Modality	Digital, Simulation
Delivery Mode	This course is delivered using a blended model: • Theory (may be online) • Simulation • Practical application (may be done remotely using virtual classroom)
Recognition	Statement of Attainment and Certificate of Completion
Assessment	Theory and Practical
Refresher	Nil

Module	1.13 Switching Fundamentals
Description	This overview course is focused on operators comprehending and undertaking switching instructions following established procedures. This course covers the following: • Switching Instructions • Switching procedures • Standard safety requirements
Target Audience	The audience for this course is: • Control room operators; • Managers; • Site operators
Baseline	**UETDRSO005Y** Develop high voltage distribution and sub-transmission switching programs. **UETDRSO004Y** Develop and evaluate power systems transmission switching programs.
Pre-requisites	**UEECD0007** Apply work health and safety regulations, codes and practices in the workplace **UEECD0036** Provide engineering solutions for problems in complex multiple path circuits **UEECD0039** Provide solutions to basic engineering computational problems **UEECD0044** Solve problems in multiple path circuits **UEECD0046** Solve problems in single path circuits **UEECD0051** Use drawings, diagrams, schedules, standards, codes and specifications **UEEEL0020** Solve problems in low voltage a.c. circuits **UEEEL0021** Solve problems in magnetic and electromagnetic devices **UEEEL0062** Provide engineering solutions to problems in complex polyphase power circuits **UETDREL005** Work safely in the vicinity of live electrical apparatus **UETDRIS005Y** Implement and monitor environmental requirements **UETDRIS006Y** Implement and monitor organisational WHS/OHS policies, procedures and programs
Modality	Digital, Simulation, Virtual Reality
Delivery Mode	This course is delivered using a blended model: • Theory (may be online) • Simulation • Practical application (may be done remotely using virtual classroom or via VR capability)
Recognition	Statement of Attainment and Certificate of Completion
Assessment	Theory and Practical
Refresher	Nil

Module	1.14 Management and Coordination of Work Parties
Description	This course is focused on operators managing and coordinating working parties. This course covers the following: • Safety requirements and procedures • Access permits and limitations • Emergency procedures
Target Audience	The audience for this course is: • Control room operators; • Managers; • Site operators
Baseline	**UETTDRSO46Y** Dispatch and monitor field staff activities **UEPOPS430** Control permit to work operations
Pre-requisites	Nil
Modality	Digital, Virtual Reality
Delivery Mode	This course is delivered using a blended model: • Theory (may be online) • Simulation • Practical application (may be done remotely using virtual classroom)
Recognition	Statement of Attainment and Certificate of Completion
Assessment	Theory and Practical
Refresher	Nil

Module	1.15 Voltage Control and Reactive Power
Description	This course is focused on operators comprehending voltage control and reactive power across the networks. This course covers the following: • Voltage and power control equipment • Power – Voltage Curve • Power concepts and formulas (Ferranti voltage rise effect, surge impedance, voltage schedules and electric power principles)
Target Audience	The audience for this course is control room operators.
Baseline	Non-accredited
Pre-requisites	Nil
Modality	Digital, Simulation
Delivery Mode	This course is delivered using a blended model: • Theory (may be online) • Simulation • Practical application (may be done remotely using virtual classroom)
Recognition	Statement of Attainment and Certificate of Completion
Assessment	Theory and Practical
Refresher	Nil

Module	1.16 Reliability Operating Limits and Reliability
Description	This course is focused on operators comprehending reliability operating limits and reliability. This course covers the following: • Service reliability • Network distribution and loads / operating limits • Network performance and improvements
Target Audience	The audience for this course is control room operators.
Baseline	Non-accredited
Pre-requisites	Nil
Modality	Digital
Delivery Mode	This course is delivered using a blended model: • Theory (may be online) • Simulation • Practical application (may be done remotely using virtual classroom)
Recognition	Statement of Attainment and Certificate of Completion
Assessment	Theory
Refresher	Nil

Module	1.17 Power control and the Energy Market
Description	This course is focused on operators comprehending the energy market - power. This course covers the following: • Service reliability • Network distribution and loads / operating limits • Network performance and improvements
Target Audience	The audience for this course is: • Control room operators; • Managers; • Site operators
Baseline	**UETDRSO003Y** Coordinate operations in a regulated energy market **UEPOPS515** Coordinate power generation
Pre-requisites	**UEECD0007** Apply work health and safety regulations, codes and practices in the workplace **UEECD0044** Solve problems in multiple path circuits **UEECD0046** Solve problems in single path circuits **UEECD0051** Use drawings, diagrams, schedules, standards, codes and specifications **UEEEL0020** Solve problems in low voltage a.c. circuits **UEEEL0021** Solve problems in magnetic and electromagnetic devices **UETDREL005** Work safely in the vicinity of live electrical apparatus **UETDRIS005Y** Implement and monitor environmental requirements **UETDRIS006Y** Implement and monitor organisational WHS/OHS policies, procedures and programs
Modality	Digital/Simulation
Delivery Mode	This course is delivered using a blended model: • Theory (may be online) • Simulation • Practical application (may be done remotely using virtual classroom)
Recognition	Statement of Attainment and Certificate of Completion
Assessment	Theory
Refresher	Nil

