higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NON-NATIONAL CERTIFICATE

INSTALLATION RULES

(Second paper)

(11040432)

30 July 2021 (X-paper)
09:00–12:00

Nonprogrammable calculators may be used.

This question paper consists of 7 pages and an information sheet of 5 pages.

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DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

NON-NATIONAL CERTIFICATE
INSTALLATION RULES
(Second paper)
TIME: 3 HOURS
MARKS: 100

INSTRUCTIONS AND INFORMATION

1. Answer all the questions.
2. Read all the questions carefully.
3. Number the answers according to the numbering system used in this question paper.
4. Answers must show that the candidate fully understands the context of the relevant question.
5. Candidates must pass PAPER 1 and PAPER 2 with 50% each.
6. Candidates may write both examination papers during the same examination period.
7. For accreditation purposes, candidates must meet the requirements prescribed by the Department of Labour.
8. No condonations will be considered
9. Write neatly and legibly

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QUESTION 1: SANS 10142 OF 2020: INSTALLATION REQUIREMENTS: CURRENT-CARRYING CAPACITY OF CONDUCTORS AND CABLES

Complete the following sentences by writing only the missing word or words next to the question number. (1.1–1.4) in the ANSWER BOOK.

1.1 The current-carrying capacity of each conductor in a circuit that comes from a distribution board shall be the same at each point in the circuit, but only if the conductor of the lowest current-carrying capacity is protected against overcurrent in accordance with 6.2.1.1.

1.1.1 The current-carrying capacity of conductors at one or more points in the circuit may be…. (1)

1.1.2 One or more spurs that have conductors of reduced current-carrying capacity may be… (1)

1.1.3 At only one point may a circuit be split into two or more branches, each having conductors of reduced… (1)

1.2 Except in the case of ring circuits there shall be no branches, tee-offs or socket outlets along parallel conductors and, where two or more conductors are connected in parallel, the conductors shall:

1.2.1 have the same characteristics in respect of conductor material … (2)

1.2.2 follow the same route and have the same... (1)

1.3 The current-carrying capacity of the circuit conductor for a motor shall be at least equal to (1.3.1) … Possible increase in temperature owing to long or frequent starting shall (1.3.2)… (2)

1.4 In the case of a circuit that supplies two or more motors, the current-carrying capacity of the conductor shall… (2)

[10]

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QUESTION 2: SANS 10142-1 OF 2020: INSTALLATION REQUIREMENTS: CURRENT-CARRYING CAPACITY OF CONDUCTORS AND CABLES

The sustained current-carrying capacity I (A) of a cable buried directly in the ground can be calculated using the equation I = Is × F1 × F2 × F3 × F4 (A).

2.1 Explain each of the following rating factors in the equation:

2.1.1 F1

2.1.2 F2

2.1.3 F3

2.1.4 F4

(4 × 1) (4)

2.2 25 mm² × 4 and a 35 mm² × 4-core copper cable plus earth are installed and buried 1200 mm directly underground, touching one another. The soil temperature is 35 °C and the thermal resistance of the soil is 4 km/W.

Calculate the sustained current-carrying capacity of each cable. (6)

[10]

QUESTION 3: SANS 10142-1 OF 2020: INSTALLATION REQUIREMENTS: INSTALLATION OF CONDUCTOR AND CABLES

3.1 All conductors of nominal cross-sectional areas that are less than 16 mm² shall be of annealed copper.

Give THREE exceptions where alternative material may be used. (3)

3.2 Conductors of nominal cross-sectional areas exceeding 2,5 mm² shall be stranded. However, there are certain exceptions in which solid conductors may be used.

Give those exceptions. (7)

[10]

QUESTION 4: SANS 10142-1 OF 2020: INSTALLATION REQUIREMENTS: DISTRIBUTION BOARDS

Briefly explain requirements regarding the switch disconnectors for distribution boards. **[10]**

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QUESTION 5: SANS 10142-1 OF 2020: INSTALLATION REQUIREMENTS: PROTECTION

Explain the requirements regarding short-circuit protection with respect to each of the following:

5.1 Breaking capabilities (2)

5.2 Installation (2)

5.3 Supplies for socket outlets and luminaires (3)

5.4 PVC insulated cable at cross-sectional area ≤4 mm² (3)

[10]

QUESTION 6: SANS 10142-1 OF 2020: INSTALLATION REQUIREMENTS: FIXED APPLIANCES

Indicate whether the following statements are TRUE or FALSE by writing only 'True' or 'False' next to the question number (6.1-6.10) in the ANSWER BOOK

6.1 Fixed appliances do not form part of an electrical installation other than their position in relation to the supply and the wiring carried out between different parts of the appliances.

6.2 Where a fan or heater is included in a luminaire, the luminaire is not regarded as a fixed appliance.

6.3 If the luminaire circuit is protected by earth leakage a disconnector is not required.

6.4 In the case where a disconnector is built on the appliance a separate disconnecting device shall be provided in the fixed installation to allow for the total removal of the appliance.

