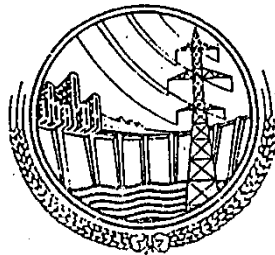


SPECIFICATION P-139:80

FABRICATION OF STEEL STRUCTURES



PAKISTAN
WATER AND POWER DEVELOPMENT AUTHORITY
DESIGN DEPARTMENT, POWER,

C O N T E N T S

0. Foreword
1. Scope
2. Steel
3. Nuts and Bolts
4. Fabrication
5. Galvanizing
6. Sign Plates
7. Tests
8. Acceptance and Rejections
9. Test Methods
10. Packing
11. Drawings

PRINTING HISTORY

First approved on 19th July, 1980.

First Amendment October, 1982.

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/mm²) 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 1.5 mm. "

3. Clause 7.2.1

Delete the clause 7.2.1 and add the following:-

1. Visual examination
2. Varification 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.

E l e m e n t	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.

	<u>Mild Steel</u>	<u>High Tensile Steel</u>
Tensile strength kg/mm ²		
Minimum	40	50
Maximum	56	80
Yield points kg/mm ²		
Minimum	26	35
Elongation in 200mm gauge 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 interchangeable 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 theoretical 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 galvanized 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 attachmer 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 |) | According |
| under eccentric load |) | to |
| 4. Cold bend test |) | WAPDA |
| 5. Hardness test |) | Specification |
| 6. Galvanizing test |) | 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) According
4. Ultimate tensile strength test) to
5. Galvanizing test) 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:

	<u>No. of Samples</u>
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 differs 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 Dimensional 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 Ladle 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 taken 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.

E l e m e n t	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 referred 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 standards/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.

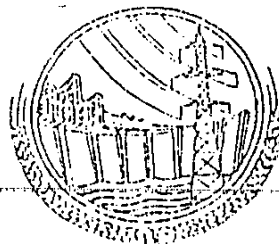
11.2.4 Bills of Material

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-82:81
(UDC NO. 669,586,5)

ZINC COATINGS



PAKISTAN
WATER AND POWER DEVELOPMENT AUTHORITY
DESIGN DEPARTMENT, POWER

CONTENTS

0. Foreword
1. Scope
2. Materials
3. Weight and Thickness of Zinc Coatings
4. Test Methods
5. Tests
6. Test Samples, Acceptance and Rejection
7. Passivation Treatment

PRINTING HISTORY

First edition March, 1971.

Second edition August, 1980.

Third edition July, 1981.

.....

SPECIFICATION P-82: 81

(UDC No. 669.588.5)

ZINC COATINGS

0 FOREWORD

- 0.1 This specification has been prepared by the Design Department of Power Wing, WAPDA and lays down specification for protective zinc coatings applied on iron and steel.
- 0.2 This standard is intended only for the purpose of procurement of materials and does not include the provisions of a contract.
- 0.3 This standard is subject to periodical revisions as and when required.
- 0.4 This specification is mainly based on ASTM A. 50 and A. 219, A.153.68, A.154.55, A.525.67, A.121.66, B 261-63, BS 443: 1961.

1 SCOPE

- 1.1 The specification lays down test for the zinc coatings which has been deposited either by Hot Dip method or by Electrodeposit Method on the articles as classified below. It also covers the weight of zinc coatings which shall be required per square meter of the surface area or its thickness.

Classification	Description of articles
Class A-Fabricated products	Fabricated products from rolled, pressed and forged steel shapes, channels, angle iron, T shapes, plates, bars and strips e.g. structural poles, tubular poles, pipes, channels and angle iron for platforms of pole mounting transformers, capacitors and voltage regulators, lattice steel cross bracket etc.
Class B-Castings	Castings, iron, malleable iron and steel.
Class C-Rolled pressed and forged articles	Rolled, pressed and forged articles such as insulator pins, anchor-shackle, eye-nuts, clamps, cotter pins, thimbles, covers, deadend clamps etc.
Class D-Nuts and bolts etc.	Nuts, bolts, washers, nails, rivets, screws and similar articles.
Class E-Steel Wires	Steel structural strands, steel wire strands for overhead transmission lines, guys, messengers, spur wires, tie wires and barbed wires.
Class F-Steel sheets	Steel sheets of all types and sizes

