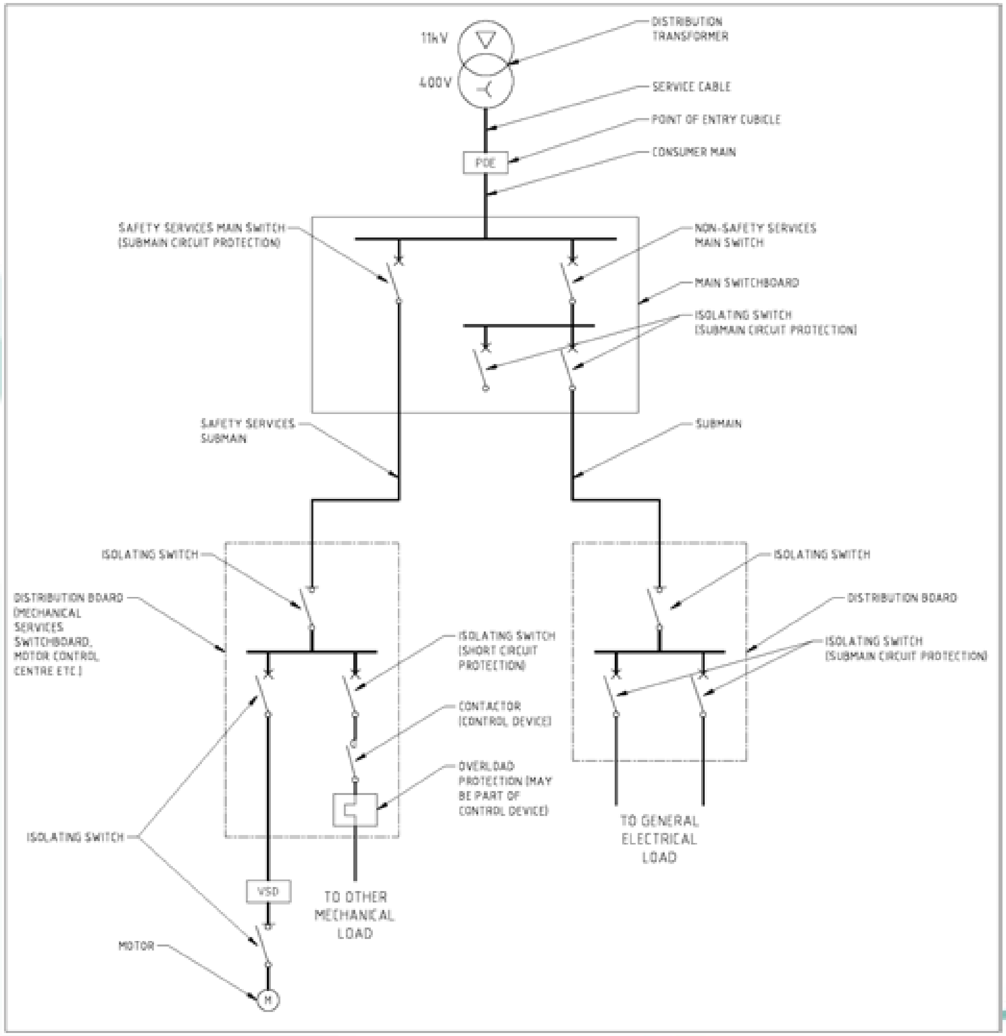
Electrical Essentials for HVAC&R Engineers

Wednesday, October 7

Main Components of an Electrical System



Accessibility of Switchboards

AS/NZS 3000-2007 REQUIRES SWITCHBOARDS TO HAVE ADEQUATE SPACE

TO ALLOW EQUIPMENT TO BE SAFELY OPERATED AND ADJUSTED

AND

WITH SUFFICIENT EXIT FACILITIES TO ALLOW A PERSON TO LEAVE IN EMERGENCY CONDITIONS

IN VERY SIMPLE TERMS THIS REQUIRES 600 mm CLEARANCE ALL AROUND WITH DOORS IN THE OPEN POSITIONS

FIGURE 2.16 FROM AS/NZS 3000-2007

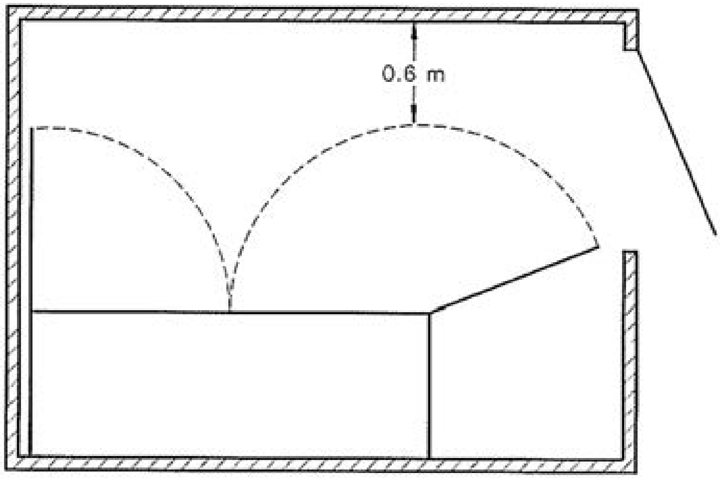


FIGURE 2.16 ACCESS TO SWITCHBOARDS—SWITCHBOARD IN CORNER POSITION

FIGURE 2.17 FROM AS/NZS 3000-2007

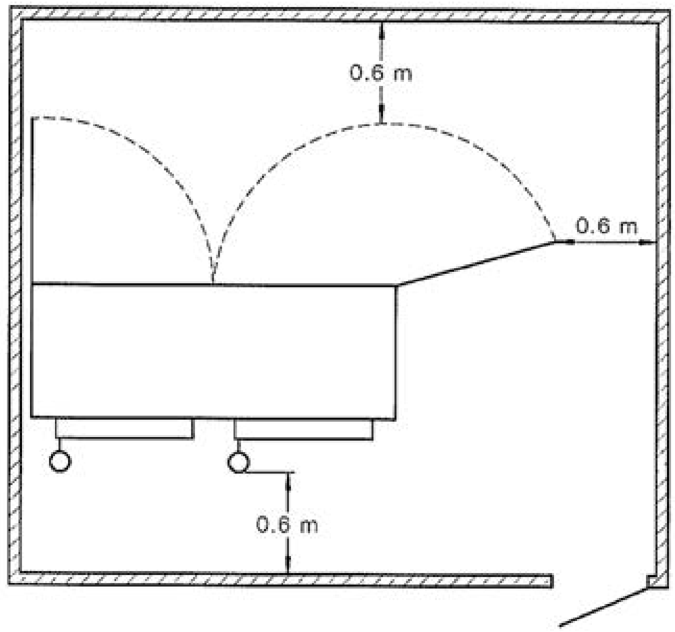


FIGURE 2.17 ACCESS TO SWITCHBOARDS—
SWITCHBOARD WITH ONE END AGAINST WALL

FIGURE 2.15 FROM AS/NZS 3000-2007

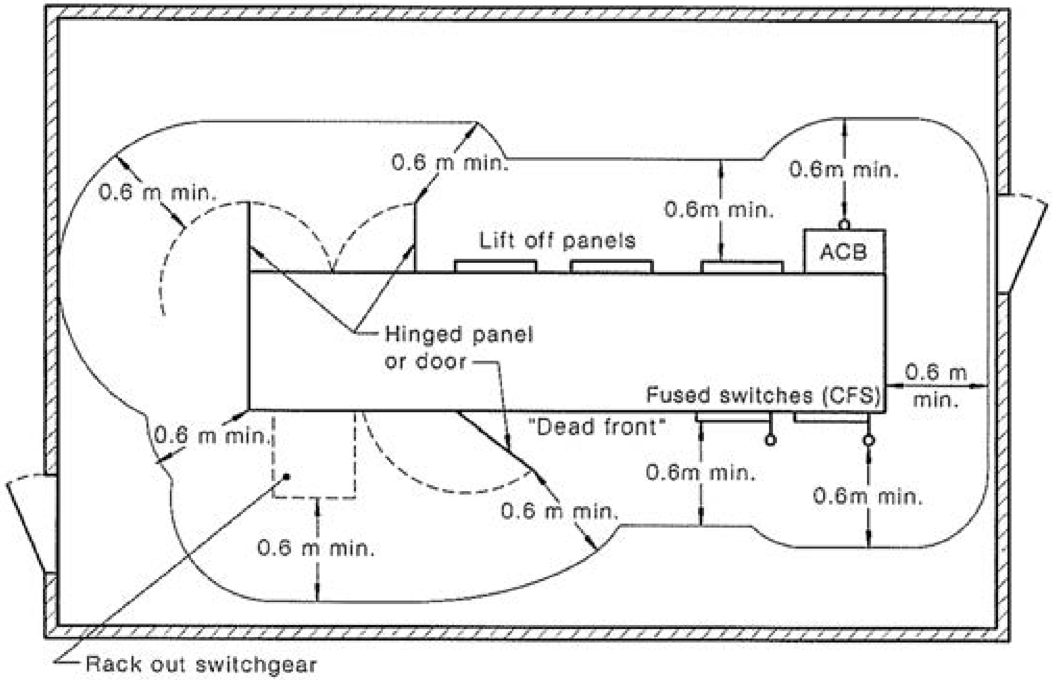


FIGURE 2.15 ACCESS TO SWITCHBOARDS—FREESTANDING SWITCHBOARD WITH RACK-OUT SWITCHGEAR

FIGURE 2.16 FROM AS/NZS 3000-2007

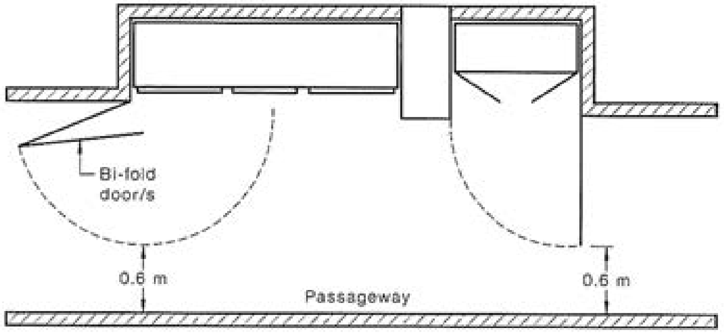


FIGURE 2.18 ACCESS TO SWITCHBOARDS—SWITCHBOARDS WITH DOORS THAT OPEN INTO ACCESSWAYS OR NARROW PASSAGEWAYS

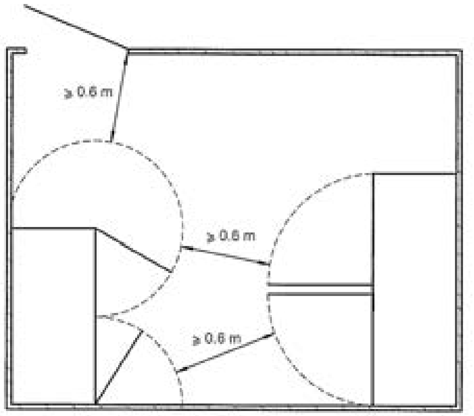


FIGURE 2.19 ACCESS TO SWITCHBOARDS—FACING SWITCHBOARDS

Large Switchboards

- AS/NZS 3000 requires that any large switchboard be located in a room with two egress paths.
- What is a large switchboard?
  - A current rating of over 800 Amps.
  - A short circuit current of over 16kA.
  - A length of over 3m.
    - Multiple switchboards located side by side over 3m are considered to be a large switchboard.
- Exception:
  - FAQ 030/2009: AS/NZS 3000:2007—CLAUSE 2.9.2.2(c)(ii) allows a large switchboard to have only a single egress path if a clearance of 3 metres is provided around the switchboard and its equipment, including switchboard doors, in all normal positions of operating, opening and withdrawal.

