

INSULATED POWER CABLES XLPE

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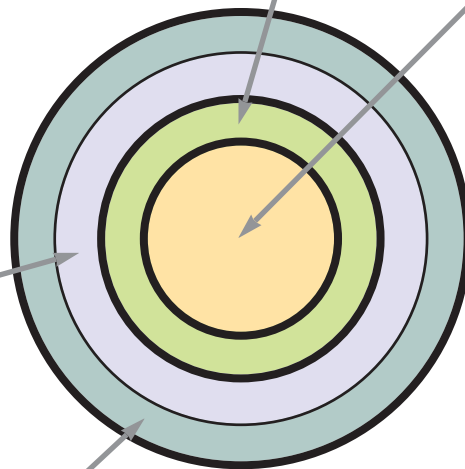
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1. CABLE DESIGN, MANUFACTURING AND TESTING OF XLPE CABLES

(1) DESIGN AND MANUFACTURING

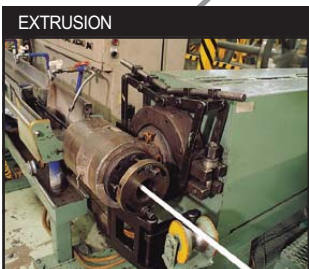


INSULATION

CONDUCTOR

SCREEN

SHEATH



CONSTRUCTION	ROLE	MATERIALS
CONDUCTOR	<ul style="list-style-type: none"> · Carrying current · Withstanding pulling force 	ANNEALED COPPER or ALUMINIUM
CONDUCTOR SCREEN	<ul style="list-style-type: none"> · Preventing concentration of electric field at any point on the conductor · Ensuring close contact 	SEMI-CONDUCTING COMPOUND
INSULATION	<ul style="list-style-type: none"> · Withstanding during the cable service life voltage ; different stress and the following <ul style="list-style-type: none"> - rating voltage - lightning voltage - switching voltage 	XLPE
INSULATION SCREEN	<ul style="list-style-type: none"> · Ensuring close contact with the insulation · Preventing concentration of the insulation electric field at any point 	SEMI-CONDUCTING COMPOUND
METALLIC SCREEN	<p>To provide;</p> <ul style="list-style-type: none"> · electrical screening · an active conductor for the capacitive and homopolar short circuit · a contribution for mechanical protection 	COPPER TAPE COPPER WIRE ALUMINIUM WIRE
OUTER SHEATH	<ul style="list-style-type: none"> · Protecting the metallic screen from the surrounding medium in order to protect it against corrosion 	PVC or PE

(2) REQUIREMENTS FOR CABLE TYPES (IEC 60502-1,2)

ELECTRICAL TEST				
TEST ITEM	TEST CONDITION		REQUIREMENT	UNIT
VOLTAGE TEST	2.5U _o +2/5min		No Breakdown	KV
	3.5U _o /5min			
ELECTRICAL RESISTANCE	at 20° C		IEC 60228	-
PARTIAL DISCHARGE TEST	IEC 60502-2 16. 3	1.73U _o	10pC ↓	KV
	IEC 60502-2 18.1.3		5pC ↓	
PARTIAL DISCHARGE TEST AFTER BENDING TEST	IEC 60502-2 18.1.4		5pC ↓	KV
Tanδ MEASUREMENT (at 90° C)	IEC 60502-2 18.1.5		0.8%	KV
PARTIAL DISCHARGE TEST AFTER HEATING CYCLE TEST	IEC 60502-2 18.1.6		5pC ↓	KV
IMPULSE TEST	IEC 60502-1 17.4 & IEC 60502-2 18.1.7,18.2.4		Withstand Without Failure	KV
VOLTAGE TEST AFTER IMPULSE TEST	IEC 60502-2 18.1.7		No Breakdown	KV
VOLTAGE TEST FOR 4hr	4U _o /4hr		No Breakdown	KV
RESISTIVITY OF SEMI-CONDUCTING SCREENS (at 90° C)	IEC 60502-2 18.1.9	Conductor screen	1000 Ω -m ↓	-
		Insulation screen	500 Ω -m ↓	

RATED VOLTAGE OF EACH CABLE [U ₀ /U(U _m)]								
0.6/1 KV	1.8/3(3.6) KV	3.6/6(7.2) KV	6/10(12) KV	8.7/15(17.5) KV	12/20(24) KV	18/30(36) KV	26/35 KV	REMARK
3.5	6.5	-	-	-	-	-	-	R. T.
-	-	12.5	21	30.5	42	63	91	
Compliance with the requirement for conductor construction of IEC 60502-1,2								R. T.
-	-	6	10	15	20	31	45	R. T.
-	-	6	10	15	20	31	45	T. T.
-	-	6	10	15	20	31	45	T. T.
-	-	-	2	2	2	2	2	T. T.
-	-	6	10	15	20	31	45	T. T.
-	40	60	75	95	125	170	250	T. T.
-	-	12.5	21	30.5	42	63	91	T. T.
2.4	7.2	14.4	24*	35*	48*	72*	104*	S. T. , T. T.
This test is applicable only to cables having conductor screen and insulation screen								T. T.