2 MATERIAL

- 2.1 The zinc used in electro-depositing and hot dip galvanizing shall be slab and shall conform to the following chemical composition:

Lead Max	1.6 percent
Iron Max	0.05 percent
Cadmium Max	0.50 percent
Zinc Min	98.0 percent

3 WEIGHT AND THICKNESS OF ZINC COATINGS

- 3.1 The weight of zinc coating by hot dip method on various articles shall be as per table-I below or otherwise specified in the relevant standards.

TABLE-I: WEIGHT OF ZINC COATINGS

Classification	Description of articles	Wt of Zinc Coating	
		Individual samples gm/sqm	Average of 3 samples gm/sqm
Class A Fabricated Products	Fabricated products from rolled pressed and forged steel shapes, channels and angle iron, T-shapes, plates bars and strips e.g. structural poles, tubular poles, pipes, channel and angle iron for platform of pole mounting transformers, capacitors and voltage regulators, lattice steel crossarm bracket etc.		
	i) When the thickness of steel is 3 mm to 6 mm	550	610
	ii) 6mm and heavier material	610	700
	iii) Pipe for service-mast only	350	400
	iv) Distribution transformer station hardware & cross-arm braces.	450	500
Class B Castings	Castings, cast iron malleable iron and steel	550	610
Class C Rolled, pressed and forged articles	Rolled, pressed and forged articles such as anchor shackle, eye-nuts, clamps, cotter pins, thimbles, covers, deadend clamps etc.		
	i) 4.75mm and over in thickness and over 200mm in length	550	610

Class D Nuts and Bolts etc.	iii) Under 4.75 mm in thickness and over 200 mm in length.	380	460
	iii) 200mm and under in length and any thickness	330	400
	iv) Hardware of service-mast other than pipe, insulator pins & D-shackle assembly	450	500
	i) Bolts, nuts and drive screws (over 9.5 mm in diameter) and similar articles, trans- mission tower bolts, washers 5 mm and over in thickness.	305	380
	ii) Screws and bolts (9.5 mm and under in diameter) rivets, nails and similar articles, washers under 5 mm in thickness.	260	305

Class E

Steel Wires

The weight of zinc coating on steel structural strand, steel wire stand for overhead trans-
mission line, guys, messengers, spur wires and
tie wires for similar purposes shall be as under:-

Stranded wire dia mm	Weight of zinc coating (gm/sqm)
0.20 to 0.30	45
0.31 to 0.39	60
0.40 to 0.50	90
0.50 to 0.79	120
0.75 to 1.00	150
1.00 to 1.50	170
1.50 to 2.00	(200)
2.01 to 2.50	225
2.50 to 3.00	250
3.01 to 4.00	275
4.01 and larger	300

ii) The minimum weight of zinc coating in gm/sqm on
barbed wires shall be as under:

dia mm	
2.5 including and above	250.00
2.0 to 2.4 mm	200.00
1.5 to 1.9 mm	1500.00

Class F

Steel Sheets

The minimum weight of zinc coating in gm/sqm on galvanized steel sheets shall be as under:-

<u>Coating class</u>	<u>Average of triple spot test</u>	<u>Min. single spot test</u>
2.75	716.00	610.00
2.5	640.00	550.00
2.25	564.00	490.00
2.00	503.00	427.00
1.75	427.00	366.00
1.50	350.00	305.00
1.25 commercial	274.00	244.00

3.2 Thickness of Zinc Coating by Electrodeposit Method

3.2.1 The minimum and average thickness of zinc coating, except threaded parts, by electrodepositing on steel articles shall be as under:-

<u>Coating class</u>	<u>Local thickness (mm)</u>	<u>Average thickness (mm)</u>	<u>Application conditions</u>
Class G	.025	.038	Outdoor
Class H	.008	.013	Indoor

3.2.2 The minimum and average thickness of zinc coating on threaded parts of steel articles shall be as under:-

<u>Diameter (mm)</u>	<u>Average thickness minimum (mm)</u>	<u>Average thickness maximum (mm)</u>
1.50 to 6.00	0.005	0.0065
6.01 to 12.00	0.0065	0.008
12.01 to 20.00	0.008	0.010

3.3 One gram of zinc per square meter of surface, based upon mathematical calculation, shall correspond to a coating thickness of 0.00014 mm.