Diversity and Maximum Demand

- What is diversity?
  - Diversity is an allowance that all connected equipment will not operate at full load at the same time.
- Maximum Demand is the sum of the connected loads with diversity applied.
- How to determine diversity?
  - AS/NZS 3000 Table C2 provides diversity calculations.

Diversity and Maximum Demand

AIRAH

Rudds Consulting Engineers

TABLE C2

MAXIMUM DEMAND NON-DOMESTIC ELECTRICAL INSTALLATIONS

1	2	3
Load group	Residential institutions, hotels, boarding houses, hospitals, accommodation houses, motels*	Factories, shops, stores, offices, business premises, schools and churches*
A Lighting other than in load group F	75% connected load	Full connected load
B (i) Socket-outlets not exceeding 10 A other than those in B(ii)	1000 W for first outlet plus 400 W for each additional outlet	1000 W for first outlet plus 750 W for each additional outlet
(ii) Socket-outlets not exceeding 10 A in [illegible]	1000 W for first socket-outlet plus [illegible] W for each additional outlet	
(iii) Socket-outlets exceeding 10 A	Full current rating of highest rated socket-outlet plus 50% of full current rating of remainder	Full current rating of highest rated socket-outlet plus 75% of full current rating of remainder
C Appliances for cooking, heating and cooling, including instantaneous water heaters, but not appliances included in groups D and J below	Full connected load of highest rated appliance plus 50% of full load of remainder	Full connected load of highest rated appliance plus 75% of full load of remainder
D Motors other than in G and H below	Full load of highest rated motor plus 50% of full load of remainder	Full load of highest rated motor plus 75% of full load of second highest rated motor plus 50% of full load of remainder
E Lifts	(i) Largest lift motor 125% full load (ii) Next largest lift motor 75% full load (iii) Remaining lift motors 50% full load For the purpose of this load group, the full load current of a lift motor shall be the current taken from the supply when lifting maximum rated load at maximum rated speed	
F Fuel dispensing units	(i) Motors: First motor full load Second motor 50% full load Additional motors 25% full load (ii) Lighting: full connected load	

TABLE C2 (continued)

1	2	3
Load group	Residential institutions, hotels, boarding houses, hospitals, accommodation houses, motels*	Factories, shops, stores, offices, business premises, schools and churches*
G Swimming pools, spas, saunas, thermal storage heaters, including water heaters, [illegible] and similar arrangements	Full connected load	
H Welding machines	In accordance with Paragraph C2.4 [illegible]	
J X-ray equipment	50% of the full load of the largest X-ray unit, additional units being ignored	
K Other equipment not covered by load groups above	By assessment	

NOTES:

[illegible]

Maximum Demand

- How to determine the full load of a motor?
  1. Use the motor AOM rated power.
     - Maximum that can be drawn by the motor.
     - Will result in oversized electrical infrastructure.
     - 4.4kW from fan data.
  2. Use the motor IEC power from nameplate.
     - Will be conservative but closer to the operating point than AOM.
     - Will still result in oversized electrical infrastructure but not as much.
     - 4kW from data sheet.
  3. Calculate operating point from data sheet.
     - Is the maximum that the fan will draw in the design condition.
     - Gives the best match of electrical infrastructure to mechanical demand.
     - Calculated by taking the fan absolute power and dividing by motor efficiency.
     - 3.23/0.896 = 3.6kW from data sheet.
- Redundant or duty/standby equipment
  - Calculate maximum demand only on equipment that operates. If a system is N+1 then calculate maximum demand on N.
  - If duty/standby then calculate maximum demand using only the duty unit.
- High duty installations
  - Make the electrical designers aware if multiple items will operate at full load together e.g. Data centre, be aware of Table C in these environments.

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Technical Data for Fan Model AP0562GP6/12

Location:

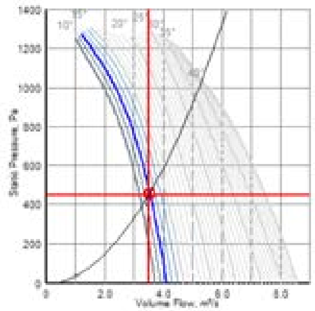
Designation:

Performance - Required

Air Flow:	3.50 m³/s
Static Pressure:	450 Pa
Selection Pressure:	450 Pa
Installation Type:	TYPE D
Air Density:	1.204 kg/m³
Atmos. Temp.:	20 °C
Altitude: m	0 m
Humidity:	0.0 %

Actual

Air Flow:	3.53 m³/s
Static Pressure:	456 Pa
Total Pressure:	562 Pa



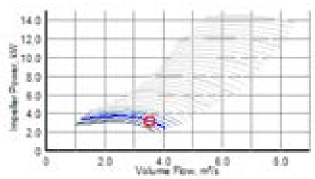
Fan Data

Catalogue Code: AP0562GP6/12 (AP0562GP68040)
Description: AP Series In-Line Direct Drive

Diameter:	560 mm	Hub:	256 mm
Impeller Type:	Axial	Pitch:	12°
Blade Material:	GRP	Blades:	6
Speed:	2860 RPM	Running:	50 Hz
Power, Abs:	3.23	Peak:	3.70
Efficiency Total:	63.7%	Static:	50.2%
Fan Weight:	78.4 kg		

Motor Data (at STP)

Motor Type:	Standard	
Electrical Supply:	415V 3ph 50Hz	
Motor Frame:	D112M	
Motor Power:	4.40kW (AOM)	(4.00kW IEC)
FLC/Start:	7.81A (AOM) / 42.60A	(7.10A FL IEC)
Motor Speed:	2 pole	
Motor Efficiency:	89.6%	



Energy Efficiency, NCC/BCA Vol. 1, Table J5.2 compliant
- 2006 - 2009

Sound Data

Spectrum (Hz):	63	125	250	500	1K	2K	4K	8K	dBW	dB(A) @ 3m
Inlet (dB):	89	86	91	89	88	86	83	80	97	73
Outlet (dB):	90	88	91	88	87	86	83	79	97	72

Sound levels are quoted as in-duct values. dB(A) values are average spherical free-field for comparative use only.

Energy Sustainability Data

Hours per Day ($):	24	Annual Electricity Cost ($):	5621.8
Days per Year:	366	Annual GH Gas (Tonnes):	51.5
CO2 per kWh (kg):	1.467	Annual Carbon Usage (Tonnes):	14.0
Cost per kWh ($):	0.16		

Voltage Drop

- What is voltage drop?
  - The reduction in voltage caused by current flow in the cables.
    - Determined by ohms law, V = IR.
    - Also dependent on power factor, typically lower power factor gives higher voltage drop.
- Why is voltage drop a problem?
  - AS/NZS 3000 mandates maximum voltage drop of either 5% or 7%.
    - 5% for shared and off-site substations.
    - 7% for dedicated on-site substations.
  - Can stop DOL or delta-star motors from starting.
    - Too high a volt drop results in insufficient torque to start the motor.
    - DOL motors in particular have high starting current and low power factor resulting in high volt drop.
- Correct voltage drop calculations require a knowledge of the entire electrical system from the substation to the load. Can be a problem for mechanical contractors if the electrical data is not provided.

Harmonics

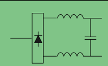
- What are harmonics?
  - Higher frequency components that add together to create a distorted waveform.
    - Are always multiples of the fundamental frequency of 50Hz.
    - Usually referred to by their harmonic number.
      - 3^{rd} harmonic = 3 x 50Hz = 150Hz
      - 4^{th} harmonic = 4 x 50Hz = 200Hz
      - 5^{th} harmonic = 5 x 50Hz = 250Hz etc.
    - Usually only odd numbered harmonics are present; 3, 5, 7, 9 etc.
- Why are harmonics a problem?
  - High frequency components cause excessive power loss and heating in motors, capacitors, transformers etc.
  - Triplen harmonics (multiples of 3 such as 3, 9, 15 etc.) add in neutral cables and can cause overloads.

Harmonics

- What are the sources of harmonics?
  - VSDs are the number one source of harmonics in a typical building.

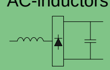
Harmonic Solutions
Summary

Passive:

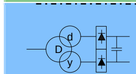


DC-Inductors

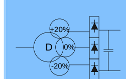
AC-inductors



- **Built-in as Standard**
- **Practical / Easy**

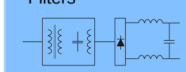


12 & 18-pulse



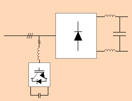
- **Low cost**
- **Robust**

Advanced Harmonic Filters



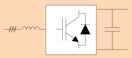
- **Low cost**
- **Robust**
- **Efficient**

Active:



Active filter &
Low Harmonic Drive

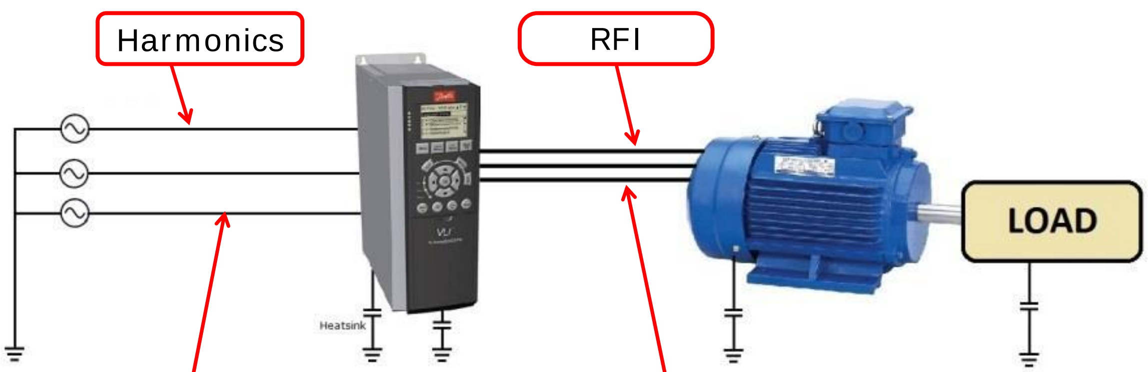
- **Sizable**
- **High mitigation**
- **Retrofit-able**
- **Efficient (sleep mode)**



