SPECIFICATION P-166:83

STEEL POLES FOR TRANSMISSION LINES

0 FOREWORD

0.1 This standard has been introduced by Wapda and has been prepared by the Transmission line section of the office of the Chief Engineer (Design).

0.2 This standard is intended only for the purpose of Technical Specification to facilitate design and fabrication of steel poles for Transmission Lines and does not include provisions of Contract.

0.3 This specification is based on international electro-technical Commission document No. 11(CO)10 Recommendation for over head lines July 1980 for determination of wind load and ASCE method of Design of steel Transmission pole structure for analysis.

1. SCOPE

This specification covers the design, fabrication and supply of galvanized steel poles for Transmission Lines.

2. DEFINITIONS

2.1 Conductor

A conductor is a wire meant to transmit electrical energy or an overhead ground wire for lightning protection and induction in telephone line.

2.2 Span

Span means the horizontal distance between the two adjacent poles of a Transmission line.

2.3 Wind span

The wind span is half the sum of the two spans adjacent to a pole.

2.4 Weight Span

Weight span is the horizontal distance between the low points of sag in the two spans adjacent to a pole under minimum temperature conditions.

2.5 Longitudinal

The horizontal direction along the run of conductors of a transmission line and parallel to its center line. At angle locations it is the direction bisecting the external angle between the two adjacent section or the transmission lines.

2.6 Transverse

The horizontal direction at right angles to the run of conductos of a tranmission line. At angle location it is the direction besecting the internal angle between the two adjacent sections of the Transmission line.

3. TYPE OF POLES

3.1 The Transmission lines pole shall consist of a galvanized steel pole with six cross-arms shall be of embedded in anchor base foundation type. The pole and cross-arm shall be circular or polygonal in shape, and tapered uniformly. The poles shall be in several sections and assembly of sections shall be achieved by slip joints.

3.2 The pole shall be of following type:

i)	Type SP-A	Tangent Pole	0^0-2^0 Angle
ii)	Type SP-B	Medium Angle	2^0-30^0 Angle
iii)	Type SP-G	Heavy Angle	30^0-60^0 Angle and dead end

the poles are designated by the code numbers. These have been assigned in the following manner;

a) The first two letter 'SP' stands for steel pole for Transmission Lines.
b) The succeeding letter A, D & G denotes the angle, these poles ran sustain.

3.3 Double Cricular Steel Pole Type SP-A

Double circular suspension pole for straight line posting and angles upto two degrees for a wind span of 180mm weight span of 225m.

3.4 30 Degree Double Circuit Steel Pole Type SP-D

Double circuit strain pole for line angles upto 30 degree on a wind span of 180m, a weight span of 225m.

3.5 60 Degree Double Circuit Steel Pole Type SP-G

Double circuit strain pole for line angles upto 6^0 on a wind span of 180m, a weight span of 225m. this shall also be capable of acting as a dead end pole with all conductors at right angles to cross arm axis on one side only at their maximum loaded tension.

4. LOADINGS

4.1 Each type of pole shall be designed to safety withstand the loading due to wind on pole, conductors, hardware, earth wire and dead weight of a pole and fittings, due to resultant transverse load at angles as indicated hereafter.

4.2 Maximum Wind Velocity (VM) has been taken as 45 m/sec and reference wind velocity (VR) as 30.2 m/sec taking into account ground roughness coefficient as 0.67. The magnitude of wind load on pole and wires is a pressure of $57/m^2$.

4.3 Wind on Pole

4.3.1 In order to determine the effect of wind on the pole itself the latter shall be divided into elements of suitable height. The ultimate wind load in the transverse direction applied at the centre of gravity of an element shall be:

A_{TC}	=	qo. $C_{XTC.}$ $G_{T.}$ d.l.		
qo	=	dynamic Reference pressure	=	57 kg/m^2
d	=	Diameter of the pole		
L	=	Length of the element		
G_T	=	Gust response factor	=	2.22 $(Z_T)^{0.175}$
Where				
Z_T	=	Height from centre of gravity of element above ground.		

4.3.2 Drag coefficient C_{XTC} shall be calculated in terms of Reynolds nos. which shall be equal to:

$R = 20.8 \times 10^5 \times d \sqrt{G_T}$

Where

d	=	diameter of pole
C_{XTC}	=	1.2 for $R \leq 3 \times 10^5$
C_{XTC}	=	0.75 for $R \geq 4.5 \times 10^5$

For values of Reynold's Nos. between 3×10^5 and 4.5×10^5, the value of C_{XTC} may be determined by:

$C_{XTC} = 15.195 - 2.555 \log R$

4.4 Ultimate Loads

4.4.1 Transverse, longitudinal and vertical loads on the pole body shall be applied along the pole.

4.4.2 The loads on conductors and insulators shall be assumed to act at the conduct attachment points.

4.4.3 The ultimate loads for all types of poles are given in Table-I.

4.4.4 Stringing condition are manually meant for design of crossarms. It shall be assumed that only two conductors shall be string simultaneously and the Angle between the Anchorage and ground shall not be more than 15^0.

4.4.5 Each pole shall be designed to withstand all combinations of vertical, transverse and longitudinal ultimate loads arising from the loading cases stated below the conditions stated in Clause 4.3. The combination and direction of loads shall be such as to induce maximum stresses in elements. In all cases the pole shall be assumed loaded with full wind and weight spana and full line angles.

Case 1 It shall be assumed that all conductors are installed and intact the wind shall be assumed to blow in the transverse direction.

