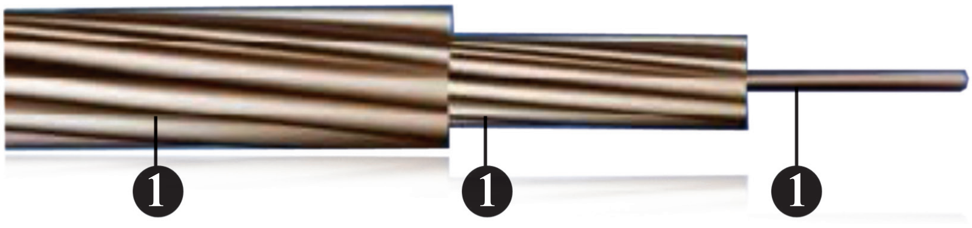
2.11.ALUMINUM CONDUCTOR.

2.11.1. All aluminum conductors(AAC)per IEC 60089

Construction: Aluminum conductors stranded successively to get required layers and standard conductor.



Where: 1 AAC

A0R-0000-04-01-22	16	7/1.70	5.1	4.33	43.3	290	1.802
A0R-0000-04-01-23	25	7/2.10	6.3	6.64	66.3	425	1.181
A0R-0000-04-01-24	35	7/2.50	7.5	9.41	94.0	590	0.8332
A0R-0000-04-01-25	50	7/3.0	9.0	13.5	135	810	0.5786
A0R-0000-04-01-26	70	19/1.80	9.0	13.3	133	862	0.5950
A0R-0000-04-01-27	95	19/2.10	10.5	18.1	181	1155	0.4371
A0R-0000-04-01-28	120	19/2.50	12.5	25.6	256	1599	0.3085
A0R-0000-04-01-29	150	19/2.80	14.0	32.2	322	1916	0.2459
A0R-0000-04-01-30	185	37/2.25	15.8	40.6	405	2581	0.1960
A0R-0000-04-01-31	240	37/2.50	17.5	50.1	500	3115	0.1587
A0R-0000-04-01-32	300	61/2.25	20.3	67.1	670	4030	0.1191
A0R-0000-04-01-33	400	61/2.50	22.5	82.8	827	4865	0.09651
A0R-0000-04-01-34	500	61/2.89	26.0	110.6	1.105	6208	0.0722
A0R-0000-04-01-35	625	61/3.23	29.1	138.2	1.381	7616	0.0578
A0R-0000-04-01-36	800	91/2.96	32.6	173.5	1.733	9716	0.0462:
A0R-0000-04-01-37	1000	91/3.35	36.9	222.2	2.220	12076	0.0361
A0R-0000-04-01-38	16000	91/3.74	41.1	277.0	2.767	14868	0.028997

2.11.2. All Aluminum alloy conductor(AAAC)

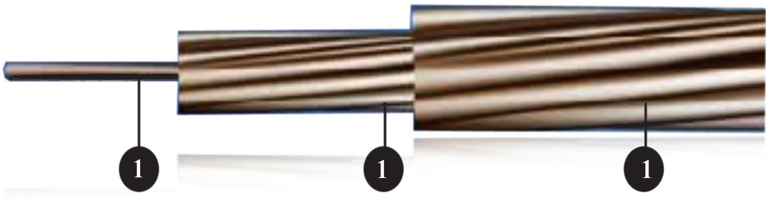
1. AAAC

It contains about 0.6% silicon and magnesium element.

It has the following benefits:

A) Strength: stronger than pure AAC about twice

B) Lighter than ACSR about 20% at equal diameter



C) It has a high atmospheric corrosion resistance which is suitable for coastal and industrial areas.

D) Has harder surface resistance than AAC which is important to reduce damage during installation

E) It contains non magnetic element which is not exhibit the magnetic core losses.

Construction: Aluminum conductors stranded successively to get required layers to get required standard

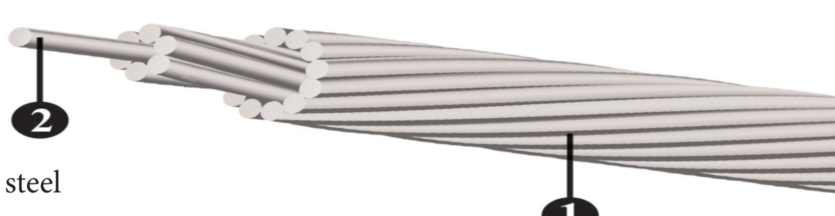
conductor.

Application: are applicable for aerial over head distribution lines that require high strength, corrosion resistance and harder surface than pure aluminum.

Product code	Nominal cross Sectional area mm2	No of wire / Wire Diameter	Approximate _ overall diameter	Approximate weight Kg/lOOm	Breaking strength Kg	DC resistance at 20 ocohm/km
A10R-0000-04-01-22	16	7/1.70	5.1	4.33	453	2.091
A10R-0000-04-01-23	25	7/2.10	6.3	6.64	691	1.370
A10R-0000-04-01-24	35	7/2.50	7.5	9.41	979	0.9669
A10R-0000-04-01-25	50	7/3.0	9.0	13.5	1410	0.6714
A10R-0000-04-01-26	70	19/1.80	9.0	13.3	1377	0.6905
A10R-0000-04-01-27	95	19/2.10	10.5	18.1	1875	0.5073
A10R-0000-04-01-28	120	19/2.50	12.5	25.6	2657	0.3580
A10R-0000-04-01-29	150	19/2.80	14.0	32.2	3333	0.2854
A10R-0000-04-01-30	185	37/2.25	15.8	40.6	4191	0.2274
A10R-0000-04-01-31	240	37/2.50	17.5	50.1	5174	0.1842
A10R-0000-04-01-32	300	61/2.25	20.3	67.1	6909	0.1383
AlOR-0000-04-01-33	400	61/2.50	22.5	82.8	8530	0.1120
A10R-0000-04-01-34	500	61/2.89	26.0	110.6	11400	0.08380
AlOR-0000-04-01-35	625	61/3.23	29.1	138.2	14239	0.06709
A10R-0000-04-01-36	800	91/2.96	32.6	173.5	17840	0.05367
AlOR-0000-04-01-37	1000	91/3.35	36.9	222.2	22850	0.04190
A10R-0000-04-01-38	16000	91/3.74	41.1	277.0	28480	0.03362

2.11.3. Aluminum conductor's steel reinforced(ACSR)

Construction: ACSR is composite concentrically stranded conductor successively to get required layers to get required light weight and high tensile strength standard conductor. Application: widely used as high tension over head distribution lines.



