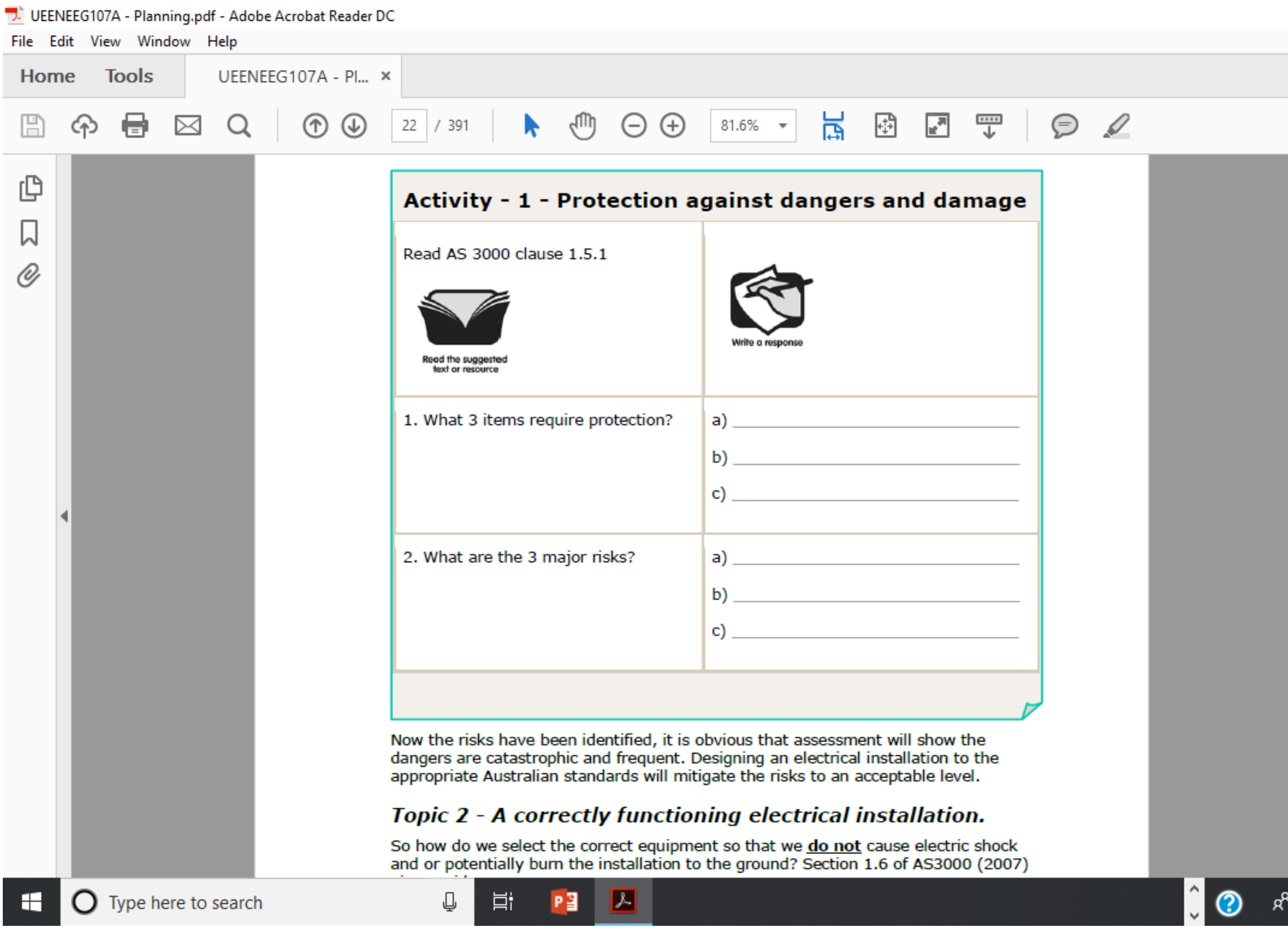


Activity - 1 - Protection against dangers and damage

Read AS 3000 clause 1.5.1 Read the suggested text or resource	Write a response
1. What 3 items require protection?	a) ______ b) ______ c) ______
2. What are the 3 major risks?	a) ______ b) ______ c) ______

Now the risks have been identified, it is obvious that assessment will show the dangers are catastrophic and frequent. Designing an electrical installation to the appropriate Australian standards will mitigate the risks to an acceptable level.

Topic 2 - A correctly functioning electrical installation.

So how do we select the correct equipment so that we **do not** cause electric shock and or potentially burn the installation to the ground? Section 1.6 of AS3000 (2007)

1.5.1 Protection against dangers and damage

The requirements of this Standard are intended to ensure the safety of persons, livestock, and property against dangers and damage that may arise in the reasonable use of electrical installations.

In electrical installations, the three major types of risk are listed below, along with applicable requirements:

(a) Shock current Shock current arising from contact with parts that are live in normal service (direct contact) and contact with parts that become live under fault conditions (indirect contact).

NOTES:

1 A 'shock current' is an electric current of sufficient magnitude and duration to cause an electric shock. AS/NZS 60479 provides further information on the effects of shock current through the human body.

2 Protection under normal conditions, designated as 'basic protection' (direct contact) is defined in Clause 1.4.97.

3 Protection under fault conditions, designated as 'fault protection' (indirect contact) is defined in Clause 1.4.98.

(b) Excessive temperatures Excessive temperatures likely to cause burns, fires and other damaging effects.

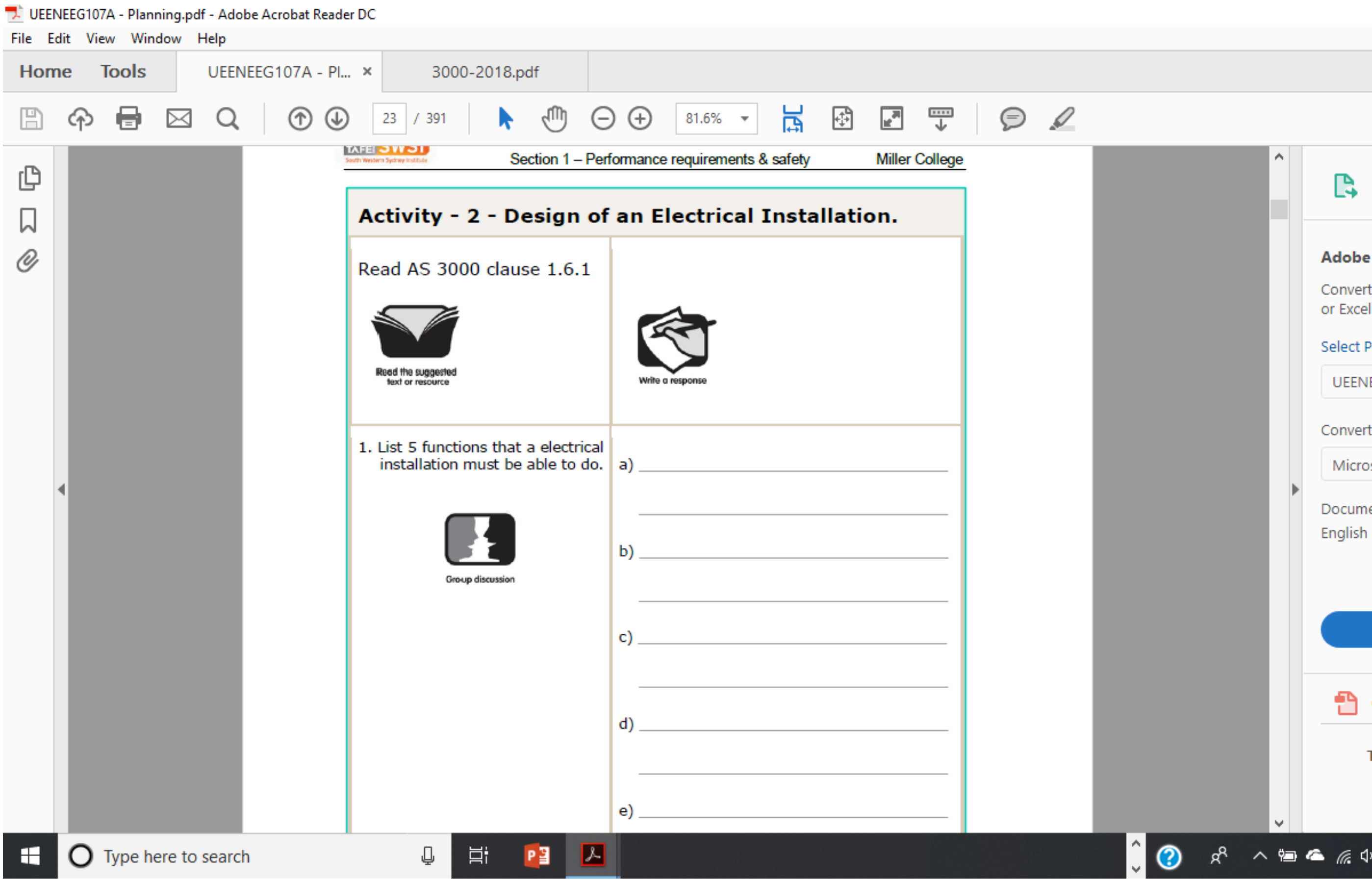
Persons, fixed equipment, and fixed materials adjacent to electrical equipment shall be protected against harmful effects of heat developed by electrical equipment, or thermal radiation, particularly the following effects:

(i) Combustion or degradation of materials.

(ii) Risk of burns.

(iii) Impairment of the safe function of installed equipment.

(c) Explosive atmospheres Equipment installed in areas where explosive gases or dusts may be present shall provide protection against the ignition of such gases or dusts.



1.6 DESIGN OF AN ELECTRICAL INSTALLATION

1.6.1 General

An electrical installation shall be designed to—

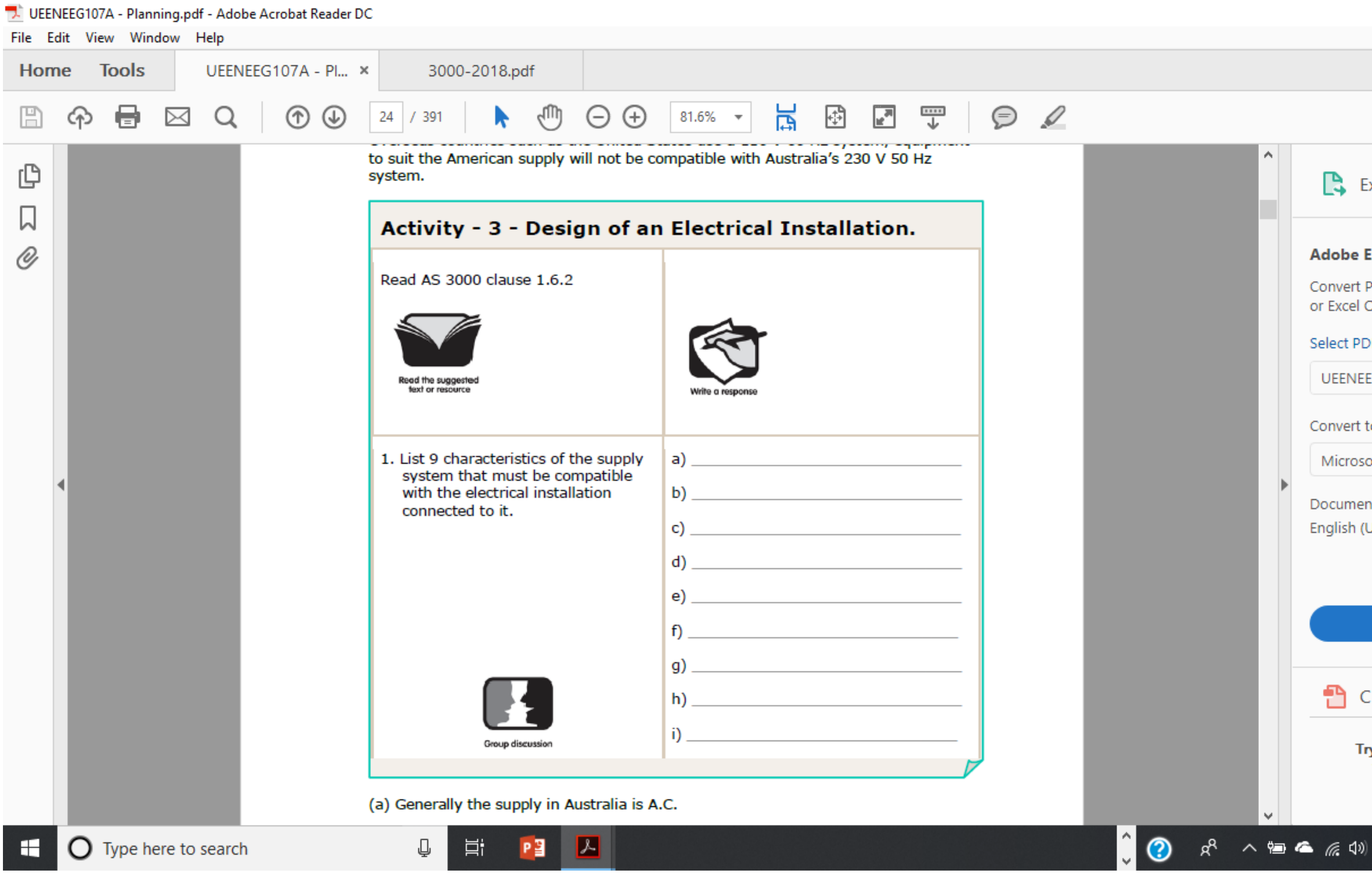
(a) protect persons, livestock and property from harmful effects;

(b) function correctly as intended;

(c) connect, operate safely and be compatible with the electricity distribution system, or other source of supply, to which the electrical installation is to be connected;

(d) facilitate safe operation, inspection, testing and maintenance; and

* (e) reduce inconvenience in the event of a fault.



1.6.2 Supply characteristics

The following characteristics of the electricity supply shall be determined:

(a) Nature of current, a.c. or d.c.

(b) Nature and number of conductors, as follows:

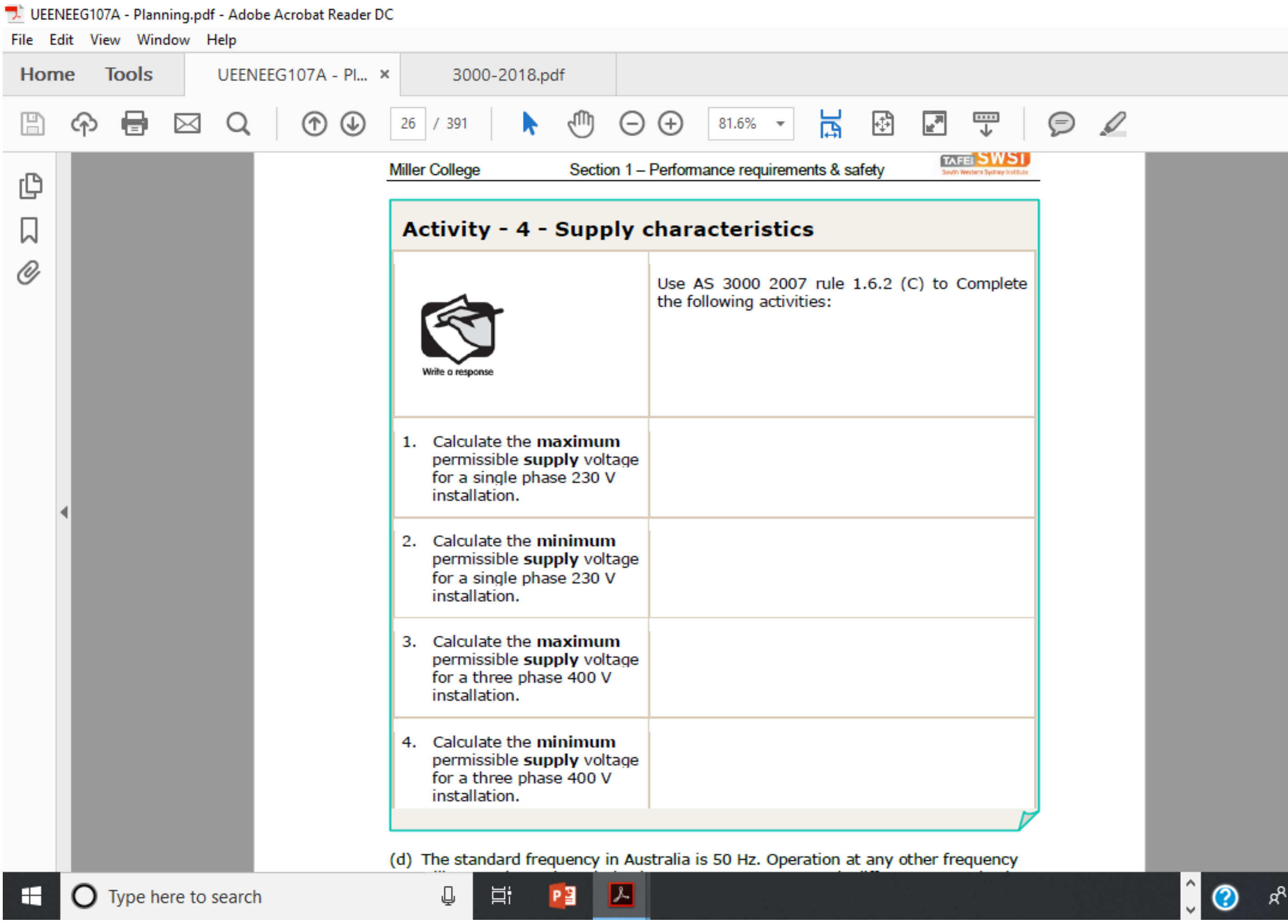
(i) Active (phase), neutral and protective earthing conductors for a.c.

(ii) Equivalent conductors for d.c.

(c) Voltage and voltage tolerances.

NOTE: The nominal voltage and tolerances for low voltage supply systems and electrical installations are—

(a) for Australia, 230/400 V + 10% to · 6% (in accordance with AS 60038);
and
(b) for New Zealand, 230/400 V + 6% to · 6% (in accordance with
IEC 60038).
(d) Frequency and frequency tolerances.
(e) Maximum current that can be supplied.
(f) Prospective short-circuit current.
NOTE: Information regarding prospective short-circuit and fault currents at
the point of supply may be obtained from the local electricity distributor.
(g) Protective measures inherent in the supply, e.g. MEN earthing system.
(h) Limits on the use of equipment.
(i) Harmonic current or other limitations.



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Miller College — Section 1 – Performance requirements & safety

Activity - 4 - Supply characteristics

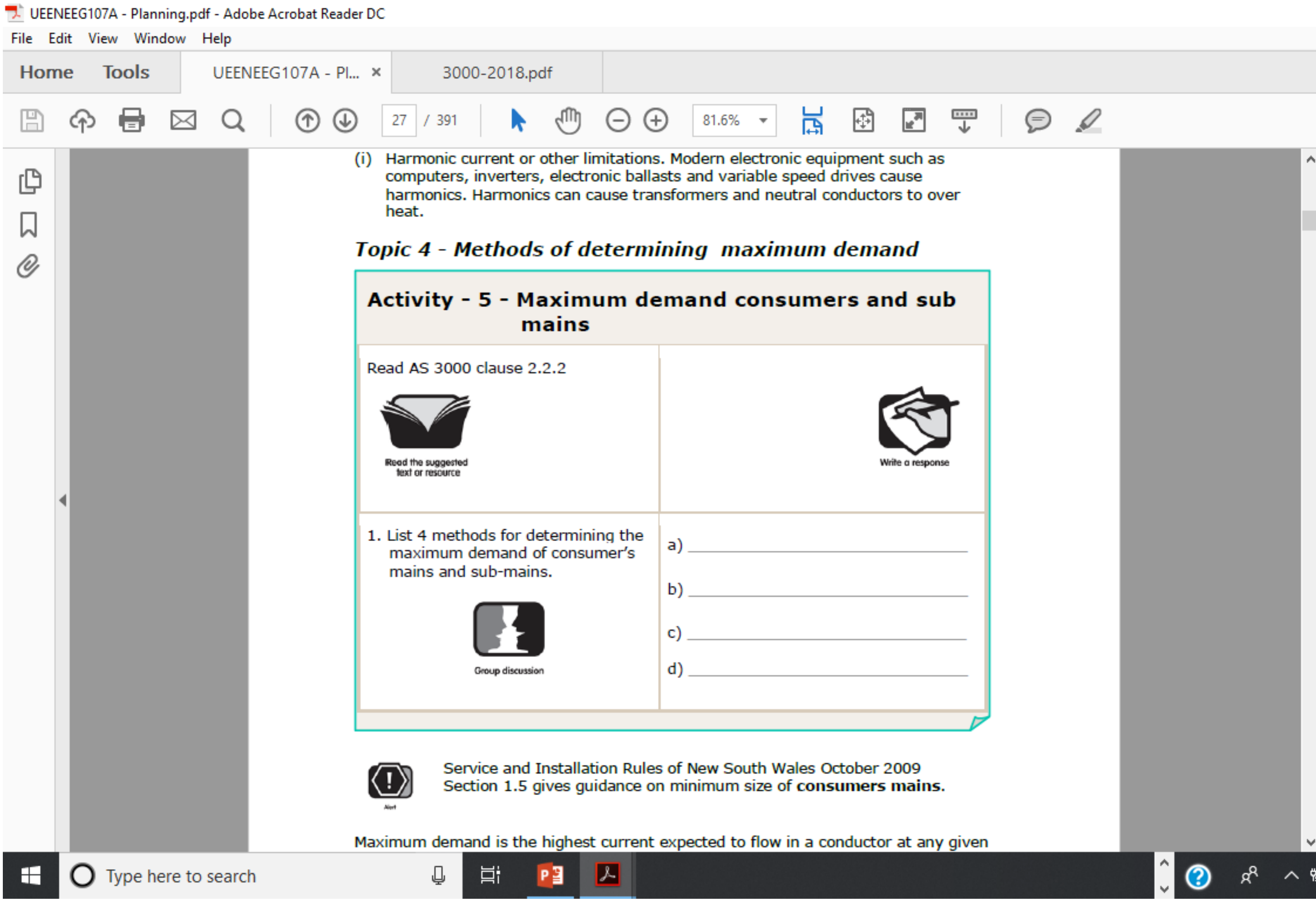
Write a response	Use AS 3000 2007 rule 1.6.2 (C) to Complete the following activities:
1. Calculate the **maximum** permissible **supply** voltage for a single phase 230 V installation.	
2. Calculate the **minimum** permissible **supply** voltage for a single phase 230 V installation.	
3. Calculate the **maximum** permissible **supply** voltage for a three phase 400 V installation.	
4. Calculate the **minimum** permissible **supply** voltage for a three phase 400 V installation.	

(d) The standard frequency in Australia is 50 Hz. Operation at any other frequency

c) Voltage and voltage tolerances.
NOTE: The nominal voltage and tolerances for low voltage supply systems
and electrical installations are—

(a) for Australia, 230/400 V + 10% to ・6% (in accordance with AS 60038); and

(b) for New Zealand, 230/400 V + 6% to ・6% (in accordance with IEC 60038).



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(i) Harmonic current or other limitations. Modern electronic equipment such as computers, inverters, electronic ballasts and variable speed drives cause harmonics. Harmonics can cause transformers and neutral conductors to over heat.

Topic 4 - Methods of determining maximum demand

Activity - 5 - Maximum demand consumers and sub mains

Read AS 3000 clause 2.2.2 Read the suggested text or resource	Write a response
1. List 4 methods for determining the maximum demand of consumer's mains and sub-mains. Group discussion	a) ____ b) ____ c) ____ d) ____

Service and Installation Rules of New South Wales October 2009 Section 1.5 gives guidance on minimum size of **consumers mains.**

Maximum demand is the highest current expected to flow in a conductor at any given

2.2.2 Maximum demand

The maximum demand in consumer mains, submains and final subcircuits, taking account of the physical distribution and intended usage of electrical equipment in the electrical installation and the manner in which the present requirements might vary, shall be determined using one of the methods set out in Items (a) to (d).

If the actual measured maximum demand is found to exceed that obtained by calculation or assessment, the measured value shall be deemed to be the maximum demand.

(a) Calculation The maximum demand may be calculated in accordance with the guidance given in this Standard for the appropriate type of electrical installation and electrical equipment supplied.

NOTE: Guidance on the determination of maximum demand is provided for basic electrical installations in Appendix C.

It is recognized that there may be considerable differences in loading from one electrical installation to another. Alternative methods of calculating the maximum demand may be used taking account of all the relevant information available for any particular electrical installation.

(b) Assessment The maximum demand may be assessed where—

(i) the electrical equipment operates under conditions of fluctuating or intermittent loading, or a definite duty cycle;

(ii) the electrical installation is large and complex; or

(iii) special types of occupancy exist.

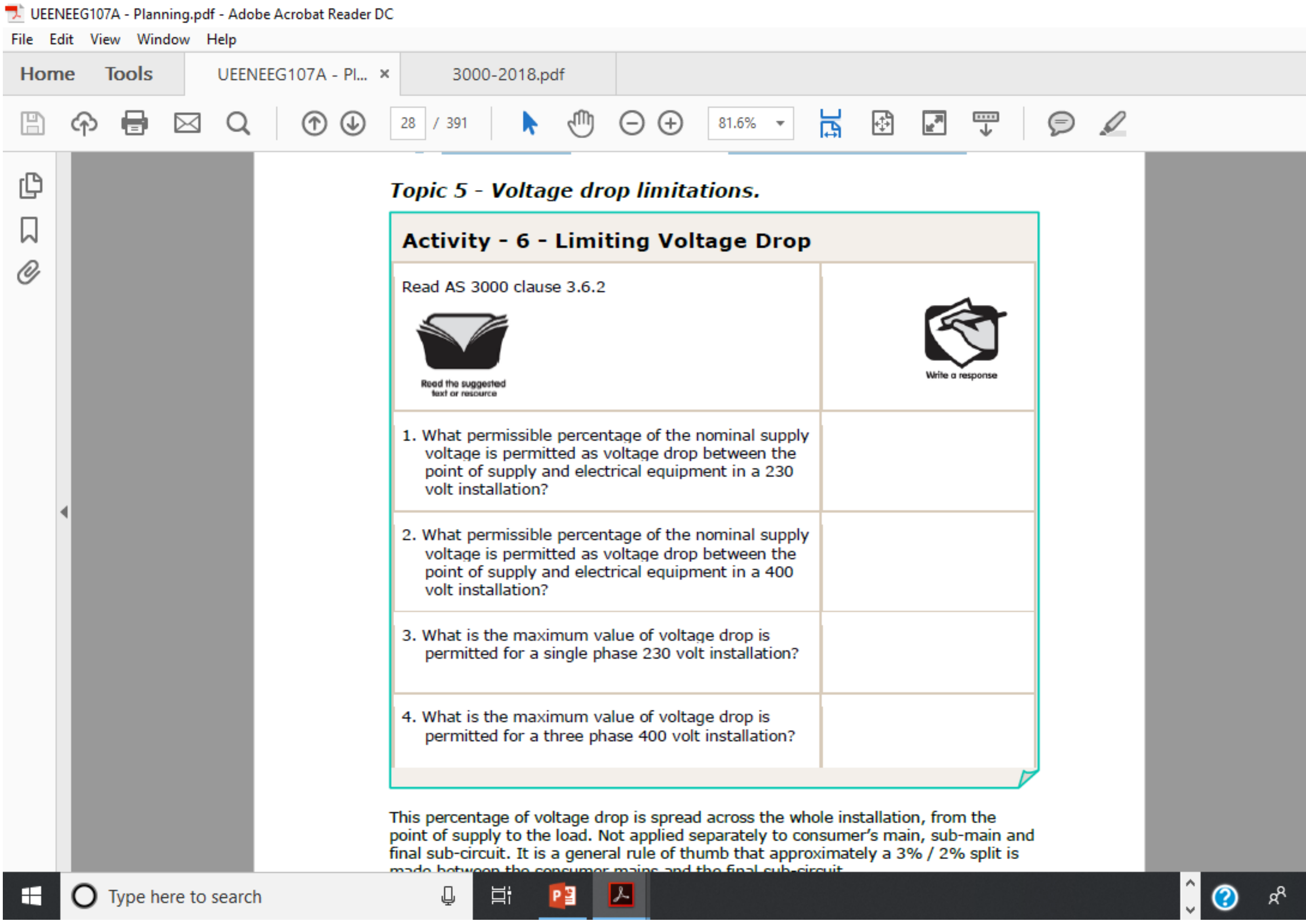
(c) Measurement The maximum demand may be determined by the highest rate of consumption of electricity recorded or sustained over a period of 30 minutes when demand is at its highest by a maximum demand indicator or recorder.

(d) Limitation The maximum demand may be determined by the current rating of a fixed setting circuit-breaker, or by the load setting of an adjustable circuit-breaker.

The maximum demand of consumer mains and submains may be determined by the sum of the current settings of the circuit-breakers protecting the associated final subcircuit/s and any further submain/s.

The most commonly used methods of determining maximum demand are, for;

- Consumers mains ____________________________
- Sub mains ____________________________
- Final sub-circuits ____________________________



Topic 5 - Voltage drop limitations.

Activity - 6 - Limiting Voltage Drop	
Read AS 3000 clause 3.6.2 Read the suggested text or resource	Write a response
1. What permissible percentage of the nominal supply voltage is permitted as voltage drop between the point of supply and electrical equipment in a 230 volt installation?	
2. What permissible percentage of the nominal supply voltage is permitted as voltage drop between the point of supply and electrical equipment in a 400 volt installation?	
3. What is the maximum value of voltage drop is permitted for a single phase 230 volt installation?	
4. What is the maximum value of voltage drop is permitted for a three phase 400 volt installation?	

This percentage of voltage drop is spread across the whole installation, from the point of supply to the load. Not applied separately to consumer's main, sub-main and final sub-circuit. It is a general rule of thumb that approximately a 3% / 2% split is made between the consumer mains and the final sub-circuit.

3.6.2 Value

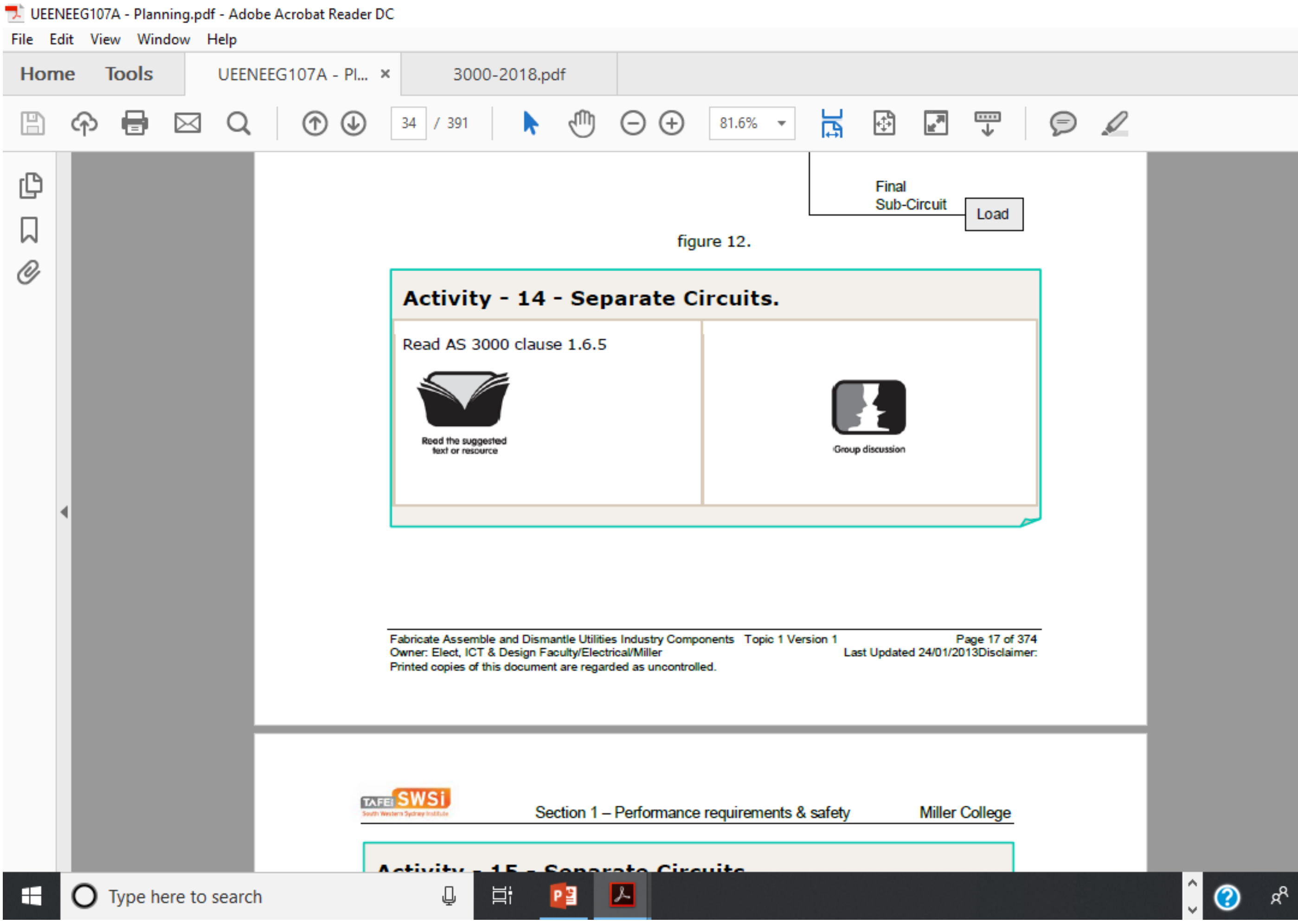
The cross-sectional area of every current-carrying conductor shall be such that the voltage drop between the point of supply for the low voltage electrical installation and any point in that electrical installation does not exceed 5% of the nominal voltage at the point of supply.

The value of current used for the calculation of voltage drop on a circuit need not exceed the—

(a) total of the connected load supplied through the circuit;

(b) maximum demand of the circuit; or

(c) current rating of the circuit protective device.

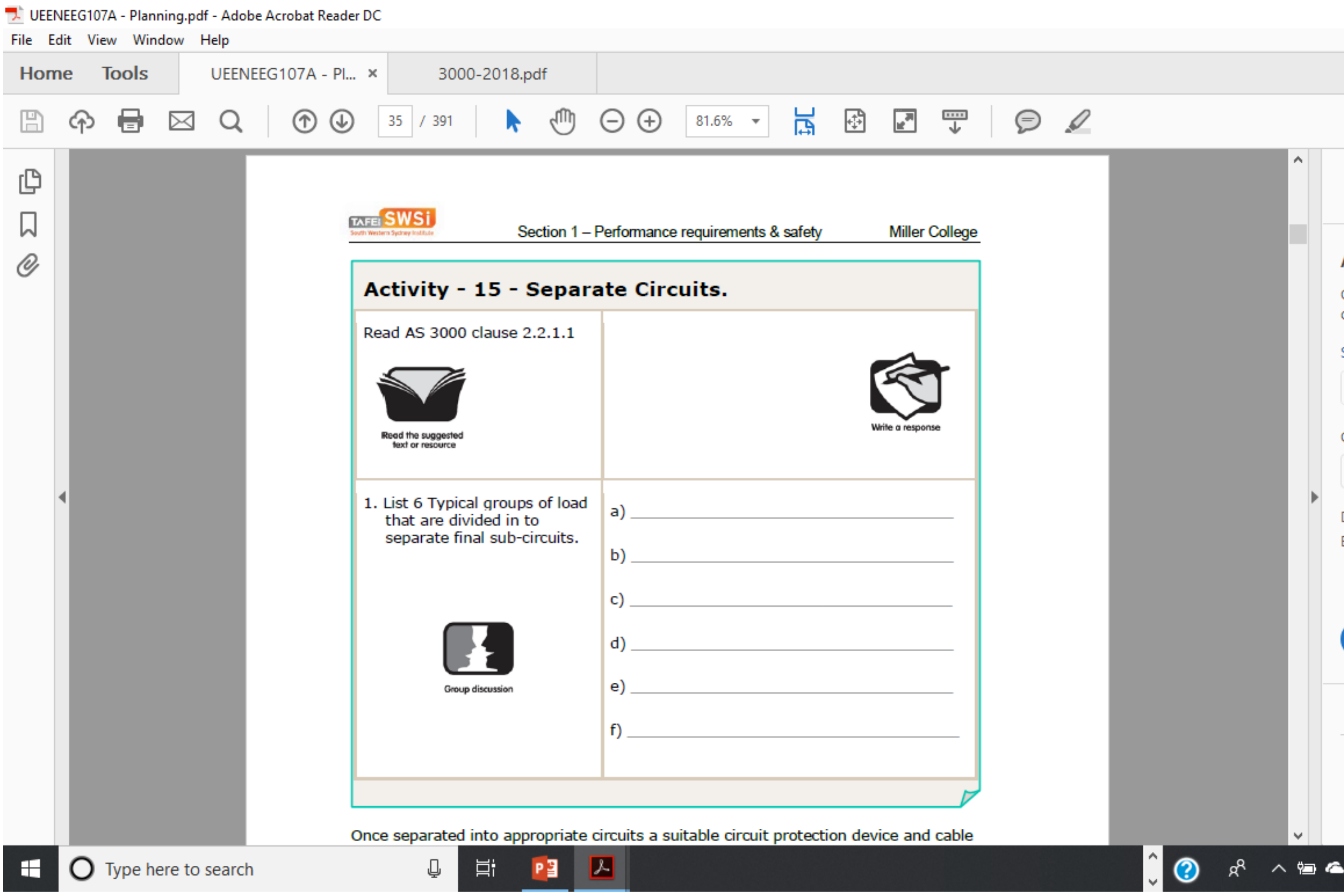


1.6.5 Electrical installation circuit arrangement

Every electrical installation shall be divided into circuits as necessary to—

(a) avoid danger and minimize inconvenience in the event of a fault; and

(b) facilitate safe operation, inspection, testing and maintenance.



2.2 ARRANGEMENT OF ELECTRICAL INSTALLATION

2.2.1 Circuits

2.2.1.1 General

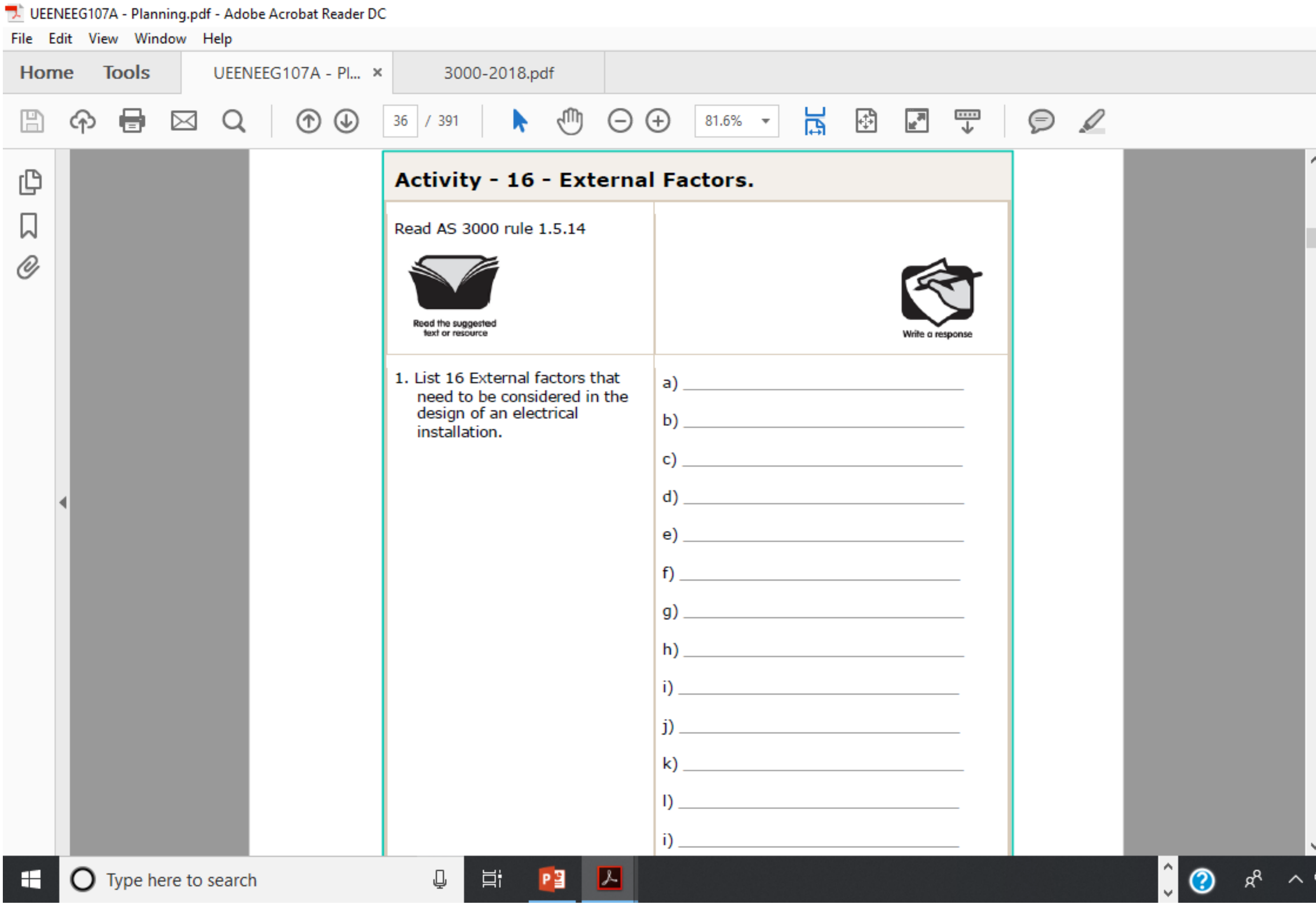
The electrical installation shall be arranged into an appropriate number of separate circuits taking the following into account:

(a) The relationship of the equipment, including any requirement for operation as a group and any special need identified by the user.

