higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T910**(E)**(A3)T

NONNATIONAL CERTIFICATE

INSTALLATION RULES
(Second Paper)

(11040432)

3 April 2017 (X-Paper)
09:00–12:00

This question paper consists of 8 pages, 1 addendum and an information sheet of 6 pages.

INSTRULEP2

DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

NONNATIONAL 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. Even though NOT explicitly stated in a question, ALL the answers must comply with the relevant codes and/or requirements of the SABS/SANS Publications (latest edition) and the Occupational Health and Safety Act Regulations.
5. The answers need NOT be word-perfect in all respects according to the publications, but must show that the candidate fully understands the context of the relevant questions. (ANY meaningful answer will be marked.)
6. The necessary tables are supplied.
7. Candidates must pass PAPER 1 and PAPER 2 with 50% each. Both examination papers may be written during the same examination period, however, candidates need not pass both examinations during the same trimester. The second examination must be passed within 12 months of the first otherwise both examinations must be rewritten. If a candidate obtains 75% of 100 marks in ANY ONE of the examinations, he/she will be permanently exempted from rewriting that examination. An appropriate statement of results will be issued. For accreditation purposes ALL candidates must meet the requirements prescribed by the Department of Labour.
8. NO condonation will be considered.
9. Start each question on a NEW page.
10. Write neatly and legibly.

QUESTION 1: SANS 10142 PART 1 OF 2008: EARTHING

1.1 On a TT earthing system all exposed conductive parts of a consumer's installation are connected to a consumer's earth electrode which is electrically independent of the source earth.

Explain with the use of a diagram how to conduct an earth electrode test. (5)

1.2 Regulation 6.12.1 refers to requirements for earth continuity conductors.

Complete the following sentences:

1.2.1 An earth continuity conductor shall consist of …

1.2.2 An earth continuity conductor shall, if it forms part of a cable other than a flexible cable, comply with …

1.2.3 An earth continuity conductor shall, if it forms part of a flexible cable, be of the same …

1.2.4 An earth continuity conductor shall, if it does not form part of a cable or flexible cable, have …

1.2.5 An earth continuity conductor shall be able to carry the prospective fault current without …

(5 × 1) (5)
[10]

QUESTION 2: SANS 10142 PART 1 of 2008: METHODS OF CABLE INSTALLATION

2.1 Regulation 6.2.5 refers to the application of tables and correction factors for the current-carrying capacity of a cable.

List FIVE factors that should be considered when determining the current-carrying capacity of a cable for a particular method of installation. (5)

2.2 Regulation 6.4.3 refers to the fixing of cables.

Complete the following sentences:

2.2.1 To avoid damage to the sheath of a cable, only appropriate …

2.2.2 Cables shall be fixed in such a way as to …

2.2.3 A cable shall not be bent more than …

2.2.4 If a cable is not run on racks or in pipes or ducts, it shall …

2.2.5 Each AC circuit shall be so arranged that …

(5 × 1) (5)
[10]

QUESTION 3: SANS 10142 PART 1 OF 2008: INSPECTION AND TESTING ON CERTIFICATE OF COMPLIANCE

3.1 State 10 inspections listed on the certificate of compliance that needs to be done by a registered person when inspecting an electrical installation. (10 × ½) (5)

3.2 State 10 tests of the 16 tests that should be conducted on electrical installations according to the certificate of compliance. (10 × ½) (5)

[10]

QUESTION 4: SANS 10142 PART 1 OF 2008: DISTRIBUTION BOARDS

According to Regulation 6.6.2 the installation of busbars in distribution boards should comply with certain conditions.

List the conditions regarding the following instances:

4.1 The size and design of the busbar system (1)

4.2 Where fishplates are used for busbar connections (1)

4.3 The standard colour coding for L1, L2 and L3 busbars (3)

4.4 The standard colour coding for the neutral busbar (1)

4.5 The standard colour coding for the earthing busbar (1)

4.6 If colour is used for control wire coding, what colour may be used on the busbar? (3)

[10]

QUESTION 5: SANS 10142 PART 1 OF 2008: INSTALLATION OF CONDUCTORS AND CABLES

5.1 Construction

Regulation 6.3.2.1 states that conductors of nominal cross-sectional area exceeding 2,5 mm^2 shall be stranded, except in certain cases where solid conductors may be used.