1. Aluminum 2.galvanized steel

Nominal cross Sectional area mm2	Construction No of wire / wire diameter		Area mm2		Total cross Sectional area	overall diameter	Approximate total weight Kg/lOOm	Breaking strength Kg	DC resistance at 20°C ohm/km
	A1	steel	A1	steel					
16/2.5	6/1.80	1/1.80	15.3	2.5	17.8	5.4	6.15	593	1.8793
25/4	6/2.25	1/2.25	23.9	4.0	27.9	6.8	9.68	920	1.2028
35/6	6/2.70	1/2.70	34.4	5.7	40.1	8.1	14.02	1295	0.8353
44/32	14/2.0	7/2.4	44.0	31.7	75.7	11.2	17.23	4637	0.6573
50/8	6/3.20	1/3.2	48.3	8.0	56.3	9.6	19.62	1752	0.5946
50/30	12/2.33	7/2.33	51.2	29.8	81.0	11.7	37.77	4517	0.5644
70/12	26/1.89	7/1.44	69.9	11.4	81.3	11.7	28.39	2687	0.4130
95/15	26/2.15	7/1.67	94.4	15.3	109.7	13.6	38.28	3587	0.3058
95/55	12/3.20	7/3.20	96.5	56.3	152.8	16.0	71.23	8180	0.2992
105/75	14/3.10	19/2.25	105.7	75.5	181.2	17.5	89.08	10882	0.2736
120/20	26/2.44	7/1.90	121.6	19.8	141.4	15.5	49.37	4584	0.2374
120/70	12/3.6	7/3.60	122.1	71.3	193.4	18.0	90.05	10012	0.2364
125/30	30/2.33	7/2.33	127.9	29.8	157.7	16.1	59.09	5902	0.2259
150/25	26/2.70	7/2.10	148.9	24.2	173.1	17.1	60.48	5546	0.1939
170/40	30/2.70	7/2.70	171.8	40.2	211.9	18.9	79.35	7855	0.1682
185/30	26/3.00	7/2.33	183.8	29.8	213.6	19.0	74.56	6761	0.1571
210/35	26/3.20	7/2.49	209.1	34.1	243.2	20.3	85.1	7644	0.1380
210/50	30/3.00	7/3.0	212.1	49.5	261.6	21.0	98.08	9410	0.1363
230/30	24/3.50	7.233	230.9	29.8	260.7	21.0	87.67	7455	0.1249
240/40	26/3.45	7/2.68	243.1	39.5	282.6	21.9	98.67	8819	0.1188
265/35	24/374	7/2.49	263.7	34.1	297.8	22.4	100.18	8460	0.1094
300/50	26/3.86	7/3.00	304.3	49.5	353.8	24.5	123.56	10719	0.0949
305/40	54/2.68	7/2.68	304.6	39.5	344.1	24.1	115.96	10129	0.0949
340/30	48/3.00	7/2.33	339.3	29.8	369.1	25.0	117.96	9441	0.0851
380/50	54/3.00	7/3.00	381.7	49.5	431.2	27.0	145.28	12333	0.0757
385/35	48/3.20	7/2.49	386.0	34.1	420.1	26.7	134.38	10640	0.0748
435/55	54/3.20	7/3.20	434.3	56.3	490.6	28.8	165.27	13900	0.0666
450/40	48/3.45	7/2.68	487.7	39.5	488.2	28.7	156.08	12259	0.0644
490/65	54/3.40	7/3.40	490.3	63.6	553.9	30.6	186.56	15591	0.0590
495/35	45/3.74	7/2.49	494.4	34.1	528.5	29.9	163.56	12272	0.0584

2.11.4.Aluminum conductor steel reinforced(ACSR) per BS EN 50182

Code Name	Construction No of wire / wire diameter	Area mm2			Total cross Sectional area	overall diameter	total weight Kg/ 100m	Breaking strength Kg	DC resistance at 20°C ohm/ km
MOLE	6/1/1.50	1.50	10.60	1.77	12.4	4.5	4.31	4780	27.062
SQUIRREL	6/1/2.1 1	2.11	20.98	3.50	24.5	6.33	8.52	8020	13.677
GOPHER	6/1/2.36	2.36	26.25	4.37	30.6	7.08	10.7	9610	10.933
WEASEL	6/1/2.59	2.59	31.61	5.27	36.9	7.77	12.9	11450	0.9077
FOX	6/1/2.79	2.79	36.68	6.11	42.8	8.37	14.9	13100	0.7822
FERRET	6/1/3.00	3.00	42.41	7.07	49.5	9.00	17.3	15200	0.6766
RABBIT	6/1/3.35	3.35	52.88	8.81	61.7	10.05	21.4	18500	0.5426
MINK	6/1/3.66	3.66	63.13	10.52	73.7	10.98	25.7	21900	0.4546
SKUNK	12/7/2.59	7.77	63.22	36.88	100.1	12.95	46.7	52900	0.4571
BEAVER	6/1/3.99	3.99	75.02	12.50	87.5	11.97	30.4	25900	0.3825
HORSE	12/7/2.79	8.37	73.36	42.80	116.2	13.95	54.1	60700	0.3939
RACCOON	6/1/4.09	4.09	78.83	13.14	92.0	12.27	32.0	27200	0.3640
OTTER	6/1/4.22	4.22	83.33	13.99	97.9	12.66	34.1	28900	0.3419
CAT	6/1/4.50	4.50	95.43	15.90	111.3	13.50	38.8	32800	0.3007
HARE	6/1/4.72	4.72	104.98	17.50	122.5	14.16	42.7	36000	0.2733
DOG	6/4.72	4.71	104.98	13.55	118.5	14.15	38.9	34700	0.2733
HYENA	7/1.57	5.79	105.95	20.48	126.4	14.57	45.3	41900	0.2697
LEOPARD	7/4.39	5.25	131.37	16.84	148.2	15.81	49.4	42200	0.2184
COYOTE	7/1.93	5.73	131.74	20.06	151.8	15.89	52.4	47300	0.3035
TIGER	6/5.28	4.72	131.23	30.62	161.9	16.52	60.6	58700	0.2202
WOLF	7/1.75	7.77	158.06	36.88	194.9	18.13	73.0	69200	0.1828
LYNX	26/2.54	8.37	183.41	42.80	226.2	19.53	84.6	79300	0.1576
PANTHER	7/1.91	9.00	212.06	49.48	261.5	21.00	97.0	90800	0.1363
LION	30/7/2.36	9.54	238.27	55.60	293.9	22.26	110.0	101000	0.1213
BEAR	30/7/2.59	10.05	264.42	61.33	326.1	23.45	122.0	112000	0.1093
GOAT	30/7/2.79	11.13	324.31	75.70	400.0	25.97	150.0	136000	0.0891
SHEEP	30/7/3.00	11.97	375.11	87.67	462.6	27.93	173.0	157000	0.0770
ANTELOPE	30/7/3.18	8.91	374.11	48.53	422.6	26.73	142.0	117000	0.0773
BISON	30/7/3.35	9.00	381.70	49.50	431.2	27.00	145.0	119000	0.0757
DEER	30/7/3.71	12.81	429.60	100.24	529.8	29.89	198.0	179000	0.0673
ZEBRA	30/7/3.99	9.54	428.88	55.60	484.5	28.62	163.0	133000	0.0674
ELK	54/7/2.97	13.50	477.13	111.33	588.5	31.50	220.0	199000	0.0606
CAMEL	54/7/3.00	10.05	475.96	61.70	537.7	30.15	181.0	147000	0.0607
MOOSE	30/7/4.27	10.59	528.49	68.51	597.0	31.77	200.0	162000	0.0547
DINOSAUR	54/7/3.18	11.80	661.73	83.11	744.8	35.50	249.3	202920	0.0437
BERSFORD	30/7/4.50	9.96	687.36	60.60	748.0	35.58	238.6	177650	0.0420

2.11.5. PVC insulation aluminium conductor (Al/PVC)

Construction

Conductor: Stranded circular aluminum conductor, as per Class 2 of IEC 60228.

Insulation: An extruded layer of Polyvinyl chloride (PVC) insulation rated 70 °C at normal operation to IEC 60502-1. ‘ ’

Outer sheath: An extruded layer of Polyvinyl chloride (PVC) sheathing compound type ST1 to TEC 605021. - - - . . .

