SPECIFICATION P-139:80

FABRICATION OF STEEL STRUCTURES

PAKISTAN
WATER AND POWER DEVELOPMENT AUTHORITY
DESIGN DEPARTMENT, POWER.

C O N T E N T S

PRINTING HISTORY

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SPECIFICATION P-139:80

FABRICATION OF STEEL STRUCTURES.

AMENDMENT NO.1, DATED: 3RD OCTOBER,1982.

1. Clause 4.3

Add the following para at the end of clause 4.3

"For the high tensile steel (yield point equal or higher than 35 kg/mm^2) holes shall be directly drilled at the definitive diameter or punched and reamed out; The difference between the punched and reamed diameter shall be at the minimum 4 mm."

2. Clause 4.6

The following para is to be added at the end of the clause 4.6.

"Diameter of a punch hole shall not vary in all the thickness of the member or gusset. The difference between both hole diameters on each face of the piece shall be lower than the tenth of the punched thickness, with a maximum of 1.2 mm. For the thickness lower than 5 mm, maximum difference is fixed at .5 mm."

3. Clause 7.2.1

Delete the clause 7.2.1 and add the following:-

1. Visual examination
2. Verification of dimension and weight
3. Assembly test
4. Chemical Composition (check analysis)
5. Tensile Tests
6. Bend tests
7. Impact tests
8. Galvanizing tests

4. Clause 9.8

Add the following after clause 9.7

Impact Tests

"The test shall be performed in accordance with ISO 630."

SPECIFICATION P-139: 80

FABRICATION OF STEEL STRUCTURES

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 fabrication of steel structures and does not include provision of contract.

0.3 This specification is subject to periodic revision as and when required.

1 SCOPE

This specification covers fabrication, galvanizing, testing and packing of transmission line towers and sub-station structures.

2 STEEL

2.1 In fabricating structures the contractor shall use structural steels having chemical composition and tensile properties as specified. The steel shall be made either by open hearth, basic oxygen or electric furnace process.

2.2 Requirement

2.2.1 Chemical Composition

2.2.1.1 The steels shall conform to the following chemical composition.

Elements	Composition Percent	
	Mild Steel	High Tensile Steel
Carbon	0.26	0.20
Manganese	0.85	1.35
Phosphorus Max.	0.04	0.04
Sulphur Max.	0.05	0.05

2.2.1.2 The Contractor may propose structural steel conforming to latest applicable industry standards specification and recommended practices having different chemical composition provided such steel has the yield point and min. elongation as specified in clause 2.2.2. In this case the type and specifications of steel will have to be approved by WAPDA. The following information shall be supplied by the Contractor:

Ultimate tensile strength

Minimum Guaranteed yield strength

Minimum elongation

Detail of test piece

Chemical Composition

2.2.2 Tensile Properties

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

	Mild Steel	High Tensile Steel
Tensile strength kg/mm^2		
Minimum	40	50
Maximum	56	80
Yield points kg/mm^2		
Minimum	26	35
Elongation in 200mm guage length percent, minimum		
Upto 8mm thickness	16	15
Over 8mm thickness	20	18

2.2.3 Bend Test Requirement

The steels shall withstand the following Bend Test Requirements.

Type of Material	Thickness of Material	Ratio of bend diameter to thickness for specimen
Mild Steel	Upto 25 mm	1
High Tensile Steel	Upto 25 mm	2

3 NUTS AND BOLTS

All bolts and nuts shall be made from mild steel to WAPDA Specification P-19 and shall be of size M 16. The bolts shall be provided with one flat washer under each nut.

Washers shall not be less than 5 mm thickness and only one thickness of washer shall be used. The diameter of the washer hole shall be 1.5 mm larger than the bolt diameter and the outside diameter of washer shall not be less than 1.5 mm larger than the diagonal of the nut. All connection bolts, nuts, lock nuts and washers shall be furnished in excess of actual number required in quantity at least 5% greater than actual requirements sufficient to compensate for normal field losses.

4 FABRICATION

4.1 All fabrication shall be performed according to approved drawings in a thorough and workman like manner in accordance with the best practice of a modern shop. All structural material shall be straight and cleaned of all rust and dirt before being laid out or worked in any manner. Necessary straightening shall be done in a manner that will not injure the material. Sharp kinks or bends shall be a cause for rejection.

4.2 In shearing and punching only sharp dies and punches shall be used, shearing and punching shall be done to guage and no variation in length shall be allowed except where otherwise noted on the shop detail drawing. No variation shall be allowed in a group or cluster of holes, and the centre to centre distance between the end holes in a piece shall not vary more than 1 mm.

4.3 Bolts holes shall be 1.5 mm to 2 mm larger than the normal bolt diameter. Bolts holes shall be cylindrical and perpendicular to members, shall be clean out and without torn or ragged edges and shall be free of burrs, rough edges, and punch cracks. Holes shall be accurately located and well matched.

4.4 Welding

All welding shall be performed in accordance with the latest edition of the "Code for Arc and Gas Welding in Building Construction," as formulated by the American Welding Society. A shield-arc welding process shall be used. All welds shall be as shown on the drawings and shall be made in such a manner that residual shrinkage stresses will be reduced to a minimum.

4.5 Marking

All structural members shall be marked with the correct designation shown on the shop drawing. Marking shall be done by stamping the members prior to galvanizing with numerals or letters of 12 mm minimum height, and shall be clearly legible after galvanizing.

4.6 Tolerances

Ease of assembling the structure in the field is of utmost importance. The structure shall be so manufactured that all members carrying the same mark shall be interchangable when assembled. The structure shall fit without undue pressing and no reaming or drifting of holes shall be required. When erected, the structures shall not deviate from the vertical by more than 1/300.

The Contractor shall be responsible for the correct fitting of all parts and shall replace free of cost any defective materials discovered during erection and shall pay all costs of the correction in the field of any errors not previously discovered.

The Cross sectional area or weight of each structural size shape shall not vary more than 2.5% from the theoratical or specified amounts..

The permissible variation from dimensions for structural size steel shapes shall not exceed the prescribed limits in ASTM A6.

5 GALVANIZING

5.1 After all the shop work is complete, all structural materials shall be hot dip galvnized to conform to WAPDA Specification P-82. Prior to galvanizing the material shall be drilled, punched, cut or otherwise fabricated as required, freed from burrs, cleaned and thoroughly prepared, so that the zinc coating shall be adherent, dense, smooth, continuous and uniform. It shall also be completely free from lumps, blisters, uncoated or porous spots, black spots, dross, flux or any other imperfection. All structural steel warped by the galvanizing process shall be straightened by re-rolling or pressing. The material shall not be hammered or otherwise straightened in a manner which may injure the galvanized coating.

All bolts and nuts shall be hot dip galvanized including threaded portions in accordance with WAPDA Specification P-82. Nuts shall have finger tight fit on bolts and develop the full strength of bolts.

5.2 Brittleness

All necessary precautions shall be taken in the composition of steel and in its fabrication and preparation for galvanizing to prevent embrittlement of any item or parts of items including bolts and nuts. For detecting embrittlement WAPDA Specification P-82 shall be followed.

6 SIGN PLATES

All the sign plates shall be fired ceramic surfaces on steel base plates. The ceramic enamel shall completely cover the front and back of the plates and also the edges of plates and the interior edges of the attachment holes. The enamel around the holes shall be protected by means of fibre washers.

7 TESTS

7.1 Manufacture's Tests

The Manufacturer shall select two samples from each heat to carry out the following tests to satisfy himself that the products comply with the specification.

7.1.1 For Sections and Plates

1. Chemical Composition (Ladle Analysis)
2. Tensile Tests
3. Bend Tests

7.1.2 For Nuts and Bolts

1. Proof Load test
2. Ultimate Tensile Strength test
3. Ultimate tensile strength test under eccentric load
4. Cold bend test
5. Hardness test
6. Galvanizing test

) According to WAPDA Specification P-19

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

7.2 Acceptance Tests

The following acceptance tests shall be carried out.