(b) The load and operating characteristics of the equipment in relation to the rating of the circuit components.

(c) The limitation of consequences of circuit failure including loss of supply to critical equipment, overload and the ability to locate a fault.

(d) The facility for maintenance work, and capacity for alterations and additions, to be performed without interrupting supply to other parts of the installation.



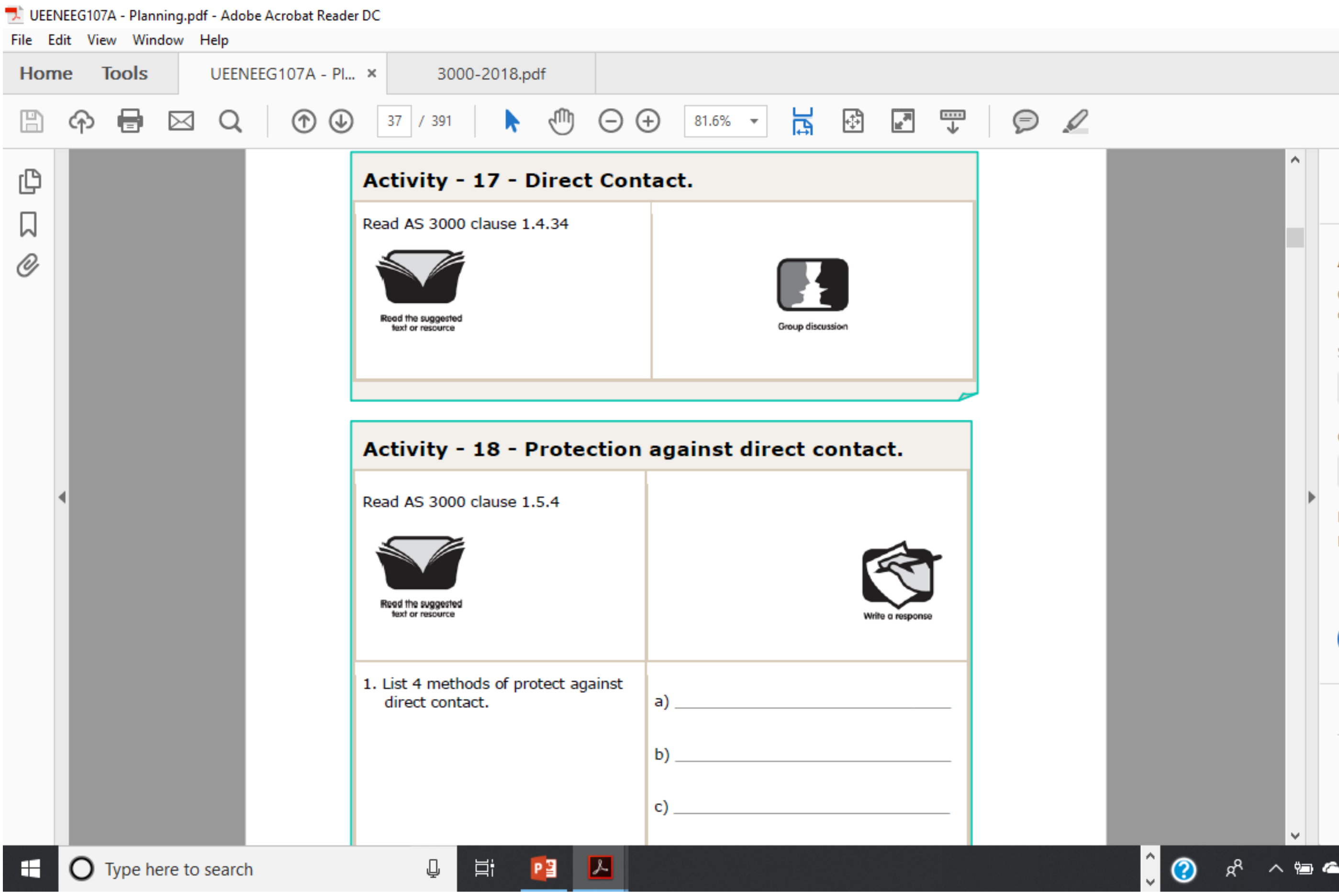
Activity - 16 - External Factors.

Read AS 3000 rule 1.5.14 Read the suggested text or resource	Write a response
1. List 16 External factors that need to be considered in the design of an electrical installation.	a) ________________ b) ________________ c) ________________ d) ________________ e) ________________ f) ________________ g) ________________ h) ________________ i) ________________ j) ________________ k) ________________ l) ________________ i) ________________

1.5.14 Protection against external influences

All parts of an electrical installation shall be designed to be adequately protected against damage that might reasonably be expected from environmental and other external influences to which the electrical installation may be exposed under the conditions of its use. These conditions would be those that would be expected during normal operation.

Damage from such influences may include mechanical damage, and damage because of exposure to weather, water, flora, fauna, seismic activity, excessive dampness, corrosive fumes, galvanic action, accumulation of dust, steam, oil, temperature, explosive atmospheres, vibration or any other influence to which the electrical installation may be exposed under the conditions of its use.



1.4.34 Competent person

A person, who has acquired, through training, qualification or experience or a combination of these, the knowledge and skill enabling that person to perform the required task correctly.

1.5.4 Basic protection

1.5.4.1 General

Protection shall be provided against dangers that may arise from contact with parts of the electrical installation that are live in normal service.

1.5.4.2 Methods of protection

Basic protection shall be provided by one or any combination of the following methods:

(a) Insulation, in accordance with Clause 1.5.4.3.

(b) Barriers or enclosures, in accordance with Clause 1.5.4.4.

(c) Obstacles, in accordance with Clause 1.5.4.5.

(d) Placing out of reach, in accordance with Clause 1.5.4.6.

RCDs are not recognized as a sole means of basic protection against contact with live parts but may be used to augment one of the above methods.

1.5.4.3 Protection by insulation

Live parts shall be completely covered with insulation capable of withstanding the mechanical, chemical, electrical and thermal influences to

1.5.4.4 Protection by barriers or enclosures

(a) Degree of protection Live parts shall be inside enclosures or behind barriers that provide a degree of protection of at least—

(i) IPXXB or IP2X; and

(ii) IP4X for horizontal top surfaces that are readily accessible.

* The IP rating shall suit the environmental conditions and the relevant mounting position as specified by the manufacturer.

NOTE: This applies in particular to parts of enclosures that might serve as—

(a) a floor; or

(b) a surface where objects on surrounding surfaces may be displaced into openings.

Larger openings are allowable in electrical equipment where they may be necessary for the proper operation and functioning of electrical equipment, or where they are required for the replacement of parts, such as lamps or fuses. In such cases—

(A) suitable precautions shall be taken to prevent unintentional contact with live parts; and

(B) as far as practicable, persons shall be advised that live parts can be touched through the opening and are not to be touched intentionally.

(b) Constructional requirements Barriers and enclosures shall be firmly secured in place and shall have adequate stability and strength to withstand any appreciable distortion that might be caused by the stresses likely to occur in normal operation, including external influences, so that the required degrees of protection and separation from live parts are maintained.

The removal of barriers, opening of enclosures, or withdrawal of parts of enclosures (doors, casings, lids, covers and the like) shall not be possible.

Exception: The removal of barriers is permitted where one of the following conditions apply:

1 The use of a key or tool is required.

NOTE: Electrical equipment complying with an appropriate Standard that allows the removal of barriers or enclosures by an alternative method is not prohibited.

2 An interlocking device is fitted that requires—

— switching off, or automatic disconnection, of the supply to all live parts protected by the barrier or enclosure that might be touched accidentally during or after the removal, opening or withdrawal process; and

— the barrier or enclosure to be replaced or closed before the supply can normally be switched on.

NOTE: Account should be taken of danger that may exist from the stored energy of power capacitors in electrical equipment or the capacitive effect of electrical equipment, such as busways, that have been isolated from the supply.

3 An intermediate barrier is provided that—

— prevents contact with all live parts when the barrier or enclosure is removed;

— is permanently in position, or arranged so that it is automatically put in position when the barrier or enclosure is removed; and

— requires the use of a key or tool to remove.

1.5.4.5 Protection by obstacles

The method of protection by obstacles shall only be used in installations where access is restricted to—

(a) competent persons; or

(b) persons under the supervision of competent persons.

Obstacles shall prevent either—

(i) unintentional bodily approach to live parts; or

(ii) unintentional contact with live parts during the operation of live electrical equipment in normal service.

Obstacles may be removed without the use of a key or tool but shall be secured to prevent unintentional removal.

NOTE: Obstacles are intended to prevent unintentional contact with live parts but not intentional contact by deliberate circumvention of the obstacle.

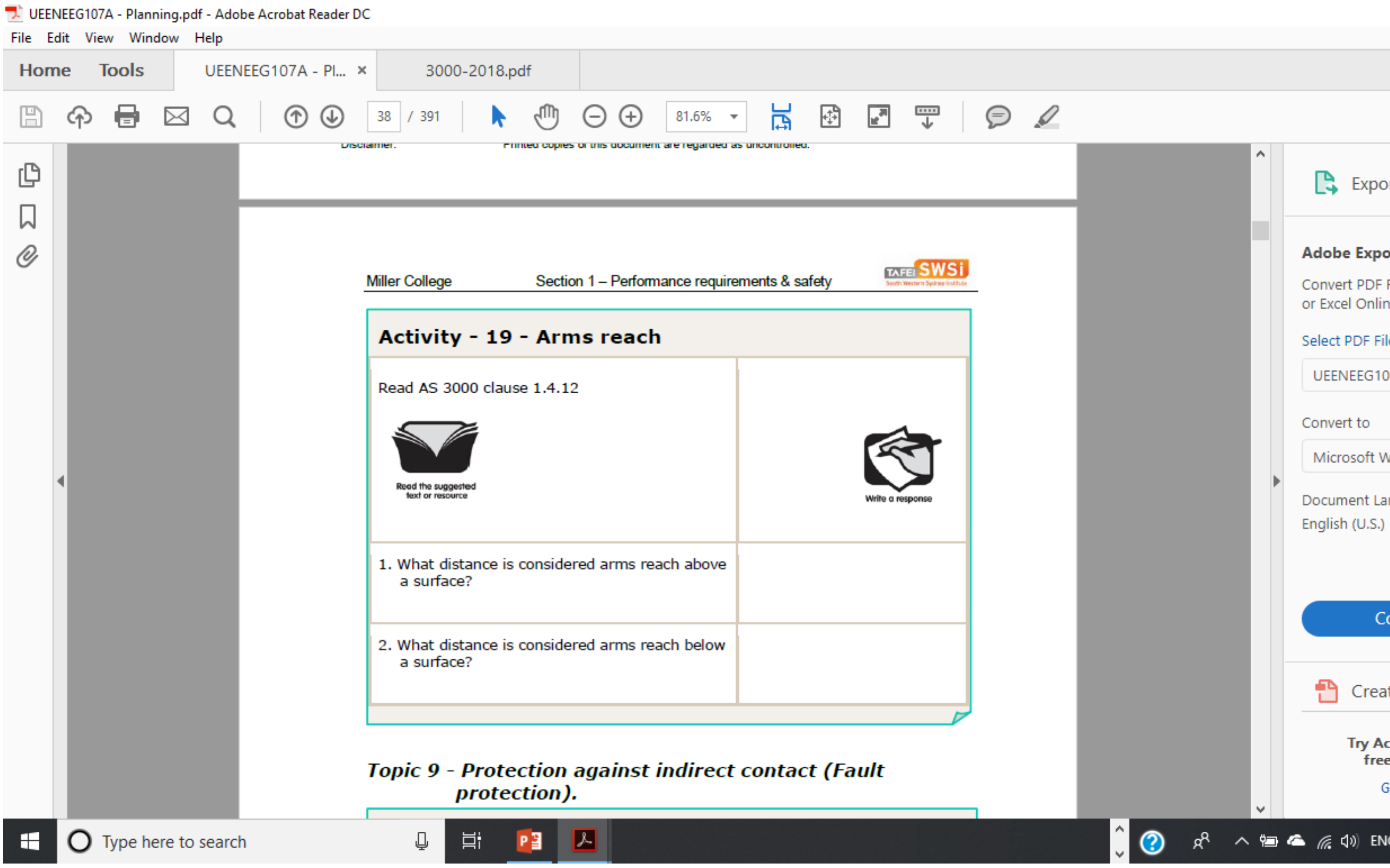
1.5.4.6 Protection by placing out of reach

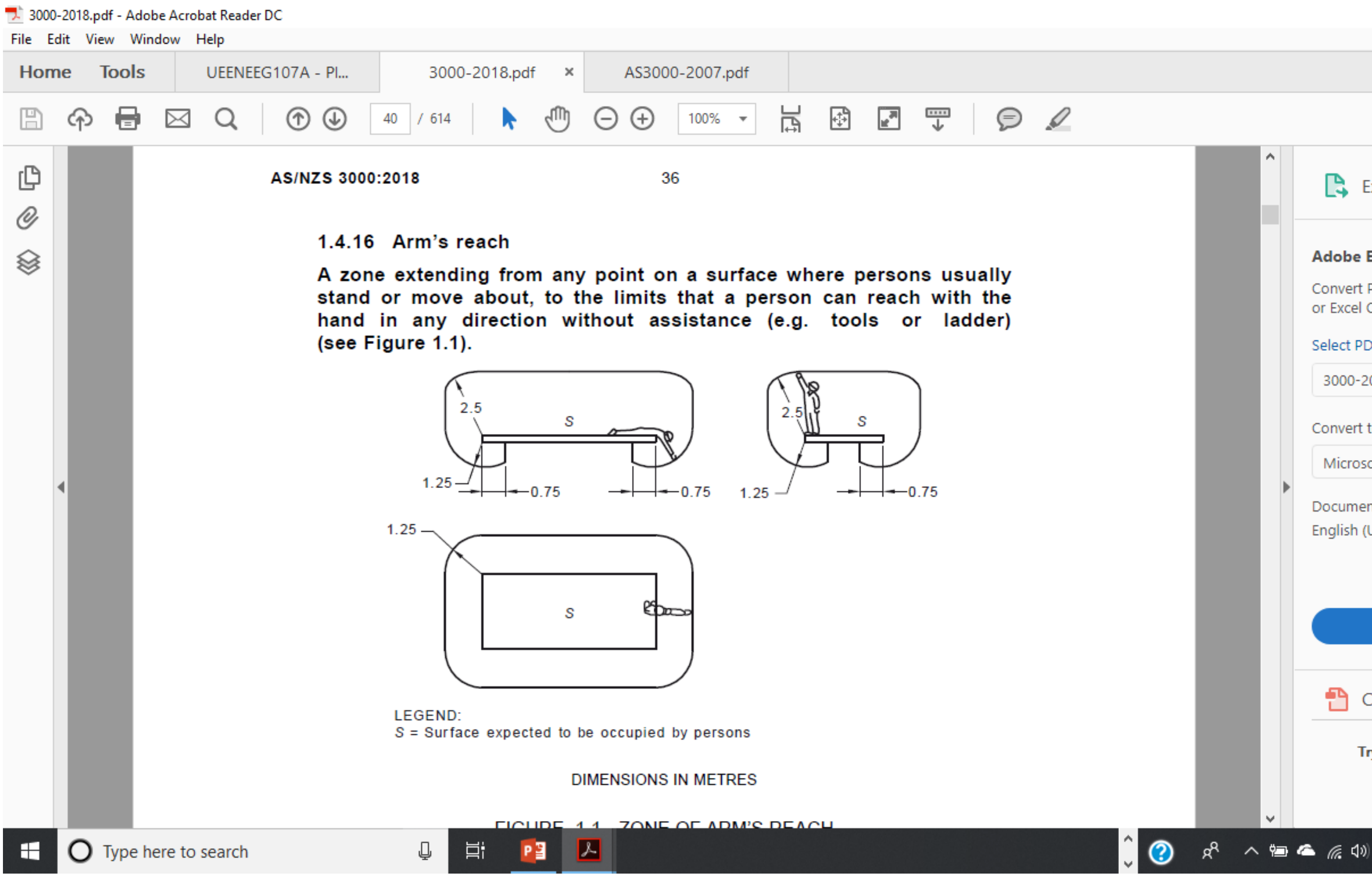
The method of protection ‘by placing out of reach’ shall only be used in installations where access is restricted to—

(a) competent persons; or

(b) persons under the supervision of competent persons.

Simultaneously accessible parts at different voltages shall not be within arm’s reach.





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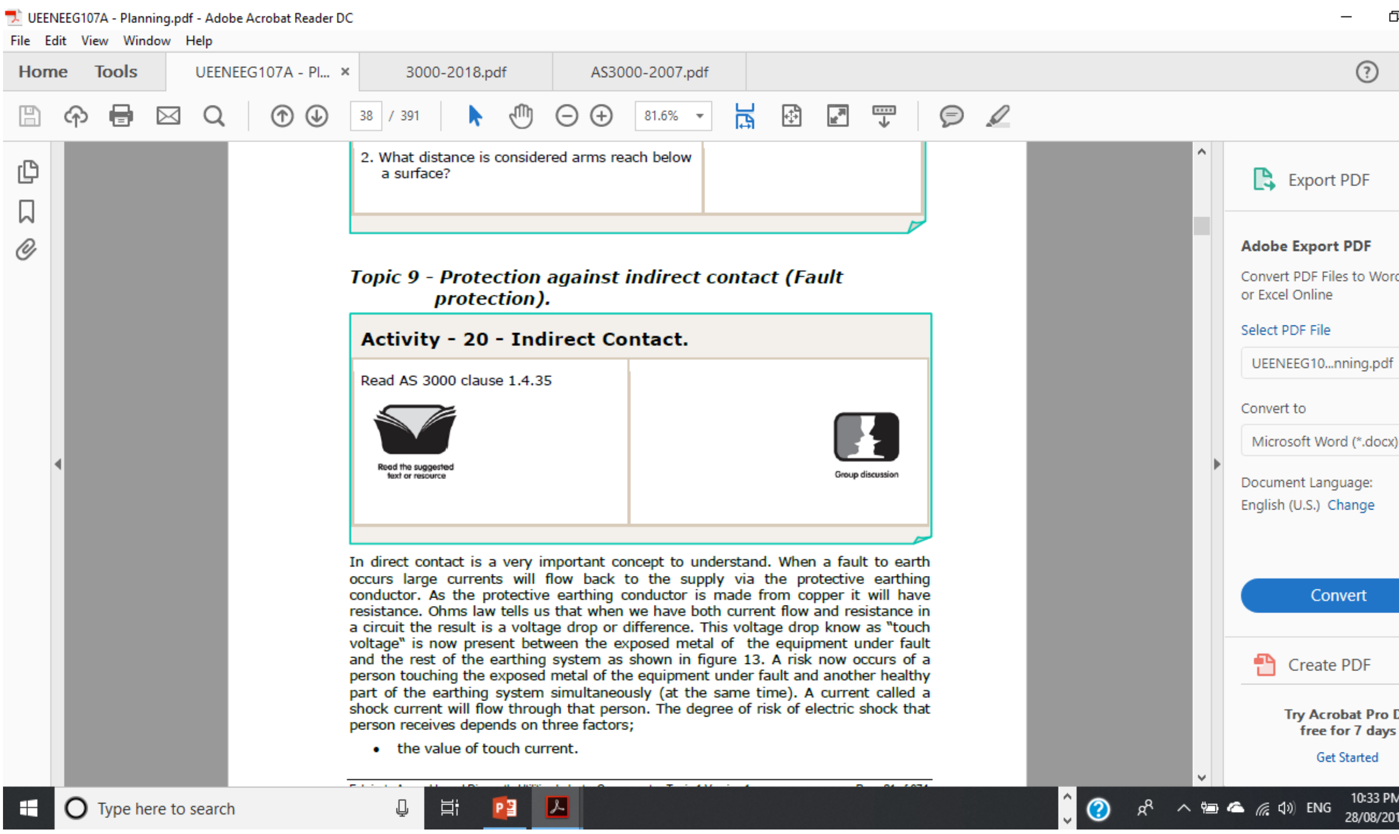
1.4.16 Arm's reach

A zone extending from any point on a surface where persons usually stand or move about, to the limits that a person can reach with the hand in any direction without assistance (e.g. tools or ladder) (see Figure 1.1).

LEGEND:
S = Surface expected to be occupied by persons

DIMENSIONS IN METRES

FIGURE 1.1 ZONE OF ARM'S REACH



2. What distance is considered arms reach below a surface?

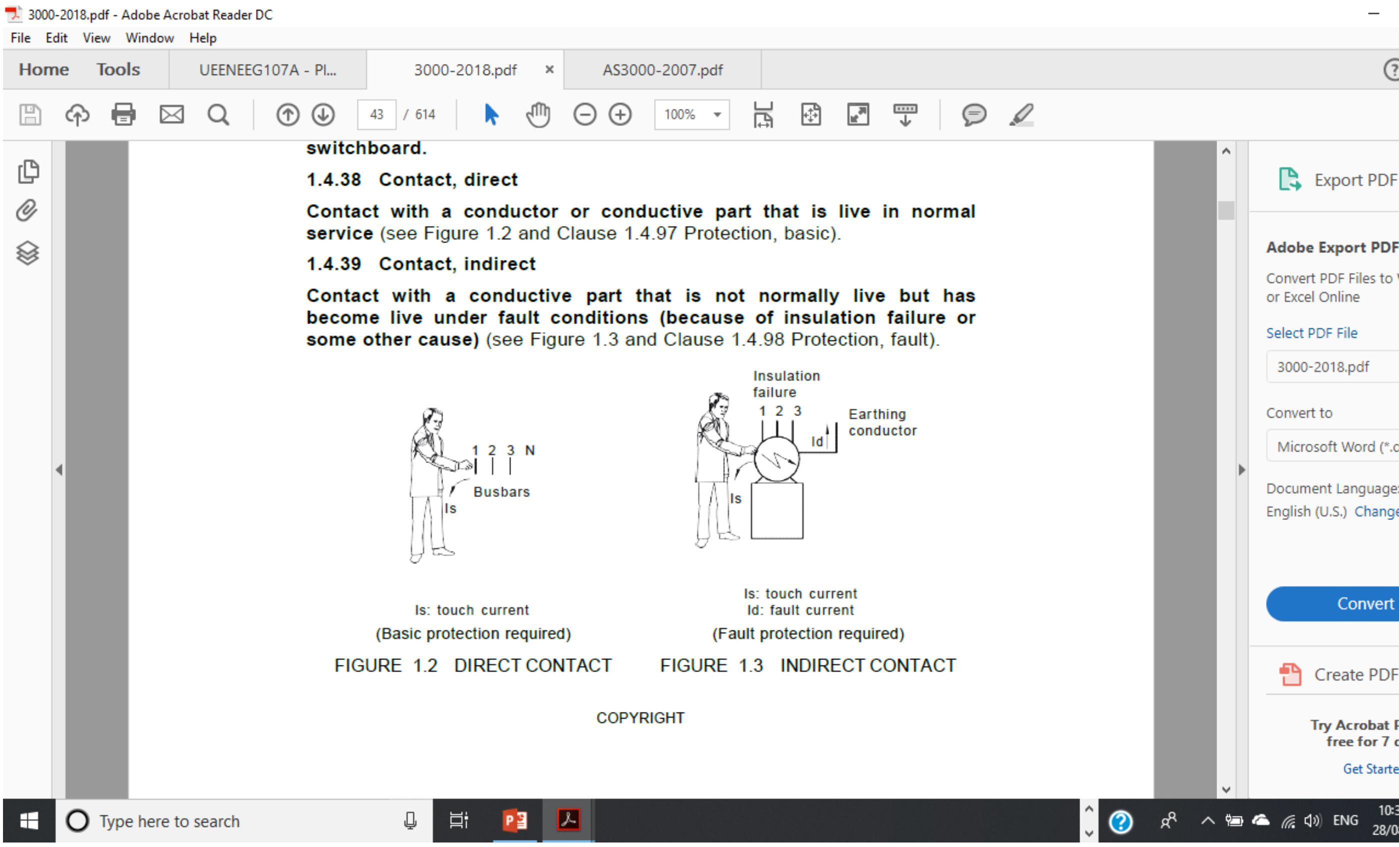
Topic 9 - Protection against indirect contact (Fault protection).

Activity - 20 - Indirect Contact.

Read AS 3000 clause 1.4.35

In direct contact is a very important concept to understand. When a fault to earth occurs large currents will flow back to the supply via the protective earthing conductor. As the protective earthing conductor is made from copper it will have resistance. Ohms law tells us that when we have both current flow and resistance in a circuit the result is a voltage drop or difference. This voltage drop know as "touch voltage" is now present between the exposed metal of the equipment under fault and the rest of the earthing system as shown in figure 13. A risk now occurs of a person touching the exposed metal of the equipment under fault and another healthy part of the earthing system simultaneously (at the same time). A current called a shock current will flow through that person. The degree of risk of electric shock that person receives depends on three factors;

- the value of touch current.



switchboard.

1.4.38 Contact, direct

Contact with a conductor or conductive part that is live in normal service (see Figure 1.2 and Clause 1.4.97 Protection, basic).

1.4.39 Contact, indirect

Contact with a conductive part that is not normally live but has become live under fault conditions (because of insulation failure or some other cause) (see Figure 1.3 and Clause 1.4.98 Protection, fault).

FIGURE 1.2 DIRECT CONTACT FIGURE 1.3 INDIRECT CONTACT

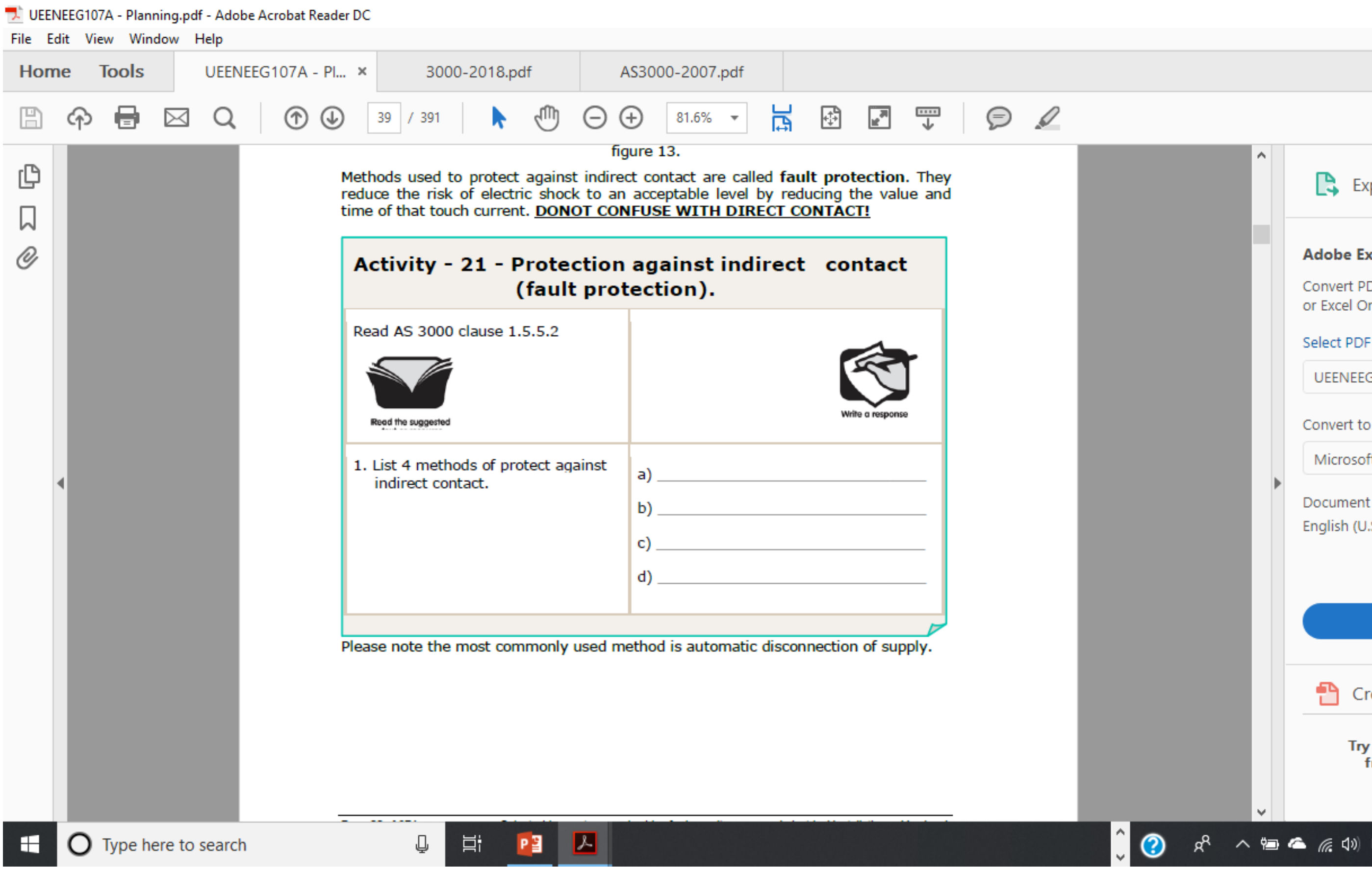


figure 13.

Methods used to protect against indirect contact are called **fault protection**. They reduce the risk of electric shock to an acceptable level by reducing the value and time of that touch current. **DONOT CONFUSE WITH DIRECT CONTACT!**

Activity - 21 - Protection against indirect contact (fault protection).

Read AS 3000 clause 1.5.5.2	Write a response
1. List 4 methods of protect against indirect contact.	a) ______ b) ______ c) ______ d) ______

Please note the most commonly used method is automatic disconnection of supply.

1.5.5.2 Methods of protection

Fault protection shall be provided by one or any combination of the following methods:

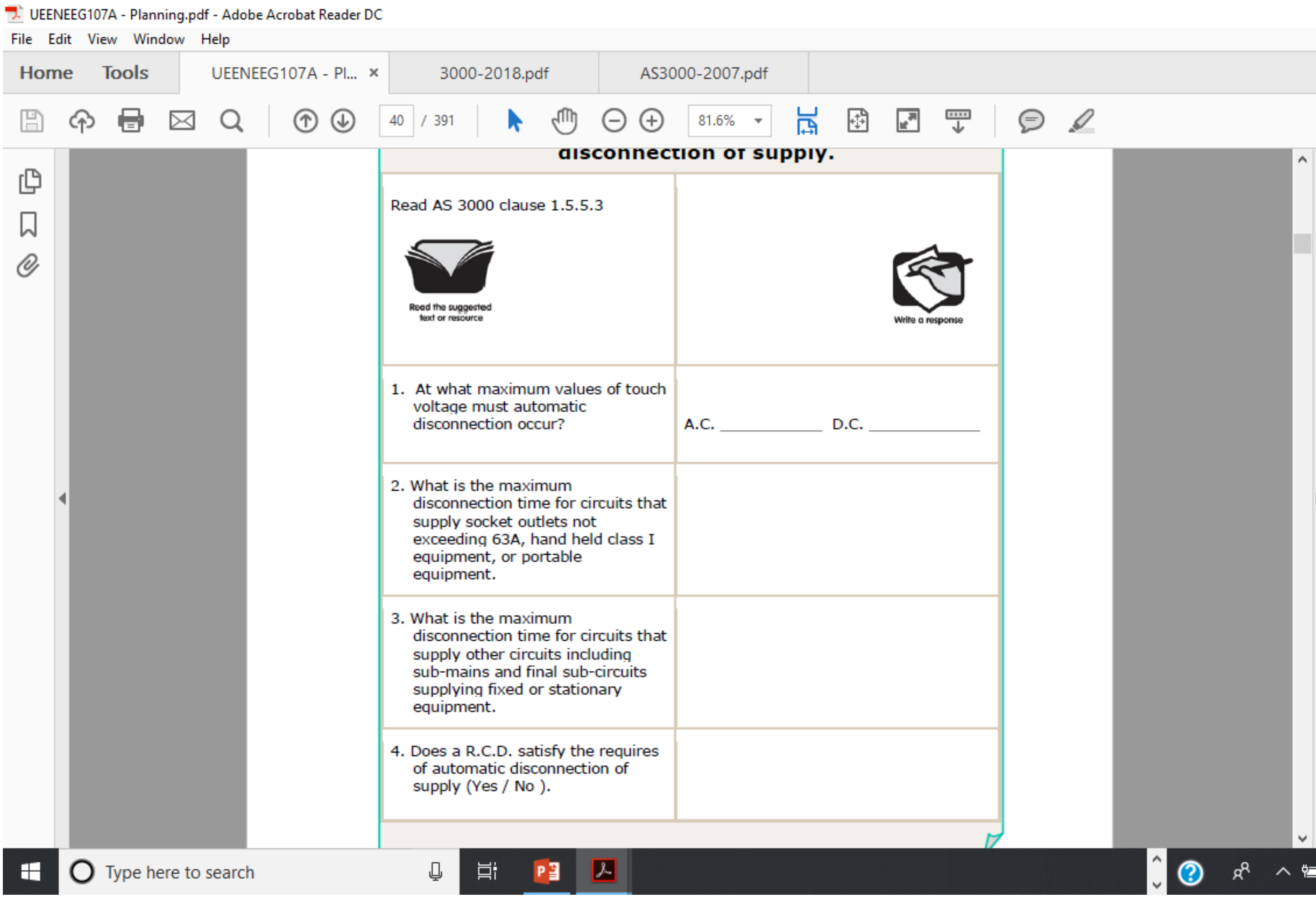
(a) Automatically disconnect the supply on the occurrence of a fault likely to cause a current flow through a body in contact with exposed conductive parts, where the value of that current is equal to or greater than the shock current, in accordance with Clause 1.5.5.3.

(b) Prevent a fault current from passing through a body by the use of Class II equipment or equivalent insulation, in accordance with Clause 1.5.5.4.

(c) Prevent a fault current from passing through a body by electrical separation of the system, in accordance with Clause 1.5.5.5.

NOTE: Clause 7.4 provides further guidance on electrical separation.

(d) Limit the fault current that can pass through a body to a value lower than the shock current



disconnection of supply.

Read AS 3000 clause 1.5.5.3	
1. At what maximum values of touch voltage must automatic disconnection occur?	A.C. ____________ D.C. ____________
2. What is the maximum disconnection time for circuits that supply socket outlets not exceeding 63A, hand held class I equipment, or portable equipment.	
3. What is the maximum disconnection time for circuits that supply other circuits including sub-mains and final sub-circuits supplying fixed or stationary equipment.	
4. Does a R.C.D. satisfy the requires of automatic disconnection of supply (Yes / No).	

1.5.5.3 Protection by automatic disconnection of supply

The following applies:

(a) Automatic disconnection of supply is intended to limit the prospective touch voltage arising between simultaneously accessible conductive parts in the event of a fault between a live part and exposed conductive parts or a protective earthing conductor.

This method of protection shall be achieved by—

(i) provision of a system of equipotential bonding in which exposed conductive parts are connected to a protective earthing conductor; and

(ii) disconnection of the fault by a protective device.

NOTES:

1 Automatic disconnection of supply may also be required for protection against overcurrents, in accordance with Clause 1.5.9 and Clause 2.5.

2 Clause 5.6 contains requirements for equipotential bonding.

3 Section 2 contains requirements for the disconnection of a fault by a protective device.

(b) Touch-voltage limits In the event of a fault between a live part and an exposed conductive part that could give rise to a prospective touch voltage exceeding 50 V a.c. or 120 V ripple-free d.c., a protective device shall automatically disconnect the supply to the circuit or electrical equipment concerned.

NOTE: Lower touch-voltage limits are required for special electrical installations or locations by the relevant clauses of Sections 6 and 7.

(c) Earthing system impedance (earth fault-loop impedance) The characteristics of protective devices and the earthing system impedance shall be such that, if a fault of negligible impedance occurs anywhere in the electrical installation between an active conductor and a protective earthing conductor or exposed conductive part, automatic disconnection of the supply will occur within the specified time.

NOTES:

1 Clause 5.7 contains further requirements and Appendix B provides guidance regarding earth fault-loop impedance.

2 Refer to Appendix B, Table B1, for comparison of circuit route length based on impedance and various voltage drops.

(d) Disconnection times The maximum disconnection time for 230/400 V supply voltage shall not exceed the following:

(i) 0.4 s for final subcircuits that supply—

(A) socket-outlets having rated currents not exceeding 63 A;

(B) hand-held Class I equipment; or

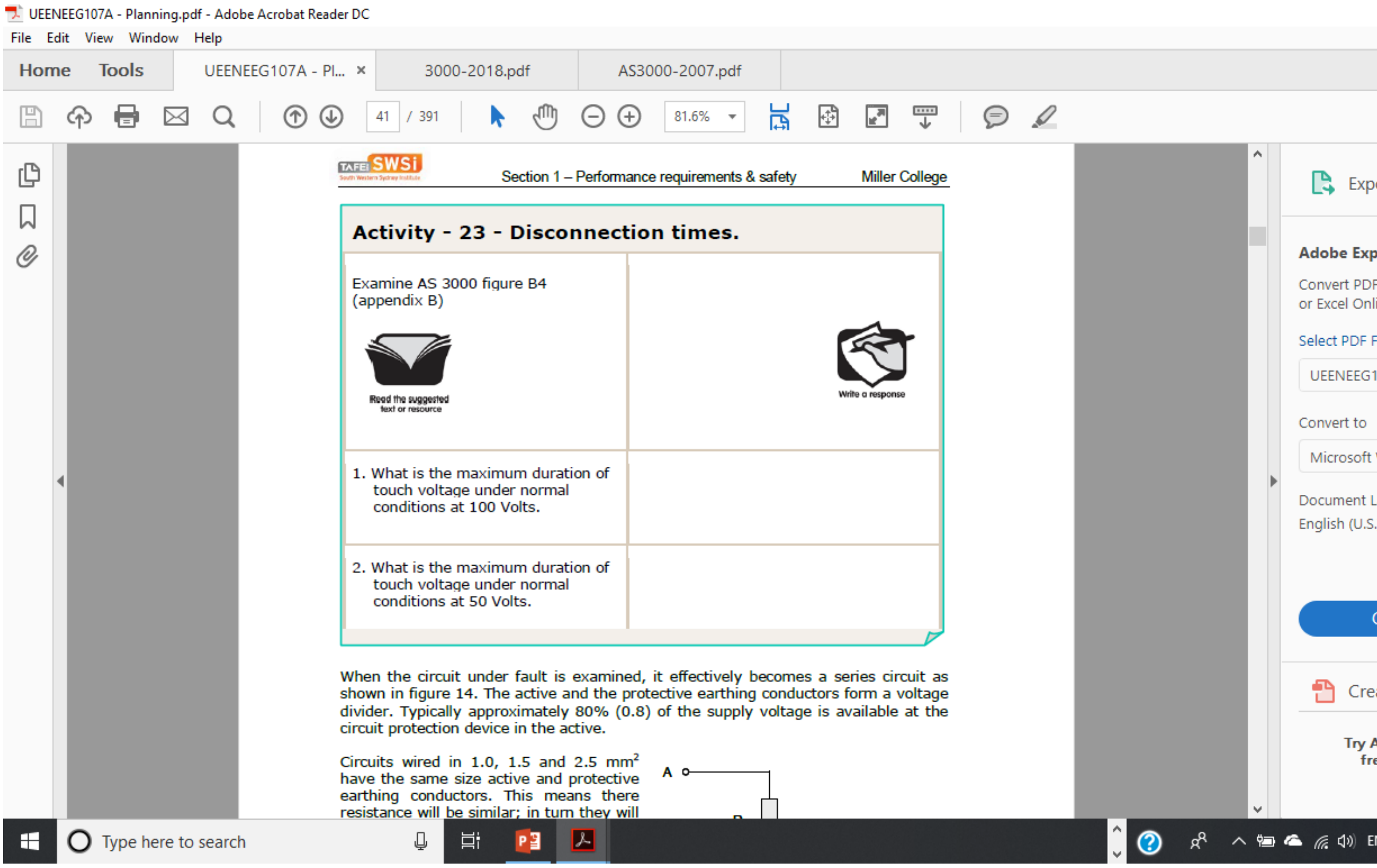
(C) portable equipment intended for manual movement during use.