Case 2 Three wires installed on one circuit and wind shall be assumed to blow in Transverse direction.

Case 3 Stringing Condition (Two conductor shall be String simultaneously)

TABLE-I
ULTIMATE LOADS ON POLES
(All Loads in kg)

Sr. No.	Type of Load	Pole Type SP-A	Pole Type SP-D		Pole Type SP-G
	A: Transverse Loads		30^0	60^0	Dead End
A1	Wind on Earth wire and fittings with E/wire intact.	260	260	260	260
A2	Due to line angle on E/Wire with E/wire intact.	26	380	732	-
A3	Wind on conductor, insulators & fittings with conductor intact.	860	935	935	935
A4	Due to line angle on conductors with conductor intact.	90	1330	2568	-
	S: Vertical Loads				
B1	Weight of E/wire and fittings for intact E/wire.	120	120	120	120
B2	Weight of conductor, insulator strings & fittings for intact conductor.	650	720	720	720
B3	Weight of E/wire and fittings for stringing condition.	275	275	275	275
B4	Weight of conductor and fittings for stringing condition.	1175	1175	1175	1175
B5	Dead weight of pole	-	-	-	-
	C: Longitudinal Loads				
C1	Due to dead-ending of intact Earth Wire	-	-	-	735
C2	Due to dead-ending of intact conductor	-	-	-	2570
C3	Due to stringing condition for conductor.	580	580	580	
C4	Due to stringing condition for conductor	1947	1947	1947	
C5	Wind on Pole	(Refer to Clause 4.2)			

5. DESIGN REQUIREMENT

5.1 General

5.1.1 Each pole shall be of self supporting with embedded anchor base foundations and shall be able to carry the loads and meet the loading conditions of this specification.

5.1.2 The general configuration and dimensions of poles and clearance shall be as per attached drawings. The diameters of poles shall not exceed the maximum values shown. Section lengths shall not exceeded 12 meters. The minimum thickness of material used for poles shall be 6 mm and for cross-arm shall be 4 mm.

5.1.3 The Contractor shall be fully responsible for the design of the poles and for their satisfactory performance. All design furnished by the Contractor and approved by the Engineer shall be considered a part of this specification.

5.1.4 All design and drawings submitted by the Contractor shall become the property of WAPDA. The WAPDA expressly reserves the right to use, reproduce in while or in part, to distribute, and to reuse any and all such drawing in connection with the installation, maintenance, replacement and repair of the materials to be furnished under the specification and also to make any and all such drawings and reproductions thereof available to subsequent Tenders and Contractors, where necessary in connection with fabricating and furnishing materials duplicating or closely similar to the materials to be furnished hereunder. The depositing of all such drawing with the Engineer shall constitute a license to the WAPDA to use said drawings in the manner herein stated.

5.2 Deign Methods

5.2.1 All calculations for determination of allowable stresses on pole shall be according to ACSE Method "Design of Steel Transmission Pole Structure".

5.2.2 All calculations carried out on computer shall be accompanied with full explanation of the computer programmes and the method used in the calculations.

5.2.3 As the poles are of cantilever type, consideration shall be given to the most favourable condition of simple buckling or combined buckling by bending and torsion.

5.2.4 Connection between the various parts to be achieved by slip joints, the overlapping length shall be at least equal to 1.5 times the inside diameter of the female section.

5.2.5 In case of anchor base type poles the dimension and thickness of base plate as well as number, diameter and length of anchor bolts shall be determined by calculations and shall be selected from the range of International Standard.

5.3 Foundations

5.3.1 The foundations shall be designed on the following basis.

5.3.2 The foundation shall be able to withstand the ultimate forces tension, compression, shear and uplift for the worst possible combination of loads given in clause. However for angle poles the ultimate loads shall be multiplied by additional factor of 1.2.

5.3.3 For design purpose the weight of concrete may be taken as 2300 kg/m^3 and of earth as 1600 kg/m^3.

5.3.4 The foundation shall be designed for soil having bearing pressure of 2.1 & 0.5kg/Sqcm.

6 MATERIAL

6.1 Poles shall be made of low alloy high tensile steel sheet or plate having the tensile properties as specified. The steel shall be made by open hearth or basic oxygen or electric furnace process.

6.1.1 The manufacturer may propose steel conforming to latest applicable Industry Standards Specification and recommendation practices provided such steel has the minimum yield point and minimum elongation as specified. The manufacturer shall indicate the grade of steel and identify the standard to which the steel complies. The specification of steel shall be approved by the Engineer. The following information shall be supplied by the Manufacturer:

- Ultimate Tensile Strength
- Minimum Guaranteed Yield Strength
- Minimum elongation
- Detail of Test Piece
- Chemical Composition

6.2 Tensile Properties

The steels shall conform to the requirements as to tensile properties prescribed below;

Yield point kg/mm^2 minimum	30-40
Elongation in 50 mm gauge length percent, minimum, upto 5 mm thickness	16
Elongation in 200 mm gauge length percent, minimum	
. 5 mm to 16 mm thickness	13
. Over 16 mm thickness	17

6.3 Bend Test Requirement

6.3.1 The steels shall withstand the following bend test requirements:

Thickness of Material	Ratio of bend diameter to thickness for specimen
For all thickness	2

6.4 Tolerances

6.4.1 The tolerance of steel grade and specification quoted by the Contractor shall be applicable.

6.4.2 Tolerance in the manufacture of the poles shall be as follows:

(i) Overall length of pole $\pm$ 10%
(ii) Outside dia $\pm$ 1%
(iii) Tube thickness $\pm$ 8%
(iv) Twisting 1:5 Degree per 3 m

(v) Weight ±3%

6.4.3 The poles shall be straight within 1/300 of length.

7. FABRICATION

7.1.1 All types of poles shall be made several sections or elements tapered uniformly starting with the base or butt end, decreasing in diameter at a suitable rate. In the case of poles made of several section their assembly shall be achieved by slip joint or flanges.