Color: for insulation

Two cores: Red, Black

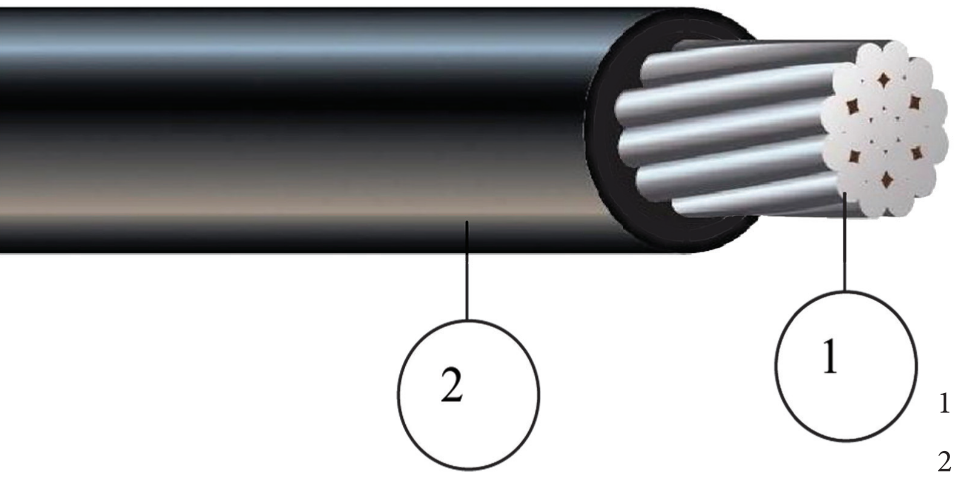
Three cores: Red, Yellow and Blue

Four core: Red. Yellow. Blue. Black

- Color for Sheath: grey for single core Black for two or more core Technical Data
- Rated voltage; U/Uo: up to and including 0.6/1.1(1.2) KV.
- Power frequency test voltage 3.5 kV for 5 minutes
- Maximum admissible temperature of conductor at normal operation 70 °C .
- Maximum admissible temperature of conductor at short circuit 160 °C for 5 seconds.

▪ 160 °C for sizes < 300 mm2

▪ 140 °C for sizes >300 mm2



1. Stranded A1 conductor
2. PVC primary insulation.

2.11.5. PVC insulated single core aluminium conductor (Al/PVC)

Product code	Nominal Cross Sectional Area in mm2	Number of Strands	Radial thickness of Insulation mm	Approx- overall diameter mm	Approximate Total Weight in kg/lOOm	Max. Conimate ductor DC Resistance at 20°C in/2/km
APR-0000-04-01-22	16	7	1.0	9.1	6.7	1.802
APR-0000-04-01-23	25	7	1.2	10.3	10.2	1.181
APR-0000-04-01-24	35	7	1.2	12.3	13.5	0.8332
APR-0000-04-01-25	50	19	1.4	13.6	19.2	0.5786
APR-0000-04-01-26	70	19	1.4	16.1	24.3	0.5950
APR-0000-04-01-27	95	19	1.6	17.6	34.1	0.4371
APR-0000-04-01-28	120	19	1.6	19.7	41.4	0.3085
APR-0000-04-01-29	150	37	1.8	21.9	52.2	0.2459
APR-0000-04-01-30	185	37	2.0	25.0	64.4	0.1960
APR-0000-04-01-31	240	61	2.2	27.7	84.9	0.1587
APR-0000-04-01-32	300	61	2.4	31.6	104.3	0.1191
APR-0000-04-01-33	400	61	2.6	35.1	137.3	0.09650
APR-0000-04-01-34	500	61	2.8	38.5	170.0	0.07221
APR-0000-04-01-35	625	127	3.0	42.3	207.9	0.05781

2.11.5.2. PVC insulated two-four core aluminum conductors (Al/PVC)

Product code	Nominal Cross Sectional Area in mm2	Approximate overall diameter mm	Approximate Total Weight in kg/100m	Max. Conductor DC Resismm tance at 20°C in 12/km
APR-000PJ-04-02-21	10	13.9	27.5	3.08
APR-000PJ-04-02-22	16	15.4	32.1	1.802
APR-000PJ-04-02-23	25	17.9	43.5	1.181
APR-000PJ-04-02-24	35	20.2	55.9	0.8332
Three core				
APR-000PJ-04-03-21	10	17.9	35.1	3.08
APR-000PJ-04-03-22	16	20.9	44.3	1.802
APR-000PJ-04-03-23	25	23.7	61.0	1.181
APR-000PJ-04-03-24	35	29.7	78.4	0.8332
Four core				
APR-000PJ-04-04-21	10	20.0	38.4	3.08
APR-000PJ-04-04-22	16	23.5	49.2	1.802
APR-000PJ-04-04-23	25	26.5	69.0	1.181
APR-000PJ-04-04-24	35	33.2	88.8	0.8332
APR-000PJ-04-04-25	50	36.6	136.1	0.5786
APR-000PJ-04-04-26	70	42.3	166.9	0.5950
APR-000PJ-04-04-27	95	45.3	224.9	0.4371

APR-000PJ-04-04-28	120	51.0	261.0	0.3085
APR-000PJ-04-04-29	150	56.2	330.6	0.2459
APR-000PJ-04-04-30	185	63.3	402.5	0.1960
APR-000PJ-04-04-31	240	68.9	515.0	0.1587
APR-000PJ-04-04-32	300	76.9	614.1	0.1191
APR-000PJ-04-04-33	400	84.1	775.2	0.09650
APR-000PJ-04-04-34	500	91.0	933.7	0.07221
APR-000PJ-04-04-35	625	96.2	1104.5	0.05781

ANNEX TECHNICAL DATA

1.1.Technical information

1. Conductor resistance

Formula of DC resistance of conductor as per IEC 60228 at 20 °C is:

R=R2o[l+a (T-20)]

Where

R: Conductor DC resistance at T °C R20: Conductor DC resistance at 20 °C T: Operating temperature in a: Resistance temperature coefficient per °C = 0.00393 for Copper = 0.00403 for Aluminum

AC resistance of the conductor at its operating temperature can be calculated using the following formula is used:

RAC = RT(1 + Ys + Yp) =; (ohm/km)

Where:

Ys is skin factor effect Yp is a proximity effect

Ys and Yp depend on operation frequency and cable spacing.

RT: DC resistance at temperature T RAC: Alternating current resistance.

At power frequencies of 50-60 Hz the skin effect factor is small for conductors smaller than about 150 mm2

2. Inductance

The formula to calculate self and mutual inductance is:

LK + 0.21oge ^, (D /km)

Where:

L: Inductance in Q/km

K: Constant that depends on number of wires obtained from table, d: diameter of wire

S: axial spacing between cables in trefoil formation in mm

S: 1.26 x axial spacing between cables in flat cable formation in mm

3. Capacitance

The capacitance for cables with circular conductors (F/m) is given by the formula below and this may also be applied for oval conductors if the geometric mean diameter is used:

Where

C: capacitance (|if/km) C=sr

iStoge (5} * 10 -19

sr: Relative permittivity of insulation material D: Diameter over insulation excluding screen (mm) d: conductor diameter including screen (mm)

4. Dielectric loses in ac cable.

Dielectric loss in each phase is calculated using the formula:

Wd — wCUo 2 tana, (W/m)

Where: w — 2nf, (1/s) in which f is frequency (Hz) (s = second)

C: capacitance

Uo: Voltage between phase and earth

5. Insulation resistance

It can be calculated the formula below based on EN BS6040 as:

R = kloglO(^)

Where:

R: insulation resistance (M Q /km)

D: Diameter over insulation excluding screen; semi-conducting layer

(mm) d: conductor diameter including screen (mm)

K: constant depending on the insulation material (0.0367 for PYC, 3.67 for XLPE and ERP), MQ.km

6. Charging current

The charging current is the capacitive current which flows capacitance between the conductor and earth and for a multi core cable in which cores are not screened between conductors. The value can be calculated from the formula:

Ic = UoU/CKT6 (A/km)

Where:

Ic : Charging current A/km

U0: Voltage between phase and earth, V

C : Capacitance to neutral

UJ = 2nf

ffrequenc

7. Cable Ampacity

Cable ampacity or current carrying capacity is defined as the continuous maximum current the cable can

carry at its maximum operating temperature. In the technical information tables the following instal-lation

conditions were assumed during the current calculation:

- Ambient air temperature :40°C
- Ground temperature :35°C
- Ground thermal resistivity: 120°C cm/watt
- Burial depth : 0.5meter
- All cable ampacities are based on IEC 60287

8. Cable short circuit capacity

The calculation of short circuit current for conductor and screen based on the following conditions required:

A- Short circuit starts from the maximum operating conductor / screen

temperature B- Maximum temperature during short circuit C- Maximum short

circuit current duration is 5 seconds.