Active Front End

- **Compact**
- **Easy to spec.**
- **High mitigation**
- **100% Regenerative**

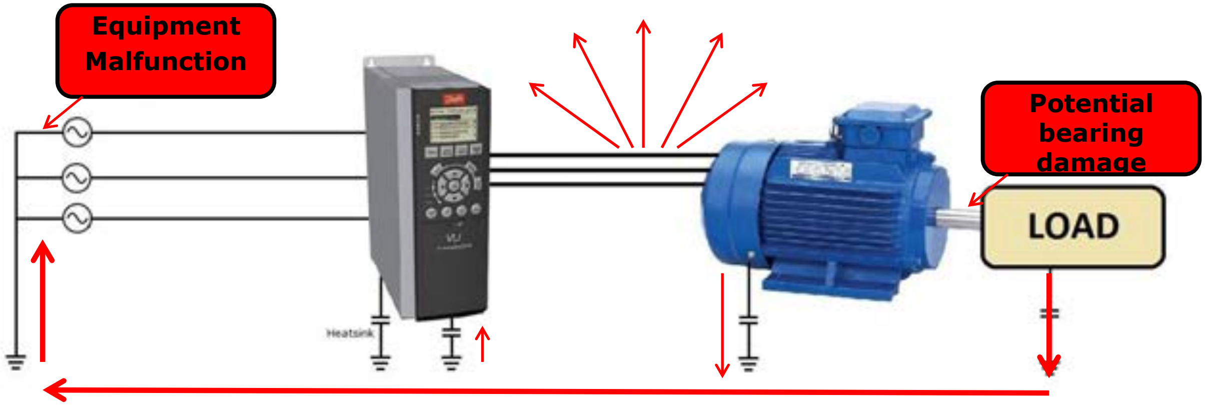
Introduction
Sources of EMI



- Harmonics cover frequencies from 50Hz to 2.5kHz (50th harmonic)
- Standard: AS61000-3

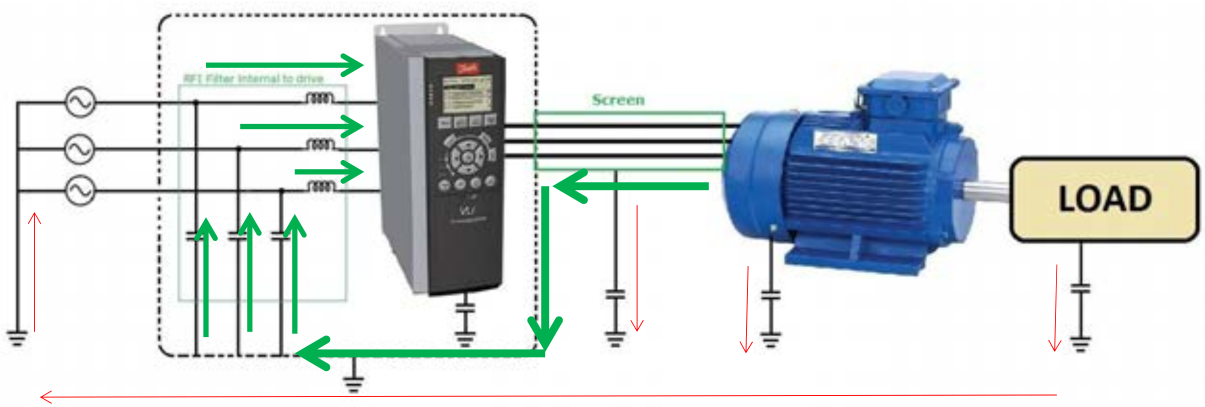
- RFI is Conducted up to 30MHz, airborne over 30MHz
- Standard: AS61800-3 (up to 30MHz)

Effects
Worst case scenario



- Without a screen the motor cable radiates RFI
- Common mode currents travel back to the drive via the earth connections, through the motor (potential bearing failure)
- This also causes problems for sensitive equipment on the mains supply also connected to the earth point i.e. instrumentation

Solutions
Limiting conducted RFI



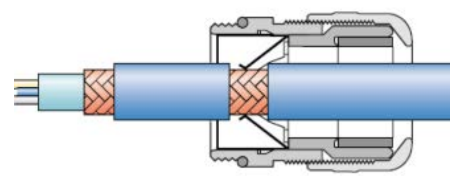
- Conducted RFI from the motor travels back to its source along the motor cable screen therefore motor cable screen **MUST BE TERMINATED AT BOTH ENDS**
- **RFI filter provides a low impedance path** for the RFI noise to travel back to it’s source i.e. the d ive. Without the R I filter the R I noise tries to travel back to source through the mains
- Reduction of Capacitive and Inductive coupling into other cables (comms / signal) can be achieved by **physical separation of cables**

Solutions
EMC glands – Pigtails

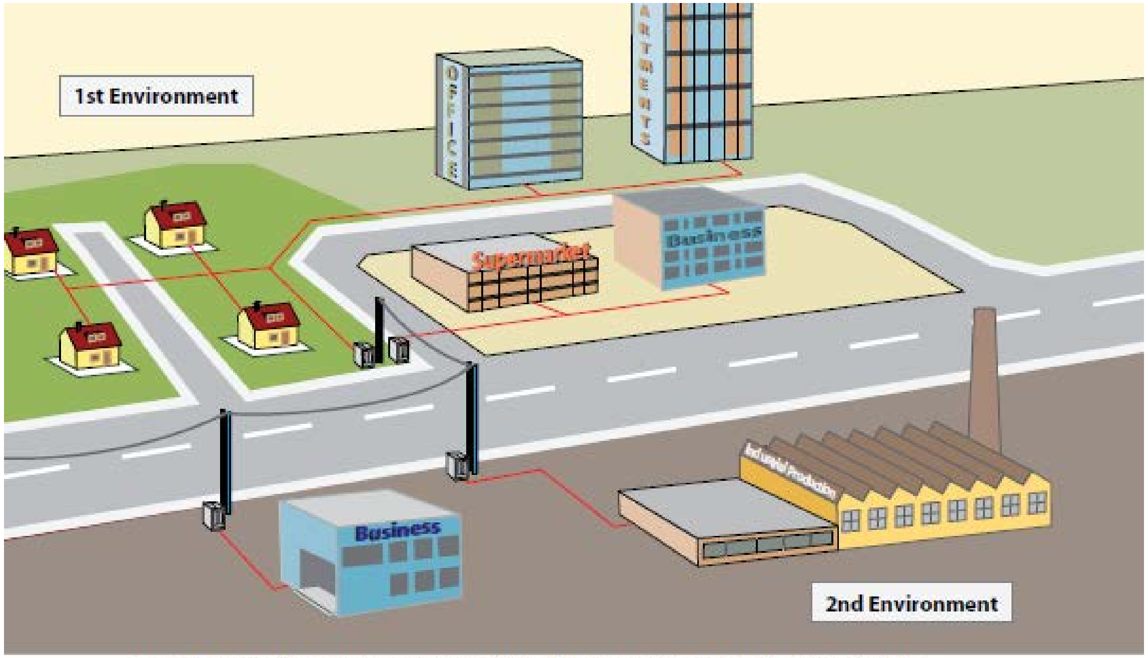
- Pigtails need to be avoided as they:
  - Act as antennae radiating noise
  - Increase the screen impedance, and so increase conducted noise on mains supply
- On signal cables Pigtails receive EMI from other circuits

- EMC cable glands ensure a good high-frequency connection of the shield

EMC cable glands should be used at the motor terminal box



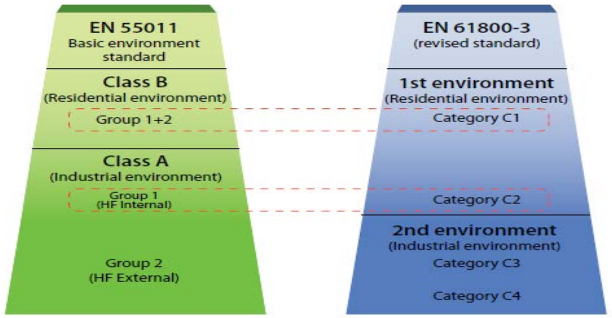
EMC Standards
IEC/EN61800-3 – Environments



Classification of operating environments in 1st and 2nd and special environments in which the operator is allowed a choice.

EMC Standards
Category Classification

Comparision of interference levels



Comparison of the new categories C1 to C4 defined by the EN 61800-3 product standard and classes A and B of the EN 55011 environment standard.

EN 61800-3 product standard (2005-07) for electrical drive systems

Classification by category	C1	C2	C3	C4
Environment	1st Environment	1st or 2nd Environment (operator decision)	2nd Environment	2nd Environment
Voltage/current		< 1000 V		> 1000 V In > 400 A Connection to IT network
EMC expertise	No requirement	Installation and commissioning by an EMC expert		EMC plan required
Limits according to EN 55011	Class B	Class A1 (plus warning notice)	Class A2 (plus warning notice)	Values exceed Class A2

