Government of Western Australia
North Metropolitan TAFE

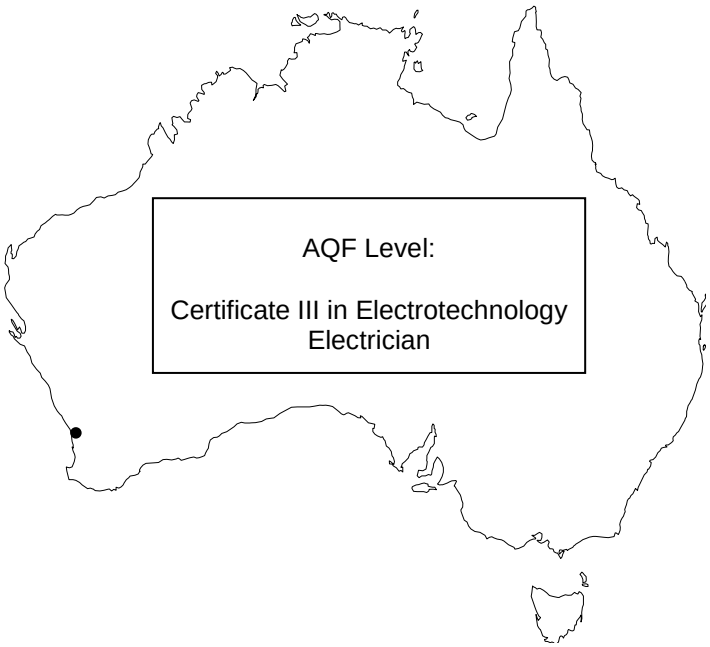
UEE 11 Training Package Support Material
(Non-Endorsed Component)

Based on:
National Electrotechnology Industry Standards

Resource Book

UEENEEG106A

Terminate cables, cords and accessories for low voltage circuits.



North Metropolitan TAFE
Edited by J. Waswo
August 2018

UEENEEE106A

Terminate Cables, Cords & Accessories for Low Voltage Circuits

A composite
Training resource

Certificate III in Electrotechnology Electrician

Version 1 – 01/2013
Version 2 – 04/2015
Version 3 – 08/2018 – alignment to AS/NZS3000:2018
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Certificate III in Electrotechnology Electrician UEE 30811

UEENEEG106A – Terminate cables, cords and accessories for low voltage circuits.

C O N T E N T S

Training Achievement Record

Name:	TAFE No:	App No
Employer:		College:

Activity	Topic	Date	Lecturer	
Section 1				
Worksheet 1-1	Electric Cables			
Worksheet 1-2	Flexible Cords and Extension Leads			
Worksheet 1-3	Cable Applications			
Activity Sheet 1-1	Cable Identification			
Activity Sheet 1-2	Power Cable Terminations			
Activity Sheet 1-3	Flexible Cord Terminations			
Activity Sheet 1-4	Single Phase Extension Leads			
Section 2				
Worksheet 2-1	Installation of TPS Cables			
Activity Sheet 2-1	Installation of TPS Cables			
Worksheet 2-2	Installation of TPI Cables in Conduit			
Activity Sheet 2-2	Installation of TPI Cables in Metal & PVC Conduit			
Worksheet 2-3	Installation of Armoured Cables			
Activity Sheet 2-3	Installation of Armoured Cables			
Worksheet 2-4	Installation of Catenary Supported Cables			
Activity Sheet 2-4	Installation of Catenary Supported Cables			
Activity Sheet 2-5	Installation of Catenary Supported Trailing Cables			
Activity Sheet 2-6	Installation of High Temp Cable [Radox]			

References

- Electrical Wiring Practice – Volume 1(7th ed.) Pethebridge & Neeson
- AS/NZS 3000 (current edition)
- Code of Practice – Safe electrical work on low voltage electrical installations
- WA Electrical Requirements

Certificate III in Electrotechnology Electrician UEE 30811

Competency Standard Units

UEENEEG106A – Terminate cables, cords and accessories for low voltage circuits.

Prerequisite Units

Granting competency in this unit shall be made only after competency in the following units have been confirmed:

UEENEEE101A – Apply occupational health and safety regulations, codes and practices in the workplace.

UEENEEE102A – Fabricate, assemble and dismantle utilities industry components.

UEENEEE105A – Fix and secure electrotechnology equipment.

UEENEEE107A – Use drawings, diagrams, schedules, standards, codes and specifications .

ELEMENT		PERFORMANCE CRITERIA	
1	Prepare to terminate cables, cords and conductors	1.1	OHS procedures for a given work area are identified, obtained and understood.
		1.2	Health and safety risks are identified and established risk control measures and procedures in preparation for the work are followed.
		1.3	Safety hazards that have not previously been identified are noted and established risk control measures are implemented.
		1.4	The junction box/ terminal enclosures and terminal types are inspected to select the type and size of cable and conductor termination devices needed.
		1.5	Tools, materials and testing devices needed to for terminating cables and cords are obtained in accordance with established procedures and checked for correct operation and safety.
2	Terminate cables, cords and conductors	2.1	OHS risk control measures and procedures for carrying out the work are followed.
		2.2	Circuits/machines/plant are checked as being isolated where necessary in strict accordance OHS requirements and procedures.
		2.3	Cable/cord ends are cut and sheath/insulation stripped with sufficient length to prevent stain on terminations and without undue waste.
		2.4	Cable glands/retaining devices are fitted and secured to ensure cable/cord cannot be pulled out of entry into junction box/ terminal enclosure
.		2.5	Conductors are prepared to suit the type of terminal at which there are to be connected.
		2.6	Conductors are terminated to ensure continuity across the terminal.

ELEMENT		PERFORMANCE CRITERIA	
		2.7	Established methods for dealing with unexpected situations are discussed with appropriate person or persons and documented.
		2.8	Unexpected situations are dealt with safely and with the approval of an authorised person.
3	Test terminated cables and cords	3.1	OHS work completion risk control measures and procedures are followed.
		3.2	Terminated cables are tested to ensure continuity and insulation resistance comply with requirements.

Required Skills and Knowledge

This describes the essential skills and knowledge and their level, required for this unit.

KS01-EG106A Wiring Systems – Types, applications and terminations

Evidence shall show an understanding of wiring systems types, application and terminations to an extent indicated by the following aspects:

T1 Cable types and terminations encompassing:

- cable variates (single cables, flexible cables, flexible cords, shielded cables, armoured cables, ribbon cables, other similar and like cables)
- structural components of cables and their purpose (conductor material, stranding, insulation type, voltage rating, screening, sheathing, armour and serving)
- Australian and International colour standards for cords and cables
- construction of common cables
- identification of cords and cables by conductor size, type and rating
- application of various cords and cables types
- identification of hardware used in terminating cords and cables
- preparation and termination of cords and cables
- termination of cords and cables using crimp lugs, tunnel connectors, soldering and solderless lugs
- requirements to protect and support cables adequately (protection against mechanical damage, protection from adverse temperatures and corrosion and protection from magnetic field that may affect the performance of the cable).

T2 Cords, cables and plugs encompassing:

- selection of flexible cords for given applications
- preparation of cord ends for connection
- fitting standard three pin plug tops to a flexible cords
- fitting standard three pin extension sockets to a flexible cords
- connecting variety of plugs to different flexible cord types
- requirements of AS/NZS 3000 for flexible cords, cables and plugs
- using test equipment to test and locate various faults in flexible cords and cables.

T3 Flat TPS wiring systems encompassing:

- Australian Standards requirements for the termination and protection of flat TPS cable
- Installation of flat TPS cable in trunking and duct for the supply of socket outlets
- using flat TPS cable for lighting looms
- testing circuits to ensure they are safe and operate as intended

T4 Circular TPS wiring systems encompassing:

- Australian Standards requirements for the installation of circular TPS cable
- installation of circular TPS cables on cable ladder/tray
- installation of circular TPS cable
- testing circuits to ensure they are safe and operate as intended

T5 Thermoplastic insulated cables in non-metallic enclosures encompassing:

- Australian Standards requirements for the installation of non-metallic enclosures
- cutting and setting rigid non-metallic ducting, trunking and conduit and accessories
- installation of circuits using TPI cables in non-metallic enclosures
- testing circuits to ensure they are safe and operate as intended

T6 Thermoplastic insulated cables in metallic enclosures encompassing:

- Australian Standards requirements for the installation of metallic enclosures
- fitting metallic conduit to metallic trunking and accessories
- cutting, threading and setting metallic conduit
- installation of circuits using thermoplastic insulated cables in metallic conduit, ducting and trunking
- testing circuits to ensure they are safe and operate as intended

T7 Fire protection cabling and systems encompassing:

- Australian Standards requirements for the installation of fire protection cable and mineral insulated metal sheathed cables
- requirements when passing a wiring system through a fire rated wall or floor

- recognising different fire protection cable types including Pyrolex, Radox and MIMS
- termination of fire protection cable.
- installation of circuits using fire protection cable.
- testing circuits to ensure they are safe and operate as intended

T8 Steel wire armoured (SWA) cables encompassing:

- Australian Standards requirements for the installation of SWA cables
- identifying accessories used with SWA cables
- installation of circuits using SWA cables
- testing circuits to ensure they are safe and operate as intended

T9 Trailing cables and catenary systems encompassing:

- Australian Standards requirements for the installation of trailing cables and catenary wiring
- identifying equipment used with trailing cable and catenary systems
- installation of catenary wiring systems
- installation of trailing cable systems supplying pendant sockets
- testing the installation to ensure it is safe and operates as intended

G106A Work Performance Tasks – (Q Tracker tasks):

UEENEEG106A – Terminate cables, cords and accessories for low voltage circuits

1. Performance requirements:

1a. Related to the following elements:

1. Prepare to terminate cables, cords and conductors.
2. Terminate cables cords and conductors.
3. Test terminated cables and cords.

1b. For each element demonstrate performance:

- across a representative body of performance criteria,
- on at least 2 occasions,
- autonomously and to requirements,
- within the timeframes typically expected of the discipline, work function and industrial environment.

2. Representative range includes the following:

All listed tasks related to performance across a representative range of contexts from the prescribed items below:

Group No	**The minimum number of items on which skill is to be demonstrated**	**Item List**
A.	All of the following: **Essential cables**	• Unenclosed thermoplastic sheathed (TPS) cable • Enclosed thermoplastic insulated (TPI) or sheathed cables
B.	At least three of the following: **Other cables**	• single cable, • flexible cable including trailing cables, • flexible cord, • shielded cable, • armoured cable, • fire protection cable (Radox, MIMS) • ribbon cable, • other similar and like cables
C.	All of the following: **Connecting accessories**	• Screwed terminals • Soldered terminals • Crimped terminals
D.	All of the following: **Testing**	• Continuity testing • Insulation resistance testing.

Workplace Rules:

Rule 1	Follow the instructions
Rule 2	Tolerate ambiguity
Rule 3	Meet your obligations

Note: This information and current details of critical aspects for each competency standard unit (CSU) in this qualification can be found at the Training Standards website www.training.gov.au.

UEENEEG106A – Terminate cables, cords and accessories for low voltage circuits.

Learning and Assessment Plan

Name of Lecturer: _____

Contact Details: _____

Delivery Mode/s: □ Face to Face □ On-Line □ Blended Delivery □ Other

Using:

Session	Nominal Duration	Program of Work (Topics to be covered)	Primary Reference
1	1 hour	Introduction to UEENEEG106A Recognition of Prior Learning of CSU	Resource Book
2	3 hours	Electric Cables and Terminations	Resource Book – Section 1
3	2 hours	Flexible Cords	Resource Book – Section 1
4	2 hours	Cable Applications	Resource Book – Section 1
5	2 hours	Cable Identification	Resource Book – Section 1
6	2 hours	Power Cable Terminations	Resource Book – Section 1
7	4 hours	Flexible Cord & Single Phase Extension	Resource Book – Section 1
8	8 hours	Installation of TPS Cables	Resource Book – Section 2
9	16 hours	Installation of TPI Cables in Conduits	Resource Book – Section 2
10	8 hours	Installation of Armoured Cables	Resource Book – Section 2
11	8 hours	Installation of Catenary Cable	Resource Book – Section 2
12	8 hours	Installation of Trailing Cable	Resource Book – Section 2
13	2 hours	Installation of High Temp Cable [Radox]	Resource Book – Section 1
	4 hours	Assessment of Unit Written (knowledge) Assessment Practical (Skills) Assessment.	Resource Book, CSU - Performance Criteria CSU – KS01 EG106A RSAK

I acknowledge that I have received and read this Delivery and Assessment Plan Student Name:_____ Signature: _____ Date: _____		
Lecturer Name	Lecturer Signature	Date

Assessment Strategy

Conditions of Assessment:

Normally learning and assessment will take place in an integrated classroom/ laboratory environment.

It is essential to work through the worksheets and activities in this workbook and follow the guidance of your lecturer. The worksheets and practical activities will provide the required skills and knowledge outlined in this Unit and assist you in achieving competency.

Assessment Methods:

Resource Book - The satisfactory completion of all worksheets and practical activities is required.

Written Theory Assessment – based on the **REQUIRED SKILLS AND KNOWLEDGE**. You must achieve a mark of 75% or more in this assessment.

Observed Practical Assessment – based on the Elements and Performance Criteria of this Competency Unit UEENEEG106A. You must achieve a mark of 100% in this assessment.

On-Job-Training:

It is expected that the off-job component of this competency unit will be complemented by appropriate on-job development involving exposure to re-occurring workplace events and supervised experiences. (See Work Performance Tasks). You are required to log your on-the-job training in your on line 'Q-Tracker' account.

Sufficiency of Evidence:

In all instances competency is to be attributed on evidence sufficient to show that a person has the necessary skills required for the scope of work. These include:

- Task skills - performing individual tasks
- Task management skills - managing a number of different tasks
- Contingency management skills - responding to irregularities and breakdowns in routines
- Job/role environment skills - dealing with the responsibilities and expectations of the work environment including working with others.

Evidence must demonstrate that an individual can perform competently across the specified range of activities and has the essential knowledge, understanding and associated skills underpinning the competency.

LABORATORY and WORKSHOP SAFETY INSTRUCTIONS

Students working in laboratories, workshops and installation skills areas at this college do so on the condition that they agree to abide by the following safety instructions. Failure to observe the safety instructions may result in immediate suspension.

1. Personally owned eye protection must be worn AT ALL TIMES where eye protection signs are displayed. Other safety equipment including hearing protection must be worn when applicable to a particular task.

2. Loose clothing must not be worn when working on fixed or portable machines. Hairnets must be worn where applicable. Clothing must cover the upper arms and body.

3. **Safety boots or safety shoes** must be worn at all times on this campus. Thongs or sandals are not permitted.

4. Tools and safety equipment are issued from the tool store on request. It is your responsibility to ask for the correct item (Size, Type and Tool). Check to see that you have been given the correct item before using it. If in doubt ask your LECTURER, not the storeperson.