If the short circuit current is required at duration not mentioned in 1 second, it is obtained by divid-ing

the short circuit current for 1 second by the square root of the required

Where: I sx.t: short circuit current in time t second (kA)

I s.c.t: short circuit current in one second

(KA) t:time(s)

9. Voltage drop

Voltage drop occurs when current flows in a cable conductor. It occurs between the ends of the conductor which is the product of the current and the impedance. If the voltage drop were excessive, it could result in the voltage at the equipment being supplied being too low for proper operation- The voltage drop is of more consequence at the low end of the voltage range of supply voltages than it is at higher voltages, and

generally it is not significant as a percentage of the supply voltage for cables rated above 1000V unless very long route lengths are involved. The following equations can be used to calculate the voltage drop:

A. Single phase circuit.

Vd = 2IL(Rcos 0 + Xsin0)

Three phase circuit Vd = V3 *

L(Rcos 0 -I- Xsin0)

Where:

Vd= voltage drop (V)

1= load current (A)

R=AC resistance (G/km)

L=lenth(km) Relation between cosp and sin0 as follows

UJ =2jrf cos(p 1.0 0.9 0.8 0.71 0.6 0.5

X= L* U7 10'6 sincp 0.0 0.44 0.6 0.71 0.8 0.87

10. Current carrying capacity

1= { A0-Wd[~+n(T2+T3+T4)

RTl+nR(l+Al)T2+nR(l+Al+A2)(T3+T4)1/2

But for d.c. cables some of the losses are not applicable and for up to 5 kV formula may be simplified to:

tR/Tl+nR'T2+nRf(T3+T4)J

Where:

A0 : Conductor temperature rise (K)

I: current flowing in one conductor (A)

R: alternating current resistance per unit length of the conductor at maximum operating temperature (Q/m)

Wd: dielectric loss per unit length for the insulation surrounding the conductor (W/m)

T1: thermal resistance per unit length between one conductor and the sheath (km/w)

T2: thermal resistance per unit length between one conductor and armor (km/w)

T3: thermal resistance per unit length of the external serving cable and surrounding medium (km/w) T4: thermal resistance per unit length between the cable surface and surrounding medium (km/w)

n: number of load-carrying conductors in the cable (conductors of equal size and carrying the same loa A1: ratio of losses in the metal sheath to total losses in all conductors in that cable.

A2: ratio of losses in the armoring to total losses in all conductors in that cable

R' =d.c. resistance per unit length of the conductor at maximum operating temperature (G/m)

11. Thermal resistance between one conductor and sheath (Tl)

The equations for various cable constructions are outlined below; IEC287 contains further informat including data for the geometric factor G and an additional screening factor which is necessary screened cables A. Single core cable

Where:

pT : Thermal resistivity of insulation (K m/W) dc: diameter of conductor (mm) tl: thickness of insulation, conductor to sheath (mm) B. Multi belted cable

C. Multi screened cables

T1 ~ * Screening factor

Where: G is geometric factor from IEC287.

D. SL and SA type cables: these are treated as single core cables.

Thermal resistance between sheath and armor

Single and multi core cables

Where: t2 is thickness of bedding (mm), Ds is thickness of outer diameter (mm) Or

T2 = — G' 2n

Where: G' is geometrical factor from IEC 287

E. Thermal resistance of outer covering

Where:

t3 is thickness of outer covering while D'a is thickness of armor

F. External thermal resistance in air (T4)

Assuming protection from solar radiation ^

T4 = -----------------------

nDeh^AGs^l/A

Where: h is heat dissipation coefficient from IEC 287, De is external diameter of cable (mm)

210s : Excess of surface temperature above ambient (K)

G. External thermal resistance for buried cable.

T4 = ^loge[p + (p2 - 1) 1 / 2]

where pT : the thermal resistivity of the soil (K m/W) g :2L/De, L

= distance from ground surface to cable axis (mm)

De = external diameter of the cable (mm)

H. Thermal resistance cable in buried ducts

HI: Thermal resistance of air space (T'4)

For cable diameters of 25 to 100mm, _ U

T 4 " 1 + 0.1(F + Y0m)De Where: U,

Vand Y are constants for various types of ducts from IEC2 87.

0m: mean temperature of the airspace(°C)

De: External diameter of cable (mm)

H2.Thermal resistance of the duct (T")

„ pT /Do\

Where: Do: outside diameter of duct (mm),Dd inside diameter of duct(mm),and pT thermal resistivity of duct(km/w) from IEC 287

Singlecore		cables	0.8	0.9	1.0	1.5	2.0	2.5	3.0
Up	to	150	1.16	1.11	1.07	0.91	0.81	0.73	0.67
185	to	400	1.17	1.12	1.07	0.90	0.80	0.72	0.66
5000	to	1200	1.18	1.13	1.08	0.90	0.79	0.71	0.65
Multi core cable									
Up	to	16	1.09	1.06	1.04	0.95	0.86	0.79	0.74
25	to	150	1.14	1.10	1.07	0.93	0.84	0.76	0.70
185	to	400	1.16	1.11	1.07	0.92	0.84	0.74	0.68

13. EFFECT OF INSTALLATION CONDITIONS ON RATINGS

There is rating differences between installation in air and in the ground, which is being associated with the

cable surface area. Some aspects that arising effect of installation condition are listed below.

13.1. Depth of Burial

The depth of lying is governed primarily by what is considered to be the most advisable to minimize effects of damage and generally increases with cable voltage. Values adopted in various countries have been given in table below. An equation covering the effect on rating has already been quoted and for most purposes the thermal resistance of the soil may be simplified to

pT: Soil thermal resistivity (K m/W)

De: cable external diameter (mm)

1: depth of burial to cable axis (mm)

In this formula variations of Pr may be extremely important but variations of laying depth have less effect.

13.2. Standard conditions

When groups of multi core power cables are installed in air it is necessary to have a sufficient air space for dissipation

of heat. No reduction in rating is necessary provided that:

a) The horizontal clearance between circuits is not less than twice the overall diameter of an individual cable.

b) the vertical clearance between circuits is not less than four times the diameter of an individual cable;

c) If the number of circuits exceeds three, they are installed in a horizontal plane.

13.3. Cables lay direct in ground standard conditions

a) Ground temperature 15°C

b) Soil thermal resistivity 1.2km/w

c) Adjacent circuits at least 1.8m distance

d) Depth of laying 0.5m for lkv cables, 0.8m for above l.Okv and up to 33kv cables.