Classification of the new categories C1 to C4 of the EN 61800-3 product standard

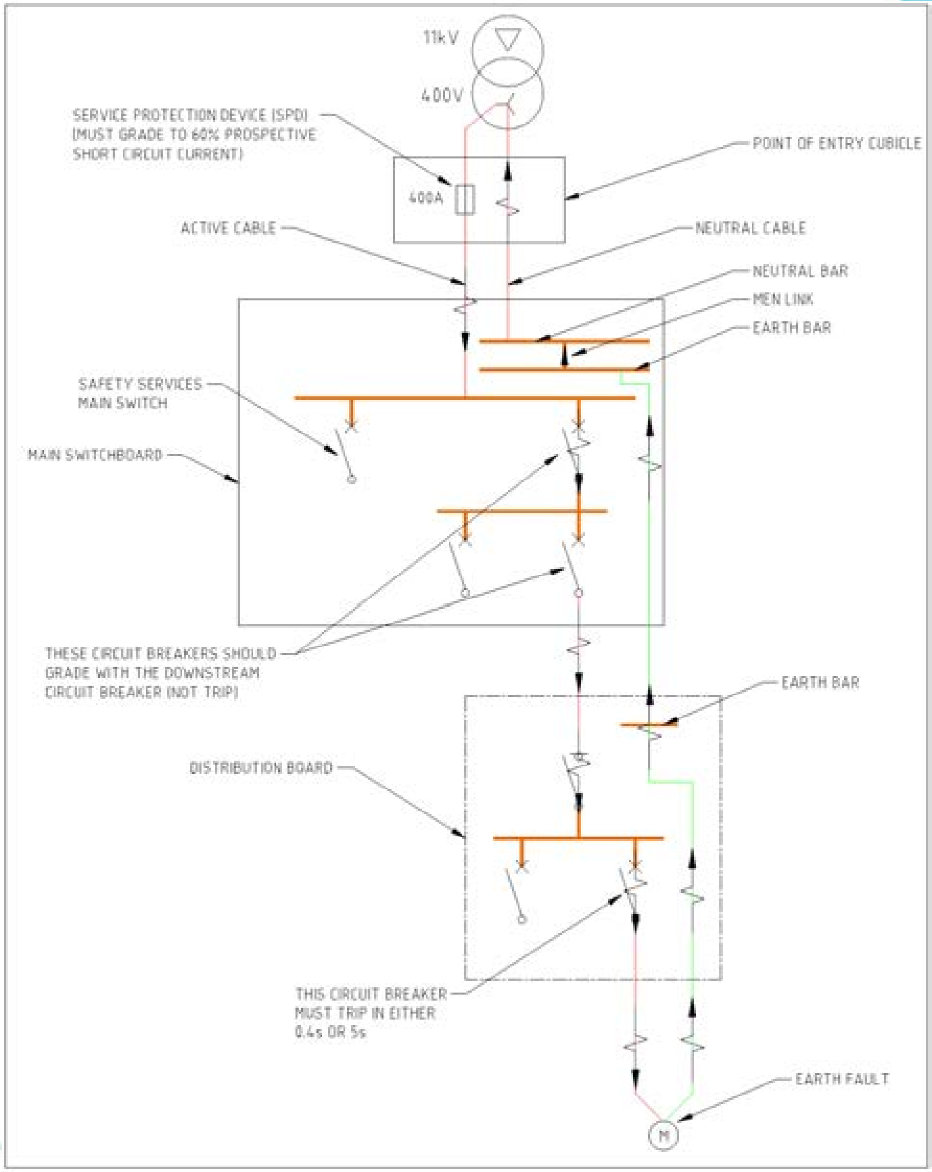
- AS/NZS CISPR11 / EN55011 is a standard which defines limits according to the basic environment, it used to be the only standard which could be applied to electrical drives
- AS61800-3 (AKA EN/IEC61800-3) is a specific standard for electrical drive systems
- Facility operators must comply with AS/NZS CISPR11 / EN55011 – Drive manufacturers must comply with EN61800-3.

Earthing

- What is earthing?
  - The connection of the general electrical installation to the ground.
- Why earth the electrical system?
  - To protect against indirect contact by the automatic disconnection of supply.
    - Indirect contact is contact with conductive parts that are not normally live but may become live in a fault situation such as a phase to earth fault.
    - Automatic disconnection of supply is the tripping of a protective device such as a circuit breaker or fuse by the current produced by a phase to earth fault (earth fault loop).
- How is the electrical system earthed?
  - By a continuous conductor connected to the exposed conductive part to an earth stake or earth mat.
  - By the connection of the electrical system neutral conductor to earth at a single point in the electrical installation (MEN link).
- Equipotential bonding
  - Electrical connections intended to bring exposed conductive parts or extraneous conductive parts to the same or approximately the same potential, but not intended to carry current in normal service.

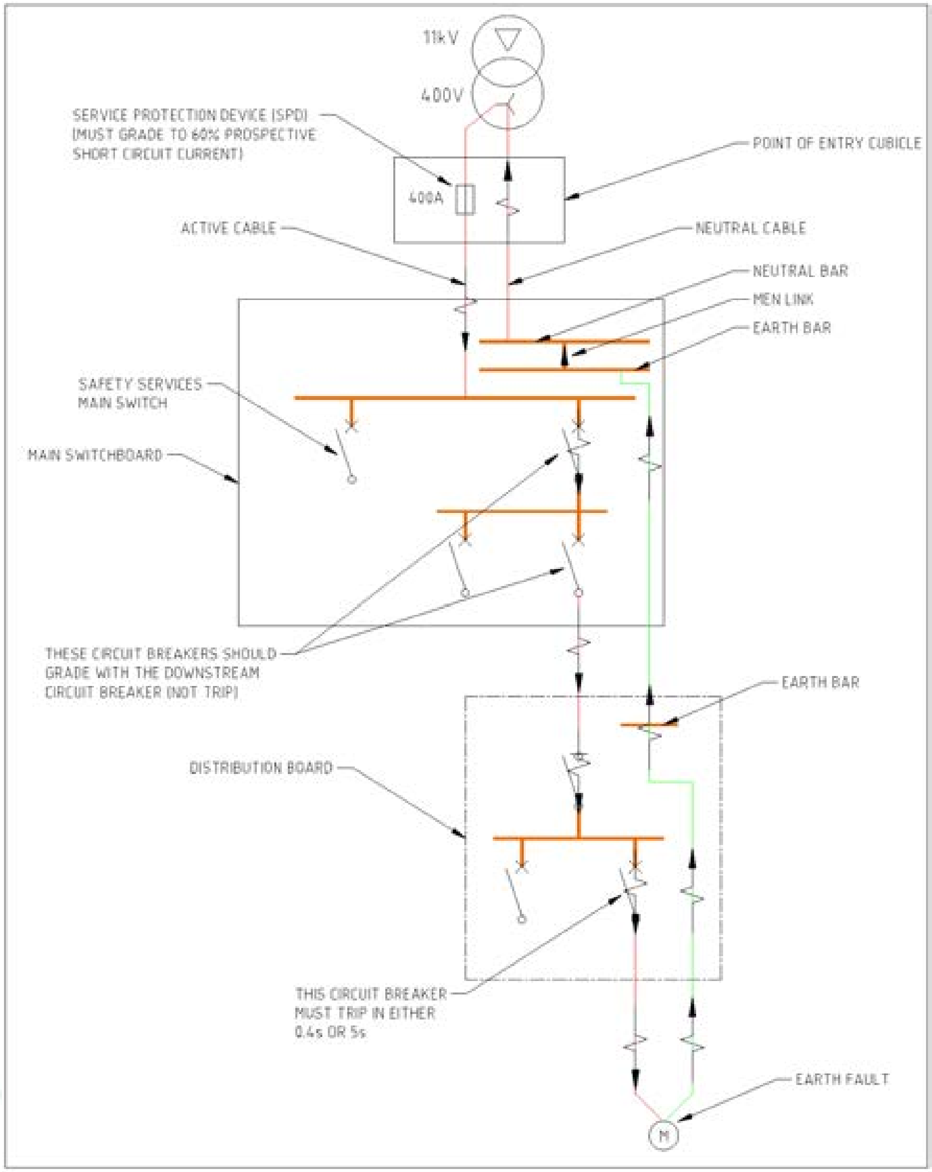
Earth Fault Loop

- The earth fault loop is the series of conductors that the current generated by an earth fault must pass through.



Earth Fault Loop Impedance

- What is earth fault loop impedance?
  - The impedance to current flow of the earth loop.
  - Determines how much current flows for an earth fault.
  - Determines the disconnect time in conjunction with the protective device setting.



Earth Fault Loop Disconnect Times

- AS/NZS 3000 mandates disconnect times for various parts of the electrical installation.
- An earth fault must be disconnected within 0.4s (400ms) for:
  - Socket-outlets having rated currents not exceeding 63 A; or
  - hand-held Class I equipment (equipment have a conductive outer case connected to earth); or
  - (iii) portable equipment intended for manual movement during use.
- An earth fault must be disconnected within 5s for all other equipment.

How to Determine Disconnect Times

- AS/NZS 3000 Table 8.1 shows maximum line impedances for various types of breakers.
- Line impedances can be determined by measurement.
- Only provides 0.4s times for thermal magnetic breakers.
- For 0.4s disconnect times on electronic trip units set the short time setting at or below the earth fault current.
  - Earth fault current = 230/Zs from ohms law (V=IR).
- For 5s disconnect times need to use breaker trip curves.

TABLE 8.1

MAXIMUM VALUES OF EARTH FAULT-LOOP IMPEDANCE (Z_s at 230 V)

Protective device rating	Circuit-breakers			Fuses	
	Type B	Type C	Type D		
	Disconnection times				
	0.4 s			0.4 s	5 s
A	Maximum earth fault-loop impedance Z_s Ω				
6	9.58	5.11	3.07	11.50	15.33
10	5.75	3.07	1.84	6.39	9.20
16	3.59	1.92	1.15	3.07	5.00
20	2.88	1.53	0.92	2.09	3.59
25	2.30	1.23	0.74	1.64	2.71
32	1.80	0.96	0.58	1.28	2.19
40	1.44	0.77	0.46	0.96	1.64
50	1.15	0.61	0.37	0.72	1.28
63	0.91	0.49	0.29	0.55	0.94
80	0.72	0.38	0.23	0.38	0.68
100	0.58	0.31	0.18	0.27	0.48
125	0.46	0.25	0.15	0.21	0.43
160	0.36	0.19	0.12	0.16	0.30
200	0.29	0.15	0.09	0.13	0.23

NOTE: Table 8.1 does not show 5 s disconnection times for circuit-breakers as the devices are intended to operate in the instantaneous tripping zone.

Overload and Short-circuit Protection

- AS/NZS 3000 requires that all cables be protected against both over load and short-circuit.
- Overload and short circuit protection may be combined in a device (circuit breaker or fuse) or by separate devices (thermal overload and circuit breaker or fuse).
- Overload protection is usually provided at the start of the cable but may be provided at the end under certain conditions (AS/NZS 3000 clause 2.5.3.3) or even omitted (AS/NZS 3000 clause 2.5.3.4).
- Short-circuit protection is provided at the start of the cable but may be provided within 3m of the start of the cable under certain conditions (AS/NZS 3000 clause 2.5.4.3) or even omitted (AS/NZS 3000 clause 2.5.4.4).

Protection Grading and Discrimination

- What is protection grading?

  Protection grading is ensuring that the protective device closest to the overload and short-circuit disconnects first to minimise the impact of the fault on the electrical system.

  Discrimination, selectivity and protection grading all describe the same thing.

- Total discrimination

  Total discrimination is when a smaller protective device is guaranteed to operate before a larger protective device under any circumstance.

  Only achievable by manufacturer's test between devices of the same manufacturer.

- Deemed Discrimination

  AS/NZS 3000 clause 2.5.7.2.3 deems discrimination is achieved for certain settings.