List SIX of these cases. (6)

5.2 Identification

Regulation 6.3.3.3 refers to the means of identification for a DC circuit that may be done by colours or by symbols.

5.2.1 List the identification for equipotential bonding, earth continuity and protective earthing conductors. (2)

5.2.2 Where colours are used, what colour must the positive conductor be? (1)

5.2.3 Where colours are used, what colour must the negative conductor be? (1)

[10]

QUESTION 6: SANS 10142 PART 1 OF 2008 (INSTALLATION REQUIREMENTS)

6.1 Regulation 6.15.6 Positioning of socket outlets

6.1.1 A socket outlet that is exposed to the weather (or to the condensation, dripping, splashing or accumulation of water) shall have an IP rating in accordance with SANS 60529/IEC 60529. The rating applies whether a plug is in or out.

What is this minimum IP rating? (1)

6.1.2 Name TWO conditions for the mounting of a floor-mounted socket outlet (recessed or not). (2)

6.1.3 A socket outlet shall not be installed within a radius of 2 m of a water tap (in the same room) unless the socket-outlet complies with one of two conditions.

Name these TWO conditions. (2)

6.2 Regulation 6.16 Fixed appliances

6.2.1 Unless part of the appliance or self-contained in their own enclosure, control components of fixed appliances that form part of the fixed installation, including their input terminations and associated protective switchgear that are not mounted in the distribution board, shall be incorporated in a suitable enclosure or enclosures.

List THREE conditions these enclosures should comply with. (3)

6.2.2 The connections between circuit conductors and appliance conductors shall comply with two conditions.

Name these TWO conditions. (2)
[10]

QUESTION 7: SANS 10142 PART 1 OF 2008 (GENERAL)

Indicate whether the following statements are TRUE or FALSE. Choose the answer and write only 'true' or 'false' next to the question number (7.1–7.10) in the ANSWER BOOK.

7.1 Wiring through building elements

If the building element is a fire break, the space around a cable need not be filled with nonflammable material.

7.2 Wireways

When a wire way is installed, joints other than expansion joints shall be at least as rigid as the wire way itself.

7.3 Fixing of rigid nonmetallic wire ways

Unless otherwise recommended by the manufacturer, a rigid nonmetallic wire way shall span not more than 2 m between supports.

7.4 Earthing of flexible conduit

Metal flexible conduit, even if insulated, need not be connected to earth and shall not be used as an earth continuity conductor.

7.5 A neutral conductor shall not have a single-pole disconnecting device.

7.6 A wire way shall be used as an earth continuity conductor.

7.7 Metal enclosures on PVC conduit should be earthed if they can become live and can be touched.

7.8 The aim of bonding is to bring all the bonded parts to earth.

7.9 In a lighting circuit, a luminaire may not be fed from a socket outlet in a wall.

7.10 The anticipated load of a circuit that feeds socket outlets shall not exceed 8 kW.

(10 × 1) **[10]**

QUESTION 8: SANS 10142 PART 1 OF 2008 (ANNEXURES)

8.1 Refer to the ADDENDUM (attached) and give FOUR reasons for using this document. (4)

8.2 ANNEXURE G

Determine how many 6 mm² single multistrand PVC conductors may be added to the following installation according to the code by using the attached tables:

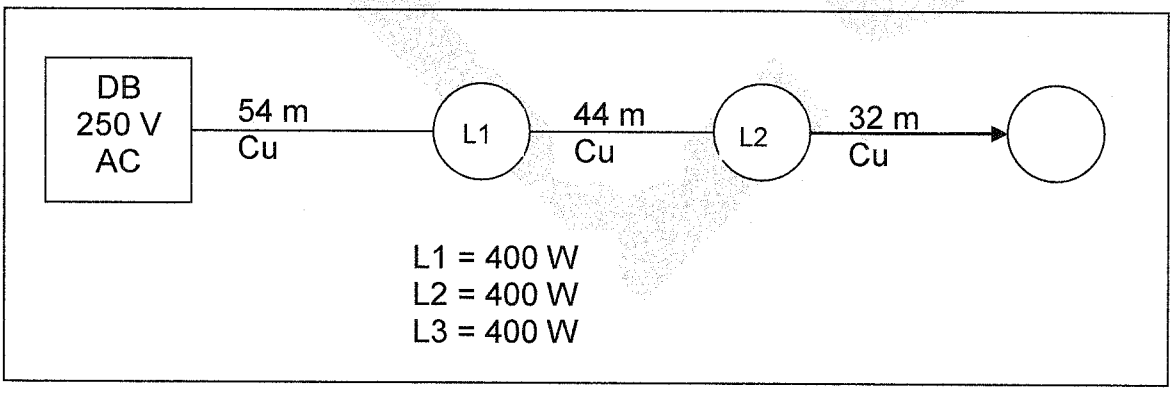
- 32 mm metal conduit
- 2 × 1,5 mm² red PVC conductors
- 3 × 4 mm² black PVC conductors
- 1 × 6 mm² green PVC conductor (3)

8.3 ANNEXURE L (SPDs)

Draw a circuit of a single-phase installation which incorporates two SPDs for a TN-S earthing system. (3)
[10]

QUESTION 9: SANS 10142 PART 1 OF 2008: ANNEXURE E (CALCULATION OF VOLT DROP)

Atudy the figure below to answer the questions.



Calculate the following:

9.1 The minimum size conductor for this installation (4)

9.2 The volt drop between section DB and L1 (1)

9.3 The volt drop between section L1 and L2 (1)

9.4 The volt drop between section L2 and L3 (1)

9.5 The total volt drop of the circuit (1)

9.6 The total percentage volt drop (1)

9.7 Is this percentage volt drop permissible? (1)
[10]

QUESTION 10: SANS 10142 PART 1 OF 2008: SECTION 8.5.6 (PROSPECTIVE SHORT-CIRCUIT CURRENT ON DC CIRCUITS)

10.1 Calculate the PSCC of a DC supply installation if the following information is given:

- 100 cell lead acid battery with a full load capacity of 200 A.h
- Total internal resistance per cell is 0,011 ohm
- Total resistance of the battery pole connectors is 1,5 ohm
- Total supply cable length: red = 50 m and black = 50 m with a cross sectional area of 25 mm² copper

$$EB = 1{,}05 \times U_{NB} \left(\text{where } U_{NB} = 2{,}0 \text{ V/cell}\right)$$

$$PSCC = \frac{E_B}{R_{BBr}}$$

$$R_{BBr} = \left(0{,}9 \times R_B\right) + R_{BL} + R_y$$

(8)

10.2 As what will the location for the installation above be classified? Substantiate the answer. (2)
[10]

TOTAL: 100

ADDENDUM

Annex K
(informative)

Notification of a potential danger
(See 8.7.6 and 8.7.10)

To: .....

..... (The supplier)

.....

From: .....

..... (The registered person)
Amdt 8

.....

During an inspection in terms of SANS 10142-1, *The wiring of premises – Part 1: Low-voltage installations,* performed at stand

No. .....

situated at .....

.....

.....

I, ... , Registration No. .....
Amdt 7

found the following potential danger:

❑...Elevated voltage on neutral of ..... V,

❑...Voltage not within limits ..... V,

❑...Other .....

Signed: ..... Date: .....

