INDEPENDENT POWER TRANSMISSION OPERATOR (IPTO or ADMIE) S.A.
TRANSMISSION NEW PROJECTS DEPARTMENT
DEPARTMENT OF DESIGN AND SPECIFICATION OF OVERHEAD TRANSMISSION LINES

TECHNICAL SPECIFICATION
FOR THE SUPPLY OF STEEL LATTICE TOWERS
FOR 150 KV O.H.T.L.

1. **Light – Single Circuit E**
2. **Heavy – Single Circuit B**
3. **Heavy – Double Circuit 2B**

JANUARY 2014

This specification covers the supply of steel lattice towers for 150 KV Transmission Lines.

A. GENERAL DATA

1. There are four tower types for each one of the following three categories of lines.

Line category	**E**	**B**	**2B**
Tower type	**Light-Single circuit**	**Heavy-Single circuit**	**Heavy-Double circuit**
Straight line	S_2	S_3	S_4
Small angle	R_2	R_3	R_4
45^0 angle	T_2	T_3	T_4
75^0 angle or Terminal Dead End	Z_2	Z_3	Z_4

2. The general characteristics of the transmission lines of each category are :

	Single circuit (E and B Categories)	**Double circuit** (2B Category)
- Line Voltage	150 KV	150 KV
- Line Circuits	One three phase circuit with single conductor per phase	Two three phase circuits with single conductor per phase
- Circuit Arrangement	The three phases are arranged in a horizontal configuration	The three phases of each circuit are arranged in an approximate vertical configuration at each side of the tower
- Shield Wires Arrangement	Each tower is equipped with two shield wires installed above the conductors symmetrically to the tower axis	Each tower is equipped with one shield wire installed at the tower's highest point on the tower axis
- Phase Conductor Data	1. For Light-single circuit line (E): ACSR LINNET 336400 CM. Overall diameter 18,3 mm, weight 0,7 kg/m. 2. For Heavy - single circuit line (B) and Heavy double circuit line (2B): ACSR GROSBEAK 636000 CM. Overall diameter 25,2 mm, weight 1,3 kg/m.	
- Shield wire data	Seven strand galvanized steel wire , overall diameter 9,5 mm, weight 0,44 kg/m.	
- Insulators data	Disc type insulators of 10 IN diameter and 5 3/4 IN spacing of Normal type (or Fog type where needed).	

3. The towers shall be manufactured from structural steel angle profiles, of Open Hearth (Siemens-Martin), Electric Furnace or LD process. Both mild and high tensile steel quality may be used. The tolerance of structural steel profiles and plates used shall be only positive and within the margin given in DIN 1612 or equivalent standards and the ratio between width and thickness shall be in accordance with DIN 4114 (and not greater than 17).
A minimum ungalvanized thickness of 5 mm material shall be used for members forming the shape of the tower and 3 mm for all other members.
Each member of the tower shall be marked before galvanizing, to facilitate erection. The marking must specify the tower type and the member number shown at the corresponding drawings.
The maximum allowable ratio of unsupported length to the radius of gyration shall be as follows; 150 for corner legs, 200 for diagonals and 250 for redundants.

4. Metric thread bolts from high tensile steel quality shall be used, having a diameter not smaller than 12 mm. Not more than 4 sizes of diameter of bolts shall be used for each tower type.
All bolts shall be of sufficient unthreaded part length, to secure that no shearing forces will be developed in the threaded part and shall be furnished with suitable washers and spring washers according to ISO 7089 (or DIN 126) and DIN 127B correspondingly.
The mechanical properties of bolts and nuts shall be in accordance with ISO 898-1 and 898-2 correspondingly while their geometric properties shall be in accordance with DIN 7990 and DIN 934 respectively. Only bolts of proper class 6.6 or 6.8 shall be used. The tolerance between hole and bolt diameter shall be in accordance with the corresponding EN 1090-2 Standard.

The fabrication of towers shall be in accordance with EN 1090-1 and 1090-2 for execution class EXC3.

All holes have to be done by drilling or punching. Punching of holes on steel members must be made in accordance with EN 1090-2. The opening of holes by drilling is mandatory only regarding the following tower elements:

- Corner legs
- Main elements of cross arms (internal bracing not included)
- Holes locate nearby the bending zone of corner members and gusset plates
- Other elements the thickness of which exceeds 10mm and 14mm for S355 and S235 steel qualities respectively, according to EN-10025 Standard.

An extra three per cent (3%) of the necessary quantity of bolts, nuts, washers and spring washers must be delivered to IPTO.
The nuts must be delivered bolted on the corresponding bolts.
All tower members and connecting material shall be hot dip galvanized in accordance with EN ISO 1461 specification.

5. Each tower shall be provided with the necessary tower fittings i.e. shackles, hangers and U-bolts, required for the attachment of the line fittings to the tower. Tower fittings shall be made of high tensile steel and shall have an opening with ample radius of curvature in order to take without any friction the line fittings in general. Their axis of rotation on the tower shall be horizontal.
Cotter pins of all tower fittings shall be made of bras or phosphorus bronze.

Anti-climbing guards shall be furnished where needed, to prevent climbing in tower of unauthorized persons. Enameled danger plates shall be also furnished to be installed on every tower.

B. TOWER CHARACTERISTICS

The height of the conductor attachment from theoretical ground level for a normal tower with normal legs is 19,95 m for tower types S and R and 19,00 m for tower types T and Z.
The towers are furnished with individual leg extensions for use on irregular ground and/or for increasing the height of the conductor attachment, from the ground level.
For all types of towers has been designed an extended body of +4,5 m.
The following leg extensions have been designed:

(a) Leg extensions -1,5 m (shorter than normal)
(b) Normal (zero) leg extensions
(c) Leg extensions +1,5 m (longer than normal)
(d) Leg extensions +3,0 m (longer than normal)
(e) Leg extensions +6,0 m (longer than normal)

For tower types S_2 and R_2 (both for extended and non-extended tower types), 1,0 m shorter than normal legs have also been designed. Also +4,5 m leg extensions have been designed for series 3 and 4 extended body (+4,5 m body extension) towers.
All legs of the same type and the same body extension are interchangeable and suitable for connection on the left or right side of the tower face.
Any horizontal section of the whole tower below waist is square and the webs of every tower face are symmetrically placed.
The use of tensioned web members has not been allowed.
All types to towers are equipped with horizontal panels located at :

- The lower surfaces of the crossarms
- The upper part of the leg extensions
- Any change in inclination of leg members

C. CONNECTIONS

Generally welding is not allowed. The connections of members shall be detailed in such a manner, as to avoid eccentricities. Empty spaces at connections between members must be filled with suitable fillers.

All connections shall meet the following minimum requirements.

1. Splices between leg members

Lap splices are not allowed
Butt splices between leg members have to be made with an inside splice angle having a thickness of at least the same with that of the thicker member and two outside straps having a thickness of at least 5 mm.

2. Connection at joints

When two or more members are jointed on another stronger member, the intersection of their bolt axes must lie within the limits of this other member. In case this cannot be effected, gusset plates should be used, having a thickness of at least 1 mm greater than that of the thicker of these jointed members.