Module	1.18 Emergency Operations
Description	This course is focused on operators comprehending and undertaking emergency operations following established procedures. This course covers the following: • Managing abnormal conditions • Emergency load transfer • Paralleling transformers and regulators • Restoration
Target Audience	The audience for this course is: • Control room operators; • Managers; • Site operators
Baseline	**UEPOPS454** Coordinate response to critical incidents **UETTDRIS70Y** Diagnose and resolve faults in distribution systems **UETTDRIS71Y** Diagnose and resolve faults in transmission systems
Pre-requisites	**UEPOPS369** Respond to a critical incident **UEECD0007** Apply work health and safety regulations, codes and practices in the workplace **UEECD0019** Fabricate, dismantle, assemble of utilities industry components **UEECD0044** Solve problems in multiple path circuits **UEECD0046** Solve problems in single path circuits **UEECD0051** Use drawings, diagrams, schedules, standards, codes and specifications **UEEEL0020** Solve problems in low voltage a.c. circuits **UEEEL0021** Solve problems in magnetic and electromagnetic devices **UETDREL005** Work safely in the vicinity of live electrical apparatus **UETTDRIS67Y** Solve problems in network equipment **UETTDRIS69Y** Diagnose and resolve faults in apparatus
Modality	Digital/Simulation
Delivery Mode	This course is delivered using a blended model: • Theory (may be online) • Simulation • Practical application (may be done remotely using virtual classroom)
Recognition	Statement of Attainment and Certificate of Completion
Assessment	Theory
Refresher	24 Months

Module	1.19 Resource and Demand Balancing
Description	This course is focused on operators comprehending resource and demand balancing across the networks. This course covers the following: • Regulated approaches • Disturbance control • Frequency response bias • Generation controls • Time correction • Inadvertent interchange
Target Audience	The audience for this course is control room operators.
Baseline	**UETDRSO007Y** Manage supply and demand in distribution and sub-transmission networks
Pre-requisites	**UEECD0007** Apply work health and safety regulations, codes and practices in the workplace **UEECD0044** Solve problems in multiple path circuits **UEECD0046** Solve problems in single path circuits **UEECD0051** Use drawings, diagrams, schedules, standards, codes and specifications **UEEEL0020** Solve problems in low voltage a.c. circuits **UEEEL0021** Solve problems in magnetic and electromagnetic devices **UETDRIS005Y** Implement & monitor environmental requirements **UETDRIS006Y** Implement and monitor organisational WHS/OHS policies, procedures and programs **UETDRSO001Y** Coordinate and manage distribution and sub-transmission network access and activities **UETDRSO005Y** Develop and validate distribution and sub-transmission switching programs
Modality	Digital/Simulation
Delivery Mode	This course is delivered using a blended model: • Theory (may be online) • Simulation • Practical application (may be done remotely using virtual classroom)
Recognition	Statement of Attainment and Certificate of Completion
Assessment	Theory
Refresher	Nil

Module	1.20 Human Factors – Effective Communications
Description	This course is focused on good practice for protocols and terminology when communicating across the network. It covers: • Use of terminology – differences and meanings • Respond to technical requests • Active listening • Clear and concise imparting of information including read-back • Effective question techniques • Record keeping
Target Audience	The audience for this course is: • Control room operators; • Managers; • Site operators
Baseline	Non-accredited
Pre-requisites	Nil
Modality	Digital/Simulation
Delivery Mode	This course is delivered using a blended model: • Theory (may be online) • Simulation • Practical application (may be done remotely using virtual classroom)
Recognition	Statement of Attainment and Certificate of Completion
Assessment	Theory
Refresher	Nil

Module	1.21 Human Factors – Fatigue and Fatigue Management
Description	This course is focused on building awareness about the effects of fatigue and techniques for managing fatigue. It covers: • Fatigue – definition and impacts • The science of fatigue • Monitoring methods – including smart watch technologies • Methods of reducing incidence of fatigue
Target Audience	The audience for this course is: • Control room operators; • Managers; • Site operators
Baseline	**TLIF2010** Apply fatigue management strategies
Pre-requisites	Nil
Modality	Digital/Simulation
Delivery Mode	This course is delivered using a blended model: • Theory (may be online) • Simulation • Practical application (may be done remotely using virtual classroom)
Recognition	Statement of Attainment and Certificate of Completion
Assessment	Theory
Refresher	Nil