7.2.1 For Sections and Plates

1. Visual examination
2. Verification of dimensions and weights
3. Prototype tests
4. Chemical composition(Check analysis)
5. Tensile tests
6. Bend Tests
7. Galvanizing test

7.2.2 For Nuts and Bolts

1. Verifications of dimensions
2. Visual inspection
3. Proof load test
4. Ultimate tensile strength test
5. Galvanizing test

) According to WAPDA Specification P-19.

The Contractor shall render all necessary assistance to the Inspector in carrying out above mentioned tests.

8 ACCEPTANCE AND REJECTION

8.1 Chemical Composition

To indicate adequately, the chemical composition of a heat or a lot, the minimum number of samples selected to represent the heat shall be as follows:

	No. of Samples
50 tons or more	2
50 tons or less	1

If a piece fails to meet the requirement the lot shall be rejected.

8.2 Tensile Properties

Two tension and two bend tests shall be made from each heat and strength unless the finished material from a heat and strength gradation is less than 50 tons, where one tension and one bend test will be sufficient. However when material from one heat and strength gradation differes 9 mm in thickness, one tension and one bend

test shall be made from both the thickness and the thinnest material rolled in that strength gradation regardless of weight represented.

Two tension and two bend tests shall be made on every finished shape for every 10 tons.

If a test piece fails to meet the requirement the lot shall be rejected.

8.3 Assembly Test

One structure of each type shall be tested.

8.4 Galvanising

The acceptance and rejection on the basis of galvanizing test will be according to WAPDA Specification P-82.

8.5 Dimensionnl and Finish Defects

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 less than the first acceptance number, the lot shall be acceptable. If the number of defectives found in the first sample is equal to or greater than the first rejection number, the lot shall be rejected. If the no. of defectives found in the first sample is between the first acceptances and rejection number, a second sample of the size given by the plan shall be inspected. The number of defectives found in the first and the second samples shall be accumulated. If the cumulative number of defectives is equal to or greater than the second rejection number, the lot shall be rejected.

TABLE-V

Sample size code letters	Sample	Sample Size	Cumulative sample size	Acceptance Number	Rejection Number
2 to 8	First	1	1	0	1
	Second	-	-	-	-
9 to 15	First	2	2	0	2
	Second	2	4	1	2
16 to 25	First	3	3	0	2
	Second	3	6	1	2
26 to 50	First	5	5	0	2
	Second	5	10	1	2
51 to 90	First	8	8	0	2
		8	16	1	2

Sample size code letters	Sample	Sample Size	Cumulative sample size	Acceptance Number	Rejection Number
91 to 150	First	13	13	0	3
	Second	13	26	3	4
151 to 280	First	20	20	1	4
	Second	20	40	4	5
281 to 500	First	32	32	2	5
	Second	32	64	6	7
501 to 1200	First	50	50	3	7
	Second	50	100	8	9

8.6 Nuts and Bolts

The sampling acceptance, and rejection of nuts and bolts will be according to WAPDA Specification P-19.

9 TEST METHODS

9.1 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 given in relevant drg.
Finish	Galvanising not proper, presence of burrs, black and bare spots, dross and projection.

9.2 Verification of Dimensions and Weight

The binding dimensions of the material shall be measured and weighed and shall be as shown on the relevant approved drawings subject to the tolerances given in clause 4.4.

9.3 Assembly Test

One structure of each type shall be assembled completely in the shop to verify the dimensions and suitability for field erection. Reaming or unfair holes shall not

be permitted and only a reasonable amount of drifting will be allowed in assembling. Poorly matching holes shall be cause for rejection.

9.4 Chemical Composition Tests

9.4.1 Laddle Analysis

An analysis of each heat of steel shall be made by the manufacturer to determine percentages of the elements specified below. This analysis shall be made from a test ingot taker during the pouring of the heat. The chemical composition thus determined shall be reported to the purchaser and shall conform to the requirements specified in clause 2.2.1.

9.4.2 Check Analysis

9.4.2.1 Analysis shall be made from finished material representing each heat or lot. The chemical composition thus determined shall not vary from the range or limits specified in clause 2.2.1.1 by more than the amounts specified below, but the several determinations of any elements in a heat may not vary both above and below the specified range.

Element	For Mild Steel		For High Tensile Steel	
	Under the Limit	Over the Limit	Under the Limit	Over the Limit
Carbon	.03	.04	.03	.04
Manganese	.06	.08	.09	.12
Phosphorus	-	.01	-	.01
Sulphur	-	.01	-	.01

9.4.2.2 In case of an approved specification as refered to in sub clause 2.2.1.2 the chemical composition and tolerances of the approved specification be applicable.

9.5 Tensile Test

The test shall be performed in accordance with ISO-82.

9.6 Bend Test

The bend test specimens shall stand being bent cold through 180 deg. without cracking to an internal diameter of the specimen as prescribed in clause 2.2.3.

9.7 Galvanising Test

9.7.1 This test shall be carried out on all ferrous parts complying with the following requirements.

1. Weight of zinc coating
2. Uniformity of zinc coating
3. Adherence of zinc coating
4. Embrittlement tests

9.7.2 Test samples for determination of compliance to the tests specified shall be performed in accordance with WAPDA Specification P-82 and shall be taken from each lot. The lot shall consist of a quantity as specified in the relevant specification.

10 PACKING

10.1 All material shall be suitably packed to final destination. Heavy pieces such as legs and large cross arm members may be packed separately or in bundles of not more than 1000 kg. with all pieces in the bundle having the same mark of the same structure. All bundles of angles shall be securely fastened at three or more locations with galvanized steel binding straps not smaller than 1x20 mm of 1350 kg. tensile strength.

10.2 All small pieces such as bolts, washers, plates and other small fittings shall be packed in strong wooden boxes with a gross weight of 50 to 100 kgs. The boxes should be strong enough to withstand rough handling. Bolts of different sizes and lengths shall be packed in separate bags before boxing. Groups of packages or bundles may be packed in the same wooden boxes. In general, separate packages less than about 50 kg. each should not be used.

11 DRAWINGS

11.1 The contractor will be supplied with single line diagram indicating the various dimensions, angle sizes used, sizes of bolts used, type of steel and various strandards/ process to be followed for fabrication and galvanizing of the structure.

11.2 After placing of contract, the contractor shall submit for approval, the following drawings based on single line diagram provided in the clause.

11.2.1 Shop Details Drawings

The detailed drawings shall show shop details including

of dimensions, shearing, punching, bevel cutting, bending and identification mark and weight for each member.

11.2.2 Erection Drawings

Erection drawings showing each member with its identification mark, location and position of the outstanding leg of angles, number and size of connection bolts and all erection details.

11.2.3 Footing Installation Drawings

Footing erection drawings showing each member with its identification mark and number and size of connection bolts, and all dimensions required for the proper setting and positioning of anchor bolts or stub angle footings with relation to the centre, of the structure.

11.2.4 Bills of Material

Bills of material for each tower shall show the quantity, kind, size, length, weight and assembly mark for each member, including bolts, washers, plates and all fittings complete for each structure.

SPECIFICATION P-166: 83

STEEL POLES FOR TRANSMISSION LINES

PAKISTAN
WATER AND POWER DEVELOPMENT AUTHORITY

C O N T E N T S

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a transmission line and parallel to its centre line. At angle locations it is the direction bisecting the external angle between the two adjacent sections of the transmission lines.

2.6 Transverse

The horizontal direction at right angles to the run of conductors of a transmission line. At angle locations it is the direction bisecting the internal angle between the two adjacent sections of the Transmission line.

3 TYPES OF POLES

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

3.2 The poles are of following types:

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

The poles are designated by the code numbers. These codes 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 can sustain.