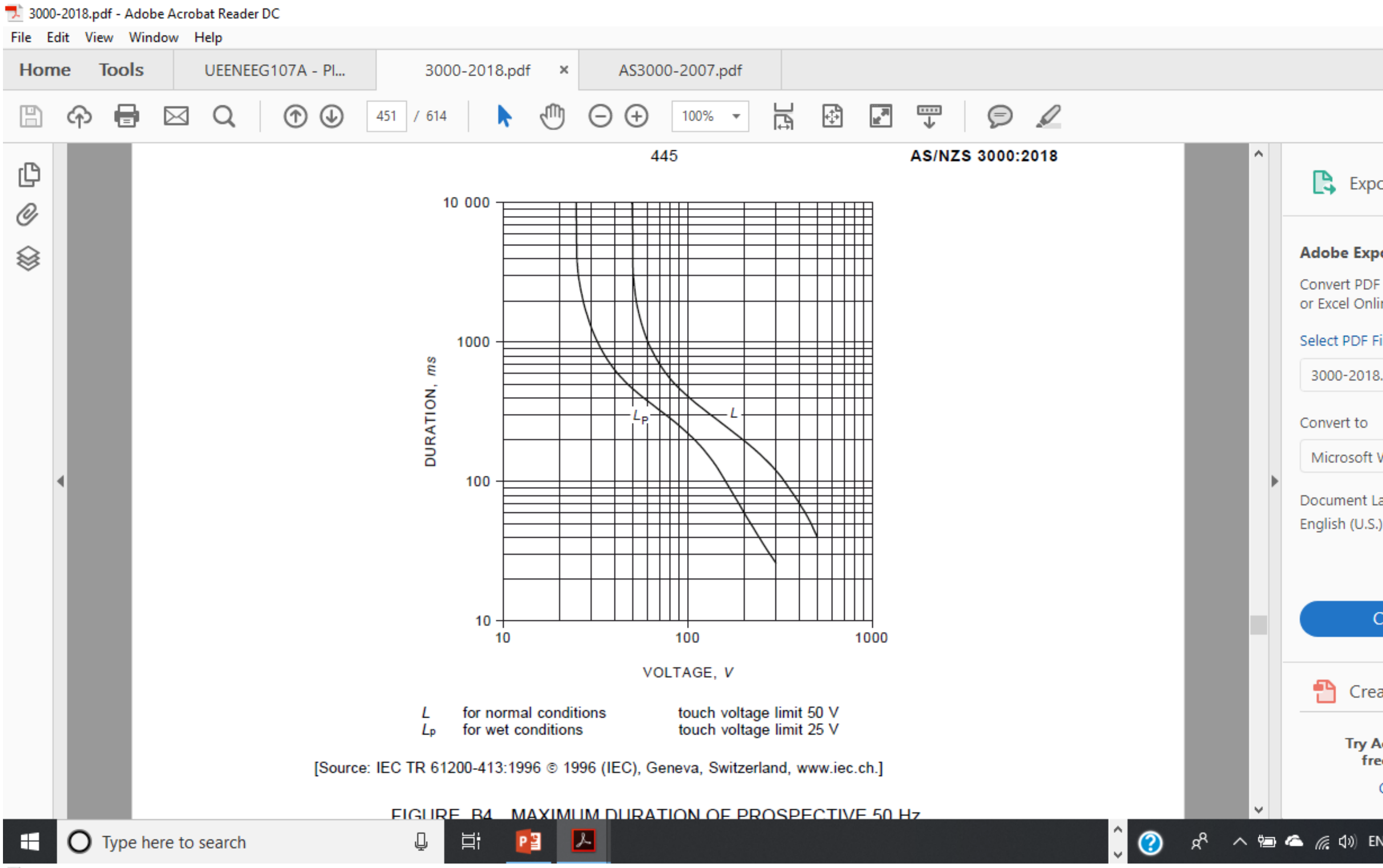
(ii) 5 s for other circuits including submains and final subcircuits supplying fixed or stationary equipment.

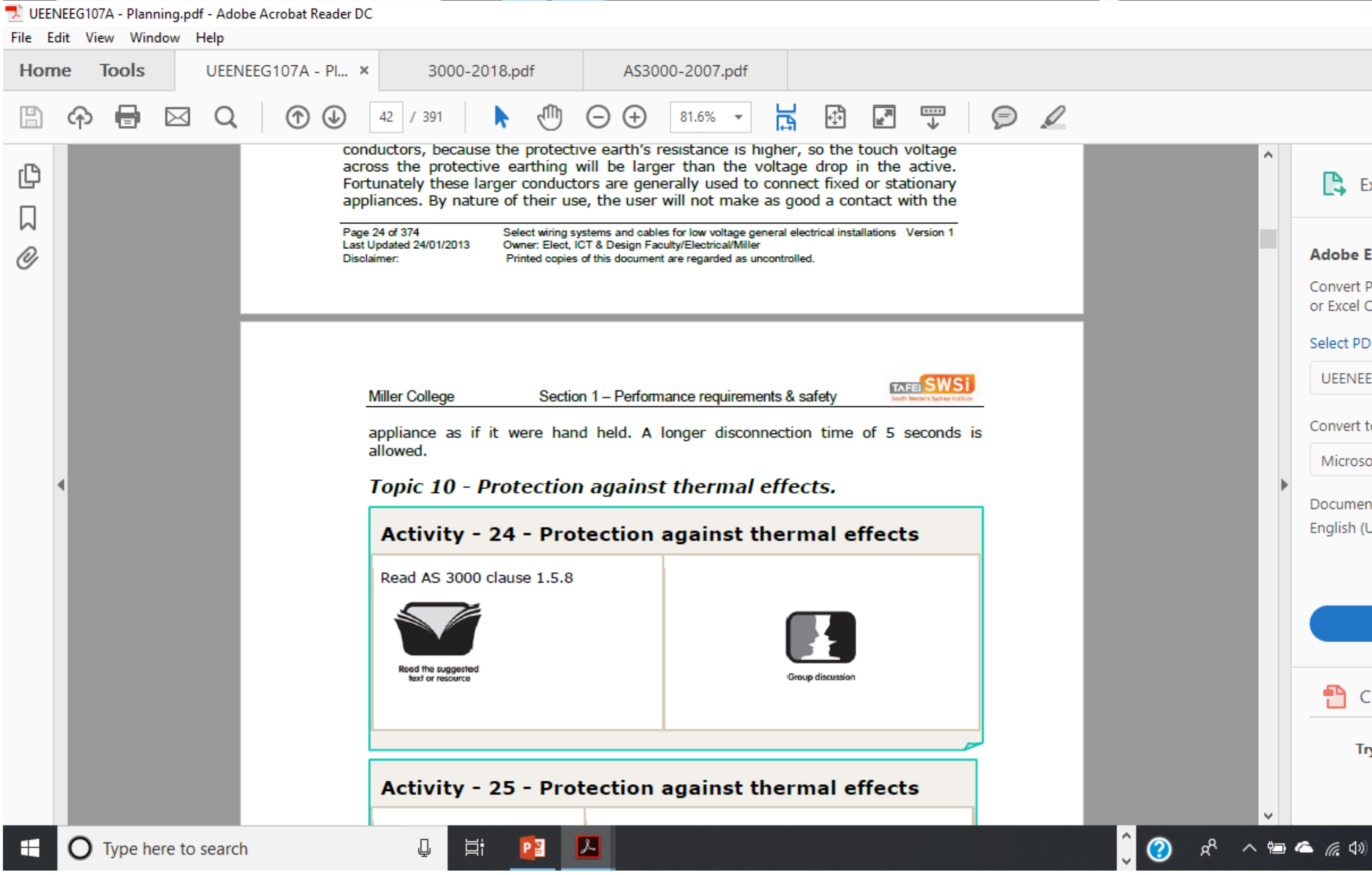
NOTE: Maximum disconnection times will vary for other voltages and installation conditions. Appendix B provides further guidance regarding disconnection times.

(e) Supplementary equipotential bonding Bonding of extraneous conductive parts and their connection to the earthing system may be used to reduce the earth fault-loop impedance, in order to ensure that the disconnection time of the protective device is sufficient to satisfy the requirements of Items (b) to (d) above.

NOTE: This provision does not preclude other measures, such as selection of an alternative protective device that has a lower automatic operating current (I_a) within the required disconnection time, e.g. an RCD.

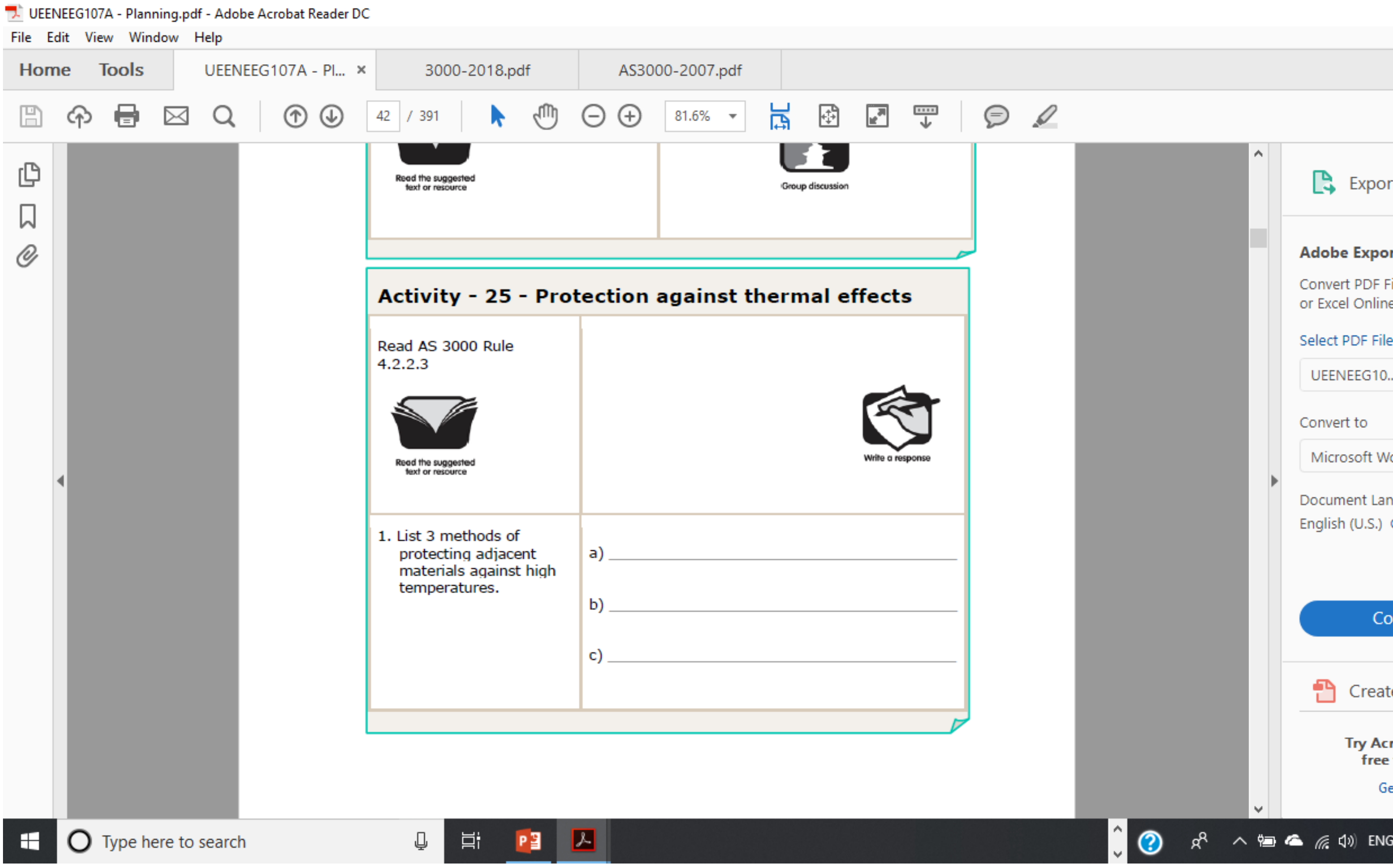






1.5.8 Protection against thermal effects in normal service

Electrical installations shall be arranged so that there is no risk of ignition of flammable materials because of high temperature or electric arc in normal service. During normal operation of the electrical equipment there shall be no risk of persons or livestock suffering burns.



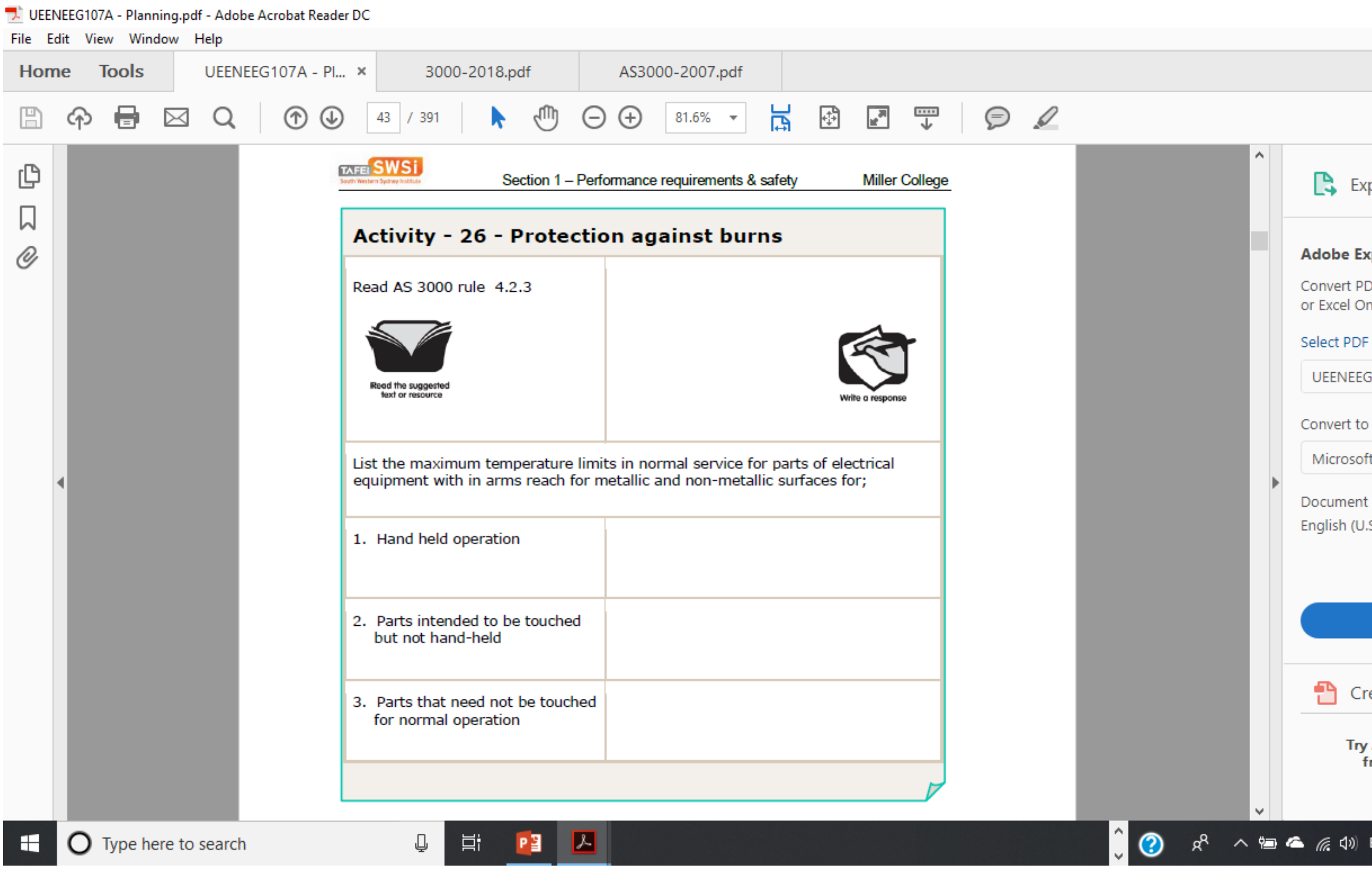
4.2.2.3 Protection from high temperatures

(a) High surface temperature Where fixed electrical equipment could attain surface temperatures that would cause a fire hazard to adjacent materials, the electrical equipment shall be—

(i) mounted on or within materials that will withstand such temperatures and are of low thermal conductance;

(ii) screened from combustible building elements by materials that will withstand such temperatures and are of low thermal conductance; or

(iii) mounted at a sufficient distance from any material on which such temperatures could have deleterious thermal effects, any means of support being of low thermal conductance so as to allow safe dissipation of heat.



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Activity - 26 - Protection against burns

Read AS 3000 rule 4.2.3

Read the suggested text or resource

Write a response

List the maximum temperature limits in normal service for parts of electrical equipment with in arms reach for metallic and non-metallic surfaces for;

1. Hand held operation	
2. Parts intended to be touched but not hand-held	
3. Parts that need not be touched for normal operation	

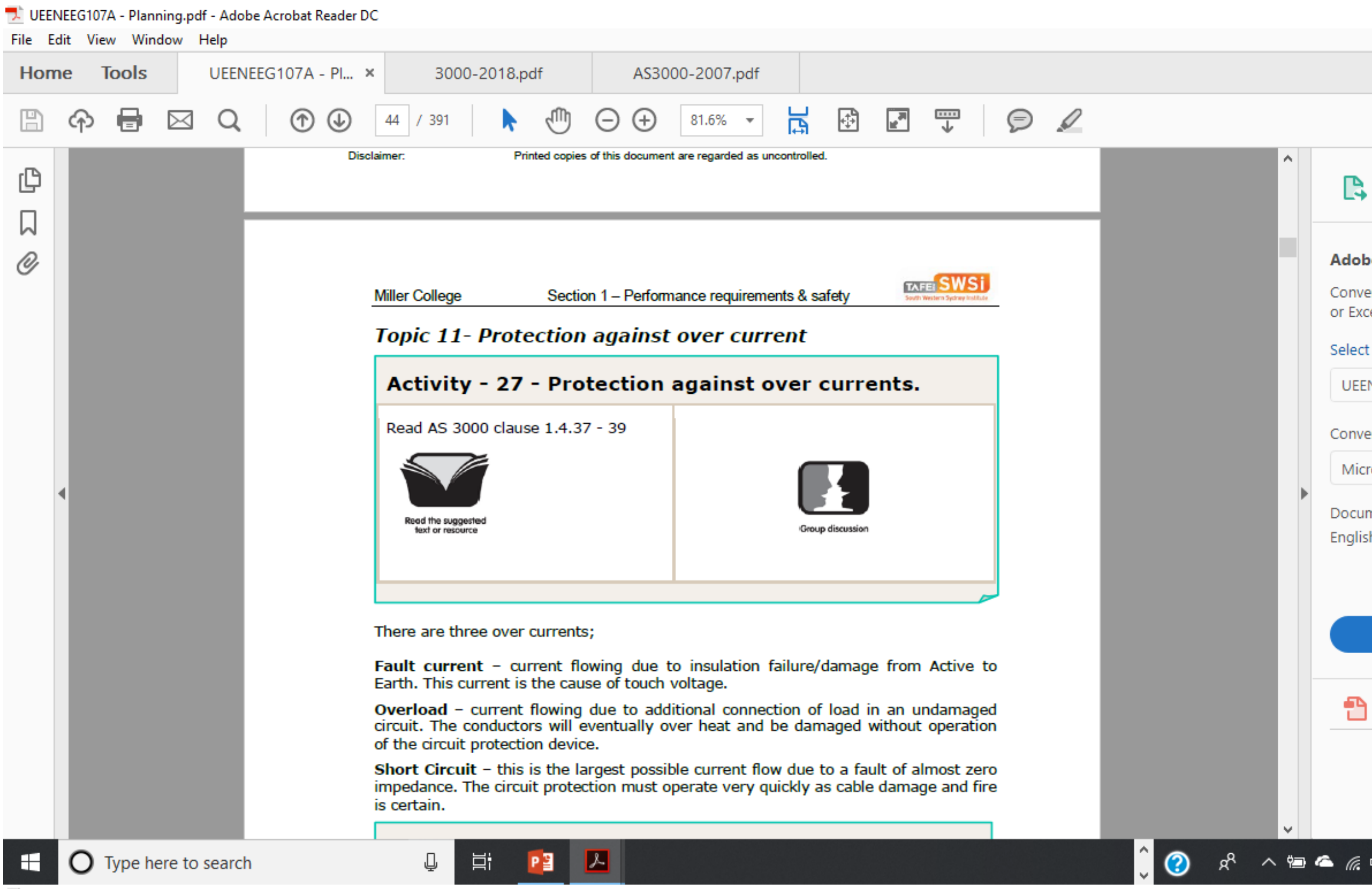
4.2.3 Protection against burns

An accessible part of electrical equipment within arm's reach shall not attain a temperature in excess of the appropriate limit stated in Table 4.1. Each accessible part of the electrical installation that may, even for a short period, attain a temperature exceeding the appropriate limit in Table 4.1 under normal load conditions shall be guarded so as to prevent accidental contact.

Exceptions:

1 This requirement need not apply to electrical equipment that complies with a limiting temperature specified in an appropriate Standard.

2 This requirement does not apply to items such as lamps.



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Miller College Section 1 – Performance requirements & safety

Topic 11- Protection against over current

Activity - 27 - Protection against over currents.

Read AS 3000 clause 1.4.37 - 39

Read the suggested text or resource

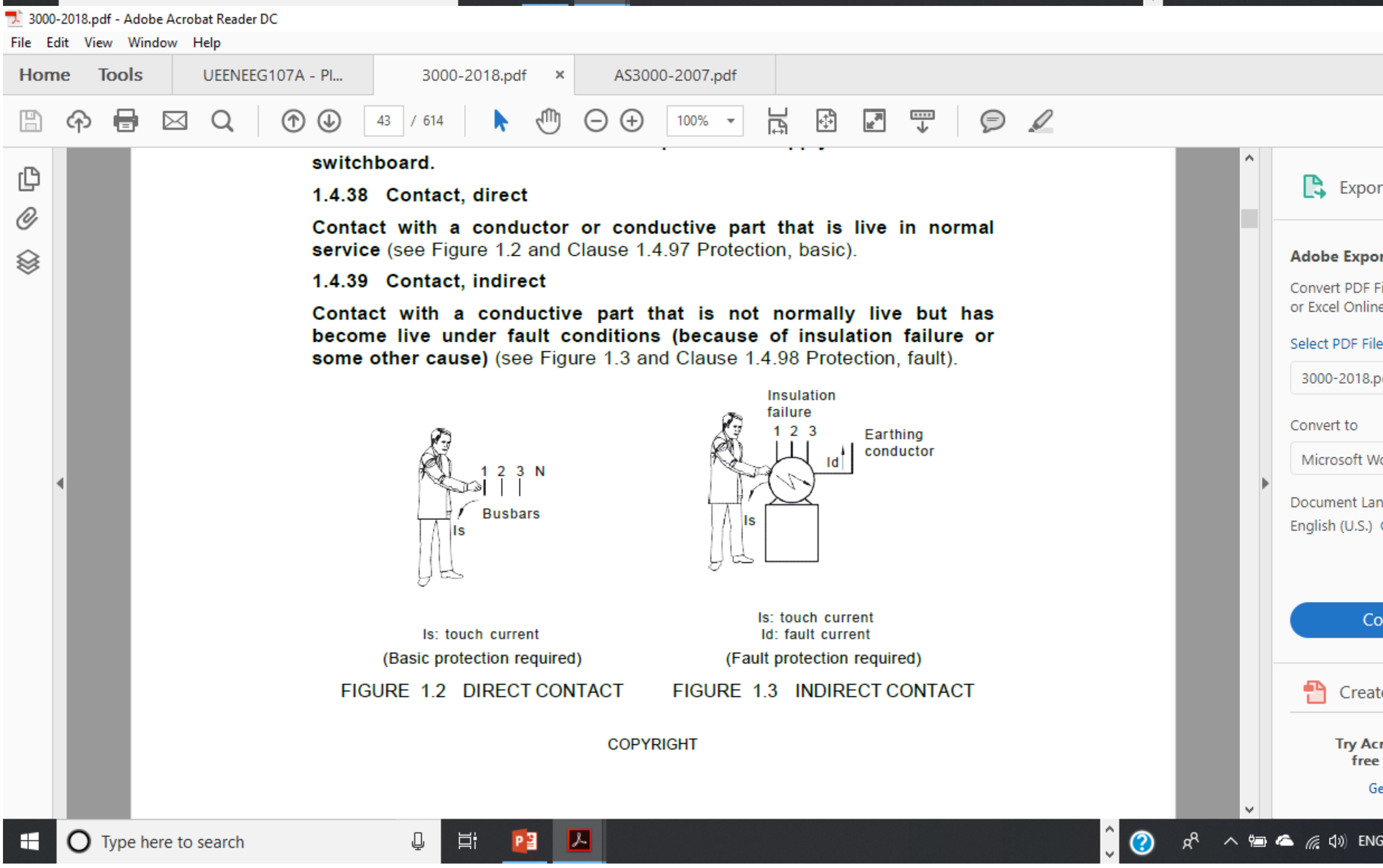
Group discussion

There are three over currents;

Fault current – current flowing due to insulation failure/damage from Active to Earth. This current is the cause of touch voltage.

Overload – current flowing due to additional connection of load in an undamaged circuit. The conductors will eventually over heat and be damaged without operation of the circuit protection device.

Short Circuit – this is the largest possible current flow due to a fault of almost zero impedance. The circuit protection must operate very quickly as cable damage and fire is certain.



switchboard.

1.4.38 Contact, direct

Contact with a conductor or conductive part that is live in normal service (see Figure 1.2 and Clause 1.4.97 Protection, basic).

1.4.39 Contact, indirect

Contact with a conductive part that is not normally live but has become live under fault conditions (because of insulation failure or some other cause) (see Figure 1.3 and Clause 1.4.98 Protection, fault).

Is: touch current
(Basic protection required)
FIGURE 1.2 DIRECT CONTACT

Is: touch current
Id: fault current
(Fault protection required)
FIGURE 1.3 INDIRECT CONTACT

1.4.37 Consumer mains

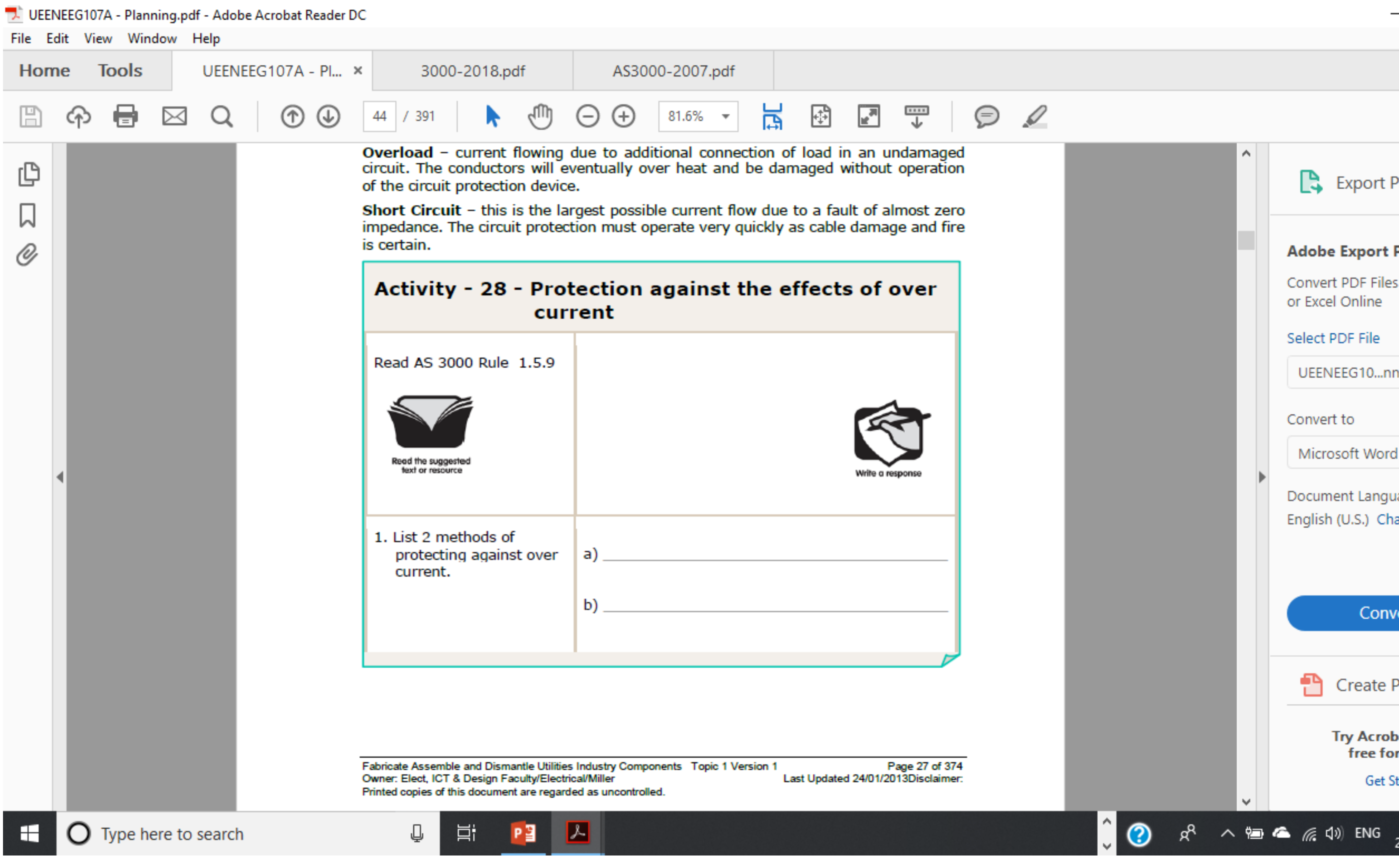
Those conductors between the point of supply and the main switchboard.

1.4.38 Contact, direct

Contact with a conductor or conductive part that is live in normal service (see Figure 1.2 and Clause 1.4.97 Protection, basic).

1.4.39 Contact, indirect

Contact with a conductive part that is not normally live but has become live under fault conditions (because of insulation failure or some other cause) (see Figure 1.3 and Clause 1.4.98 Protection, fault).



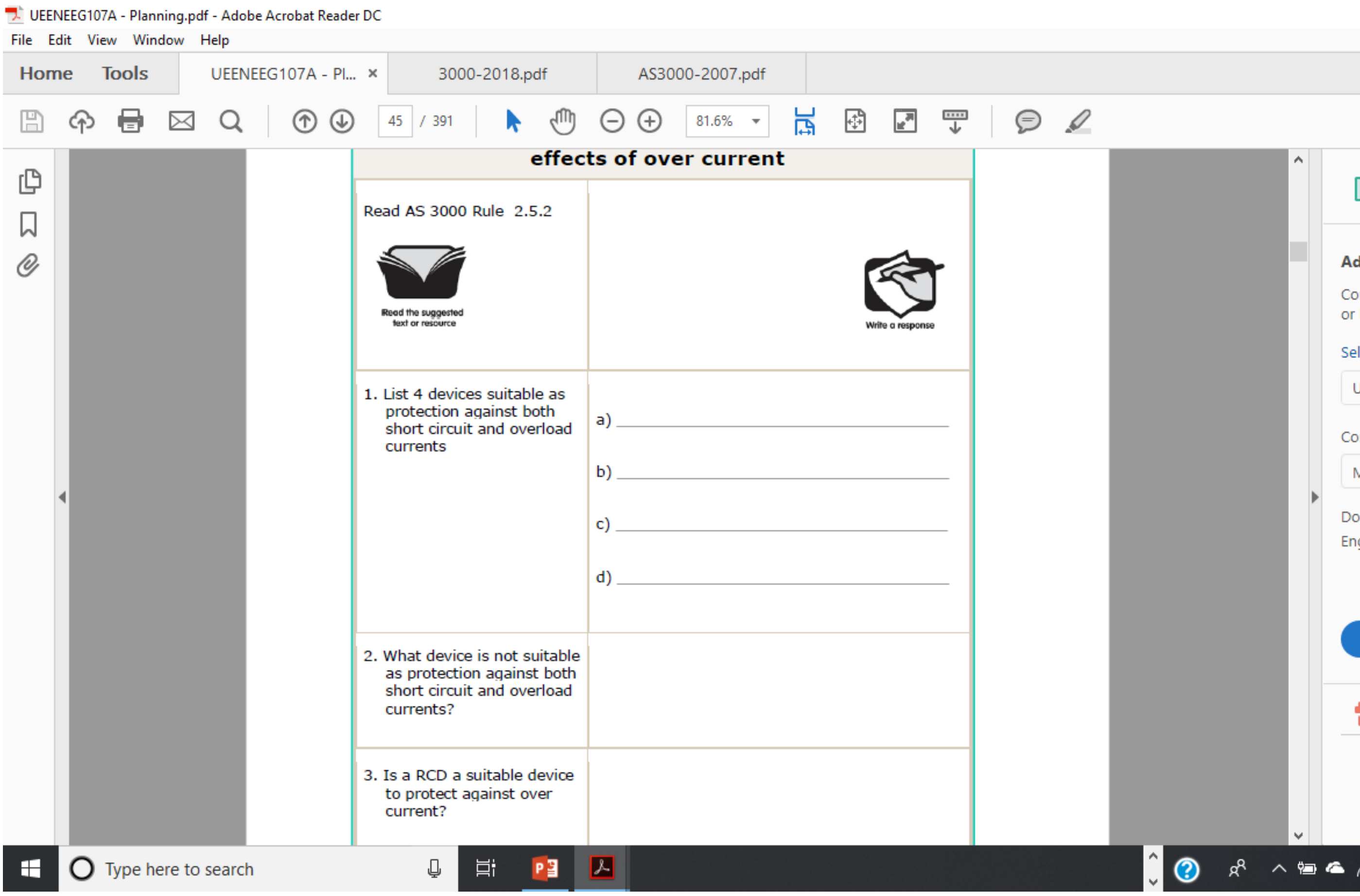
1.5.9 Protection against overcurrent

Protection shall be provided against injury or property damage because of excessive temperatures or electromechanical stresses caused by any over currents likely to arise in live conductors.

Protection may be provided by one of the following methods:

(a) Automatic disconnection on the occurrence of an overcurrent, before this overcurrent attains a dangerous value, taking into account its duration.

(b) Limiting the maximum overcurrent to a safe value and duration.



2.5.2 Devices for protection against both overload and short-circuit currents

Protective devices providing protection against both overload and shortcircuit current shall be capable of breaking any overcurrent up to and including the prospective short-circuit current at the point where the device is installed.

The device shall comply with the requirements of Clauses 2.5.3 and 2.5.4.

Exception: A protective device having a breaking capacity below the value of the prospective short-circuit current may be used in conjunction with another device in accordance with Clause 2.5.7.2.

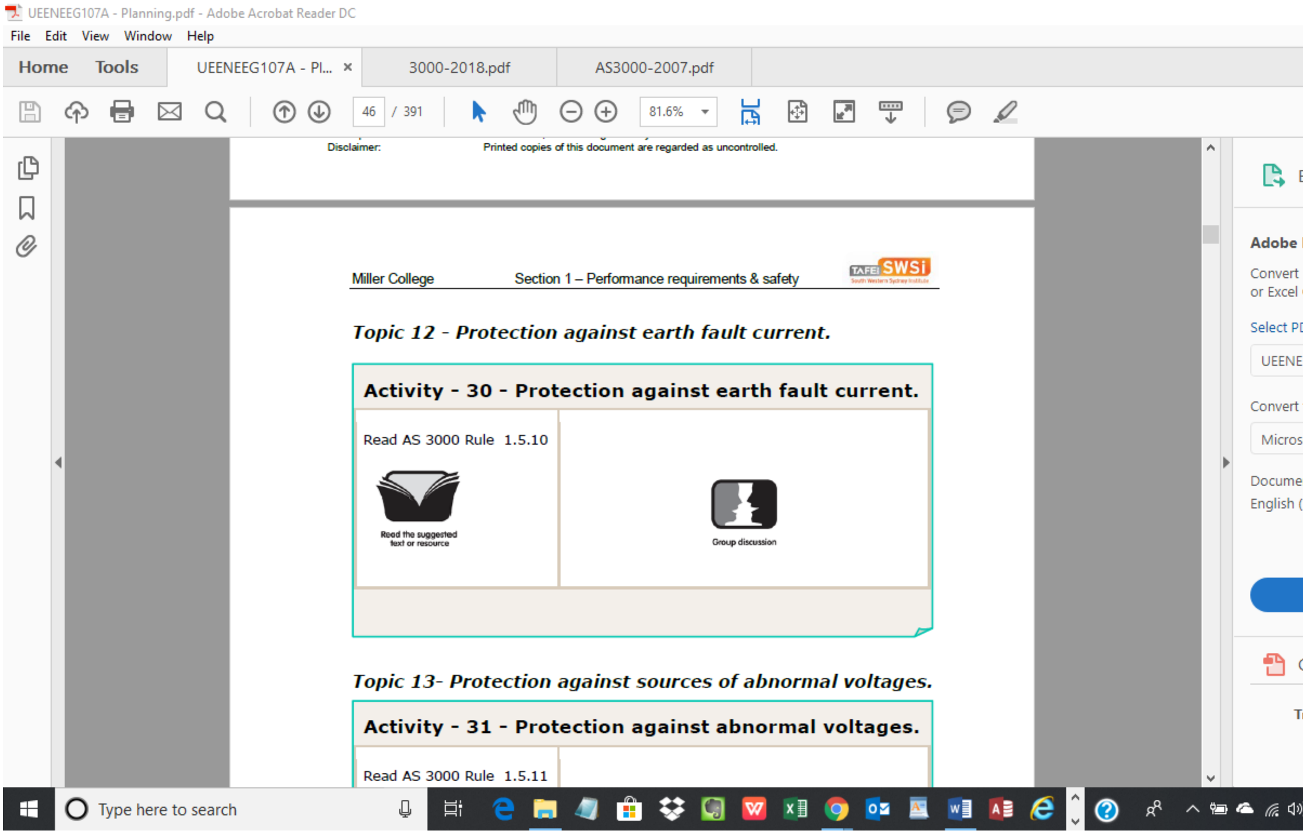
Protective devices may be one of the following:

(a) Circuit-breakers incorporating short-circuit and overload releases

(b) (b) Fuse-combination units (CFS units).

(c) (c) Fuses having enclosed fuse-links (HRC fuses).