7.1.2 Pole and cross-arms shall have no transverse joints or welds and only one longitudinal weld per thickness of pole shall be permissible.

7.2.3 The upper part of the pole shall be accommodate cross-arm of the dimensions and clearances shown on the drawings, necessary for the attachment of conductor and shall be made to match aesthetics of the pole. Cross-arms connection to the pole shall be made by flanges.

7.2.4 In case of anchor base type poles the lower part shall be equipped with a base plate to be anchored on a concrete foundation by means of anchor bolts.

7.2.5 The anchor base shall be of sufficient cross section to develop the full strength of the pole by means of two transverse electric welds. The base shall telescope the pole and one weld shall be on the inside of the base at the end of the pole and other weld on the outside at the top of the base.

7.2.6 Anchor bolts shall be of suitable diameter and length to develop full ultimate strength of the pole. The upper ends of anchor bolts shall be threaded and furnished with hexagonal heads. The lower end of the bolt shall have “L” bend of length not less than 3 times the diameter of bolts. The anchor bolts and nuts shall be hot dip galvanized to WAPDA Specification P-82 Metal covers shall be provided for covering the nuts and the portion of the bolts extending above the base and metal cover shall be attached to the steel base by means of cap screws.

7.1.7 A ground sleeve shall be attached to each embedded type pole. The sleeve be made from one piece of sheet or plate. The thickness of the ground sleeves shall not less than 6mm. The one longitudinal weld shall be ground or rolled smooth. Unless otherwise specified, the sleeves shall be 600mm. The top of the sleeves shall be welded to the pole by means of a fillet weld, which shall be sufficiently beveled to shed water and make joint watertight.

7.2 Welding

7.2.1 All welds shall be performed in works before galvanizing. All welding shall be Electric Arc according to International Standards and shall include the following process:

- Shielded metal Arc welding
- Submerged Arc welding
- Gas metal Arc welding

7.2.1.1 The electrodes used shall be compatible with grade and chemical composition of the steel used and shall have mechanical properties at least equal to physical properties of the steel to be welded. Uncoated electrodes shall be used.

7.2.2 The welds shall conform the following minimum requirements.

7.2.2.1 Longitudinal Welds i.e. (For poles and cross-arms).

- 90% penetration of all thickness of sheet steel.
- The weld shall be free from any inside and outside cracks.
- No blow holes on the surface of the weld shall be allowed.
- No surface blister shall be tolerated.

7.2.2.2 Transverse Weld i.e. (For Base Plate)

- 100% penetration between steel sheets regardless of thickness considerations.
- All welds shall be free from all cracks both inside and outside.
- The blisters, parasites, spherical inclusions exceeding 5% of the minimum thickness of the sheet steel shall be refused.
- The detectable angular inclusion shall not be tolerated.

7.2.3 In order to maintain the quality of the weld manufacturer shall make use of the most adequate method and control instruments in order to verify the quality of completed weld: ultra sonic or radio control method (X or gamma rays) shall be used in the works.

7.3 Galvanizing

7.3.1 All parts of the poles and cross-arms shall be hot dip galvanized after completion of manufacturing operations. No further manufacturing, touching up or modification shall be performed on the pole or cross-arms after they have been galvanized.

7.3.2 The galvanizing shall be performed on both inside and outside faces of pole and cross-arms.

7.3.3 The galvanizing of the relevant plate or sheet of steel used for the manufacturing of pole or cross-arms and nuts and bolts shall be as per WAPDA Specification P-82.

8 ACCESSORIES

8.1 Sign Plates

All poles shall be fitted with danger and number phase plates in accordance with drawing No. PDW/DF-207. The plates shall be fixed in accordance with Drawing No. PDW/DF-207. the sign plates the ceramic enamel shall completely cover the front and back of the interior edges of the attachment holes. The enamel around the hole shall be protected by means of fiber washers.

8.2 Step Bolts

Removable step bolts of 16mm dia and 130mm step shall be provided in a staged manner, every 450mm on the pole above anticlimbing devices.

8.3 Anti-Climbing Devices

The anti climbing devices shall consist of an arrangement of barbed wire around the pole to prevent unauthorized persons from climbing the pole. It shall be made according to drawing No. GW/TZ-7 the outer most barbed wire shall be at least 600mm from the pole spacing of barber wire shall not exceed 150mm. The anticlimbing device shall be fixed at about 3 m from ground level.

8.4 Details for Attachment

8.4.1 Provision shall be made for attachment of suspension and tension strings, overhead ground wire and the ground rods.

8.4.2 For attachment of ground wire, arrangement shall be made at the top for suspension and tension fittings for 9mm E/Wire to accept assemblies as per drawing No. PDW/DF-319.

8.4.3 For attachment of suspension or tension strings provision in the crossarm shall be made to accept assemblies as per drawing Nos. PDW/DF-314 & PDW/DF-327.

8.4.4 For attachment of ground rods the embed part of the pole shall be provided with a threaded socket for 16mm dia stud of adequate length for attaching the grounding terminal.