14. Current carrying capacity rating factor

Table 6 Group rating factor for circuit of three single core cables in trefoil and laid flat touching horizontal formation

14. Current carrying capacity rating factor

Table 8 Group rating factor for circuit of three single core cables in trefoil and laid flat touching horizontal formation

Table10 five core cables with conductors PVC 90 °C insulated and PVC Sheathed copper conductor rated voltage, U/Uo 0.6/1 KV

Nominal Cross Sectional Area in mm2	Approximate current carrying capacity (Ampere)						Voltage drop(mv/Amp/m)	
	In ground			In air			PVC rated 90 °C	PVC rated 90 °C
	R Direct laid(flat)	Direct laid (trfoil)	In duct	H Direct laid(flat)	Direct laid (trefoil)	In pipe	Flat	Trefoil
1.5	17	17	13	14	13	10	22.6	22.5
2.5	23	22	17	19	16	13	13.9	13.8
4	30	30	22	26	22	18	8.7	8.6
6	38	36	28	33	29	23	5.8	5.7
10	50	49	37	45	39	31	3.5	3.4
16	65	63	48	60	51	40	2.3	2.2
25	84	81	63	79	68	53	1.5	1.4
35	103	99	76	99	85	65	1.1	1
50	122	116	92	121	104	79	0.83	0.82
70	151	144	114	154	133	99	0.61	0.6
95	183	174	139	193	166	122	0.47	0.45
120	208	197	158	225	193	140	0.39	0.38
150	235	223	179	259	223	160	0.34	0.33
185	266	251	203	300	258	183	0.29	0.28
240	312	292	237	361	308	216	0.25	0.24
300	353	328	267	417	355	245	0.22	0.21

Nominal Cross Sectional Area in mm2	Approximate current carrying capacity (Ampere)						Voltage drop(mv/Amp/m)
	In ground Unarmored			Armored			
	Direct laid	Laid in direct	Direct laid	Direct laid	In duct	Direct laid	PVC rated 90 #C Trefoil
1.5	24	19	20	19	14	17	22.60
2.5	30	25	28	24	19	23	13.80
4	40	32	39	32	24	32	8.60
6	50	40	50	40	30	42	5.80
10	65	55	66	52	41	55	3.50
16	85	65	88	68	49	73	2.00
25	110	85	116	88	64	97	1.40
35	130	105	143	104	79	119	1.10
50	160	131	162	128	98	135	0.80

Approximate current carrying capacity (Ampere)

Voltage drop(mv/Amp/m)

In ground

Unarmored

Armored

Nominal Cross Sectional Area in mm2	Direct laid	Laid in direct	Direct laid	Direct laid	In duct	Direct laid	PVC rated 90 #C Trefoil
1.5	21	18		16	14		22.60
2.5	27	23		22	19		13.80
4	36	30	36	29	24	29	8.60
6	45	37	45	37	31	37	5.80
10	60	50	60	50	41	51	3.50
16	78	65	78	66	54	66	2.00
25	100	83	100	87	70	88	1.40
35	125	101	124	106	84	109	1.10
50	149	121	147	130	102	133	0.80
70	183	148	180	163	126	167	0.58
95	219	178	215	201	154	204	0.44
120	249	203	245	233	177	235	0.37
150	280	229	273	268	202	268	0.32
185	315	259	306	308	230	305	0.27
240	364	301	349	364	269	355	0.23
300	409	339	387	417	306	401	0.20
400	465	386	428	485	352	454	0.18

1.5	31	30	22	27	22	19	22.90	22.80
2.5	40	39	29	36	29	24	14.10	14.00
4	52	50	38	47	38	32	8.80	8.70
6	65	63	47	60	49	40	5.90	5.80
10	87	83	63	82	66	54	3.60	3.50
16	112	107	82	109	88	70	2.30	2.20
25	144	137	105	145	116	92	1.50	1.40
35	172	165	127	178	143	112	1.10	1.00
50	204	195	151	218	175	134	0.84	0.83
70	251	238	187	277	222	168	0.61	0.60
95	301	286	225	344	274	205	0.47	0.46
120	345	327	258	409	326	237	0.39	0.38
150	385	363	290	461	367	269	0.34	0.33

185	436	410	430	534	425	308	0.29	0.28
240	507	474	382	638	505	361	0.25	0.24
300	573	532	434	740	583	411	0.22	0.21
400	645	600	489	865	676	469	0.19	0.18
500	744	673	550	1009	779	533	0.17	0.16
630	847	752	615	1184	900	603	0.16	0.15

Table 15 Single core cables with copper conductor, XLPE insulated and PVC Sheathed; rated voltage; U/Uo 0.6/1 kv

1.S	31	30	22	27	22	19	22.90	22.80
2.5	40	39	29	36	29	24	14.10	14.00
4	52	50	38	47	38	32	8.80	8.70
6	65	63	47	60	49	40	5.90	5.80
10	87	83	63	82	66	54	3.60	3.50
16	112	107	82	109	88	70	2.30	2.20
25	144	137	105	145	116	92	1.50	1.40
35	172	165	127	178	143	112	1.10	1.00
50	204	195	151	218	175	134	0.84	0.83
70	251	238	187	277	222	168	0.61	0.60
95	301	286	225	344	274	205	0.47	0.46
120	345	327	258	409	326	237	0.39	0.38
150	385	363	290	461	367	269	0.34	0.33
185	436	410	430	534	425	308	0.29	0.28
240	507	474	382	638	505	361	0.25	0.24

300	573	532	434	740	583	411	0.22	0.21
400	645	600	489	865	676	469	0.19	0.18
500	744	673	550	1009	779	533	0.17	0.16
630	847	752	615	1184	900	603	0.16	0.15

Table 16 Two core cable with copper conductor, XLPE 90°C insulated and PVC sheath rated voltage ;U/Uo 0.6/1.2 kV.

1.5	30	25	25	24	19	21	22.80
2.5	37	32	24	30	24	20	14.00
4	50	40	46	40	30	38	8.70
6	63	52	60	50	39	50	5.90
10	82	69	79	66	52	66	3.50
16	106	83	105	85	62	87	2.20
25	139	107	138	111	80	115	1.50

Table 17 Three and four core cable with copper conductor, XLPE insulated and PVC sheathed,rated voltage U/Uo; 0.6/1 kv.

1.5	27	22		22	18		22.80
2.5	35	29		29	24		14.00
4	45	37	46	38	31	39	8.70
6	56	46	57	48	39	50	5.90
10	76	62	76	67	52	67	3.50
16	98	80	98	88	68	89	2.20
25	128	104	128	118	90	120	1.50
35	157	125	158	142	107	149	1.10
50	187	149	188	175	129	182	0.81
70	229	183	229	220	161	229	0.58
95	276	220	274	272	196	280	0.44
120	313	251	310	316	226	322	0.37
150	350	283	346	363	258	368	0.31
185	395	321	387	418	295	420	0.27
240	458	372	444	496	346	491	0.23
300	516	420	494	571	394	557	0.20
400	584	478	549	665	454	635	0.18

Table 18. Minimum cable bending radius

Cable outer diameter (mm)	Cable rated voltage volt	Cable	radius * outer diameter
Single ore cables diameter	300/300,450/750,600/1000		
Up to 10	66	3	
10 to 25	66	4	
Over 25 mm	«	6	
Any armored cable	66	6	
Any cable with shaped conductors	66	8	
Without armor or screen	1900/3300 to 6350/11000	6	
Un armored 66 8			
Armored	66	12	

Table 19. Thermally permissible short-circuit currents of the screen, with a final temperature not exceeding 350 °C, in line withNEN 3620.

	0.5	0.4	0.3	0.2	0.1	1	2	3	4	5
10	2.52	2.81	3.25	3.98	5.63	1.78	1.26	1.03	0.89	0.80
16	4.03	4.50	5.20	6.37	9.01	2.85	2.01	1.64	1.42	1.27
25	6.29	7.04	8.12	9.95	14.07	4.45	3.15	2.57	2.23	1.99
35	8.81	9.85	11.37	13.93	19.70	6.23	4.41	3.60	3.12	2.79
50	12.59	14.07	16.25	19.90	28.14	8.90	6.29	5.14	4.45	3.98
70	18.88	21.11	24.37	29.85	42.22	13.35	9.44	7.71	6.68	5.97
95	23.91	26.74	30.87	37.81	53.47	16.91	11.96	9.76	8.46	7.56
120	30.21	33.77	39.00	47.76	67.55	21.36	15.10	12.33	10.68	9.55
150	37.76	42.22	48.75	59.70	84.43	26.70	18.88	15.42	13.35	11.94
185	46.57	52.07	60.12	73.63	104.13	32.93	23.29	19.01	16.47	14.73
240	60.42	67.55	78.00	95.52	135.09	42.72	30.21	24.66	21.36	19.10
300	75.52	84.43	97.49	119.41	168.87	53.40	37.76	30.83	26.70	23.88
400	100.69	112.58	129.99	159.21	225.15	71.20	50.35	41.11	35.60	31.84
500	125.87	140.72	162.49	199.01	281.44	89.00	62.93	51.38	44.50	39.80
630	158.59	177.31	204.74	250.75	354.62	112.14	79.29	64.74	56.07	50.15

The short circuit current indicated in table 17 has been calculated in line with NEN 3620 for cables with a copper earthling screen only which is allowed to reach a temperature of 350 9c. The temperature allowed for an aluminum foil screen is onlyl60 9C. Even so, the thermally permissible short-circuit currents for the screen of transversally and Longitudinally watertight cables are close to the values applying to copper wire screens. This is caused by the current distribution.