When more than two members are jointed together through a gusset plate, this should have a thickness of at least 1 mm greater than of the thicker jointed member.
Generally the gusset plates shall have a thickness of at least 5 mm.

3. Quality of splice angles, straps and plates.

The quality (ultimate strength) of the splice angles, butt straps and gusset plates, shall be at least equal to the higher quality of the members involved in the connection.

4. Minimum distances from bolts

The following minimum distances from the center of the bolt hole, must be kept (d=nominal diameter of bolt):

- For all members and straps of splice connections :

Distance from sheared edge	= 2,00 D
Distance from rolled edge	= 1,35 D
Distance from the center of the nearest bolt	= 3,50 D

- For all members and plates of connections at joints :

Distance from sheared edge	= 1,50 D
Distance from rolled edge	= 1,20 D
Distance from the center of the nearest bolt	= 2,50 D

D. FOUNDATIONS

Each tower will be based on four separate concrete footings.
The steel stubs shall be cast into concrete blocks, suitably reinforced if necessary.
Stub extensions of standard lengths are used on irregular ground. The quantities and the corresponding lengths of stub extensions shall be determined by IPTO.
The types of foundations that are mainly used are Rock Anchor, Auger and Pad and Chimney. For soils with low allowable bearing pressure Special Type foundations are used.
For each type of foundation a standard length of stubs is used.
Each footing shall be provided with one galvanized steel grounding rod of 2 cm diameter and 200 cm length. The grounding rod shall be attached with good electrical connection to the tower at the bottom of the footing, through a length of 10 mm diameter galvanized steel solid wire. For every tower 4 such grounding rods are required, one for each leg.
Counterpoise will be used for additional tower grounding, where needed, and shall be connected at the tower on an individual bolt of suitable diameter above ground, long enough to take this connection. For every tower 4 such bolts are required, one for each leg.

E. REQUIREMENTS FOR BIDDER AND CONTRACTOR

1. Bidder has to submit with his offer the guaranteed characteristics of steel to be used, which must be in accordance with EN 10025 Standard.

2. After the award of the contract the CONTRACTOR has to submit the following for approval.

- Table of characteristics and dimensions of the steel sections to be used if there are changes in the construction drawings.
- Construction drawings of any changes that may be required by IPTO (and CONTRACTOR is obliged to accept) and also the resultant difference of unit weight. These drawings are property of IPTO hereafter.
- Detailed drawings of any proposed modifications to tower fittings. Any changes will be done under IPTO approval and without any extra charge of IPTO.

F. ROUTINE TESTS AND SAMPLING

For each tower type, an assembly test of tower body and body extensions and (after IPTO'S representative request) assembly of leg extensions, will be made.
The following routine tests shall by made on every lot of tower elements for shipment, but in no way shall restrict the IPTO'S representative to request any other additional or supplementary tests.

1.	Material control :	Tension test, Elongation measurement Bending test, Shear test
2.	Galvanizing tests :	Visual control, Adherence test, Uniformity of coating test, Weight of coating test
3.	Dimension control :	General dimensions control, Profile measurement, Interchangeability control

4. All tests required by EN 1090-1 and EN 1090-2 for execution class EXC3.

All the above tests shall be made on all qualities of steel and connecting material used in the manufacture of the lot to be delivered.
The number of test specimens will be sufficient to secure that the delivered lot is suitable for its intended use and is in conformity with the specifications.

G. ATTACHMENTS

For bidder's information are attached

1. Table of unit weights of towers' parts (ΤΜΓΜ 681Δ)
2. Tower outlines of line categories 2, 3 and 4 (sch 225, sch 251, sch 177).
3. Table of steel sections used and their geometrical characteristics (4 pages).
4. Table of construction drawings that IPTO S.A. will give to CONTRACTOR after the award of the Contract (ΤΜΓΜ 682 Γ).

ΔΕΗ Α.Ε. / ΔΝΕΜ / ΤΟΜΕΑΣ ΣΧΕΔΙΑΣΜΟΥ ΚΑΙ ΠΡΟΔΙΑΓΡΑΦΩΝ ΓΡΑΜΜΩΝ ΜΕΤΑΦΟΡΑΣ

TABLE OF WEIGHTS OF TOWER PARTS FOR 150 KV T.L.

LINE CATEGORY	LIGHT SINGLE CIRCUIT				HEAVY SINGLE CIRCUIT				HEAVY DOUBLE CIRCUIT			
TOWER TYPE	S_2	R_2	T_2	Z_2	S_3	R_3	T_3	Z_3	S_4	R_4	T_4	Z_4
Tower body	2277	2755	3590	4643	2675	3130	4036	5260	3234	4095	5257	7050
Horiz. Panel for Normal Tower	127	127	144	183	143	143	187	220	247	300	285	407
Leg extension -1,5 for Normal Tower	42	47	108	110	60	69	85	112	92	119	153	218
Leg extension -1,0 for Normal Tower	48	53	---	---	---	---	---	---	---	---	---	---
Leg extension N for Normal Tower	66	72	146	178	93	110	126	175	144	188	229	308
Leg extension +1,5 for Normal Tower	116	126	211	241	145	159	194	243	205	251	307	399
Leg extension +3,0 for Normal Tower	148	172	275	319	192	210	256	315	264	320	394	502
Body extension +4,5 with horiz. panel	610	654	1096	1222	797	900	1283	1462	972	1202	1613	2270
Leg extension -1,5 for Extended Tower	48	53	114	103	78	85	97	123	115	140	172	239
Leg extension -1,0 for Extended Tower	53	59	---	---	---	---	---	---	---	---	---	---
Leg extension N for Extended Tower	73	81	142	169	106	117	152	186	168	209	248	341
Leg extension +1,5 for Extended Tower	127	135	201	236	155	169	217	258	224	279	315	442
Leg extension +3,0 for Extended Tower	164	179	267	317	212	230	287	345	287	346	406	556
Leg extension +4,5 for Extended Tower	236	247	340	421	266	294	376	444	370	451	534	692
Leg extension +6,0 for Extended Tower	274	291	400	501	324	351	455	533	415	526	643	823
Stub ext. for PAD foundation (P)	19	27	51	77	25	36	63	105	44	70	102	158
Stub ext. for Auger foundation (A1)	10	13	23	38	13	14	28	54	22	30	52	79
Stub ext. for Auger foundation (A2)	13	17	30	52	17	20	36	71	28	39	71	104
Stub ext. for Auger foundation (A3)	17	22	37	67	22	26	44	88	34	47	89	129
Stub ext. for Auger foundation (A4)	20	26	44	---	26	32	52	---	39	56	---	---
Stub ext. for Auger foundation (A5)	24	30	---	---	30	38	59	---	45	65	---	---