8.4.5 In case of Anchor Base type poles, the grounding rods shall be attached to one of the anchor bolts by means of a Copper cable of suitable length as shown on drawing No. EW/TC-42.

8.4.6 All ferrous hardware shall be hot dip galvanized as per applicable ASTM standards.

9. TESTS

9.1 Manufacturer Tests

9.1.1 The manufacturer shall select two samples from each heat to carry out the following tests to satisfy himself that the products comply with this specification. The Tests shall be performed as per WAPDA Specification P-139:80.

For Steel

1. Chemical Analysis
2. Tensile Tests
3. Bend Tests

For Nuts, Bolts and Washers

1. Tensile Strength Test
2. Bend Test

The manufacturer shall maintain a record of tests carried out by him for examination by Inspector.

9.2 Acceptance Tests

The following acceptance tests shall be carried out.

For Pole

1. Visual Examination
2. Verification of Dimension and Weights
3. Prototype Test

For Nuts, Bolts and Washers

1. Verification of Dimensions
2. Visual Inspection
3. Proof Load Test (as per Wapda
4. Ultimate Tensile Strength Test Specification P-139)
5. Galvanized Test
6. Bend Test

9.3 Visual Examination

The test samples shall be examined visually for the following:

Visual Examination

Examination	Defects
Material	Not as specified in relevant clauses
Construction	Not of the shape indicated
Finish	Galvanizing not proper, presence of burrs, black and bare spots, dross and projection.
Welding	Not as specified

9.4 Verification of Dimensions and Weight

For conformity to the requirement of dimensions and weight, in case the rejection number increases as specified in this specification, for the limits of tolerances mentioned in clause 6.4.2. The entire lot shall be rejected.

9.5 Prototype Test

This test will be carried out in accordance with clause 9.6 of this specification.

9.6 Prototype Test

9.6.1 Full scale tests shall be carried out on selected assembly poles of maximum height as shown on the drawings. Different cases are to be tested to the ultimate design loads without failure. Loading cases shall be as approved by the Engineer at a later stage.

9.6.2 The pole shall be erected on a foundation structure with Anchor Bolts which shall be of adequate strength and stiffness to withstand safely the pole reactions under test

loadings without any mobility. The foundation structure with Anchor Bolts arrangement should be such that as simulating the conditions which will be encountered in service.

9.6.3 Each part of the pole and cross-arm shall be of the same grade and class as those to be furnished for the specified poles of the same type.

9.6.4 The poles to be tested shall be galvanized and in all respects identical to the poles to be supplied.

9.6.5 The testing bench shall be so designed as to prevent practically any introduction of appreciable error in measurement such as friction. For that purpose the measuring device used shall be placed in such a manner as to directly record the loads.

9.6.6 Prior to testing, the Contractor shall submit for approval of the Engineer a line diagram showing layout of the test site, rigging, location of load measuring instruments to be used and a series of line diagrams showing the loads to be applied, taking into account the weight of rigging and angle of load application. The Contractor shall submit for approval a tabulated form on which the applied load and corresponding deflection readings will be entered for each load case.

9.6.7 Testing Bench at the test site shall be capable of handling ultimate loads with safety. Testing Bench shall be capable of handling increased loads during destruction testing with adequate safely of personnel working on the test facility.

9.6.8 The load monitoring equipment shall be electronic transducers complete with appropriate digital readout meters and recorders with an overlal accuracy $\pm$1%. All load monitoring equipments shall be calibrated before and after testing of the poles.

9.6.9 The testing of pole shall be carried out in the presence of personnel of the Engineer.

9.6.10 WAPDA shall be notified at least six weeks in advance of the date of the tests are to be conducted. Time shall be allowed for the Engineer to approve the actual / physical test arrangement prior to the start of each test.

9.6.11 The ultimate loads shall be applied. The loads shall be applied in five steps of 50%, 75%, 90%, 95% and 100% of the ultimate loads. Each test loading shall be applied according to the drawings and maintained for not less than 5 minutes during which time there shall be no slacking of or adjustment of the loads. Should it become necessary to adjust the loading, the 5 minutes period shall start after the loading is established and constant. All test loads shall be removed completely before the loads for the next test are applied. After each test load deformation due to longitudinal, transverse torque strain shall be measured (a 10% deformation residue of the maximum deformation recorded at the end of the pole due to the adjustment of the parts and to the remaining tension in the hoisting cables will be acceptable). All test loads corresponding to conductor and ground wire loading shall be applied directly ot the regular attachment details provided for test loads. Test load equivalent towind load on the pole shall be applied at the center of gravity the specified section of element, taking into account the drag coefficient as calculated according to this specification. To ensure application of full test loads to the pole, frication losses in rigging shall be added to specified loads, if there is rigging between the pole and the load measuring device. Application of impact loads shall be avoided.

9.6.12 Any conspicuous yielding or any failure under any of the above test loadings shall be considered a defect. If a defect develops because of faulty workmanship or materials, the Contractor shall correct the defect and repeat the test loading at his own expense, including any additional cost incurred by WAPDA for the witnessing of the repeat test loading by Engineer.

9.6.13 In the event of collapse of part under loads of value lower than 95% of ultimate loads, the part that has collapsed may be replaced by another with greater mechanical strength. The modified structure shall be required to pass the test for the specified 100% ultimate load.

9.6.14 If the collapse of a part occurs at loads between those corresponding to the 95% and 100% of the ultimate loads, one of the following two procedures may be adopted.

(a) The poles shall be tested according to the procedures as mentioned in clause 9.6.13

(b) The test shall be repeated on another pole of the same batch and the structure shall be required to pass the 100% of the ultimate load as specified by the Engineer.