3.3 Double Circuit Steel Pole Type SP-A

Double circuit suspension pole for straight line position and angles upto two degrees for a wind span of 180m, a weight span of 225m.

3.4 30 Degree Double Circuit Steel Pole Type SP-D

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

3.5 60 Degrees Double Circuit Steel Pole Type SP-G

Double circuit strain pole for line angles upto 60 degrees on a wind span of 180m, a weight span of 225m. This pole

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 (Designs).

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 Electrotechnical Commission document no 11(CO)10 Recommendation for over head lines, July 1980 fordetermination of wind load and ASCE method of Design of Steel Transmission pole structure for analysis.

1 SCOPE

1.1 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

shall also be capable of acting as a dead end pole with all conductors strung at right angles to crossarm axis on one side only at their maximum loaded tension.

4 LOADINGS

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

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

4.3 Wind On Pole

4.3.1 In order to determine the effect of the 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:

$$A_{TC} = qo \cdot C_{XTC} \cdot G_T \cdot d \cdot L.$$

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:

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

Where d = diameter of pole

CXTC= 1.2 for $R \leq 3 \times 10^5$

CXTC= 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 Tranverse, longitudinal and vertical loads on the pole

body shall be applied uniformly along the pole.

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

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

4.4.4 Stringing conditions are mainly meant for design of crossarms. It shall be assumed that only two conductors shall be strung simultaneously and the Angle between the Anchorge and ground shall not be more than 15^{0}.

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^{o}	60^{o}	Dead End
A1	Wind on Earthwire 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	-
	B: 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

Sr. No.	Type of Load	Pole Type SP-A	Pole Type SP-D		Pole Type SP-G
			30^{o}	60^{o}	Dead End
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 Earth Wire.	580	580	580	
C4	Due to stringing condition for conductor.	1947	1947	1947	
C5	Wind on Pole	(Refer to clause 4.2)			

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 and 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 spans 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)

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 max values shown. Section lengths shall not exceed 12 meter. The min thickness of material used for poles shall be 6 mm and for crossarm 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 designs furnished by the Contractor and approved by the Engineer shall be considered a part of this specification.

5.1.4 All designs 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 drawings 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 licence to the WAPDA to use said drawings in the manner herein stated.

5.2 Design Methods

5.2.1 All calculations for determining allowable stresses on pole shall be according to ASCE Methods "Design of Steel Transmission Pole Structures".

5.2.2 All calculations carried out on computer shall be accompanied by a full explanation of the computer programmes and the methods used in the calculations.

5.2.3 As the poles are of cantilever type, consideration shall be given to the most unfavourable 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 some 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 ultimate loads given in clause 4. However for angle poles the ultimate loads shall be multiplied by an additional factor of 1.2.

5.3.3 For design purposes 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 bearing pressure of 2,1, 0.5 Kg/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, 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 Wapda. The following information shall be supplied by the Manufacture

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 50mm guage length percent, minimum upto 5mm thickness	16
Elongation in 200mm guage length percent, minimum.	
5mm to 16mm thickness	13
Over 16mm 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 Tolerances in the mahufacturer of the poles shall be as follows:

i) Overall length of pole $\pm$ 10%

ii) Outside dia ± 1%

iii) Tube thickness - 8%

iv) Twisting 1.5 Degree per 3m

v) Weight ± 3%.

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

7 FABRICATION

7.1.1 All type of poles shall be made of one or 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 sections their assembly shall be achieved by slip joint or flanges.

7.1.2 Poles and crossarms shall have no transverse joints or welds and only one longitudinal weld per thickness of pole shall be permissible.

7.1.3 The upper part of the pole shall be made to accomodate cross-arm of the dimensions and clearances shown on the drawing, necessary for the attachment of conductor and shall be made to match aesthetics of the pole. Crossarms connection to the pole shall be made by flanges.

7.1.4 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.

7.1.5 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.

7.1.6 Anchor bolts shall be of suitable diameter and length to develop full the ultimate strength of the pole. The upper ends of anchor bolt 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 bolt. 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 bolt extending about 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 shall be made from one piece of sheet or plate. The thickness of the ground sleeves shall be

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 some International Standards and shall include the following processes:

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

7.2.1.1 The electrodes used shall be compatiable 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 to the following minimum requirements.

7.2.2.1 Longitudinal Welds l.c. (For poles and Crossarms)

- 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 l.c. (For Base Plate)

- 100% penetration between sheet steels regardless of thickness considerations.
- all welds shall be free from all cracks both inside and outside.
- no blow holes on the outside of the weld.
- the blisters, porosites, spherical inclusions exceeding 5% of the minimum thickness of the sheet steel shall be refused.
- the detectible angular inclusions 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 methods (X or gamma rays) shall be used in the works.

7.3 Galvanizing

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

7.3.2 The galvanizing shall be performed on both inside and Outside faces of pole and crossarms.

7.3.3 The galvanizing of the relevant plate or sheet of steel used for the manufacturing of pole or crossarms 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; number and 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 shall be fired ceramic surfaces on steel base 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 fibre washers.

8.2 Step Bolts

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

8.3 Anticlimbing Device

The anticlimbing device shall consist of an arrangement of barbed wire around the pole to prevent un-Authorised 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 barbed wire shall not exceed 150mm. The Anticlimbing device shall be fixed at about 3M 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 grounding 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/DP-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/DP-314 & PDW/DP-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 WAPDA Specification P-82.

9 TESTS

9.1 Manufacturer Tests

9.1.1 The manufacturer shall select two samples from each heat to carryout 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 Dimensions and Weights
3. Prototype Test

For Nuts Bolts and Washers

1. Verification of Dimensions (As per (WAPDA (Specification (P-139
2. Visual Inspection
3. Proof Load Test
4. Ultimate Tensile Strength Test
5. Galvanizing 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 confirmity 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 lit 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 each type of pole of maximum height as shown on the drawings. Different cases are to be tested to the ultimate design loads without failure. The pole shall then be tested to

destruction. Load cases shall be specified by the Engineer at a later stage.

9.6.2 The pole shall be erected on a foundation structure or Anchored on Bolts which shall be of adequate strength and stiffness to withstand safely the pole reactions under test loadings without any mobility. The foundation structure or Anchor Bolt arrangement should be such that as simulating the conditions which will be encountered in service.

9.6.3 Each part of the pole and crossarm 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 the supplied.

9.6.5 The testing Bench shall be so designed as to prevent practically any introduction of appreciable error in measurement such as frictions. 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 safety 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 overall accuracy + 1%. All load monitoring equipment shall be calibrated before and after testing of the poles.

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

9.6.10 WAPDA shall be notified at least six weeks in advance of the date the tests are to be conducted. Time shall be allowed for the Engineer to approve the actual.

9.6.11 The ultimate loads shall be applied. The drawing showing the combination of loads for testing shall be supplied by the Engineer at a later stage. 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 stablized 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 longitudnal, 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 to the regular attachement detailed provided for these loads. Test load equivalent to wind load on the pole shall be applied at the Centre of Gravity of the specified section of element, taking into account the drag coefficient as calculated according to clause 4.1 of this specification. To ensure application of full test loads to the pole, friction 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 loadingat his ownexpense, including any additional cost incurred by WAPDA for the witnessing of the repeat test loading by the Engineer.

9.6.13 In the event of collapse of part under loads of a 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 applicable 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 sample is equal to or greater than the first rejection 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 No. 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 lot 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 defects
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	Sample	Sample Size	Cumulative sample size	Acceptance Number	Rejection Number
A	First	1	1	0	1
	Second	-	-	-	-
B	First	3	2	0	2
	Second	3	4	1	2
C	First	3	3	0	2
	Second	3	6	1	2
D	First	5	5	0	2
	Second	5	10	1	2
E	First	8	8	0	2
	Second	8	16	1	2
F	First	13	13	0	3
	Second	13	26	3	4
G	First	20	20	1	4
	Second	20	40	4	5
H	First	32	32	2	5
	Second	32	64	6	7
J	First	50	50	3	7
	Second	50	100	6	9

16 DRAWINGS AND DATA

10.1 The Contractor shall submit outline drawings and design drawings of steel poles as indicated in clauses 10.2 to 10.6 with his bid. After placing of the Contact the Contractor shall submit for approval, drawings as indicated in paras 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 Standardised item.

ii) Test Certificate.

iii) Detail of manufacturing welding and testing facilities available with manufactures.