5. Report any broken, damaged or unserviceable equipment to your Lecturer. Do not use damaged tools or machines.

6. Clean down the machines immediately after use. All tools must be cleaned before returning them to the store.

7. Skylarking is not permitted at any time.

8. Always use protective vice jaws when cutting off material in a bench vice.

9. Accidents resulting in cuts, abrasions or other personal injury must be reported to your Lecturer immediately - no matter how minor they may seem. A first-aid kit is available in the tool store.

10. Never leave a machine unattended when it is running. Do not allow yourself to be distracted when operating a machine.

11. Read all safety signs and notices and follow the instructions.

12. Do not use a fixed or portable machine unless you have been instructed in its proper use.

13. Read all risk assessment documentation provided (JSAs) and conduct a relevant risk assessment process before performing any task.

Student's Signature _____ Date: _____

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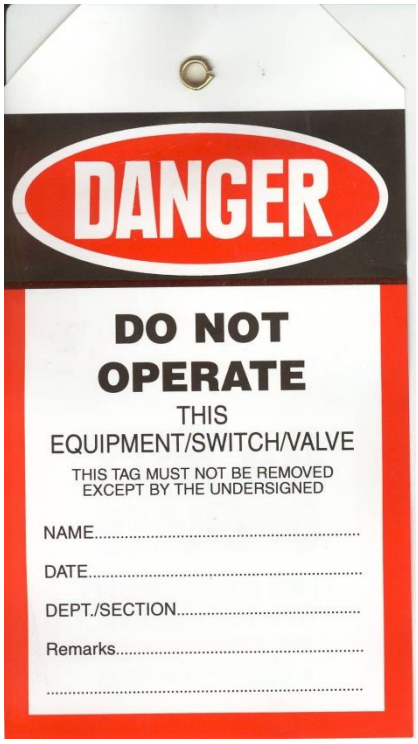
Danger Tag Procedure

Use of Danger Tags



If you have a practical task to do and there is a possibility that you could be injured if someone turns on the electricity, then you **MUST** fasten a red danger tag to the machine main isolation switch, circuit-breaker or the equipment plug top.

Each danger tag you use must clearly show; your name, your section (class) and the date.

Nobody must operate the danger tagged switch or control point until the job is made safe and the danger tag has been removed.

Your lecturer will check your task before you are allowed to remove your danger tag.

Only the person who is named on the tag and attached the tag, is allowed to remove it.

Points to Watch

Make absolutely sure the switch/circuit-breaker/plug top is the correct one to tag. If you have any doubts, ask your lecturer.

Make sure that you have switched the isolator to **OFF** position before you attach your danger tag.

Fasten the danger tag securely.

The purpose of using Danger Tags is to prevent electrical accidents from happening.

Failure to follow Danger Tag Procedures when working on practical activities and practical assessments will result in a **Not Yet Competent** comment recorded for this Unit of Competency – UEENEEG106A

Student's Signature _____ Date: _____

Government of Western Australia North Metropolitan TAFE	**Terminate cables, cords and accessories for LV circuits**	Introduction Section 1 - 1	SGB 02/2008 G106A

Electrical Cables and Terminations

Task:

To correctly identify and terminate various common types of electrical cables, including power cables, flexible cords and communications cables.

Why:

Electrical cables terminations are available in a wide range of types and sizes and there are specific techniques associated with each type of termination. You need to be able to identify the most common types and competently terminate and/or join them in accordance with the mandatory requirements and the generally accepted principles of sound and safe practice.

To Pass:

1. You must correctly answer the questions on the Work Sheets provided and achieve a mark of 75% or more in an overall competency written test.

2. You must satisfactorily complete the set laboratory activities.

3. You must achieve 100% in a final practical competency assessment.

Equipment

Samples of electrical cables.
Samples of communications cables and terminations.
Samples of electrical cable terminations.
Cable terminating and joining accessories.
Samples of common electrical accessories associated with cables.
Manufacturers' cable and accessory data sheets

References

* Electrical Wiring Practice (7th ed.)- Volume 1, Pethebridge & Neeson
* AS/NZS 3000:2018 (Wiring Rules). Standards Australia
* AS/NZS 3008.1.1 Electrical Installations - Selection of Cables. Part 1
* Basic Training Manual 16-12, Cables, Conduits and Busbars, AGPS, Canberra
* Training Manual. Cords, Cables, and Applications, AGPS,

Government of Western Australia North Metropolitan TAFE	**Terminate cables, cords and accessories for LV circuits**	Study Guide 1 - 1	SGB 02/2008 G106A

Electrical Cables and Terminations

Suggested Self-Study Guide

1 Study the following sections in the recommended references:

Electrical Wiring Practice (7th ed.)- Volume 1. McGraw-Hill: Sydney

Conductors and cables	Page 76	
Types of cable insulation	Page 78	
Power cable classification	Page 80	
Power cable types and applications	Page 81	
Power cable termination and conductor Connection methods	Page 88	
Chapter Summary	Page 107	
Chapter Review Questions	Page 108	

Wiring Rules (AS/NZS 3000:2018)

Clause 1.5 Fundamental Principles - Protection for Safety
Section 3 Selection and Installation of Wiring Systems

Cable Manufacturers' Catalogues

Cable Termination Data Sheets

2. Read the Summaries and practise answering the questions provided on the Work Sheets. Refer to other relevant texts if you feel it is necessary.

3. Answer the questions given on the Work Sheets. Use a separate answer sheet or sheets for each Work Sheet. Note that you are required to answer ALL questions correctly, although not necessarily at the same time.

4. Complete the activities for this section.

5. Submit your answers to the Work Sheets and your completed activity reports to your Lecturer for discussion.

Government of Western Australia North Metropolitan TAFE	**Terminate cables, cords and accessories for LV circuits**	Summary Section 1 - 1	SGB 02/2008 G106A

Electrical Cables

Definitions

1. CABLE is one insulated conductor (solid or stranded) or two or more such conductors laid together with or without fillings, reinforcements or protective coverings (see AS/NZS 3000:2018 Clause 1.4.21). The two most common metals used as electrical conductors are copper and aluminium.

2. FLEXIBLE CABLE is a cable, the conductors, insulation and covering of which are such as to afford flexibility (see AS/NZS 3000 Clause 1.4.24). 2.5 square mm building wire is a typical small flexible cable.

3. FLEXIBLE CORD is a special type of flexible cable which is manufactured from many small wires so as to provide greater flexibility than flexible cable (see AS/NZS 3000 Clause 1.4.40). The familiar three core flex used on portable electrical appliances is a type of flexible cord.

4. BARE CONDUCTOR is a conductor without covering or insulation (See AS/NZS 3000 Clause 1.4.36). The overhead (aerial) distribution cables used by the supply authority are usually bare conductors.

Characteristics

5. Every electrical cable has particular characteristics which distinguish it from other types of cable - such as conducting material, insulation type, size and so on. Cables also have RATINGS specified by the manufacturer or an authority such as the Wiring Rules. A rating is a value which must not be exceeded during normal service. The following terms are used to describe the most common characteristics or ratings of electrical cables.

6. **Cores and Strands** The core of a cable is the conducting material which carries the current, and includes the surrounding insulation. A cable can be single core or it can have two or more cores (multi-core cable). Each core consists of one or more STRANDS of conducting material. Copper cables over 2.5 square mm in area are usually stranded when used as building wire.

7. **Size** The size of a cable is usually expressed as the total cross sectional area (CSA) of the conducting material in each core expressed in square millimetres. It is also possible to refer to the size of the cable as the number of strands followed by the diameter of each strand. A typical three core flexible cord used in portable appliances has three insulated CORES, each core consisting of 32 strands of 0.02 mm DIAMETER copper wire (32/0.02). The total nominal cross sectional area of each core is 1 square mm, so the 'size' of the cable is 1 square mm.

8. **Current Rating** The current rating of a cable is the maximum permissible current it can have flowing through it under normal operating conditions - usually expressed in amps. The current rating of a specific cable under defined installation conditions is determined using the Wiring Rules or AS/NZS 3008.1.1. If the current rating of a cable is exceeded the cable may overheat and burn out.

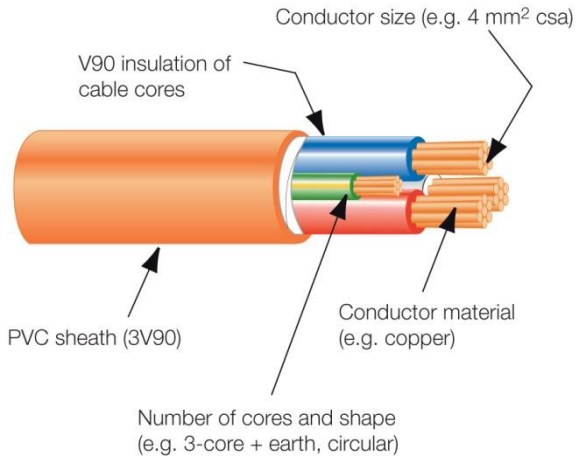
9. **Voltage Rating** The voltage rating of a cable is the maximum permissible voltage to which it may be connected. If the voltage rating is exceeded the insulation between cable cores, or between a cable core and earth, may break down and cause a short circuit or a fire. Typical voltage ratings are 0.6/1 kV and 450/750 V. 0.6/1 kV means that it is cable of withstanding a voltage of 0.6 kV (600 volts rms) between the conductor and earth, and 1 kV (1000 V rms) between adjacent conductors. The voltage rating of a particular cable can usually be found on the cable reel or drum.

10. **Temperature Rating** The temperature rating of a cable is the maximum permissible temperature at which it may be operated without damaging the insulation. A typical temperature rating for general wiring in a domestic installation is 75 degrees Celsius. Special cables are available with insulation capable of withstanding higher temperatures, such as V105 PVC, woven glass, heat resisting fibrous compounds, R-S-150 elastomer compound, PTFE, XLPE, or mineral powder insulants.

11. **Cable Colours** The colour of a cable is the colour of the insulation. Where colours are required to be used to identify different cables (such as active, neutral and earth), there are specific colours for specific purposes. Cables used for typical installations are available in a variety of different colours - Black for neutral, Green/yellow for earth, and other colours for active - such as red, white, blue, brown and so on. The single colours yellow and green are not permissible on any electrical conductors which are required to be identified by colour, and all earthing conductors must be green/yellow. The colour code used for fixed wiring in WA is NOT the same as the international colour code for flexible cords (see AS/NZS 3000 Clause 3.8.1), nor is the same fixed wiring colour code used in all countries.

The description of 3-core and earth cables from a cable manufacturer's catalogue:

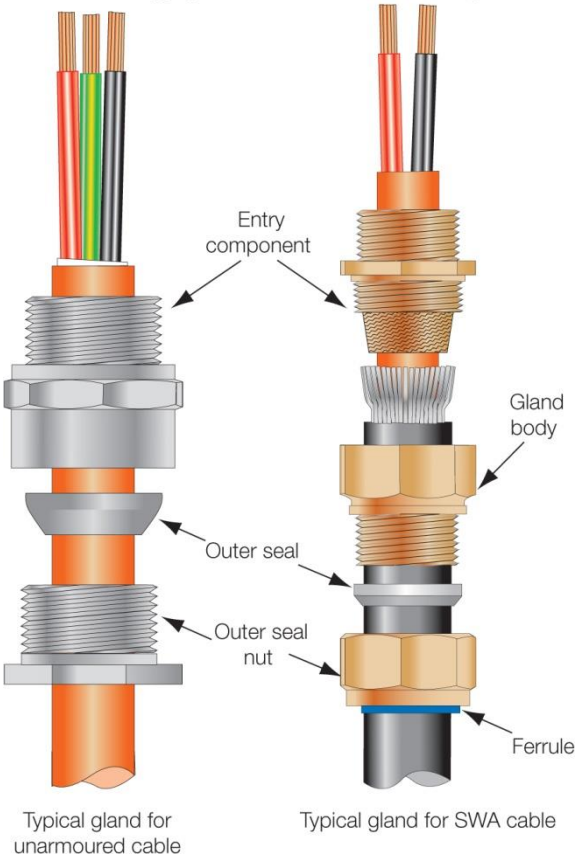
3-core + earth, circular, V-90 insulated, PVC (3V90) sheathed to AS/NZS 5000, copper conductors, 90°C
1.5 to 16 mm^2 450/750V to AS/NZS 5000.2; 10 to 300 mm^2 0.6/1kV to AS/NZS 5000.1



12. **Insulation** All cables in general wiring are required to be insulated (including the earthing conductors). Various types of insulation for particular types of cable - such as polyvinyl chloride (PVC), fibreglass, synthetic rubber, paper, magnesium oxide powder (in mineral insulated metal sheathed cables), and various other compounds. The maximum operating temperature and voltage rating of a cable are usually determined by the type of insulation. The insulation on typical domestic building wire (V90) is PVC and has a temperature rating of 90 degrees Celsius with a voltage rating of 0.6/1kV. You should determine the voltage rating of a cable by examining the drum or reel - some PVC insulated cables are designed for voltages lower than, for example, 240 volts.

13. **Sheathing** The primary layer of insulation on cable cores is known as the functional insulation. Some types of cable have an additional layer of PROTECTIVE insulation over the functional insulation, to provide double insulation and additional mechanical strength. The outer protective insulation is known as a sheathing. The sheathing is usually provided in a form which results in either a FLAT or CIRCULAR sheathed cable. In mineral insulated cables (using the trade name Pyrotenax) the term sheathing is applied to the outer metallic covering which encloses the main current carrying conductors. Mineral insulated cables are available with a covering of insulation over the outer metal sheathing - the outer insulation is usually orange PVC and is known as a SERVING.

14. **Shielding** Single or multicore cables which are required to be protected against electronic noise or interference often have an outer layer of braided tinned or bare copper known as the shielding or screening. Shielding from the effects of electrical interference is achieved by earthing the outer metallic braiding. Shielded cables have a particular value of capacitance per unit length and are designed for low frequency applications (such as those used in a sound system).



15. **Armouring** Some installations require additional mechanical protection without being installed in metallic conduit; such applications include heavy industrial wiring, mining, underground reticulation and wiring in hazardous areas. Armoured cables have an outer layer of steel wires arranged to form a protective sheath inside a final layer of insulated serving (often PVC). These cables are known as steel wire armoured (SWA) cables and require special terminating glands to ensure that the armouring is electrically and mechanically continuous throughout their length.

General Cable Types

16. The most common types of electrical cable in general use for power applications are listed below. The specific characteristics and termination methods applicable to each type will be dealt with later.

Single strand TPI (building wire)
Multi strand TPI (building wire)
Single core flat TPS
Twin core flat TPS
Three core flat TPS
Three core circular TPS
Four core flat TPS
Three core TPS flexible cord - ordinary duty
Three core braided flexible cord
'Figure 8' flexible cord
Ribbon cables
Single core Mineral Insulated Metal Sheathed (MIMS) cable unserved
Multi core MIMS cable - PVC served
Radox and Pyrolex heat resistant cables
Steel Wire Armoured (SWA) cable
Screened multi-core cable
Aerial cable

Cable Joints and Terminations

17. A cable joint can be defined as a means of connecting two or more electrical cables in such a way that the electrical, mechanical and insulating characteristics of the cables to be joined are not impaired in any way.