9.7 Sampling Plan-Acceptance and Rejection

Sampling sizes are designated by code letters. Table-III shall be used to find the application code letter for the particular lot or batch size for various tests specified in this specification. While the number of units of product from each lot or batch which are to be inspected (sample size) and the criteria for determining the acceptability of the lot or batch (acceptance and rejection numbers) for different code letters can be obtained from the Table-V given below.

The number of sample units inspected shall be equal to the first sample size given in Table-V. if the number of defective units found in the first sample is equal to or less than the first acceptance number, the lot shall be acceptable. If the number of defectives found in the first number, the lot shall be rejected. If the number of defectives found in the first sample is between the first acceptance and rejection number, second sample of the size given by the plan shall be inspected. The Nos. of defectives found in the first and the second samples shall be accumulated. If the cumulative No. of defectives is equal to or less than the second acceptance number the lots shall be acceptable. If the cumulative No. of defectives is equal to or greater than the second rejection number. The lot shall be rejected.

TABLE-V SAMPLE SIZE

Lot or Batch Size	Sample size for Test specified In clause 9.6	Sample size for dimensional and finish defect
2 to 8	A	A
9 to 15	A	B
16 to 25	A	C
26 to 50	A	D
51 to 90	B	E
91 to 150	B	F
151 to 280	B	G
281 to 500	C	H

501 to 1000	D	J

TABLE-V SAMPLE ACCEPTANCE CRITERIA

Sample Size code Letters	Samples	Sample Size	Cumulative Sample size	Acceptance Number	Rejection Number
A	First	1	1	0	1
	Second	2	2	-	-
B	First	3	2	0	2
	Second	3	4	1	2
C	First	3	4	0	2
	Second	3	8	1	2
D	First	0	8	0	2
	Second	0	10	1	2
E	First	9	6	0	2
	Second	9	10	1	2
F	First	13	13	0	3
	Second	13	20	3	4
G	First	20	20	1	4
	Second	20	40	4	5
H	First	32	32	2	6
	Second	32	64	0	7
J	First	50	50	3	7
	Second	50	100	6	9

10. DRAWING AND DATA

10.1 The Contractor shall submit outline drawings and design drawings of steel poles as indicated in relevant clauses. After placing of the Contract the Contractor shall submit for approval, drawings as indicated in para 10.7 to 10.10 and any other calculations and drawings required by the Engineer.

10.2 The following information shall be supplied:

(i) Catalogues/Literature of Standardized item
(ii) Test Certificates.
(iii) Detail of manufacturing, welding and testing facilities available with the manufacturer.

10.3 Material Details

Information such as grade and standard of steel used giving ultimate tensile strength, minimum elongation, minimum yield strength, chemical composition of steel, standard and method of galvanizing and welding and method of fabrication of pole shall also be appended. English language copy of the particular standard according to which the steel is supplied, and the standard for all galvanizing, welding and other applicable steel shall be supplied with the Bid.

10.4 Outline Drawings

Outline drawings for each type of pole showing the size, location and arrangement of all elements, principal outline dimensions and conductor clearance to the poles, the size and length of elements shall be provided. It should be possible to verify the drag coefficient and weight of poles. Separate details to a large scale shall be shown for all

insulator and ground wire connection. If necessary for clarification, a large scale shall also be used for plotting details.

10.5 Design Calculation and Stress Diagram

Design calculations and stress diagrams including detailed calculation of wind loadings on pole, loading calculations, bending moments, stress diagrams, section modulus, thickness, inside and outside diameter for each section or elements of pole.

Design calculations if carried out by computer shall be fully documented. Full detail of the analytical methods used shall be provided. Documentation shall provided a full explanation of the methods of programming and the interpretation of the detailed results.

10.6 Foundation Drawing and Calculations

Fully dimensioned drawings of all foundation showing the loads imposed on the foundations and the resultant bearing pressure and uplift resistance of the foundations shall be submitted.

10.7 Shop Detail Drawings

Shop detail drawings showing all shop details including all dimensions of slip joint or flanges, bevel cutting, binding and the identification mark and weight for each element. The Contractor shall not proceed with the shop detail drawings until the outline drawings and design stress diagrams have been approved by the Engineer.

10.8 Erection Drawings

Erection drawings showing each element or section with its identification mark, location or position of the outstanding pole element number and size of connection bolts and all erection details.