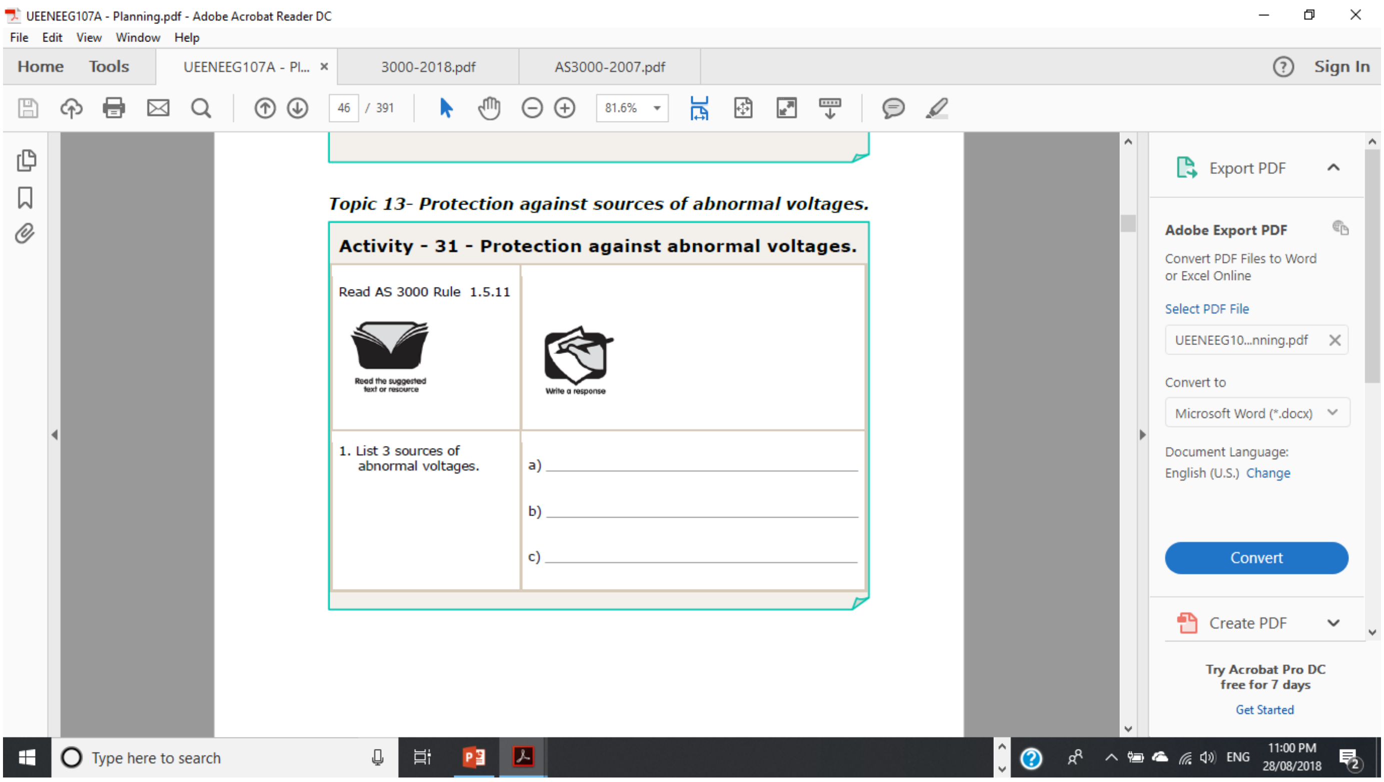
(d) (d) Circuit-breakers in conjunction with fuses.



(e)

1.5.10 Protection against earth fault currents

Protective earthing conductors and any other parts intended to carry an earth fault current shall be capable of carrying that current without attaining excessive temperature.



1.5.11 Protection against abnormal voltages

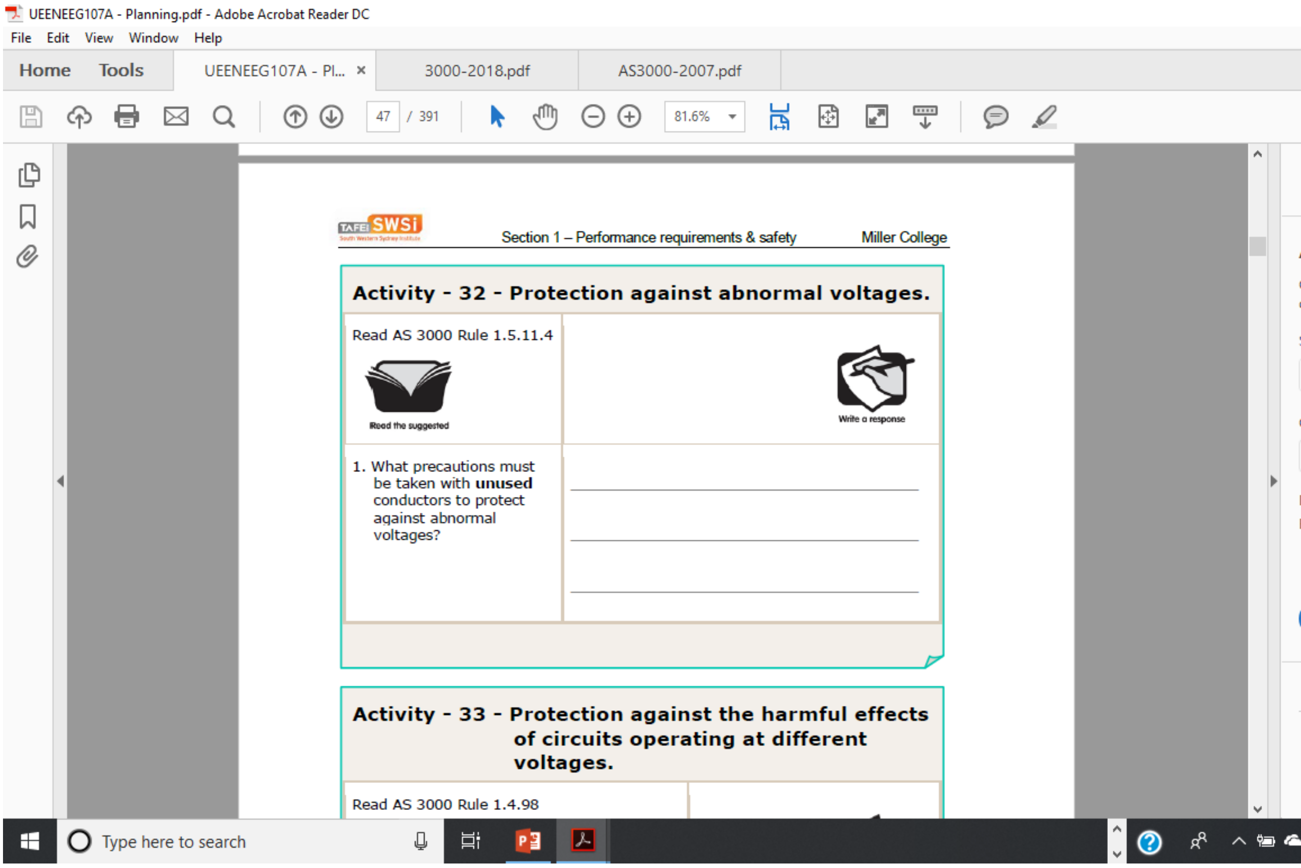
1.5.11.1 General

Protection shall be provided against any harmful effects of abnormal voltages—

(a) caused by a fault between live parts of circuits supplied at different voltages;

(b) induced or otherwise occurring in unused conductors; or

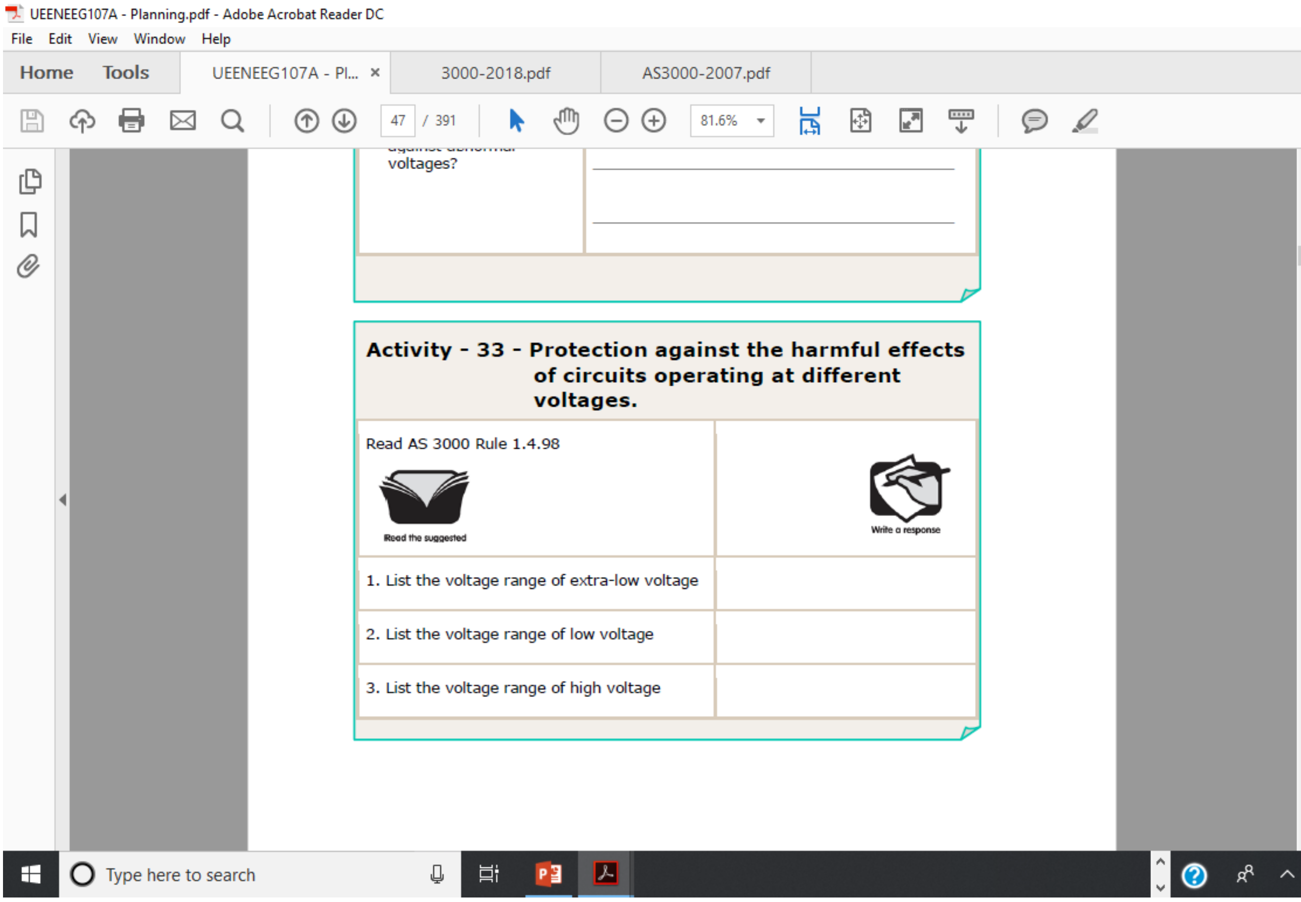
(c) occurring as a result of any harmful influence between different circuits and installations.



1.5.11.4 Voltage in unused conductors

Protection shall be provided against injury or property damage because of any harmful effects of voltage that may be induced or otherwise occur in unused conductors. Disconnected, redundant or unused conductors associated with conductors that remain connected shall be terminated and protected at both ends in the same manner as is required for live conductors.

NOTE: Such conductors are capable of attaining induced, unwanted voltages that may be dangerous, particularly where in close proximity to high voltage conductors.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voltages?

Activity - 33 - Protection against the harmful effects of circuits operating at different voltages.

Read AS 3000 Rule 1.4.98 Read the suggested	Write a response
1. List the voltage range of extra-low voltage	
2. List the voltage range of low voltage	
3. List the voltage range of high voltage	

Type here to search

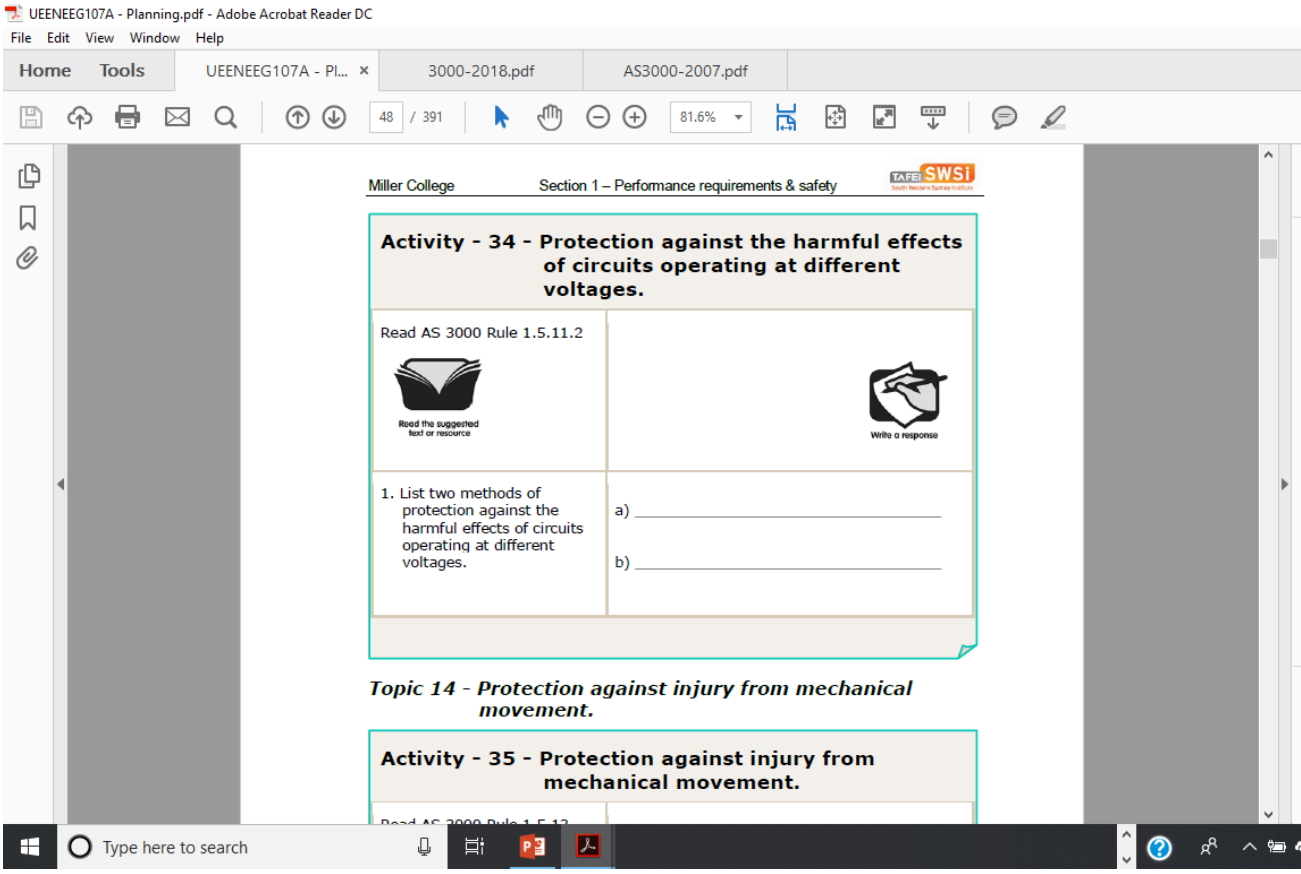
1.4.128 Voltage

Differences of potential normally existing between conductors or between conductors and earth as follows:

(a) Extra-low voltage Not exceeding 50 V a.c. or 120 V ripple-free d.c.

(b) Low voltage Exceeding extra-low voltage, but not exceeding 1000 V a.c. or 1500 V d.c.

(c) High voltage Exceeding low voltage.



Miller College Section 1 – Performance requirements & safety

Activity - 34 - Protection against the harmful effects of circuits operating at different voltages.

Read AS 3000 Rule 1.5.11.2	
1. List two methods of protection against the harmful effects of circuits operating at different voltages.	a) ____________ b) ____________

Topic 14 - Protection against injury from mechanical movement.

Activity - 35 - Protection against injury from mechanical movement.

1.5.11.2 Circuits operating at different voltages

Protection shall be provided against injury or property damage because of any harmful effects of a fault between live parts of circuits supplied at different voltages.

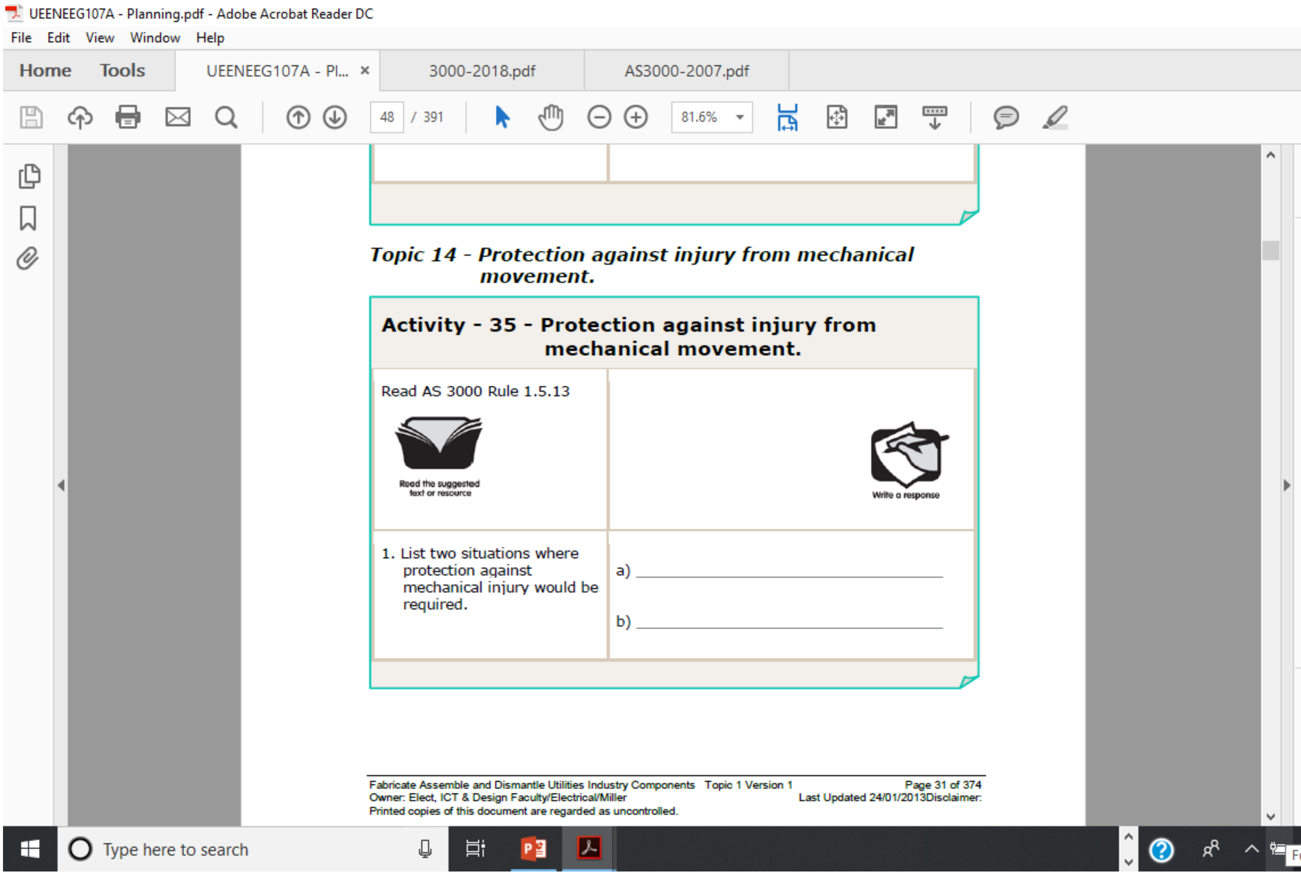
Protection may be provided by—

(a) segregation; or

NOTE: Clause 3.9.8 provides guidance on the segregation of circuits of different voltage levels.

(b) installation of devices for protection against over voltages.

NOTE: Clause 2.7 provides guidance on the installation of devices for protection against over voltages.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Topic 14 - Protection against injury from mechanical movement.

Activity - 35 - Protection against injury from mechanical movement.

Read AS 3000 Rule 1.5.13 Read the suggested text or resource	Write a response
1. List two situations where protection against mechanical injury would be required.	a) ______ b) ______

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1.5.13 Protection against injury from mechanical movement

Protection shall be provided against injury from mechanical movement of electrically actuated equipment, where—

(a) mechanical maintenance may involve risk of physical injury; or

(b) emergency stopping may be necessary to remove any unexpected danger.

Protection may be provided by the provision of devices to disconnect or isolate electrical equipment, as may be necessary to prevent or remove danger

Page 48

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Activity - 34 - Protection against the harmful effects of circuits operating at different voltages.

Read AS 3000 Rule 1.5.11.2  Read the suggested text or resource	 Write a response
1. List two methods of protection against the harmful effects of circuits operating at different voltages.	a) ______________________ b) ______________________

1.5.11.2 Circuits operating at different voltages

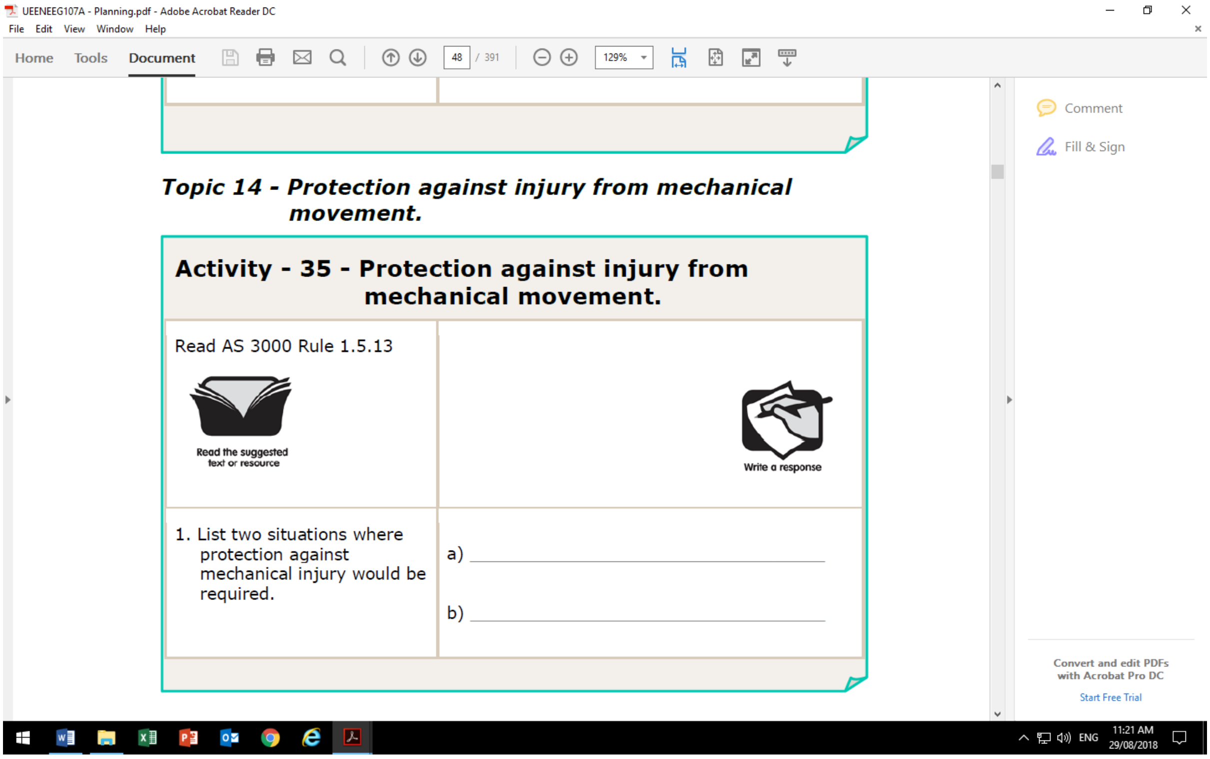
Protection shall be provided against injury or property damage because of any harmful effects of a fault between live parts of circuits supplied at different voltages.

Protection may be provided by—

(a) segregation; or

NOTE: Clause 3.9.8.1 provides guidance on the segregation of circuits of different voltage levels.

(b) installation of devices for protection against overvoltages.



Topic 14 - Protection against injury from mechanical movement.

Activity - 35 - Protection against injury from mechanical movement.	
Read AS 3000 Rule 1.5.13 Read the suggested text or resource	Write a response
1. List two situations where protection against mechanical injury would be required.	a) ______ b) ______

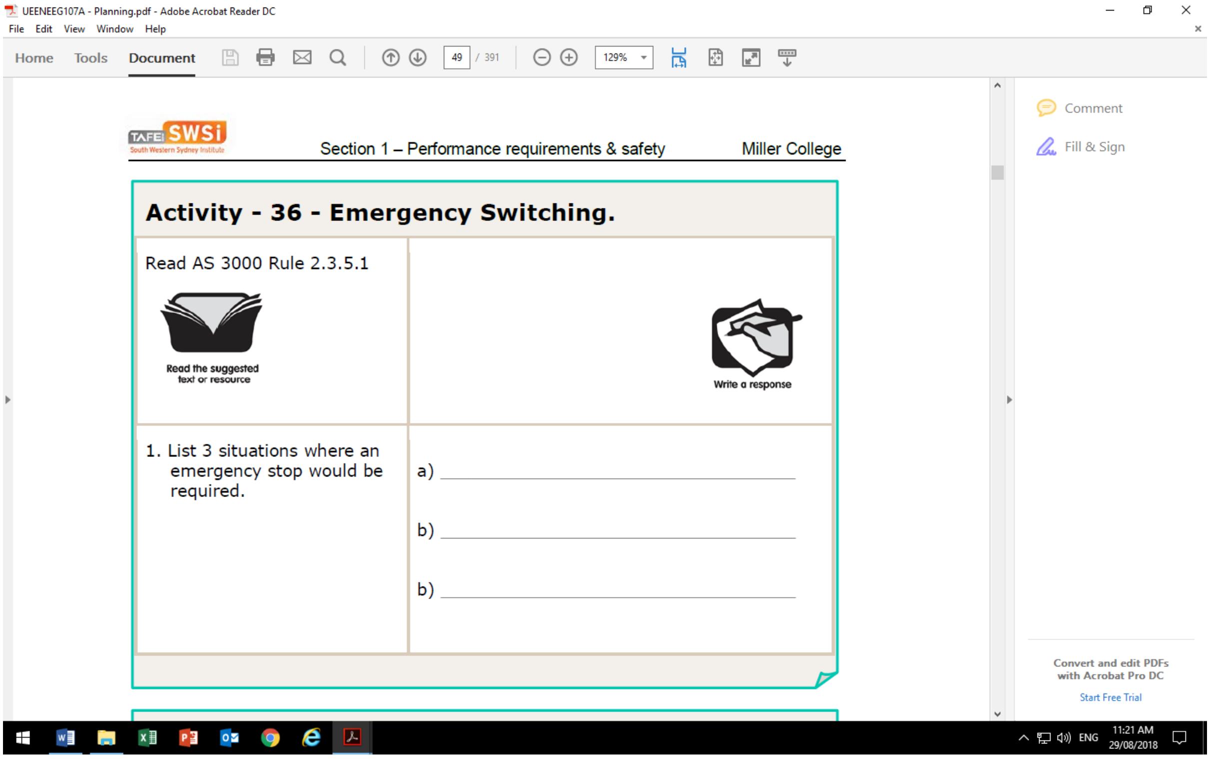
1.5.13 Protection against injury from mechanical movement

Protection shall be provided against injury from mechanical movement of electrically actuated equipment, where—

(a) mechanical maintenance may involve risk of physical injury; or

(b) emergency stopping may be necessary to remove any unexpected danger.

Protection may be provided by the provision of devices to disconnect or isolate electrical equipment, as may be necessary to prevent or remove danger.



Section 1 – Performance requirements & safety Miller College

Activity - 36 - Emergency Switching.

Read AS 3000 Rule 2.3.5.1 Read the suggested text or resource	Write a response
1. List 3 situations where an emergency stop would be required.	a) ______ b) ______ b) ______

2.3.5.1 General

Means shall be provided for emergency switching of any part of an electrical installation where it may be necessary to control the supply to remove an unexpected danger.

* Where required, because of the risk of electric shock, the emergency switching device shall be an isolating device.

The arrangement of the emergency switching shall be such that its operation does not introduce a further danger or interfere adversely with the complete operation necessary to remove the danger.

NOTES:

1 Emergency switching may require switching OFF or switching ON.

2 Examples of electrical installations where means for emergency switching are used are as follows:

(a) Machinery.

(b) Conveyors.

(c) Groups of machines.

(d) Pumping facilities for flammable liquids.

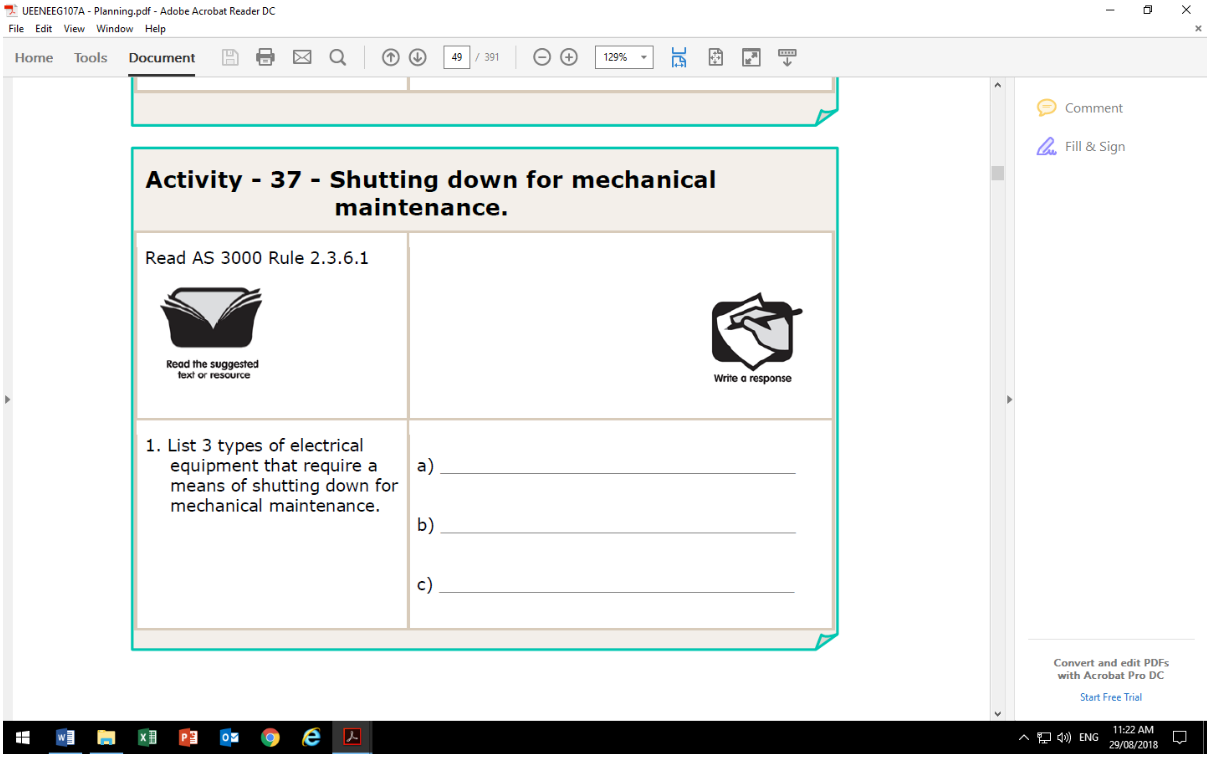
(e) Ventilation systems.

(f) Certain large buildings, e.g. department stores.

(g) Electrical testing and research facilities.

(h) Boiler rooms.

(i) Large kitchens



Activity - 37 - Shutting down for mechanical maintenance.

Read AS 3000 Rule 2.3.6.1 Read the suggested text or resource	Write a response
1. List 3 types of electrical equipment that require a means of shutting down for mechanical maintenance.	a) ______ b) ______ c) ______

2.3.6.1 General

Means of disconnecting electricity supply (shutting down) shall be provided where mechanical maintenance of electrically powered equipment might involve a risk of physical injury.

NOTES:

1 Such injuries include burns and those caused by radiated heat and unexpected mechanical movements.

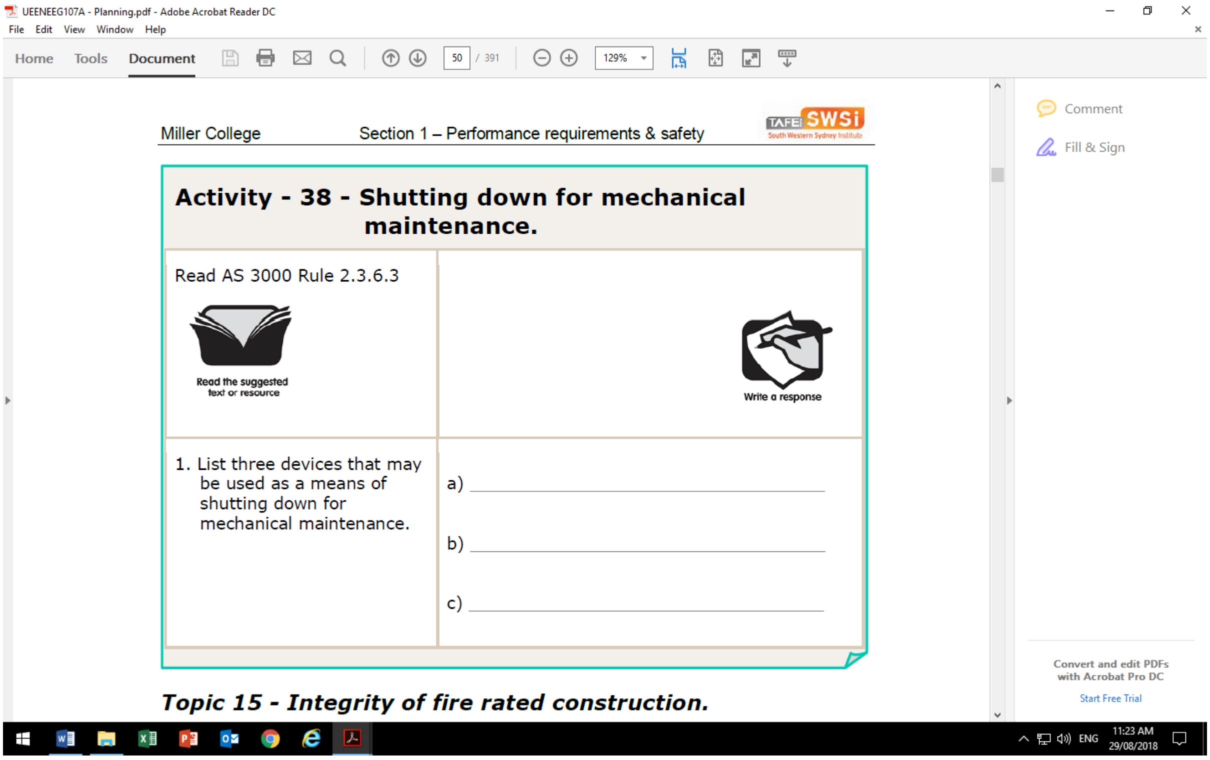
2 Electrically powered mechanical equipment may include rotating machines, heating elements and electromagnetic equipment.

3 Examples of electrical installations where means of shutting down for mechanical maintenance are used include cranes, lifts, escalators, conveyors, machine tools and pumps.

4 Systems powered by other means, e.g. pneumatic, hydraulic or steam, are not within the scope of this Clause. In such cases, shutting down any associated supply of electricity may not be sufficient to ensure safety.

Suitable means, such as facilities for locking the means of shutting down in the open position, the enclosure of the means of shutting down in a lockable enclosure or facilities for the attachment of a warning notice or notices, shall be provided to prevent operation of the means of shutting down and electrically powered equipment from being inadvertently started during mechanical maintenance.

Exception: Locking facilities or a lockable enclosure need not be provided where the means of shutting down is continuously under the control of the person performing such maintenance.



Miller College — Section 1 – Performance requirements & safety

Activity - 38 - Shutting down for mechanical maintenance.

Read AS 3000 Rule 2.3.6.3 Read the suggested text or resource	Write a response
1. List three devices that may be used as a means of shutting down for mechanical maintenance.	a) ____ b) ____ c) ____

Topic 15 - Integrity of fire rated construction.

2.3.6.3 Installation

Devices for shutting down for mechanical maintenance shall be inserted in the main circuit.

Where switches are provided for this purpose, they shall be capable of interrupting the full-load current of the relevant part of the electrical installation. They need not interrupt all live conductors.

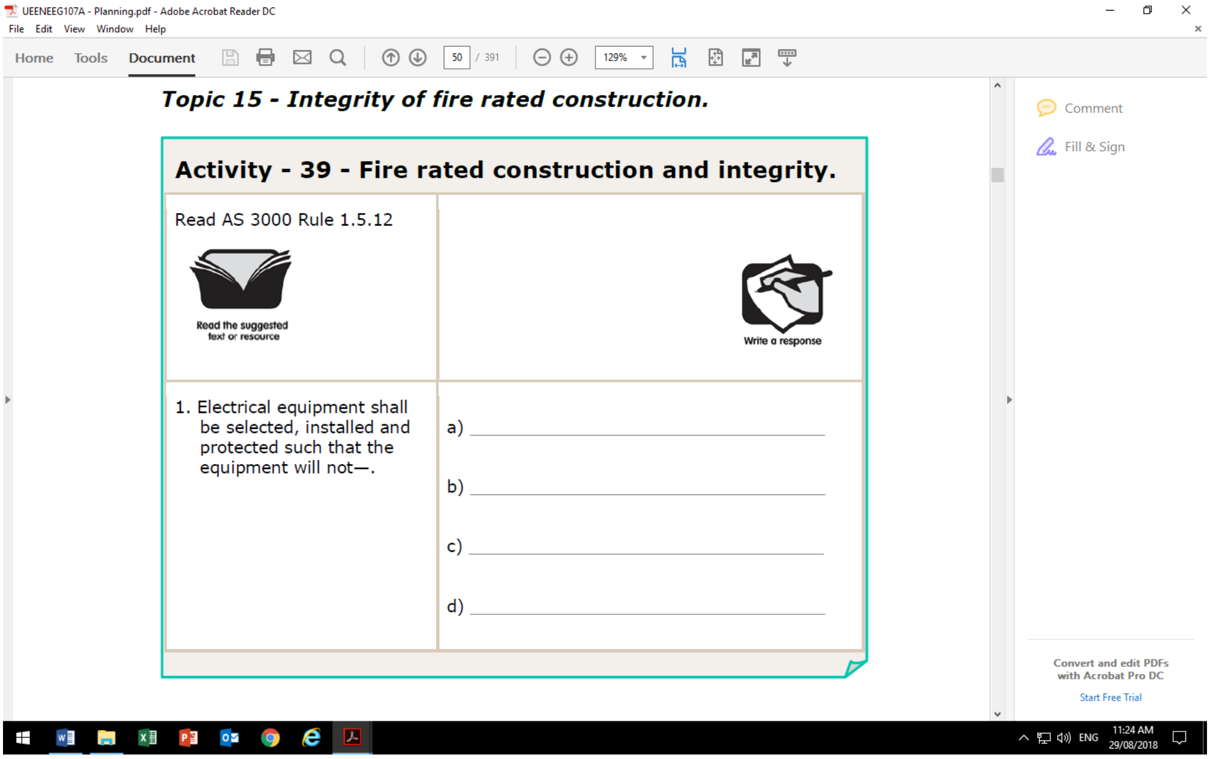
Exception: Interruption of the control circuit of a drive or the like may occur where—

(a) supplementary safeguards, such as mechanical restrainers are provided; or

(b) direct interruption of the main supply is achieved by another means.

NOTE: Shutting down for mechanical maintenance may be achieved by devices, such as switches, circuit-breakers or plugs and sockets.

A device located remotely from the electrical equipment it controls, which is used for shutting down for mechanical maintenance, shall be provided with facilities for securing it in the open position.



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Topic 15 - Integrity of fire rated construction.