Module	1.22 Human Factors – Human Machine Interface
Description	This course is focused on factors involved in operators working in complex user interface situations including alarm management. It covers: • Managing multiple sources of information • Combining information to analyse impacts and outcomes • Managing alarms and warnings • Ergonomics
Target Audience	The audience for this course is: • Control room operators; • Managers
Baseline	Non-accredited
Pre-requisites	Nil
Modality	Digital / Simulation
Delivery Mode	This course is delivered using a blended model: • Theory (may be online) • Simulation • Practical application (may be done remotely using virtual classroom)
Recognition	Statement of Attainment and Certificate of Completion
Assessment	Theory
Refresher	Nil

Module	1.23 Human Factors – Decision-making and degradation factors
Description	This course is focused on factors involved in operators working in control situations during periods of heavy workload and/or emergency conditions: • Sorting and prioritising information • Decision making techniques • Working under, and managing, stress • Use of effective communication • Post-incident reporting and evaluation techniques
Target Audience	The audience for this course is: • Control room operators; • Managers; • Site operators
Baseline	Non-accredited
Pre-requisites	Nil
Modality	Digital/ Simulation/ Online Evaluation
Delivery Mode	This course is delivered using a blended model: • Theory (may be online) • Simulation • Practical application (may be done remotely using virtual classroom)
Recognition	Statement of Attainment and Certificate of Completion
Assessment	Theory
Refresher	Nil

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Appendix 3
Overview of Findings

Subsequent analysis of common threads across the interviews determined the following findings:

Content Focus Areas		
Focus Area	**Modules**	**Emphasis**
Foundational (technical)	Emergency operations – network coordination	50 comments
	General knowledge of the network,	41
	Protection (fundamentals),	32
	Renewables (interaction and impacts in the network),	31
	Switching basics,	24
	Markets,	23
	Generation	22
	Voltage management	20
	Fault finding	18
	Constraints	15
	Load Shedding	15
	Power Flow	7
	Isolations	7
	Electrical fundamentals,	6
Foundational (non-technical)	Communications (protocols and terminology)	51 comments
	Human Factors - generally	10
	Fatigue	11
	Decision making	10
	Prioritising	5

Delivery Modes		
Focus Area	**Comments**	**Emphasis**
Blended	The majority indicated that this is the most common or most likely application of learning.	13
Workshop	There was support for centralised workshops	6
Online	Online self-paced modes were generally found to be ineffective without supervised or team management.	5
Virtual	There was some interest in the use of virtual/distance education using virtual classrooms	4
Face-to-Face	This was a preferred methodology although logistical limitations were acknowledged.	1
Blocks	Most organisations indicated that where training was required, they had processes to facilitate it. Training for new starters/trainees would be much simpler than controllers on shift. Gathering groups of controllers for training at the same time poses significant challenges.	N/A

Simulation		
Focus Area	**Comments**	**Emphasis**
Generic	For Generic simulation	12
	Against generic simulation	3
Online	Online simulation was seen as useful for reinforcing the basics.	12

Coverage		
Focus Area	**Comments**	**Emphasis**
How much of training does the framework provide content for	Framework covers core and common aspects, but internal training required for specifics of the network and local application	19
	Framework covers all aspects of training required by individual operators	0
	Only local processes and no Framework	1

Recognition		
Focus Area	**Comments**	**Emphasis**
Non-accredited	An industry certification is accepted with provisos that it would need wide-spread industry support, be transportable and be based on a recognised curriculum.	15
Accredited	Nationally recognised (accredited) training accepted but not a required approach.	8

Use of Advanced Diploma		
Focus Area	**Comments**	**Emphasis**
Accredited use	Accredited Adv Dip used as a recruitment prerequisite	2
	Accredited Adv Dip used in training	3
	Accredited Adv Dip partially used	2
	Accredited Adv Dip not used but some benchmarking	12

Framework Model		
Focus Area	**Comments**	**Emphasis**
Pathway -modular	Provide a pathway that has modules that can be a 'pick and choose' option.	17
Pathway -structured	Provide a pathway that is a structured curriculum	7
Single Framework	The preferred model is a single framework with a core and common base and then branches for TNSP, DNSP, Renewables. It would apply across all levels of experience.	10
Multiple Frameworks		2

In addition to analysis of interview data a comparative analysis process was conducted between the draft PSO Framework, selected current and proposed nationally recognised training packages, and the North American Electric Reliability Corporation (NERC) model.

The purpose of this comparison analysis was to further assist in the development of initial modelling by determining alignments and gaps.

The analysis data is summarised below.

PSO Framework and VET Products.

Given the VET products do not have entry requirements the higher levels have been used. Subsequently, core, elective and pre-requisite units were included. The impacts of packaging rules are not defined in this table, but they do impact the ability of the VET products to cover the full suite.