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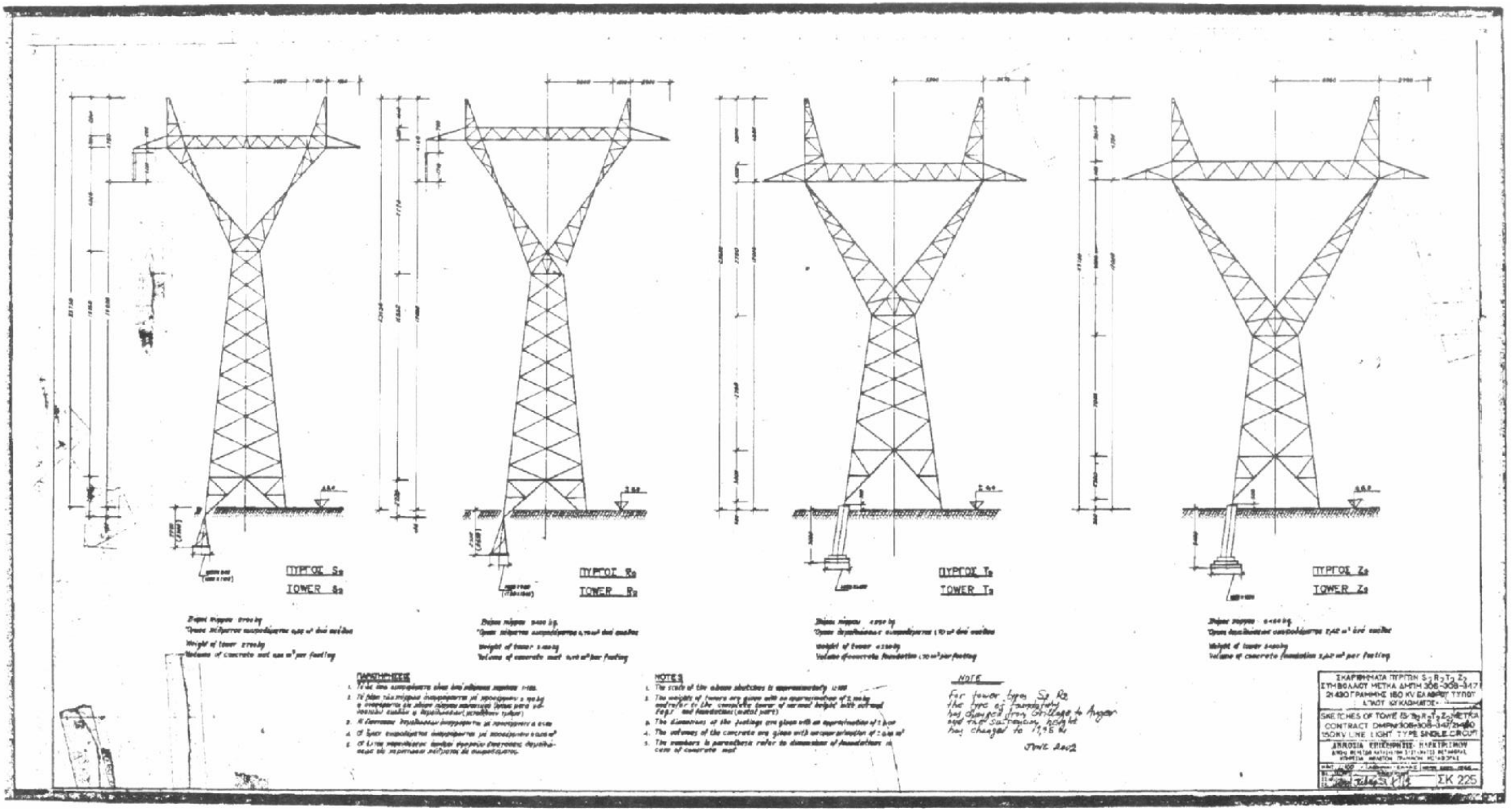
Τ.Μ.Γ.Μ 681Δ


ΠΥΡΓΟΙ S2
TOWER S2
ΠΥΡΓΟΙ R2
TOWER R2
ΠΥΡΓΟΙ T2
TOWER T2
ΠΥΡΓΟΙ Z2
TOWER Z2
ΣΧΕΔΙΑ ΠΥΡΓΩΝ S2 R2 T2 Z2
ΣΤΗ ΒΟΛΟΥ ΜΕΤΣΑ ΔΗΠΤΗ 308-309-347
21.430 ΓΡΑΜΜΗΣ 150 KV ΕΛΑΦΡΥ ΤΥΠΟΥ
ΑΠΛΟΥ ΚΥΚΛΩΜΑΤΟΣ
SKETCHES OF TOWE S2 R2 T2 Z2 METSA
CONTRACT DIMPE 308-309-347/21430
150KV LINE LIGHT TYPE SINGLE CIRCUIT
ΔΗΜΟΣΙΑ ΕΠΙΧΕΙΡΗΣΙΣ ΗΛΕΚΤΡΙΣΜΟΥ
ΣΧΕΔΙΟ
ΙΚ 225