Activity - 39 - Fire rated construction and integrity.

Read AS 3000 Rule 1.5.12 Read the suggested text or resource	Write a response
1. Electrical equipment shall be selected, installed and protected such that the equipment will not—.	a) ________ b) ________ c) ________ d) ________

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1.5.12 Protection against the spread of fire

Protection shall be provided against fire initiated or propagated by components of the electrical installation.

Electrical equipment shall be selected, installed and protected such that the equipment will not—

(a) obstruct escape routes, either directly or by the products of combustion;

(b) contribute to or propagate a fire;

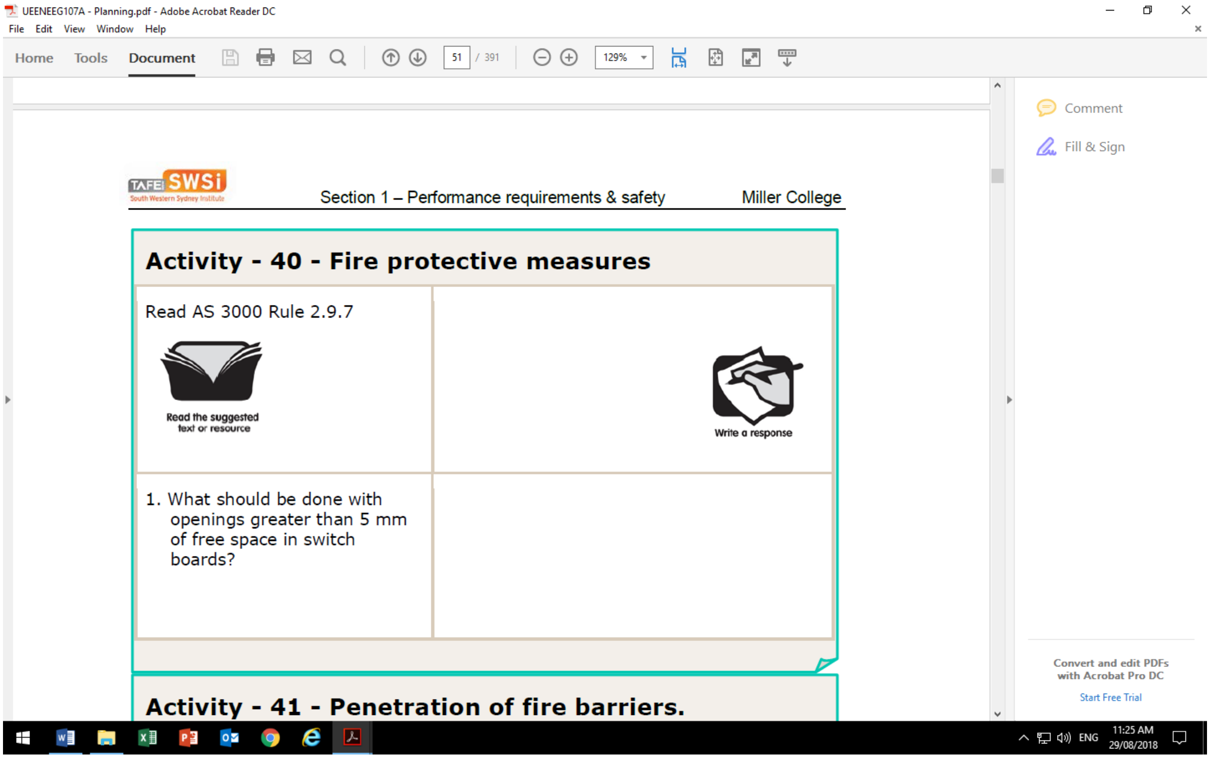
(c) attain a temperature high enough to ignite adjacent material; or

(d) adversely affect means of egress from a structure.

NOTES:

1 Clause 2.10.2.5(h) contains requirements for the placement of switchboards in or near fire exits and egress paths.

2 Clauses 2.10.7, 3.9.9 contain requirements and Appendix E provides guidance on fire safety.



2.9.7 Fire-protective measures (AS3000:2007)

Wiring associated with switchboards shall be installed in such a manner that, in the event of fire originating at the switchboard, the spread of fire will be kept to a minimum.

Where a switchboard is enclosed in a case or surround, any wiring systems entering the switchboard enclosure shall pass through openings that provide a close fit.

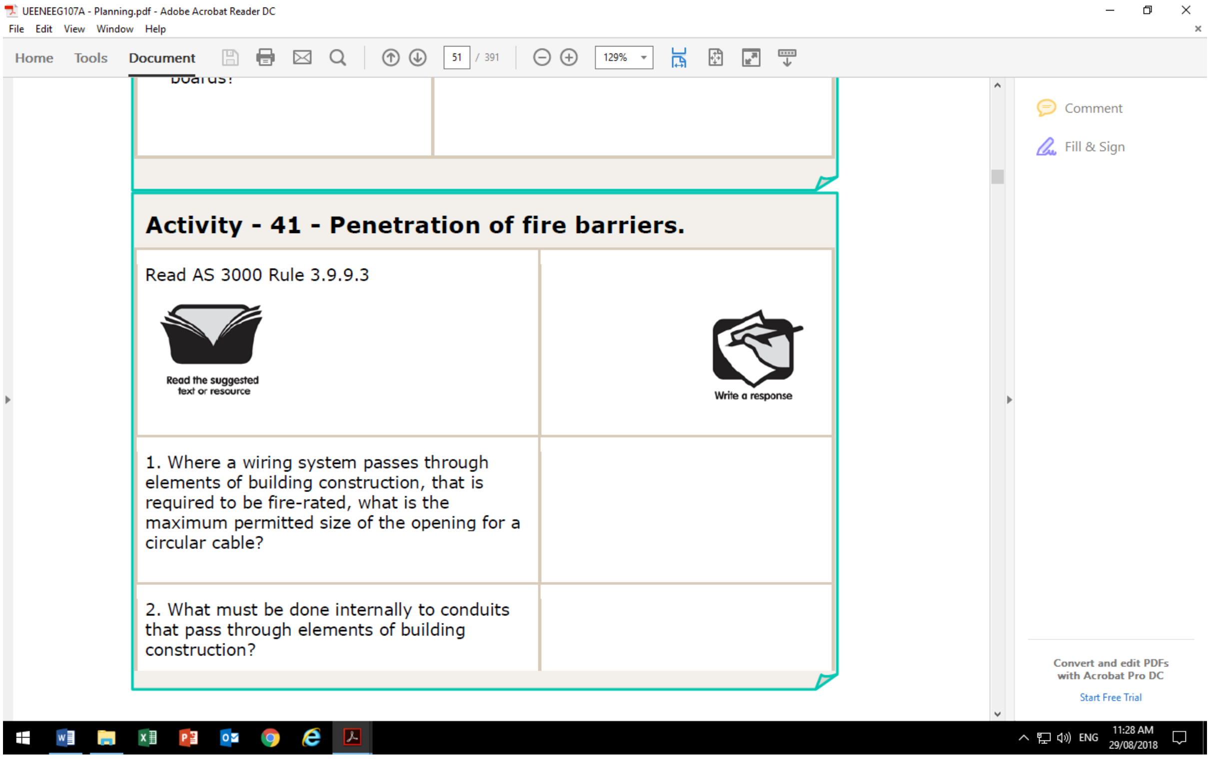
NOTES:

1 See also Clause 2.9.2.5 (h) regarding restricted location of switchboards in or near egress paths or fire exits and Clause 3.9.9 regarding requirements to prevent the spread of fire.

2 There is a very high risk that wiring enclosures, especially those that enter at the top or sides of a switchboard, will contribute to the spread of fire and for this reason care needs to be taken to ensure that these wiring systems are provided with close-fitting entries. In some cases internal sealing should be provided.

3 An opening with less than 5 mm diameter of free space is considered to be a close fit. Therefore, any opening of 5 mm diameter or greater requires sealing with a fire-retardant sealant.

4 Wiring enclosures, such as conduits, having an internal free space of greater than 5 mm diameter also require sealing to stop any draft effect that could allow the spread of fire.



boards?

Activity - 41 - Penetration of fire barriers.

Read AS 3000 Rule 3.9.9.3 Read the suggested text or resource	Write a response
1. Where a wiring system passes through elements of building construction, that is required to be fire-rated, what is the maximum permitted size of the opening for a circular cable?	
2. What must be done internally to conduits that pass through elements of building construction?	

3.9.9.3 Penetration of fire barriers

(a) Where a wiring system passes through elements of building construction, such as floors, walls, roofs, ceilings, partitions or cavity barriers that are required to be fire-rated—

(i) the opening shall be close-fitting to the wiring system and at least 50 mm from any other service opening;

(ii) the cross-sectional area of the opening shall be not greater than 500 mm^2, i.e. if circular, 25 mm diameter; and

increased up to a maximum of 2000 mm^2 (50 mm diameter) for a single cable that leaves a gap of not more than 15 mm between the cable and the opening.

(iii) the fire-rating of structures shall be reinstated where openings remain after passage of the wiring system, in accordance with the relevant provisions of national building codes.

NOTE: Guidance on materials suitable for restoring fire-rated constructions is given in national building codes.

(b) Wiring systems, such as conduits, cable ducting, cable trunking, busbars or busbar trunking systems, and flush boxes that penetrate elements of building construction required to have a specified firerating shall be internally sealed to the degree of fire-rating of the respective element before penetration and externally sealed as required by Item (a)(iii).

(c) Conduit and trunking systems of material complying with the flame propagation test of AS/NZS 2053 series or AS/NZS 61386 series or AS/NZS 4296, as appropriate, and having a maximum internal crosssectioned area of 710 mm^2, i.e. 30 mm internal diameter, need not be internally sealed provided that—

(i) the system satisfies the degree of protection IP33; and

(ii) any termination of the system in one of the compartments separated by the building construction being penetrated satisfies the degree of protection IP33.

(d) All sealing arrangements used in accordance with Items (a) to (c) shall comply with the following requirements.

Sealing arrangements shall—

(i) be compatible with the materials of the wiring system with which they are in contact;

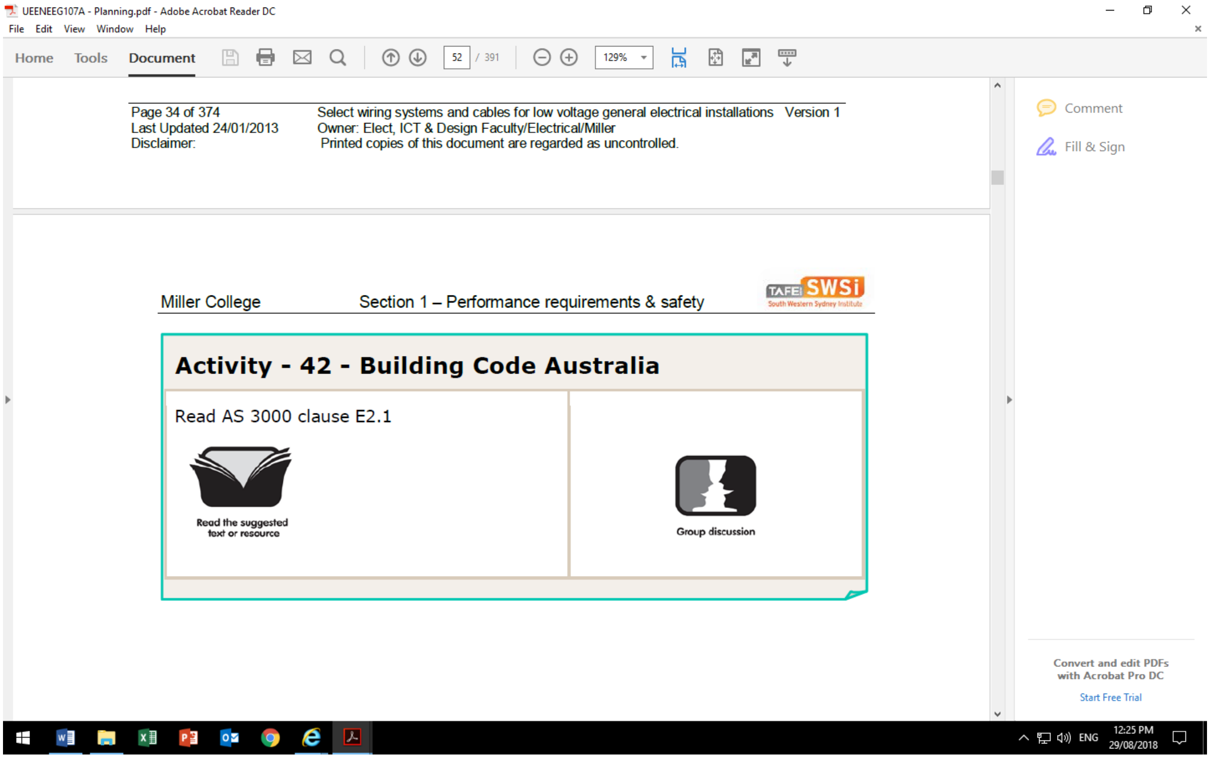
(ii) permit thermal movement of the wiring system without reduction of the sealing quality; and

(iii) be of adequate mechanical stability to withstand the stresses that may arise through damage to the support of the wiring system because of fire.

NOTE: This requirement may be satisfied if—

(a) either cable clamps or cable supports are installed within 750 mm of the seal, and are able to withstand the mechanical loads expected following the collapse of the supports on the fire side of the seal to the extent that no strain is transferred to the seal; or

(b) the design of the sealing system provides adequate support.



E2 AUSTRALIA

E2.1 General

The NCC is written by the Australian Building Codes Board in conjunction with the building and plumbing authorities of the States and Territories. Its goals are nationally consistent health, safety, amenity and sustainability in building construction and plumbing and drainage.

The NCC is adopted under building and plumbing construction legislation in Australian States and Territories, which have responsibility for building construction and plumbing and drainage installations. The NCC is implemented through building certifiers, both local government and private, and other professional practitioners.

The NCC is in three volumes:

(a) Volume One—Building Code of Australia Class 2 to Class 9 Buildings (for multi-residential, commercial, industrial and public buildings and structures).

(b) Volume Two—Building Code of Australia Class 1 and Class 10 Buildings (for houses and associated structures).

(c) Volume Three—Plumbing Code of Australia (for plumbing and drainage associated with all classes of buildings).

The NCC is performance-based and contains fundamental ‘performance requirements’ together with acceptable solutions, known as ‘deemed-to satisfy

provisions', often based on compliance with Standards.
The ABCB also produces a Handbook, NCC Volume One Energy Efficiency Provisions. The Handbook, which is available free from the ABCB website (www.abcb.gov.au), has been developed to alert electricians and plumbers to the energy efficiency provisions of the NCC and how these provisions may affect them.

Tutorial 1 Miller College s

elect wiring systems and cables for low voltage general electrical installations Topic 1 Version 1 Page 37 of 374 Owner: Elect, ICT & Design Faculty/Electrical/Miller Last Updated 24/01/2013 Disclaimer: Printed copies of this document are regarded as uncontrolled. In the following statements one of the suggested answers is best. Place the identifying letter on your answer sheet.

1. What maximum disconnection time does AS/NZS 3000 specify for a final sub-circuit supplying a fixed cooking appliance (free-standing range)?

(a) 30 milliseconds.

(b) 40 milliseconds.

(c) 0.4 second.

(d) 5 seconds.

2. Which of the following methods provides protection against indirect contact?

(a) Obstacles.

(b) Secure barriers.

(c) Placing out of reach.

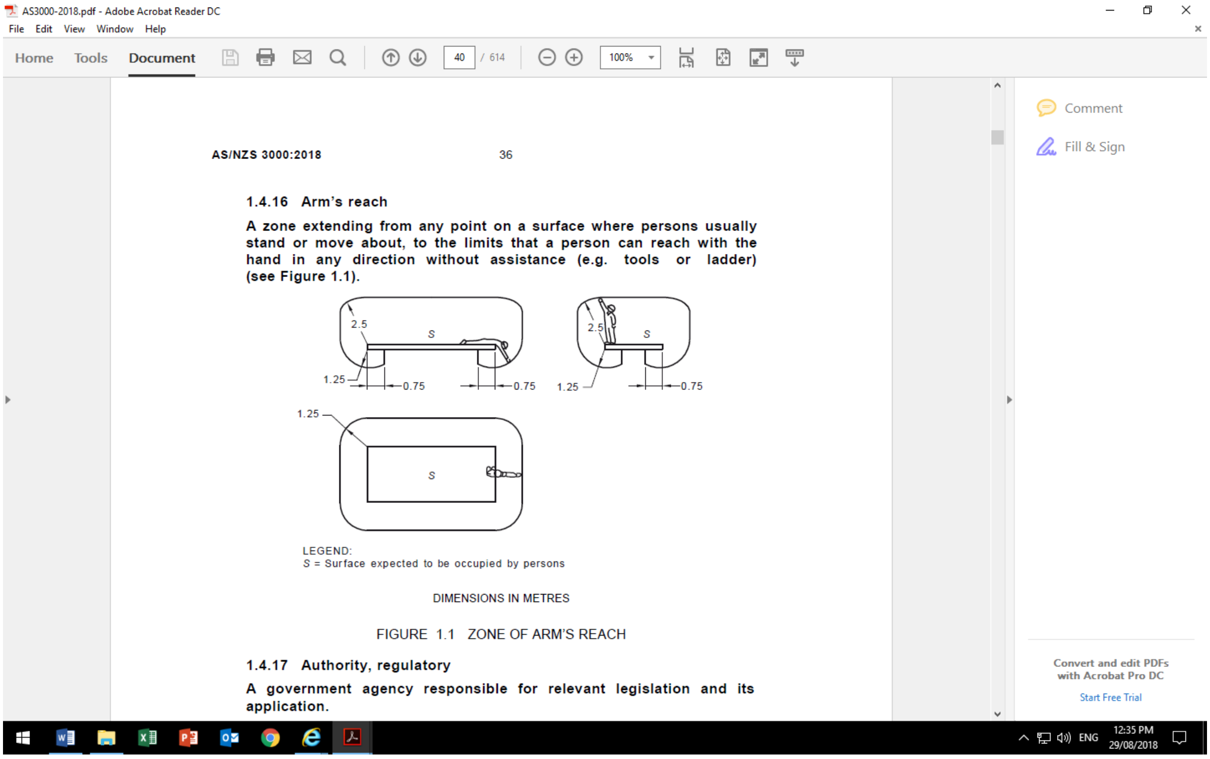
(d) Automatic disconnection of the supply.

3. Arms reach is what vertical distance (↕) above a surface that a person may stand on:
(a) 0.5m

(b) 0.75.

(c) 1.25m

(d) 2.5m


AS/NZS 3000:2018 36

1.4.16 Arm's reach

A zone extending from any point on a surface where persons usually stand or move about, to the limits that a person can reach with the hand in any direction without assistance (e.g. tools or ladder) (see Figure 1.1).

LEGEND:
S = Surface expected to be occupied by persons

DIMENSIONS IN METRES

FIGURE 1.1 ZONE OF ARM'S REACH

1.4.17 Authority, regulatory

A government agency responsible for relevant legislation and its application.

4. Arms reach is what horizontal distance (↔) from a surface that a person may stand on: (a) 0.5m

(b) 0.75.

(c) 1.25m

(d) 2.5m

5. The minimum permissible voltage measured at the load terminals of a 230V appliance is:

(a) 218.5V

(b) 230V

(c) 11.5V

(d) 225V

6. A method of protecting against direct contact is:

(a) using Class 1 equipment

(b) installing an RCD

(c) automatic disconnection of supply

(d) placing equipment out of arms reach

7. The maximum disconnection time specified for protection against indirect contact for a final sub circuit supplying socket outlets is:

(a) unspecified.

(b) 100ms.

(c) 400ms.

(d) 5s.

8. What is the maximum allowable prospective touch voltage before a protective device must automatically disconnect the supply for circuits supplying hand held equipment?

(a) 32Vac.

(b) 50Vac.

(c) l00Vac.

(d) 240V ac.

9. It is normal to divide an electrical installation into a number of circuits. One reason for this is to:

(a) Maximise the number of cables used.

(b) Minimise the number of cables used.

(c) Allow for the use of a single cable size.

(d) Minimise the inconvenience in the event of a fault.

10.One method for determining the size of consumer's mains and sub-mains of an electrical installation is:

(a) Location of points.

(b) Safe design and construction.

(c) Demand of devices for isolation.

(d) Measuring the highest rate of electricity in any 15 minute period.

11.The two points in an electrical installation from where the maximum permissible voltage drop is considered:

(a) Is between any two points in the installation.

(b) Is between the point of supply and the main switchboard.

(c) Is between the point of supply and any other point in the installation.

(d) Is between the main switchboard and the furthermost final sub-circuit.

12.The term *'direct contact'* refers to:

(a) touching a live uninsulated conductor or busbar.

(b) contact with an exposed conductive part which is not normally live, but is live due to a fault.

(c) touching another person who is in contact with the supply.

(d) contact with exposed metal which is earthed.

13.The limit to circuit lengths, as set down in AS 3000, is required:

(a) to keep the cost of electrical installations as low as possible.

(b) to limit the voltage drop in the circuit.

(c) because shorter cable runs are the easier to install

(d) for protection against the danger of indirect contact

14.Which of the following methods does not provide protection against direct contact?
(a) obstacles.

(b) secure barriers.

(c) placing out of reach.

(d) circuit breakers and fuses.

15.An example of a situation where a emergency stop is required is a:

(a) Lathe

(b) Hot Water System

(c) Sub main

(d) Lighting circuit

16.Specify the four (4) acceptable methods of protection against indirect contact.

(a) ____

(b) ____

(c) ____

(d) ____

Protective earthing

Insulation

Residual current device

Barrier

17.List three factors to consider when designing an electrical installation.

(a) ____

(b) ____

(c) ____

AS 3000 Reference (Clause number ______________)

15.Factors in Designing an Installation (any 3) (a) protect persons, livestock and property from harmful effects

(b) function correctly as intended

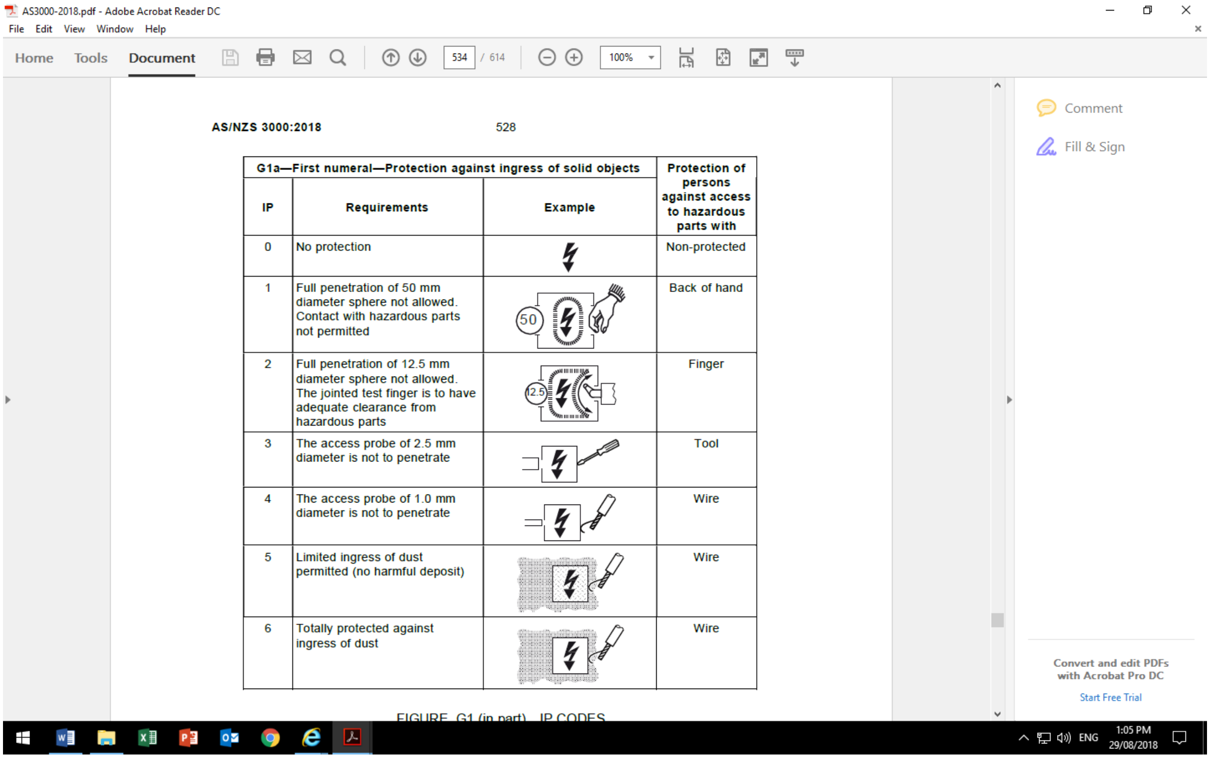
(c) connect, operate safely and be compatible with the electricity distribution system, or other source of supply, to which the electrical installation is to be connected

(d) minimize inconvenience in the event of a fault

(e) facilitate safe operation, inspection, testing and maintenance.

(clause number 1.6.1)

16.Live parts are to be protected against direct contact by enclosures or barriers.
(a) What is the minimum degree of protection that must be provided by the enclosures or barrier?



AS/NZS 3000:2018 528

G1a—First numeral—Protection against ingress of solid objects			Protection of persons against access to hazardous parts with
IP	Requirements	Example	
0	No protection		Non-protected
1	Full penetration of 50 mm diameter sphere not allowed. Contact with hazardous parts not permitted	50	Back of hand
2	Full penetration of 12.5 mm diameter sphere not allowed. The jointed test finger is to have adequate clearance from hazardous parts	12.5	Finger
3	The access probe of 2.5 mm diameter is not to penetrate		Tool
4	The access probe of 1.0 mm diameter is not to penetrate		Wire
5	Limited ingress of dust permitted (no harmful deposit)		Wire
6	Totally protected against ingress of dust		Wire

FIGURE G1 (in part) IP CODES

.Protection against direct contact by enclosures or barriers. (a) IP2X or IP4X for horizontal surfaces

(b) (Clause number 1.6.1)

(c) 12.5mm for IPX2, 1.0mm for IP4X

(Clause number Table G1)

____

AS 3000 Reference (Clause number _______________)

(b) What is the maximum size of an object that is allowed to enter the enclosure or barrier?

____

AS 3000 Reference (Clause number _______________)

19.List three factors that aid in determining the number and type of circuits needed in an electrical installation.

(a) ____

(b) ____

(c) ____

AS 3000 Reference (Clause number _______________)

17.Factors in Determining the number of circuits (any 3) (a) The relationship of the equipment,
(b) The load and operating characteristics
(c) The limitation of consequences of circuit

failure including loss of supply

(d) The facility for maintenance work

(clause 2.2.1.1)

20.List four methods of determining the maximum demand of a consumer main. (a) ____

(b) ____

(c) ____

(d) ____

AS 3000 Reference (Clause number ______________).

.Methods of determining maximum demand

(a) calculation

(b) assessment

(c) measurement

(d) limitation

21.List two of the essential requirements for the selection and installation of electrical equipment. (a) ____

.Selection and installation of equipment (any 2) (a) Provide control or isolation of the electrical installation, circuits or individual items

(b) Enable automatic disco of supply in the event of an overload, short-circuit or excess earth leakage current

(c) Protection of the electrical installation against failure from overvoltage or under voltage conditions.

(d) Provide for switchgear and control gear to be grouped and interconnected on switchboards, enclosed against external influences, and located in accessible positions.

(e) Provide for switchgear and control gear to be grouped

and interconnected on switchboards

(f) enclosed against external influences, and located in accessible positions.

(clause 2.1.2)

22.What are the requirements regarding protecting a redundant cable against induced voltages?

____

____

____

AS 3000 Reference (Clause number ______________)

.Redundant cables must be terminated at both ends the same as live cables.
(clause 1.5.11.4)

23.List two of methods of protecting against the harmful effects of abnormal voltages for electrical equipment of different rated voltages. (a) ____

(b) ____

AS/NZS 3000 Reference (Clause number _______________)

.Protection of equipment at different voltages (a) segregation

(b) devices for protection against overvoltages.

(clause 1.5.11.2)

22.When protecting electrical actuated equipment against injury from mechanical movement, what is the protection device required to do? ____
____
____

AS 3000 Reference (Clause number _______________)

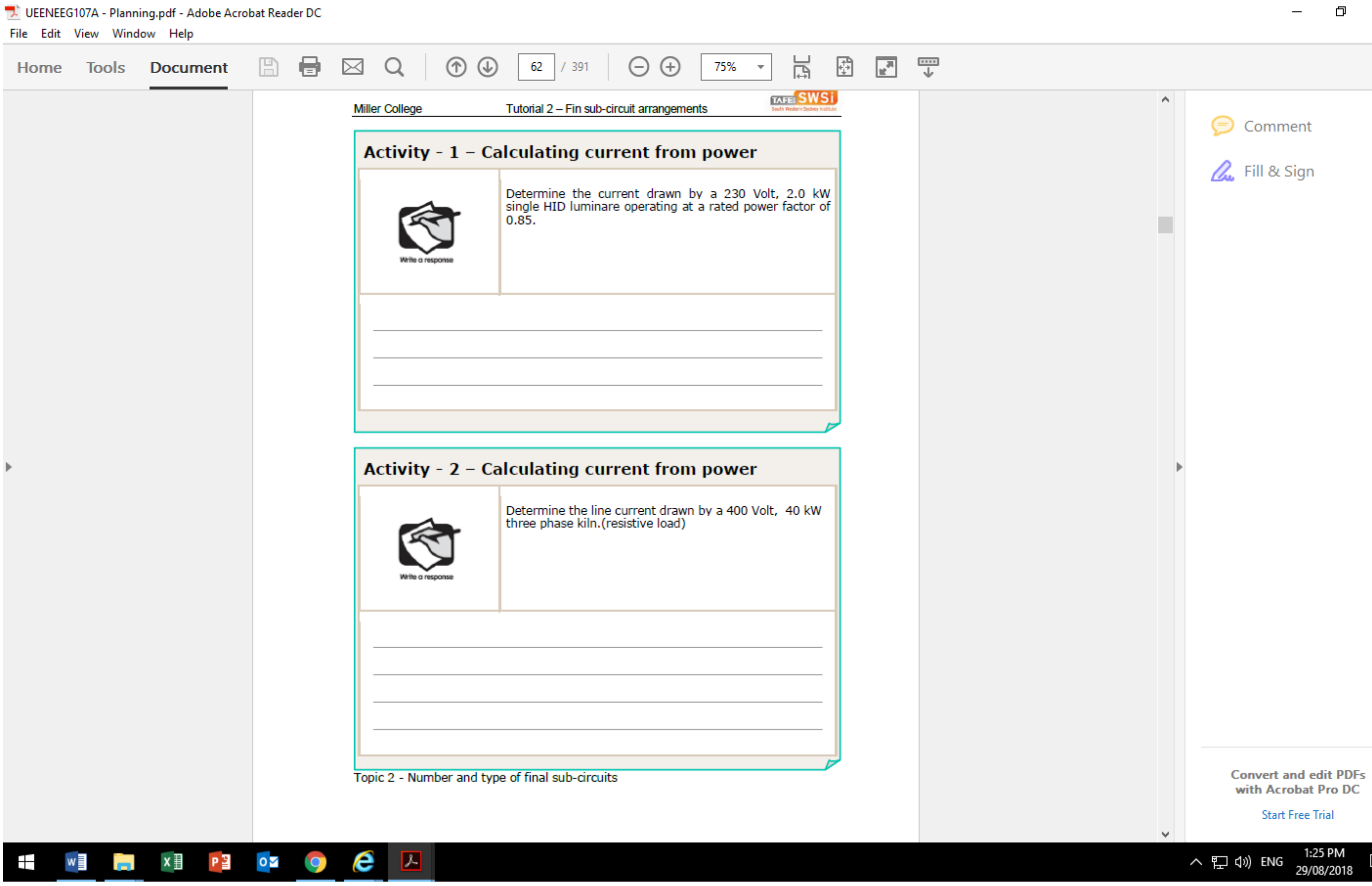
22. Protection against mechanical movement – devices must disconnect or isolate electrical equipment, as may be necessary to prevent or remove danger.

(clause 1.5.13)

25.What is the maximum size hole aloud to be made if a single cable is required to

Maximum hole is 50mm

(clause 3.9.9.3)



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Activity - 1 – Calculating current from power

Write a response

Determine the current drawn by a 230 Volt, 2.0 kW single HID luminare operating at a rated power factor of 0.85.

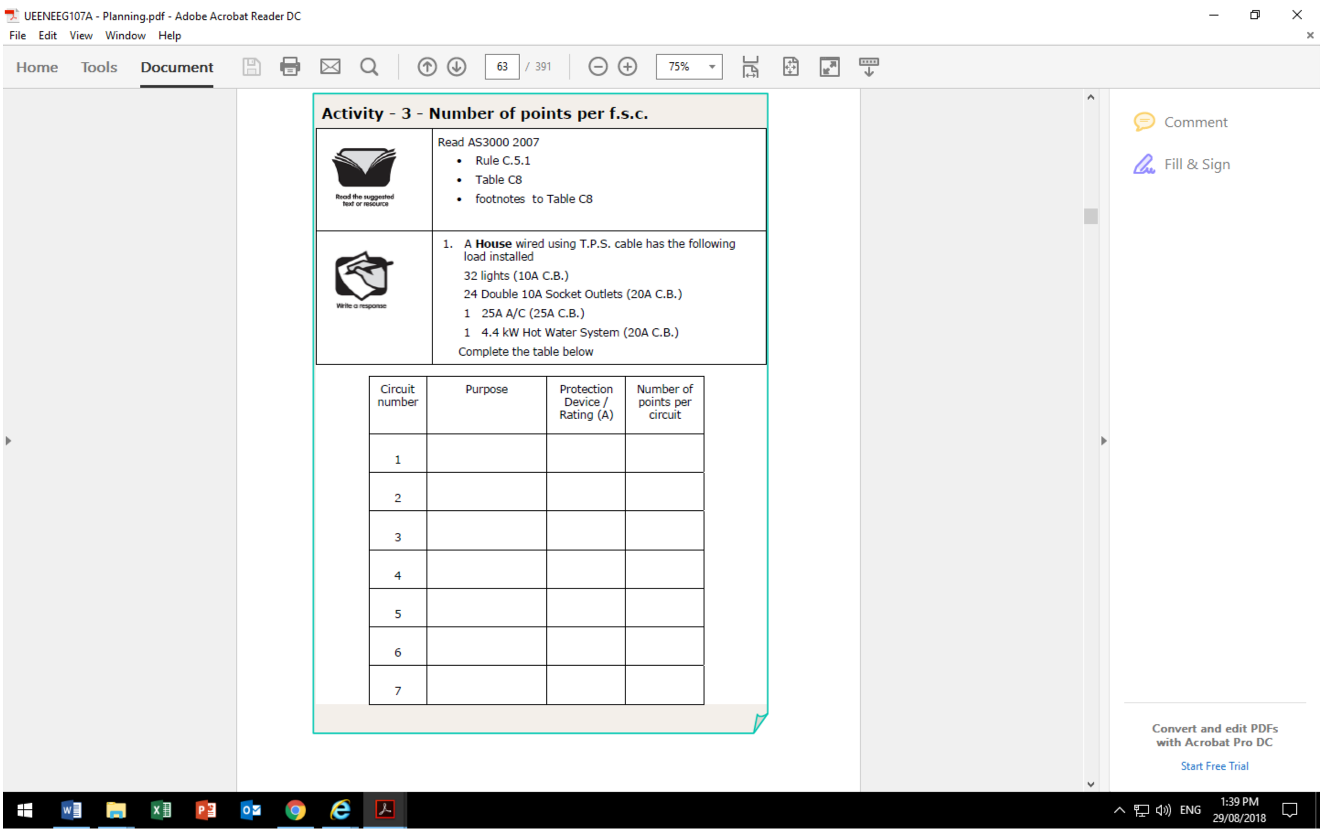
Activity - 2 – Calculating current from power

Write a response

Determine the line current drawn by a 400 Volt, 40 kW three phase kiln.(resistive load)

Topic 2 - Number and type of final sub-circuits

To do in the class



Activity - 3 - Number of points per f.s.c.

Read the suggested text or resource

Read AS3000 2007

- Rule C.5.1
- Table C8
- footnotes to Table C8

Write a response

1. A **House** wired using T.P.S. cable has the following load installed

   32 lights (10A C.B.)

   24 Double 10A Socket Outlets (20A C.B.)

   1 25A A/C (25A C.B.)

   1 4.4 kW Hot Water System (20A C.B.)

   Complete the table below

Circuit number	Purpose	Protection Device / Rating (A)	Number of points per circuit
1			
2			
3			
4			
5			
6			
7			

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Activity - 5 - Number of points per f.s.c.

1. A 3 phase **factory unit** is wired using T.P.S. cable has the following load installed
   - 10 Hi-bay MV lights rated at 1.85 A each (16A C.B.)
   - 12 10A Socket Outlets (20A C.B.)
   - 3 three phase 32 A Socket Outlets (32A C.B.)

   Complete the table below

Circuit number	Purpose	Protection Device / Rating (A)	Number of points per circuit
1			
2			
3			
4			
5			
6			
7			
8			

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TABLE C9

GUIDANCE ON THE LOADING OF POINTS PER FINAL SUBCIRCUIT

Cable cross-sectional area[1] mm²	Rating of circuit-breaker[1] A	Contribution of each point (A) (sum not to exceed rating of circuit-breaker): Lighting points[6]	10 A single-phase or multiphase socket-outlets[3, 7, 8, 9]: Non-domestic installations without permanent airconditioning	10 A single-phase or multiphase socket-outlets[3, 7, 8, 9]: All domestic installations and non-domestic installations with permanent airconditioning	15 A single-phase or multi-phase socket-outlets[8, 9]	20 A single-phase or multi-phase socket-outlets[8, 9]	Permanently connected fixed or stationary appliances[6, 10] or water heaters	Maximum connected load for a range[4, 5] W
1	6	0.5	NP	NP	NP	NP	Connected load	NP
1	8	0.5	NP	NP	NP	NP		NP
1	10	0.5	NP	NP	NP	NP		NP
1	13	0.5	NP	NP	NP	NP		NP
1	16	0.5	NP	NP	NP	NP		NP
1.5	8	0.5	NP	NP	NP	NP		NP
1.5	10	0.5	NP	NP	NP	NP		NP
1.5	13	0.5	NP	NP	NP	NP		NP
1.5	16	0.5	NP	NP	NP	NP		5000
1.5	20	0.5	NP	NP	NP	NP		5000
2.5	10	0.5	NP	NP	NP	NP		NP
2.5	13	0.5	2	1	NP	NP		NP
2.5	16	0.5	2	1	15	NP		5000
2.5	20	0.5	2	1	12	20		8000
2.5	25	0.5	2	1	10	18		8000

(continued)

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TABLE C9 *(continued)*

Cable cross-sectional area[1]	Rating of circuit-breaker[1]	Contribution of each point (A) (sum not to exceed rating of circuit-breaker)						Maximum connected load for a range[4, 5]
		Lighting points[6]	10 A single-phase or multiphase socket-outlets[3, 7, 8, 9]: Non-domestic installations without permanent airconditioning	10 A single-phase or multiphase socket-outlets[3, 7, 8, 9]: All domestic installations and non-domestic installations with permanent airconditioning	15 A single-phase or multi-phase socket-outlets[8, 9]	20 A single-phase or multi-phase socket-outlets[8, 9]	Permanently connected fixed or stationary appliances[6, 10] or water heaters	
mm^2	A							W
2.5	32	0.5	2	1	8	16		10 000
4	16	0.5	2	1	15	NP		5000
4	20	0.5	2	1	12	20		8000
4	25	0.5	2	1	10	18		10 000
4	32	0.5	2	1	8	16		10 000
6[2]	20	0.5	2	1	12	20		10 000
6[2]	25	0.5	2	1	10	18		10 000
6[2]	32	0.5	2	1	8	16		13 000
10[2]	32	0.5	2	1	8	16		13 000
10[2]	40	0.5	2	1	8	16		>13 000

NP = denotes socket-outlets not permitted on these circuits

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reduce installation cost. Even if all elements are switched on at the same time the circuit protection device will take time to operate. The current flowing is only a small overload in relation to the nominal rating of the protection device and the cable it protects. In other words by the time the circuit breaker is about to trip the temperature controllers start to cycle the elements and current drops to a value that will not operate the protection or damage the conductors.