18. A satisfactory cable joint should have the following general characteristics:

a. The joint must comply with the appropriate safety and test requirements of the Wiring Rules and the supply authority.

b. The outer covering should be fitted so as to prevent mechanical damage to the joint, and to prevent the ingress of moisture or dirt.

c. The insulation between conductors in a multicore cable should be at least equivalent to the unbroken cable.

d. The joints in the conductors should be soldered, bolted or crimped in such a way that they are absolutely reliable, and there is the least possible resistance in the joint.

e. The joint must be capable of withstanding the electrical and mechanical stresses likely to experienced.

f. The joint must be capable of withstanding the same temperatures as the cable.

g. The materials used in the fabrication of the joint should not react with each other to cause failure or deterioration during service.

19. Joints or terminations in other conducting materials such as copper or aluminium busbars should be in accordance with the general principles listed above, but the requirement to maintain continuous insulation is not always relevant because busbars are usually installed bare in locations to which only authorised persons have access.

20. A wide range of cable jointing and terminating methods is available, ranging from a commercially manufactured high voltage encapsulated joint to a joint made with a simple Bluepoint connector. This module deals with jointing and terminating methods usually associated with cables or conductors operating at 415 volts or less.

21. The insulating material on a cable must not be removed further than is necessary to allow the conductor to extend to the full length of the terminating device. Joints between insulated cables must be insulated to provide a degree of insulation not inferior to that on the cables.

22. If the insulating material is damaged by heat during the process of soldering it must be stripped away and replaced with insulation equivalent to the original (see AS/NZS 3000 Clause 3.7.2.2).

23. If a termination is to be made using an insulated terminal block, the connection must be arranged so that the conductor is clamped between metal surfaces between two metal nuts (or the equivalent). A termination which has an insulating material as one of the clamping surfaces is not acceptable.

24. Corrosive fluxes such as Baker's Soldering Fluid or 'killed spirits' must not be used to solder joints in electrical cables. The preferred flux is resin for copper conductors, although commercial paste fluxes are usually satisfactory. Soldered joints must always be made that the conductors are held in position independent of the solder.

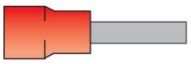
Power Cable Joints and Terminations

Crimp lugs are classified by whether they are insulated and the type of terminal connection they are intended for.

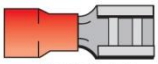
Examples of the pre-insulated crimp lugs for conductor sizes 0.2 mm^2 to 6.0 mm^2.

Ring lug for connection to screw or a stud type terminal

Spade lug for connection to a stud type terminal



Flat blade lug for connection in a tunnel terminal



Female lug

Male lug

Quick connect lug for use with corresponding fixed terminal

The lug insulation colour indicates conductor sizes that a lug is designed for.

Typical conductors sizes:

0.5 to 1.6 mm^2

1.0 to 2.6 mm^2

0.2 to 0.5 mm^2 (small)
2.5 to 6.0 mm^2 (large)

Using the wrong size lug may result in a poor connection.

Bootlace pin for use in tunnel terminals to ensure all conductor strands are contained and are not breaken by terminal screws. Available in sizes from 0.25 to 120 mm^2. Colour coding is different to the standard pre-insulated lugs

Uninsulated crimp lugs range in sizes from small (1.00 mm^2) to large (630 mm^2 and above) conductors sizes, most being for the stud or bolted type terminals.

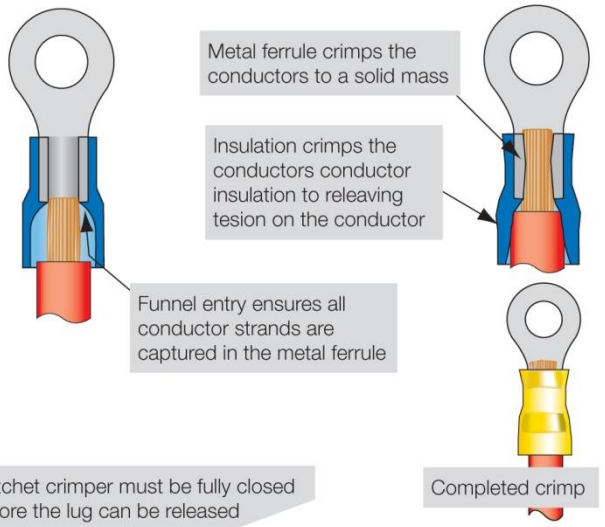
Examples include:

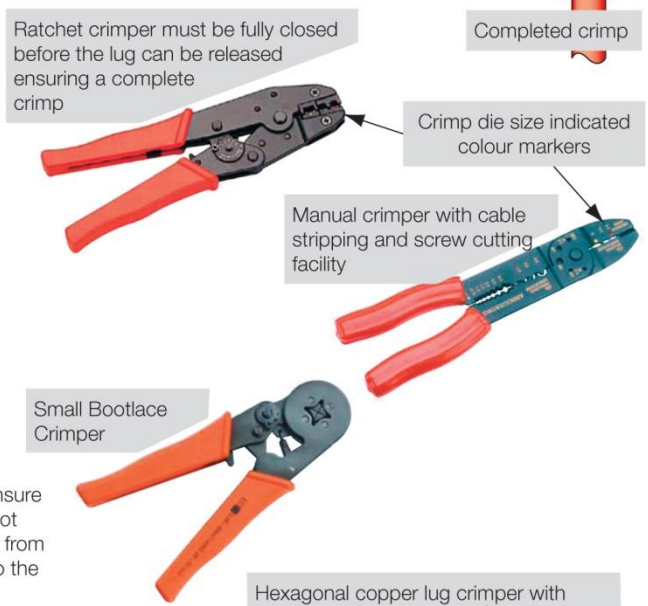
Copper crimp link used for extending cables typically in alteration at distribution boards

Bi-metal lug for terminating an aluminium conductor for connection to a copper terminal

Reverse bi-metal lug for terminating an copper conductor for connection to a aluminium terminal, such as a aluminium busbar

Aluminium lug for terminating an aluminium conductor. The sealing cap indicates that a lug is pre-filled with joint compound.





25. The most common methods of joining or terminating copper conductors in power applications are:

a. Single or double screw tunnel terminals.

b. Solder lugs.

c. Crimp lugs (compression lugs).

d. Bluepoint connectors.

e. Threaded pillar or post type terminals.

f. Line taps.

g. Splices and tee joints (soldered or unsoldered).

h. Bolted busbar.

i. Commercial resin encapsulated cable joints.

j. Tee-off to rising mains.

k. MIMS terminations.

l. Steel wire armoured cable terminations.

Flexible Cord Terminations

26. Terminations in flexible cords within 240 volt appliances may be made using any of the following methods:

a. Tunnel connectors.

b. Cup washers with bolted terminals.

c. Solder lugs.

d. Solder lugs with an insulation clamping mechanism.

e. Crimp lugs.

f. Blue point connectors.

g. Quick connect terminals.

h. Soldering to pins, a tag strip or turret terminal.

i. Other clamping between metal surfaces.

27. Stranded conductors must not be terminated by soft soldering the conductors and clamping them under a clamping screw or between metal surfaces (AS/NZS 3000 Clause 3.7.2.7)

28. Joints between 240 volt flexible cords used for purposes other than fixed wiring shall be made by means of an approved plug and cord extension socket, except that a joint may be made in the form of harness wiring provided that the joint is encapsulated in an approved moulding or equivalent form of construction integral with the flexible cord.

29 When connecting flexible cords to terminals of equipment extreme care must be taken that every strand of the flexible cord conductor is effectively clamped. The strands of the cable should always be twisted together (and doubled over where applicable).

Aluminium Joints and Terminations

30. Joints and terminations involving aluminium conductors cannot be treated in the same way as copper joints and terminations. Aluminium is a softer metal, it is prone to galvanic corrosion because it is negative with respect to many other common metals, and it has a thin transparent insulating oxide film which forms as soon as the metal is exposed to air.

31. The most common types of joints involving aluminium conductors and associated accessories are:

a. Soldered with special fluxes, solders and soldering techniques which take the oxide film into account.

b. Bolted with Belleville-type washers and an oxide inhibiting compound such as Alminox.

c. Crimped with very careful attention to the correct choice of crimping die and crimp lugs.

Telecommunications Cables

32. Cables used for telecommunications customer cabling that has access to a telecommunications carrier's network such as voice, data, fire, security and telecommunications control circuits must comply with the Australian Communications Media Authority (ACMA) Technical Standard AS/CA 5008:2010. Cable may be of a number construction types including optical fibre, co-axial, twisted pair with or without shielding, or cored cables using dedicated core pairs.

33. The installation of telecommunications cabling to be connected to the telecommunications carrier's network requires a special telecommunications cabling registration. Licensed electricians can obtain the necessary open cabling license by undertaking additional training and completing the required formal assessment process. There are severe penalties for performing telecommunications cabling without the appropriate licence.

34. Extra-low voltage cabling for applications not involving the telecommunications carrier's network do not require a licence, such as personal computer data cabling.

Fibre Optic Cable

35. Fibre optic cables are used to transmit data as pulses of light instead of the flow of electricity, so the transmitted data is not effected by induced voltages. It also provides a secure system because the cables cannot be tapped into as they can with copper sheathed cables.

36. Fibre optic cable has several advantages over copper cored cable for data transmission purposes, including high data capacity, small size and low mass. Although the installation of fibre optic cable is a relatively simple process, terminations require the use of special equipment and procedures beyond the scope of this module.

Segregation of Wiring Systems

37. Cables for single and three phase circuits are required to be segregated (separated) from cables of other systems such as extra-low voltage systems, radio systems, television, bell, call or sound systems (See AS/NZS 3000 Clause 3.9.8.3).

Data Cable Connectors and Terminations

38. Connectors for electronic equipment cables are available in a wide range of shapes and sizes. Details of typical types can be found in any general electronic equipment supplier's catalogue, such as Tandys, Altronics or the Radio Spares Catalogue.

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Thermoplastic Insulated (TPI) Cable

1. Thermoplastic Insulated (TPI) cable has a single layer of coloured polyvinyl chloride (PVC) insulation over copper conductors. TPI cable is also known as 'building wire'. TPI is single insulated cable because there is only one functional layer of insulation on the cable.

2. The maximum voltage rating of building wire is 0.6/1 kV. The voltage rating of a particular cable can usually be found on the cable reel or drum.

3. Building wires are classified according to the type of insulation used and the maximum operating temperature of the insulation. V75 cable is insulated with polyvinyl chloride (PVC) and has a maximum operating temperature of 75 degrees Celsius. Other types of insulation are available on cables but they are not usually used as building wire. The size and type of cable is usually marked on the cable drum or reel.

4. Building wire is available in sizes ranging from 1 square mm to over 25 square mm. Cables of 2.5 square mm and under are available with a single strand of conducting material or with seven strands. Copper cables over 2.5 square mm in area are usually stranded when used as building wire. The most common standard sizes of building wire are:

Area (sq mm)	Strands/diameter of each strand
1	1/1.13
1.5	1/1.38
1.5	7/0.50
2.5	1/1.78
2.5	7/0.67
4	7/0.85
6	7/1.04
10	7/1.35
16	7/1.70

5. **Colours** Building wires are available in a variety of different colours - Black for neutral, Green/yellow for earth, and any other colour (except yellow or green) for active - such as red, white, dark blue, brown and so on (see AS/NZS 3000 Clause 3.8).

6. Cables installed as fixed wiring in general circuits are required to be colour coded according to Clause 3.8, but some other types of wiring such as overhead (aerial) wiring, switchboard wiring and internal wiring in appliances and equipment need not be colour coded (although it is often good practice to do so). However, the single colours yellow and green and not permitted to be used as the insulation on any conductor.

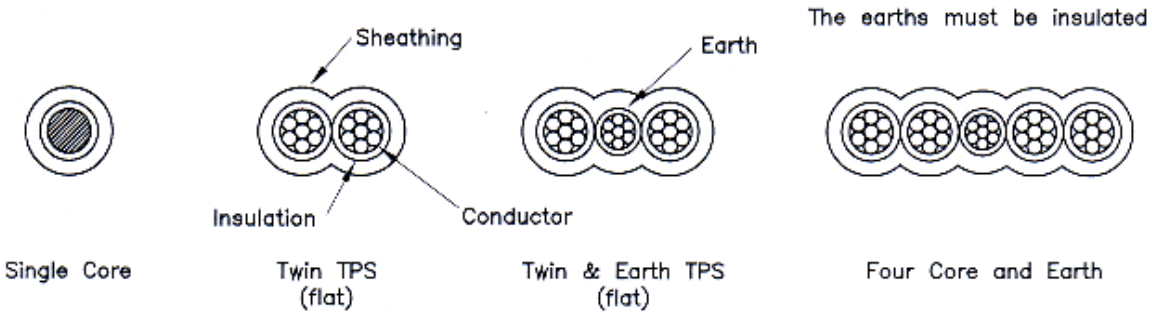
7. **Protection** TPI cables are single insulated so they must be protected from damage - usually by enclosing them in a conduit or duct (see Table 3.1). The Wiring Rules require that cable enclosures be of adequate size (see Clause 3.10.3.5).

Thermoplastic Sheathed (TPS) Cable

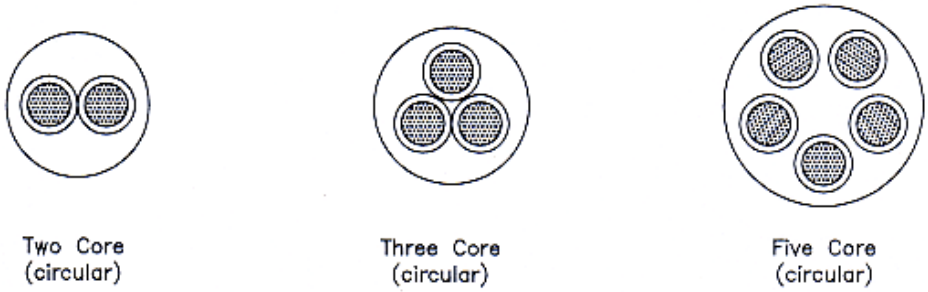
8. A cable which has a functional (basic) insulated core, and is surrounded by an additional outer supplementary layer of insulation is known as a sheathed or double insulated cable. The most common type is thermoplastic sheathed cable or TPS. See AS/NZS 3000 clause number 1.4.73 for a description of Basic and Supplementary insulation in regards to double insulated cables.

9. TPS cable is available with a single core or several insulated cores including a laid up insulated earthing conductor. Some of the more common types of TPS cables are shown below.

10. **Power Cables (Sheathed)**



11. **Flexible Cords (Sheathed)**



Current Rating

12. The current rating of a cable is the maximum continuous current it is permitted to carry under normal operating conditions. The current rating for cables under various operating conditions is given in the tables in AS 3008.1.1. It is important to read the notes under the tables when determining the current rating of a particular cable.