INFORMATION SHEET

Table 6.23 — Values of *C* for conductor nominal cross-sectional area

1	2
Nominal cross-sectional area of conductor mm²	**Value of *C***
1	8
1,5	10
2,5	14
4	17
6	22
10	30
16	42
25	65
35	84
50	118
70	152

Table 6.24 — Values of *K* for conduit diameter

1	2
Value of *K*	**Conduit diameter** mm
90	20
144	25
240	32
398	40
640	50

Table 6.22 c Capacity of conduit for single-core cables

1	2	3	4	5	6
Nominal cross-sectional area of conductors mm²	**Number of cables that may be used in conduit**				
	Conduit diameter mm				
	20	**25**	**32**	**40**	**50**
1	11	16	–	–	–
1,5	9	13	–	–	–
2,5	6	9	17	–	–
4	5	7	14	–	–
6	4	6	10	18	–
10	3	4	8	13	–
16	–	3	5	9	–
25	–	2	3	6	9
35	–	–	2	4	7
50	–	–	–	3	5
70	–	–	–	2	4

INFORMATION SHEET

Table E.2(a) — Maximum lengths, in metres, of copper cables/circuits at a given circuit-breaker current rating for single phase (F_V = 2)

1	2	3	4	5	6	7	8	9	10
Nominal cross-sectional area mm^2	Circuit-breaker current rating A								
	10	15	20	25	30	40	50	60	80
1	26	–	–	–	–	–	–	–	–
1,5	39	26	–	–	–	–	–	–	–
2,5	66	44	33	26	–	–	–	–	–
4	104	69	52	41	34	–	–	–	–
6	159	106	79	63	53	39	–	–	–
10	261	174	130	104	87	65	52	43	–
16	410	273	205	164	136	102	82	68	51

NOTE 1 Power factor is unity.
NOTE 2 Maximum permissible voltage drop between phases and neutral if full circuit-breaker loading is 5 % of 230 V, i.e. 11,5 V.
NOTE 3 Only popular circuit-breaker ratings have been selected.

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INFORMATION SHEET

Table E.1 – Impedance of 600/1 000 V conductors that comply with SANS 1507

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

1	2	3	4	5	6	7
Nominal cross-sectional area of conductor mm²	**Conductor resistance *R* for a.c. circuits** Ω/km		**Conductor reactance *X* for a.c. circuits** Ω/km		**Conductor resistance *R* for d.c. circuits** Ω/km	
	Material of conductor					
	Copper Cu	**Aluminium Al**	**Copper Cu**	**Aluminium Al**	**Copper Cu**	**Aluminium Al**
1	21,9	36,0	0,107	0,107	21,9	36,0
1,5	14,6	24,0	0,100	0,100	14,6	24,0
2,5	8,7	14,4	0,095	0,095	8,7	14,4
4	5,5	9,0	0,093	0,093	5,5	9,0
6	3,6	6,0	0,090	0,090	3,6	6,0
10	2,2	3,6	0,084	0,084	2,2	3,6
16	1,4	2,3	0,080	0,080	1,4	2,2
25	0,88	1,44	0,079	0,079	0,87	1,44
35	0,63	1,03	0,076	0,076	0,62	1,03
50	0,44	0,72	0,076	0,076	0,44	0,72
70	0,31	0,52	0,074	0,074	0,31	0,51
95	0,23	0,38	0,073	0,073	0,23	0,38
120	0,18	0,30	0,072	0,072	0,18	0,30
150	0,15	0,24	0,072	0,072	0,15	0,24
185	0,12	0,20	0,072	0,072	0,12	0,19
240	0,095	0,156	0,072	0,072	0,091	0,150
300	0,077	0,127	0,071	0,071	0,073	0,120
400	0,060	0,099	0,071	0,071	0,055	0,090
500	0,050	0,083	0,070	0,070	0,044	0,072
630	0,043	0,071	0,069	0,069	0,035	0,057
800	0,037	0,061	0,058	0,058	0,027	0,045
1 000	0,033	0,054	0,049	0,049	0,022	0,036

INFORMATION SHEET

Table 6.4(b) — Multicore PVC insulated armoured cables (SANS 1507)
Voltage drop (per ampere per metre) copper conductors