Foundational

Module	Title	UET60221	UEP50218	UET60221Y
1.1	Australian Networks and Elements of Electrical Power Systems.	UETDRSO003	Potential Gap	UETDRSO003Y
1.2	Renewables and Emerging Technologies	Potential Gap	Potential Gap	Potential Gap
1.3	Communication Technologies	Potential Gap	Potential Gap	Potential Gap
1.4	Legislation and Regulation Overview	Potential Gap	Potential Gap	Potential Gap
1.5	Electrical Fundamentals - DC	UEENEEE104A	Potential Gap	UEEEL0019
1.6	Electrical Fundamentals - AC	UEENEEG102A	Potential Gap	UEEEL0020
1.7	Electrical Fundamentals – Use drawings, schedules, codes, and specifications	UEENEEE107A	Potential Gap	UEECD0051
1.8	Electrical Fundamentals - Electromagnetics	UEEEL0021	Potential Gap	UEEEL0021
1.9	Electrical Fundamentals - basic electrical computational problems.	UEENEEE126A	Potential Gap	UEECD0039
1.10	Electrical Fundamentals - Provide engineering solutions to problems in complex polyphase power circuits	UETDRTS027	Potential Gap	Potential Gap
1.11	Electrical Fundamentals – Electrical measurements	UETDRTS027	Potential Gap	UETDRTS027Y
1.12	Protection Fundamentals	UETTDRIS68	UEPOPS342 UEPOPS426	UETDRSO010Y
1.13	Switching Fundamentals	UETDRSO005	UEPOPS428	UETDRSO005Y
1.14	Management and coordination of work parties and field operators	UETTDRSO46	UEPOPS430	UETTDRSO46Y
1.15	Voltage Control and Reactive Power	Potential Gap		Potential Gap

1.16	Reliability Operating Limits and Reliability	Potential Gap	UEPOPS510	Potential Gap
1.17	Energy Market Power	UETDRSO003	UEPOPS515	UETDRSO003Y
1.18	Emergency Operations	Potential Gap	UEPOPS454	UETTDRIS70Y UETTDRIS71Y
1.19	Resource and Demand Balancing	UETDRSO007	UEPOPS422 UEPOPS413	UETDRSO007Y
1.2	Human Factors – Effective Communications	Potential Gap	Potential Gap	Potential Gap
1.21	Human Factors – Fatigue and Fatigue Management	Potential Gap	Potential Gap	TLIF2010
1.22	Human Factors – Human Machine Interface	Potential Gap	Potential Gap	Potential Gap
1.23	Human Factors – Decision making and degradation factors	Potential Gap	Potential Gap	Potential Gap

Transmission Standard

Module	Title	UET60221	UEP50218	UET60221Y
2.1	System Ride Through	Potential Gap		Potential Gap
2.2	Power System Disturbance and Contingency Response	Potential Gap		Potential Gap
2.3	Coordination	UETDRSO002		UETDRSO002Y
2.4	Power System Stability	Potential Gap		Potential Gap
2.5	Fault Finding and Management	UETTDRIS71 UETTDRIS72 UETDRSO008		UETTDRIS71Y
2.6	Monitor and control field staff	UETTDRSO46		UETTDRSO46Y
2.7	Respond to protection operations	UETDRSO011		UETTDRIS68Y
2.8	Develop switching programs	UETDRSO004		UETDRSO004Y
2.9	Operate and monitor system SCADA	UETTDRSO45		UETTDRSO45Y

Distribution Standard

Module	Title	UET60221	UEP50218	UET60221Y
3.1	System Ride Through	Potential Gap		Potential Gap
3.2	Power System Disturbance and Contingency Response	Potential Gap		Potential Gap
3.3	Coordination	UETDRSO001		UETDRSO001Y
3.4	Power System Stability	Potential Gap		Potential Gap
3.5	Fault Finding and Management	UETTDRIS70 UETTDRIS72 UETDRSO008		UETTDRIS70Y
3.6	Transmission Operations	UETDRSO009		Potential Gap
3.7	Monitor and control field staff	UETTDRSO46		UETTDRSO46Y
3.8	Respond to protection operations	UETDRSO011		UETDRSO010Y
3.9	Develop switching programs	UETDRSO005		UETDRSO005Y UETDRSO007Y
3.10	Operate and monitor system SCADA	UETTDRSO45		UETTDRSO45Y

Generation Standard

Module	Title	UET60221	UEP50218	UET60221Y
4.1	System Ride Through		Potential Gap	
4.2	Power System Disturbance and Contingency Response		UEPOPS420	
4.3	Coordination		UEPOPS424 UEPOPS525	
4.4	Energy Market Services		Potential Gap	
4.5	Fault Finding and Management		UEPMNT411 UEPMNT417	
4.6	Monitor and control operations staff		UEPOPS430	
4.7	Respond to protection operations		UEPMNT411 UEPMNT417	
4.8	Operate and monitor generation system		UEPOPS515	
	Develop H.V. switching programs		UEPOPS428	