Table 20. Short circuit current

	0.5	0.4	0.3	0.2	0.1	1	2	3	4	5
16	2.13	3.62	4.18	5.12	7.24	1.50	1.06	0.87	0.75	0.67
25	3.32	5.65	6.53	7.99	11.31	2.35	1.66	1.36	1.18	1.05
35	4.65	7.91	9.14	11.19	15.83	3.29	2.33	1.90	1.65	1.47
50	6.65	11.31	13.05	15.99	22.61	4.70	3.32	2.71	2.35	2.10
70	9.97	16.96	19.58	23.98	33.92	7.05	4.99	4.07	3.53	3.15
95	12.63	21.48	24.80	30.38	42.96	8.93	6.31	5.16	4.47	3.99
120	15.95	27.13	31.33	38.37	54.26	11.28	7.98	6.51	5.64	5.04
150	19.94	33.92	39.16	47.96	67.83	14.10	9.97	8.14	7.05	6.31
185	24.59	41.83	48.30	59.16	83.66	17.39	12.30	10.04	8.70	7.78
240	31.90	54.26	62.66	76.74	108.53	22.56	15.95	13.03	11.28	10.09
300	39.88	67.83	78.32	95.93	135.66	28.20	19.94	16.28	14.10	12.61
400	53.17	90.44	104.43	127.90	180.88	37.60	26.59	21.71	18.80	16.82
500	66.47	113.05	130.54	159.88	226.10	47.00	33.23	27.14	23.50	21.02
630	83.75	142.44	164.48	201.45	284.89	59.22	41.87	34.19	29.61	26.48

ANNEX 2. Handling of products

Producing products is not enough to get the quality product for the intended wire and cable installation. There shall proper handling of products in the store, during delivery loading unloading and at the installation activities. Operators; production workers; labourers and installation technicians shall follow the instruction listed below.

1. Rolling reels with workers

a) Don't stack reels poorly

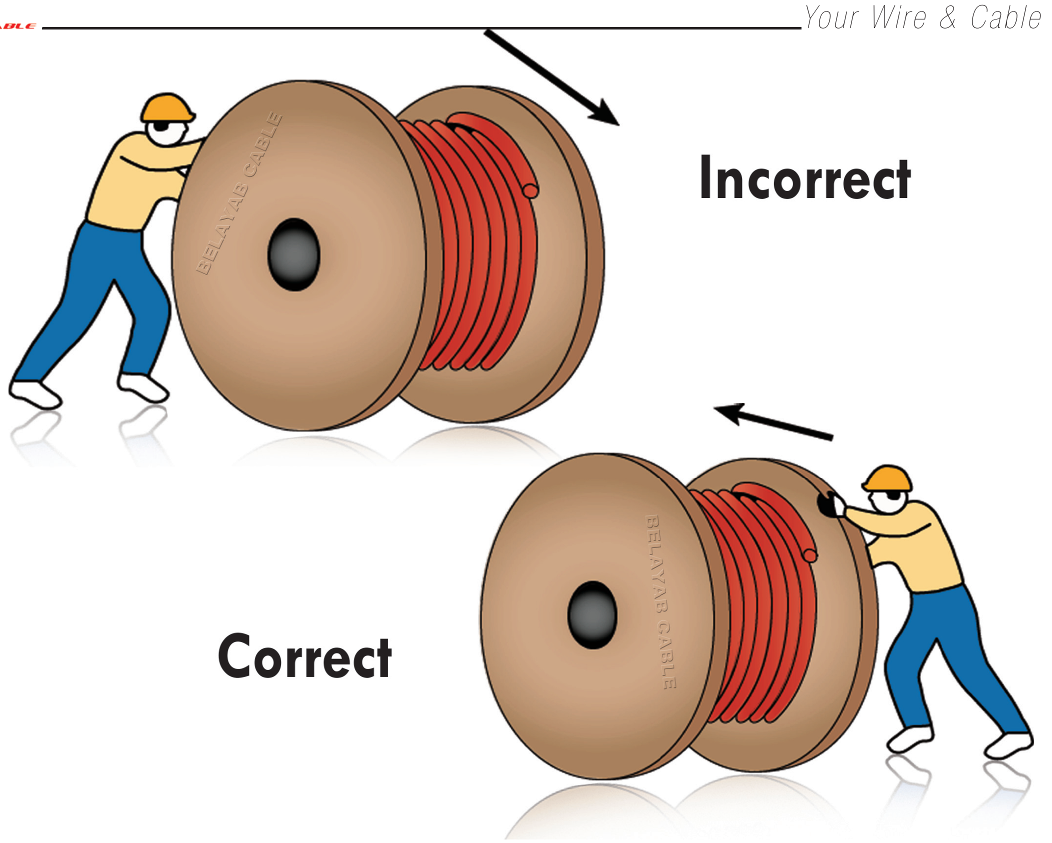
b) Don't use damaged or broken reel flanges or nailed reel.

c) Tie ends of cable firmly.

d) Make sure the cable ends are secure before moving drums.

e) Roll reels only in the same direction it was turned when the cable was wound onto the reel.

f) If reels are moved by rolling, examine the route and clear the path of any debris such as rocks, wooden blocks, pipes, or other
equipment.