Activity - 6 - Maximum demand of cooking appliances

Using Table C4 of AS 3000

Read the suggested text or resource

Write a response

List the assessed maximum demand from table C4 and calculate the current from the connected load for each load below.

1. Not greater than 5000W.		
2. 5000W to 8000W		
3. 8000W to 10000W		

Note Table C4 does not apply to cooking appliances in non domestic installations.

Topic 3 - Current requirements of final sub-circuits

To protect conductors from overload and short circuit faults protection devices such as circuit breakers or H.R.C. fuses are used. They must be able to carry the maximum demand continuously without operation, and still be able to detect an overload or short circuit and disconnect the circuit before the circuit conductors are damaged.

TABLE C4

UPSTREAM CIRCUIT LOADING AFTER DIVERSITY

Number of circuit-protection devices downstream	Diversity factor
2 and 3	0.9
4 and 5	0.8
6 to 9	0.7
10 or more	0.6

C2.5 Maximum demand in final subcircuits

C2.5.1 *General*

The maximum demand in final subcircuits is determined—

(a) for single items of equipment, by assessment of the connected load; or

(b) for multiple items of equipment, by limitation of the current rating of a circuit-breaker.

NOTE: Table C9 provides guidance on the loading of points per final subcircuit.

In some applications, the connected equipment may operate in a particular manner that allows for diversity to be applied. This includes welding machines (see Paragraph C2.5.2), domestic cooking appliances (Paragraph C2.5.3) and interlocked equipment (Paragraph C2.5.4).

C2.5.2 *Welding machines*

C2.5.2.1 *Definitions*

For the purpose of this Paragraph (C2.5.2), the following definitions apply:

(a) *Rated primary current*—

Activity - 7 - Devices for protection against both overload and short circuit.

Read AS 3000 Rule 2.5.2 Read the suggested text or resource	Write a response
List 4 circuit protection devices suitable to protect against both overload and short circuit conditions	a) ________ b) ________ c) ________ d) ________
Can a rewireable fuse to protect against overload and short circuit conditions? Yes/No	

When selecting the circuit protection device (C.B.) it is important to remember the protection device protects the cable not the load. Clause 2.5.3.1 provides the statement;

2.5.2 Devices for protection against both overload and short-circuit currents

Protective devices providing protection against both overload and shortcircuit current shall be capable of breaking any overcurrent up to and including the prospective short-circuit current at the point where the device is installed.

The device shall comply with the requirements of Clauses 2.5.3 and 2.5.4.

Exception: A protective device having a breaking capacity below the value of the prospective short-circuit current may be used in conjunction with another device in accordance with Clause 2.5.7.2.

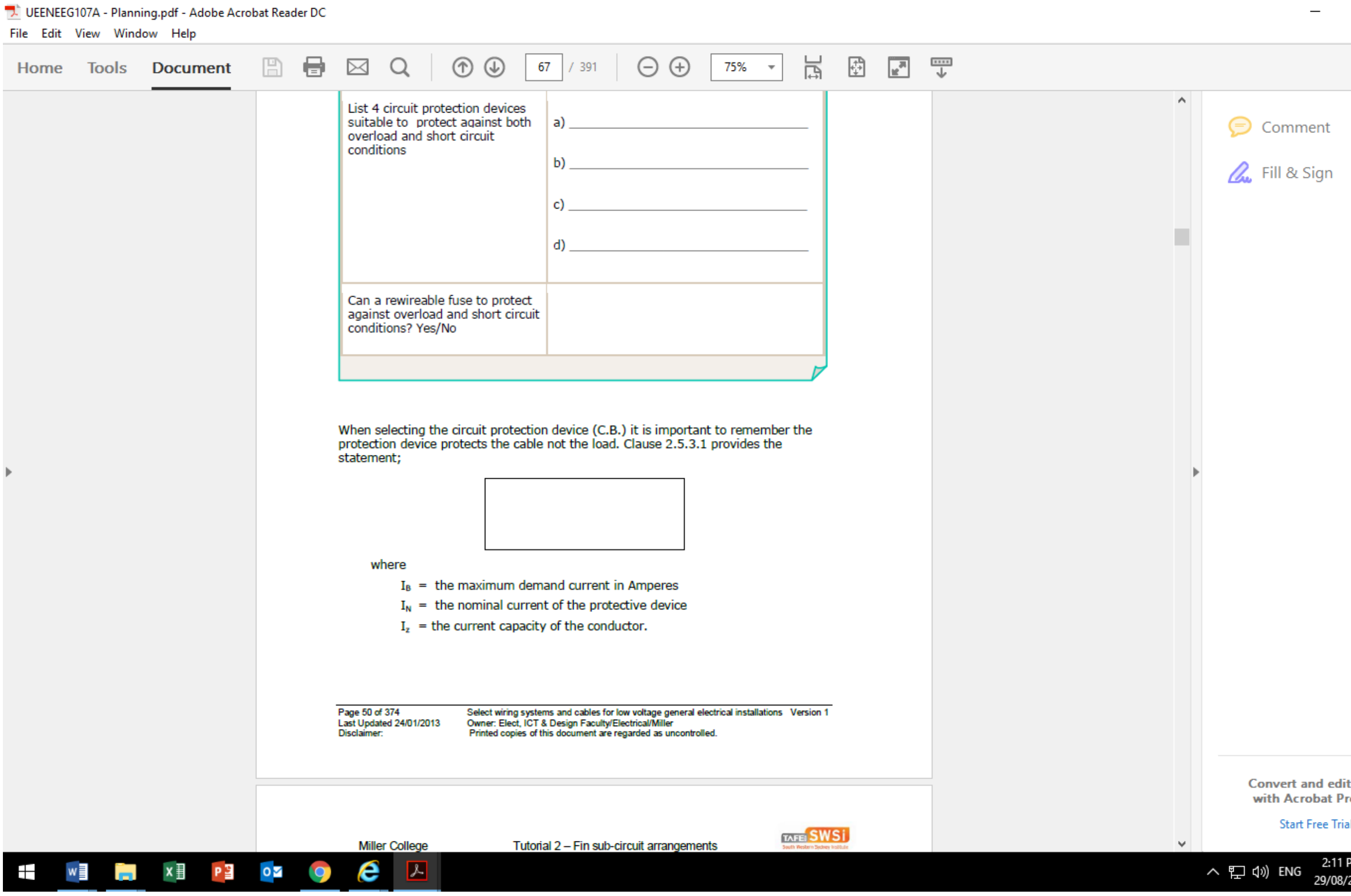
Protective devices may be one of the following:

(a) Circuit-breakers incorporating short-circuit and overload releases.

(b) Fuse-combination units (CFS units).

(c) Fuses having enclosed fuse-links (HRC fuses).

(a) (d) Circuit-breakers in conjunction with fuses.



acceptable. However, because of interchangeability with semi-enclosed rewireable fuse-carriers, such circuit-breakers should be rated at not more than 80% of the current-carrying capacity of the protected conductor.

* 4 Screw-type fuses of the enclosed type that meet the requirements of IEC 60269-3 System A Type D are acceptable.

2.5.3 Protection against overload current

2.5.3.1 *Coordination between conductors and protective devices*

The operating characteristics of a device protecting a conductor against overload shall satisfy the following two conditions:

$$I_B \leq I_N \leq I_Z \qquad \ldots 2.1$$

$$I_2 \leq 1.45 \times I_Z \qquad \ldots 2.2$$

where

I_B = the current for which the circuit is designed, e.g. maximum demand

I_N = the nominal current of the protective device

I_Z = the continuous current-carrying capacity of the conductor (see the AS/NZS 3008.1 series)

I_2 = the current ensuring effective operation of the protective device and may be taken as equal to either—

(a) the operating current in conventional time for circuit-breakers (1.45 I_N); or

(b) the fusing current in conventional time for fuses (1.6 I_N for fuses in accordance with the IEC 60269 series).

NOTES:

1 To satisfy Equation 2.2, the nominal current I_N of a fuse should not exceed 90% of I_Z (1.45/1.6 = 0.9), therefore—

for circuit-breakers Equation 2.1 applies

for HRC fuses $I_B \leq I_N \leq 0.9 I_Z$ . . . 2.3

Activity - 8 - Coordination between conductors and protective devices

Read AS 3000 Rule 2.5.3.1

Read the suggested text or resource

Write a response

Below are a number of load, circuit breaker and cable rating combinations. Do the following circuits comply with clause 2.5.3.1?

Maximum demand I_B	Protective device rating I_N	Conductor current carrying capacity I_Z	Complies **Yes/No**
10A	10A	10A	
18A	10A	13A	
32A	25A	33A	
40A	63A	40A	

If the circuit satisfies the equation $I_B \leq I_N \leq I_Z$ it will not operate the circuit protection under normal load. (Will it work?) See figure 1.

To ensure the circuit protection will operate in the case of an over current we use the equation;

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4 Screw-type fuses of the enclosed type that meet the requirements of IEC 60269-3 System A Type D are acceptable.

2.5.3 Protection against overload current

2.5.3.1 *Coordination between conductors and protective devices*

The operating characteristics of a device protecting a conductor against overload shall satisfy the following two conditions:

$$I_B \leq I_N \leq I_Z \qquad ...\ 2.1$$

$$I_2 \leq 1.45 \times I_Z \qquad ...\ 2.2$$

where

I_B = the current for which the circuit is designed, e.g. maximum demand

I_N = the nominal current of the protective device

I_Z = the continuous current-carrying capacity of the conductor (see the AS/NZS 3008.1 series)

I_2 = the current ensuring effective operation of the protective device and may be taken as equal to either—

(a) the operating current in conventional time for circuit-breakers (1.45 I_N); or

(b) the fusing current in conventional time for fuses (1.6 I_N for fuses in accordance with the IEC 60269 series).

NOTES:

1 To satisfy Equation 2.2, the nominal current I_N of a fuse should not exceed 90% of I_Z (1.45/1.6 = 0.9), therefore—

for circuit-breakers Equation 2.1 applies

for HRC fuses $I_B \leq I_N \leq 0.9 I_Z$ ... 2.3

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40A	63A	40A	

If the circuit satisfies the equation $I_B \leq I_N \leq I_Z$ it will not operate the circuit protection under normal load. (Will it work?) See figure 1.

To ensure the circuit protection will operate in the case of an over current we use the equation;

where

I_2 = the current ensuring effective operation of the protective device (operates in 1 hour) as shown in figure 1.

C.B.'s 1.45 x I_Z, fuses 1.6 x I_Z

I_z = the current capacity of the conductor.

Where the protection is a circuit breaker, if the equation $I_B \leq I_N \leq I_Z$ is true, so will this equation and the circuit will trip under over current conditions.

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rewireable fuse-carriers, such circuit-breakers should be rated at not more than 80% of the current-carrying capacity of the protected conductor.

* 4 Screw-type fuses of the enclosed type that meet the requirements of IEC 60269-3 System A Type D are acceptable.

2.5.3 Protection against overload current

2.5.3.1 *Coordination between conductors and protective devices*

The operating characteristics of a device protecting a conductor against overload shall satisfy the following two conditions:

$I_B \leq I_N \leq I_Z$ . . . 2.1

$I_2 \leq 1.45 \times I_Z$ . . . 2.2

where

I_B = the current for which the circuit is designed, e.g. maximum demand

I_N = the nominal current of the protective device

I_Z = the continuous current-carrying capacity of the conductor (see the AS/NZS 3008.1 series)

I_2 = the current ensuring effective operation of the protective device and may be taken as equal to either—

(a) the operating current in conventional time for circuit-breakers (1.45 I_N); or

(b) the fusing current in conventional time for fuses (1.6 I_N for fuses in accordance with the IEC 60269 series).

NOTES:

1 To satisfy Equation 2.2, the nominal current I_N of a fuse should not exceed 90% of I_Z (1.45/1.6 = 0.9), therefore—

for circuit-breakers Equation 2.1 applies

for HRC fuses $I_B \leq I_N \leq 0.9 I_Z$ . . . 2.3

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Where the protection is a circuit breaker, if the equation $I_B \leq I_N \leq I_Z$ is true, so will this equation and the circuit will trip under over current conditions.

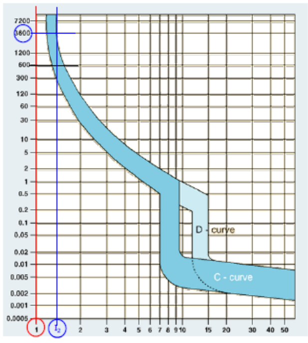

figure 1.- source www.clipsal.com

If a H.R.C. fuse is the protection device the cable rating (I_Z) must be de-rated to 90% of its original capacity eg. if the cable was originally rated at 20 Amperes the cable would only have a current caring a capacity of 18 Amperes (I_Z x 0.9) after it had been de-rated. Once de-rated I_N **is not less than** I_Z.

To ensure the fuse will operate in the case of an over current we use the equation;

where

I_B = the maximum demand current in Amperes

I_N = the nominal current of the protective device

I_z = the current capacity of the conductor.

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rewireable fuse-carriers, such circuit-breakers should be rated at not more than 80% of the current-carrying capacity of the protected conductor.

* 4 Screw-type fuses of the enclosed type that meet the requirements of IEC 60269-3 System A Type D are acceptable.

2.5.3 Protection against overload current

2.5.3.1 *Coordination between conductors and protective devices*

The operating characteristics of a device protecting a conductor against overload shall satisfy the following two conditions:

$I_B \leq I_N \leq I_Z$ . . . 2.1

$I_2 \leq 1.45 \times I_Z$ . . . 2.2

where

I_B = the current for which the circuit is designed, e.g. maximum demand

I_N = the nominal current of the protective device

I_Z = the continuous current-carrying capacity of the conductor (see the AS/NZS 3008.1 series)

I_2 = the current ensuring effective operation of the protective device and may be taken as equal to either—

(a) the operating current in conventional time for circuit-breakers (1.45 I_N); or

(b) the fusing current in conventional time for fuses (1.6 I_N for fuses in accordance with the IEC 60269 series).

NOTES:

1 To satisfy Equation 2.2, the nominal current I_N of a fuse should not exceed 90% of I_Z (1.45/1.6 = 0.9), therefore—

for circuit-breakers Equation 2.1 applies

for HRC fuses $I_B \leq I_N \leq 0.9 I_Z$ . . . 2.3

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Activity - 9 - Coordination between conductors and protective devices (fuse)

Write a response

Below are a number of load, fuse and cable rating combinations. Do the following circuits comply with clause 2.5.3.1?

Maximum demand I_B	Protective device rating I_N	Conductor current carrying capacity I_Z	Complies **Yes/No**
10A	10A	10A	
18A	20A	21A	
32A	32A	36A	
16A	12A	16A	

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Activity - 10 - De-rating factors

Write a response

List the required current carrying capacity of conductors protected by the following protection devices

Protection (I_N)	De-rating	Current carrying capacity (I_Z)
1. 20A C.B.		
2. 20A H.R.C. fuse		
3. 32A C.B.		
4. 32A H.R.C. fuse		
5. 40A H.R.C. fuse		

Cable Selection

When a conductor carries an electric current work is done to overcome the resistance of the conductor, as a result heat is produced. If the temperature rise in the cable exceeds safe limits the insulation of the cable will be permanently damaged.

Activity - 11 - Current Carrying Capacity

Read AS 3000 clause 3.4.1

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IEC 60269-3 System A Type D are acceptable.

2.5.3 Protection against overload current

2.5.3.1 *Coordination between conductors and protective devices*

The operating characteristics of a device protecting a conductor against overload shall satisfy the following two conditions:

$I_B \leq I_N \leq I_Z$ . . . 2.1

$I_2 \leq 1.45 \times I_Z$ . . . 2.2

where

I_B = the current for which the circuit is designed, e.g. maximum demand

I_N = the nominal current of the protective device

I_Z = the continuous current-carrying capacity of the conductor (see the AS/NZS 3008.1 series)

I_2 = the current ensuring effective operation of the protective device and may be taken as equal to either—

(a) the operating current in conventional time for circuit-breakers (1.45 I_N); or

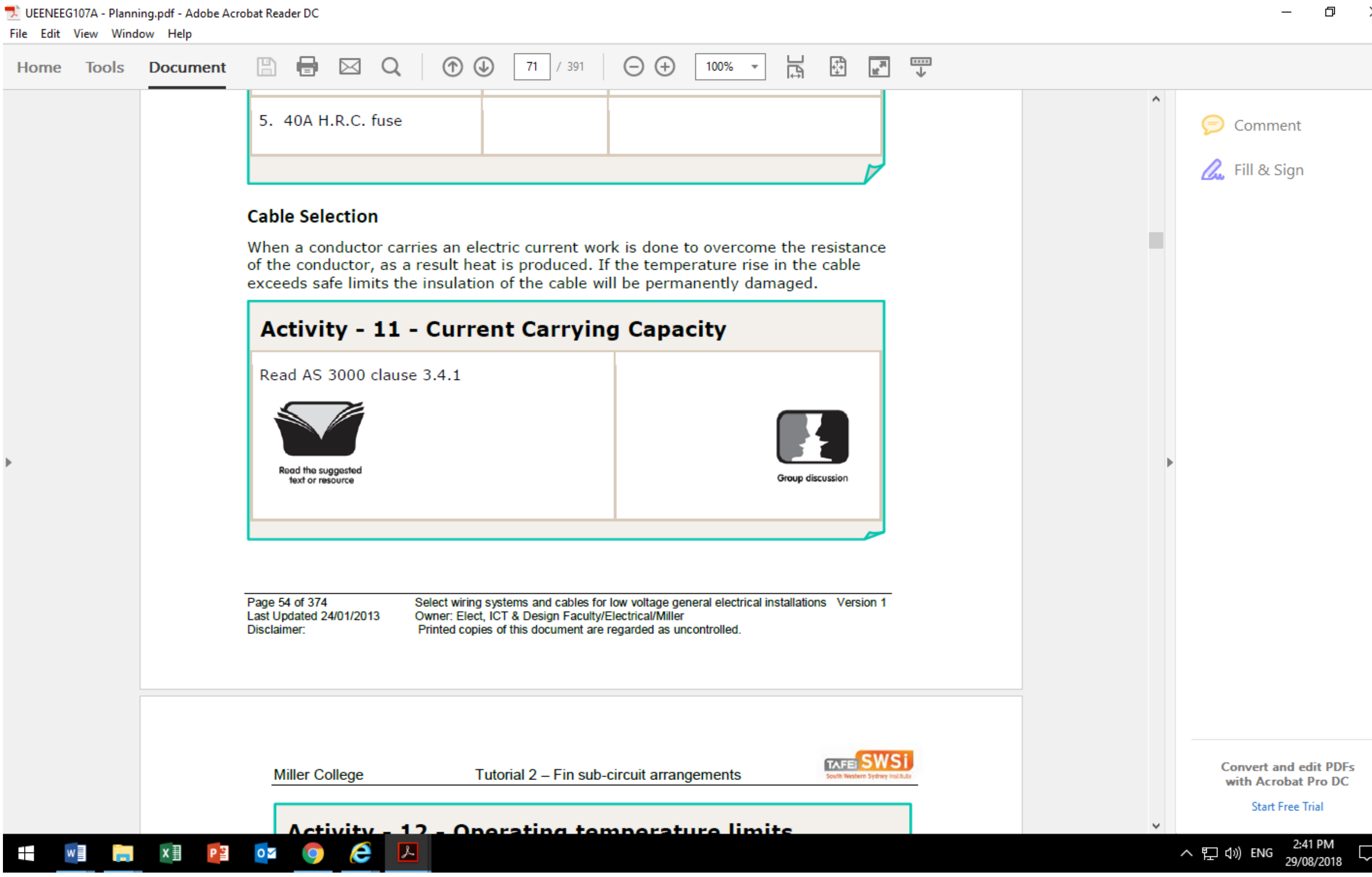
(b) the fusing current in conventional time for fuses (1.6 I_N for fuses in accordance with the IEC 60269 series).

NOTES:

1 To satisfy Equation 2.2, the nominal current I_N of a fuse should not exceed 90% of I_Z (1.45/1.6 = 0.9), therefore—

for circuit-breakers Equation 2.1 applies

for HRC fuses $I_B \leq I_N \leq 0.9 I_Z$ . . . 2.3



5. 40A H.R.C. fuse		

Cable Selection

When a conductor carries an electric current work is done to overcome the resistance of the conductor, as a result heat is produced. If the temperature rise in the cable exceeds safe limits the insulation of the cable will be permanently damaged.

Activity - 11 - Current Carrying Capacity

Read AS 3000 clause 3.4.1

Activity - 12 - Operating temperature limits

3.4 CURRENT-CARRYING CAPACITY

3.4.1 General

Every conductor shall have a current-carrying capacity in accordance with the AS/NZS 3008.1 series, not less than the current to be carried by the conductor.

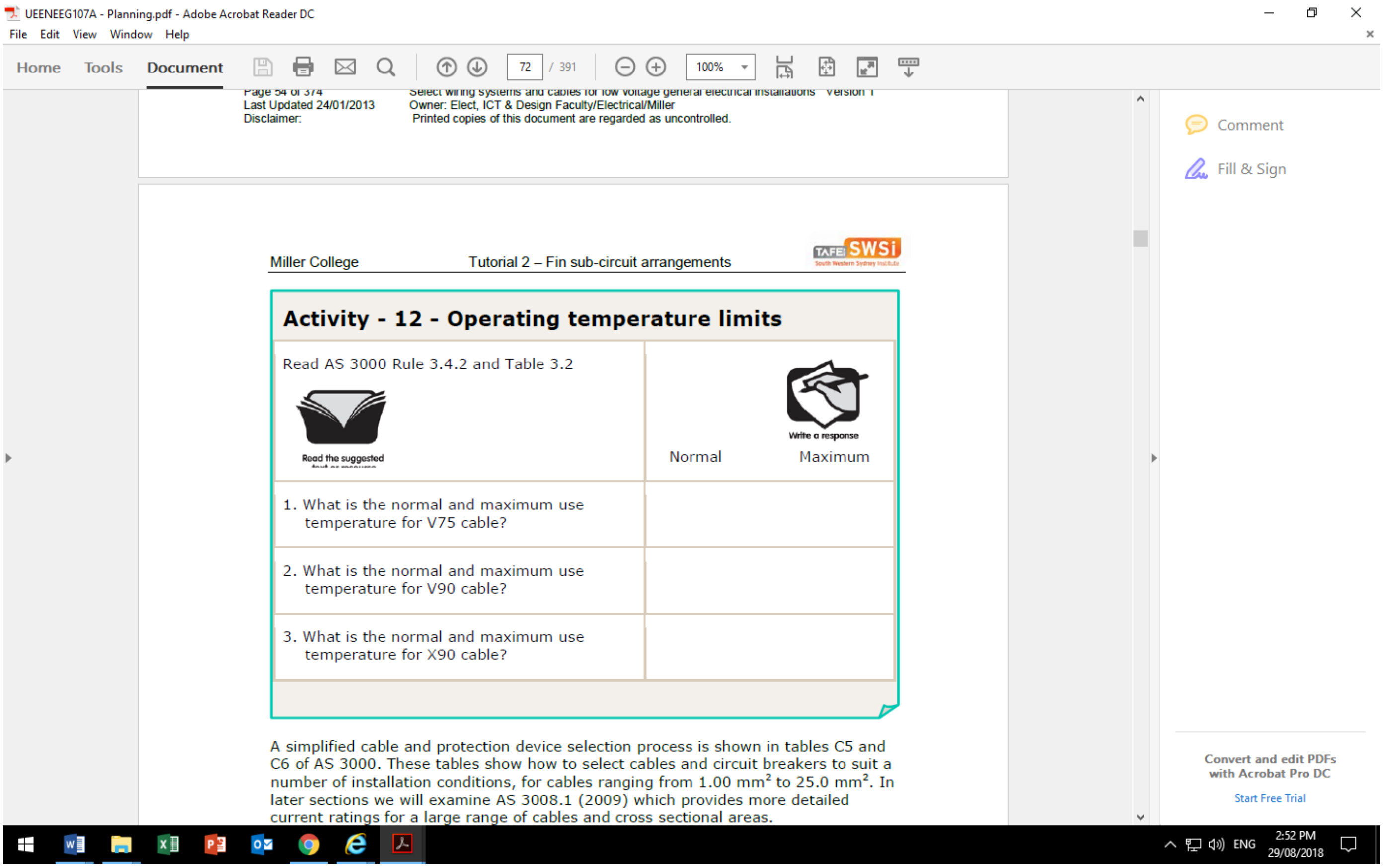
In determining the required current-carrying capacity, provision shall be made for reasonably foreseeable changes to external influences, such as the installation of thermal insulation in ceiling spaces and walls.

* Wiring systems in domestic installations shall be installed on the assumption that thermal insulation in ceilings, walls and under floors, if not currently installed, will be installed in the future.

NOTES:

1 Appendix C, Paragraph C3 provides a set of current ratings that may be assigned to circuits in typical simple installations as an alternative to compliance with the AS/NZS 3008.1 series. The ratings assign cable current-carrying capacities that are aligned with the current rating of protective devices.

2 National building codes contain mandatory requirements for the thermal insulation of ceilings and walls in certain situations.
3 The AS/NZS 5000 series of cable standards provide higher operating temperature materials for some cable insulation than was the case with their predecessors.
4 Current-carrying capacities for busbars and busways should be obtained from the manufacturer. Information relating to busways is given in AS/NZS 3439.2 or AS/NZS 61439.6.



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Activity - 12 - Operating temperature limits

Read AS 3000 Rule 3.4.2 and Table 3.2	Normal	Maximum
1. What is the normal and maximum use temperature for V75 cable?		
2. What is the normal and maximum use temperature for V90 cable?		
3. What is the normal and maximum use temperature for X90 cable?		

A simplified cable and protection device selection process is shown in tables C5 and C6 of AS 3000. These tables show how to select cables and circuit breakers to suit a number of installation conditions, for cables ranging from 1.00 mm² to 25.0 mm². In later sections we will examine AS 3008.1 (2009) which provides more detailed current ratings for a large range of cables and cross sectional areas.

3.4.2 Operating temperature limits
The operating temperatures of conductors shall not exceed the limits given in Table 3.2.
Polymeric cables with normal use temperatures below 75° C (see Notes to Table 3.2) are deemed not suitable for Australian or New Zealand conditions.

TABLE 3.2
LIMITING TEMPERATURES FOR INSULATED CABLES

Type of cable insulation(1)	Operating temperature of conductor, °C		
	Normal use(2)	Maximum permissible(7)	Minimum ambient(3)
Thermoplastic(4)			
V-75	75	75	0
HFI-75-TP, TPE-75	75	75	−20
V-90	75	90	0
HFI-90-TP, TP-90	75	90	−20
V-90HT	75	105	0
Elastomeric			
R-EP-90	90	90	−40
R-CPE-90, R-HF-90, R-CSP-90	90	90	−20
R-HF-110, R-E-110	110	110	*
R-S-150	150	150	−50
Cross-linked polyethylene			
X-90, X-90UV, X-HF-90	90	90	*
X-HF-110	110	110	*
MIMS(5)	100	250	(6)
Other types			
PE, LLDPE	70	70	*

* Refer to manufacturer's information.

NOTES:

1 The types of cable insulation given in Table 3.2 are included in relevant specifications, i.e. the AS/NZS 5000 series, AS/NZS 3191, AS/NZS 3808 and AS/NZS 60702.1.

2 Lower maximum temperatures will apply where materials used in the construction of the cables or in association therewith, such as coverings, sheathings, insulating sleeving on connections and sealing compounds, have maximum operating

Activity - 13 - Circuit protection and cable selection

Using Table C5 AS 3000 Read the suggested text or resource	Write a response
1. What is the maximum rating of a C.B. protecting a $2.5mm^2$ cable installed in air.	
2. What is the maximum rating of a C.B. protecting a $2.5mm^2$ cable installed partially surrounded by thermal insulation.	
3. What is the maximum rating of a C.B. protecting a $2.5mm^2$ cable installed enclosed in an underground conduit.	
4. What is the maximum rating of a C.B. protecting a $4.0\ mm^2$ cable installed enclosed in air.	
5. What is the maximum rating of a C.B. protecting a $6.0\ mm^2$ cable installed completely surrounded by thermal insulation.	

(a) an individual appliance using the energy rating of the appliance; or

(b) more than one appliance, e.g. separate oven and hotplates using the total energy rating of the appliances.

TABLE C5

MAXIMUM DEMAND—DOMESTIC COOKING APPLIANCES

Appliance full-load energy rating per phase	Assessed maximum demand
Not greater than 5000 W	16 A
Greater than 5000 W but not greater than 8000 W	20 A
Greater than 8000 W but not greater than 10 000 W	25 A
Greater than 10 000 W but not greater than 13 000 W	32 A
Greater than 13 000 W	40 A

C2.5.4 *Interlocked equipment*

Where more than one item of equipment is connected to the same final subcircuit, but is interlocked so that only a limited number of items can be connected at one time, e.g. duty and stand-by arrangements, the maximum demand may be assessed from the combination of items that presents the highest simultaneous load.

C3 SIMPLIFIED PROTECTIVE DEVICE SELECTION

As specified in Clause 3.4, the current-carrying capacity of cables is required to be determined from the AS/NZS 3008.1 series. These Standards provide a comprehensive set of tables and calculation methods taking into account different cable/conductor types, installation methods and external influences.

Activity - 14 - Circuit protection and cable selection

Using Table C6 AS 3000

Read the suggested text or resource

Write a response

1. What is the maximum rating of a C.B. protecting a 2.5mm² four core and earth, circular cable installed enclosed in air.

2. What is the maximum rating of a C.B. protecting a 4.0 mm² four core and earth, circular cable installed in air.

3. What is the maximum rating of a C.B. protecting a 6.0 mm² four core and earth, circular cable installed enclosed in the ground.

4. What is the maximum rating of a C.B. protecting a 4.0 mm² cable installed enclosed in air.

5. What is the maximum rating of a C.B. protecting a 10.0 mm² cable installed completely surrounded by thermal insulation.

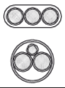
circuit by the selection of appropriately rated protective devices.

Tables C6 and C7 provide guidance on the selection of protective devices suitable for use with cables of cross-sectional area from 1 mm² to 25 mm², for single-phase and three-phase cable applications respectively, under a range of installation conditions.

TABLE C6

SIMPLIFIED PROTECTIVE DEVICE SELECTION FOR CABLES FROM 1 mm² TO 25 mm² USED IN SINGLE-PHASE APPLICATIONS

Cable type—PVC insulated and sheathed cables, two-core and earth marked V-90



Cable cross-sectional area mm²	Protective device rating (I_n) A — Unenclosed: In air	Unenclosed: In thermal insulation partially surrounded	Unenclosed: In thermal insulation completely surrounded	Enclosed: In air	Enclosed: In ground (see Note 3)
1	16	10	8	13	16
1.5	20	16	10	16	20
2.5	25	20	16	20	32
4	32	25	20	25	40
6	40	32	25	32	50
10	63	50	32	50	63
16	80	63	40	63	80
25	100	80	50	80	100

NOTES TO TABLES C6 AND C7:

1 Protective device ratings (I_n) have been assigned to align with typical current-carrying capacity (I_z) figures for flat and circular cables in AS/NZS 3008.1.1 for Australian conditions. The same ratings can be conservatively applied to New Zealand conditions.

Activity - 15 - Final sub-circuit design

A single phase house is wired using T.P.S. cable has the following load installed

- Complete the table below

22 - Light points wiring installed clipped to timbers in the roof

24 - Double 10A Socket Outlets wiring installed clipped to timbers in the roof

1 - 15A socket outlet for a split system A/C wiring installed clipped to timbers in the roof.

1 - 6.0 kW cook top wiring installed clipped to timbers under the floor

1 - 3.9 kW wall oven wiring installed clipped to timbers under the floor

1 - 4.4 kW storage H.W.S. wiring installed enclosed in conduit in air.

Circuit number	Purpose	Cable C.S.A.	Protection Device / Rating (A)	Number of points per circuit
1				
2				
3				
4				
5				

TABLE C9

GUIDANCE ON THE LOADING OF POINTS PER FINAL SUBCIRCUIT

Cable cross-sectional area[1] mm²	Rating of circuit-breaker[1] A	Contribution of each point (A) (sum not to exceed rating of circuit-breaker): Lighting points[6]	10 A single-phase or multiphase socket-outlets[3, 7, 8, 9]: Non-domestic installations without permanent airconditioning	10 A single-phase or multiphase socket-outlets[3, 7, 8, 9]: All domestic installations and non-domestic installations with permanent airconditioning	15 A single-phase or multi-phase socket-outlets[8, 9]	20 A single-phase or multi-phase socket-outlets[8, 9]	Permanently connected fixed or stationary appliances[6, 10] or water heaters	Maximum connected load for a range[4, 5] W
1	6	0.5	NP	NP	NP	NP	Connected load	NP
1	8	0.5	NP	NP	NP	NP		NP
1	10	0.5	NP	NP	NP	NP		NP
1	13	0.5	NP	NP	NP	NP		NP
1	16	0.5	NP	NP	NP	NP		NP
1.5	8	0.5	NP	NP	NP	NP		NP
1.5	10	0.5	NP	NP	NP	NP		NP
1.5	13	0.5	NP	NP	NP	NP		NP
1.5	16	0.5	NP	NP	NP	NP		5000
1.5	20	0.5	NP	NP	NP	NP		5000
2.5	10	0.5	NP	NP	NP	NP		NP
2.5	13	0.5	2	1	NP	NP		NP
2.5	16	0.5	2	1	15	NP		5000
2.5	20	0.5	2	1	12	20		8000
2.5	25	0.5	2	1	10	18		8000

(continued)

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TABLE C9 *(continued)*

Cable cross-sectional area[1] mm²	Rating of circuit-breaker[1] A	Contribution of each point (A) (sum not to exceed rating of circuit-breaker): Lighting points[6]	10 A single-phase or multiphase socket-outlets[3, 7, 8, 9]: Non-domestic installations without permanent airconditioning	10 A single-phase or multiphase socket-outlets[3, 7, 8, 9]: All domestic installations and non-domestic installations with permanent airconditioning	15 A single-phase or multi-phase socket-outlets[8, 9]	20 A single-phase or multi-phase socket-outlets[8, 9]	Permanently connected fixed or stationary appliances[6, 10] or water heaters	Maximum connected load for a range[4, 5] W
2.5	32	0.5	2	1	8	16		10 000
4	16	0.5	2	1	15	NP		5000
4	20	0.5	2	1	12	20		8000
4	25	0.5	2	1	10	18		10 000
4	32	0.5	2	1	8	16		10 000
6[2]	20	0.5	2	1	12	20		10 000
6[2]	25	0.5	2	1	10	18		10 000
6[2]	32	0.5	2	1	8	16		13 000
10[2]	32	0.5	2	1	8	16		13 000
10[2]	40	0.5	2	1	8	16		>13 000

NP = denotes socket-outlets not permitted on these circuits

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Activity - 16 - Final sub-circuit design

A three phase house is wired using T.P.S. cable and orange circular has the following load installed

- Complete the table below

Write a response

48 - Light points wiring installed clipped to timbers in the roof.
30 - Double 10A Socket Outlets wiring installed clipped to timbers in the roof.
2 - 3 in one Fan/heat lamps (4 x 275 W) clipped to timbers in the roof.
1 - 18A 3 Φ ducted A/C wiring installed enclosed in conduit in air.
1 - 7.8 kW 1 Φ range wiring installed clipped to timbers under the floor
1 - 22.0 kW 3 Φ spa heater, wiring installed enclosed in conduit in air.
1 - 3.6 kW Sauna wiring installed clipped to timbers in the roof
1 - 4.4 kW storage H.W.S. wiring installed enclosed in conduit in air.

Circuit number	Purpose	Cable C.S.A.	Protection Device / Rating (A)	Number of points per circuit
1				
2				
3				
4				

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Activity - 16 - Final sub-circuit design (cont'd)

Circuit number	Purpose	Cable C.S.A.	Protection Device / Rating (A)	Number of points per circuit
7				
8				
9				
10				

Activity - 17 - Final sub-circuit design

A three phase factory unit is wired using T.P.S. and orange circular cable, has the following load installed

- Complete the table below

Write a response

16 - MH Hi-bay Lights (1.25A each) split over two circuits unenclosed in air.
24 - Twin 36W Fluorescent lights (0.333 A each) unenclosed in air.
15 - 10A double socket outlets wiring installed enclosed in conduit in air.
3 - 32A 3 Φ socket outlets wiring installed enclosed in conduit in air.
1 - Hard wired machine 54A / phase installed enclosed in conduit in air.
2 - Hard wired machines 34A / phase enclosed in conduit in air.
1 - 4.4 kW H.W.S. wiring installed enclosed in conduit in air.

Circuit number	Purpose	Cable C.S.A.	Protection Device / Rating (A)	Number of points per circuit
1				
2				
3				
4				

Do in class

Activity - 15 - Final sub-circuit design

A single phase house is wired using T.P.S. cable has the following load installed

- Complete the table below

Write a response

22 - Light points wiring installed clipped to timbers in the roof
24 - Double 10A Socket Outlets wiring installed clipped to timbers in the roof
1 - 15A socket outlet for a split system A/C wiring installed clipped to timbers in the roof.
1 - 6.0 kW cook top wiring installed clipped to timbers under the floor
1 - 3.9 kW wall oven wiring installed clipped to timbers under the floor
1 - 4.4 kW storage H.W.S. wiring installed enclosed in conduit in air.

Circuit number	Purpose	Cable C.S.A.	Protection Device / Rating (A)	Number of points per circuit
1				
2				
3				
4				

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Pos.	Amps	Designation	Pos.	Amps	Designation
1	32	Lighting Distribution Board No. 01 (Kitchen Pantry)	2	20	Spare
3	32	Lighting Distribution Board No. 01(Kitchen Pantry)	4	20	Spare
5	32	Lighting Distribution Board No. 01 (Kitchen Pantry)	6	20	Spare
7	32	Lighting Distribution Board No. 02 (First Floor Study)	8	20	Kitchen – Dishwasher GPO (RCD)
9	32	Lighting Distribution Board No. 02(First Floor Study)	10	20	Kitchen – Steam Oven GPO (RCD)
11	32	Lighting Distribution Board No. 02 (First Floor Study)	12	20	Kitchen – Microwave GPO (RCD)
13	25	10 HP Daikin Air Conditioning Unit No. 01	14	20	Kitchen – Bench GPO's (RCD)
15	25	10 HP Daikin Air Conditioning Unit No. 01	16	20	Spare
17	25	10 HP Daikin Air Conditioning Unit No. 01	18	20	Ground Floor – General GPO's (RCD)
19	25	10 HP Daikin Air Conditioning Unit No. 02	20	20	Ground Floor – General GPO's (RCD)
21	25	10 HP Daikin Air Conditioning Unit No. 02	22	20	Ground Floor – Home Theatre GPO's (RCD)
23	25	10 HP Daikin Air Conditioning Unit No. 02	24	20	Ground Floor – Garage GPO's (RCD)
25	20	Sauna Heater – Squash Area	26	20	Ground Floor – Squash GPO's (RCD)
27	20	Sauna Heater – Squash Area	28	20	Spare
29	20	Sauna Heater – Squash Area	30	20	First Floor – General GPO's (RCD)
31	20	Spare TP MCB	32	20	First Floor – General GPO's (RCD)
33	20	Spare TP MCB	34	20	Spare
35	20	Spare TP MCB	36	20	Front Gate – GPO (RCD)
37	20	1 x 3.6kW Heat Pump Hot Water Unit (Squash)	38	20	Pool – GPO's (RCD)
39	32	Kitchen – Electric Induction Cook-top	40	20	First Floor – Spa GPO (RCD)
41	25	Kitchen – Electric Wall Oven	42	20	Tennis Court Future – GPO's (RCD)
43			44	20	Spare
45	10	Dimmer 1 (RCD)	46	20	Spare
47	10	Dimmer 2 (RCD)	48	20	Spare
49	10	Dimmer's 3 & 4. (RCD)	50		
51	10	Dimmer's 5 & 15. (RCD)	52		
53	10	Relay 1 (RCD)	54		
55	10	Relay 2 (RCD)	56		
57	10	Relay 3 (RCD)	58		
59	10	Relay's 7, 8 & 9. (RCD)	59		

figure 2.