Transmission Advanced

Module	Title	UET60221	UEP50218	UET60221Y
5.1	Synchrophases	Potential Gap		Potential Gap
5.2	Transmission Planning	Potential Gap		Potential Gap
5.3	Facilities Design, Connections and Maintenance	Potential Gap		Potential Gap
5.4	Power System Simulation	Potential Gap		Potential Gap
5.5	Power System Restoration	Potential Gap		Potential Gap
5.6	Cyber Infrastructure and Security	Potential Gap		Potential Gap
5.7	Respond to complex protection operations	UETDRSO010 UETDRSO011		Potential Gap
5.8	Lead and coordinate a control room	Potential Gap		BSBTWK502
5.9	Transmission Congestion	Potential Gap		

Distribution Advanced

Module	Title	UET60221	UEP50218	UET60221Y
6.1	Power System Simulation	Potential Gap		Potential Gap
6.2	Power System Restoration	Potential Gap		Potential Gap
6.3	Cyber Infrastructure and Security	Potential Gap		Potential Gap
6.4	Respond to complex protection operations	UETDRSO010 UETDRSO011		UETDRSO010Y
6.5	Lead and coordinate a control room	Potential Gap		BSBTWK502
6.6	Design and Interface of Distributed Energy Resources on the Distribution Network	Potential Gap		UETDRDS999Y

Generation Advanced

Module	Title	UET60221	UEP50218	UET60221Y
7.1	Transmission Congestion		Potential Gap	
7.2	Power System Restoration		UEPOPS437	
7.3	Cyber Infrastructure and Security		Potential Gap	
7.4	Respond to complex protection operations		UEPMNT411 UEPMNT417	
7.5	Lead and coordinate a control room		BSBWOR502	

It should be noted that there are other nationally recognised units of competency that may apply against some of these requirements outside of the specific packing of the qualifications. Where these can be identified as suitable, they would be used separate to any qualification requirement.

In addition to a comparative analysis to the VET products, an analysis against an international standard was also conducted. The standard used for comparison was the NERC System Operator Certification requirements (April 2020). The result of that analysis is depicted below:

NERC System Operator Certification Manual 2020	PSO Framework	
Requirements	**Module**	**Title**
1. Basic Concepts		
a. Basic ac/dc Electricity	1.5	Electrical Fundamentals - DC
	1.6	Electrical Fundamentals - AC
b. Basic Power System Mathematic Concepts	1.9	Electrical Fundamentals - basic electrical computational problems.
c. Characteristics of the Bulk Electric System	1.1	Australian Networks and Elements of Electrical Power Systems.
2. System Protection Principles		
a. Transmission lines	1.12	Protection Fundamentals
b. Transformers	1.12	Protection Fundamentals
c. Busses	1.12	Protection Fundamentals
d. Generators	1.12	Protection Fundamentals
e. Relays and protection schemes	2.7	Respond to protection operations
f. Power system faults	2.7	Respond to protection operations
g. Synchronizing equipment	2.7	Respond to protection operations
h. Under-frequency load shedding	2.7	Respond to protection operations
i. Under-voltage load shedding	2.7	Respond to protection operations
j. Communication systems utilized	1.3	Communication Technologies

3. Interconnected Power System Operations		
a. Voltage control	1.15	Voltage Control and Reactive Power
b. Frequency control		
c. Power system stability	2.4	Power System Stability
d. Facility outage both planned and unplanned	2.6	Monitor and control field staff
e. Energy accounting		Potential Gap
f. Inadvertent energy		Potential Gap
g. Time error control		Potential Gap
h. Balancing of load and resources	1.9	Resource and Demand Balancing
4. Emergency Operations		
a. Loss of generation resource(s)	1.18	Emergency Operations
b. Loss of transmission element(s)	1.18	Emergency Operations
c. Operating reserves	1.18	Emergency Operations
d. Contingency reserves		Emergency Operations
e. Line loading relief		Emergency Operations
f. Load shedding		Emergency Operations
g. Voltage and reactive flows during emergencies		Emergency Operations
h. Loss of EMS		Potential Gap
i. Loss of primary control centre		Potential Gap
5. Power System Restoration		
a. Restoration philosophies	5.5	Power System Restoration
b. Facility restoration priorities	5.5	Power System Restoration
c. Blackstart restoration	5.5	Power System Restoration
d. Stability (angle and voltage)	5.5	Power System Restoration
e. Islanding and synchronizing	5.5	Power System Restoration

6. Market Operations		
a. NAESB standards	AEMO	Potential Gap
b. Standards of conduct		
c. Tariffs	1.17	Energy Market Power
d. OASIS applications (Transmission Reservations)		
e. E-Tag application		
f. Transaction scheduling	4.4	Energy Market Services
g. Market applications	1.17	Energy Market Power
h. Interchange	4.4	Energy Market Services
7. Tools		
a. Supervisory Control and Data Acquisition (SCADA)	3.9	Operate and monitor system SCADA
b. Automatic Generation Control (AGC) application	4.8	Operate and monitor generation system
c. Power flow application		Potential Gap
d. State Estimator application		Potential Gap
e. Contingency analysis application	4.2	Power System Disturbance and Contingency Response
f. P-V Curves		Potential Gap
g. Load forecasting application		Potential Gap
h. Energy accounting application		Potential Gap
i. Voice and data communication systems	1.3	Communication Technologies