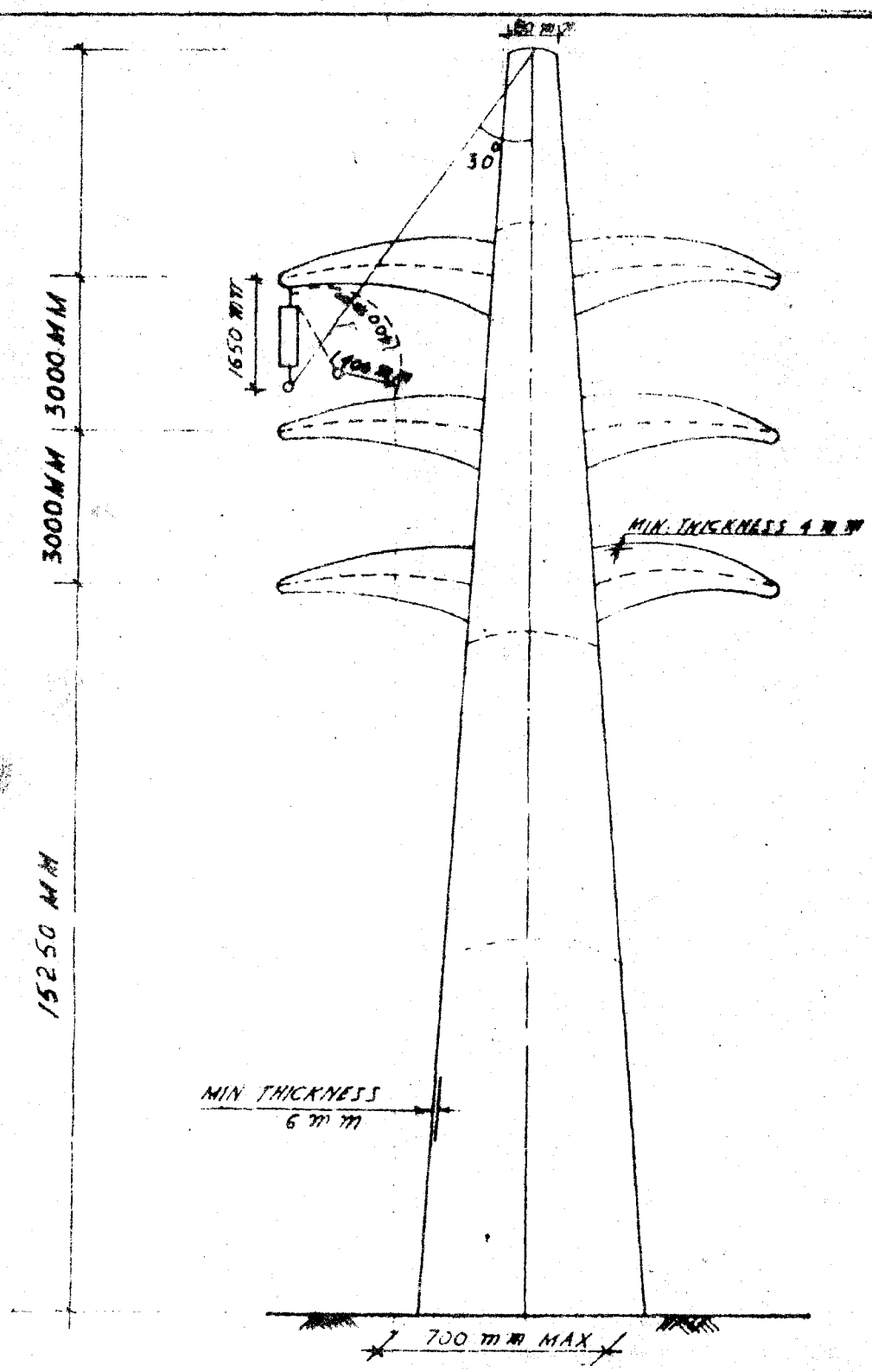
10.9 Footing Insulation Drawings

Footing erection drawings showing embedded part with its identification mark or all dimensions required for the proper setting and positioning of anchor bolts with relation to the center of the pole.