Protection Settings

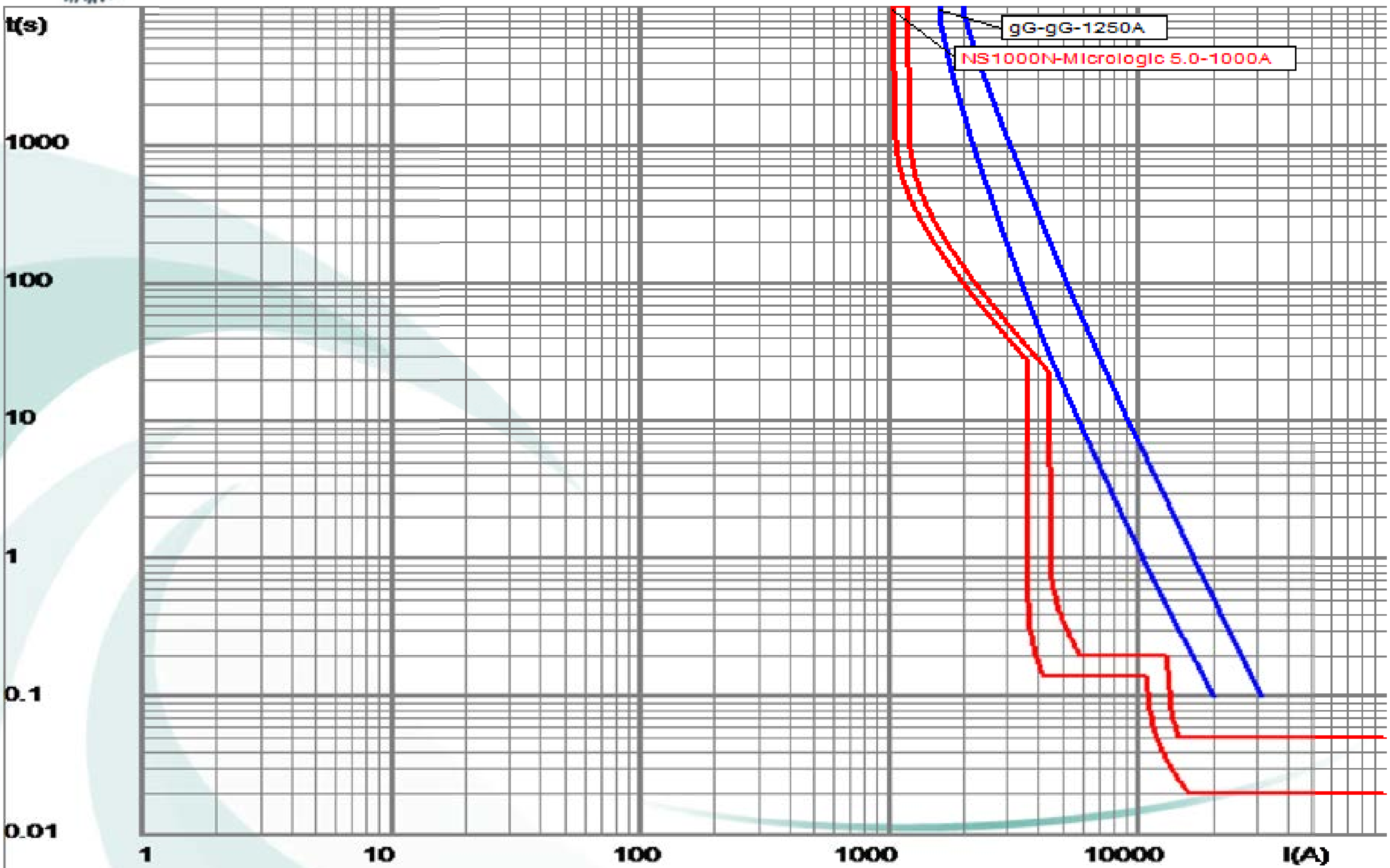
- Circuit breakers have various dials to adjust the protection settings.
  - Long time settings.

    Long time settings protect against overload (low level currents) and may consist of a current setting and a time setting
  - Short time settings

    Short time settings protect against high level currents and also may consist of a current setting and a time setting
  - Instantaneous settings

    Instantaneous settings protect against very high level currents and also may consist of a current setting and a time setting

Protection Grading

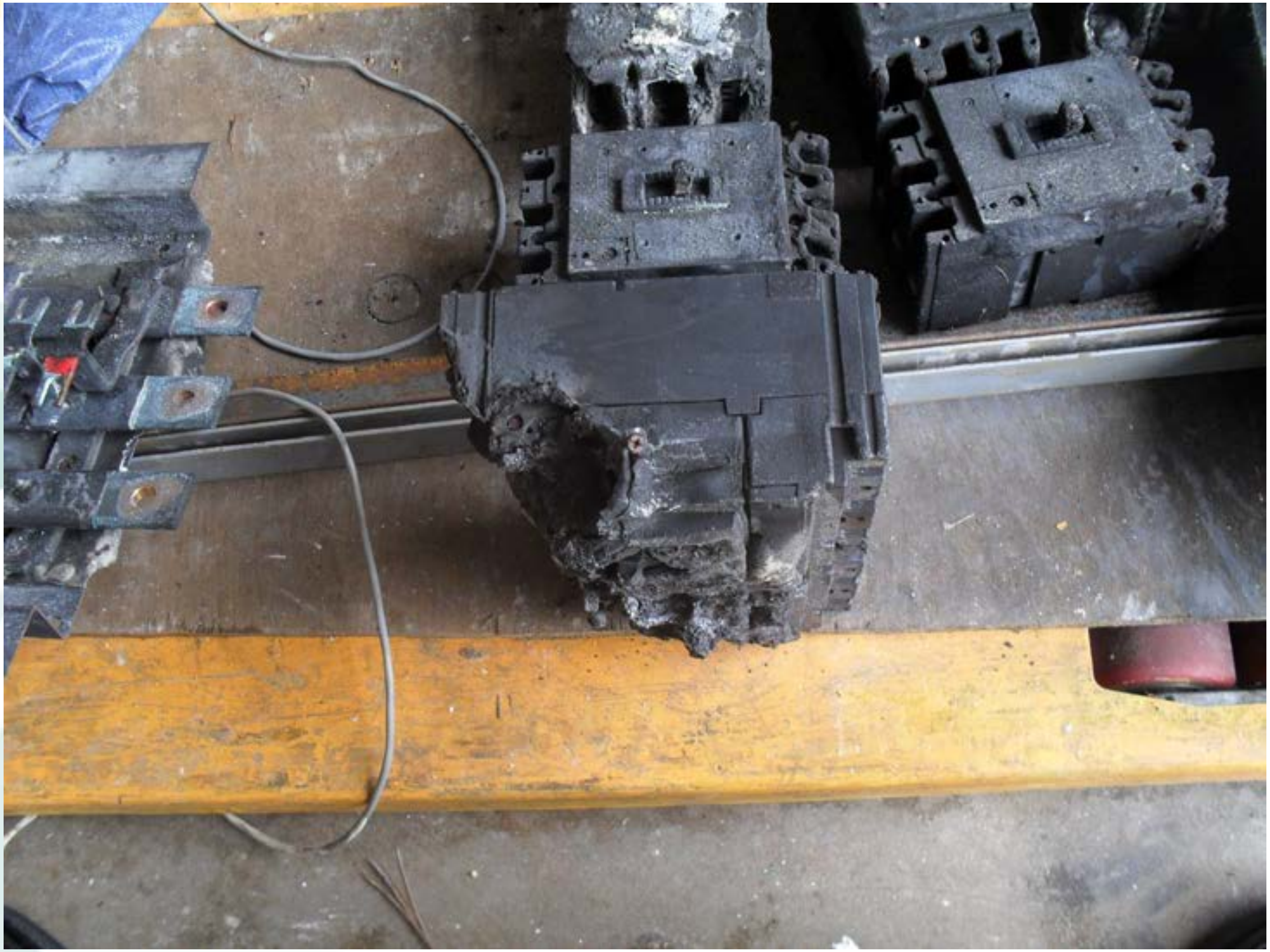


Cascading

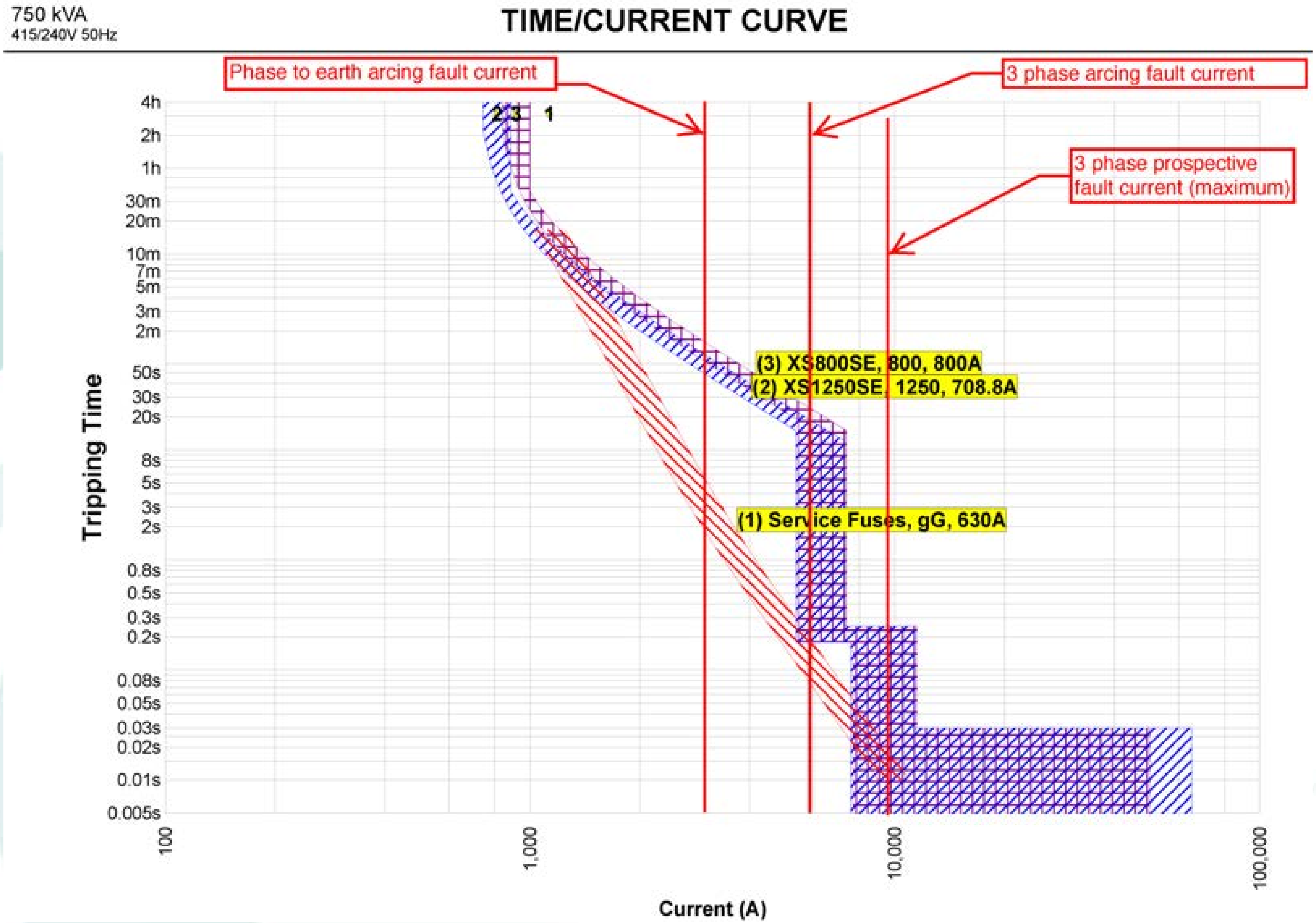
- Cascading is the use of protective devices with a fault current lower than the prospective fault current.
  - Relies on an upstream device limiting the let through energy to below the rating of the device.
  - Proven by manufacturer's testing.
  - Only valid for the equipment that has been tested.
    - Can't change manufacturer in system that rely on cascading.
  - Systems that rely on cascading should be identified by labels in the switchboard