13. The use of AS 3008.1.1 for determining cable sizes is covered in detail in later units.

Applications

14. Thermoplastic insulated (TPI) cables are used for wiring in domestic and non-domestic installations, where the cables are run in metallic or non-metallic conduit or other types of enclosure. It is not permissible to embed TPI cables in plaster or cement render without further protection.

15 Thermoplastic sheathed (TPS) flexible cables are used in domestic and non-domestic installations where further enclosure is not required, including:

a. Power and lighting circuits in domestic installations.

b. Power and lighting circuits in commercial and industrial installations.

c. Wiring embedded direct in plaster or cement render walls where the run is vertical and does not exceed 3 metres in length.

d. Overhead wiring supported by a catenary cable.

Installation

16. TPS cables are relatively simple to install using special metallic or PVC clips. They may be clipped to roof trusses or the side of ceiling joists in a roof space without further protection. TPS may be installed down brick cavity walls without further protection if they are protected by an RCD. Where they are required to be clipped in position, they must be installed in accordance with Clause 3.9.3.1 of AS/NZS 3000.

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Electrical Cables

1. Is sheathed cable double insulated?
2. How many CORES does a 7/0.85 TPI cable have?
3. How many STRANDS does a 7/0.50 TPI cable have?
4. What is the diameter of each STRAND of a 7/0.85 TPI cable?
5. How is the 'size' of metric building wire usually specified?
6. The terms ‘functional' and ‘protective' can be used to describe two separate parts of a TPS cable. To which part of the cable to the terms refer?
7. The conductors in one type of flexible cord often have a silver appearance. What type of material would the conductors be made from?
8. Is YELLOW insulation permissible on TPI cables installed in conduit?
9. Which Section in the Wiring Rules specifies the distinguishing colours of insulation on electrical cables?
10. Name the two most common metals used as conductors in electrical cables.
11. What is the most common material used as the insulant on insulated copper building wire?
12. What is the maximum operating temperature for V75 building wire?
13. What does a 'shielded' cable have that a typical TPS cable does not have?
14. What colour insulated cable is normally used on the active conductor in fixed wiring to a 3 pin general purpose socket-outlet?
15. What colour is the insulant on insulated earthing conductors installed in conduit?
16. What type of material is used to provide the ARMOURING on armoured electrical cables?
17. What is the maximum specified voltage rating of typical V90 insulated building wire?
18. Is three core TPS flexible cord double insulated?
19. Name a high temperature cable insulant used in domestic stoves and hotplates.
20. What is the special characteristic of woven glass insulated cable?
21. What is the special characteristic of Radox cable?

Notes:

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Flexible Cords

Types of Flexible Cord

1. A flexible cord is defined as a flexible cable, no wire of which exceeds 0.31 mm diameter and no conductor of which exceeds 4 square mm cross sectional area and having not more than 5 cores (Wiring Rules, Clause 1.4.40). The most common types of flexible cord approved for power electrical work are:

a. 2 core - parallel unsheathed (Figure 8), - light duty sheathed
b. *Textile braided overall
c. Light duty, sheathed
d. Ordinary duty, sheathed
e. Heavy duty, sheathed
f. Single core, unsheathed.

* Includes unkinkable cords.

2. A flexible cord consists of individual strands of copper wire laid together with an outer covering of insulant (usually elastomer or PVC); the resulting cable is known as a 'core'. In most types of flexible cord the cores are laid together and surrounded by an outer protective PVC sheathing. The thickness of the sheathing governs the type of duty - i.e. light duty, ordinary duty or heavy duty. Cables of this type are known as TPS (thermo-plastic sheathed); the individual cores are known as TPI (thermo-plastic insulated).

3. The 'size' of a flexible cord is usually expressed as the cross sectional area (in square mm) of each of the individual cores, for example 0.75 square mm, but it can also be referred to by stating the number of strands and diameter of each strand in each core. A common type of 0.75 square mm flexible cord could be referred to as 24/0.2 (24 strands, each 0.2 mm in diameter). Each core in multi-core flexible cord is the same size. Some types of flexible cord have more strands of a smaller wire to provide greater flexibility, even though the overall cross sectional area may be the same as other types. The most common types of flexible cord used for portable electrical appliances are 0.75 and 1 square mm three core sheathed cord - known as 'three core flex'.

4. Flexible cords are usually used to connect portable electrical appliances to the supply. Other cables which may be similar in appearance may be found in situations such as extra-low voltage installations (not exceeding 50 volts a.c. or 120vdc.) and instrumentation applications, but they may not be suitable for connecting to a 240 volt supply.

Limitations

5. The maximum current carried by each core of a flexible cord must not exceed the value given in Table 16 of AS 3008.1.1.

Cord Anchorage

6. Every flexible cord must be attached to an appliance, appliance connector, plug or cord extension socket or any other equipment in such a manner that no undue stress is imposed on its electrical connections. This can be achieved using a tortuous path cord grip, clamp, pillar, post or other effective means. Tying a knot in a flexible cord to prevent undue stress on connections is not permissible (Clause 3.7.2.8).

Distinguishing Colours of Cables

7. **Installation Wiring** The colour coding of conductors in installation (fixed) wiring is not the same as that used for internationally colour coded flexible cords. In fixed wiring, red, or any colour other than black, green, light blue, yellow or green and yellow combination may be used for actives or switch wires, with black for neutral. Green/yellow is used only for earthing conductors. Three core flexible cords manufactured to old Australian Standards used the same colour code as fixed wiring - red for active, black for neutral and green or green/yellow for earth.

8. **Flexible Cords** The colours green or yellow, or a combination of green and yellow must not be used to identify any conductor other than an earthing conductor. The following colour coding of the cores of flexible cords is being adopted in several countries and is commonly used for supplying single phase portable appliances in Australia (See Clause 3.8 and Table 3.4).

2 Core - brown (active) , light blue (neutral).
3 Core - brown (active), light blue (neutral) and, for earthing conductors green/yellow.

9. The Tables which follow provide details of the uses and characteristics of the recommended types of flexible cords.

Applications of Flexible Cords

Types of Flexible Cords	Nominal Area of Conductors	Applications
Parallel 2 Core unsheathed	0.5 sq mm	Hand held double insulated (or equivalent) appliances of small current rating, not exceeding 3 amps. Not allowable for use in damp situations.
	0.75 sq mm	Double insulated (or equivalent) appliances or luminaires where the cord is not subject to rough usage. For unsupported pendants provided the cord is not subject to excessive temperature. Not allowable for use in damp situations. temperature.
Textile Braided overall. (Includes unkinkable cords)	Not smaller than 0.75 sq mm	Any appliance or luminaire where the cord is not subject to rough usage. Not allowable for use in damp situations. For unsupported pendants provided that the cord is not subject to excessive temperature.
Light Duty Sheathed	Not smaller than 0.75 sq mm	Appliances or luminaires where the cord is not subject to rough usage. For unsupported pendants provided that the cord is not subject to excessive temperatures.
Ordinary Duty Sheathed	Not smaller than 0.75 sq mm	Any appliance or unsupported pendant provided that the cord is not subject to excess temperatures.
	Not smaller than 1 sq mm	Any appliance or unsupported pendant. Flexible extension cord.
Heavy Duty Sheathed	Not smaller than 1 sq mm	Any appliance or unsupported pendant. Flexible extension cord.

Current Ratings of Typical Flexible Cords

The current ratings are based on a maximum operating temperature of 60 degrees Celsius (cords with V60 or higher insulation).

Nominal Area of Conductor (sq mm)	Number and Diameter of Conductors (No/sq mm)	Current Rating (Amperes, single phase)
0.5 sq mm	16/0.2	3
0.75 sq mm	24/0.2	7.5
1.0 sq mm	32/0.2	10
1.5 sq mm	30/0.25	15
2.5 sq mm	50/0.25	20

Single Phase Cord Extension Leads

10. A single phase extension lead (or cord extension set) is a length of three core ordinary duty or heavy duty sheathed flexible cord with a three pin plug top on one and a three pin cord extension socket on the other. They are usually used to temporarily extend the length of the cord supplied with a portable appliance.

11. Single phase cord extension sets must have three cores, each core must have a cross sectional area of at least 1 square mm, and the maximum permissible length is governed by the size of the cable. The maximum permissible length of cord extension sets is shown in Table 1 below.

Cord Extension Set Rating (amperes)	Conductor Area (square mm)	Maximum Length of Flexible Cord (metres)
10 amperes	1.0	25
	1.5	32
15 amperes	1.5	25
	2.5	40
20 amperes	2.5	32
	4.0	40

Table 1 - Maximum length of cord extension sets

Polarisation

12. The cord extension socket must be polarised as for standard single phase flat pin three pin outlets; the three pin plug top must be polarised to match. When viewed from the front of the socket outlet the order of connection must be EARTH, ACTIVE, NEUTRAL in a clockwise direction (See Wiring Rules Clause 4.4.5). In internationally colour coded (IEC) three core flexible cord the earth is coloured green/yellow, active is brown and the neutral is light blue.

Wound on a Drum

13. If a cord extension set is stored on a drum or reel it should be unwound completely if it is to be used at its full current carrying capacity. If it is not unwound the current carrying capacity must be decreased (derated) in accordance with Table 16 of AS 3008.1.1, to prevent the cable from being damaged due to overheating, i.e.:

Number of Layers on the drum:	1	2	3	4
Derating factor:	0.76	0.58	0.47	0.4

14. You can calculate the derated current carrying capacity by multiplying the maximum current rating by the derating factor. If a 10 amp cable was used with four layers wound on a drum, the derated current carrying capacity of the cable would be 10 x 0.4 or 4 amps.

Construction Sites

15 Occupational Safety and Health Regulations require that if an extension cord is to be used on a construction site it must be of a type which cannot be re-wired, or the plug and socket must be made of transparent material. Extension cords must also be inspected by a licensed electrician at regular intervals and tagged to indicate that they are in a safe condition.

Joints in Extension Cords

16. It is not permissible to join an extension cord by any method other than using an approved plug-top and cord extension socket. Soldering the cables then taping them up, for example, is not permissible.

17. When you are fitting a plug top or cord extension socket you must take care to observe the following points:

a. Remove the sheathing without marking or damaging the insulation around the cable cores in any way.

b. Do not remove any more of the sheathing than is absolutely necessary.

c. Twist the strands of the cable cores and double them over before you insert them in the clamping terminal.

d. Do not allow any insulation to be clamped between the metal surfaces of any terminal.

e. Ensure that the plug top and cord extension socket is correctly polarised (active on the left as you look at the SOCKET from the front).

f. Ensure that the insulation on each cable core is as close as possible to the clamping terminal.

g. Observe the required colour coding for the cable insulation.

h. Ensure that the plug top and socket have the correct voltage and current rating.

i. Ensure that the flexible cord has the appropriate temperature rating.

j. Ensure that the flexible cord passes through the tortuous path in the accessory.

Inspection and Testing

18. A finished extension lead must be inspected or tested for the following aspects before it can be regarded as safe to use:

a. Correct polarity of all connections.

b. Correct colour coding of all conductors.

c. Correct terminations at each clamping terminal.

d. Continuity of all of the conductors. Continuity of the active and neutral can be checked with a multimeter, but continuity of the earthing conductor should be tested with a high current tester such as a Safe-T-Checker if one is available.

e. Insulation resistance between all cores. The insulation resistance should be infinity when measured with a 500 volt insulation tester (Megger).

f. No insulation removed unnecessarily.

g. No cable cores extending outside of the outer cover of the plug top or extension socket.

h. No nicks in cable insulation or sheathing.

i. No insulation between clamping terminals.

j. Cable cores doubled over before connecting (where applicable).

k. No mechanical damage to any of the accessories or the flexible cord.

l. The correct accessories and cable have been used.

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Flexible Cords and Extension Leads

1. What is the maximum permissible current carrying capacity of 0.75 square millimetre (24/0.2) flexible cord?

2. What is the recommended colour for the NEUTRAL conductor in internationally colour coded three core flexible cord?

3. What is the recommended colour for the ACTIVE conductor in internationally colour coded three core flexible cord?

4. What colour is the EARTHING conductor in internationally colour coded three core flexible cord?

5. What are the colours of the conductors in three core flexible cord manufactured to OLD Australian Standards? Which colour is the ACTIVE?

6. Is 'Figure 8' flexible cord double insulated?

7. How many strands does a 1 square mm (32/0.2) flexible cord have?

8. What is the maximum permissible current carrying capacity of 1 square millimetre flexible cord?

9. Name two types of 240 volt three core flexible cord which are not permissible as an extension cord.

10. What dangerous situation can arise if a long extension cord is used while it is wound on a drum or reel?

11. What is the only permissible method of making a joint in a three core extension cord?

12. How can the earth pin in a three flat pin plug top be distinguished from the other two pins?

13. What type of sheath must an extension cord have if it is to be used on a construction site?

14. Is it permissible to use three core braided flexible cord as a flexible cord extension set?

15. How must a cord extension socket be polarised (when viewed from the front)?

16. What colour is the active conductor in typical colour coded three core flexible cord?

17. A particular three core extension lead has a maximum current rating of 10 amps. What would its current rating be if it was used with four layers wound on a reel or drum?

18. How many strands would there be in flexible cord if the manufacturer described the cable as 24/0.2?

19. How can a 240 volt 15 amp three flat pin plug-top be distinguished from a 10 amp plug top of the same type?

20. Can a 10 amp three flat pin plug-top be safely inserted into a 15 amp socket outlet?

21. What is the name of the feature of a plug top which prevents direct strain being exerted on the connecting terminals?

22. What special feature must the plug top and cord extension socket have if the extension set is to be used on a construction site?

23. Who is permitted to inspect, test and tag an extension cord on a construction site?

24 What measuring instrument must be used to test the insulation resistance between cable cores in a three core extension lead?

25. What measuring instrument is usually used to test the active and neutral cores of a cord extension set for continuity?

26. Why is a multimeter or Megger sometimes unsuitable for testing the continuity of an earthing conductor in a three core extension lead?

27. What special instrument should be used to check the continuity of the earthing conductor in a three core flexible cord extension set?

Notes:

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Cable Applications

1. What type of cable would be most suitable for a typical lighting circuit in a domestic installation.

2. What type of cable would be most suitable for suspending a cord-grip lampholder in a domestic installation.

3. What type of cable would be most suitable for installation from the ceiling to an architrave socket outlet down the cavity of a double brick wall in a domestic installation.

4. What type of cable would be most suitable for a typical single phase power circuit in a domestic installation.

5. What type of cable would be most suitable for wiring internally a domestic bench-top electrical cooking range which has four 960 watt heating elements.

6. What type of two core 1.5 square mm cable would be most suitable for supplying sensors fixed to the outside of a steam boiler in a hospital.

7. What type of cable would be most suitable for supplying four overhead luminaires inside a wheat silo.

8. What type of cable would be most suitable for supplying a three phase 2 kW totally enclosed fan cooled (TEFC) motor on an oil rig where explosive gases are sometimes present.

9. What type of cable would be most suitable for a 4 square mm 240 volt four core trailing cable in an underground mine.

10. What type of cable would be most suitable for consumer's mains to be installed in conduit from the point of attachment to the main switchboard in a small single domestic installation.