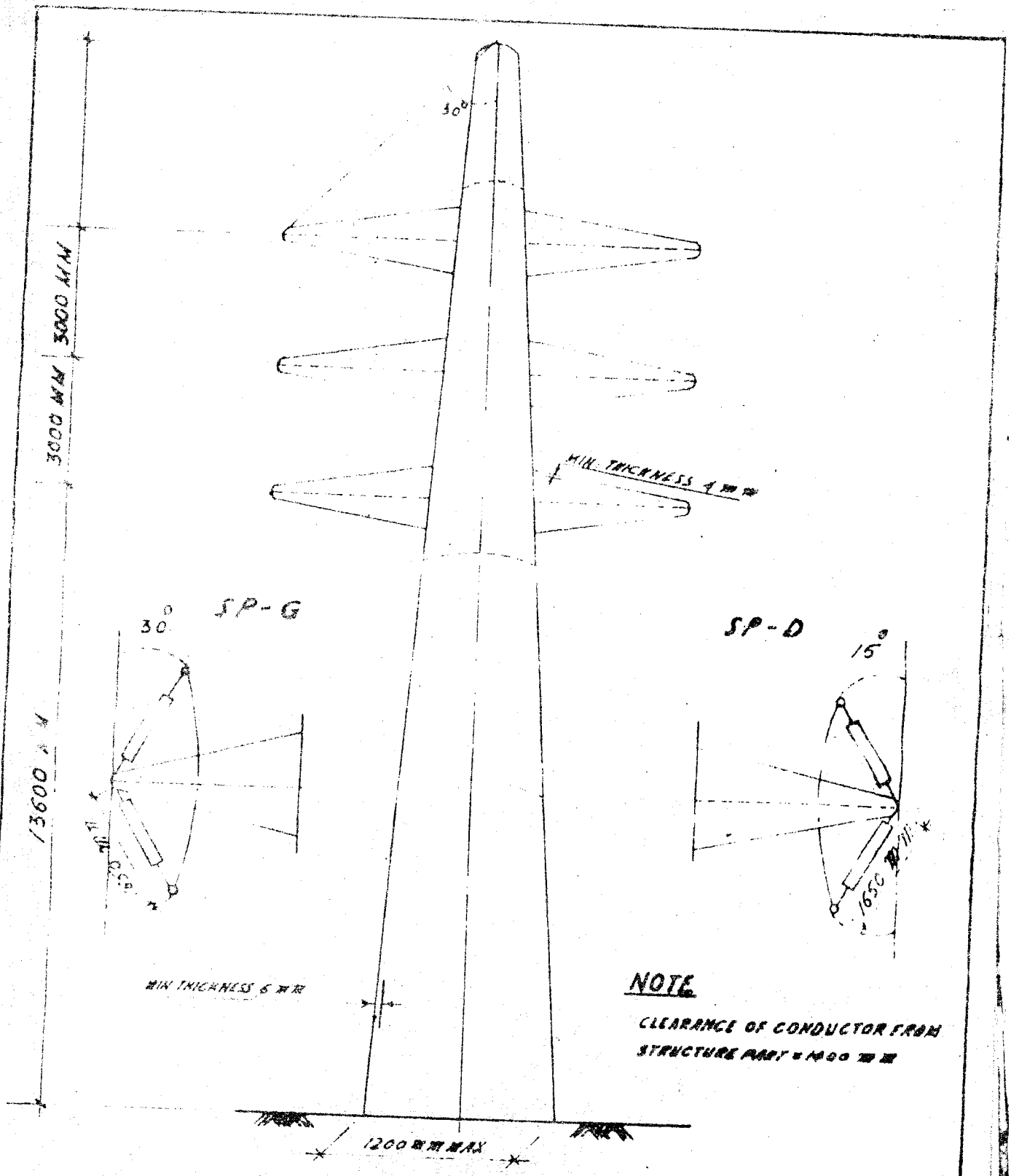
10.10 Bills of Material

Bills of material for each pole shall show the quantity, kind outside diameter, inside diameter thickness, length weight and assembly mark for each section, including bolts, washers, plates and all fittings complete for each poles.

1. Dwg. No. PDW/TC-220
2. Dwg. No. PDW/TC-221
3. Dwg. No. PDW/DF-207
4. Dwg. No. PDW/DF-314
5. Dwg. No. PDW/DF-319
6. Dwg. No. PDW/DF-327
7. Dwg. No. EW/TC-42
8. Dwg. No. GW/TZ-07



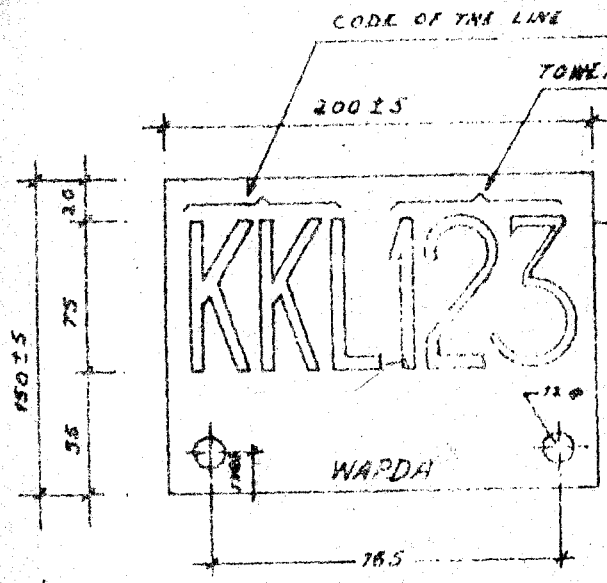
PAKISTAN WATER AND POWER DEVELOPMENT AUTHORITY			DESIGN DEPARTMENT POWER
DRAWN			POLE TYPE SP-A
CHECKED			
		SCALE ✓	DATE 1.3.1983
			DWG. NO. PDW/TC 221

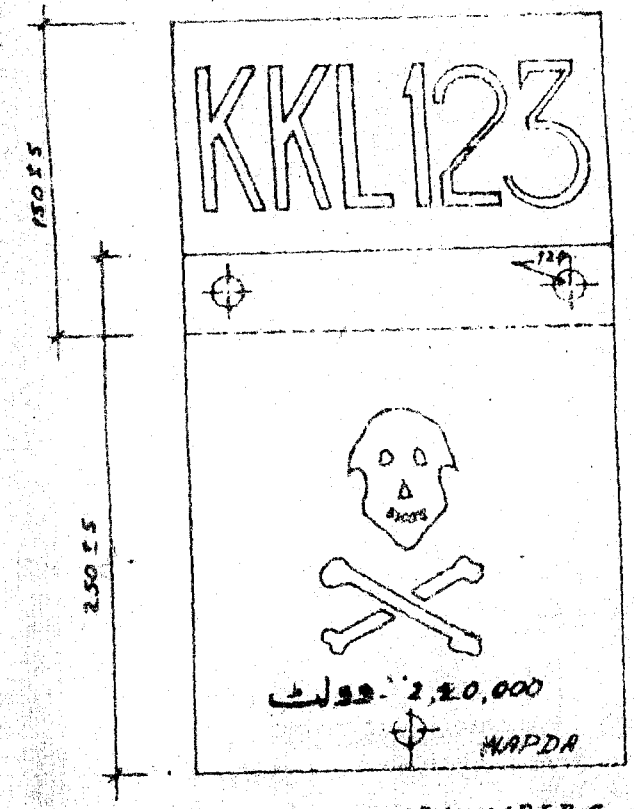


NOTE

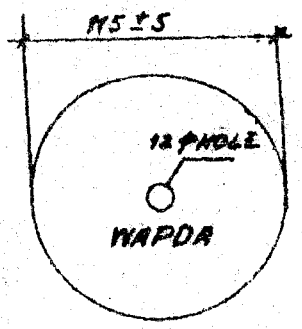
CLEARANCE OF CONDUCTOR FROM STRUCTURE PART = 1400 MM