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- voltage drop considerations,
- and fault loop impedance;
- cost.

Activity - 1 - Cable selection and installation.

Read AS 3000 clause 3.1.2

Read the suggested text or resource

Group discussion

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Activity - 2 - Installation conditions.

Read AS 3000 Table 3.1 	
Give examples of cables installed; Unenclosed • On a surface • On a surface partly surrounded by thermal insulation • On a surface fully surrounded by thermal insulation • Buried direct in the ground	
In an enclosure • On a surface • On a surface and partly surrounded by thermal insulation • Fully surrounded by thermal insulation • Underground,	
Supported on a catenary system	
Supported on insulators	

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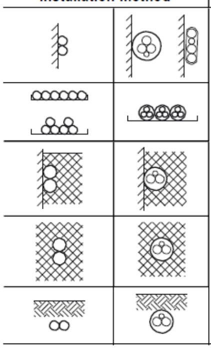
TABLE 3.1

CABLE TYPES AND THEIR APPLICATION IN WIRING SYSTEMS



Installation method		Description	Typical cable types
(see drawings)	Unenclosed	On a surface (including cable tray or ladder)	Insulated and sheathed Screened or armoured Mineral insulated, metal sheathed (MIMS) Earthing conductors
		On a surface partly surrounded by thermal insulation	
		Fully surrounded by thermal insulation	
		Buried direct in the ground, subject to the requirements of Clause 3.11	Insulated and sheathed, screened or armoured, earthing conductors

(continued)

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TABLE 3.1 *(continued)*

Installation method	Description		Typical cable types
	In an enclosure	On a surface (including cable trunking)	Insulated, unsheathed Insulated and sheathed Screened or armoured MIMS Earthing conductors
		On a surface and partly surrounded by thermal insulation	
		Fully surrounded by thermal insulation	
		Underground, subject to the requirements of Clause 3.11	Insulated, unsheathed Insulated and sheathed Screened or armoured Earthing conductors
	Supported on a catenary system		Insulated and sheathed Screened or armoured Earthing conductors
	Supported on insulators		Aerial conductors Earthing conductors

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Activity - 2 - External Factors.

Read AS 3000 section 3.3

1. List 12 External factors that need to be considered in the design of an electrical installation.

a) ____________________
b) ____________________
c) ____________________
d) ____________________
e) ____________________
f) ____________________
g) ____________________
h) ____________________
i) ____________________
j) ____________________
k) ____________________
l) ____________________

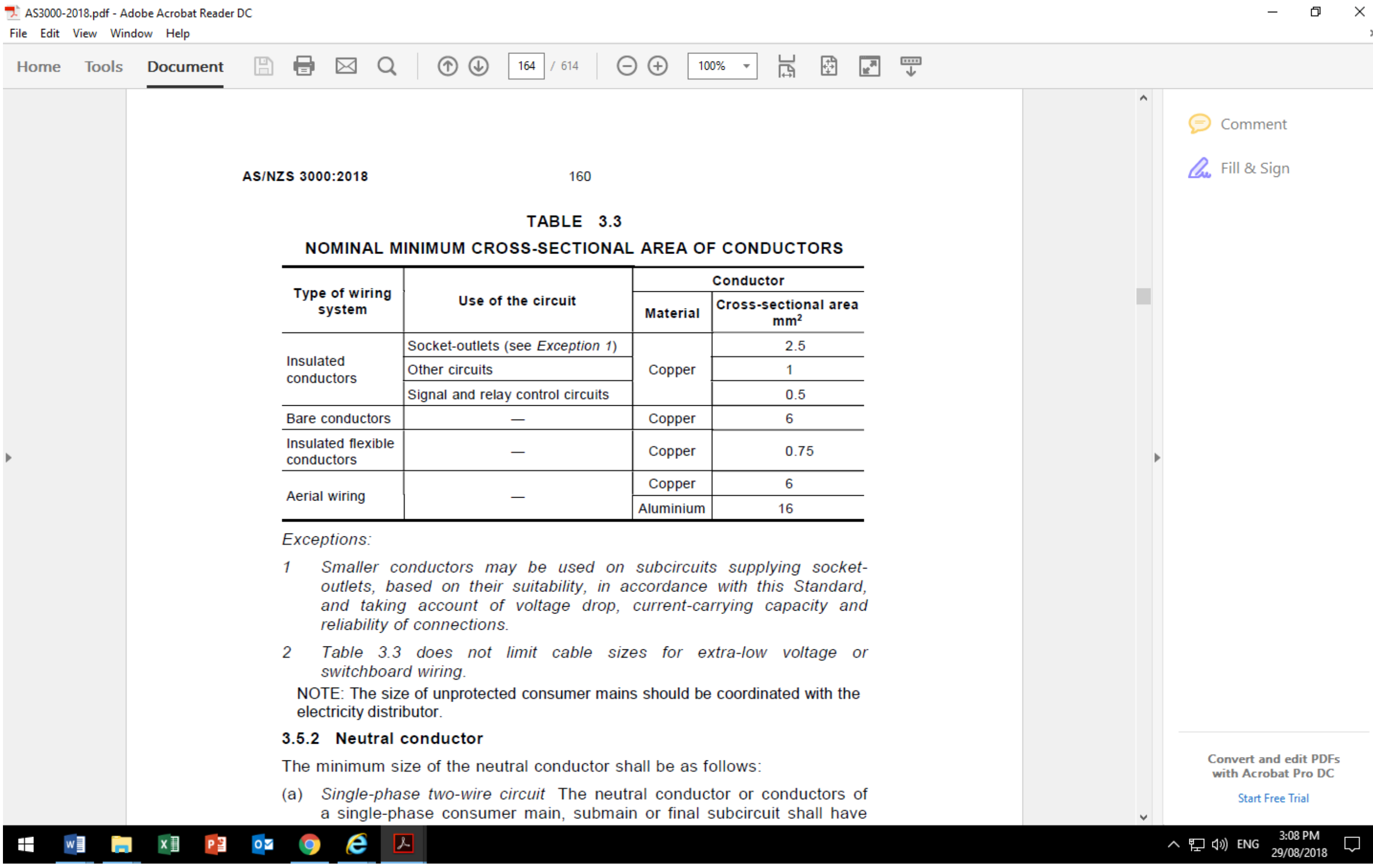
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TABLE 3.3

NOMINAL MINIMUM CROSS-SECTIONAL AREA OF CONDUCTORS

Type of wiring system	Use of the circuit	Conductor	
		Material	Cross-sectional area mm²
Insulated conductors	Socket-outlets (see *Exception 1*)	Copper	2.5
	Other circuits		1
	Signal and relay control circuits		0.5
Bare conductors	—	Copper	6
Insulated flexible conductors	—	Copper	0.75
Aerial wiring	—	Copper	6
		Aluminium	16

Exceptions:

1 *Smaller conductors may be used on subcircuits supplying socket-outlets, based on their suitability, in accordance with this Standard, and taking account of voltage drop, current-carrying capacity and reliability of connections.*

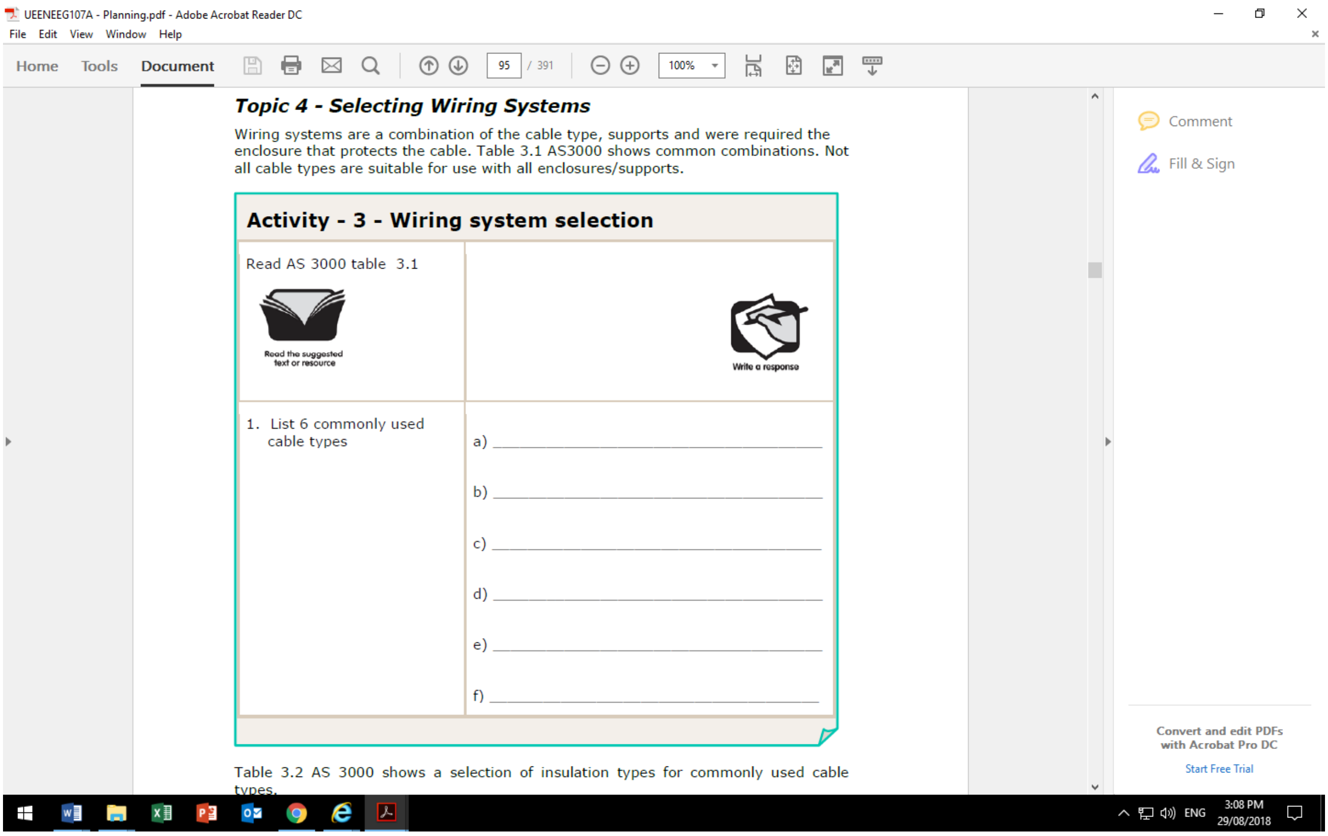
2 *Table 3.3 does not limit cable sizes for extra-low voltage or switchboard wiring.*

NOTE: The size of unprotected consumer mains should be coordinated with the electricity distributor.

3.5.2 Neutral conductor

The minimum size of the neutral conductor shall be as follows:

(a) *Single-phase two-wire circuit* The neutral conductor or conductors of a single-phase consumer main, submain or final subcircuit shall have


Topic 4 - Selecting Wiring Systems

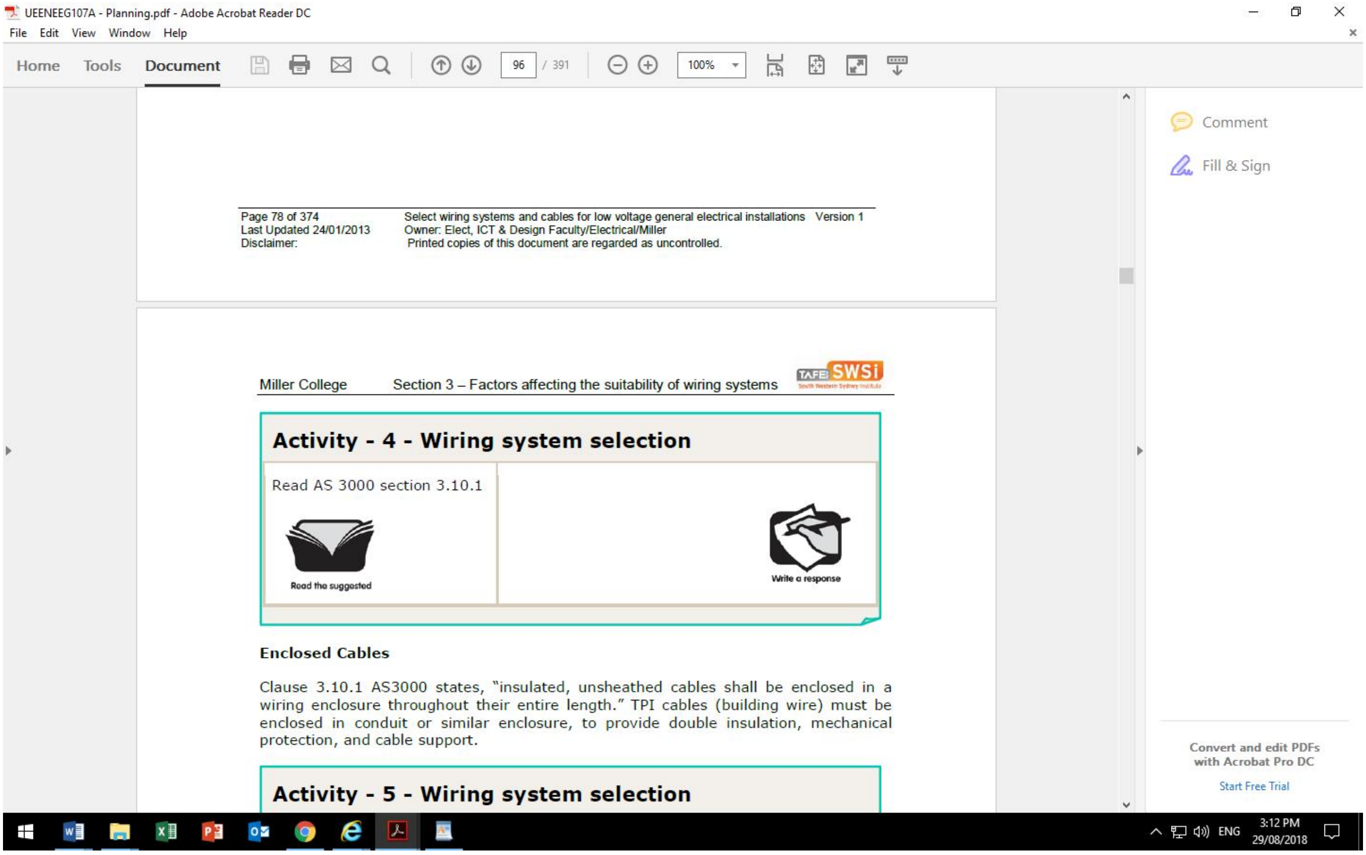
Wiring systems are a combination of the cable type, supports and were required the enclosure that protects the cable. Table 3.1 AS3000 shows common combinations. Not all cable types are suitable for use with all enclosures/supports.

Activity - 3 - Wiring system selection

Read AS 3000 table 3.1 Read the suggested text or resource	Write a response
1. List 6 commonly used cable types	a) ____ b) ____ c) ____ d) ____ e) ____ f) ____

Table 3.2 AS 3000 shows a selection of insulation types for commonly used cable types.

Insulated, unsheathed, Insulated and sheathed, Screened or armoured, MIMS, Earthing conductors, Aerial conductors



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Miller College Section 3 – Factors affecting the suitability of wiring systems

Activity - 4 - Wiring system selection

Read AS 3000 section 3.10.1

Enclosed Cables

Clause 3.10.1 AS3000 states, "insulated, unsheathed cables shall be enclosed in a wiring enclosure throughout their entire length." TPI cables (building wire) must be enclosed in conduit or similar enclosure, to provide double insulation, mechanical protection, and cable support.

Activity - 5 - Wiring system selection

3.10 ENCLOSURE OF CABLES

3.10.1 General

3.10.1.1 Insulated, unsheathed cables

Insulated, unsheathed cables shall be enclosed in a wiring enclosure throughout their entire length.

Exceptions: Wiring enclosures need not be provided for insulated, unsheathed cables installed as follows:

1 As aerial conductors, in accordance with Clause 3.12.

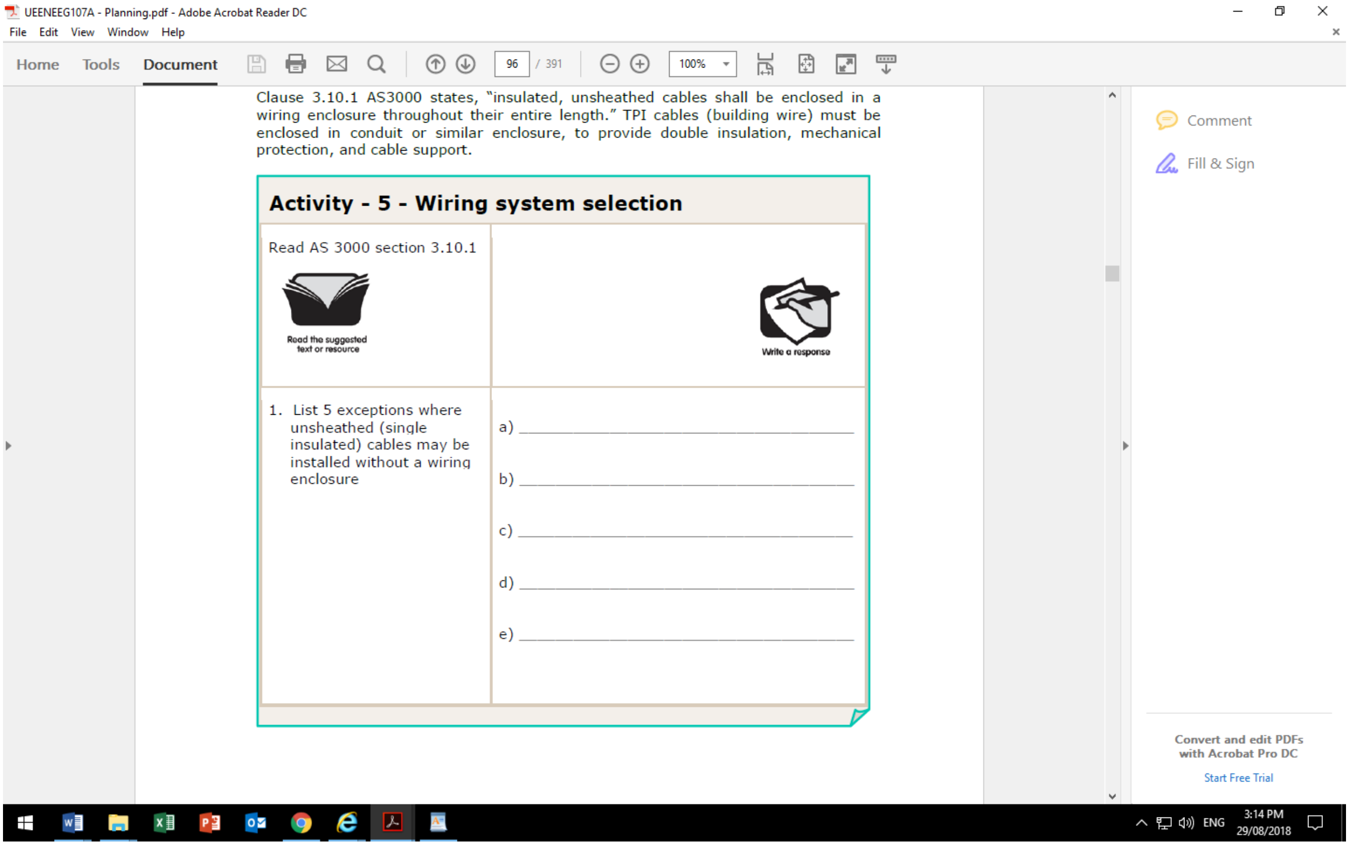
2 In an enclosed wall cavity between an accessory and a wiring enclosure or sheathing terminated within 100 mm of the hole over or within which the accessory is mounted.

NOTE: This exception does not apply within a roof space.

3 Within switchboards, metering and similar enclosures, provided that such cables are not exposed to touch during normal switching or meter-reading operations.

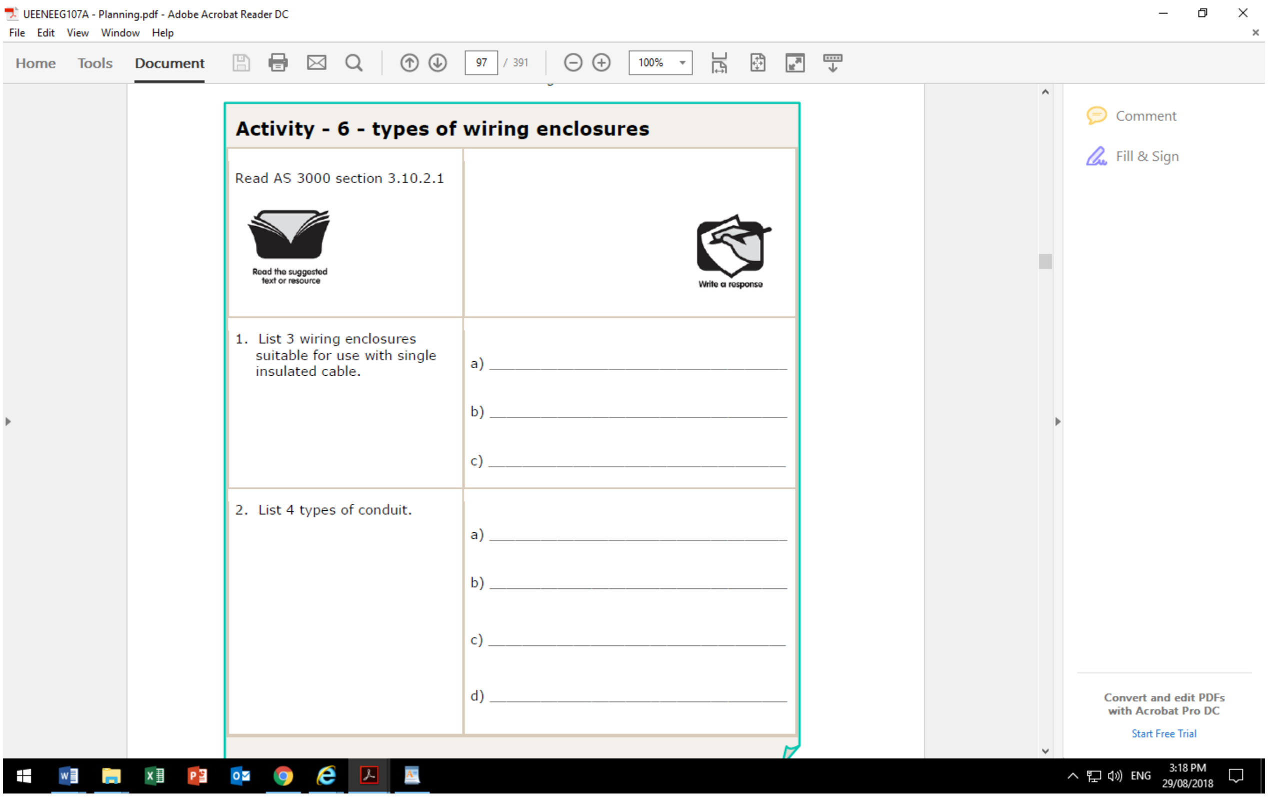
4 As earthing or equipotential bonding conductors installed in accordance with Section 5.

5 As an extra-low voltage circuit, in accordance with Clause 7.5.



Clause 3.10.1 AS3000 states, "insulated, unsheathed cables shall be enclosed in a wiring enclosure throughout their entire length." TPI cables (building wire) must be enclosed in conduit or similar enclosure, to provide double insulation, mechanical protection, and cable support.

Activity - 5 - Wiring system selection	
Read AS 3000 section 3.10.1 Read the suggested text or resource	Write a response
1. List 5 exceptions where unsheathed (single insulated) cables may be installed without a wiring enclosure	a) __________ b) __________ c) __________ d) __________ e) __________



Activity - 6 - types of wiring enclosures	
Read AS 3000 section 3.10.2.1 Read the suggested text or resource	Write a response
1. List 3 wiring enclosures suitable for use with single insulated cable.	a) __________ b) __________ c) __________
2. List 4 types of conduit.	a) __________ b) __________ c) __________ d) __________

3.10.2 Wiring enclosures

3.10.2.1 Types

The following types of wiring enclosures may be used for the protection of cables requiring enclosure as specified in Clause 3.10.1:

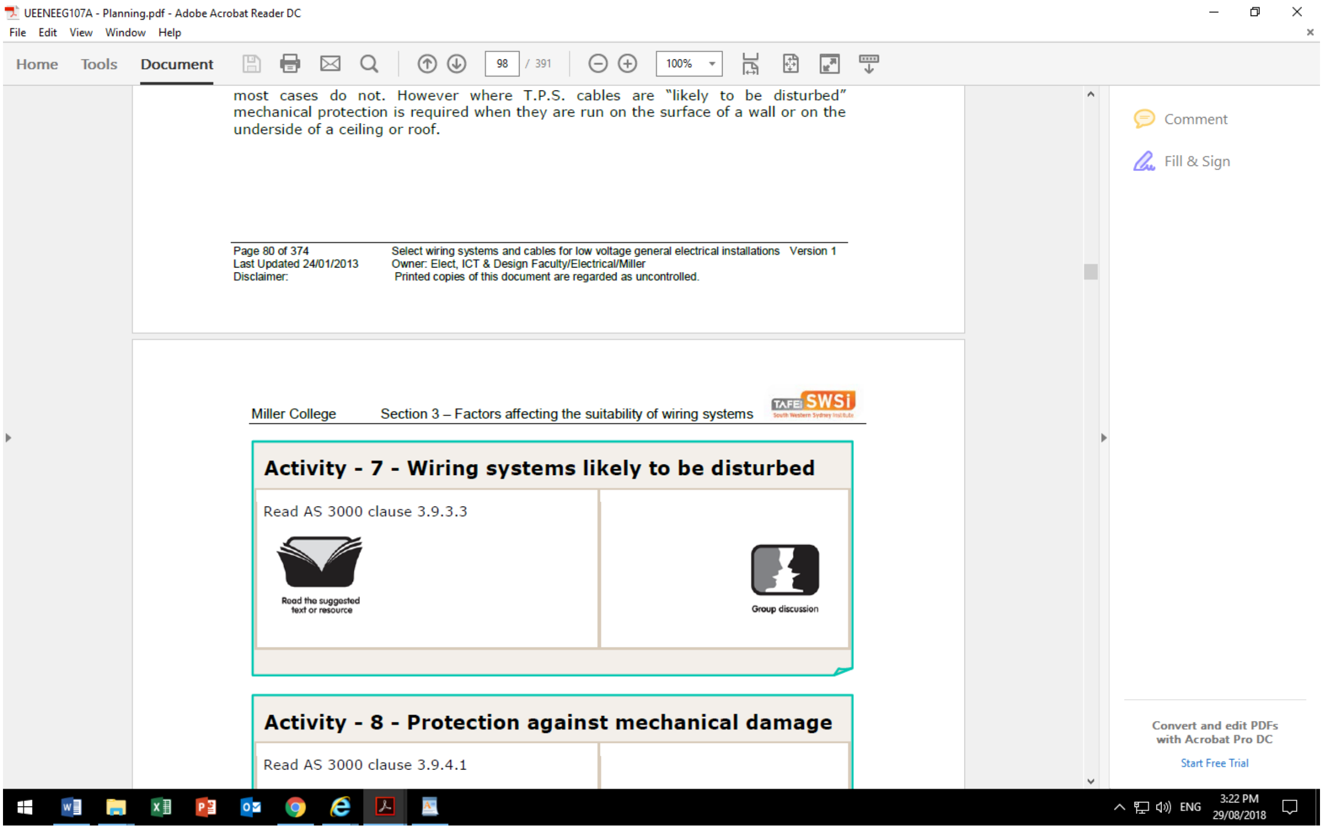
* (a) Conduits in accordance with AS/NZS 2053 series or the AS/NZS 61386 series, including—

(i) steel conduits or other metal tubing or conduit;

(ii) flexible metal conduit;

(iii) rigid and flexible insulating conduit; and

(iv)corrugated insulating conduit.



3.9.3.3 Wiring systems likely to be disturbed

3.9.3.3.1 Location

Wiring systems installed in the following locations are deemed likely to be disturbed:

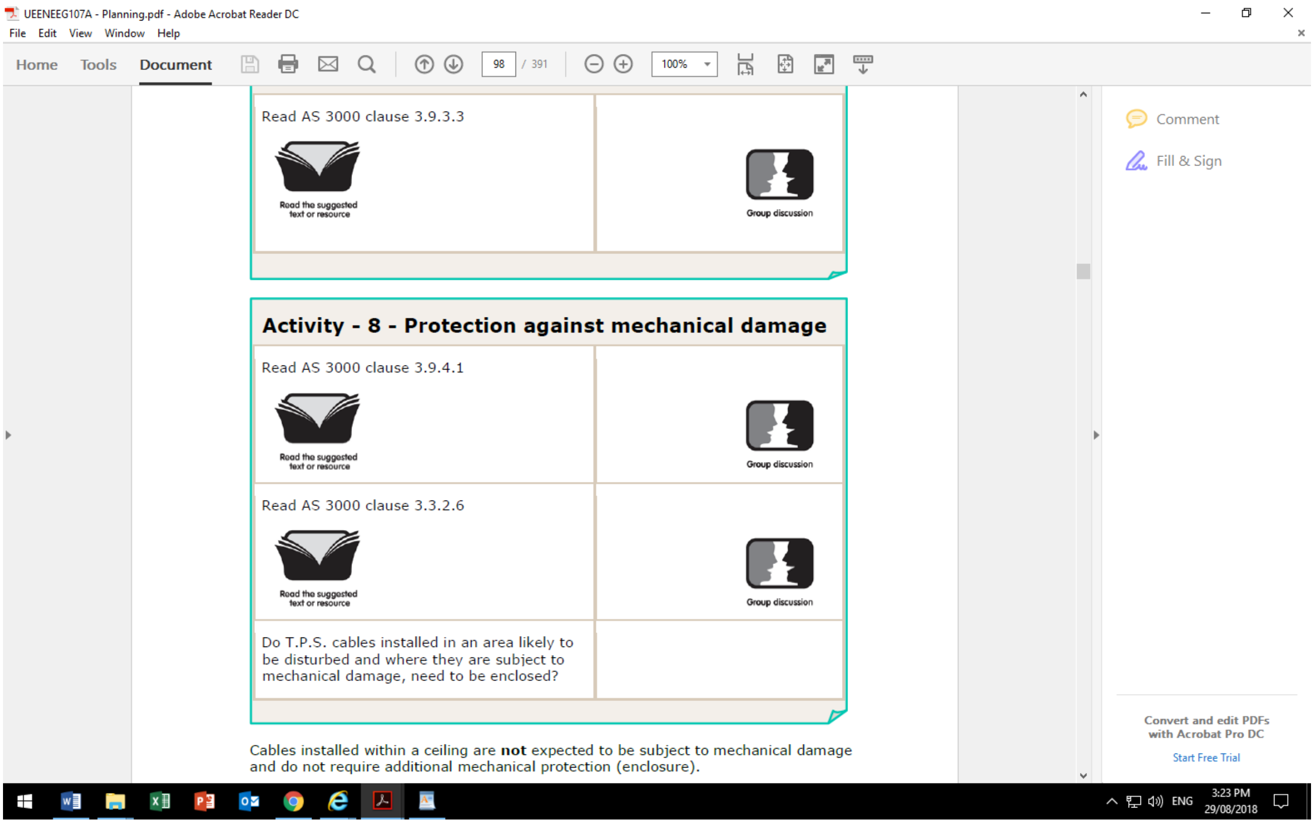
(a) On the surface of a wall or on the underside of a ceiling or roof.

(b) In a space between a floor and the ground to which a person may gain entry.

(c) In parts of a ceiling space where access is greater than 0.6 m in height.

(d) Within 2.0 m of any access to any space to which a person may gain entry.

(f) Below raised floors.



Read AS 3000 clause 3.9.3.3 Read the suggested text or resource	Group discussion

Activity - 8 - Protection against mechanical damage

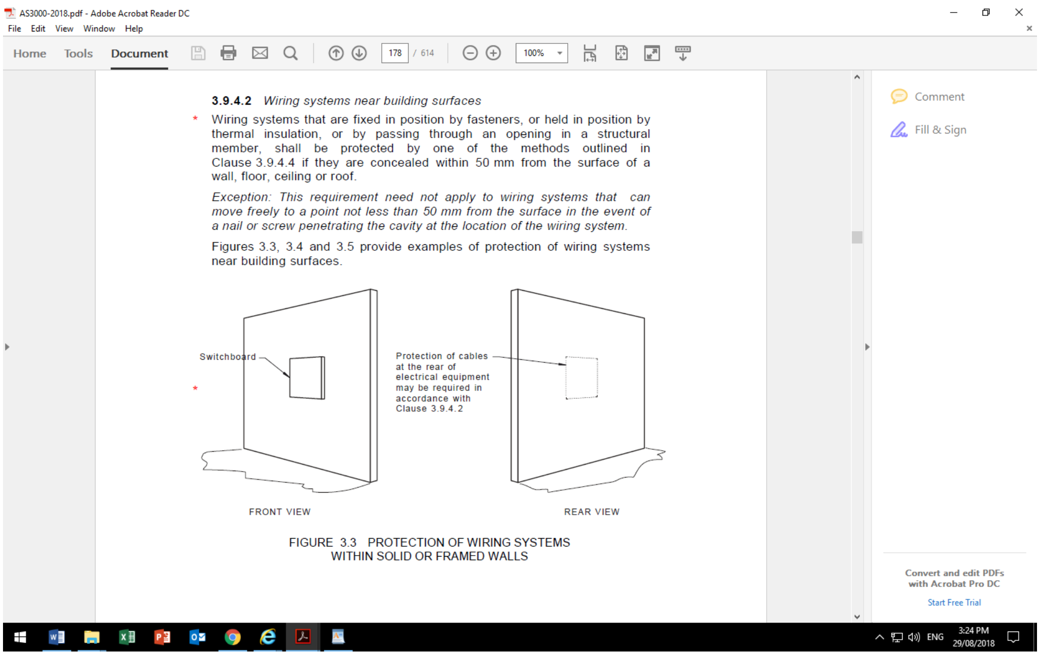
Read AS 3000 clause 3.9.4.1 Read the suggested text or resource	Group discussion
Read AS 3000 clause 3.3.2.6 Read the suggested text or resource	Group discussion
Do T.P.S. cables installed in an area likely to be disturbed and where they are subject to mechanical damage, need to be enclosed?	

Cables installed within a ceiling are **not** expected to be subject to mechanical damage and do not require additional mechanical protection (enclosure).

3.9.4 Protection against mechanical damage

3.9.4.1 General

Wiring systems installed in positions where they may reasonably be expected to be subject to mechanical damage shall be adequately protected in accordance with Clause 3.3.2.6 and the applicable requirements of Clauses 3.9.4.2 to 3.9.4.4



3.9.4.2 *Wiring systems near building surfaces*

* Wiring systems that are fixed in position by fasteners, or held in position by thermal insulation, or by passing through an opening in a structural member, shall be protected by one of the methods outlined in Clause 3.9.4.4 if they are concealed within 50 mm from the surface of a wall, floor, ceiling or roof.

Exception: This requirement need not apply to wiring systems that can move freely to a point not less than 50 mm from the surface in the event of a nail or screw penetrating the cavity at the location of the wiring system.

Figures 3.3, 3.4 and 3.5 provide examples of protection of wiring systems near building surfaces.

FIGURE 3.3 PROTECTION OF WIRING SYSTEMS WITHIN SOLID OR FRAMED WALLS

3.3.2.6 Mechanical damage

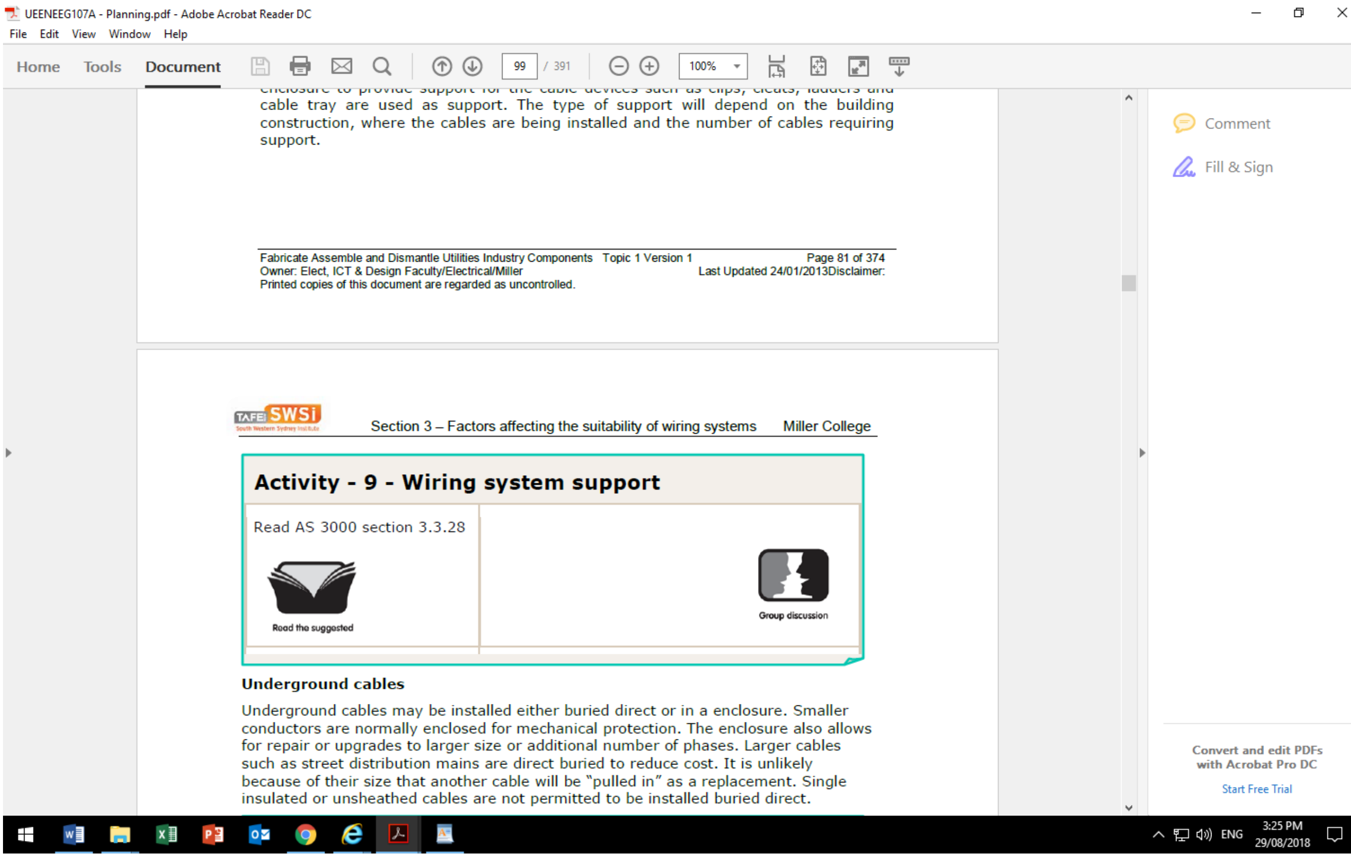
Wiring systems shall be selected and installed so as to minimize the risk of mechanical damage.

Protection against mechanical damage shall be provided by one or any combination of the following:

(a) Mechanical characteristics of the wiring system.

(b) Location selected.

(c) Provision of additional local or general mechanical protection


cable tray are used as support. The type of support will depend on the building construction, where the cables are being installed and the number of cables requiring support.

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Section 3 – Factors affecting the suitability of wiring systems Miller College

Activity - 9 - Wiring system support

Read AS 3000 section 3.3.28

Underground cables

Underground cables may be installed either buried direct or in a enclosure. Smaller conductors are normally enclosed for mechanical protection. The enclosure also allows for repair or upgrades to larger size or additional number of phases. Larger cables such as street distribution mains are direct buried to reduce cost. It is unlikely because of their size that another cable will be "pulled in" as a replacement. Single insulated or unsheathed cables are not permitted to be installed buried direct.

3.3.2.8 Other mechanical stresses

Wiring systems shall be selected and installed so as to minimize damage to the cable insulation, sheathing and connections during installation, operation and maintenance.

