

# NATIONAL METAL & ENGINEERING CURRICULUM

**MODULE:** GENERATION AND DISTRIBUTION OF ELECTRICAL ENERGY (NE042)

**PURPOSE:** This module aims to provide the student with instruction in the generation, transmission and distribution of electrical energy.

**NOMINAL DURATION:** Half module

*A full module is designed on the assumption that most of the students will achieve the competencies specified in 35 to 40 hours.*

*The length of time taken to complete a module will vary depending on factors such as teaching method used, knowledge and skills at entry and individual students ability.*

**PREREQUISITES:** Single and Three Phase Circuits (NE09)

**LEARNING OUTCOMES:** On completion of this module the student will be able to:

1. Describe the process known as generation and name the two predominant types of generating system used in Australia and the reasons for their adoption.
2. Explain the function of a transmission system within an overall power system.
3. Describe the need for a distribution system within an overall power system.
4. Explain the need for and the purpose of substations within an overall power system.
5. Describe the relative advantages and disadvantages of overhead and underground supply systems within a power system.

***STUDENTS SHOULD BE MADE AWARE OF OCCUPATIONAL HEALTH AND SAFETY ISSUES IN ALL SITUATIONS AND BE EXPECTED TO DEMONSTRATE SAFE WORKING PRACTICES AT ALL TIMES.***

**OUTLINE OF CONTENT:** The module contains:

1. **Generation**
  - definition
  - primary energy sources
  - power stations
  - power station output
  - acts and legislation relating to generation

2. **Transmission**
  - system requirements
  - principal components of a power system
  - voltage levels
  - grid systems
  - acts/legislation relating to transmission
  - future trends
  
3. **Distribution**
  - high voltage distribution systems
  - medium/low voltage distribution systems
  - radial feeders
  - parallel feeders
  - ring main feeders
  - acts/legislation relating to distribution
  
4. **Substations**
  - purpose
  - location
  - layout
  
5. **Overhead and underground systems**
  - relative merits
  - applications
  - planning
  - installation

\* Details of topics available in APPENDIX 1

**ON-THE-JOB TRAINING:**

For consolidation, the material in this module should be linked with and complemented by relevant on-the-job skill practice or other equivalent experience.

**PERFORMANCE CRITERIA:**

The criteria for each learning outcome should be:

**Learning Outcome 1**

**Assessment:**

**Short answer questions**

**Performance:**

- a. **Define generation.**
- b. **State the two main types of power station in Australia.**
- c. **Explain the reasons for power station location.**
- d. **Describe the overall layout of thermal and hydroelectric power stations.**
- e. **Explain how power control is achieved to meet load requirements in both thermal and hydroelectric generating systems.**
- f. **State typical operating speeds for thermal and hydroelectric generating sets.**
- g. **State typical generator voltage levels and output ratings.**
- h. **Name the body responsible for generation in a given state.**

**Learning Outcome 2**

**Assessment:**

**Short answer questions**

**Performance:**

- a. **State the basic requirements of a transmission system.**
- b. **Name the principal components of a power system.**
- c. **State typical voltage levels for primary and secondary transmission.**
- d. **Explain the advantages of a grid type transmission system.**
- e. **Interpret information from a single line diagram of a transmission system.**
- f. **Name the body responsible for transmission in a given state.**

### **Learning Outcome 3**

**Assessment:** Short answer questions

- Performance:**
- a. Describe two methods of high voltage distribution.
  - b. Describe four methods of medium/low voltage distribution.
  - c. Identify radial, parallel and ring main feeders from a single line diagram.
  - d. State the advantages and disadvantages of radial, parallel and ring main feeders.
  - e. Name the body responsible for distribution in a given state.

### **Learning Outcome 4**

**Assessment:** Short answer questions

- Performance:**
- a. State the reasons for incorporating substations in a power system.
  - b. Describe how substations are located in relation to load centres.
  - c. Describe the layout of high voltage equipment in a substation.
  - d. List the auxiliary equipment used in substations.
  - e. Interpret information from a single line diagram of the high-voltage equipment of a substation.

### **Learning Outcome 5**

**Assessment:** Short answer questions

- Performance:**
- a. Describe the relative merits of overhead and underground systems.
  - b. List applications for overhead systems in the areas of transmission and distribution .
  - c. List applications for underground systems in the areas of transmission and distribution.
  - d. State the basic steps involved in the planning of an overhead and an underground distribution line.
  - e. State the basic steps involved in the installation of an overhead and an underground distribution line.

## APPENDIX 1

### Suggested module content:

1. **Generation**
  - definition
    - energy conversion
  - primary energy sources
    - thermal energy from coal or oil
    - kinetic energy of moving water
  - power stations
    - location
    - types, thermal and hydroelectric
    - overview of power station makeup, thermal and hydro
    - block diagram, thermal and hydro
    - system power flow, thermal and hydro
  - power control to meet load requirements
    - system frequency and typical operating speeds, thermal and hydro
  - power station output
    - generator output ratings
    - generator voltage levels
  - acts and legislation relating to generation
    - bodies responsible for generation

Suggested teaching time: 4 hours.

2. **Transmission**
  - system requirements
    - meet load requirements
    - voltage stability
    - frequency stability
    - safety standards
  - principal components of a power system
    - generating station
    - transmission system
    - substations
    - distribution system
    - load
    - power system block diagram
  - voltage levels
    - primary transmission
    - secondary transmission
    - grid systems
    - reasons for
    - interconnection between states
  - acts and legislation relating to transmission
    - bodies responsible for transmission
  - future trends
    - voltage levels

Suggested teaching time: 4 hours.

- 3. Distribution**
- high-voltage systems
    - three phase three wire
    - single wire earth return (SWER) system
  - medium/low-voltage systems
    - 240 volt two wire supply
    - 415/240 volt three wire supply
    - 415/240 volt four wire supply
    - 480/240 volt single wire earth return (SWER) system
  - radial feeders
    - single line diagram
    - advantages and disadvantages
    - applications
    - parallel feeders
    - single line diagram
    - advantages and disadvantages
    - applications
    - ring main feeders
    - single line diagram
    - advantages and disadvantages
    - applications
  - acts and legislation relating to distribution
    - bodies responsible for distribution

**Suggested teaching time: 4 hours.**

- 4. Substations**
- purpose
    - load control
    - transformation of voltages
    - distribution of power
    - switching (for load control or maintenance purposes)
  - location in relation to load centres
    - regional distribution centres
    - zone substations
    - distribution centres (kiosk or pole mount)
  - layout
    - high-voltage equipment (transformers, circuit breakers, isolators, busbars, capacitors, reactors)
    - auxiliary equipment (control, metering and protection schemes, current and voltage transformers)
    - single line diagram of high voltage equipment

**Suggested teaching time: 4 hours.**

- 5. Overhead and underground systems**
- relative merits
    - cost
    - environmental aspects
    - reliability
    - increasing load capacity
  - applications
    - overhead systems for transmission and distribution
    - underground systems for transmission and distribution
  - planning and installation
    - basic planning of an overhead system
    - installation of an overhead system
    - basic planning of an underground system
    - installation of an underground system