6.5 A socket outlet may supply more than one fixed appliance.

6.6 A dedicated circuit shall be provided for water heaters and there may be more than one water heater on each circuit.

6.7 A dedicated circuit(s) shall be provided for all cooking appliance(s) that are fixed and are rated less than 16 A.

6.8 The cables used to terminate underfloor heating shall be metal-sheathed, double-insulated or armoured only.

6.9 Except in the case of a direct on-line starting, a starter shall have an over-voltage release that open the circuit if the supply voltage drops sufficiently to cause the motor to stop.

6.10 All accessible extraneous conductive parts associated with a water pump motor shall be bonded to the earth continuity conductor.

(10 × 1) **[10]**

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QUESTION 7: SANS 10142-1 OF 2020: VERIFICATION AND CERTIFICATION

Explain each of the following if a reading of 2,556 kA is obtained during testing of prospective short-circuit current on a single-phase distribution board:

7.1 How was the test performed using a 3-lead PSCC/loop tester? (2)

7.2 What will be the minimum KA rating of the main switch disconnector?

Substantiate your answer. (2)

7.3 What is the maximum current rating of the main switch disconnector for which this method of testing can be performed? (1)

7.4 Give FIVE alternative ways to obtain a PSCC on a three-phase circuit. (5)
[10]

QUESTION 8: SANS 10142-1 OF 2020: VERIFICATION AND CERTIFICATION

8.1 Give SEVEN electrical tests that can only be performed when the supply is on. (7)

8.2 Give TWO supplementary test reports that may be added to the test report for all electrical installations. (2)

8.3 What is the maximum resistance allowed when performing continuity of bonding tests? (1)
[10]

QUESTION 9: SANS 10142-1 OF 2020: ANNEXURE D – CALCULATION OF VOLTAGE DROP

Study FIGURE 1 and answer the questions.

NOTE: Use method 3 for cable installation of stove circuit.

9.1 Calculate the voltage at the distribution board. (3)

9.2 Calculate the correct cable size to feed the stove, and explain the reason why you think it is the correct cable. (5)

9.3 Calculate the maximum voltage drop between the meter panel and the stove. (2)
[10]

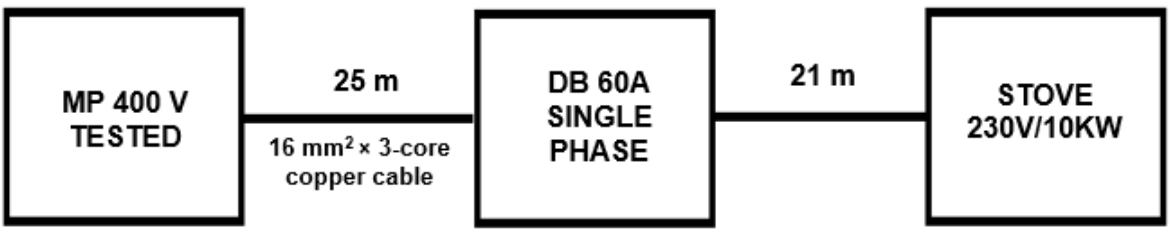


FIGURE 1

QUESTION 10: SANS 1973-3 OF 2020: SAFETY OF ASSEMBLIES WITH A RATED PROSPECTIVE SHORT-CIRCUIT CURRENT OF UP TO AND INCLUDING 10 KA.

Define each of the following terms:

10.1	Assembly	(3)
10.2	Pollution degree	(4)
10.3	Series-connected (cascaded) system	(3)
		[10]

TOTAL: 100

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INSTALLATION RULES P2

INFORMATION SHEET

Table 6.8 — Multicore PVC insulated armoured cables buried directly in the ground (SANS 1507) Current-carrying capacity

Soil temperature: 25 °C
Maximum conductor temperature: 70 °C

1	2	3	4	5
Nominal conductor size mm²	Standard rating[a] — Copper cables A			
	Cables buried in the ground		Cables in pipes or ducts buried in the ground	
	Two-core	Three-core or four-core	Two-core	Three-core or four-core
	Cu	Cu	Cu	Cu
1,5 2,5	29 37	24 32	23 31	20 26
4 6 10	50 62 83	42 53 70	41 51 68	34 43 58
16 25 35	107 142 171	91 119 143	88 116 139	75 96 116
50 70 95	203 249 299	169 210 251	165 203 244	138 171 205
120 150 185	339 380 430	285 320 361	278 311 354	234 263 298
240 300 400	496 554 624	416 465 522	410 459 517	344 385 441
NOTE See table 6.4(b) for voltage drop.				
[a] Standard conditions of installation: Depth of burial 0,5 m; Thermal resistivity of soil 1,2 K m/W; and Each cable is thermally independent.				