8. System Operator Situational Awareness		
a. Identifying loss of facilities	1.22	Human Factors – Human Machine Interface
b. Recognizing loss of communication facilities	1.22	Human Factors – Human Machine Interface
c. Recognizing telemetry problems	1.22	Human Factors – Human Machine Interface
d. Recognizing and identifying contingency problems	4.2	Power System Disturbance and Contingency Response
e. Proper communications (three-part)	1.2	Human Factors – Effective Communications
f. Communication with appropriate entities including the Reliability Coordinator	1.2	Human Factors – Effective Communications
g. Cyber and physical security and threats	5.6	Cyber Infrastructure and Security
h. Reducing System Operator errors using Human Performance Tools, such as Self Checking, Peer Checking, Place Keeping, and Procedure Use	1.23	Human Factors – Decision making and degradation factors
9. Policies and Procedures		
a. ISO/RTO operational and emergency policies and procedures	1.1	Australian Networks and Elements of Electrical Power Systems.
b. Regional operational and emergency policies and procedures		Potential Gap
c. Company-specific operational and emergency policies and procedures		Potential Gap
10. ERC Reliability Standards		
a. Application and/or implementation of NERC Reliability Standards	1.4	Legislation and Regulation Overview

NOTE: *As Phase 2 is undertaken, detailed analysis against the requirements of each PSO Framework module against the individual units of competencies and NERC requirements will be required.*

10 Appendix 4 The Framework

The build of The Framework is depicted in Image 1:

POWER SYSTEMS OPERATOR NATIONAL TRAINING FRAMEWORK

	All		
Fundamental	1.1 Australian Networks and Elements of Electrical Power Systems. 1.2 Renewables and Emerging Technologies. 1.3 Communication Technologies. 1.4. Legislation and Regulation Overview. 1.5. Electrical Fundamentals - DC. 1.6. Electrical Fundamentals - AC. 1.7. Electrical Fundamentals – Use drawings, schedules, codes, and specifications 1.8. Electrical Fundamentals - Electromagnetics	1.9. Electrical Fundamentals - basic electrical computational problems. 1.10. Electrical Fundamentals - Provide engineering solutions to problems in complex polyphase power circuits. 1.11. Electrical Fundamentals – Electrical measurements 1.12. Protection Fundamentals 1.13. Switching Fundamentals 1.14. Management and coordination of work parties and field operators 1.15. Voltage Control and Reactive Power	1.16. Reliability Operating Limits and Reliability 1.17. Power Control and the Energy Market 1.18. Emergency Operations 1.19. Resource and Demand Balancing 1.20. Human Factors – Effective Communications 1.21. Human Factors – Fatigue and Fatigue Management 1.22. Human Factors – Human Machine Interface 1.23. Human Factors – Decision making and degradation factors
	Transmission	**Distribution**	**Generation**
Standard	2.1 System Ride Through 2.2 Power System Disturbance and Contingency Response 2.3 Coordination 2.4 Power System Stability 2.5 Fault Finding and Management 2.6 Monitor and control field staff 2.7 Respond to protection operations 2.8 Develop switching programs 2.9 Operate and monitor system SCADA	3.1 System Ride Through 3.2 Power System Disturbance and Contingency Response 3.3 Coordination 3.4 Power System Stability 3.5 Fault Finding and Management 3.6 Transmission Operations 3.7 Monitor and control field staff 3.8 Respond to protection operations 3.9 Develop switching programs 3.10 Operate and monitor system SCADA	4.1 System Ride Through 4.2 Power System Disturbance and Contingency Response 4.3 Coordination 4.4 Energy Market Services 4.5 Fault Finding and Management 4.6 Monitor and control operations staff 4.7 Respond to protection operations 4.8 Operate and monitor generation system **Thermal | Wind | Solar | Hydro**
Advanced	5.1 Synchrophases 5.2 Transmission Planning 5.3 Facilities Design, Connections and Maintenance 5.4 Power System Simulation 5.5 Power System Restoration 5.6 Cyber Infrastructure and Security 5.7 Respond to complex protection operations 5.8 Lead and coordinate a control room 5.9 Transmission Congestion	6.1 Power System Simulation 6.2 Power System Restoration 6.3 Cyber Infrastructure and Security 6.4 Respond to complex protection operations 6.5 Lead and coordinate a control room 6.6 Design and interface of Distributed Energy Resources on the Distribution Network 7.1 Transmission Congestion	7.2 Power System Restoration 7.3 Cyber Infrastructure and Security 7.4 Respond to complex protection operations 7.5 Lead and coordinate a control room

Image 1. *PSO National Training Framework.*

The Framework modules are described across the following tables:

Power Systems Operator National Training Framework

Fundamentals		
Module	**Title**	**Description**
1.1	Australian Networks and Elements of Electrical Power Systems.	Overview of the NEM, regulators, market forces, operation, and assets.
1.2	Renewables and Emerging Technologies	Overview of the renewable sector, interactions and impacts on the network.
1.3	Communication Technologies	The systems and considerations for communication across the network
1.4	Legislation and Regulation Overview	Overview of the regulatory framework the network operates in. Obligations and conditions and the role of the regulator.
1.5	Electrical Fundamentals - DC	Identify DC circuits, determine and solve problems
1.6	Electrical Fundamentals - AC	Identify AC circuits, determine and solve problems
1.7	Electrical Fundamentals – Use drawings, schedules, codes, and specifications	Use and interpretation of drawings, schedules, codes, and specifications
1.8	Electrical Fundamentals - Electromagnetics	Identify electromagnetic devices and related circuits, determine, and solve problems
1.9	Electrical Fundamentals - basic electrical computational problems.	Provide solutions to basic engineering computational problems, including basic energy formulas.
1.10	Electrical Fundamentals - Provide engineering solutions to problems in complex polyphase power circuits	Provide solutions to complex engineering computational problems
1.11	Electrical Fundamentals – Electrical measurements	Undertake and interpret electrical measurements
1.12	Protection Fundamentals	Overview of Network protections, relays, and isolation processes during faults
1.13	Switching Fundamentals	Overview of switching instructions and operators comprehending field operations and following established procedures.
1.14	Management and coordination of work parties and field operators	Overview of the considerations and work environments of work parties and field operators.
1.15	Voltage Control and Reactive Power	Overview of voltage control and reactive power across the networks.
1.16	Reliability Operating Limits and Reliability	Overview of reliability operating limits and reliability and impacts.

1.17	Power Control and the Energy Market	Overview of national electricity market concepts and regulation, including pricing and demand, power flow, network interactions and impacts and risk factors.
1.18	Emergency Operations	Overview of managing abnormal conditions, emergency load transfer, paralleling transformers and regulators, and restoration across the network
1.19	Resource and Demand Balancing	Overview of regulated approaches, disturbance control, frequency response bias, generation controls, time correction, and inadvertent interchange
1.20	Human Factors – Effective Communications	Overview of good practice for protocols and terminology when communicating across the network.
1.21	Human Factors – Fatigue and Fatigue Management	Factors of fatigue and techniques for managing fatigue organisationally and personally
1.22	Human Factors – Human Machine Interface	Overview of factors involved in operators working in complex user interface situations including alarm management.
1.23	Human Factors – Decision Making and Degradation Factors	Overview of the factors in prioritising and making decisions including performance under stress.
Standard - Transmission		
Module	**Title**	**Description**
2,1	System Ride Through	A module focused on operators comprehending system ride-through, including generators and power management, fault, under voltage, low voltage ride-throughs and distribution impacts.
2.2	Power System Disturbance and Contingency Response	A module focused on operators comprehending power system disturbance and contingency response. This includes basics of power systems, circuit breaker operations, load shedding and blackouts.
2.3	Coordination	A module focused on operators applying the protocols for coordination across the network. This includes coordinating load relief, between agencies and coordinators, and events requiring coordination.
2.4	Power System Stability	A module focused on operators applying the protocols for power system stability across the network. This includes types of disturbances and grid instability impacts, operating conditions, states of stability and process for assessing stability/ analysis modes.

2.5	Fault Finding and Management	A module focused on operators undertaking fault finding and fault management procedures across the networks. This includes faults and fault management, problem solving and diagnosis of faults and fault management systems.
2.6	Monitor and control field staff	A module on managing and communicating with work parties and field operators specific to transmission operations.
2.7	Respond to protection operations	A module on operating priorities for responding to Network protections, relays, and isolation processes during faults.
2.8	Develop switching programs	A module on good practice development of switching instructions
2.9	Operate and monitor system SCADA	A module on effective use and monitoring of control systems
Standard - Distribution		
Module	**Title**	**Description**
3.1	System Ride Through	A module focused on operators comprehending system ride-through, including generators and power management, fault, under voltage, low voltage ride-throughs and distribution impacts.
3.2	Power System Disturbance and Contingency Response	A module focused on operators comprehending power system disturbance and contingency response. This includes basics of power systems, circuit breaker operations, load shedding and blackouts.
3.3	Coordination	A module focused on operators applying the protocols for coordination across the network. This includes coordinating load relief, between agencies and coordinators, and events requiring coordination.
3.4	Power System Stability	A module focused on operators applying the protocols for power system stability across the network. This includes types of disturbances and grid instability impacts, operating conditions, states of stability and process for assessing stability/ analysis modes.
3.5	Fault Finding and Management	A module focused on operators undertaking fault finding and fault management procedures across the networks. This includes faults and fault management, problem solving and diagnosis of faults and fault management systems.
3.6	Transmission Operations	A module on transmission operations relevant to up-stream / down-stream impacts on network operations.