Amdt 1

Conductor operating temperature: 70 °C

1	2	3			4		
Conductor cross-sectional area mm²	**Two-core cable d.c.** ‡ mV/A/m	**Two-core cable, single-phase a.c.** ‡ mV/A/m			**Three-core or four-core cable, three-phase a.c.** mV/A/m		
1,5	29	29			25		
2,5	18	18			15		
4	11	11			9,5		
6	7,3	7,3			6,4		
10	4,4	4,4			3,8		
16	2,8	2,8			2,4		
		r	x	z	r	x	z
25	1,75	1,75	0,170	1,75	1,50	0,145	1,50
35	1,25	1,25	0,165	1,25	1,10	0,145	1,10
50	0,93	0,93	0,165	0,94	0,80	0,140	0,81
70	0,63	0,63	0,160	0,65	0,55	0,140	0,57
95	0,46	0,47	0,155	0,50	0,41	0,135	0,43
120	0,36	0,38	0,155	0,41	0,33	0,135	0,35
150	0,29	0,30	0,155	0,34	0,26	0,130	0,29
185	0,23	0,25	0,150	0,29	0,21	0,130	0,25
240	0,180	0,190	0,150	0,24	0,165	0,130	0,21
300	0,145	0,155	0,145	0,21	0,135	0,130	0,185
400	0,105	0,115	0,145	0,185	0,100	0,125	0,160

‡ In the case of single-phase circuits, the return path has been accounted for in the values given.

Amdt 5

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INFORMATION SHEET

Table 6.28 — Minimum size and maximum length of copper earth continuity conductors

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Rated current of protective device	Minimum nominal cross-sectional area of copper earth continuity conductors mm²													
	1	1,5	2,5	4	6	10	16	25	35	50	70	95	120	185
A	Maximum length of earth continuity conductor m													
1	805	1 207	–	–	–	–	–	–	–	–	–	–	–	–
1,4	503	755	1 258	–	–	–	–	–	–	–	–	–	–	–
2,0	402	604	1 006	–	–	–	–	–	–	–	–	–	–	–
2,5	322	483	805	1 288	–	–	–	–	–	–	–	–	–	–
3,2	252	377	629	1 006	–	–	–	–	–	–	–	–	–	–
4,0	201	302	503	805	1 207	–	–	–	–	–	–	–	–	–
5,0	161	241	402	644	966	–	–	–	–	–	–	–	–	–
6,3	128	192	319	511	767	–	–	–	–	–	–	–	–	–
10,0	80	121	210	322	483	805	–	–	–	–	–	–	–	–
16	50	75	126	210	302	503	805	–	–	–	–	–	–	–
20	–	60	101	161	241	402	644	–	–	–	–	–	–	–
25	–	–	80	129	193	322	515	–	–	–	–	–	–	–
32	–	–	63	101	151	252	402	629	–	–	–	–	–	–
40	–	–	–	80	121	201	322	503	704	–	–	–	–	–

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Rated current of protective device	Minimum nominal cross-sectional area of copper earth continuity conductors mm²													
	1	1,5	2,5	4	6	10	16	25	35	50	70	95	120	185
A	Maximum length of earth continuity conductor m													
50	–	–	–	64	97	161	258	402	563	–	–	–	–	–
63	–	–	–	–	77	128	204	319	447	639	–	–	–	–
80	–	–	–	–	60	101	161	252	352	503	704	–	–	–
100	–	–	–	–	–	80	129	201	282	402	563	765	–	–
125	–	–	–	–	–	64	103	161	225	322	451	612	773	–
160	–	–	–	–	–	–	80	126	176	252	352	478	604	–
200	–	–	–	–	–	–	64	101	141	201	282	382	483	744
250	–	–	–	–	–	–	–	80	113	161	225	306	386	596
315	–	–	–	–	–	–	–	64	89	128	179	243	307	473
400	–	–	–	–	–	–	–	–	70	101	141	191	241	372
500	–	–	–	–	–	–	–	–	–	80	113	153	193	298
630	–	–	–	–	–	–	–	–	–	64	89	121	153	236
800	–	–	–	–	–	–	–	–	–	–	70	96	121	186