10.3 Material Details

Information such as grade and standard of steel used giving ultimate tensile strength, min Elongation, min yield strength chemical composition of steel, standard & method

galvanizing & 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 bid.

10.4 Outline Drawings

Outline drawings for each type of pole and showing the size, location and arrangement of all elements principal outline dimensions and conductor clearances 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 Calculations and Stress Diagrams

Design calculations and stress diagrams shall show the following information. Detailed calculations of wind loadings on pole shall be included. Loading calculations, Bending Moments, stress diagrams, Sectionmodulus, Thicknesses, Inside & Outside diameter for each section or Elements of pole.

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

10.6 Foundation Drawings and Calculations

Fully dimensioned drawings of all foundations showing also the volume of the foundations. Calculations showing the loads imposed on the foundations and the resultant bearing pressure and uplift resistance of the foundations.

10.7 Shop Detail Drawings

Shop detail drawings showing all shop details including all dimensions slip joint or flanges, bevel cutting, bending 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 and position of the outstanding pole element number and size of connection bolts and all erection details.

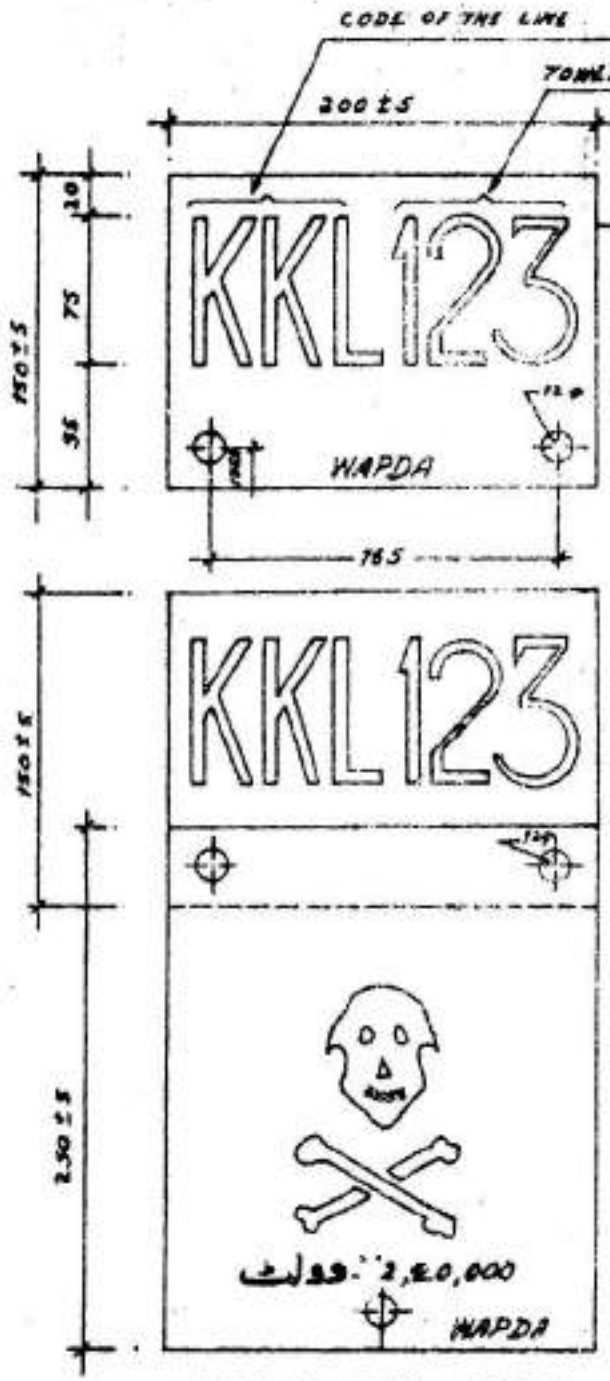
10.9 Footing Installation Drawings

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 centre of the pole.

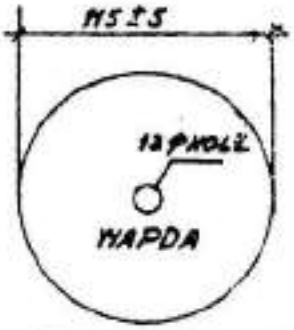
10.10 Bills of Material

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.

Encls: 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



ASSEMBLY OF NUMBER & DANGER PLATE OF TRANSMI-SSION LINE.