3.7	Monitor and control field staff	A module on managing and communicating with work parties and field operators specific for distribution operations.
3.8	Respond to protection operations	A module on operating priorities for responding to Network protections, relays, and isolation processes during faults.
3.9	Develop switching programs	A module on good practice development of switching instructions
3.10	Operate and monitor system SCADA	A module on effective use and monitoring of control systems
Standard - Generation		
Module	**Title**	**Description**
4.1	System Ride Through	A module focused on operators comprehending system ride-through, including generators and power management, fault, under voltage, low voltage ride-throughs and distribution impacts.
4.2	Power System Disturbance and Contingency Response	A module focused on operators comprehending power system disturbance and contingency response. This includes basics of power systems, circuit breaker operations, load shedding and blackouts.
4.3	Coordination	A module focused on operators applying the protocols for coordination across the network. This includes coordinating load relief, between agencies and coordinators, and events requiring coordination.
4.4	Energy Market Services	A module focused on operators comprehending the energy market - services. This includes generation sources, regulatory impacts, services, and ancillary services.
4.5	Fault Finding and Management	A module focused on operators undertaking fault finding and fault management procedures across the networks. This includes faults and fault management, problem solving and diagnosis of faults and fault management systems.
4.6	Monitor and control operations staff	A module on managing and communicating with work parties and field operators specific for generation operations.
4.7	Respond to protection operations	A module on operating priorities for responding to Network protections, relays, and isolation processes during faults.
4.8	Operate and monitor generation system	A module on effective use and monitoring of control systems

Advanced - Transmission		
Module	**Title**	**Description**
5.1	Synchrophases	A module focused on operators comprehending and applying synchrophases across the networks. This includes synchrophasor definition and concepts, network infrastructure, wide area measurements, analysis, and corrective actions, planning and protections.
5.2	Transmission Planning	A module focused on operators comprehending and applying transmission planning across the networks. This includes roles of regulators and providers, national transmission network development plan, national electricity rules and planning, and implementation and reporting.
5.3	Facilities Design, Connections and Maintenance	A module focused on operators comprehending the facilities design, connections, and maintenance across the networks. This includes regulatory design considerations, network operating limits and reliability standards, and the national network – interconnections.
5.4	Power System Simulation	A module focused on operators undertaking power system simulation across the networks. This includes system modelling and types of simulation, data collection and analysis methods, calculations and power flow and modelling and specifications.
5.5	Power System Restoration	A module focused on distribution operators comprehending the processes and protocols for power system restoration applied across the networks. This includes emergency protocols, system operating limits, contingency analysis, planning and protocols, restoration protocols including 'black start', voltage and frequency control.
5.6	Cyber Infrastructure and Security	A module focused on operators comprehending the cyber infrastructure and security protocols applied across the networks. This includes threats and protections, physical access protocols, digital access protocols, responding to an attack, recovering from an attack.
5.7	Respond to complex protection operations	A module on responding to complex protection operations.
5.8	Lead and coordinate a control room	A module focused on team resource management to lead and coordinate a control room.
5.9	Transmission Congestion	A module focused on operators comprehending transmission congestion across the networks. This includes operating levels and conditions, path ratings and impacts, operator procedures, and reporting and management.

Advanced - Distribution		
Module	**Title**	**Description**
6.1	Power System Simulation	A module focused on operators undertaking power system simulation across the networks. This includes system modelling and types of simulation, data collection and analysis methods, calculations and power flow and modelling and specifications.
6.2	Power System Restoration	A module focused on distribution operators comprehending the processes and protocols for power system restoration applied across the networks. This includes emergency protocols, system operating limits, contingency analysis, planning and protocols, restoration protocols including 'black start', voltage and frequency control.
6.3	Cyber Infrastructure and Security	A module focused on operators comprehending the cyber infrastructure and security protocols applied across the networks. This includes threats and protections, physical access protocols, digital access protocols, responding to an attack, recovering from an attack.
6.4	Respond to complex protection operations	
6.5	Lead and coordinate a control room	A module focused on team resource management to lead and coordinate a control room.
6.6	Design and Interface of Distributed Energy Resources on the Distribution Network	Interfacing with renewable energy sources on the distribution network.

Advanced - Generation		
Module	**Title**	**Description**
7.1	Transmission Congestion	A module focused on operators comprehending transmission congestion across the networks. This includes operating levels and conditions, path ratings and impacts, operator procedures, and reporting and management.
7.2	Power System Restoration	A module focused on distribution operators comprehending the processes and protocols for power system restoration applied across the networks. This includes emergency protocols, system operating limits, contingency analysis, planning and protocols, restoration protocols including 'black start', voltage and frequency control.
7.3	Cyber Infrastructure and Security	A module focused on operators comprehending the cyber infrastructure and security protocols applied across the networks. This includes threats and protections, physical access protocols, digital access protocols, responding to an attack, recovering from an attack.
7.4	Respond to complex protection operations	A module on responding to complex protection operations.
7.5	Lead and coordinate a control room	A module focused on team resource management to lead and coordinate a control room.

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