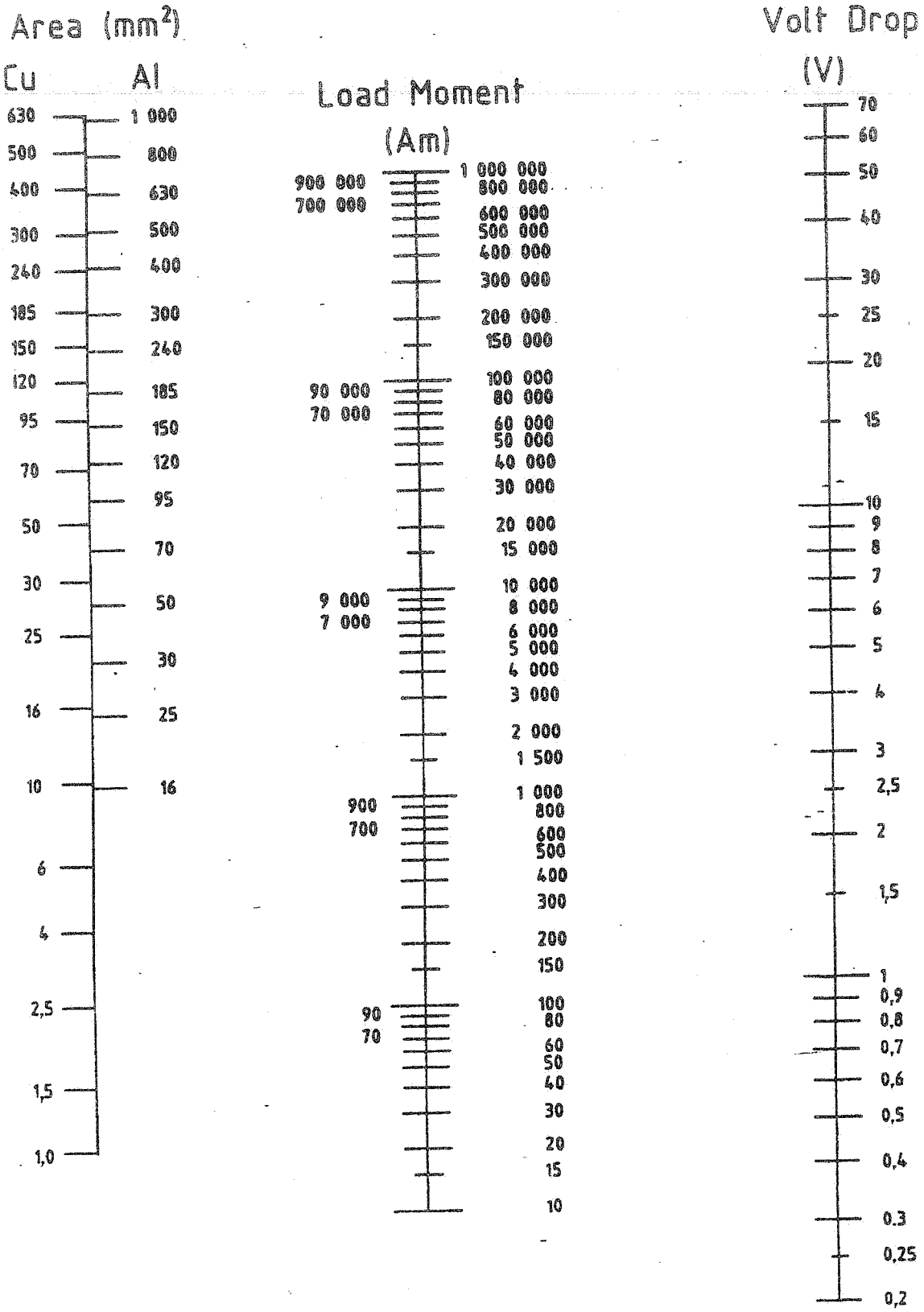
NOTE 1 This table is not to be used to determine the maximum length of live conductors because the voltage drop may be excessive for the current that they carry.

NOTE 2 The values in the table are based on a fault current of 2,5 times the rated current of the protective device and a touch voltage of 30 V.

NOTE 3 This table applies to overcurrent protective devices and might not be appropriate to other types of protective device.

NOTE 4 If the full load current rating of the protective device is non-standard, the maximum length of the earth continuity conductor shall be taken as that applying to the next higher standard rating.

INFORMATION SHEET



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