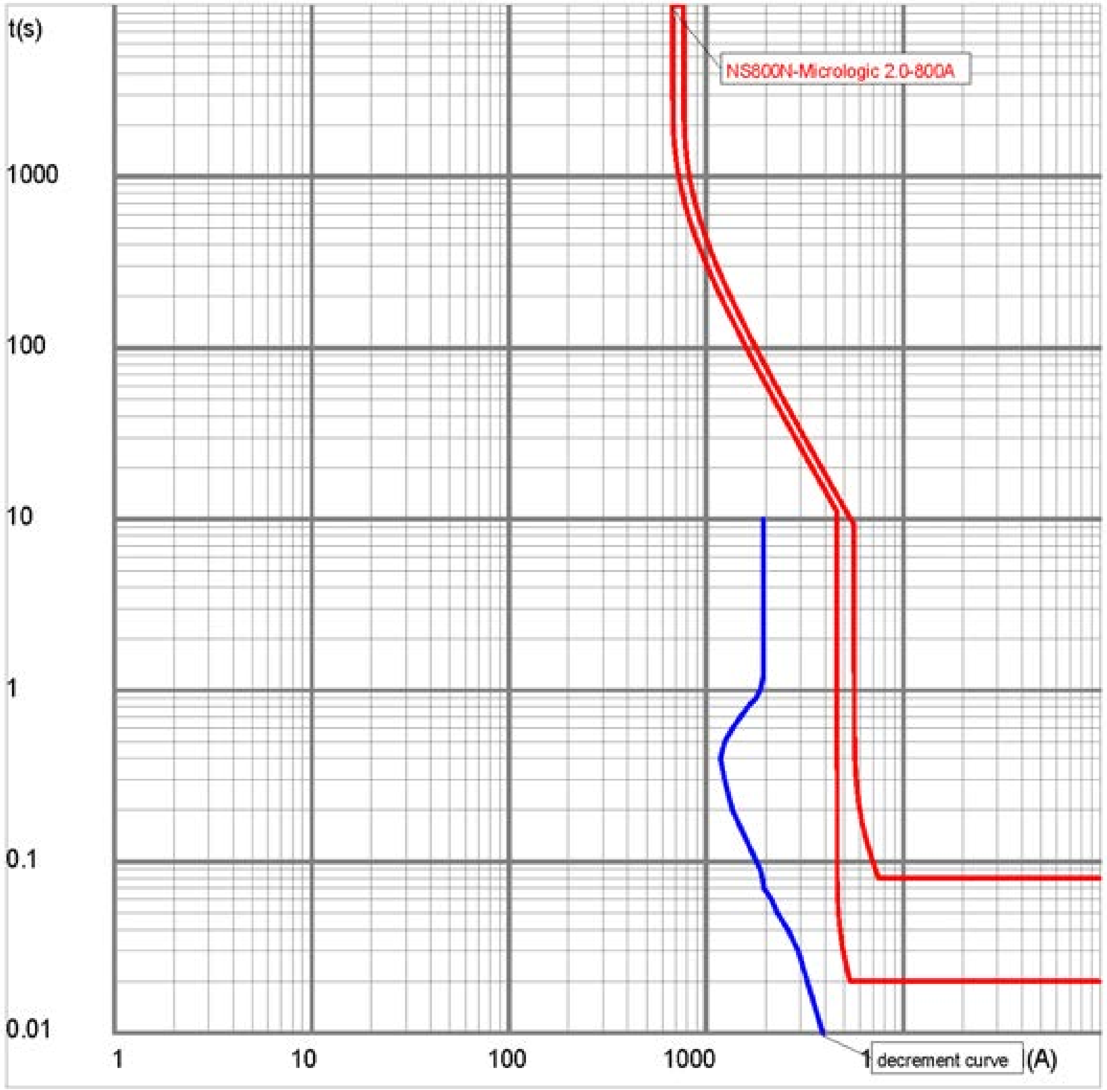
This switchboard relies on cascading protection
Do not use different manufacturer circuit breakers

Why does all this matter?



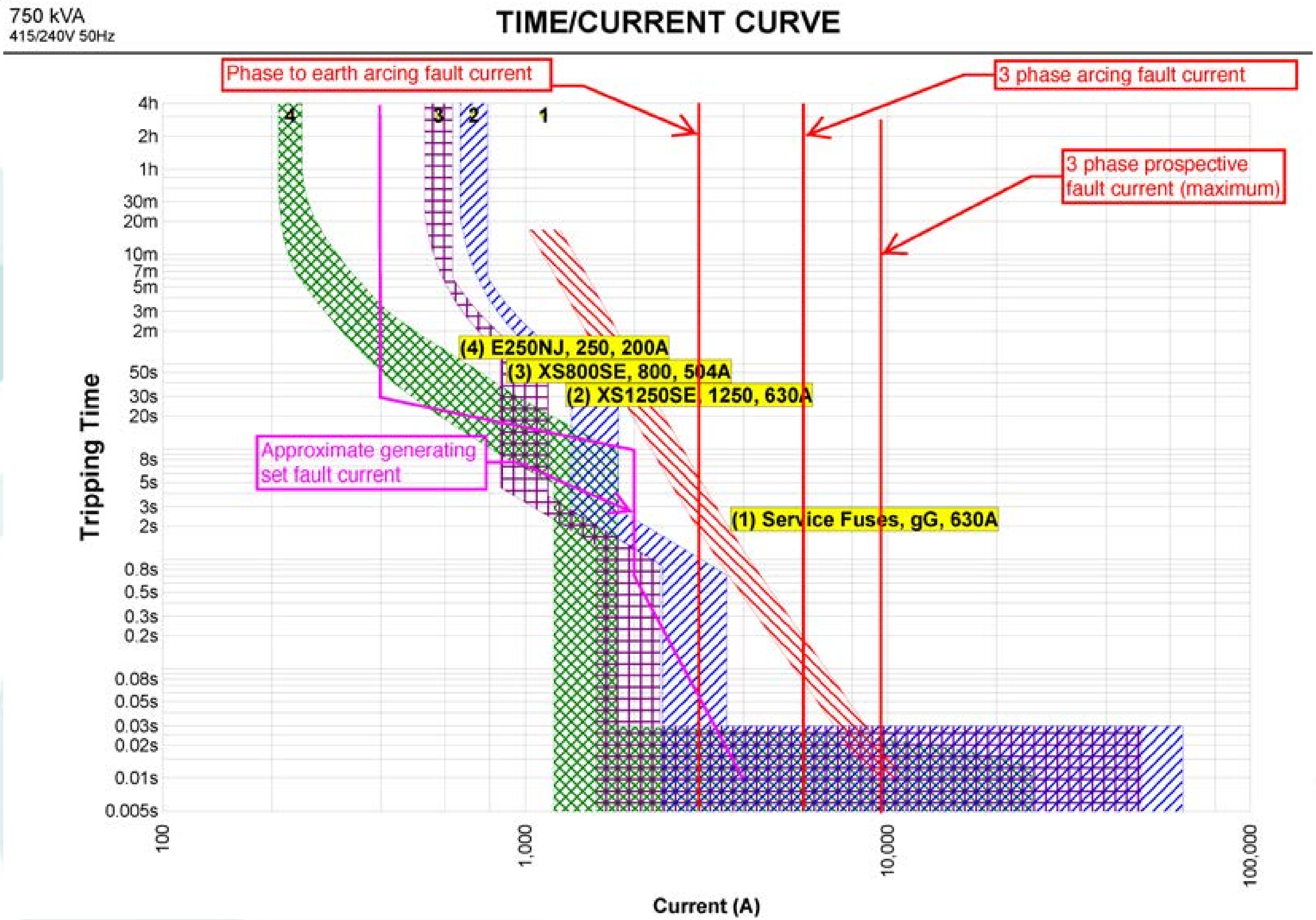
How did this happen?

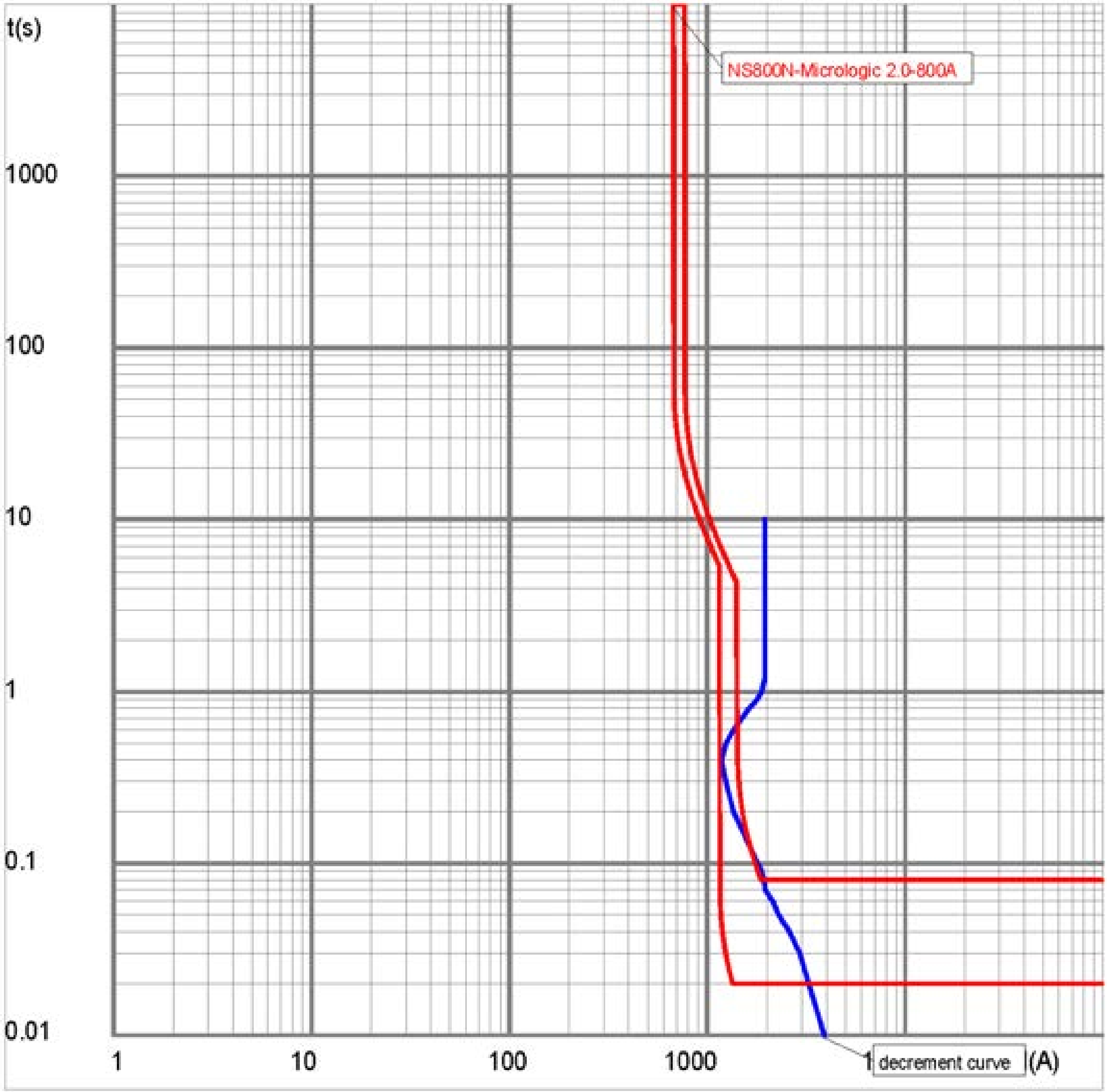




t(s)
1000
100
10
1
0.1
0.01
1
10
100
1000
1
(A)
NS800N-Micrologic 2.0-800A
decrement curve