11. What type of cable would be most suitable to be supported by a galvanised steel catenary wire for luminaires suspended over a lawn bowling green.

12. What type of cable would be most suitable for fire-proof general cabling in a hospital.

13. What type of cable would be most suitable for embedding in a brick/plaster wall vertically for a length of 2.5 metres supplying a 240 volt socket outlet in a domestic installation.

14. What type of cable would be most suitable for supplying a single 500 watt luminaire mounted on a roof truss made from galvanised tubular steel - in a small sheetmetal factory.

15. What type of cable would be most suitable for a 10 amp single phase general purpose 20 metre extension cord to be used on a construction site.

16. What type of cable would be most suitable for embedding in a brick/plaster wall horizontally for a length of 4 metres supplying a 240 volt socket outlet in a domestic installation.

17. What type of cable would be most suitable for overhead sub-mains to a single phase sub distribution board in a store shed in a domestic installation.

18. What type of cable would be most suitable for a 10 amp single phase general purpose 20 metre extension cord to be used in an office building.

19. What type of cable would be most suitable for general wiring to machinery in the production plant of a brewery where moisture is present for most of the time.

Notes:

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Cable Identification

Objective

To identify common types of electrical cable.

Equipment

Prepared cable samples, including:
- Single strand TPI
- Multi strand TPI
- Single core flat TPS
- Twin core flat TPS
- Three core flat TPS
- Four core flat TPS
- Three core circular TPS flexible cord
- 'Figure 8' flexible cord
- Heat resistant flexible cable
- Single core MIMS - terminated at one end
- Multi core MIMS - served, with a pot seal at one end
- Armoured cable - with gland at one end
- Aerial cable
- Ribbon cable

Sample cable reels or packs
0-25 mm outside micrometer
Wiring Rules
Manufacturers' cable data sheets

Procedure

1. Identify each of the sample cables supplied and record your results in the Results Table.
2. Have your Results Table(s) checked by your Lecturer.

Cable Identification Table

Cable									
Cable size									
Conductor material									
Number of cores									
Number of strands per core									
Core colours									
Insulant type									
Voltage rating									
Temperature rating									
Maximum current rating									
Sheathing material									
Serving (Yes/No)									
Armoured (Yes/No)									
Screened (Yes/No)									

Assessment (Cable Identification):

Satisfactory:		Not Satisfactory:	

Lecturer: _____ Date: _____

Government of Western Australia North Metropolitan TAFE	**Terminate cables, cords and accessories for LV circuits**	Activity Sheet 1 - 2	SGB 02/2008 G106A

Power Cable Terminations

Objective

To prepare and join or terminate commonly used TPI power and communications cables using a range of terminating methods.

Equipment

Single and double screw tunnel terminal strip
Solder lugs - 10 amp to 200 amp
Crimp lugs and matching crimping tools
Bluepoint connectors
Threaded pillar or post type terminals
Line taps
Samples of completed terminations

Communications cables and terminations

Flexible TPI cable to suit the terminations supplied
4 square mm TPI earthing conductor

PVC insulating tape (assorted colours - including green/yellow)
Reel of 1 mm PVC tubing (for looming)
Heat-shrink PVC tubing - assorted sizes
Electric blow heater
Propane gas bottle with flint gun
50/50 stick solder
Block resin soldering flux
Commercial soldering paste
3-way junction box

Hand tools as required
Permanent felt marking pen
Reel of 25 mm wide masking tape

Procedure

1. Prepare the cable, correctly fit the termination, and replace the insulation for each of the terminations listed below. The size of the cable or termination can be varied to suit local requirements. Mark your name on each of the completed terminations (use masking tape as required).

	Completed
a. Connect four 2.5 mm^2 TPI cables between two neutral links and bind the cables together to form a wiring loom.	
b. Connect two 2.5 mm^2 TPI cables using a blue-point connector.	
c. Fit a solder lug to a 150 mm length of 10 mm^2 copper TPI cable.	
d. Fit a suitable crimp lug to a 150 mm length of 10 mm^2 copper TPI cable.	
e. Terminate a length of **stranded** 2.5 mm^2 TPI copper cable at a bolted terminal without using a lug.	
f. Terminate a length of **single** strand 2.5 mm^2 TPI copper cable at a bolted terminal without using a lug.	
g. Join three lengths of 2.5 mm^2 twin and earth TPS inside a 3-way junction box using bluepoint connectors.	
h. Make a soldered TEE joint consisting of four 2.5 mm^2 copper earthing conductors joined to a 4 or 6 mm^2 main earthing conductor.	
i. Make a splice in 6 mm^2 copper TPI cable.	
j. Fit an RJ45 plug to a short length of Category 5 telecommunications cable.	
k. Connect a BNC coaxial connector to a length of 75 ohm coaxial cable.	

2. Complete any other joints or terminations specified by your Lecturer.

3. Submit each of your terminations to your Lecturer for discussion.

Assessment (Power Cable Terminations):

Satisfactory:		Not Satisfactory:	

Lecturer: _____ Date: _____

Government of Western Australia North Metropolitan TAFE	**Terminate cables, cords and accessories for LV circuits**	Activity Sheet 1 - 3	SGB 02/2008 G106A

Flexible Cord Terminations

Objective

To prepare and join or terminate commonly used flexible cords using a range of terminating methods.

Equipment

Flexible cord - 0.75, 1 and 2.5 square mm (copper conductors)
Single and double screw tunnel terminal strip
Spade terminals
Crimp lugs and matching crimping tools
Bluepoint connectors
Threaded pillar or post type terminals
Quick connect terminals

Samples of completed terminations
Tag strip
Heat-shrink PVC tubing - assorted sizes
Electric blow heater
60/40 resin cored solder (3 mm)
Electric temperature-controlled soldering station
Block resin soldering flux
Commercial non corrosive soldering paste

Reel of 0.5 mm^2 hook-up wire
Hand tools and accessories as required
Permanent felt marking pen
Reel of 25 mm wide masking tape

Procedure

1. Prepare the cable and correctly fit the termination for each of the terminations listed below. The size of the cable or termination can be varied to suit local requirements. Mark your name on each of the completed terminations (use masking tape as required).

	Completed
a. Connect a 1 mm^2 flexible cord to a three terminal terminal strip.	
b. Connect a 1 mm^2 flexible cord to a post terminal using a cup washer.	

c. Terminate a length of 2.5 mm^2 flexible cord using a crimp lug.

d. Terminate a length of 0.75 mm^2 flexible cord using a spade terminal.

e. Terminate a length of 1.5 mm^2 flexible cord using a quick connect terminal.

f. Solder six short lengths of hook-up wire to a tag strip.

g. Make off an earthing connection under a round head metal thread screw using a cup washer.

h. Join two lengths of 1 mm^2 flexible cord using a Bluepoint connector.

2. Complete any other joints or terminations specified by your Lecturer.

3. Submit each of your terminations to your Lecturer for assessment and comment.

Assessment (Flexible Cord Terminations):

Satisfactory:		Not Satisfactory:	

Lecturer: _____ Date: _____

Government of Western Australia North Metropolitan TAFE	**Terminate cables, cords and accessories for LV circuits**	Activity Sheet 1 - 4	SGB 02/2008 G106A

Single Phase Extension Leads

Objective

To make up and test a three core flexible extension lead.

Equipment

10 amp three flat pin plug top
10 amp three core cord extension socket
At least 500 mm of 1 square mm three core ordinary or heavy duty flexible cord.
Safe-T-Checker or equivalent
Multimeter
High voltage insulation tester

Procedure

1. Determine the voltage and current rating of the three pin plug top by inspection.

Current: _____

Voltage: _____

2. Identify the active, neutral and earth pins on the plug top.

3. Connect the length of 1 square mm three core flexible cord to the three pin plug top. Make sure that you select the correct end of the flexible cord and polarise the plug top correctly.

4. Determine the voltage and current rating of the cord extension socket by inspection.

Current: _____

Voltage: _____

5. Identify the active, neutral and earth sockets in the cord extension socket.

6. Connect the flexible cord to the cord extension socket. Make sure that you polarise the extension socket correctly.

7. Inspect and test the extension lead for all aspects of safety and record your results in Results Table 1.

8. Submit your complete extension lead to your Lecturer for comment and assessment.

Results Table 1

Correct type of flexible cord?	
Correct end of cable for plug top?	
Cables pass through tortuous path?	
Polarity of plug top?	
All cable cores doubled over?	
Polarity of cord extension socket?	
Continuity of active conductor?	
Continuity of neutral conductor?	
Continuity of earthing conductor?	
Insulation resistance between cores?	
Are terminations made correctly?	
Has insulation been removed correctly?	
Mechanical damage to components?	
Other points	

Assessment (Single Phase Extension Leads):

Satisfactory:		Not Satisfactory:	

Lecturer: _____ Date: _____

Government of Western Australia North Metropolitan TAFE	**Terminate cables, cords and accessories for LV circuits**	Introduction Section 2	SGB 02/2008 G106A

Installation of Wiring Systems

Task:

To install and test various types of wiring systems in a simulated installation in accordance with all regulatory requirements and having due regard for environmental and heritage considerations.

Why:

You need to be able to install and test circuits in accordance with regulatory requirements and the generally accepted principles of sound and safe practice in order to avoid exposing the occupants or others to the hazards associated with electricity, and to avoid unwanted fire.

To Pass:

1. You must correctly answer the questions on the Work Sheets provided and achieve a mark of 75% or more in a competency written test.

2. You must satisfactorily complete the set laboratory activities.

3. You must achieve 100% in a final competency test for each practical activity.

Equipment

Simulated domestic installation.
Multimeters.
High voltage insulation testers.
Typical flexible cables and flexible cords
Typical electrical accessories and fixed wired appliances.

References

* Electrical Wiring Practice (7th ed.)- Volume 1, Pethebridge & Neeson
* AS/NZS 3000:2018 (Wiring Rules). Standards Australia
* AS/NZS 3008.1.1:2017 Electrical installations. Selection of cable
* WA Electrical Requirements (Current edition)
* Basic Training Manual 16-1, Safe Procedures Electrical Trades, AGPS

Government of Western Australia North Metropolitan TAFE	**Terminate cables, cords and accessories for LV circuits**	Study Guide Section 2	SGB 02/2008 G106A

Installation of Wiring Systems

Suggested Self-Study Guide

1. Study the following sections in the recommended references:

Electrical Wiring Practice - Volume 1 (7th Ed): Chapter 7

Wiring and cable routes	Page 172	
Wiring and cabling systems	Page 178	
Installing wiring systems	Page 181	
Enclosed wiring and cables	Page 189	
Underground systems	Page 209	
Aerial and catenary systems	Page 211	
Testing of cable systems	Page 265	

AS/NZS 3000:2018 - Wiring Rules:

Clause 1.6 Design of an electrical installation
Clause 1.7 Selection of and installation of electrical equipment
Clause 1.8 Verification (Inspection and testing)
Clause 1.9 Means of compliance
Clause 3.8 Identification
Clause 3.9 Installation requirements
Section 8 Verification

AS/NZS 3008.1.1:2017- Electrical installations - Selection of cables

WA Electrical Requirements

Section 3 General Requirements

2. Read the Summary and practise answering the questions provided on the Work Sheet. Refer to other relevant texts if you feel it is necessary.

3. Answer the questions given on the Work Sheet. Note that you are required to answer ALL questions correctly, although not necessarily at the same time.

4. Complete the practical activities for each Section.

5. Submit your answers to the Work Sheets to your Lecturer for discussion.

Sample Risk Assessment (JSA)

JOB SAFETY ANALYSIS WORKSHEET

JSA No.: _____ Date:

Risk: H = High
S= Significant
M = Medium
L = Low

	A	B	C	D	E
1	H	H	H	S	S
2	H	H	S	S	M
3	H	H	S	M	L
4	H	S	M	L	L
5	S	S	M	L	L

Probability:
A – common or repeating occurrence
B – known to occur or "It has happened"
C – could occur, "I've heard of it happening"
D – not likely to occur
E – practically impossible

Consequences:

People:
1 – fatality or permanent disability
2 – lost time injury or illness
3 – medical treatment
4 – first aid treatment
5 – incident report only

Environment:
1 – toxic release off site with detrimental effect
2 – off site release with no detrimental effect
3 – off site release contained with outside assistance
4 – on site release immediately contained
5 – no environmental impact

STEP NO	JOB STEP List the steps required to perform the task in the sequence they are carried out.	POTENTIAL HAZARD Against each step list the potential risk/ hazards that could cause injury / damage when the task step is performed.	Probability	Consequence	Risk Rank L S M H	REQUIRED HAZARD CONTROL For each hazard identified list the control measures required to eliminate or minimise the risk of injury.	RESPONSIBILITY Nominate the person who will be required to action the control measures
1							

Job Safety Analysis Work Team Sign-on/ Review Register

Personnel are required to sign this register to indicate they have read, understand and will adhere to the requirements of the JSA

This JSA covers:				JSA No	
Name	Employee Signature	Date	Name	Employee Signature	Date

Government of Western Australia North Metropolitan TAFE	**Terminate cables, cords and accessories for LV circuits**	Summary Section 2	SGB 02/2008 G106A

Installation of TPS Cables

1. Study Types of Wiring Systems starting on page 172 in Electrical Wiring Practice by Pethebridge & Neeson. Refer to the other Chapters and/or publications listed in the Study Guide as required.

2. The Check Lists on the following page illustrate the aspects which must be considered when inspecting and testing minor work. The lists should form the basis of the inspection and testing process for each of the practical tasks in this Section.

3. Each of the practical tasks in this section must be carried out to a standard acceptable in the workplace and with due regard to the following:

a. All relevant safety procedures must be used during the installation work.

b. All relevant personal protective equipment (PPE) must be worn. Eye protection and foot protection must be worn at all times in the installation area.

c. All signs, safety notices must be read and understood before commencing work.

d. Seek assistance from your lecturer if you are unsure how to perform a task.

e. All work must be carried out with minimum waste of materials and without damage to apparatus.

f. Power tools must be switched off and stored safely when not in use.

g. Notify your lecturer when you have completed each task.

h. Equipment must be installed in accordance with the generally accepted principles of sound and safe practice (see AS/NZS 3000 Clauses 1.7.2 & 3.9.1).

i. All work must be done according to the given specifications unless variations are negotiated with your lecturer.

j. Make sure that you coordinate effectively with other members of your work team.

k. Advise your lecturer if you need assistance when dealing with non-routine events.

l. Clean up on completion of the installation work and make sure that the area is left in a safe condition. Notify your Lecturer that the work has been completed.