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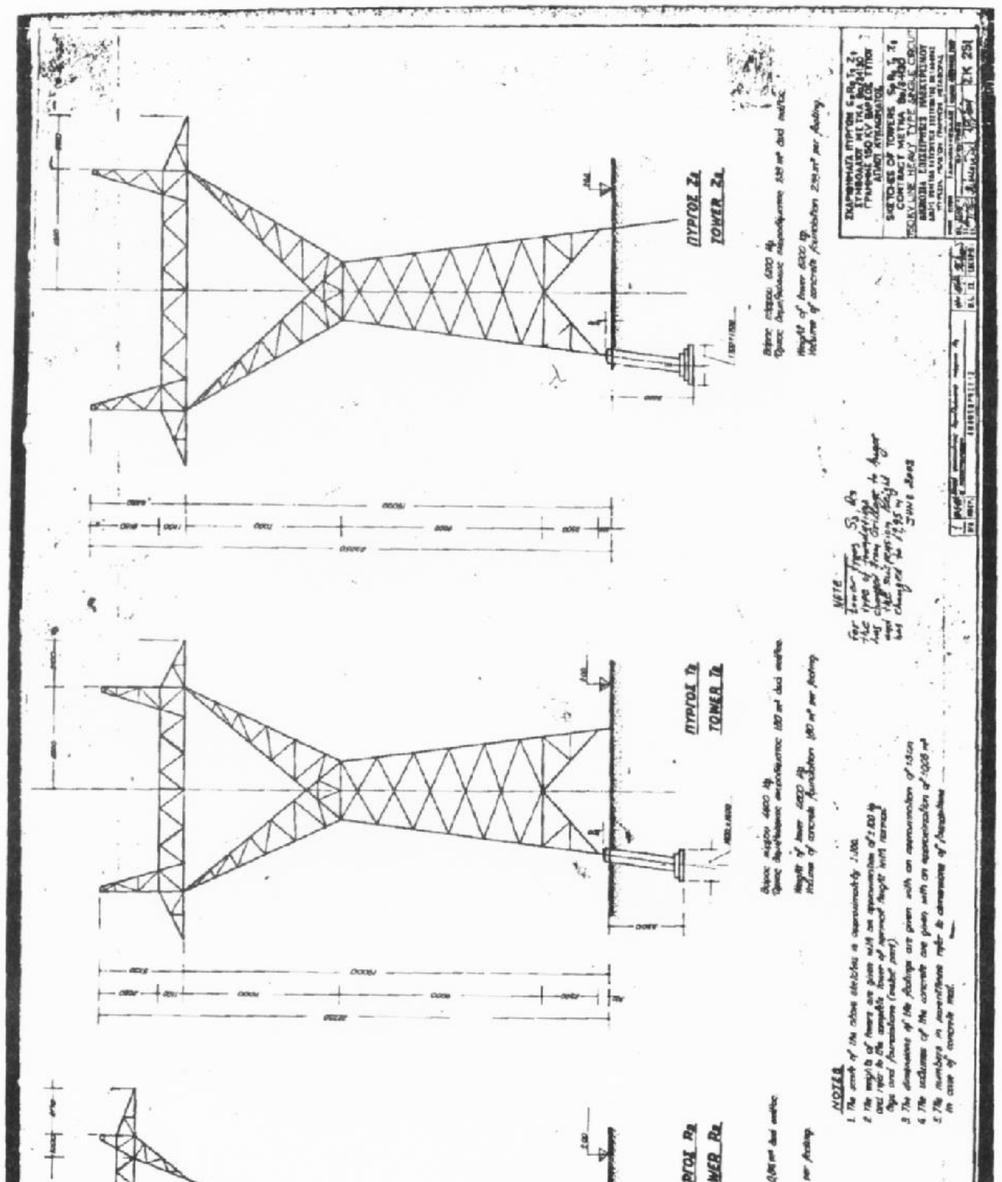
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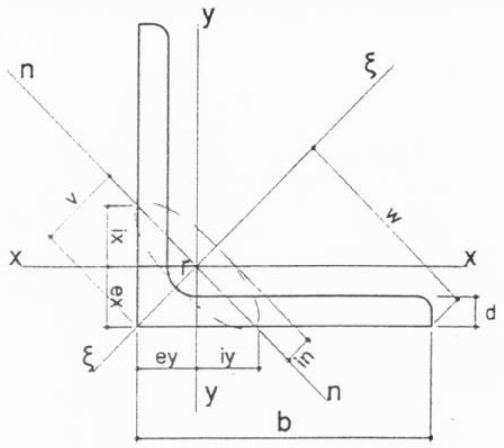
TOWER S2
ΠΑΡΑΤΗΡΗΣΕΙΣ
ΠΥΡΓΟΣ R2
TOWER R2
NOTES
ΠΥΡΓΟΣ T2
TOWER T2
ΠΥΡΓΟΣ Z2
TOWER Z2

ΠΥΡΓΟΣ S4
ΠΥΡΓΟΣ R4
ΠΥΡΓΟΣ T4
ΠΥΡΓΟΣ Z4
ΜΕΛΕΤΗ
ΣΧΕΔΙΑΣΗ
ΕΛΕΓΧΟΣ
ΕΓΚΡΙΣΗ
ΔΕΗ ΑΕ
ΔΝΕΜ
ΤΟΜΕΑΣ ΣΧΕΔΙΑΣΜΟΥ ΚΑΙ ΠΡΟΔΙΑΓΡΑΦΩΝ ΓΜ
150 KV
ΜΟΝΟΓΡΑΜΜΙΚΑ ΣΧΕΔΙΑ ΠΥΡΓΩΝ ΔΙΠΛΟΥ ΚΥΚΛΩΜΑΤΟΣ
ΑΡ. ΣΧΕΔΙΟΥ: ΣΚ 177
Μάϊος 2005
ΚΛΙΜΑΚΑ: 1/300

ΔΕΗ Α.Ε./ ΔΝΕΜ / ΤΟΜΕΑΣ ΣΧΕΔΙΑΣΜΟΥ ΚΑΙ ΠΡΟΔΙΑΓΡΑΦΩΝ ΓΡΑΜΜΩΝ ΜΕΤΑΦΟΡΑΣ

Sections 150 KV (Total : 4 pages)



L (EQUAL LEGS)