4 TEST METHODS4.1 Weight of Zinc Coating on Galvanized Sheets4.1.1 Test Samples

Test specimens shall be (50 ± 0.25) mm square, except for material narrower than 50 mm wide, in which case test specimens shall be of such a length that the area of the specimen is 2500 sq mm. When it is not possible to secure a specimen of 2500 sq mm in area, a smaller size may be used but it is recommended that a specimen of not less than 1,300 sq mm be used.

4.1.1.2 The specimens shall be clean, they shall be washed with solvent naphtha or other suitable solvent, then with alcohol and dried thoroughly.

4.1.2 Test Method

4.1.2.1 Reagents

1) Antimony chloride solution:-

Dissolve 20 grams of Sb_2O_3 or 32 gm of $SbCl_3$ in 1000 ml of HCl (sp.g. 1.19)

4.1.2.2 Weigh the specimens obtained in accordance with 4.1.1 to the nearest 0.01 g. After weighing immerse each specimen singly in a solution made by adding 5 ml of antimony chloride to 100 ml of HCl (specific gravity 1.19) to cover the specimen and allow to remain therein until the violent evolution of Hydrogen has ceased and only a few bubbles are being evolved. This requires about 15 to 30 sec. The same solution may be used repeatedly until the time required for stripping becomes inconveniently long. The temperature of the stripping solution shall at no time exceed $38^\circ C$. After stripping, wash the specimen by scrubbing them under running water, dip in hot water and wipe or blow dry. Again weigh the specimen to the nearest 0.01 g.

4.1.2.3 Calculations

1) The loss in weight represents the weight of zinc coating in grams on the sample; to find the weight of zinc coating per sq meter proceed as follows:-

$$\text{Wt of coating in grams per square meter of steel surface} = \frac{\text{Loss in wt in grams} \times 10^6}{A}$$

Where A = Area of stripped sample in sq mm

4.2 Weight of Zinc Coating on Galvanized Wire

4.2.1 Test Sample

4.2.1.1 The specimens of galvanized wire may be of any length over 300 mm, but preferably about 600 mm. Where a continuous length is not available, shorter specimens totalling 300 mm but preferably 600 mm shall be used.

4.2.1.2 The specimen shall be cleaned by washing with solvent naphtha or other suitable solvent, then rinsed with Alcohol and dried thoroughly.

4.2.2 Test Method

4.2.2.1 Test method shall be the same as described in clause 4.1.2.

4.2.3 Test Results

4.2.3.1 Calculate the weight of zinc coating as follows:

$$C = \frac{W_1 - W_2}{W_3} \times d \times 100$$

Where C = Wt of zinc coating in grams per sqm
 W_1 = Original weight of specimen in grams
 W_2 = Weight of stripped specimen in grams
 W_3 = a constant = 1950
 d = diameter of stripped wire in mm

4.3 Weight of Zinc Coating on Articles Covered under Class A, B, C&D

4.3.1 Test Samples

- i) Samples for weight of coating determination, shall be selected in accordance with clause 6.4 or as specified in the relevant specification.
- ii) In the case of threaded articles, such as bolts and screws, the determination shall be made on a portion of the article that does not include any thread.
- iii) The specimens shall be cleaned by washing with solvent naphtha or other suitable solvent, then rinsed with Alcohol and dried.

4.3.2 Test Procedure

The procedure shall be the same as described in clause 4.1.2.

4.3.3 Test Results

- 4.3.3.1 Determine the total coated area of the specimen to the nearest 5 sq mm. Alternatively for specimens of uniform thickness of base metal, such as piece of plate or pipe, determine the average thickness of the specimen to the nearest 0.25 mm.