Generic Check Lists (Safety Certificate)

All electrical installation work must be inspected and tested before it is connected to the supply. Read AS/NZS 3000 Section 8

	Verification - Inspection	**Yes**	**No**	**N/A**
1	Installation to specifications			
2	Continuity of metallic conduit			
3	Continuity of armouring			
4	Permissible supports and fixings			
5	Permissible bending radii			
6	Treatment of conduit joints			
7	Permissible accessories			
8	Appropriate conductor size(s)			
9	Appropriate conductor type(s)			
10	Appropriate insulation type(s)			
11	Appropriate insulation colour(s)			
12	Appropriate installation conditions			
13	Permissible terminations			
14	Enclosure of terminations			
15	Appropriate circuit protection arrangements			
16	Appropriate earthing arrangements			
17	Appropriate equipotential bonding arrangements			
18	Correct wiring			
19	Permissible route for wiring			
20	Correct clearances			
21	No damage to components			
22	Correct connections of neutral conductors			
23	Correct connect ion of MEN point			
24	Correct identification markings			
25				
26				
27				
28				
29				
30				

	Verification - Testing	**Test Instrument**	**Reading**	**OK**
1	Continuity of earthing system			
2	Resistance of Main earthing conductor			
3	Insulation resistance between live conductors and earth			
4	Polarity of active conductors			
5	Polarity of neutral conductors			
6	Polarity of earth conductors			
7	Correct circuit connections			
8	Correct operation of circuit(s)			
9	Earth loop impedance test(s)			
10	Operation of RCD(s)			
11				
12				

Notes:

Government of Western Australia North Metropolitan TAFE	**Terminate cables, cords and accessories for LV circuits**	Work Sheet 2 - 1	SGB 02/2008 G106A

Installation of TPS Cables

1. Is it permissible to install TPS cables in a boxed eave without clipping them? Give the AS/NZS 3000 Clause number.

2. What does the abbreviation TPS stand for?

3. Is it permissible to install TPS cables within 50 mm of the underside of roofing materials? Give the AS/NZS 3000 Clause number.

4. Is it permissible to install TPS cables direct in a concrete floor slab without any further protection? Give the AS/NZS 3000 Clause number.

5. Is it permissible to install TPS cables direct in a plaster or cement render wall without further protection? If so, what are the conditions? Give the AS/NZS 3000 Clause number.

6. According to WAER, what special condition is deemed to apply when cables are run within 100 mm of a ceiling in a roof space in a domestic installation?

7. Is it acceptable to make a hole in the lintel support over a door or window without the permission of a structural engineer?

8. What is the maximum recommended spacing between cable supports when a TPS cable is run on the underside of a ceiling in a position where it is likely to be disturbed?

9. Is it permissible to install TPS cables on top of a continuous horizontal plaster ceiling without fixings, where they are not likely to be disturbed? Give the AS/NZS 3000 Clause number.

10. What is the maximum recommended spacing between cable supports when a TPS cables are run vertically in a position where they are not likely to be disturbed?

11. Is it permissible to drill a 20 mm hole in the centre of a nogging in a timber framed building for the purpose of allowing TPS cables to pass through it?

12. Is it permissible to install V75 or V90 TPS cables in a refrigerated store in which the average temperature is -5 degrees C?

13. What is the minimum recommended bending radius for copper unarmoured sheathed cables?

14. What is the minimum permissible insulation resistance to earth in a 415 volt three phase domestic installation which does not include fixed electrical heating appliances?

15. Is it permissible to use a typical multimeter to measure the insulation resistance in a 240 volt single phase installation?

16. What is the maximum permissible resistance of a main earthing conductor?

Notes:

Government of Western Australia North Metropolitan TAFE	**Terminate cables, cords and accessories for LV circuits**	Activity Sheet 2 - 1	SGB 02/2008 G106A

Installation of TPS Cables

Objective

To install TPS wiring in a simulated installation so that it complies with all relevant regulatory requirements and the generally accepted principles of safe and sound practice.

Equipment

Simulated electrical installation wiring cubicle
TPS cables and accessories
Installation test instruments
Hand tools as required
AS/NZS 3000:2007 and AS 3008.1.1:2009
WA Electrical Requirements
Sample Electrical Safety Certificate
Electrical accessory catalogues

Procedure

1. Examine the attached specifications (or another specification provided by your lecturer). Plan the installation to ensure that Occupational Safety and Health (OS&H) policies and procedures are followed.

2. Consult appropriate personnel to ensure that the work is coordinated effectively with others involved on the work site.

3. Obtain the cables, accessories, test equipment and hand tools necessary to complete the work in accordance with job requirements.

4. Check the tools, equipment and testing devices for correct operation and safety.

5. Have your preparatory work checked by your Lecturer, and discuss how you plan to proceed with the installation.

6. Install the wiring in accordance with requirements without damage or distortion to the surrounding environment or services. Obtain approval from your Lecturer before any contingencies are implemented. Carry out on-going checks of the quality of your work in accordance with the requirements of safe and sound practice.

7. Inspect your completed installation to ensure that it conforms to the specifications and to all relevant regulatory requirements.

8. Test your completed installation using appropriate test equipment and record the results.

Type of Test	Test Instrument	Expected Result	Actual Result	OK

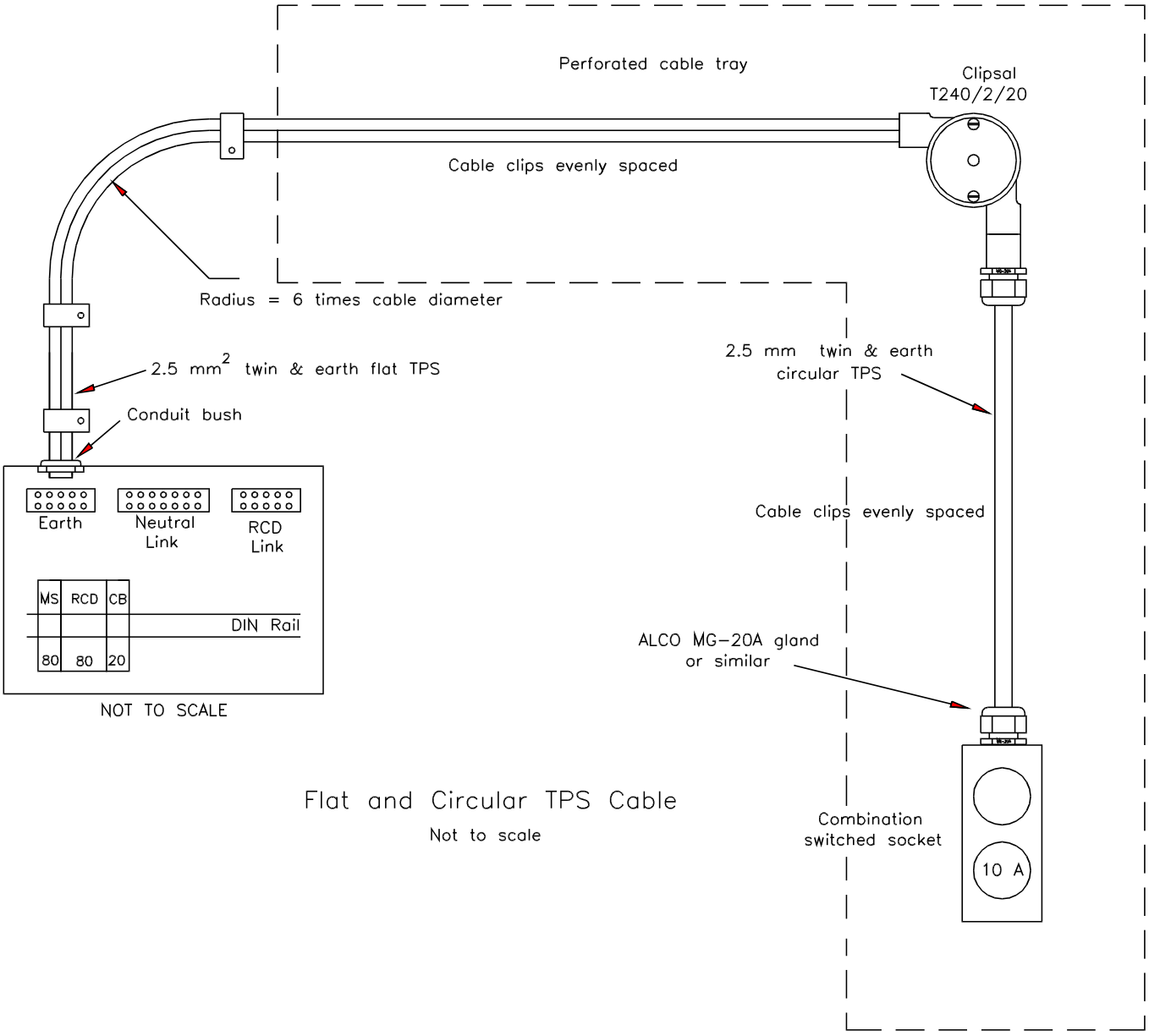
9. Complete the sample Electrical Safety Certificate.

10. Have your installation, test results and Electrical Safety Certificate checked by your Lecturer.

11. Disconnect your wiring and prepare all accessories for re-use where practicable. Clean up the work area and ensure that all equipment is left in a safe condition.

12. Make a list of the cable and accessories used to complete this project.

Specifications



Flat and Circular TPS Cable

Not to scale

Accessories

Cable/Accessory/etc.	Catalogue & Number

Assessment (Installation of TPS Cables):

Satisfactory:		Not Satisfactory:	

Lecturer: _____ Date: _____

Electrical Safety Certificate

Department of Consumer and Employment Protection
EnergySafety

Form authorised by the Director of Energy Safety – Issued July 2008

Certificate number AA 001

ELECTRICAL SAFETY CERTIFICATE

Electricity (Licensing) Regulations 1991, Regulation 52B

This certificate warrants that the electrical installing work described below is safe and complies with the *Electricity (Licensing) Regulations 1991.*

This Electrical Safety Certificate is the certificate of compliance referred to in Regulation 52B of the *Electricity (Licensing) Regulations 1991.* This regulation requires that the electrical contractor/authorised[1] electrician completing electrical installing work must, within 28 days of completing the work, provide a certificate of compliance in respect of the work to the person for whom the work was carried out.

Installation details

Owner/Occupier Name		Meter No.	
Address			
New Installation (Y/N)		Alteration/Addition (Y/N)	
Date of Completion			

Details of work completed (indicate a number/rating where relevant)

General description of the work:

The following detailed information MUST ALSO be provided – indicate the number or rating in each category

Lights		Water Heaters	
Socket Outlets		Motors	
Cooking Appliances		Air Conditioners	

Details of any defects observed (alterations and additions only)

Certification by authorised[1] electrician who completed the work

I certify that the electrical installing work that is subject of this certificate has been completed, checked and tested and, at the time of testing, met the requirements of the *Electricity (Licensing) Regulations 1991* and is safe.

Name (please print)	
Signature	
Licence No.	E W

Details of electrical contractor

Licence No.	E C
Business Name	
Business Address	
Phone No.	
Facsimile No.	

Date

[1] Authorised pursuant to Regulation 52B(5) of the *Electricity (Licensing) Regulations 1991*

CUSTOMER COPY

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Government of Western Australia North Metropolitan TAFE	**Terminate cables, cords and accessories for LV circuits**	Summary 2 - 2	SGB 02/2008 G106A

Installation of TPI Cables in Conduit

1. Study Chapter 7 – Enclosed wiring and cables in Electrical Wiring Practice (7th Edition) by Pethebridge and Neeson. Refer to other Chapters and/or publications listed in the Study Guide as required.
2. In particular refer to drawing cables using Yellow 77 or cable Lube.
3. Application of different cable enclosures.

Notes

Government of Western Australia North Metropolitan TAFE	**Terminate cables, cords and accessories for LV circuits**	Work Sheet 2 - 2	SGB 02/2008 G106A

Installation of TPI Cables in Conduit

1. What are the three main types of rigid PVC conduit?

2. What special condition must be met if rigid PVC conduit is installed in direct sunlight?

3. What is the maximum length of rigid non-metallic conduit which should be installed without an expansion fitting where excessive temperature variations occur, such as in ceiling spaces?

4. Is it permissible to use rigid PVC conduit to enclose the supply cables to fire control equipment? Give the AS/NZS 3000 Clause number.

5. Is it permissible to use flexible PVC conduit to enclose cables in a concrete floor slab? Give the AS/NZS 3000 Clause number.

6. What is the minimum recommended distance between supports for metallic conduits?

7. What is the minimum recommended distance between supports for rigid non-metallic conduits?

8. What is one disadvantage of using an elbow instead of a bend in a run of conduit which involves two changes of direction?

9. What is the common name of a lubricant which can be used when drawing cables into rigid PVC conduit?

10. Is it permissible to install flexible PVC conduit fittings without using adhesive cement at the joints?

11. Name 6 different fittings (conduit accessories) used in conjunction with 20 mm electrical conduit.

12. What is the standard length for HD rigid PVC conduit?

13. What is one advantage of using trunking to enclose cables rather than conduit.

14. Name the common accessory which can be used to bend rigid PVC conduit without distorting the conduit.

15. What is the minimum recommended bending radius for unplasticised PVC (UPVC) conduit?

16. Is galvanised screwed steel conduit permissible as an enclosure for underground wiring?

17. What are two disadvantages of Halogen-free, Fire-resistant, Temperature-stable (HFT) conduit?

18. Name 6 different types of electrical conduit.

19. Is it permissible to install rigid PVC conduit fittings without using an adhesive cement at the conduit joints?

Government of Western Australia North Metropolitan TAFE	**Terminate cables, cords and accessories for LV circuits**	Activity Sheet 2 - 2	SGB 02/2008 G106A

Installation of TPI Cables in Conduit

Objective

To install TPI wiring in conduit in a simulated installation so that it complies with all regulatory requirements and the generally accepted principles of safe and sound practice.

Equipment

Simulated electrical installation wiring cubicle
TPI cables and conduit - see Specifications
Installation test instruments
Hand tools as required
AS/NZS 3000 and AS/NZS 3008.1.1
WA Electrical Requirements
Electrical accessory catalogues

Procedure

1. Examine the specification indicated by your lecturer and plan the installation to ensure that Occupational Safety and Health (OS&H) policies and procedures are followed.

2. Consult appropriate personnel to ensure that the work is coordinated effectively with others involved on the work site.

3. Obtain the cables, accessories, test equipment and hand tools necessary to complete the work in accordance with job requirements.

4. Check the tools, equipment and testing devices for correct operation and safety.

5. Have your preparatory work checked by your Lecturer, and discuss how you plan to proceed with the installation.

6. Install the wiring in accordance with requirements without damage or distortion to the surrounding environment or services. Obtain approval from your Lecturer before any contingencies are implemented. Carry out on-going checks of the quality of your work in accordance with the requirements of safe and sound practice.

7. Inspect your completed installation to ensure that it conforms to the specifications and to all relevant regulatory requirements.