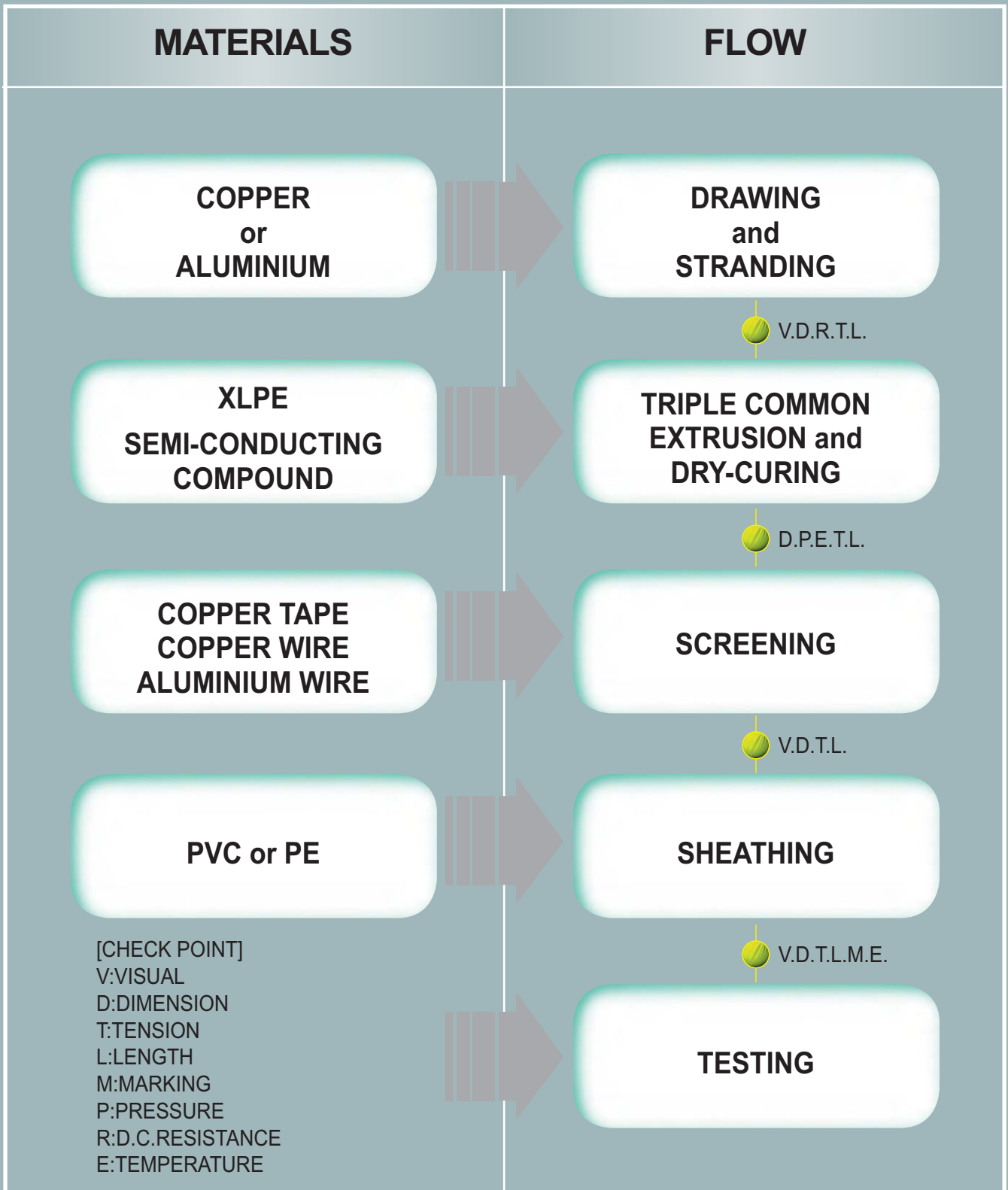
* Sample test is applicable only to cables of rated voltages 6/10(12) KV and above R.T. : Routine Test S.T. : Sample Test T.T. : Type Test