PHASE PLATE

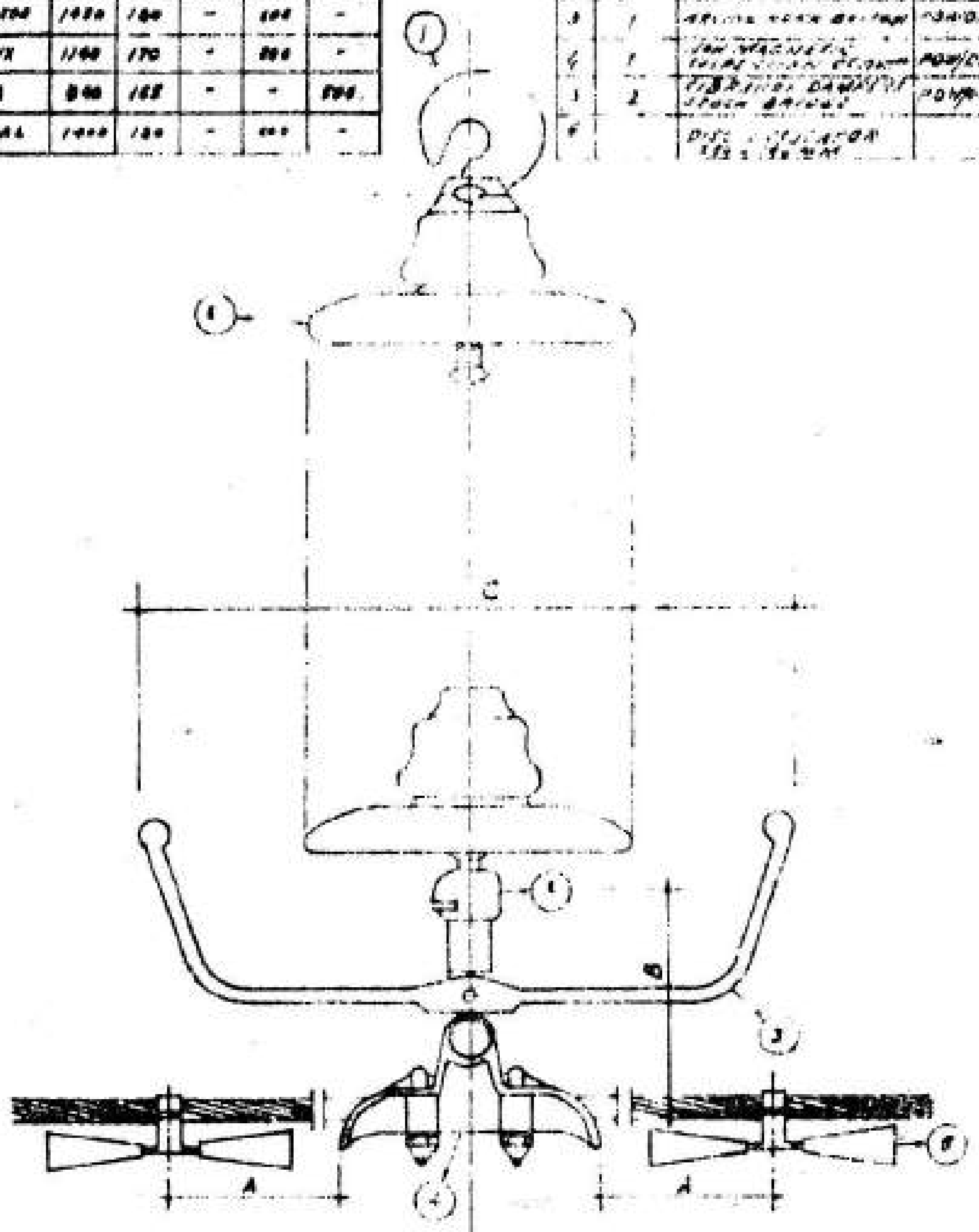
COLOUR RED, YELLOW, & BLUE

ALL DIMENSIONS IN MILLIMETRES

PAKISTAN WATER AND POWER DEVELOPMENT AUTHORITY	DESIGN DEPTT. POWER
NUMBER PLATE & PHASE PLATE FOR TRANSMISSION LINES	
TRD.	DATE:- 13-4-76
DWN.	DWG NO. PDN/DF-207
CHD.	

CONDUCTOR DESIGNATION	DIMENSIONS A	B	C		
			[illegible]	[illegible]	[illegible] KV
RAIL	1525	180	700	600	—
CUCKOO	1450	180	—	600	—
LYNX	1140	170	—	600	—
DOG	840	165	—	—	700
ORIGINAL	1400	180	—	600	—

ITEM	QTY	DESCRIPTION	DRG. NO.
1	1	SELF LOCKING BALL HOOK	PDM/[illegible]
2	1	SOCKET EYE	PDM/[illegible]
3	1	ARCING HORN [illegible]	PDM/[illegible]
4	1	NON MAGNETIC SUSPENSION CLAMP	PDM/DF-[illegible]
5	2	VIBRATION DAMPER STOCK BRIDGE	PDM/[illegible]
6		DISC INSULATOR [illegible]	



DIMENSION SHOWN IN MILLIMETRES

1	[illegible]	DIMENSION FOR ACSR CARDINAL CONDUCTOR ADDED	
NO	DATE	REVISIONS	BY

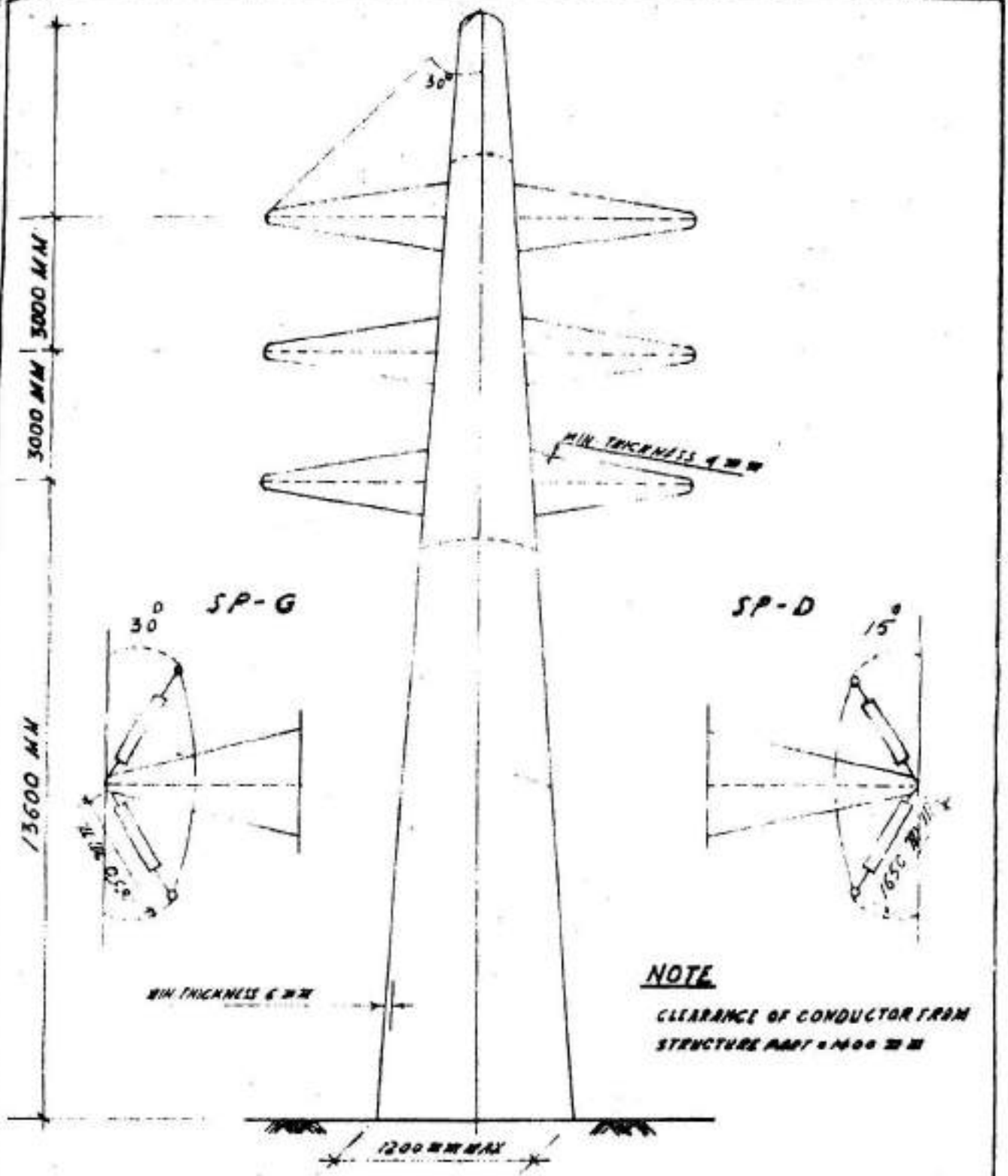
PAKISTAN WATER AND POWER DEVELOPMENT AUTHORITY — DESIGN DEPARTMENT

DRAWN	AZHAR SHAH	[signature]
CHECKED	GHULAM [illegible]	[signature]
JUNIOR ENGINEER	MAZAR ABBAS	[signature]
SENIOR ENGINEER	MUHAMMAD A. MALIK	[signature]
[illegible] FOR	[illegible]	[signature]
CHIEF ENGINEER	[illegible]	[signature]