Designation	Dimension				Cross section	weight	Distange of axes			for bending axis								k
										x-x = y-y			ξ-ξ		n-n			
L	b	d	r	r1	F	G	e	w	v	Jx	Wx	ix	Jξ	iξ	Jn	Wn	in	
(mm)x(mm)x(mm)	(mm)	(mm)	(mm)	(mm)	(cm^2)	(kg/m)	(cm)	(cm)	(cm)	(cm^4)	(cm^3)	(cm)	(cm^4)	(cm)	(cm^4)	(cm^3)	(cm)	
40x40x3	40	3	6	3	2,35	1,84	1,07	2,83	1,52	3,45	1,18	1,21	5,45	1,52	1,44	0,95	0,78	3,84
45x45x4	45	4	7	3,5	3,49	2,74	1,23	3,18	1,75	6,43	1,97	1,36	10,20	1,71	2,68	1,53	0,88	4,54
50x50x4	50	4	7	3,5	3,89	3,06	1,36	3,54	1,92	8,97	2,46	1,52	14,20	1,91	3,73	1,94	0,98	4,06
55x55x4	55	4	8	4	4,31	3,38	1,47	3,89	2,08	12,00	2,98	1,67	19,00	2,10	5,01	2,41	1,08	3,71
55x55x9	55	9	8	4	9,16	7,19	1,68	3,89	2,38	24,20	6,35	1,63	38,20	2,04	10,30	4,33	1,06	1,15
60x60x4	60	4	8	4	4,71	3,70	1,60	4,24	2,26	15,80	3,58	1,83	24,90	2,30	6,61	2,93	1,19	3,35
60x60x9	60	9	8	4	10,10	7,90	1,81	4,24	2,56	32,10	7,66	1,79	50,70	2,25	13,50	5,27	1,16	7,56
65x65x6	65	6	9	4,5	7,53	5,91	1,80	4,60	2,55	29,20	6,21	1,97	46,30	2,48	12,10	4,74	1,27	4,69
65x65x10	65	10	9	4,5	12,10	9,49	1,97	4,60	2,78	45,10	9,94	1,93	71,20	2,43	19,00	6,82	1,25	7,71
70x70x5	70	5	9	4,5	6,84	5,37	1,88	4,95	2,66	31,20	6,10	2,14	49,50	2,69	13,00	4,87	1,38	3,60
70x70x6	70	6	9	4,5	8,13	6,38	1,93	4,95	2,73	36,90	7,27	2,13	58,50	2,68	15,30	5,60	1,37	4,32
70x70x10	70	10	9	4,5	13,10	10,30	2,09	4,95	2,96	57,20	11,70	2,09	90,50	2,63	24,00	8,10	1,35	7,15
75x75x5	75	5	10	5	7,36	5,78	1,99	5,30	2,81	38,50	6,99	2,29	61,00	2,88	16,10	5,55	1,48	3,37
75x75x6	75	6	10	5	8,75	6,87	2,04	5,30	2,89	45,60	8,35	2,28	72,20	2,87	18,90	6,54	1,47	4,05
80x80x6	80	6	10	5	9,22	7,34	2,22	5,66	3,15	57,30	9,92	2,48	91,40	3,15	23,10	7,32	1,59	3,68
80x80x7	80	7	10	5	10,80	8,49	2,21	5,66	3,13	64,20	11,10	2,44	102,00	3,07	26,50	8,48	1,57	4,40
90x90x6	90	6	11	5,5	10,60	8,30	2,41	6,36	3,41	80,30	12,20	2,76	127,00	3,47	33,30	9,80	1,78	3,35
90x90x7	90	7	11	5,5	12,20	9,60	2,45	6,36	3,46	92,40	14,10	2,75	147,00	3,46	38,20	11,00	1,77	3,92
90x90x8	90	8	11	5,5	13,90	10,9	2,50	6,36	3,53	104,00	16,10	2,74	165,00	3,45	43,50	12,30	1,77	4,44
90x90x14	90	14	11	5,5	23,20	18,30	2,76	6,36	3,90	171,00	27,40	2,71	269,00	3,40	71,50	18,30	1,75	7,53
100x100x7	100	7	12	6	13,70	10,70	2,67	7,07	3,77	128,00	17,50	3,06	203,00	3,86	53,10	14,10	1,97	3,52
100x100x8	100	8	12	6	15,50	12,20	2,74	7,07	3,87	145,00	19,90	3,06	230,00	3,85	59,90	15,50	1,96	4,01
100x100x9	100	9	12	6	17,30	13,60	2,78	7,07	3,93	161,00	22,30	3,05	255,00	3,84	66,50	16,90	1,96	4,50
110x110x9	110	9	12	6	19,00	15,10	3,08	7,78	4,35	221,00	27,90	3,45	359,00	4,35	96,10	22,10	2,20	3,76
110x110x13	110	13	12	6	26,90	21,30	3,22	7,78	4,56	312,00	40,00	3,35	491,00	4,27	133,00	29,20	2,20	5,44
120x120x8	120	8	13	6,5	18,70	14,70	3,23	8,49	4,57	255,00	29,10	3,69	405,00	4,65	105,00	23,10	2,37	3,40
120x120x9	120	9	13	6,5	21,00	16,50	3,27	8,49	4,63	285,00	32,60	3,68	452,00	4,64	117,00	25,40	2,36	3,75
120x120x10	120	10	13	6,5	23,20	18,20	3,31	8,49	4,69	313,00	36,00	3,67	497,00	4,63	129,00	27,50	2,36	4,17
130x130x8	130	8	14	7	20,40	16,00	3,46	9,19	4,90	327,00	34,30	4,00	518,00	5,04	135,00	27,60	2,58	3,07
130x130x9	130	9	14	7	22,80	17,90	3,51	9,19	4,96	364,00	38,40	4,00	578,00	5,04	150,00	30,30	2,57	3,46
130x130x10	130	10	14	7	25,20	19,80	3,55	9,19	5,03	401,00	42,50	3,99	637,00	5,03	165,00	32,90	2,56	3,85
130x130x11	130	11	14	7	27,60	21,70	3,60	9,19	5,09	437,00	46,50	3,98	694,00	5,01	180,00	35,40	2,55	4,23
130x130x13	130	13	14	7	32,30	25,40	3,68	9,19	5,20	506,00	54,30	3,96	806,00	4,99	209,00	40,00	2,54	4,99
140x140x9	140	9	15	7,5	24,60	19,30	3,75	9,90	5,30	458,00	44,70	4,31	726,00	5,43	189,00	35,70	2,77	3,21
140x140x10	140	10	15	7,5	27,20	21,40	3,79	9,90	5,36	504,00	49,40	4,30	801,00	5,42	208,00	38,70	2,76	3,57
140x140x11	140	11	15	7,5	29,80	23,40	3,84	9,90	5,43	550,00	54,10	4,29	874,00	5,41	227,00	41,70	2,76	3,93
140x140x12	140	12	15	7,5	32,50	25,50	3,85	9,90	5,44	599,00	59,00	4,29	925,00	5,32	252,00	46,30	2,78	4,19

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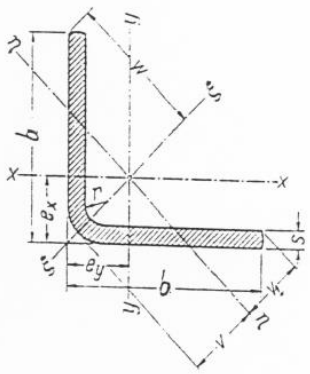
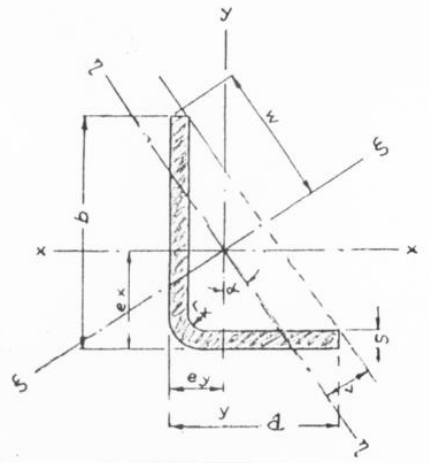


KL (EQUAL LEGS)