TEST ITEM	TEST CONDITION		REQUIREMENT
XLPE INSULATION			
MEASUREMENT OF THICKNESS OF INSULATION	IEC 60502-1 18.1 & IEC 60502-2 19.1		$t_m \geq t_n(0.1+0.1t_n)$ tm:minimum thickness tn:nominal thickness
MECHANICAL PROPERTIES - TENSILE STRENGTH (min.) - ELONGATION (min.)	IEC 60502-1 18.3 & IEC 60502-2 19.3	Before Aging	1.275kg/mm ² ,200%
		After Aging	Variation, $\pm 25\%$
HOT-SET TEST	IEC 60502-1 18.11 & IEC 60502-2 19.11		175% ↓ ,15% ↓
WATER ABSORPTION TEST	IEC 60502-1 18.13 & IEC 60502-2 19.13		1mg/cm ² ↓
SHRINKAGE TEST	IEC 60502-1 18.6 & IEC 60502-2 19.16		4%
PVC SHEATH			
MEASUREMENT OF THICKNESS OF SHEATH	IEC 60502-1 18.2 & IEC 60502-2 19.2		IEC 60502-1 18.2.3 & IEC 60502-2 17.5.3
MECHANICAL PROPERTIES - TENSILE STRENGTH (min.) - ELONGATION (min.)	IEC 60502-1 18.4 & IEC 6050-2 19.4	Before Aging	1.275kg/mm ² ,150%
		After Aging	Variation, $\pm 25\%$
LOSS OF MASS (max.)	IEC 60502-1 18.6 & IEC 60502-2 19.6		1.5mg/cm ² ↓
PRESSURE TEST AT HIGH TEMPERATURE	IEC 60502-1 18.7 & IEC 60502-2 19.7		50% ↓ of thickness value
BEHAVIOUR AT LOW TEMPERATURE	IEC 60502-1 18.8 & IEC 60502-2 19.8	Elongation	20%
		Impact	No Crack
HEAT SHOCK TEST	IEC 60502-1 18.9 & IEC 60502-2 19.9		No Crack

RATED VOLTAGE OF EACH CABLE [U _o /U(U _m)]								
0.6/1 KV	1.8/3(3.6) KV	3.6/6(7.2) KV	6/10(12) KV	8.7/15(17.5) KV	12/20(24) KV	18/30(36) KV	26/35 KV	REMARK
The measurements shall be made as described in Clause 6 of IEC 60502-1, 2								T. T.
The test result for unaged and aged test pieces shall comply with the requirements given in Table 15 of IEC 60502-1 and 17 of IEC 60502-2								T. T.
The test procedures shall be carried out in accordance with Clause 9 of IEC 60811-2-1								S.T., T. T.
The test procedures shall be carried out in accordance with Clause 9.2 of IEC 60811-1-3								T. T.
The test procedures shall be carried out in accordance with Clause 10 of IEC 60811-1-3								T. T.
The measurements shall be made as described in Clause 13 of IEC 60502-1 and 14 of IEC 60502-2								T. T.
The test result for unaged and aged test pieces shall comply with the requirements given in Table 16 of IEC 60502-1 and 18 of IEC 60502-2								T. T.
The test procedures shall be in accordance with Clause 8.2 of IEC 60811-3-2								T. T.
The test procedures shall be in accordance with Clause 8 of IEC 60811-3-1								T. T.
The test procedures shall be in accordance with Clause 8 of IEC 60811-1-4								T. T.
The test procedures shall be in accordance with Clause 9 of IEC 60811-3-1								T. T.

R.T. : Routine Test S.T. : Sample Test T.T. : Type Test

(3) QUALITY CONTROL FLOW CHART



2. RESEARCH AND DEVELOPMENT FACILITIES (1) HIGH VOLTAGE LABORATORY



(2) INVESTIGATION AND INSPECTION EQUIPMENT



PILOT EXT.