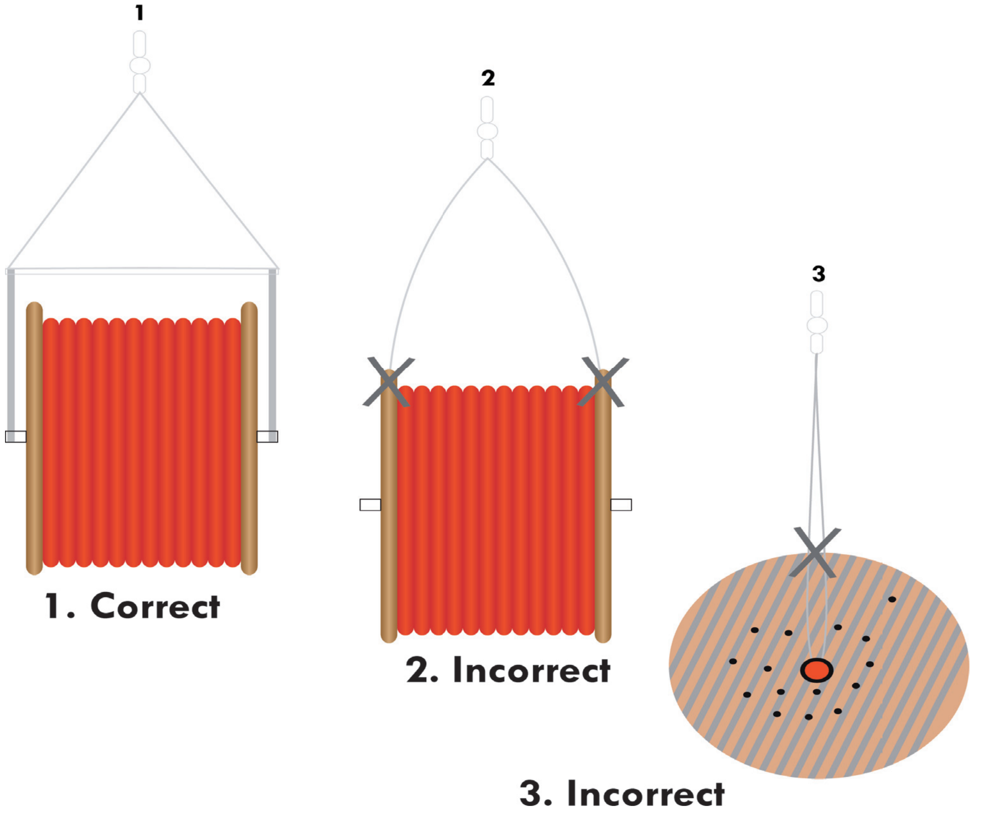
2. How to use for lifts to move reels

a) Use forks of the capacity that is not lift it

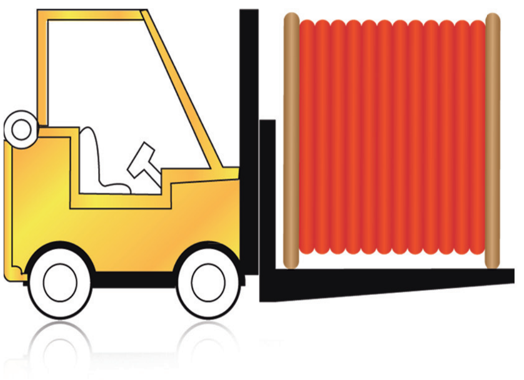
b) Only lift from the sides and only if the forks are of sufficient length to securely capture both flanges.

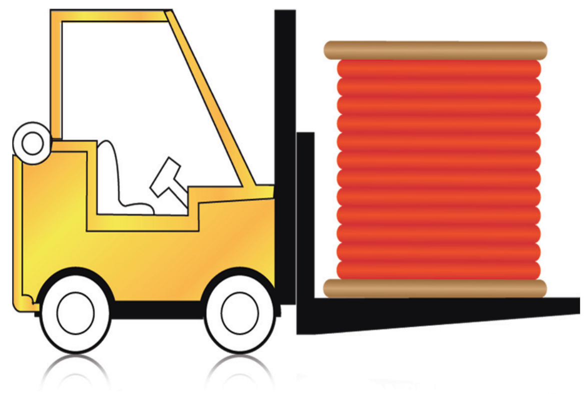
c) Don't lift reels with the forks between the reel flanges or let the forks contact the cable or the protective covering.

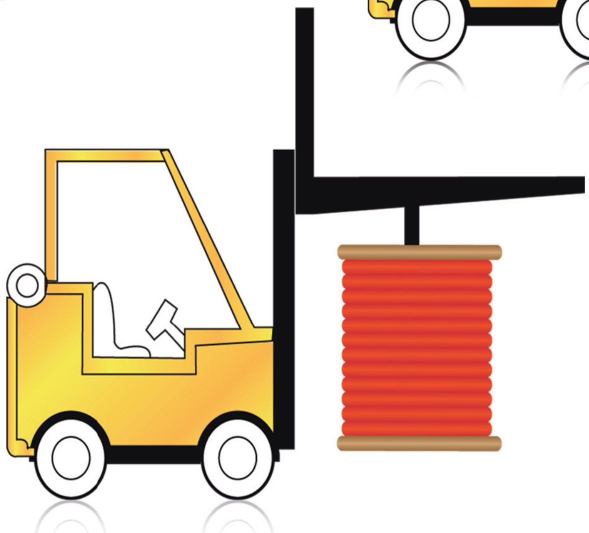
d) Use suitable holding device inserted in the arbor hole of the top flange.



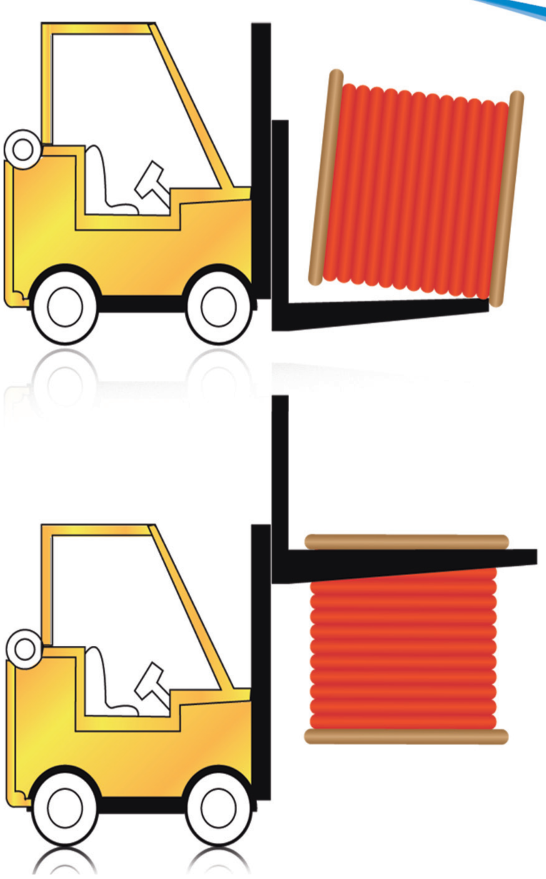
e) Insert steel lifting bars of suitable length and size through the arbor hole in the center of the flange when there is requirement to use crane or other over head lift.

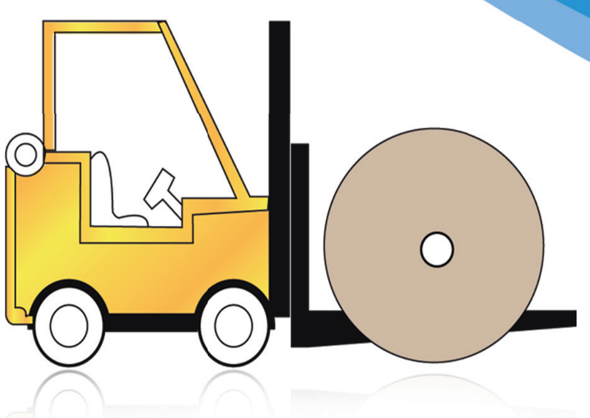






1. Correct





2. Incorrect

3. Storage of product in reels.

a) The area of store shall be accessible for using fork lift. Choose Stores reels in an orderly manner to allow easy access for moving and lifting

b) Reels should be stored indoors on a smooth, hard, and dry surface.

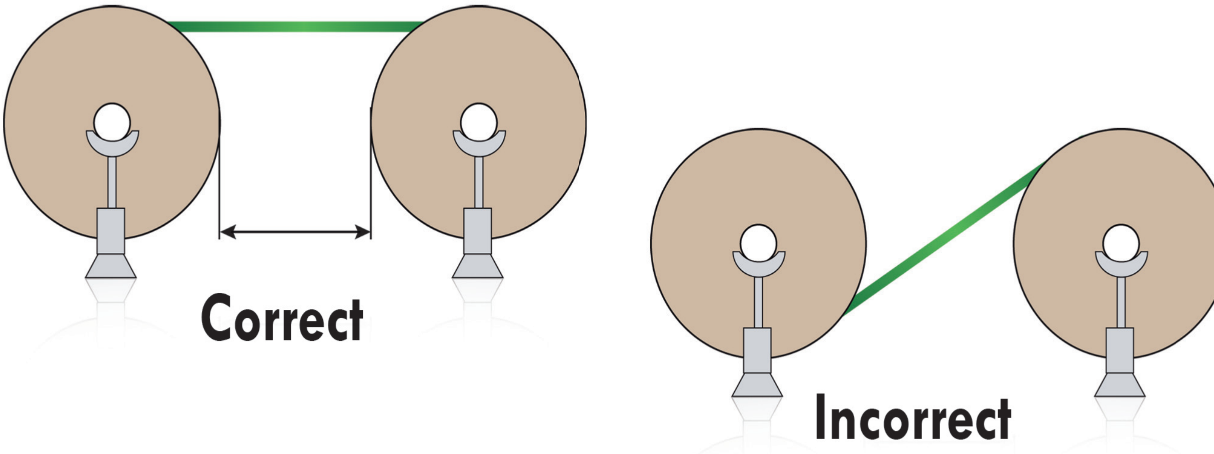
c) Chock reels from both sides.

d) Align reels flange to flange.