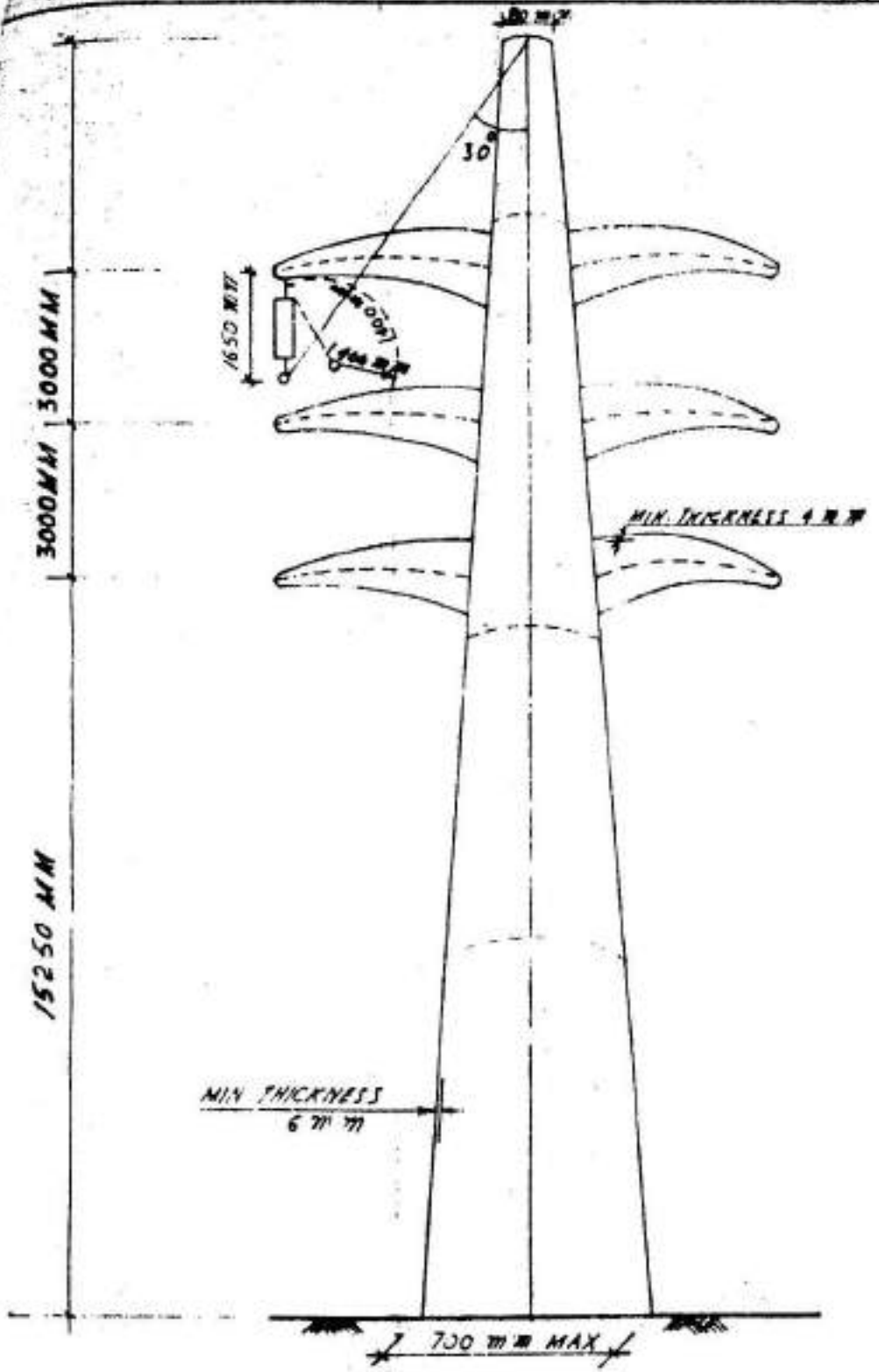
SINGLE SUSPENSION STRING

SCALE ✓ — DATE 27-9-80

DRG. NO. PDM/DF-314



PAKISTAN WATER AND POWER DEVELOPMENT AUTHORITY			DESIGN DEPARTMENT POWER
DRAWN			POLE TYPE SP-D & SP-G
CHECKED			
		SCALE ✓	DATE 1-7-1963
			DWG. NO. PDM/TC.220



PAKISTAN
WATER AND POWER DEVELOPMENT AUTHORITY

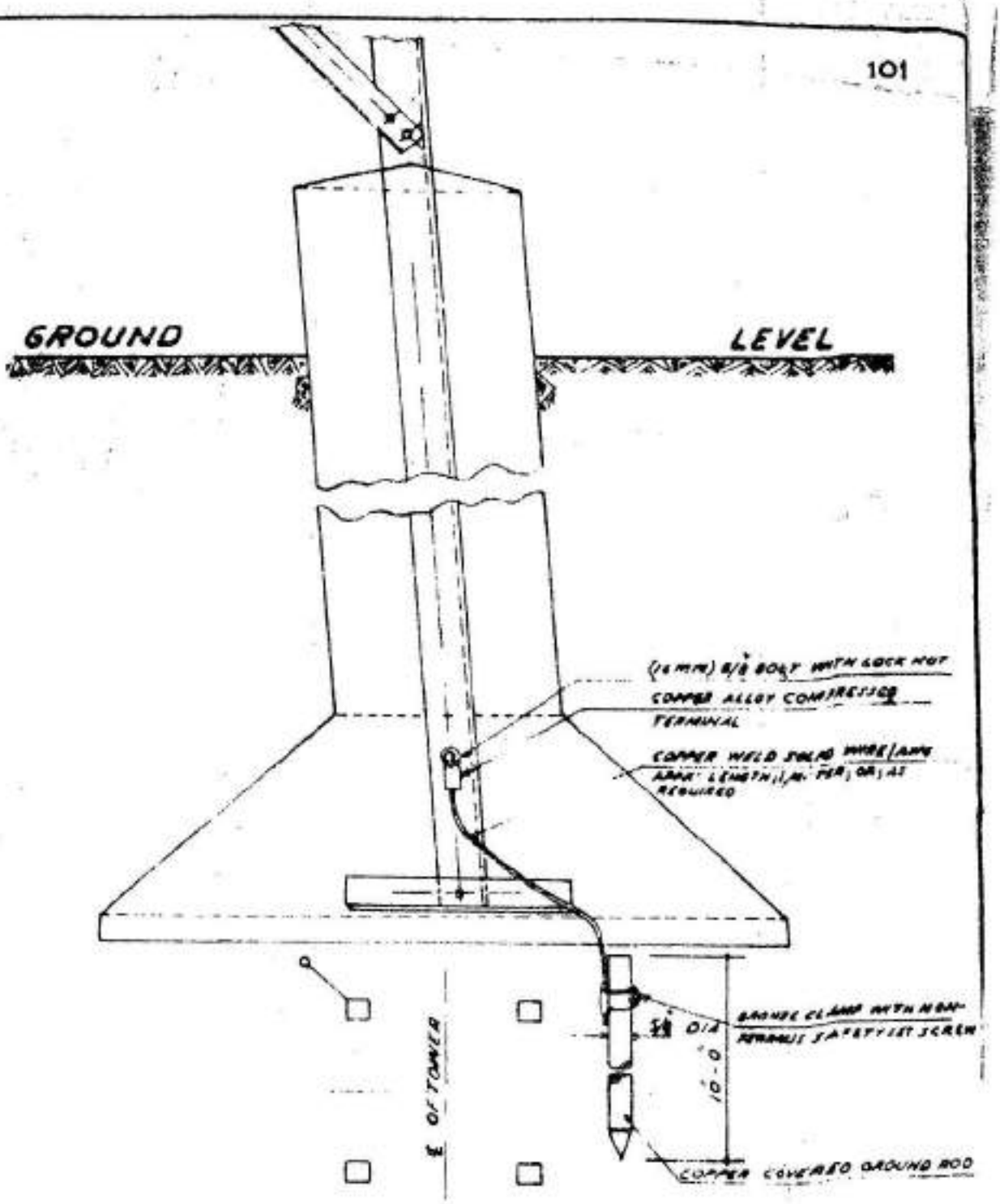
DESIGN
DEPARTMENT
POWER

POLE TYPE SP-A

SCALE ✓

DATE 1-2-1983

DWG. NO. PDM/TC. 221



NO	DATE	REVISION	BY
1	6.5.83	DRAWING RETRACED	

PAKISTAN
WATER AND POWER DEVELOPMENT AUTHORITY

DESIGN DEPARTMENT (POWER)

DRAWN	NOOR-UL-HUDA
CHECKED	A. LATIF
JUNIOR ENGINEER	M. A. SHAH
SENIOR ENGINEER	DR. A. RAHMAN
DIRECTOR	S.I. HUSSAIN
CHIEF ENGINEER	JAVED AKRAM

EARTHING ARRANGEMENT

SCALE :-

DATE : 8.11.66

DWG: NO. EW/TC-42

SPECIFICATION P-8: 89

DISC TYPE PORCELAIN INSULATORS
(BALL AND SOCKET COUPLING TRANSMISSION CLASS)

PAKISTAN
WATER AND POWER DEVELOPMENT AUTHORITY
DESIGN DEPARTMENT (T&G) POWER

C O N T E N T S

PRINTING HISTORY

First approved on November, 1967.