MELT INDEXER



FT-IR



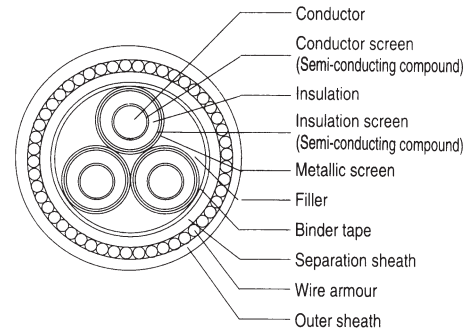
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3. CONSTRUCTION DATA OF CABLES



6/10(12)kV

XLPE Insulated Wire
Armoured Cable
(XLPE / WA / PVC)



Single Core

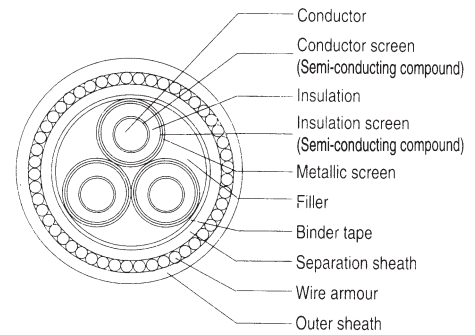
Conductor Nominal Area mm ²	Insulation Thickness mm	Separation Sheath Thickness mm	Armour Wire Size mm	Outer Sheath Thickness mm	Approx. Overall Diameter mm	Approx. Cable Weight kg / km		Standard Length Per Drum m
						Copper	Aluminium	
16	3.4	1.2	1.6	1.8	24	770	670	500
25	3.4	1.2	1.6	1.8	25	910	750	500
35	3.4	1.2	1.6	1.8	26	1,040	820	500
50	3.4	1.2	1.6	1.8	28	1,190	900	500
70	3.4	1.2	1.6	1.9	30	1,480	1,040	500
95	3.4	1.2	1.6	2.0	31	1,780	1,190	500
120	3.4	1.2	2.0	2.0	34	2,150	1,410	500
150	3.4	1.2	2.0	2.1	35	2,480	1,560	500
185	3.4	1.2	2.0	2.1	37	2,890	1,730	500
240	3.4	1.2	2.0	2.2	39	3,590	2,050	500
300	3.4	1.2	2.0	2.3	42	4,230	2,330	500
400	3.4	1.3	2.5	2.4	47	5,320	2,890	500
500	3.4	1.3	2.5	2.5	50	6,500	3,380	500
630	3.4	1.4	2.5	2.6	55	8,060	3,990	400

Three Core

Conductor Nominal Area mm ²	Insulation Thickness mm	Separation Sheath Thickness mm	Armour Wire Size mm	Outer Sheath Thickness mm	Approx. Overall Diameter mm	Approx. Cable Weight kg / km		Standard Length Per Drum m
						Copper	Aluminium	
16	3.4	1.2	2.0	2.3	42	3,000	2,700	500
25	3.4	1.3	2.5	2.5	46	3,900	3,430	500
35	3.4	1.3	2.5	2.5	50	4,460	3,770	500
50	3.4	1.4	2.5	2.6	52	5,080	4,190	500
70	3.4	1.4	2.5	2.8	56	6,050	4,750	500
95	3.4	1.5	2.5	2.9	60	7,180	5,380	500
120	3.4	1.6	2.5	3.0	63	8,230	5,960	400
150	3.4	1.6	2.5	3.1	67	9,380	6,580	300
185	3.4	1.7	3.15	3.2	72	11,610	8,110	300
240	3.4	1.8	3.15	3.4	80	14,210	9,510	250
300	3.4	1.9	3.15	3.6	84	16,420	10,630	200
400	3.4	2.0	3.15	3.8	92	20,260	12,880	200

12/20(24)kV

XLPE Insulated Wire
Armoured Cable
(XLPE / WA / PVC)



Single Core

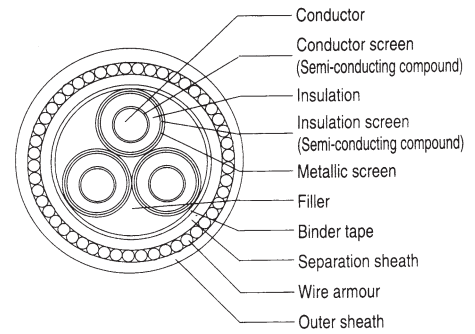
Conductor Nominal Area mm ²	Insulation Thickness mm	Separation Sheath Thickness mm	Armour Wire Size mm	Outer Sheath Thickness mm	Approx. Overall Diameter mm	Approx. Cable Weight kg / km		Standard Length Per Drum m
						Copper	Aluminium	
35	5.5	1.2	1.6	1.9	30	1,350	1,070	500
50	5.5	1.2	2.0	2.0	33	1,550	1,250	500
70	5.5	1.2	2.0	2.1	35	1,840	1,420	500
95	5.5	1.2	2.0	2.1	37	2,160	1,570	500
120	5.5	1.2	2.0	2.2	38	2,470	1,730	500
150	5.5	1.2	2.0	2.2	40	2,810	1,890	500
185	5.5	1.2	2.0	2.3	42	3,240	2,090	500
240	5.5	1.2	2.0	2.4	45	4,150	2,580	500
300	5.5	1.3	2.5	2.5	48	4,800	2,890	500
400	5.5	1.3	2.5	2.6	52	5,780	3,350	500
500	5.5	1.4	2.5	2.7	55	6,970	3,850	500
630	5.5	1.5	2.5	2.8	60	8,600	4,500	400