Designation		Dimension			Cross section	Weight	Distance of axes				for the bending axis									Jxy
											x-x			ξ-ξ			n-n			
KL		b	s	r	F	G	ex=ey	w	v	vn	Jx	Wx (min)	ix	Jξ	Wξ (min)	iξ	Jn	Wn (min)	in	
(mm)x(mm)x(mm)	(mm)	(mm)	(mm)	(mm)	(cm²)	(kg/m)	(cm)	(cm)	(cm)	(cm)	(cm⁴)	(cm³)	(cm)	(cm⁴)	(cm³)	(cm)	(cm⁴)	(cm³)	(cm)	(cm⁴)
35x35x3	65	35	3	3	1,95	1,53	1,01	2,48	1,18	1,25	2,32	0,93	1,09	3,77	1,52	1,39	0,85	0,68	0,66	1,53
38x38x3	70	38	3	3	2,10	1,65	1,07	2,65	1,27	1,34	2,87	1,07	1,17	4,66	1,76	1,49	1,07	0,80	0,71	1,83
40x40x3	75	40	3	3	2,26	1,77	1,14	2,83	1,36	1,43	3,51	1,23	1,25	5,69	2,01	1,59	1,31	0,92	0,76	2,20
43x43x3	80	43	3	3	2,40	1,88	1,20	3,00	1,45	1,52	4,24	1,39	1,33	6,88	2,29	1,69	1,60	1,05	0,82	2,64
45x45x3	85	45	3	3	2,55	2,00	1,26	3,18	1,54	1,61	5,07	1,57	1,41	8,22	2,58	1,80	1,91	1,19	0,87	3,15
48x48x3	90	48	3	3	2,70	2,12	1,32	3,36	1,62	1,70	6,00	1,75	1,49	9,72	2,90	1,90	2,27	1,34	0,92	3,72
50x50x3	95	50	3	3	2,85	2,24	1,39	3,53	1,71	1,78	7,03	1,95	1,57	11,40	3,22	2,00	2,67	1,50	0,97	4,36
53x53x3	100	53	3	3	3,00	2,36	1,45	3,71	1,80	1,87	8,18	2,16	1,65	13,20	3,57	2,10	3,12	1,67	1,02	5,06
55x55x3	105	55	3	3	3,15	2,47	1,51	3,89	1,89	1,96	9,45	2,37	1,73	15,30	3,93	2,20	3,61	1,84	1,07	5,84
58x58x3	110	58	3	3	3,30	2,59	1,57	4,06	1,98	2,05	10,80	2,60	1,81	17,50	4,31	2,31	4,15	2,03	1,12	6,69
60x60x3	115	60	3	3	3,45	2,71	1,64	4,24	2,07	2,14	12,40	2,84	1,89	20,00	4,72	2,41	4,75	2,22	1,17	7,62
36x36x4	65	36	4	4	2,60	2,04	1,08	2,53	1,19	1,29	3,15	1,26	1,10	5,15	2,03	1,41	1,16	0,90	0,67	1,99
38x38x4	70	38	4	4	2,80	2,20	1,14	2,71	1,28	1,38	3,90	1,45	1,18	6,38	2,36	1,51	1,44	1,05	0,75	2,47
41x41x4	75	41	4	4	3,00	2,36	1,20	2,88	1,37	1,46	4,78	1,66	1,26	7,29	2,70	1,61	1,87	1,21	0,77	3,01
42x42x4	77	42	4	4	3,08	2,42	1,23	2,95	1,41	1,50	5,16	1,75	1,29	8,41	2,84	1,65	1,92	1,28	0,79	3,24
43x43x4	80	43	4	4	3,20	2,51	1,27	3,06	1,46	1,55	5,77	1,88	1,34	9,39	3,07	1,71	2,15	1,38	0,82	3,72
46x46x4	85	46	4	4	3,40	2,67	1,33	3,24	1,55	1,64	6,89	2,12	1,42	11,20	3,46	1,82	2,57	1,57	0,87	4,32
48x48x4	90	48	4	4	3,60	2,83	1,39	3,41	1,64	1,73	8,14	2,37	1,50	13,20	3,88	1,92	3,05	1,76	0,92	5,09
51x51x4	95	51	4	4	3,80	2,98	1,45	3,59	1,72	1,82	9,54	2,63	1,58	15,50	4,32	2,02	3,54	1,97	0,97	5,95
53x53x4	100	53	4	4	4,00	3,14	1,52	3,77	1,81	1,41	11,10	2,91	1,67	18,00	4,78	2,12	4,18	2,19	1,02	6,91
56x56x4	105	56	4	4	4,20	3,30	1,58	3,94	1,90	2,00	12,80	3,20	1,75	20,80	5,26	2,22	4,84	2,43	1,07	7,96
58x58x4	110	58	4	4	4,40	3,45	1,64	4,12	1,99	2,08	14,70	3,50	1,83	23,80	5,77	2,33	5,56	2,67	1,13	9,12
61x61x4	115	61	4	4	4,60	3,61	1,70	4,30	2,08	2,17	16,70	3,82	1,91	27,10	6,31	2,43	6,35	2,92	1,18	10,40
63x63x4	120	63	4	4	4,80	3,77	1,77	4,47	2,17	2,26	19,00	4,16	1,99	30,70	6,86	2,53	7,21	3,19	1,23	11,80
66x66x4	125	66	4	4	5,00	3,93	1,83	4,65	2,25	2,35	21,40	4,50	2,07	34,60	7,44	2,63	8,15	3,47	1,28	13,20
68x68x4	130	68	4	4	5,20	4,08	1,89	4,83	2,34	2,44	24,00	4,86	2,15	38,90	8,05	2,73	9,17	3,76	1,33	14,80
71x71x4	135	71	4	4	5,40	4,24	1,95	5,00	2,43	2,53	26,80	5,24	2,23	43,40	8,68	2,84	10,30	4,04	1,38	16,60
73x73x4	140	73	4	4	5,60	4,40	2,02	5,18	2,52	2,61	29,90	5,63	2,31	48,30	9,33	2,94	11,40	4,38	1,43	18,40
76x76x4	145	76	4	4	5,80	4,55	2,08	5,36	2,61	2,70	33,20	6,03	2,39	53,60	10,00	3,04	12,70	4,71	1,48	20,40
78x78x4	150	78	4	4	6,00	4,71	2,14	5,54	2,70	2,79	36,70	6,44	2,47	59,20	10,90	3,14	14,10	5,04	1,53	22,60
81x81x4	155	81	4	4	6,20	4,87	2,20	5,71	2,78	2,88	40,40	6,87	2,55	65,20	11,40	3,24	15,50	5,39	1,58	24,90



KL (UNEQUAL LEGS)