8. Test your completed installation using appropriate test equipment and record the results.

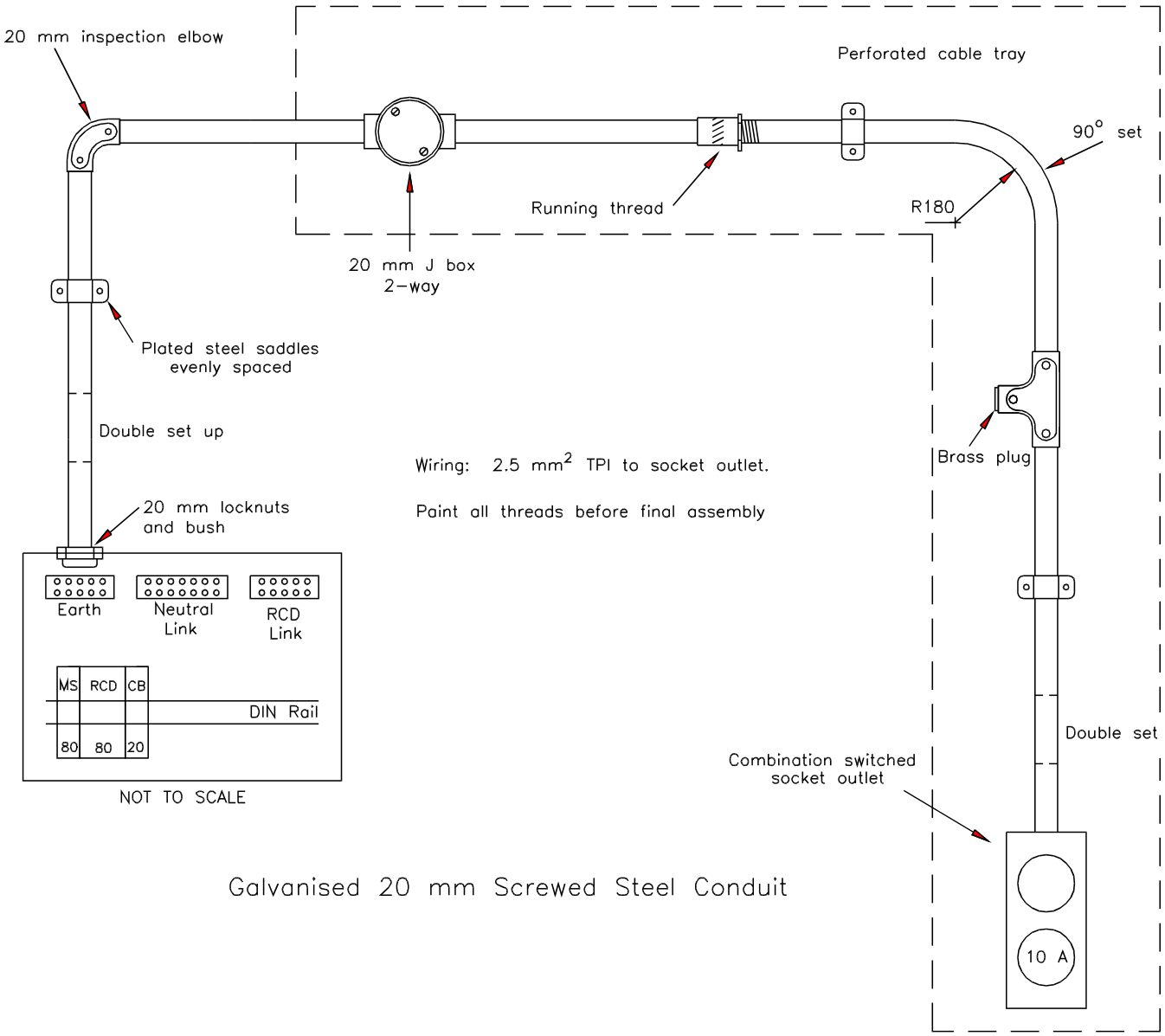
Type of Test	Test Instrument	Expected Result	Actual Result	OK

9. Have your installation and test results checked by your Lecturer.

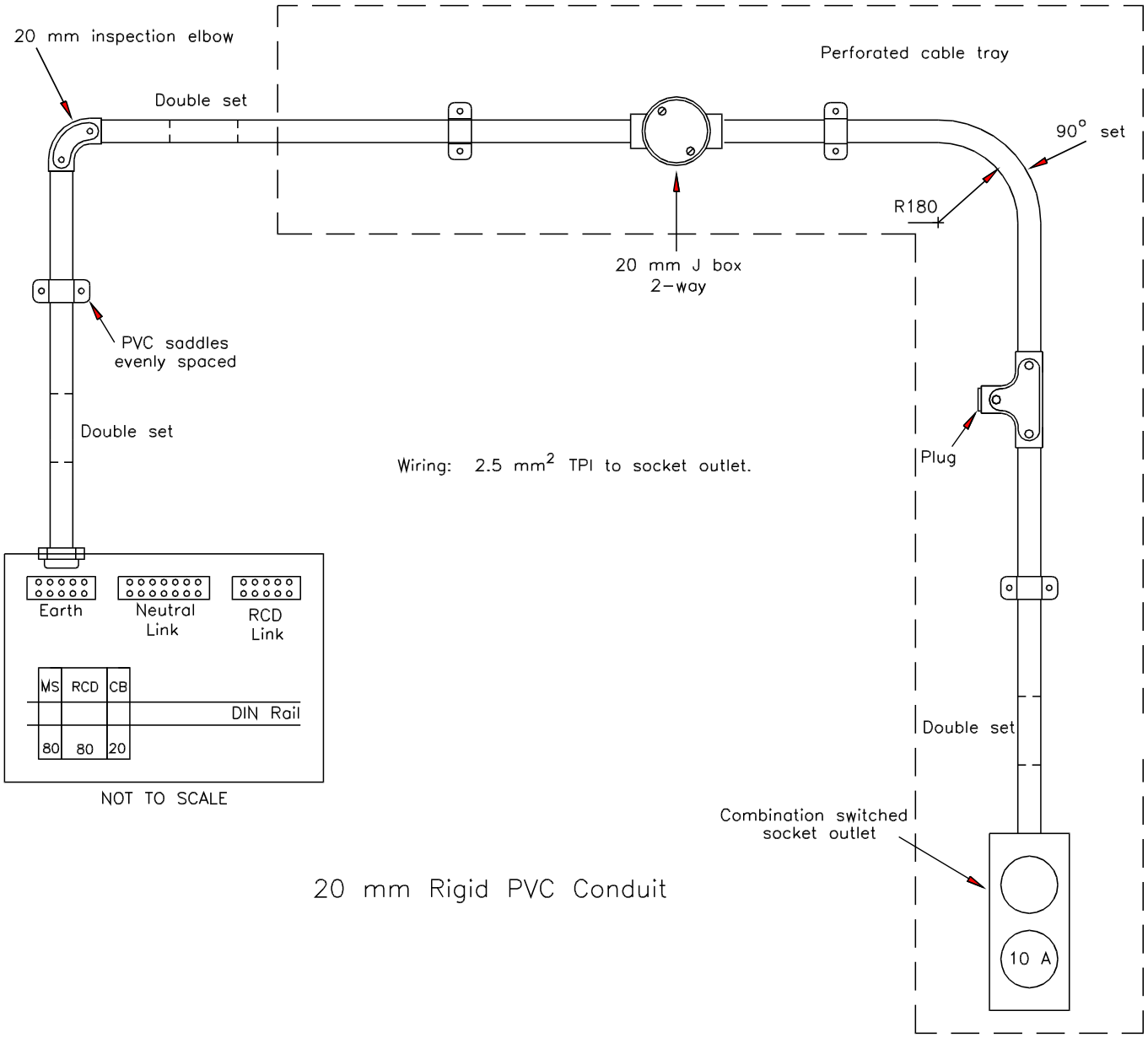
10. Disconnect your wiring and prepare all accessories for re-use where practicable. Clean up the work area and ensure that all equipment is left in a safe condition.

11. Make a list of the cable and accessories used to complete this project.

Specifications – Galvanised Steel Conduit



Specifications – Rigid PVC Conduit



20 mm Rigid PVC Conduit

Accessories – Galvanised Steel Conduit

Cable/Accessory/etc.	Catalogue & Number

Accessories – Rigid PVC Conduit

Cable/Accessory/etc.	Catalogue & Number

Government of Western Australia North Metropolitan TAFE	**Terminate cables, cords and accessories for LV circuits**	Summary 2 - 3	SGB 02/2008 G106A

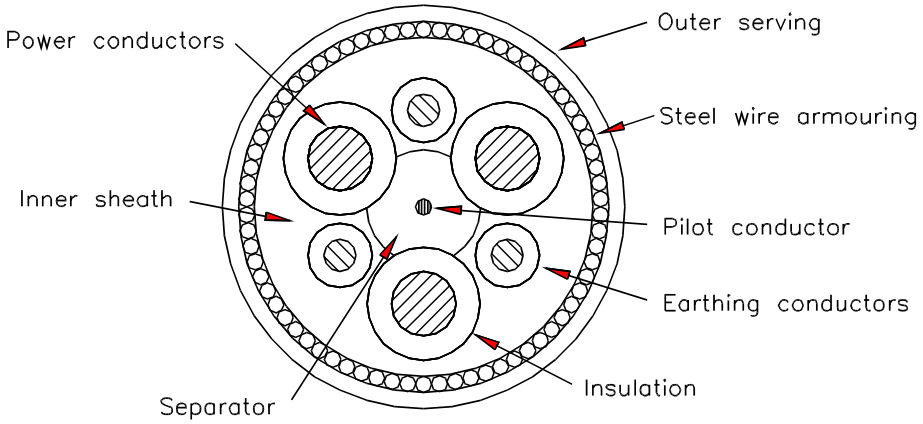
Installation of Armoured Cables

Description

1. Steel Wire Armoured (SWA) or Galvanised Steel Wire (GSW) Armoured cables have an outer layer of steel wires arranged to form a protective sheath inside a final layer of insulated serving (often PVC).

2. SWA cables are available in several types, the most common ones being paper insulated lead sheathed, and PVC insulated PVC sheathed. They are manufactured in a range of sizes with a range of cores; the cores may be stranded or solid, copper or aluminium.

3. One type of armoured trailing cable as used in the mining industry is shown below:



4. Armoured cables are primarily intended to be used in situations where there is a risk of mechanical damage such as in industrial or mining installations or hazardous areas involving explosive gases or dusts.

5. Armoured cables require special terminating glands to ensure that the armouring is electrically and mechanically continuous throughout their length as required by AS/NZS 3000.

Notes

Government of Western Australia North Metropolitan TAFE	**Terminate cables, cords and accessories for LV circuits**	Work Sheet 2 - 3	SGB 02/2008 G106A

Installation of Armoured Cables

1. What is the minimum recommended bending radius for armoured sheathed cables according to the Wiring Rules?

2. Is it permissible to install served armoured cables in concrete without a wiring enclosure?

3. What three electrical tests must be carried out on a steel wire armoured cable used for a 240 volt single phase final subcircuit?

4. Is it essential for the armouring of steel wire armoured cables to be electrically continuous?

Notes:

Government of Western Australia North Metropolitan TAFE	**Terminate cables, cords and accessories for LV circuits**	Activity Sheet 2 - 3	SGB 02/2008 G106A

Installation of Armoured Cables

Objective

To install steel wire armoured cable in a simulated installation so that it complies with all regulatory requirements and the generally accepted principles of safe and sound practice.

Equipment

Simulated electrical installation wiring facility
Armoured cables and associated glands
Installation test instruments
Hand tools as required
AS/NZS 3000 and AS/NZS 3008.1.1
Cable manufacturers' catalogues

Procedure

1. Examine the attached specifications and plan the installation to ensure that Occupational Safety and Health (OS&H) policies and procedures are followed.

2. Consult appropriate personnel to ensure that the work is coordinated effectively with others involved on the work site.

3. Obtain the cables, accessories, test equipment and hand tools necessary to complete the work in accordance with job requirements.

4. Check the tools, equipment and testing devices for correct operation and safety.

5. Have your preparatory work checked by your Lecturer, and discuss how you plan to proceed with the installation.

6. Install the wiring in accordance with requirements without damage or distortion to the surrounding environment or services. Obtain approval from your Lecturer before any contingencies are implemented. Carry out on-going checks of the quality of your work in accordance with the requirements of safe and sound practice.

7. Inspect your completed installation to ensure that it conforms to the specifications and to all relevant regulatory requirements.

8. Test your completed installation using appropriate test equipment and record the results.

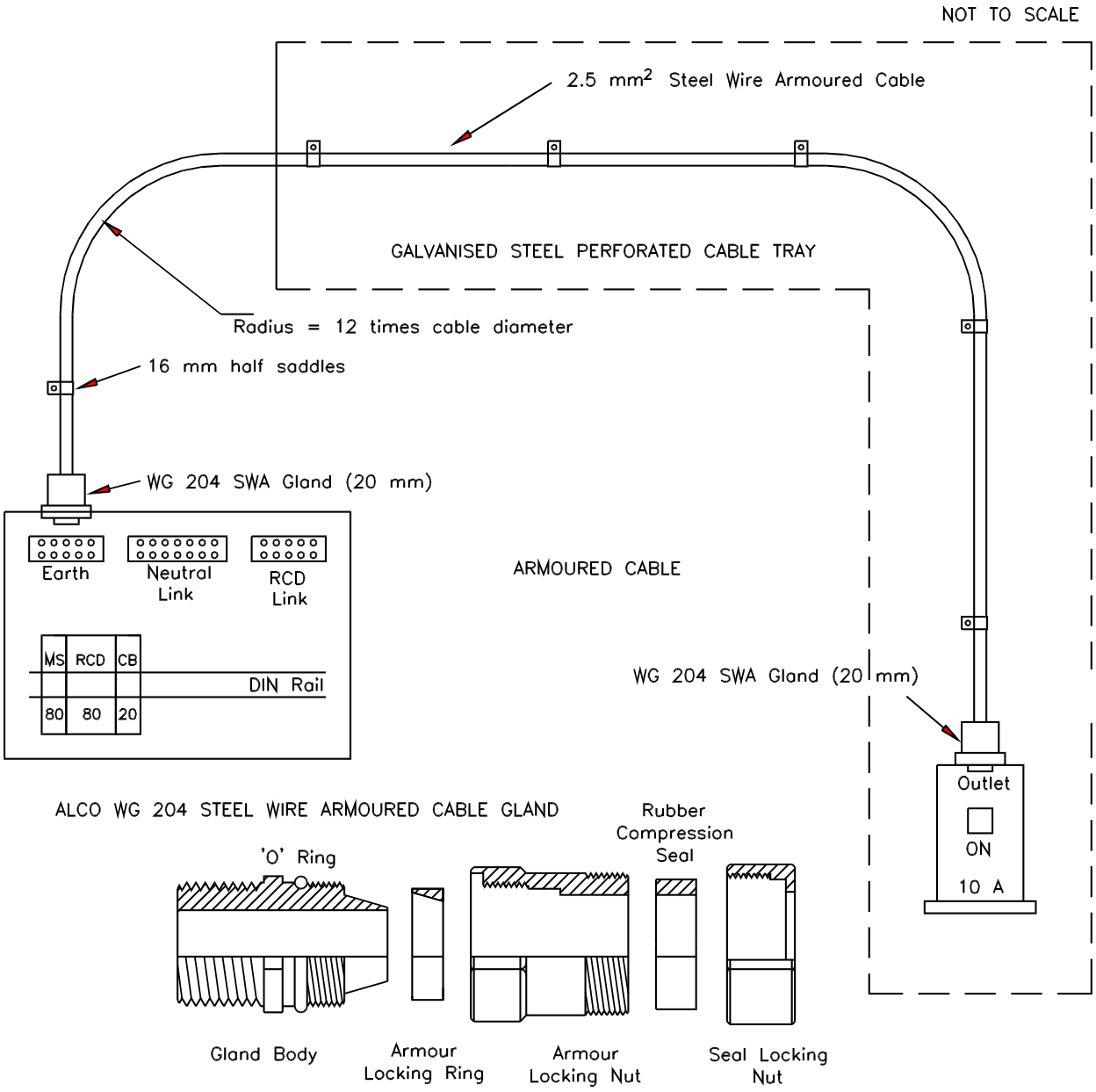
Type of Test	Test Instrument	Expected Result	Actual Result	OK

9. Have your installation and test results checked by your Lecturer.

10. Disconnect your wiring and prepare all accessories for re-use where practicable. Clean up the work area and ensure that all equipment is left in a safe condition.