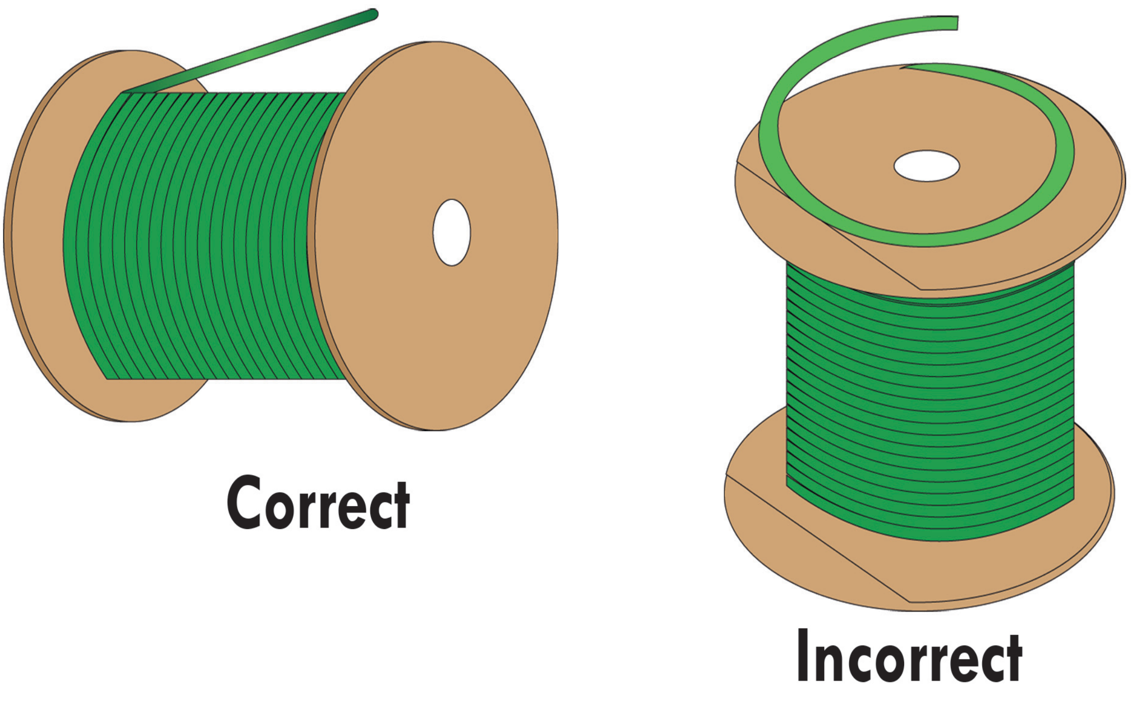
4. How to remove cables from reel

a) Unwound cable from bottom or from the top but if the cable is wound from reel to reel; position it from top to top of each reel as shown in the figure below.

b) Use suitable support for the reel at the rotating side.

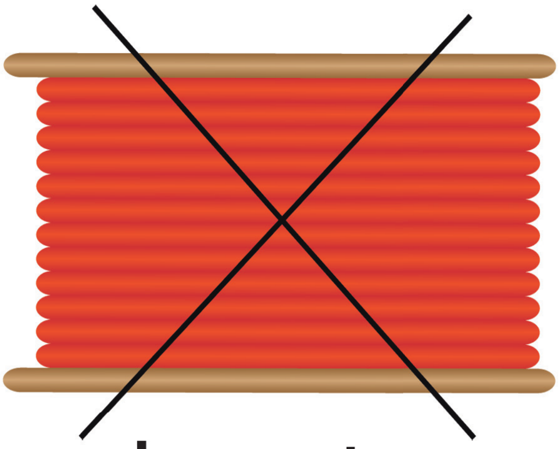


c) Don't pool the cable over the reel flange or the side of the coil as shown below.



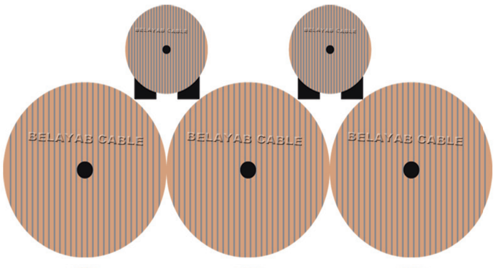
e) Put the reel its edge not on the flat position of reel as shown:

Correct

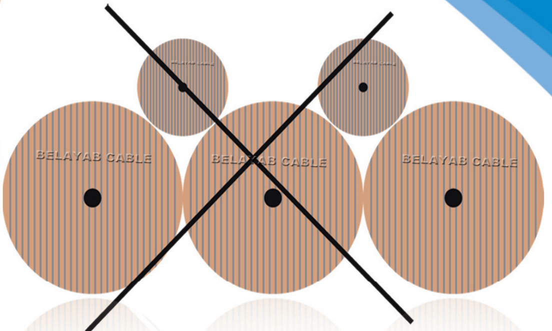


Incorrect

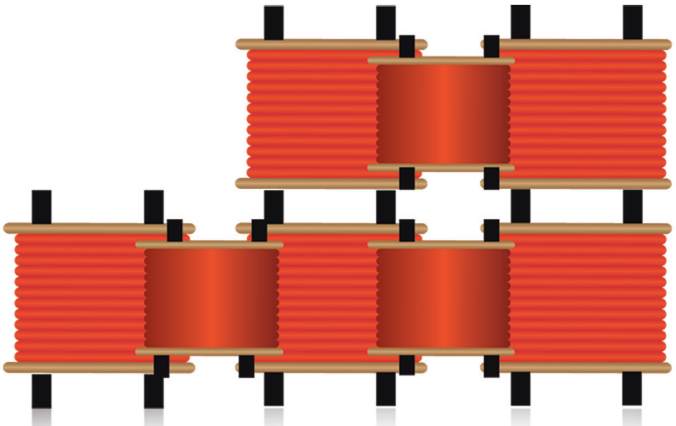
f) Avoid stacking of reels.



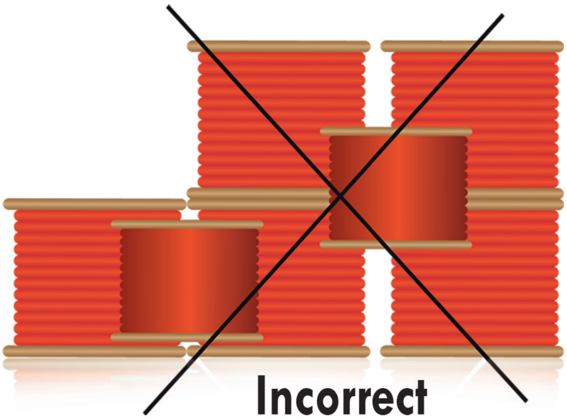
Correct



Incorrect



Correct



Incorrect

5. How keep reels from damage during installation.
   a) Use wheeling devices to unwound cable from reel in the field as shown below.
   b) Keep the direction of unwinding cable as shown below.
   c) Check the edge of reel not damage cable.

Proper loading method