Designation		Dimension				Cross Section	Weight	Distance of axes				tg a	for the bending axis											
													x-x			y-y			ξ-ξ			η-η		
KL		a	b	s	r	F	G	ex	ey	v	w		Jx	Wx (min)	ix	Jy	Wy (min)	iy	Jξ	Wξ (min)	iξ	Jη	Wη (min)	iη
(mm)x(mm)x(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(cm^2)	(kg/m)	(cm)	(cm)	(cm)	(cm)		(cm^4)	(cm^3)	(cm)	(cm^4)	(cm^3)	(cm)	(cm^4)	(cm^3)	(cm)	(cm^4)	(cm^3)	(cm)
46x35x4		35	46	4	4	2,98	2,34	1,50	0,93	1,65	3,14	0,592	6,33	2,04	1,46	3,21	1,25	1,04	8,01	2,55	1,64	1,53	0,93	0,72
46x36x4		36	46	4	4	3,02	2,37	1,49	0,97	1,66	3,16	0,624	6,39	2,05	1,46	3,48	1,32	1,07	8,25	2,61	1,65	1,63	0,98	0,74
52x35x4	80	34,6	51,9	4	4	3,20	2,51	1,76	0,87	1,78	3,49	0,465	8,84	2,57	1,66	3,24	1,25	1,01	10,40	2,99	1,80	1,69	0,95	0,73
55x37x4	85	36,6	54,9	4	4	3,40	2,67	1,85	0,91	1,89	3,69	0,465	10,50	2,89	1,76	3,87	1,40	1,07	12,40	3,36	1,91	2,02	1,07	0,77
58x39x4	90	38,6	57,9	4	4	3,60	2,83	1,94	0,95	2,00	3,89	0,465	12,50	3,23	1,86	4,58	1,57	1,13	14,60	3,76	2,02	2,40	1,20	0,82
61x41x4	95	40,6	60,9	4	4	3,80	2,98	2,03	0,99	2,10	4,10	0,464	14,60	3,59	1,96	5,37	1,74	1,19	17,10	4,18	2,12	2,83	1,34	0,86
64x43x4	100	42,6	63,9	4	4	4,00	3,14	2,12	1,03	2,21	4,31	0,464	17,00	3,97	2,06	6,24	1,93	1,25	19,90	4,52	2,23	3,30	1,49	0,91
67x45x4	105	44,6	66,9	4	4	4,20	3,30	2,21	1,07	2,32	4,52	0,464	19,60	4,37	2,16	7,21	2,12	1,31	23,00	5,09	2,34	3,82	1,65	0,95
70x47x4	110	46,6	69,9	4	4	4,40	3,45	2,30	1,11	2,43	4,73	0,463	22,50	4,78	2,26	8,27	2,33	1,37	26,30	5,57	2,45	4,39	1,81	1,00
73x49x4	115	48,6	72,9	4	4	4,60	3,61	2,39	1,15	2,54	4,93	0,463	25,60	5,22	2,36	9,44	2,54	1,43	30,00	6,08	2,55	5,02	1,98	1,04
76x51x4	120	50,6	76,9	4	4	4,80	3,77	2,48	1,19	2,64	5,14	0,463	29,00	5,69	2,46	10,70	2,76	1,49	34,00	6,61	2,66	6,71	2,16	1,09
79x53x4	125	52,6	78,9	4	4	5,00	3,93	2,57	1,23	2,75	5,35	0,463	32,70	6,14	2,56	12,10	2,99	1,56	38,30	7,17	2,77	6,45	2,35	1,14
82x55x4	130	54,6	81,9	4	4	5,20	4,08	2,66	1,27	2,86	5,56	0,463	36,70	6,63	2,66	13,60	3,23	1,62	43,00	7,74	2,88	7,26	2,54	1,18
47x37x5		37	47	5	5	3,78	2,97	1,56	1,04	1,68	3,21	0,633	8,23	2,62	1,47	4,54	1,70	1,09	10,70	3,33	1,68	2,07	1,23	0,74
57x37x5		37	57	5	5	4,29	3,37	1,98	0,95	1,91	3,78	0,445	14,13	3,80	1,81	4,82	1,75	1,06	16,42	4,35	1,96	2,52	1,32	0,77
57x47x5		47	57	5	5	4,79	3,76	1,80	1,29	2,07	3,94	0,688	15,48	3,97	1,80	9,61	2,81	1,42	20,78	5,27	2,08	4,31	2,08	0,95
57x37x6		37	57	6	6	5,05	3,96	2,04	0,99	1,89	3,75	0,447	16,34	4,46	1,80	5,55	2,05	1,05	19,03	5,08	1,94	2,86	1,51	0,75
57x47x6		47	57	6	6	5,65	4,43	1,85	1,33	2,06	3,92	0,690	17,97	4,67	1,78	11,13	3,30	1,40	24,19	6,17	2,07	4,91	2,38	0,93

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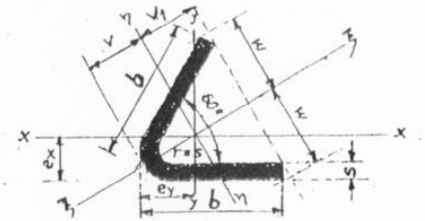