11. Make a list of the cable and accessories used to complete this project.

Specifications



Accessories

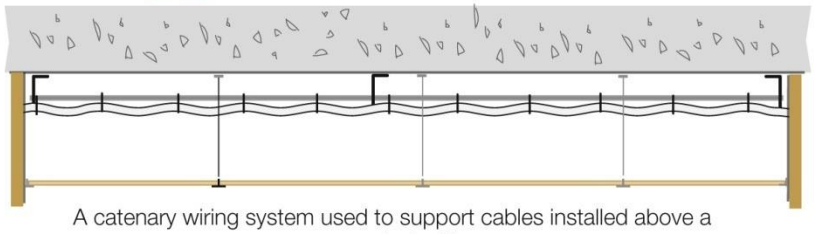
Cable/Accessory/etc.	Catalogue & Number

Government of Western Australia North Metropolitan TAFE	**Terminate cables, cords and accessories for LV circuits**	Summary 2 - 4	SGB 02/2008 G106A

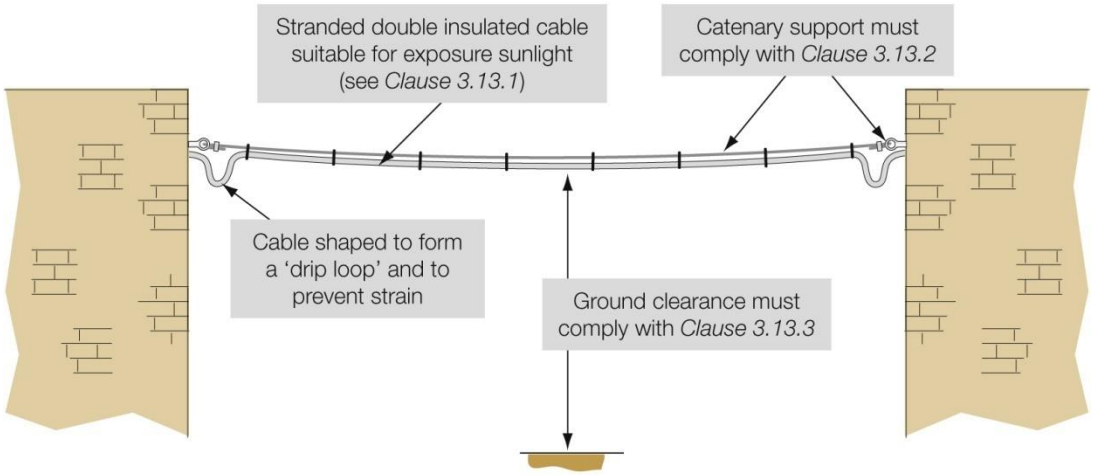
Installation of Catenary Supported Cables

1. Study Aerial and Catenary systems on page 211 of Electrical Wiring Practice (7th Edition) by Pethebridge and Neeson. Refer to the other Chapters and/or publications listed in the Study Guide as required.

2. Study AS/NZS 3000 clause 3.13 Cables supported by a catenary.



A catenary wiring system used to support cables installed above a suspended ceiling



Catenary support system outdoors
The system is usually employed only for short spans because long spans would be uneconomical compared with aerial construction.

Notes

Government of Western Australia North Metropolitan TAFE	**Terminate cables, cords and accessories for LV circuits**	Work Sheet 2 - 4	SGB 02/2008 G106A

Installation of Catenary Supported Cables

1. Is it permissible to install single insulated TPI cables by a catenary wire?

2. Why is it necessary to provide a loop of at least 150 mm before the first and after the last point of fixture of a cable to a catenary wire?

3. What conditions must be met for double insulated cables supported by a catenary wire outdoors?

Notes:

Government of Western Australia North Metropolitan TAFE	**Terminate cables, cords and accessories for LV circuits**	Activity Sheet 2 - 4	SGB 02/2008 G106A

Installation of Catenary Supported Cable

Objective

To install catenary supported cable in a simulated installation so that it complies with all regulatory requirements and the generally accepted principles of safe and sound practice.

Equipment

Simulated electrical installation wiring facility
Galvanised steel catenary wire (7 strands)
Catenary support accessories
Outdoor 2.5 square mm TPS twin and earth
Installation test instruments
Hand tools as required
AS/NZS 3000 and AS/NZS 3008.1.1
Cable manufacturers' catalogues

Procedure

1. Examine the attached specifications and plan the installation to ensure that Occupational Safety and Health (OS&H) policies and procedures are followed.

2. Consult appropriate personnel to ensure that the work is coordinated effectively with others involved on the work site.

3. Obtain the cables, accessories, test equipment and hand tools necessary to complete the work in accordance with job requirements.

4. Check the tools, equipment and testing devices for correct operation and safety.

5. Have your preparatory work checked by your Lecturer, and discuss how you plan to proceed with the installation.

6. Install the wiring in accordance with requirements without damage or distortion to the surrounding environment or services. Obtain approval from your Lecturer before any contingencies are implemented. Carry out on-going checks of the quality of your work in accordance with the requirements of safe and sound practice.

7. Inspect your completed installation to ensure that it conforms to the specifications and to all relevant regulatory requirements.

8. Test your completed installation using appropriate test equipment and record the results.

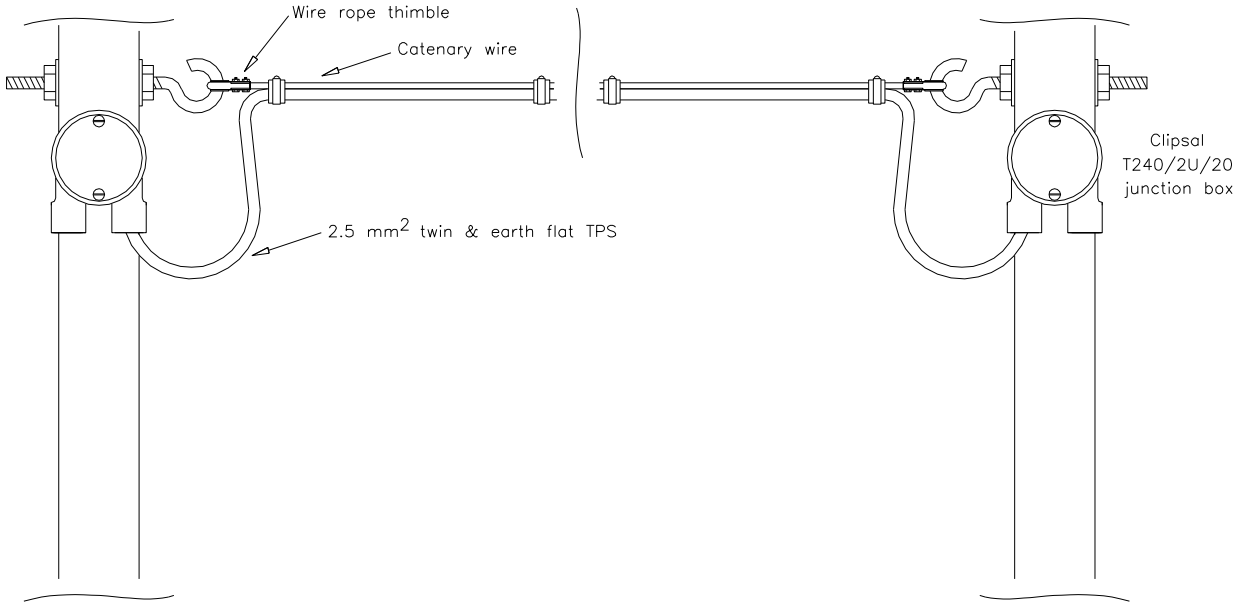
Type of Test	Test Instrument	Expected Result	Actual Result	OK

9. Have your installation and test results checked by your Lecturer.

10. Disconnect your wiring and prepare all accessories for re-use where practicable. Clean up the work area and ensure that all equipment is left in a safe condition.

11. Make a list of the cable and accessories used to complete this project.

Specifications



Accessories

Cable/Accessory/etc.	Catalogue & Number

Government of Western Australia North Metropolitan TAFE	**Terminate cables, cords and accessories for LV circuits**	Activity Sheet 2 - 5	SGB 02/2008 G106A

Installation of Catenary Supported Trailing Cable

Objective

To install a catenary supported trailing cable in a simulated installation so that it complies with all regulatory requirements and the generally accepted principles of safe and sound practice.

Equipment

Simulated electrical installation wiring facility
Galvanised steel catenary wire (7/1.25 or similar)
Trailing cable accessories
2.5 square mm circular TPS twin and earth
20 mm CABAC or ALCO cable glands for the circular TPS
20 mm Rigid UPVC conduit and accessories
2.5 square mm TPI cables for a single phase circuit
Installation test instruments
Hand tools as required
AS/NZS 3000 and AS/NZS 3008.1.1
Cable manufacturers' catalogues

Procedure

1. Examine the attached specifications and plan the installation to ensure that Occupational Safety and Health (OS&H) policies and procedures are followed.

2. Consult appropriate personnel to ensure that the work is coordinated effectively with others involved on the work site.

3. Obtain the cables, accessories, test equipment and hand tools necessary to complete the work in accordance with job requirements.

4. Check the tools, equipment and testing devices for correct operation and safety.

5. Have your preparatory work checked by your Lecturer, and discuss how you plan to proceed with the installation.

6. Install the wiring in accordance with requirements without damage or distortion to the surrounding environment or services. Obtain approval from your Lecturer before any contingencies are implemented. Carry out on-going checks of the quality of your work in accordance with the requirements of safe and sound practice.

7. Inspect your completed installation to ensure that it conforms to the specifications and to all relevant regulatory requirements.

8. Test your completed installation using appropriate test equipment and record the results.

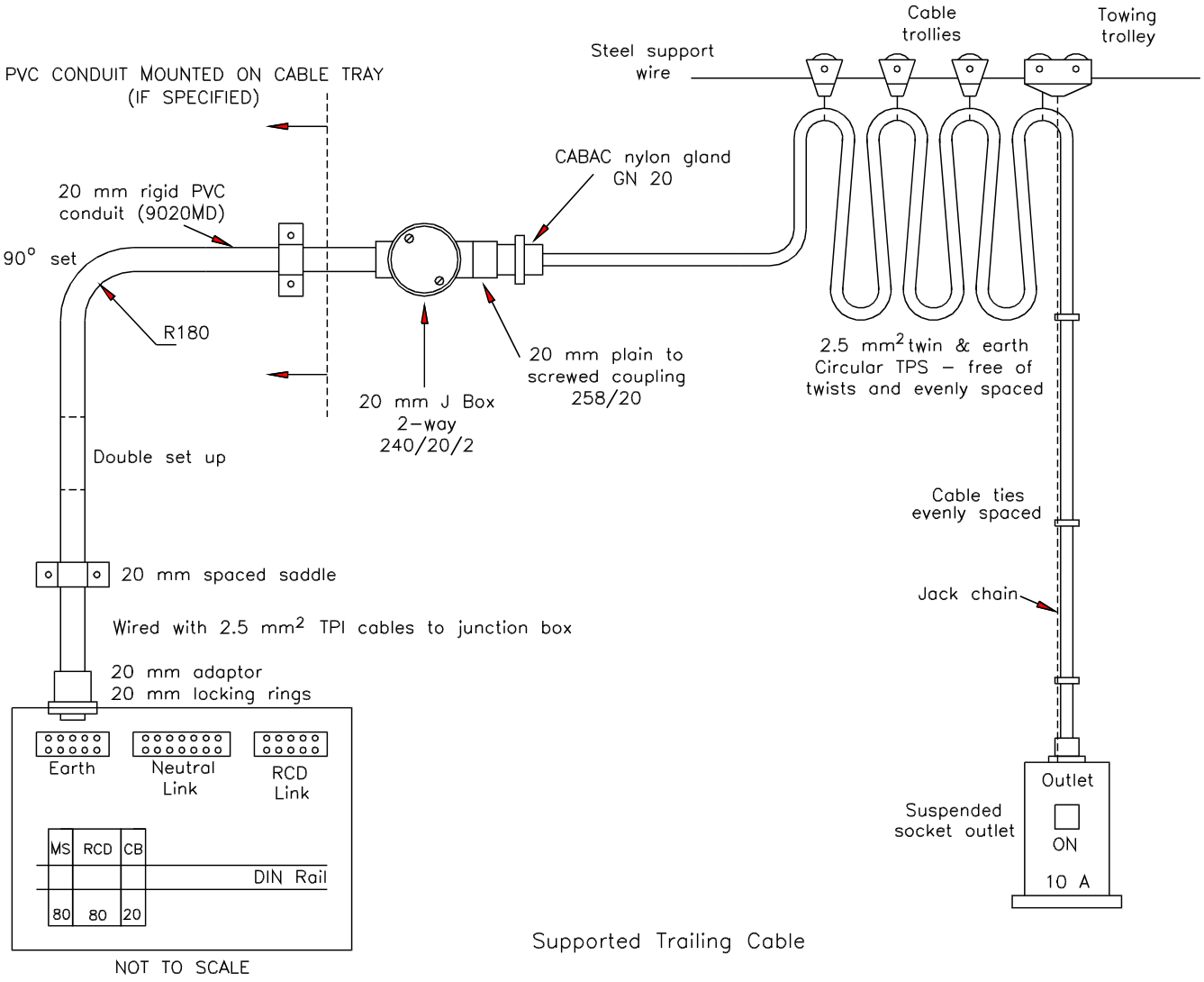
Type of Test	Test Instrument	Expected Result	Actual Result	OK

9. Have your installation and test results checked by your Lecturer.

10. Disconnect your wiring and prepare all accessories for re-use where practicable. Clean up the work area and ensure that all equipment is left in a safe condition.

11. Make a list of the cable and accessories used to complete this project.

Specifications



Supported Trailing Cable

Accessories

Cable/Accessory/etc.	Catalogue & Number

Notes