First revision on August, 1982.

Second revision on March, 1984.

Third revision on November, 1985.

Fourth revision on October, 1989.

* * * * * * * *

SPECIFICATION P-8: 89

DISC TYPE PORCELAIN INSULATORS

(Ball & Socket Coupling - Transmission Class)

0. FOREWORD

0.1 This standard specification has been introduced by WAPDA and lays down the specifications for ball and socket disc type porcelain insulators for use on transmission system. It has been prepared by the Design Department (Power Wing).

0.2 This specification is comprehensive and should facilitate procurement of quality material. It does not include provisions of contract.

0.3 This is fifth edition of this specification based on the recommendations of IEC Publications Nos. 120, 305, 372-1. 372-2, 838, 575 and 591. The first edition was based on IEC 75, 120 and ASAC 29.2.61.

0.4 This specification is subject to periodic revision as and when required.

1 SCOPE

1.1 This specification covers ball and socket disc type insulators made of porcelain to be used on over-head transmission system in respect of characteristics and acceptance tests.

2 DEFINITIONS

2.1 Flashover

Flashover is a discharge through air, taking the form of an arc or a spark or of several arcs or sparks, connecting the parts of an insulator which normally have the operating voltage between them.

2.2 Leakage distance

The leakage distance of an insulator is the sum of the shortest distances measured along the insulating surfaces between the conduvtive parts, as arranged for dry flash over test.

2.3 Lot

A quantity of insulators manufactured or produced under conditions which are presumed uniform and offered for acceptance.

2.4 Mechanical Impact Strength

The mechanical impect strength of an insulator is the impact which, under specified conditions, the insulator can withstand without damage.

2.5 Puncture

Puncture is a local or total destruction of the insulating material caused by a discharge passing through it.

NOTE A fragment breaking away from the rim of a shed or damage to the insulator due to the heat of a surface discharge shall not be considered a puncture.

2.6 Radio-influence Voltage

The radio-influence voltage of an insulator is the radio frequency voltage produced, under specified conditions, by the applications of an alternating voltage of 50 cycles per second ± 5 percent.

2.7 Sample

Items selected from the lot to be subject to the acceptance tests.

2.8 Simple Random Sample

A sample of n items from a population of N items in such a way that all possible combinations of n items have the same probability of being chosen.

2.9 Standard Atmospheric Conditions

For the purpose of this specification are:-

Ambient Temperature	25°C.
Barometric Pressure	1014 millibars, 760 mm (29.9 inches) of mercury.
Humidity	15 grams water per cubic metre, this is equivalent to a partial Pressure of 15.46 mm (0.6 inch) of mercury at 25°C.

2.10 Test Specimen

A test specimen is an insulator which is representative of the product being tested; it is specimen that is undamaged in any way which would influence the result of the test.

2.11 The Dry or Wet One-minute Power Frequency Test Voltage

This is a power frequency voltage which the disc insulator can withstand for one-minute dry or wet, under the conditions prescribed, without flashover or puncture.

2.12 The 24-Hour Mechanical Test Load of Disc Insulator

This is a machanical load which the disc type insulator can withstand for 24 hours, under the conditions prescribed without breakage or puncture.

2.13 The Short Time Electro-Mechanical Breaking load of Disc Insulator

This is the mechanical load which, under the conditions prescribed, causes puncture or breakage of any part of the disc type insulator unit.

2.14 The Mechanical Breaking load of Disc Insulator

This is the mechanical load which, under the conditions prescribed, causes separation of the metal parts.

2.15 The Puncture Voltage

The Puncture Voltage of an insulator is the voltage which under the conditions prescribed causes puncture.

3 GENERAL

3.1 Standard insulators shall conform in all respects to the requirements hereinafter stated.

3.2 Manufacturer's drawings shall besupplied and shall show the outline of the insulator together with all pertinent dimensions. Any variation in these dimensions due to manufacturing tolurance shall be indicated.

4 MAERIAL

4.1 The insulators shall be made of good commercial grade wet process porcelain.

4.2 The entire surface of the insulators shall be smoothly glazed. The standard colour of the glaze be as in Table-1. The entire surface shall be free from imperfections.

4.3 Metal Parts, except for split pins, shall be made of a good malleable iron,ductile,cast iron or open-hearth or electric furnace steel, and galvanized according to clause-6.

4.4 The insulator unit shall be designed to inhibit the accelerated corrosion of metal fittings due to leakage currents. A corrosion intercepting zinc sleeve shall be used on the insulator coupling pin for Pog type insulators.

4.5 The design of the insulator shall be "straight headed" with sanding of the porcelain internally where the metal work is cemented to the porcelain.

5 DIMENSIONS AND CHARACTERISTICS

5.1 Dimensions and Characteristics shall conform to values given in Fig. , and Table-1:

TABLE-I

	NORMAL TYPE				FOG TYPE			
TYPE DESIGNATION	U70DL	U80DL	U100DL	U160DS	U70DLF	U80DLF	U100DLF	U160DSF
DIMENSIONS								
Disc Diameter(D),mm	255	255	255	280	255	255	255	292
Disc spacing(P),mm	146	146	146	146	146	146	146	146
Minimum Creepage Distance, mm	290	290	290	300	430	430	430	430
Standard Coupling dia (d_1), mm	16	16	16	20	16	16	16	20
MECHANICAL VALUES								
Short-time electro-mechanical breakaging load, KN	70	80	100	160	70	80	100	160
Mechanical Routine test load, KN	28	32	40	64	28	32	40	64
Mechanical Impact strength, Nm	6.2	6.2	11.3	11.3	6.2	6.2	11.3	11.3
ELECTRICAL VALUES								
Power frequency withstand voltage,KV	70	70	70	70	85	85	85	85
Wet power frequency withstand voltage,KV	40	40	40	40	50	50	50	50
Impluse withstand voltage,KV	110	110	110	110	110	110	110	110
Low frequency puncture voltage,KV	110	110	110	110	130	130	130	130
RADIO NOISE								
Max. radio influence voltage at 1000Hz, micro volts	50	50	50	50	50	50	50	50
Test voltage to ground, KV	10	10	10	10	10	10	10	10
Colour of glaze	Brown	White	Grey	Brown	Brown	White	Grey	Brown

5.2 Coupling

Dimensions of standard ball and socket coupling shall conform to the IEC Publication 120.

5.3 Locking Devices

Standard split pin locking device shall have the Shapes and dimensions in accordance with IEC Publication 372-1 and Fig: 2 of this Specification.

5.3.1 Material

The material for split pin shall be standard quality stainless steel or bronze, having quality for resistance to internal corrosion.

6. GALVANIZING

6.1 Ferrous parts shall be hot dip galvanized with zinc coating conforming the tests carried out as per WAPDA Specification P-82.

6.2 Please add the following for "Class B Castings" at page 3 after 2nd line in Wapda Specification P-82.

" Class B Castings to be used for Fog type Insulators.	Castings, Cast iron, malleable iron & steel to be used for Fog type Insulators. 1050 1080"

7. TESTS

7.1 Type Test

7.1.1 These tests are intended to verify the main electrical characteristics of an insulator Mainly depend primarily on its shape and size. They are made once only on insulators.

7.1.2 Following type tests are to be carried in accordance with the requirements and methods laid down in IEC standards 383 and 575.

i) Dry lightning impules withstand voltage test (IEC 383

ii) Dry power frequency withstand voltage test

iii) Wet power frequency withstand voltage test (IEC 383)

iv) Thermal Mechanical Performance test (IEC 575)

v) Radio influence voltage test (ANSI C 29-1-1982).