How do you fix it?





t(s)
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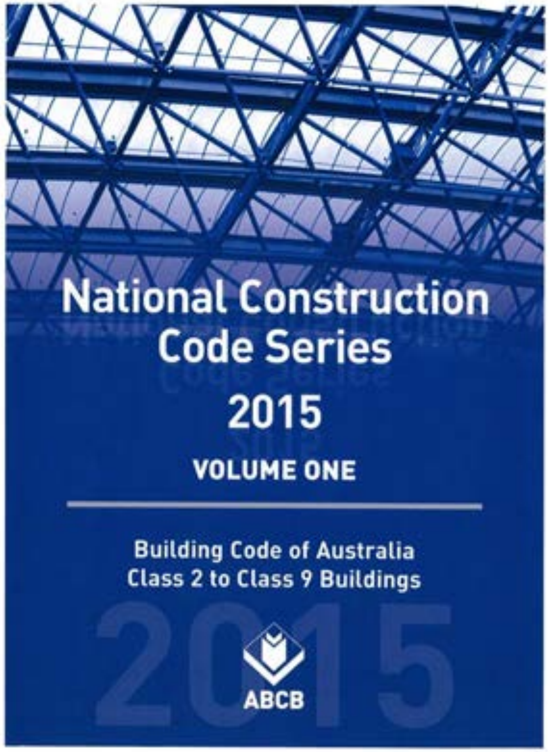
NS800N-Micrologic 2.0-800A
decrement curve

Regulatory Regimes

Generally building work including mechanical work is regulated through the building act and the national construction code



Australian Capital Territory

Building Act 2004

A2004-11

Republication No 26
Effective: 27 May 2014

Republication date: 27 May 2014

Last amendment made by A2014-23

Authorised by the ACT Parliamentary Counsel

Electrical work is regulated via a different and independent system through the occupations licencing act and the electrical safety act

Australian Capital Territory

Construction Occupations (Licensing) Act 2004

A2004-12

Republication No 31

Effective: 18 April 2014

Republication date: 18 April 2014

Last amendment made by A2014-10

Authorised by the ACT Parliamentary Counsel

Australian Capital Territory

Electricity Safety Act 1971

A1971-30

Republication No 24

Effective: 18 April 2014

Republication date: 18 April 2014

Last amendment made by A2014-10

Authorised by the ACT Parliamentary Counsel

The construction occupations act covers ten occupations

Asbestos Assessor

Builder

Building Assessor

Building Surveyor

Drainer

Electrician

Gasfitter

Plumber

Plumbing plan certifier

Works Assessor

ELECTRICAL SAFETY ACT

Calls up AS/NZS 3000 as the primary technical compliance standard.
Requires electrical work to be carried out by someone who is licensed

Punitive in application and defines offences if conditions are not met.
The key features are

- Electrical work must be inspected tested and passed by an inspector before connection to the electricity network
- Electrical work must be carried out by licensed person
- Electrical work must be registered and notified to the registrar. (Access Canberra)
- Electrical work must be registered and as a result can be inspected
- Penalties apply for unsafe work
- Unsafe work can be disconnected.

The act also defines roles and powers of inspectors, rectification of unsafe installations and covers electrical equipment approvals

AS/NZS 3000-2007

Importantly the electrical safety act calls up

AS/NZS3000-2007 as the primary standard for electrical work

Unlike the National Construction Code that is a performance based code,

AS/NZS3000-2007 is a prescriptive set of rules designed for application by electricians and electrical contractors.

WHY IS THIS IMPORTANT

Electrical engineers and designers have no role whatsoever in the electrical approval process

Regardless of an engineering design the electrical contractor is legally responsible for the electrical safety and compliance of electrical installations

Electrical inspection in the act is very diligent

The prescriptive nature of AS/NZS 3000-2007 means that electrical designs need to be fully compatible with the standard. This raises potential for:

- Rejection of final installation by the inspector
- Delay in connection of supply
- Contract variations in order to achieve compliance.

SAFETY SERVICES
EMERGENCY SYSTEMS
ESSENTIAL LIFE SAFETY PLANT

An understanding of safety services is important as it can influence mechanical plant layout and design

Definitions:

AS/NZS 3000-2007 specifically uses the term SAFETY SERVICES

This includes

- Fire and Smoke Control Equipment
- Fire hydrant pumps
- Fire detection and alarm systems
- Sprinkler pumps
- Air Handling systems that exhaust and control the spread of fire and smoke.
- Lifts

and

- Items nominated as “EMERGENCY EQUIPMENT” in the NCC Building Code of Australia

Just to make things interesting

AS/NZS 1668.1 uses the term “ESSENTIAL SERVICES”

Control and Isolation

- Safety Services must be arranged so that control is separate from the control of other equipment
- Circuits for Safety services must be separate from other circuits
- Failure or fault on one safety service must not result in the loss of other safety services
- Faults in the general installation must not result in the loss of supply to safety services – protection grading.
- There must be a metal barrier in the switchboard between safety services section and other sections of the switchboard

Control and Isolation Implications

- Avoid mechanical control panels that mix safety services and non-safety services
- Leave space for separate conduits or spacing between cable reticulation.
- Be careful in the design of electrical protection (see slides on discrimination)

Wiring Systems

All wiring systems must have a WS classification in accordance with AS/NZS 3013.

The selection of WS classification is determined by the relevant Standard

The NCC BCA typically calls up WS 52W

AS 1668.1 Appendix E describes wiring for Smoke controls

The base requirement is for 120 minutes fire rating

APPENDIX E from AS/NZS 1668.1

AIRAH

Rudds Consulting Engineers

APPENDIX E

WIRING SYSTEMS RATING

(Normative)

E1 PROTECTION AGAINST EXPOSURE TO FIRE All wiring systems required to have a protection against exposure to fire shall have a rating of not less than 120 min (WS5), and shall be protected against mechanical and water damage as appropriate to the installation in accordance with Paragraphs E2 and E3.

E2 PROTECTION AGAINST MECHANICAL DAMAGE

E2.1 General Protection against mechanical damage shall be provided for areas listed in Paragraphs E2.2, E2.3, E2.4, E2.5, E2.6 and E2.7. The areas indicated are not considered as a rigid list to be adhered to with no deviations; rather they are considered as a guide to the types of areas and causes of damage to be encountered. Details of ways to achieve the required grade of protection can be found in AS/NZS 3013.

E2.2 WS5X These are areas where physical damage is considered to be unlikely. Examples of these areas include—

(a) masonry riser shafts with strictly limited access;

(b) non-trafficable ceiling void areas;

(c) inaccessible underfloor areas;

(d) underground installation in accordance with building regulations; and

(e) internal domestic and office situations where cabling is mounted on walls at heights above 1.5 m.

E2.3 WS51 These are areas where physical damage by light impact is considered possible. Examples of these areas include—

(a) internal domestic or office situations where cable is mounted on walls at heights below 1.5 m; and

(b) trafficable ceiling void areas where access to building services for maintenance purposes is required.

E2.4 WS52 These are areas where physical damage by impact from manually propelled vehicles is possible. Examples of these areas are—

(a) passageways and storerooms in domestic, office, health care and commercial locations where hand trucks and barrows may be used, and cables are mounted at a height of less than 1.5 m;

(b) plant rooms where only minor equipment is installed; and

(c) workshops where repair and maintenance, on small equipment and furniture, or the like, is carried out, and cables are mounted at a height of less than 2.0 m.

E2.5 WS53 These are areas where physical damage by impact from light vehicles is possible. Examples of these areas include—

(a) car parks and driveways where cars and other light vehicles are present, and cables are mounted at a height of less than 2.0 m; and

(b) storage areas where manually operated devices such as pallet trucks may be operated, and cables are mounted at a height of less than 2.5 m.

E2.6 WS54 These are areas where physical impact from vehicles with rigid frames or rigid objects, the weight of which does not exceed 2.0 t, is possible. Examples of these areas include—

(a) small delivery docks where the cabling is mounted below a height of 3.0 m;

(b) warehouses with pallet storage up to 3.0 m and use of forklift trucks; and

(c) heavy vehicle workshops.

E2.7 WS55 These are areas where physical damage from impact by laden vehicles or objects the laden weight of which exceed 2.0 t, is possible. Examples of these areas include—

(a) loading and delivery docks;

(b) fabrication and maintenance areas for medium to heavy engineering; and

(c) large high pile storage warehouses with forklift trucks.

E2.8 Various protection Where any WS cabling traverses areas of various protection requirements, and it is neither viable nor practicable to change the degree of protection at the transition points, the installed cabling shall comply with the highest requirement of protection.

E3 PROTECTION AGAINST HOSING WITH WATER Where the wiring system is required to maintain its integrity after exposure to fire and subsequent hosing with water, it shall have the suffix W appended to its rating, i.e. WS5XW.

Wiring Systems AS/NZS 3013-2005

AS/NZS 3013 is a test specification that allows cabling and other systems to be tested and certified for fire rating and mechanical strength.

- The first numeral is the fire rating.
- The second numeral describes mechanical resistance to impact
- A third item W can be added to include spraying with water after the fire test.

The basic 2 hour fire rating is WS 5X

Typically WS 52 is the commonly specified cabling system.

Wiring Systems AS/NZS 3013-2005 Important things to know

Access Canberra have a very literal and strict interpretation of fire rating of submains.

Electrical contractors have to provide a dossier that supports the cable selection and the CABLE SUPPORT SYSTEM.

This dossier must include certification of the cable and support system as well as certification that the system is supported from a 2 hour fire rated building element.