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INFORMATION SHEET (CONTINUED)

Table 6.8 (*concluded*)

1	2	3	4	5
Nominal conductor size mm²	Standard rating[a] — Aluminium cables A			
	Al	Al	Al	Al
25	106	90	86	73
35	128	108	104	87
50	151	129	123	104
70	188	158	153	130
95	225	192	184	157
120	–	219	–	179
150	–	245	–	201
185	–	278	–	229
240	–	324	–	268
300	–	366	–	304
400	–	–	–	–

NOTE See table 6.7(b) for voltage drop.

[a] Standard conditions of installation:
Depth of burial 0,5 m;
Thermal resistivity of soil 1,2 K m/W; and
Each cable is thermally independent.

Table 6.11 — Correction factors for soil temperature

Maximum conductor temperature: 70 °C

1	2
Soil temperature °C	Correction factors for cables buried directly or buried in pipes in the ground
10	1,15
15	1,11
20	1,05
25	1,00
30	0,94
35	0,88
40	0,82

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INFORMATION SHEET (CONTINUED)

Table 6.12 — Correction factors for thermal resistivity of soil

1	2	3
Thermal resistivity of soil K·m/W	Correction factors	
	Cables buried directly in the ground	Cables installed in pipes buried in the ground
0,7	1,17	1,07
0,8	1,13	1,05
0,9	1,09	1,04
1,0	1,06	1,02
1,2	1,00	1,00
1,5	0,93	0,96
2,0	0,83	0,91
2,5	0,76	0,87
3,0	0,71	0,83
3,5	0,65	0,8
4,0	0,61	0,77
NOTE The correction factors given have been averaged over the range of conductor sizes. Consult SANS 10198-4 if specific conductor size correction factors are required.		

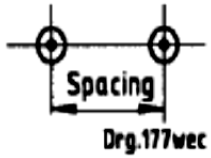
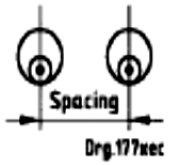
Table 6.16 — Correction factors for depth of cables buried in the ground

1	2	3
Depth m	Correction factors	
	Cables buried directly in the ground	Cables installed in pipes buried in the ground
0,5	1,0	1,0
0,6	0,98	0,99
0,8	0,96	0,98
1,0	0,94	0,96
1,25	0,92	0,95
1,5	0,9	0,94

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INFORMATION SHEET (CONTINUED)

Table 6.13 — Correction factors for grouping of cables buried in the ground

1	2	3	4	5	6	7	8	9	10	11
Cable or pipe arrangement	Number of cables in group	Correction factors								
		Cables buried directly in the ground					Cables installed in pipes in the ground			
		Centre-line spacing mm								
		Touching	150	300	450	600	Touching	300	450	600
 Horizontal spacing 	2	0,81	0,87	0,91	0,93	0,94	0,90	0,93	0,95	0,96
	3	0,70	0,78	0,84	0,87	0,90	0,82	0,87	0,90	0,93
	4	0,63	0,74	0,81	0,86	0,89	0,78	0,85	0,89	0,91
	5	0,59	0,70	0,78	0,83	0,87	0,75	0,82	0,87	0,90
	6	0,55	0,67	0,76	0,82	0,86	0,72	0,81	0,86	0,90
	7	0,52	0,65	0,75	0,81	0,86	0,70	0,80	0,86	0,89
	8	0,50	0,64	0,74	0,81	0,85	0,69	0,79	0,85	0,89
	9	0,48	0,63	0,74	0,80	0,85	0,68	0,78	0,84	0,88
	10	0,47	0,62	0,73	0,80	0,85	0,67	0,78	0,84	0,88
	11	0,45	0,61	0,72	0,80	0,84	0,66	0,77	0,84	0,88
	12	0,44	0,60	0,72	0,79	0,84	0,65	0,77	0,83	0,87

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INFORMATION SHEET (CONTINUED)

Table 6.4(a) — Multicore PVC insulated armoured cables (SANS 1507)
Current-carrying capacity copper conductors

Ambient temperature: 30 °C
Conductor operating temperature: 70 °C

1	2	3	4	5
Conductor cross-sectional area	Installation method 3 (clipped direct)		Installation method 4 (on a perforated horizontal or vertical cable tray), or installation method 6 (in free air)	
	One two-core cable, single-phase a.c. or d.c.	One three-core or four-core cable, three-phase a.c.	One two-core cable, single-phase a.c. or d.c.	One three-core or four-core cable, three-phase a.c.
mm²	A	A	A	A
1,5	21	18	22	19
2,5	28	25	31	26
4	38	33	41	35
6	49	42	53	45
10	67	58	72	62
16	89	77	97	83
25	118	102	128	110
35	145	125	157	135
50	175	151	190	163
70	222	192	241	207
95	269	231	291	251
120	310	267	336	290
150	356	306	386	332
185	405	348	439	378
240	476	409	516	445
300	547	469	592	510
400	621	540	683	590

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