7.2 Sample Tests

7.2.1 These tests are for the purpose of verifying the other characteristics of an insulator and the quality of the materials used. They are made on insulators taken at random from batches offered for acceptance.

7.2.2 Insulator

Following sample tests shall be carried out in accordance

with IEC publication 383, WAPDA Specification P-82 and Table-1 of this Specification:

i) Verification of Dimensions (IEC 383 and Table-1)

ii) Temperature cycle test (IEC 383)

iii) Electro-mechanical failing load test (IEC 383)

iv) Porosity test (IEC 383)

v) Galvanizing test (WAPDA Specification P-82:80)

vi) Power frequency puncture test (IEC 383)

7.2.3 Locking Device for ball & socket coupling

Following sample tests are to be carried out in accordance with methods given in IEC 372-2 and the Fig:2 of this Specification:

i) Visual Examination

ii) Verification of Dimensions

iii) Verification of Resistance to Bending

iv) Hardness Test

v) Operation Test

7.3 Routine Tests

These tests are for the purpose of eliminating insulators with manufacturing defects. They are made on every insulator offered for acceptance by the manufacturer. Following routine tests are required in accordance with IEC 383.

i) Visual Examination

ii) Mechanical Routine Tests

iii) Electrical Routine Tests

8. SAMPLING RULES AND ACCEPTANCE CRITERIA FOR SAMPLE TESTS

8.1 Rules for Insulator Sampling and their Distribution for Tests

8.1.1 For sample tests insulators shall be offered in lots of size 1,200 to 10.000. The insulators intended for the sample tests shall be taken at random each lot by the Inspector after performing routine tests of IEC Publication 383 and elimination of any defective insulator.

8.1.2 The number 'n' of insulators to be selected is indicated in Table-11 below:

TABLE-11 SAMPLING

Number of Insulators in the lot	Number of Insulators selected	Number of Insulators in the 1st partial sample	Number of Insulators in the 2nd partial sample
N	n	n_1	n_2

1200 to 3000	14	10	4
3001 to 10000	20	15	5

The total sample of ' n1 ' insulators is further divided into two partial samples composed of 'n1 ' and 'n2 ' insulators.

8.1.3 The sample of 'n1 ' insulators is submitted to the following tests of IEC Publication 383 which are applicable in the order indicated:

1. Verification of dimensions
2. Temperature cycle test.
3. Electro-mechanical test. The load shall be increased until the failing load of the insulator. The value obtained will be used for the statistical analysis. The acceptance criteria shall be as defined in clause 8.2.

8.1.4 The sample of 'n2 ' insulators is submitted to the following tests of IEC publication 383 which are applicable with the acceptance specified in that publication:

1. Verification of dimensions
2. Temperature cycle test
3. Puncture test
4. Galvanizing test
5. Porosity test

8.2 Conditions for the Acceptance of a Lot

While performing mechanical and electro-mechanical tests, the process for the decision of acceptance is as follows:

1) Compute the quality index Qs with the following formula:

$$Qs = \frac{\bar{R} - R_s}{S}$$

In this formula:

- Average value $\bar{R} = \frac{R_1 + R_2 + \cdots R_\lambda + \cdots R_{n1}}{n_1}$

$R_1, R_2, \cdots R_\lambda \cdots R_{n1}$ are the measured values of mechanical or electro-mechanical failing load.

- R_s : specified value of the mechanical or electro-mechanical failing load.
- Standard deviation :

$$S = \sqrt{\frac{\sum_1^{n_1} (R - \bar{R})^2}{n_1 - 1}}$$

P-B:89.

2) Ascertain the acceptance constant K from Table-III for the partial sample size n_1 given in Table-II.

TABLE-III

Sample size n_1	Acceptance constant K
10	1.58
15	1.68

3) Compare the quality index Q_s with the acceptance constant K:

If $Q_s \geq K$ the lot meets the acceptability criterion.

If $Q_s < K$ the lot does not meet the acceptablity criterion.

9 MARKING

Each insulator unit shall bear symbols indentifying the manufacturers, year of manufacture and the rated combined Electrical and Mechanical strenth. The marking shall be legible and durable.

10 PACKING

The packing shall be as per general conditions of the contract/ order.

11 DRAWINGS AND DATA

The following information shall be supplied with the bid and failure to supply the same may subject the bid to disqualification:

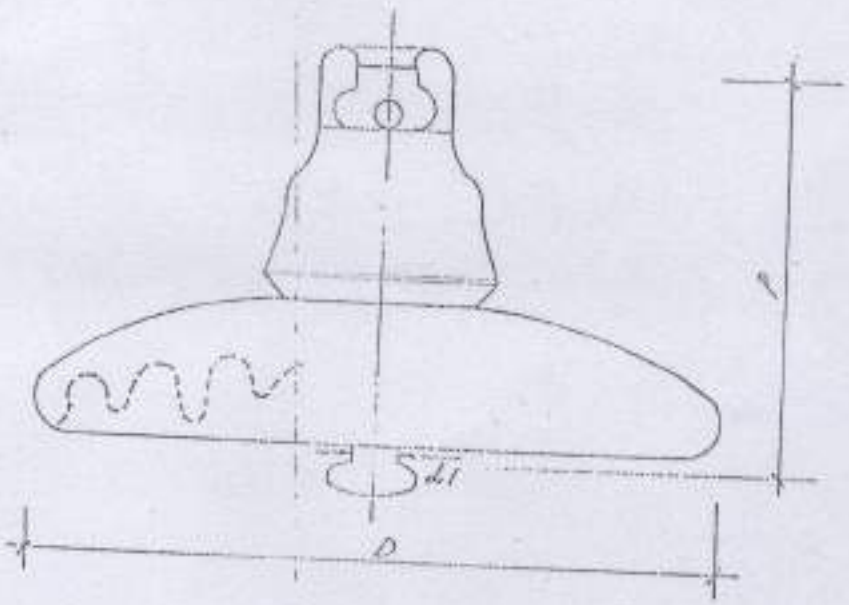
i) Detailed fully dimensioned drawing of insulators.

ii) Specification giving material grade composition of all parts of the insulators, and locking arrangements.

iii) Catalogues/literature.

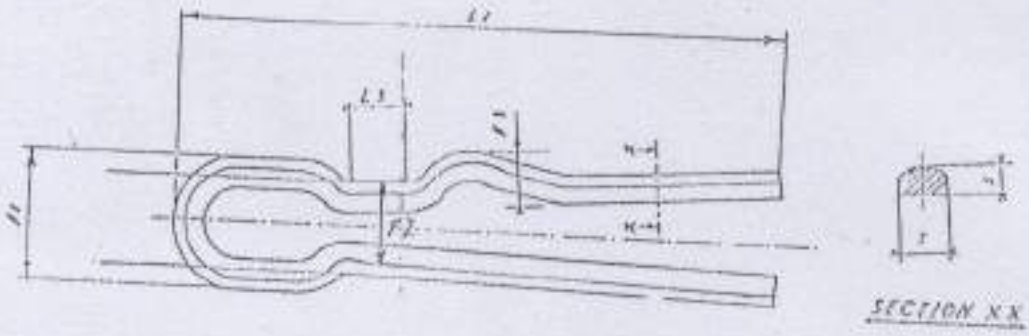
iv) Detail of manufacturing and testing facilities available with manufacturer.

Encls: Figs: 1 and 2.



TRANSMISSION CLASS DISC INSULATOR

FIG-1



DIMENSION STANDARD SIZE	L1		L3	F1		F2		F3		T		S	
	MAX.	MIN.	MIN.	MAX	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
16A	66.5	63.5	4.7	15	14	10.1	10.3	5.7	5.3	5.7	5.5	3.3	3.1
20	81.5	78.5	6	16.9	15.9	11.1	10.7	6.2	5.8	7.2	7	3.3	3.1

FIG-2