There are very few certified cable support systems on the market

In other words if it hasn't undergone a fire test to AS/NZS 3013-2005 don't use it.

Wiring Systems AS/NZS 3013-2005 Implications

- Natspec the standard standard clauses pass the responsibility on to the contractor.
- If you specify a cable type or document cable tray systems, you need to make sure that it is an approved system.
- The certified systems are expensive and bulky. Therefore you need to allow space for them in your planning.
- Existing cable systems although compliant when installed, may not meet current Standards
- AS/NZS 3013 has been amended and re-issued over time with revised testing and certification.
- Many existing systems that were certified in the past won’t necessarily have certification to the current AS/NZS 3013-3005.   (MIMS cables are an example)

Generators and Redundancy

ISSUES TO CONSIDER

- Types of transfer switch based on location
- Generators that back up safety services have additional conditions.
- Brief that require no break return to mains

Types of Transfer Switch

3 POLE 3 POLE – Only used at a Main Switchboard

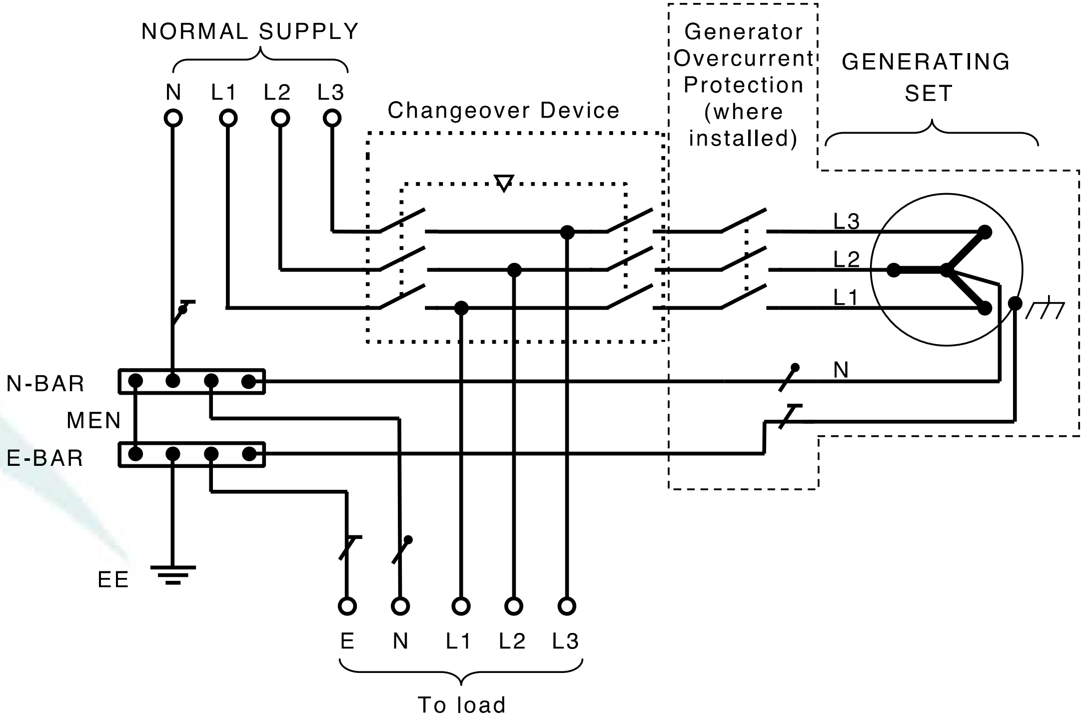


FIGURE 2.2 THREE POLE/THREE POLE CHANGEOVER ARRANGEMENT FOR A THREE-PHASE GENERATING SET INSTALLED ON A SWITCHBOARD WITH AN MEN LINK

Fig 2.2 from AS.NZS 3010

Types of Transfer Switch

3 POLE 4 POLE – Used within an electrical installation away from the main Switchboard

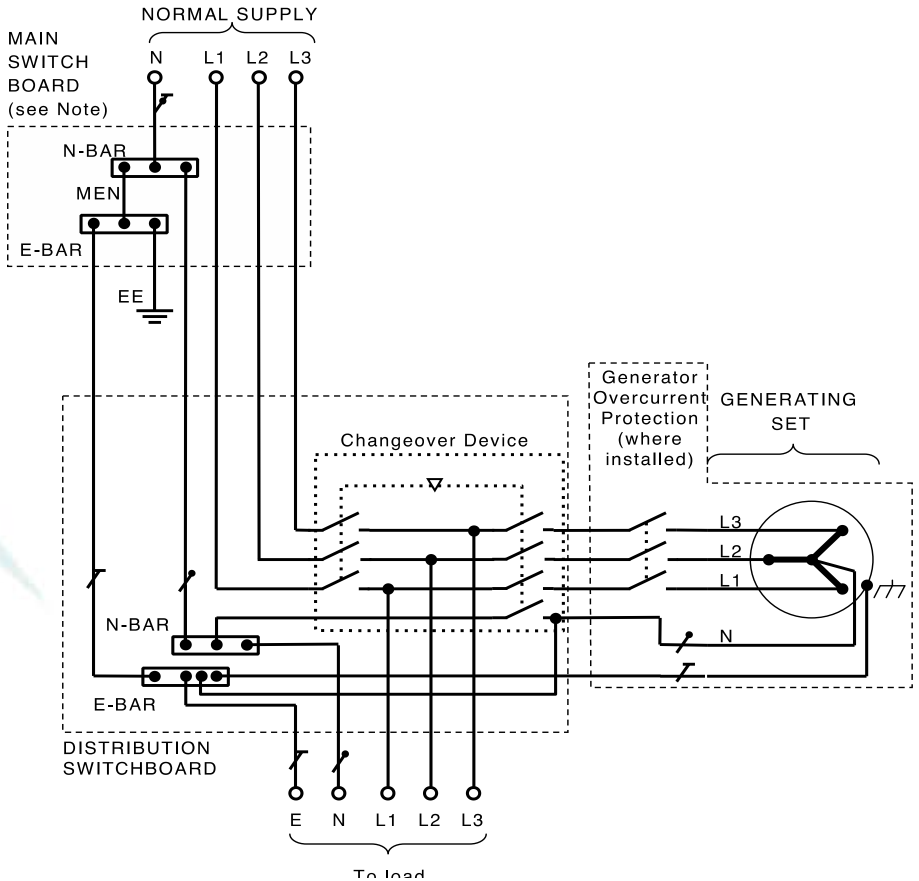


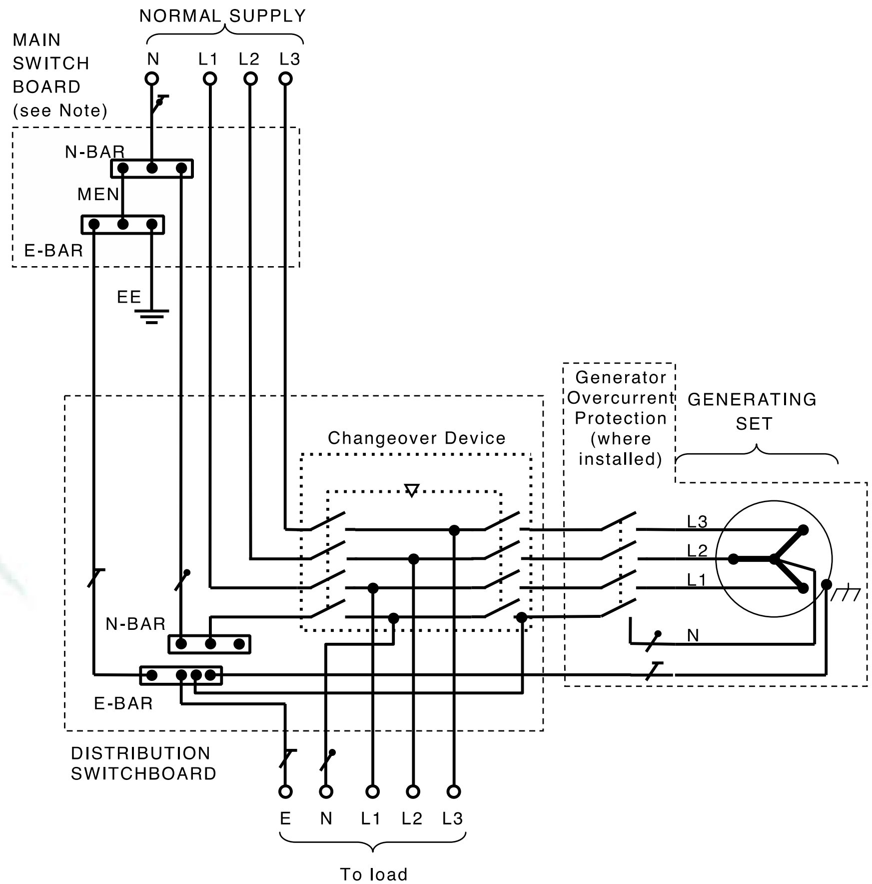
Fig 2.8 from AS.NZS 3010

Types of Transfer Switch

4 POLE 4 POLE – Only use this when you deliberately want to create a separated system.

(Make sure the design is by an experienced electrical engineer)

Fig 2.9 from AS.NZS 3010



Transfer Switches
Dangers and Risks if you get it wrong

Circulating Neutral Currents

- Current can flow in the neutrals of circuits that have been isolated (safety risk)
- Currents can flow in earth cables. (Safety risk)

Incorrect neutral connection

- Fault loop can be increased to the extent that protection doesn’t trip on earth fault

Incorrect use of 4 pole 4 pole

- Loss of neutral/earth reference if transfer switch fails in open position
- Loss of neutral/earth reference during transfer (Problem with down stream UPS)

Transfer Switches
Types Location and Connection

A good rule is to ensure that the specification references AS/NZS 3010

Considerations for Generators that support Safety Services

THE GENERATOR ROOM MUST MEET 2 HOUR FIRE SEPARATION

- Generator room
- Supply Air and exhaust for generator cooling
- Fuel system

THE CABLING SYSTEMS FROM THE GENERATOR TO THE SAFETY SERVICES MUST ACHIEVE WS 5X MINIMUM

THE LOCATION OF THE GENERATOR CONNECTION IS LIMITED BY AS/NZS 3000-2007

- At the Main Switch Board
- At the safety services control panel

No Break Transfer

BRIEFS THAT SPECIFY NO BREAK TRANSFER INTRODUCE ADDITIONAL REQUIREMENTS

The ActewAGL service and installation rules will allow this under very strict conditions.

If the transfer takes more than 400 milliseconds the system is considered to be an embedded generator.

This requires a detailed formal submission to ActewAGL and imposes very strict control and protection requirements on the generator system.

Typically costing $60,000 in protection and controls

Short time parallel systems still require a formal submission but may not need the backup protection system.

For these briefs make sure you engage qualified and experienced designer.

Questions

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