K<

Designation		Dimension			Cross section	Weight	Distance of axes					for the bending axis												
												x-x			y-y			ξ-ξ			η-η			x-y
K<		b	s	r	F	G	ex	ey	w	v	v1	Jx	Wx (min)	ix	Jy	Wy (min)	iy	Jξ	Wξ	iξ	Jn	Wn (min)	in	Jxy
(mm)x(mm)x(mm)	(mm)	(mm)	(mm)	(mm)	(cm^2)	kg/m	(cm)	(cm)	(cm)	(cm)	(cm)	(cm^4)	(cm^3)	(cm)	(cm^4)	(cm^3)	(cm)	(cm^4)	(cm^3)	(cm)	(cm^4)	(cm^3)	(cm)	(cm^4)
34X34X3	65	33,8	3	3	1,95	1,53	0,99	1,28	1,91	1,37	1,47	2,00	0,85	1,01	1,53	0,72	0,88	2,25	1,17	1,08	1,25	0,85	0,80	0,44
36X36X3	70	36,8	3	3	2,10	1,65	1,05	1,37	2,03	1,48	1,58	2,46	0,99	1,08	1,88	0,83	0,95	2,77	1,35	1,15	1,58	0,99	0,87	0,52
39X39X3	75	38,8	3	3	2,25	1,77	1,10	1,46	2,16	1,59	1,69	2,98	1,13	1,15	2,31	0,95	1,01	3,35	1,55	1,22	1,95	1,15	0,93	0,61
41X41X3	80	41,3	3	3	2,40	1,88	1,15	1,56	2,28	1,70	1,80	3,59	1,28	1,22	2,78	1,08	1,08	4,00	1,75	1,29	2,37	1,31	0,99	0,71
44X44X3	85	43,8	3	3	2,55	2,00	1,21	1,65	2,41	1,81	1,91	4,27	1,44	1,29	3,32	1,22	1,14	4,74	1,97	1,36	2,84	1,49	1,06	0,82
46X46X3	90	46,3	3	3	2,70	2,12	1,26	1,74	2,53	1,92	2,02	5,02	1,60	1,36	3,93	1,36	1,21	5,57	2,20	1,44	3,38	1,67	1,12	0,95
49X49X3	95	48,8	3	3	2,85	2,24	1,31	1,84	2,66	2,03	2,13	5,85	1,78	1,43	4,60	1,51	1,27	6,48	2,44	1,51	3,98	1,87	1,18	1,08
51X51X3	100	51,3	3	3	3,00	2,36	1,37	1,93	2,78	2,14	2,24	6,78	1,96	1,50	5,35	1,67	1,34	7,49	2,69	1,58	4,64	2,08	1,24	1,23
54X54X3	105	53,8	3	3	3,15	2,47	1,42	2,02	2,91	2,24	2,34	7,79	2,15	1,57	6,18	1,84	1,40	8,60	2,96	1,65	5,38	2,30	1,31	1,39
56X56X3	110	56,3	3	3	3,30	2,59	1,48	2,12	3,03	2,35	2,45	8,90	2,36	1,64	7,09	2,02	1,47	9,81	3,23	1,72	6,19	2,52	1,37	1,57
59X59X3	115	59,0	3	3	3,46	2,72	1,53	2,22	3,17	2,47	2,57	10,23	2,59	1,72	8,18	2,22	1,54	11,25	3,55	1,80	7,16	2,78	1,44	
34X34X4	65	34,2	4	4	2,60	2,04	1,09	1,30	2,00	1,37	1,50	2,90	1,20	1,06	2,07	0,93	0,89	3,28	1,84	0,92	1,56	1,11	0,80	0,68
37X37X4	70	36,7	4	4	2,80	2,20	1,14	1,39	2,13	1,48	1,61	3,54	1,38	1,12	2,57	1,10	0,96	3,98	1,87	1,10	2,07	1,29	0,86	0,82
39X39X4	75	39,2	4	4	3,00	2,36	1,19	1,48	2,25	1,59	1,71	4,25	1,57	1,19	3,16	1,27	1,03	4,77	2,12	1,26	2,56	1,50	0,93	0,97
42X42X4	80	41,7	4	4	3,20	2,51	1,25	1,58	2,38	1,70	1,82	5,08	1,77	1,26	3,77	1,45	1,09	5,73	2,41	1,34	3,12	1,71	0,99	1,13
44X44X4	85	44,2	4	4	3,40	2,67	1,30	1,67	2,50	1,80	1,93	6,01	1,98	1,33	4,51	1,64	1,15	6,76	2,70	1,41	3,75	1,94	1,05	1,30
47X47X4	90	46,7	4	4	3,60	2,83	1,36	1,76	2,63	1,91	2,04	7,05	2,21	1,40	5,33	1,83	1,22	7,91	3,01	1,48	4,47	2,19	1,11	1,49
49X49X4	95	49,2	4	4	3,80	2,98	1,41	1,86	2,75	2,08	2,15	8,20	2,44	1,47	6,24	2,04	1,28	9,18	3,33	1,55	5,26	2,45	1,18	1,70
52X52X4	100	51,7	4	4	4,00	3,14	1,46	1,95	2,88	2,13	2,25	9,47	2,69	1,54	7,26	2,25	1,35	10,60	3,68	1,63	6,15	2,72	1,24	1,92
54X54X4	105	54,2	4	4	4,20	3,30	1,52	2,04	3,00	2,24	2,37	10,90	2,95	1,61	8,38	2,48	1,42	12,10	4,03	1,70	7,13	3,01	1,30	2,16
57X57X4	110	56,7	4	4	4,40	3,45	1,57	2,14	3,13	2,34	2,47	12,40	3,22	1,68	9,60	2,72	1,48	13,80	4,41	1,77	8,21	3,32	1,37	2,42
59X59X4	115	59,2	4	4	4,60	3,61	1,63	2,23	3,25	2,45	2,58	14,10	3,51	1,75	10,90	2,97	1,54	15,60	4,80	1,84	9,39	3,63	1,43	2,70
62X62X4	120	61,7	4	4	4,80	3,77	1,68	2,32	3,38	2,56	2,69	15,90	3,80	1,82	12,40	3,22	1,61	17,60	5,21	1,91	10,70	3,97	1,49	2,99
64X64X4	125	64,2	4	4	5,00	3,93	1,73	2,42	3,58	2,67	2,80	17,80	4,11	1,89	14,00	3,49	1,67	19,70	5,63	1,99	12,10	4,31	1,56	3,31
67X67X4	130	66,7	4	4	5,20	4,08	1,79	2,51	3,63	2,78	2,91	19,90	4,43	1,96	15,70	3,78	1,74	22,00	6,07	2,06	13,60	4,69	1,62	3,65
69X69X4	135	69,2	4	4	5,40	4,24	1,84	2,60	3,75	2,88	3,02	22,20	4,76	2,03	17,60	4,07	1,80	24,50	6,53	2,13	15,20	5,05	1,68	4,02
72X72X4	140	71,7	4	4	5,60	4,40	1,90	2,70	3,88	2,99	3,13	24,60	5,11	2,10	19,50	4,37	1,87	27,20	7,00	2,20	17,00	5,44	1,74	4,40
74X74X4	145	74,2	4	4	5,80	4,55	1,95	2,79	4,00	3,10	3,23	27,20	5,46	2,17	21,70	4,68	1,93	30,00	7,50	2,28	18,90	5,84	1,80	4,81
77X77X4	150	76,7	4	4	6,00	4,71	2,00	2,89	4,13	3,21	3,34	30,00	5,83	2,24	24,00	5,01	2,00	33,00	8,00	2,35	20,90	6,26	1,87	5,24
79X79X4	155	79,2	4	4	6,20	4,87	2,06	2,98	4,25	3,32	3,45	33,00	6,21	2,31	26,40	5,34	2,06	36,30	8,53	2,42	23,10	6,70	1,93	5,70

ΔΕΗ Α.Ε. / ΔΝΕΜ / ΤΟΜΕΑΣ ΣΧΕΔΙΑΣΜΟΥ ΚΑΙ ΠΡΟΔΙΑΓΡΑΦΩΝ ΓΡΑΜΜΩΝ ΜΕΤΑΦΟΡΑΣ
TABLE OF CONSTRUCTION DRAWINGS FOR 150 KV TOWERS

LINE CATEGORY	LIGHT SINGLE CIRCUIT				HEAVY SINGLE CIRCUIT				HEAVY DOUBLE CIRCUIT			
TOWER TYPE	S2	R2	T2	Z2	S3	R3	T3	Z3	S4	R4	T4	Z4
General number of drawings	25124				25263				25124			
Body upper part	119g	124h	129h	133j	169d	174d	179d	183	19d	24d	29c	33c
Body upper part			129 /b	133 /a			179 /f	183 /e				
Body lower part	120g	125d	130c	134b	170c	175b	180a	184b	20c	25d	30d	34d
Legs for normal tower	121g	126e	131c	135g	171d	176e	181d	185c	21d	26d	31h	35h
Legs for extended tower	122e	127d	132d	136e	172d	177d	182c	186c	22d	27c	32g	36g
Legs +4,5 for extended tower ΤΜΕΓΜ	1346/1	1346/2	1346/3	1346/4	1347/1	1347/2	1347/3	1347/4	1348/1	1348/2	1348/3	1348/4
Plates for normal & ext. tower ΤΜΕΓΜ					1345/1	1345/2	1345/3	1345/4	1342/1	1342/2	1342/3	1342/4
Suspension of Ph. Conductor	137b	138c			187	188 /			37	38 /		
Suspension of Shied Wire	139b	139b			189	189			39a	39a		
Link for tension towers			140	140			190	190			40a	40a
V Hanger for jumper insul. String			141	141			191	191			41	41
Anticlimbing guard	142	142	142	142	192	192	192	192	42b	42b	42b	42b
Grounding rod			143	143			193	193			43	43
Danger plate	144	144	144	144	194	194	194	194	44b	44b	44b	44b
Number of drawings	30				34				32			

TRANSMISSION LINE 150 KV TABLE OF CONSTRUCTION DRAWINGS FOR TOWERS SERIES 2, 3 & 4				
ΣΧΕΔΙΑΣΗ	ΜΕΛΕΤΗ	ΕΛΕΓΧΟΣ	ΕΓΚΡΙΣΗ	ΗΜ/ΝΙΑ
				11 . 9 . 00
ΔΕΗ	ΔΙΕΥΘΥΝΣΗ ΝΕΩΝ ΕΡΓΩΝ ΜΕΤΑΦΟΡΑΣ ΤΟΜΕΑΣ ΣΧΕΔΙΑΣΜΟΥ ΚΑΙ ΠΡΟΔΙΑΓΡΑΦΩΝ Γ.Μ.		ΚΛΙΜΑΚΑ: -	
			ΤΜΕΓΜ 682 Γ	