PAKISTAN WATER AND POWER DEVELOPMENT AUTHORITY		DESIGN DEPARTMENT POWER
DRAWN	AZHAR JAMIL	POLE TYPE SP-D & SP-G
CHECKED		
JUNIOR ENGINEER		
SUPERINTENDING ENGINEER		
INSPECTED		SCALE — DATE 7.1982
CHIEF ENGINEER		DWG. NO. PDW/TC.220





ASSEMBLY OF NUMBER & DANGER PLATE OF TRANSMI-SSION LINE

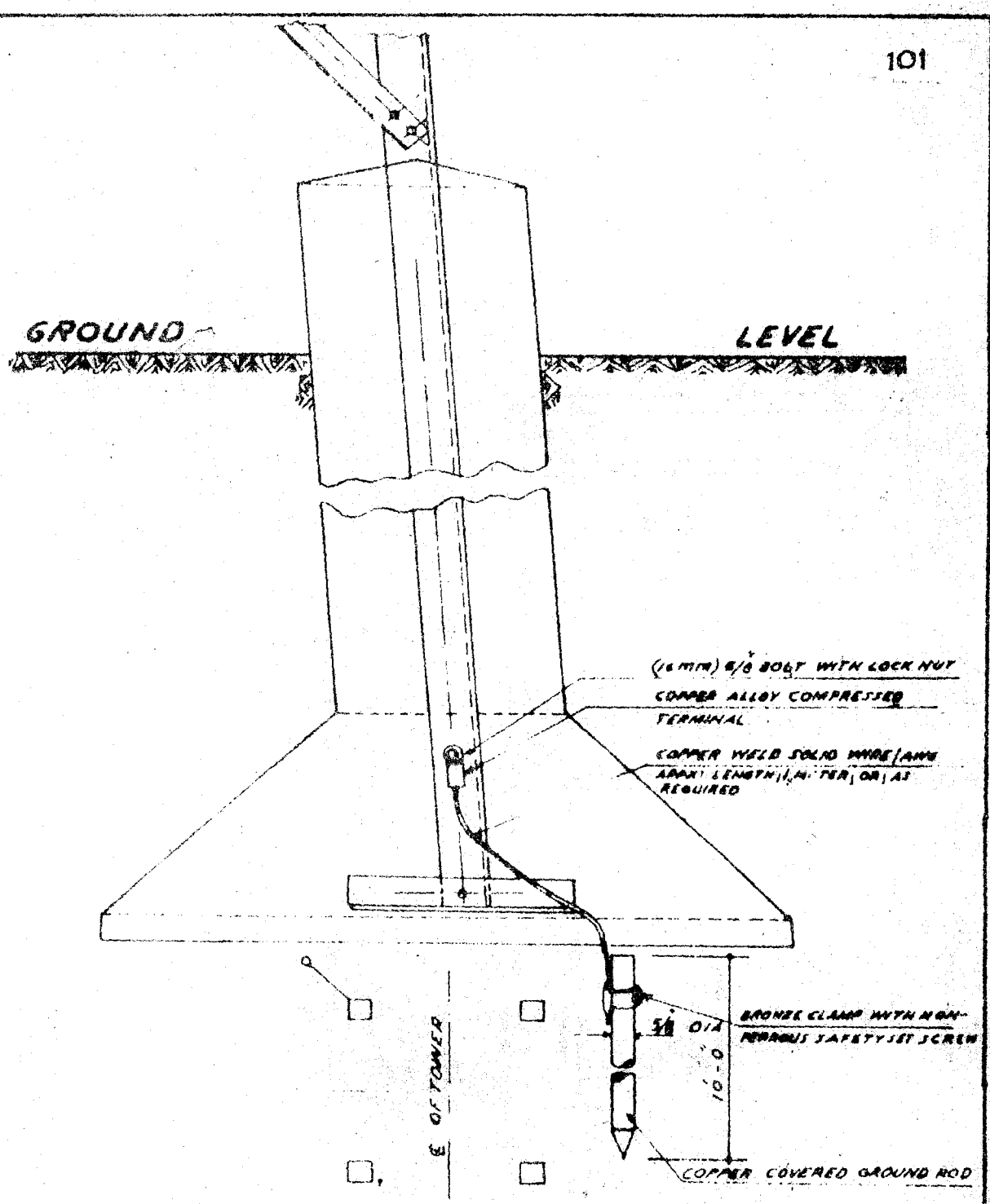


PHASE PLATE

COLOUR, RED, YELLOW, & BLUE

ALL DIMENSIONS IN MILLIMETRES

PAKISTAN WATER AND POWER DEVELOPMENT AUTHORITY	DESIGN DEPTT: POWER
NUMBER PLATE & PHASE PLATE FOR TRANSMISSION LINES.	
TRD. / DWN. / CKD.	SCALE:- / DATE:- 19-4-78 / DWG NO POW/DT-207



1	6.3.83	DRAWING RETRACED	
NO	DATE	REVISION	BY

PAKISTAN
WATER AND POWER DEVELOPMENT AUTHORITY

DESIGN DEPARTMENT (POWER)

DRAWN	NOOR-UL-HADDA
CHECKED	A. LATIF
JUNIOR ENGINEER	M. A. SHAIN
SENIOR ENGINEER	QR A. MAHMEED
DIRECTOR	S.I. HUSSAIN
CHIEF ENGINEER	JAVED AKHTAR

EARTHING ARRANGEMENT

SCALE :-

DATE : 8.11.66

DWG. NO. [illegible]