Measures undertaken to minimize damage may include the following:

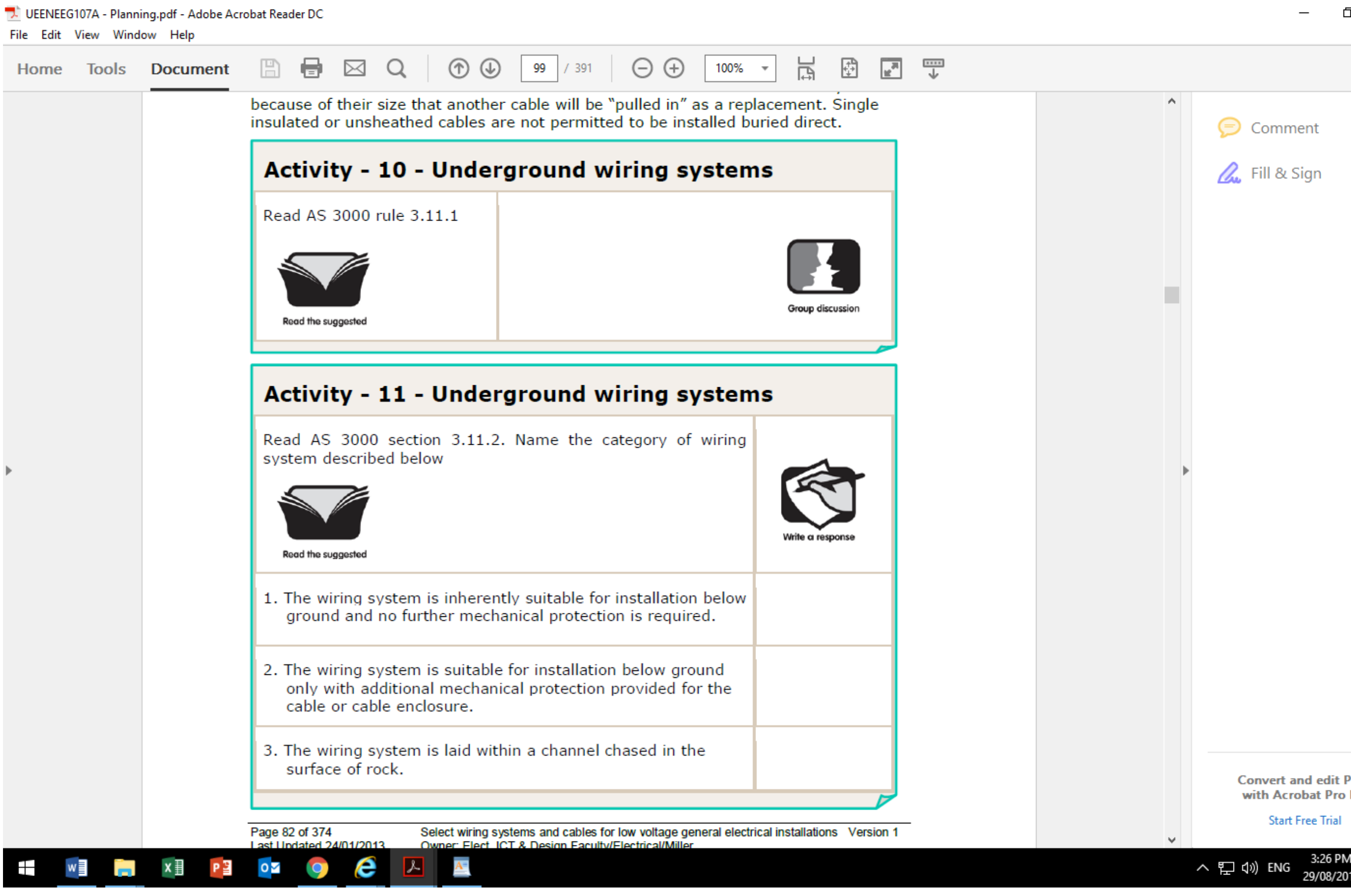
(a) Provision of supports, continuous or at appropriate intervals suitable for the mass of the cable.

(b) Use of suitable fixings for the cable size and type that hold the cable in position without damage.

(c) Use of suitable connections for the cable size and type that reduce mechanical strain at joints and terminations.

(d) Attention to minimum bending radius limits of cables.

(e) Provision of flexibility to accommodate any movement or tension stresses.



because of their size that another cable will be "pulled in" as a replacement. Single insulated or unsheathed cables are not permitted to be installed buried direct.

Activity - 10 - Underground wiring systems

Read AS 3000 rule 3.11.1 Read the suggested	Group discussion

Activity - 11 - Underground wiring systems

Read AS 3000 section 3.11.2. Name the category of wiring system described below Read the suggested	Write a response
1. The wiring system is inherently suitable for installation below ground and no further mechanical protection is required.	
2. The wiring system is suitable for installation below ground only with additional mechanical protection provided for the cable or cable enclosure.	
3. The wiring system is laid within a channel chased in the surface of rock.	

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3.11 UNDERGROUND WIRING SYSTEMS

3.11.1 Suitability and protection

Cables installed underground shall be—

(a) suitable for the environment in which they are placed;

(b) provided with protection against inadvertent damage likely to be caused by manual or mechanical excavation work; and

(c) provided with suitable warnings, marking or other means to minimize the risk of inadvertent damage likely to be caused by manual or mechanical excavation works.

3.11.2 Classification of wiring systems

Underground wiring systems are classified as one of three categories.

The type of cable and form of enclosure determine the category assigned to the underground wiring system.

Category A system—where the wiring system is inherently suitable for installation below ground and no further mechanical protection is required.

Activity - 12 - Underground wiring systems

Read AS 3000 table 3.5

Activity - 13 - Underground wiring systems

Read AS 3000 table 3.6

Aerial cables

To cover large distances at minimal cost an aerial wiring system is used. The types of cable which are suitable as aerials are listed in AS300 rule 3.12.1.

WELCOME TO THE JUNGLE GOAT FUCKERS

TABLE 3.5

UNDERGROUND WIRING SYSTEM CATEGORIES

1	2	3	4	5	6	7	8	9
Method of protection— Type of cable	**Heavy-duty conduit***	**Medium-duty conduit* encased in concrete**	**Heavy-duty fibre cement conduit**	**Fibre cement conduit encased in concrete**	**Medium- or heavy-duty galvanized pipe**	**Medium-duty, corrugated or flexible conduit***	**Buried direct in the ground with no enclosure**	**Chased in rock with no enclosure**
Insulated, unsheathed conductors	A	A	NP	NP	NP	B	NP	NP
Insulated and sheathed conductors	A	A	A	A	A	B	B	NP
Sheathed, armoured and served cables	A	A	A	A	A	A	A	C
Neutral-screened cables suitable for underground	A	A	A	A	A	A	A	NP
Neutral-screened cables	A	A	A	A	A	B	B	NP
Served MIMS cables	A	A	A	A	A	B	B	C
Aluminium sheathed or strip armoured cables with PVC sheath	A	A	A	A	A	B	B	C

* These conduits and any associated fittings consist of insulating material only and do not have any conductive components.

KEY:

A = Category A wiring system

B = Category B wiring system

C = Category C wiring system

NP = Not permitted

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These dimensions shall apply vertically between the upper surface of—

(a) the wiring system for a Category A or Category C system; or

(b) the additional mechanical protection of a Category B system,

and the surface of the ground or below any poured concrete laid on that surface (see Figures 3.10 to 3.17).

* Where cables are buried close to a sloping or vertical surface, these dimensions shall also apply perpendicular to that surface (see Figure 3.17).

TABLE 3.6

UNDERGROUND WIRING SYSTEMS—MINIMUM DEPTH OF COVER

Location of wiring system	Covering on surface of ground above wiring system	Cat A system	Cat B system	Cat C system
Within confines of a building	Poured concrete of 75 mm minimum thickness	0 mm (directly below)	0 mm (directly below)	0 mm (directly below)
	No surface covering or less than 75 mm thickness of concrete	500 mm	500 mm	50 mm
Elsewhere external to a building	Poured concrete of 75 mm minimum thickness	300 mm	300 mm	50 mm
	No surface covering or less than 75 mm thickness of concrete	500 mm	500 mm	50 mm

3.11.4.5 *Identification of underground wiring*

Wiring systems installed underground shall be identified by an orange marker tape complying with AS/NZS 2648.1. In order to provide early detection of the presence of underground wiring during excavation work, marker tape shall be positioned at approximately 50% of the depth of cover above the wiring system or any additional mechanical protection provided for that system.

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Read the suggested

Group discussion

Aerial cables

To cover large distances at minimal cost an aerial wiring system is used. The types of cable which are suitable as aerials are listed in AS300 rule 3.12.1.

Activity - 14 - Aerial wiring systems

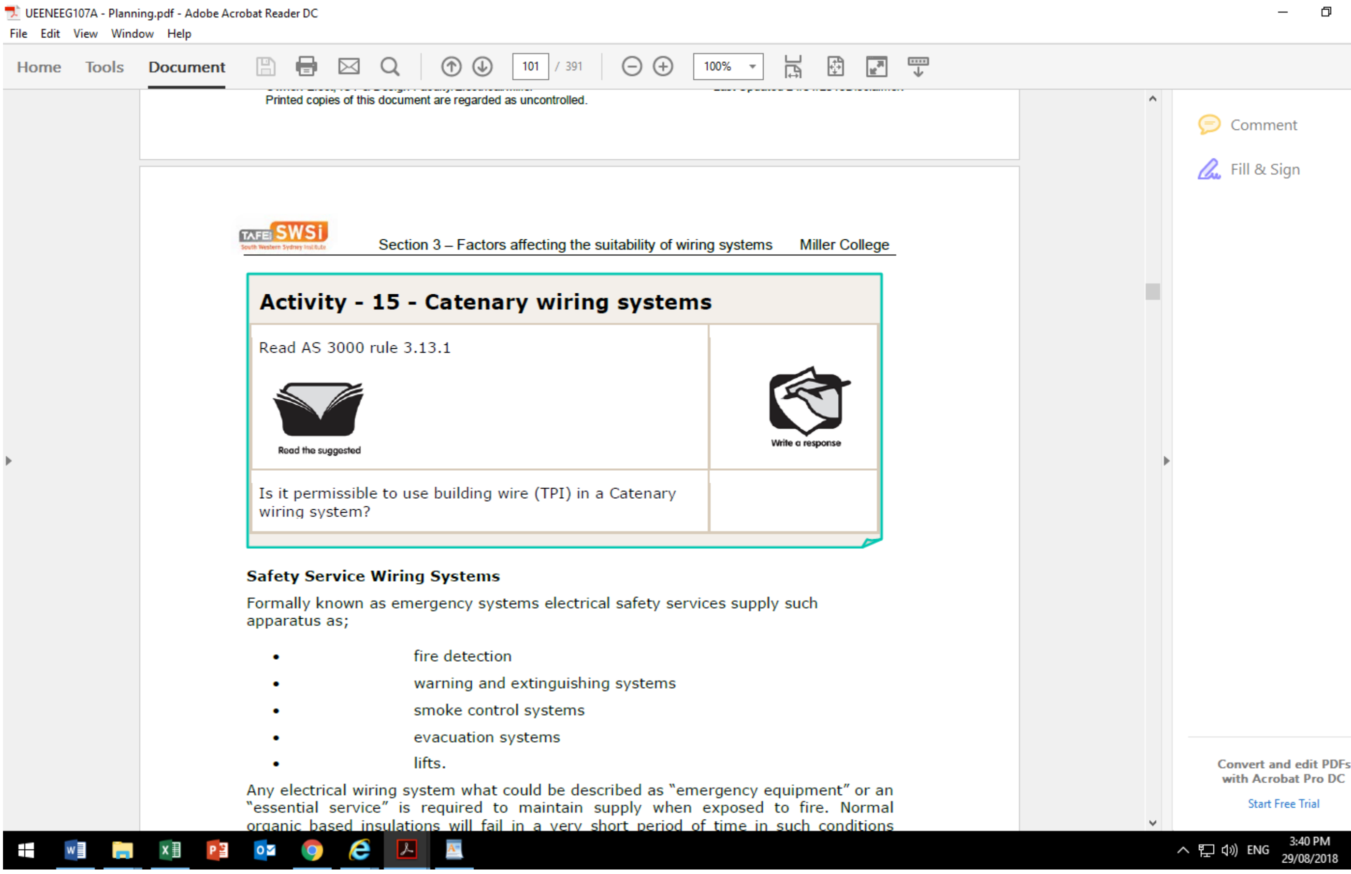
Read AS 3000 rule 3.12.1

Read the suggested

Group discussion

Catenary Wiring Systems

Catenarys are used to support the mass of cables not suitable for aerial wiring. A orange circular strung between two supports of any distance will not be able to support its own weight. Depending on the distance it will stretch and possibly even break. The solution is the catenary support. The requirements for cables in catenary system are listed in AS300 rule 3.13.1.



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Activity - 15 - Catenary wiring systems

Read AS 3000 rule 3.13.1 Read the suggested	Write a response
Is it permissible to use building wire (TPI) in a Catenary wiring system?	

Safety Service Wiring Systems

Formally known as emergency systems electrical safety services supply such apparatus as;

- fire detection
- warning and extinguishing systems
- smoke control systems
- evacuation systems
- lifts.

Any electrical wiring system what could be described as "emergency equipment" or an "essential service" is required to maintain supply when exposed to fire. Normal organic based insulations will fail in a very short period of time in such conditions

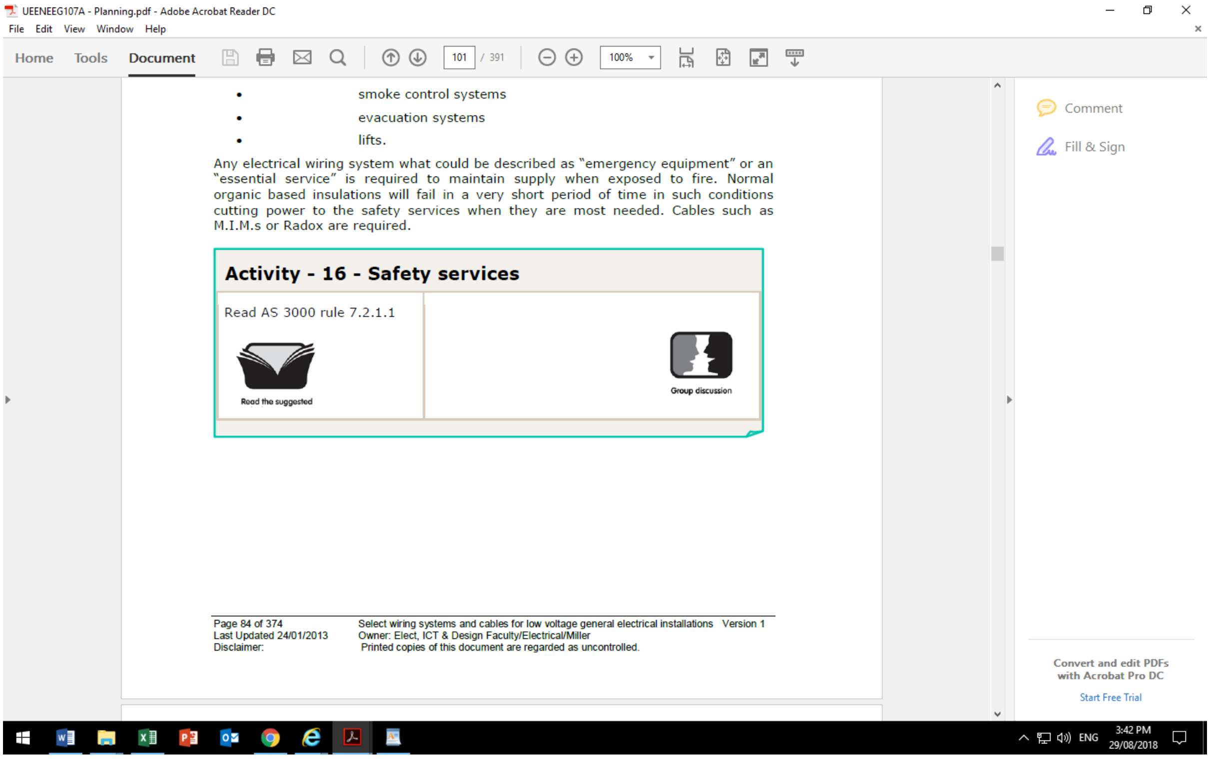
3.13 CABLES SUPPORTED BY A CATENARY

3.13.1 Types of cables

Cables supported by means of a catenary shall be stranded cables affording double insulation or the equivalent of double insulation.

Cables and catenary supports installed out of doors shall be suitable for exposure to direct sunlight.

Yes



- smoke control systems
- evacuation systems
- lifts.

Any electrical wiring system what could be described as "emergency equipment" or an "essential service" is required to maintain supply when exposed to fire. Normal organic based insulations will fail in a very short period of time in such conditions cutting power to the safety services when they are most needed. Cables such as M.I.M.s or Radox are required.

Activity - 16 - Safety services

Read AS 3000 rule 7.2.1.1

Read the suggested

Group discussion

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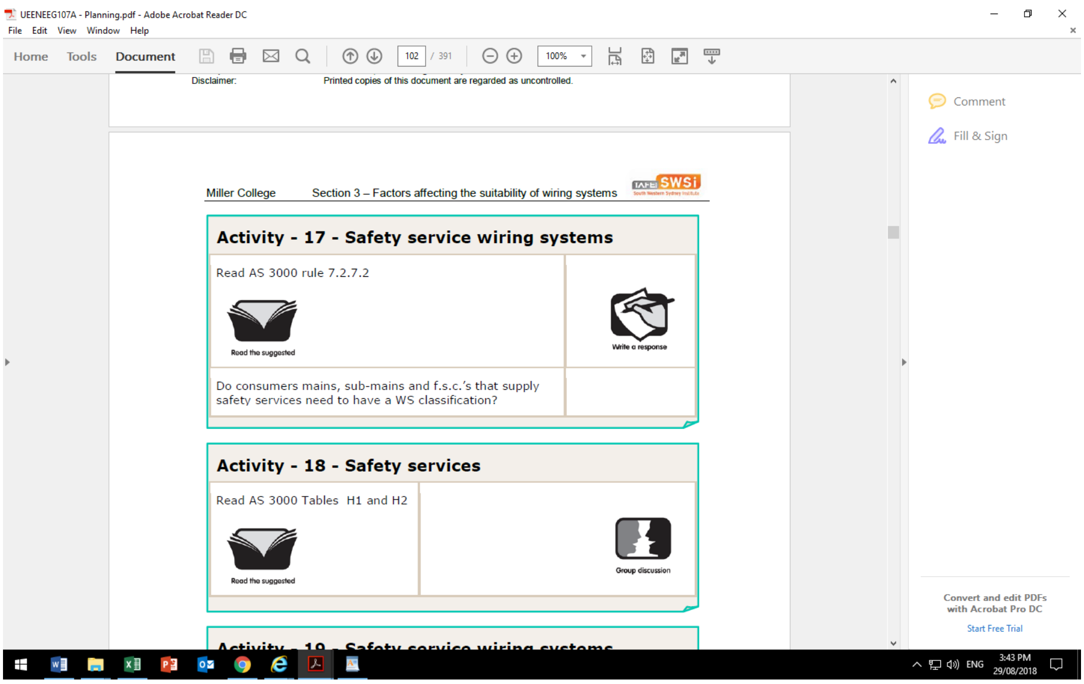
7.2 SAFETY SERVICES

* 7.2.1 Scope and general

7.2.1.1 Scope

The particular requirements of this Clause (Clause 7.2) apply to the electrical installation of building services that are essential for the safe operation of safety services consisting of fire detection, warning and extinguishing systems, smoke control systems, evacuation systems and the safety of persons using lifts.



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Miller College Section 3 – Factors affecting the suitability of wiring systems

Activity - 17 - Safety service wiring systems

Read AS 3000 rule 7.2.7.2

Read the suggested

Write a response

Do consumers mains, sub-mains and f.s.c.'s that supply safety services need to have a WS classification?

Activity - 18 - Safety services

Read AS 3000 Tables H1 and H2

Read the suggested

Group discussion

Activity - 19 - Safety service wiring systems

cable or incorporated with conductors of any other wiring system within a multi-core cable.

7.2.6.3 *Interposing switches for fire detection and alarm systems*

No switch shall be interposed between a main switch and downstream switchboards supplying fire and smoke detection and fire alarm systems.

* **7.2.7 Air-handling systems**

7.2.7.1 *General*

Air-handling systems intended to exhaust and control the spread of fire and smoke are safety services.

7.2.7.2 *Wiring systems for air-handling systems*

7.2.7.2.1 *Types of wiring system for air-handling systems*

Wiring systems supplying air-handling systems shall comply with AS/NZS 3013 with a WS classification as specified by the Standard relevant to the installation of such equipment.

NOTE: See Appendix H for further information regarding the application of the WS classification system.

Where the relevant Standard does not specify a WS classification, the wiring system shall be of a type that is—

(a) capable of maintaining supply to the equipment when exposed to either fire or mechanical damage; or

(b) capable of maintaining supply to the equipment when exposed to fire and protected against mechanical damage by—

    (i) installation in an effective enclosure; or

    (ii) installation in a location where the system will not be exposed to mechanical damage.

Exception: The fire and mechanical protection requirements specified in Items (a) and (b) above need not apply to the following:

Wiring systems in an enclosure or location that provides protection against fire and mechanical damage.

Example: Cables or enclosed wiring systems installed in underground locations, buried enclosed in concrete or masonry walls or floors, or installed in an appropriate fire-rated enclosure and provided with effective mechanical protection.

7.2.7.2.2 *Segregation of cables for air-handling systems*

Conductors supplying air-handling systems shall not be enclosed with different safety services or with conductors of any other system.

For the purposes of this Clause, the following applies:

(a) If a duct or trunking is divided into separate channels by means of fixed and continuous barriers that provide effective segregation, each channel may be regarded as a separate enclosure.

(b) Wiring systems of air-handling systems shall be physically separated from all other wiring systems by at least 50 mm or by effective barriers.

(c) Conductors of different safety services shall not be incorporated with each other within a multi-core cable or incorporated with conductors of any other wiring system within a multi-core cable.

7.2.7.2.3 *Interposing switches for air-handling systems*

No switch shall be interposed between a main switch and downstream switchboards supplying air-handling systems.

* **7.2.8 Evacuation equipment**

7.2.8.1 *General*

Evacuation equipment shall include sound systems and intercom

be assigned the associated characteristic numeral.

TABLE H1

DEGREE OF PROTECTION INDICATED BY THE FIRST CHARACTERISTIC NUMERAL

Degree of protection indicated by the first characteristic numeral (Protection against exposure to fire)	
First characteristic numeral	**Minimum time for which the circuit integrity of the wiring system is maintained min**
X	Degree of protection does not apply
1	15
2	30
3	60
4	90
5	120

H1.4 Second characteristic numeral

The second characteristic numeral represents the degree of mechanical impact and cutting load to which the wiring system can be subjected without losing circuit integrity.

Table H2 indicates the degree of impact for which the wiring system needs to maintain circuit integrity when tested in accordance with AS/NZS 3013.

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TABLE H2

DEGREE OF PROTECTION INDICATED BY THE SECOND CHARACTERISTIC NUMERAL

Degree of protection indicated by the second characteristic numeral (Protection against mechanical damage)	
Second characteristic numeral	**Protected against (see Paragraphs H4.2 and H5)**
X	Degree of protection does not apply
1	Light impact
2	Moderate impact
3	Heavy impact
4	Very heavy impact
5	Extremely heavy impact

H1.5 Supplementary letter W

The addition of the supplementary letter W to a wiring system designation means that the wiring system is able to maintain circuit integrity when—

(a) tested for protection against exposure to fire for the period specified by the first characteristic numeral; and

(b) then hosed with water.

H1.6 Supply and installation

H1.6.1 *Components*

All components of a wiring system assigned a particular classification should comply with AS/NZS 3013.

H1.6.2 *Instructions*

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Activity - 19 - Safety service wiring systems

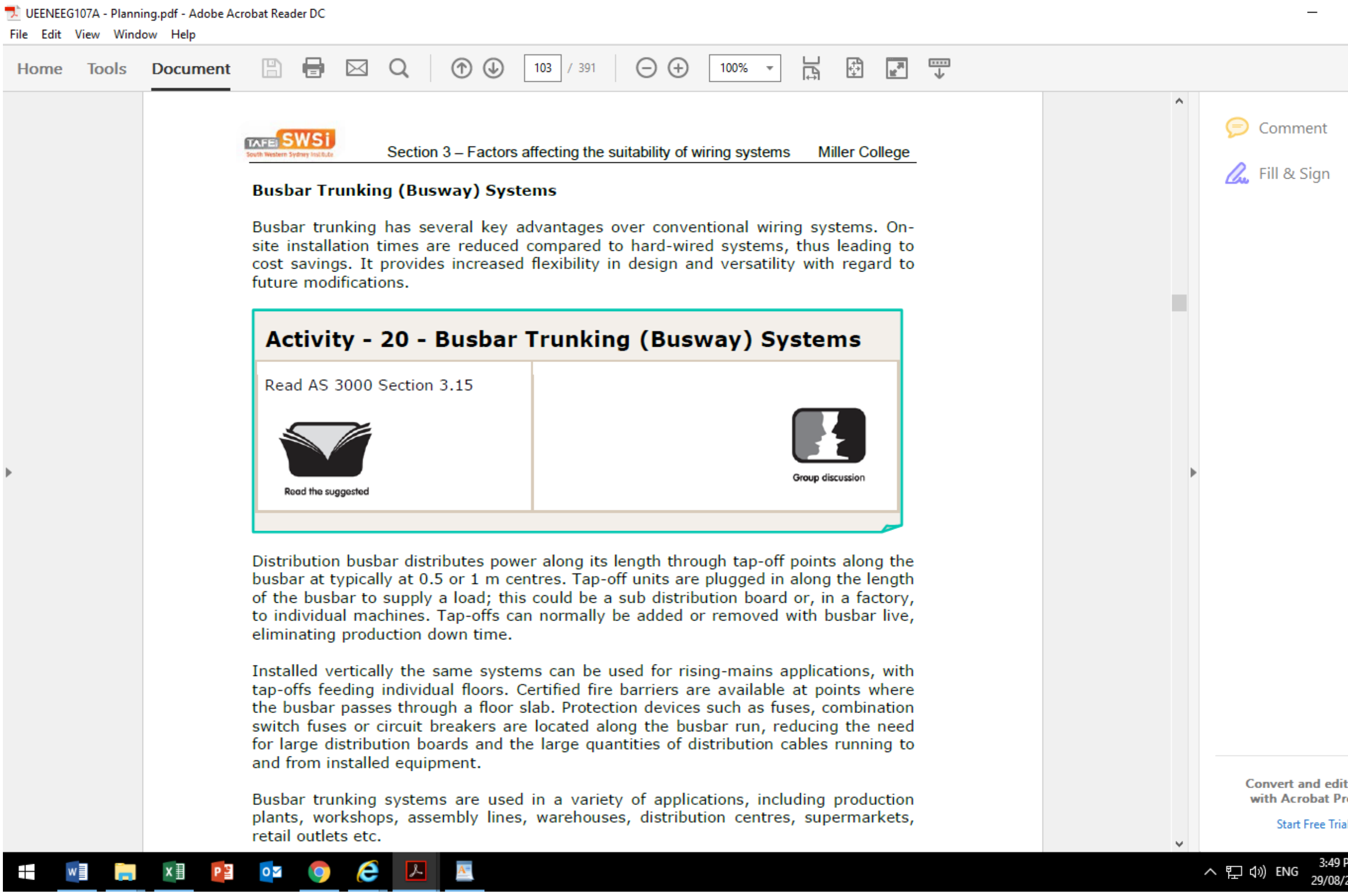
Read AS 3000 section H2

Read the suggested

Write a response

What is the required WS classification for a wiring system that supplies;

1. residential sprinkler pumpsets.	
2. Smoke venting equipment	
3. Passenger and goods lifts.	



Busbar Trunking (Busway) Systems

Busbar trunking has several key advantages over conventional wiring systems. On-site installation times are reduced compared to hard-wired systems, thus leading to cost savings. It provides increased flexibility in design and versatility with regard to future modifications.

Activity - 20 - Busbar Trunking (Busway) Systems

Read AS 3000 Section 3.15

Read the suggested

Group discussion

Distribution busbar distributes power along its length through tap-off points along the busbar at typically at 0.5 or 1 m centres. Tap-off units are plugged in along the length of the busbar to supply a load; this could be a sub distribution board or, in a factory, to individual machines. Tap-offs can normally be added or removed with busbar live, eliminating production down time.

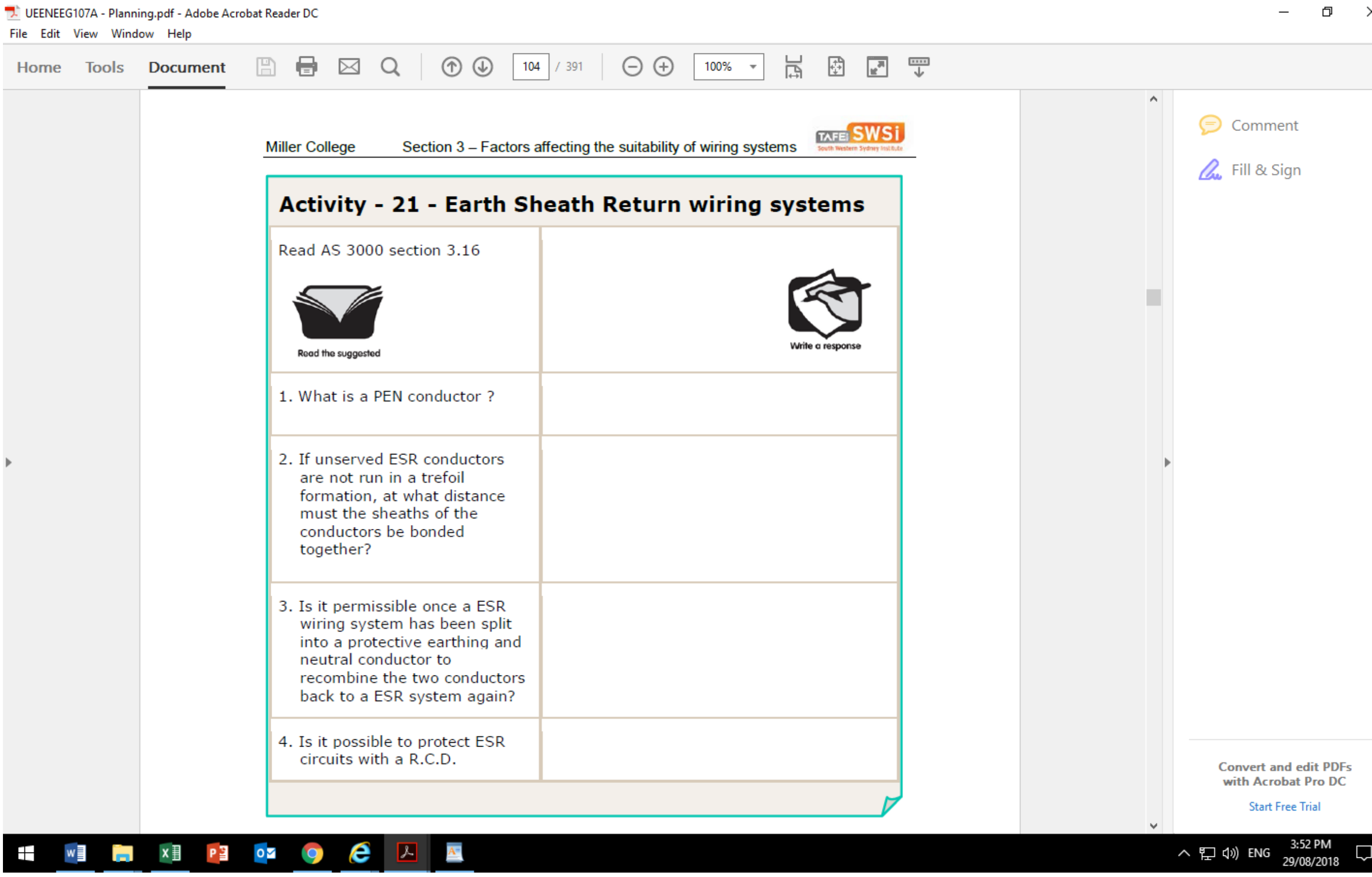
Installed vertically the same systems can be used for rising-mains applications, with tap-offs feeding individual floors. Certified fire barriers are available at points where the busbar passes through a floor slab. Protection devices such as fuses, combination switch fuses or circuit breakers are located along the busbar run, reducing the need for large distribution boards and the large quantities of distribution cables running to and from installed equipment.

Busbar trunking systems are used in a variety of applications, including production plants, workshops, assembly lines, warehouses, distribution centres, supermarkets, retail outlets etc.

3.15 BUSWAYS, INCLUDING RISING MAINS SYSTEMS

Busbar trunking systems (busways) shall comply with AS/NZS 3439.2 or AS/NZS 61439.6, and shall be installed in accordance with the manufacturer's instructions.

Where used as a wiring system, the installation shall be in accordance with the relevant requirements of Clause 3.9.



Miller College Section 3 – Factors affecting the suitability of wiring systems

Activity - 21 - Earth Sheath Return wiring systems

Read AS 3000 section 3.16 Read the suggested	Write a response
1. What is a PEN conductor ?	
2. If unserved ESR conductors are not run in a trefoil formation, at what distance must the sheaths of the conductors be bonded together?	
3. Is it permissible once a ESR wiring system has been split into a protective earthing and neutral conductor to recombine the two conductors back to a ESR system again?	
4. Is it possible to protect ESR circuits with a R.C.D.	

3.16 EARTH SHEATH RETURN (ESR) SYSTEM

The earth sheath return (ESR) system is one where the copper sheath of a MIMS cable forms a single conductor that is used as both a protective earthing (PE) conductor and a neutral (N) conductor simultaneously.

Only a copper sheath may be used as a combined protective earthing and neutral (PEN) conductor.

These cables shall be installed in accordance with Clause 3.9.7.3 and the following:

(a) The sheath shall be of adequate cross-sectional area and conductivity.

(b) The ESR system shall be used only in electrical installations where the MEN earthing system is used. It shall commence at the location where the neutral and earthing conductors are connected to form the MEN connection.

(c) Where the combined protective earthing and neutral (PEN) conductor is changed to provide a separate neutral and protective earth to electrical equipment, then the neutral and protective earth shall not be combined again to form a combined protective earthing and neutral

(PEN) conductor.

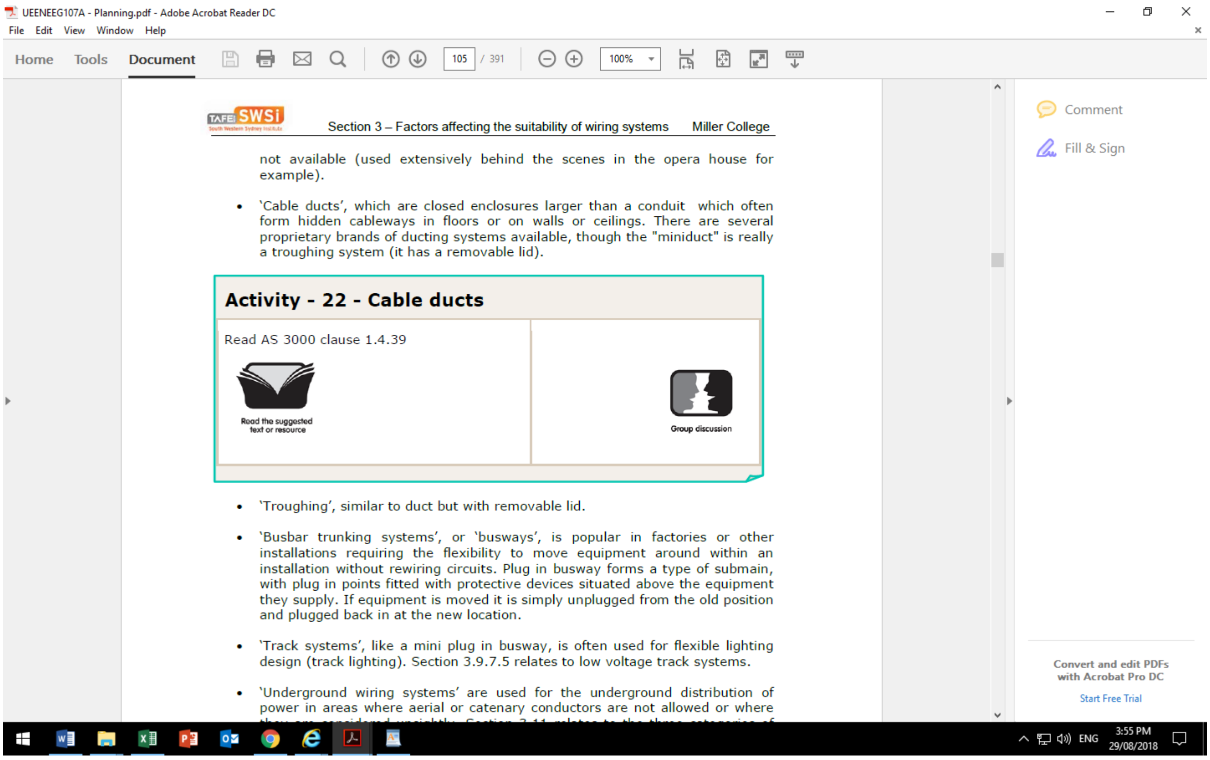
(d) The ESR system shall not be installed in hazardous areas.

(e) Conductors used in an ESR system shall not be smaller than 2.5 mm^2.

(f) At every joint in the sheathing, and at terminations, the continuity of the combined protective earthing and neutral (PEN) conductor shall be ensured by a bonding conductor in addition to the means used for sealing and clamping the external conductor.

The resistance of the bonding conductor at joints shall not exceed that of the cable sheath.

(g) Two conductors, one for protective earthing and one for the neutral, shall be used at terminations. The minimum size for the protective earthing conductor shall be in accordance with Clause 5.3.3 and Table 5.1, and the minimum size for the neutral conductor shall be 6 mm^2, or in accordance with Clause 3.5.2.



Section 3 – Factors affecting the suitability of wiring systems Miller College

not available (used extensively behind the scenes in the opera house for example).

- 'Cable ducts', which are closed enclosures larger than a conduit which often form hidden cableways in floors or on walls or ceilings. There are several proprietary brands of ducting systems available, though the "miniduct" is really a troughing system (it has a removable lid).

Activity - 22 - Cable ducts

Read AS 3000 clause 1.4.39

Read the suggested text or resource

Group discussion

- 'Troughing', similar to duct but with removable lid.
- 'Busbar trunking systems', or 'busways', is popular in factories or other installations requiring the flexibility to move equipment around within an installation without rewiring circuits. Plug in busway forms a type of submain, with plug in points fitted with protective devices situated above the equipment they supply. If equipment is moved it is simply unplugged from the old position and plugged back in at the new location.
- 'Track systems', like a mini plug in busway, is often used for flexible lighting design (track lighting). Section 3.9.7.5 relates to low voltage track systems.
- 'Underground wiring systems' are used for the underground distribution of power in areas where aerial or catenary conductors are not allowed or where

current, but not including wire or other metallic parts directly employed in converting electrical energy into another form.

1.4.36 Conductor, bare

A conductor without covering or insulation.

1.4.37 Consumer mains

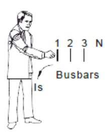
Those conductors between the point of supply and the main switchboard.

1.4.38 Contact, direct

Contact with a conductor or conductive part that is live in normal service (see Figure 1.2 and Clause 1.4.97 Protection, basic).

1.4.39 Contact, indirect

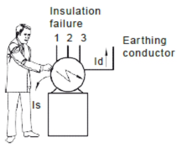
Contact with a conductive part that is not normally live but has become live under fault conditions (because of insulation failure or some other cause) (see Figure 1.3 and Clause 1.4.98 Protection, fault).



Is: touch current

(Basic protection required)

FIGURE 1.2 DIRECT CONTACT



Is: touch current
Id: fault current

(Fault protection required)

FIGURE 1.3 INDIRECT CONTACT