Three Core

Conductor Nominal Area mm ²	Insulation Thickness mm	Separation Sheath Thickness mm	Armour Wire Size mm	Outer Sheath Thickness mm	Approx. Overall Diameter mm	Approx. Cable Weight kg / km		Standard Length Per Drum m
						Copper	Aluminium	
35	5.5	1.5	2.5	2.9	60	5,700	5,010	500
50	5.5	1.6	2.5	3.0	62	6,370	5,480	500
70	5.5	1.6	2.5	3.1	66	7,370	6,070	400
95	5.5	1.7	2.5	3.2	72	9,400	7,600	300
120	5.5	1.8	3.15	3.4	75	10,530	8,270	300
150	5.5	1.8	3.15	3.5	80	11,800	8,940	300
185	5.5	1.9	3.15	3.6	83	13,350	9,850	250
240	5.5	2.0	3.15	3.8	90	16,430	11,820	200
300	5.5	2.1	3.15	3.9	95	18,870	13,080	200
400	5.5	2.2	3.15	4.2	103	23,260	15,930	200

26/35kV

XLPE Insulated Wire
Armoured Cable
(XLPE / WA / PVC)

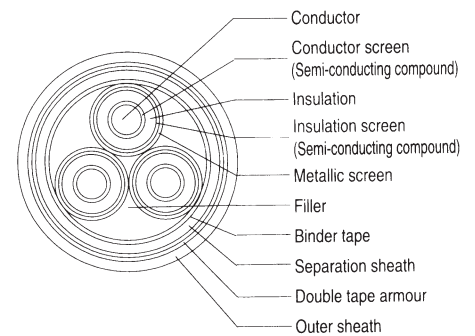


Three Core

Conductor Nominal Area mm ²	Insulation Thickness mm	Separation Sheath Thickness mm	Armour Wire Size mm	Outer Sheath Thickness mm	Approx. Overall Diameter mm	Approx. Cable Weight kg / km		Standard Length Per Drum m
						Copper	Aluminium	
35	10.5	1.9	3.15	3.7	86	11,700	11,075	400
50	10.5	2.0	3.15	3.8	89	12,680	11,835	400
70	10.5	2.1	3.15	3.9	93	13,850	12,625	400
95	10.5	2.1	3.15	4.1	96	15,400	13,700	300
120	10.5	2.2	3.15	4.2	100	16,700	14,575	300
150	10.5	2.3	3.15	4.3	105	18,200	15,547	300
185	10.5	2.3	3.15	4.4	106	20,060	16,730	200
240	10.5	2.4	3.15	4.6	111	22,900	18,520	200
300	10.5	2.5	3.15	4.7	117	27,000	21,465	200
400	10.5	2.6	3.15	5.0	124	28,900	21,835	200

26/35kV

XLPE Insulated Tape
Armoured Cable
(XLPE / DTA / PVC)



Three Core

Conductor Nominal Area mm ²	Insulation Thickness mm	Separation Sheath Thickness mm	Armour Tape Thickness mm	Outer Sheath Thickness mm	Approx. Overall Diameter mm	Approx. Cable Weight kg / km		Standard Length Per Drum m
						Copper	Aluminium	
35	10.5	1.9	0.8	3.6	83	8,950	8,325	400
50	10.5	2.0	0.8	3.7	86	9,670	8,824	400
70	10.5	2.1	0.8	3.8	90	10,820	9,595	400
95	10.5	2.1	0.8	3.9	93	12,300	10,595	400
120	10.5	2.2	0.8	4.1	97	13,520	11,394	300
150	10.5	2.3	0.8	4.2	101	14,900	12,248	300
185	10.5	2.3	0.8	4.3	103	16,620	13,290	300
240	10.5	2.4	0.8	4.5	108	19,250	14,870	200
300	10.5	2.5	0.8	4.6	113	23,170	17,632	200
400	10.5	2.6	0.8	4.9	121	24,820	17,754	200