4.3.3.2 Calculation

Calculate the weight of zinc coating by using the formula:

$$C = \frac{W_1 - W_2}{A} \times N$$

Where C = Wt of zinc coating in gms/sqm of surface
 W_1 = Original wt of specimen in grams
 W_2 = Weight of stripped specimen in grams
 A = Coated area of the specimen in sq mm.
 N = A constant = (1000400)

- (b) If the specimen has a uniform thickness of base metal, the weight of the zinc coating may be calculated using the following formula:-

$$C = \frac{W_1 - W_2}{W_2} \times G \times Z$$

Where C = Wt of zinc coating in gm/sqm of the surface

W_1 = Original weight of the specimen in grams

W_2 = Weight of stripped specimen in grams

G = Thickness of stripped specimens in mm

Z = A constant = 3935

4.4 Test for Thickness of Electrodeposit Coating

4.4.1 Microscopic Test

The thickness of coating shall be determined on cross-sections taken perpendicular to the significant surfaces by the microscopic method described in the methods given below.

4.4.2 Test Specimens

- 4.4.2.1 To determine compliance with a specified minimum thickness of electrodeposited zinc, section the specimen at one or more significant surface where such a minimum may be expected.

4.4.3 Test Method

- 4.4.3.1 Hold the specimen rigidly and in such a position that the surface to be tested is perpendicular to the flat surface that is to be ground and polished (A deviation of 10 degrees from normal introduces an error of about 2% in thickness). The pieces may be plated first with a relatively thick coating of copper to protect the edges during grinding and polishing. On zinc deposit the first layer of copper from a cyanide solution after which, if desired, an acid copper solution may be used.
- 4.4.3.2 Grind and polish the section to be examined by regular metallographic methods, using successively finer abrasives the last being no coarser than 500 mesh. Polish zinc coating with minimum pressure in the direction from the hard basis metal to the soft coating, and alternatively at 45° and 135° angle to the plated surface.
- 4.4.3.3 Then treat the surface in such a manner as to obtain the maximum contrast between the coatings and the adjacent metals. Obtain such contrast by etching either the coating or the adjacent metal by an appropriate reagent. Suitable etching is desirable even when a contrast exists, since it will remove any soft metal that may have spread over a harder metal.

4.4.3.4 The following typical reagents are suitable for etching plated coatings:-

Chromic Acid (Cr O ₃)	200 g/Litre
Sodium Sulphate Na ₂ SO ₄	15 g/Litre

4.4.3.5 Measure the thickness of coating at any desired point on the exposed section by either of the methods described below:

- i) Measure the thickness with a filar micrometer ocular that has been calibrated in order to determine the value of the unit scale division against a scale graduated so accurately that the error will not exceed 2% for example, the scale may be graduated to 0.01 mm.
- ii) Project the image of the specimen especially of those specimens having very thin coatings, at a known and properly calibrated magnification on the ground-glass focusing plane of the camera of a metallographic microscope. Measure the width of the projected line of deposit with a graduated linear scale, the reading divided by the magnification shall give the thickness of the coating.

4.5 Adherence of the Coating Tests

4.5.1 Galvanized Sheets:

4.5.1.1 Galvanized steel sheets shall withstand a bend through 180° in any direction without flaking of coating on the outside surface.

4.5.1.2 The sample under test shall be gripped in a hand operated vice with smooth jaws and shall be bent through 180° over a mandrel twice as thick as the sample if weight of zinc coating is equal or more than 525 grams/sq.m. The sample shall be folded over a mandrel equal to the thickness of sample if the weight of zinc coating is less than 525 grams/sq.m.

4.5.2 Galvanized Wire

4.5.2.1 Zinc coated wire shall be capable of being wrapped at a rate not exceeding 15 turns per minute in a close helix of at least two turns around a cylindrical mandrel equal to three times the nominal diameter of wire under test, without cracking or flaking the zinc coating to such an extent that any zinc can be removed by rubbing with the bare fingers.

4.5.3 Articles covered under Class A, Class B and C - Heavy Materials

4.5.3.1 The pivoted hammer may be used to determine adherence of zinc coating on steel products 8 mm thick and heavier covered under class A, B and C. This test is applicable to flat surfaces only and shall not be used on round and curved surfaces. The hammer used

shall conform to fig 4. The hammer blow shall be controlled by clamping or holding the pivoted base of the handle firmly on a horizontal surface of the galvanized member and allowing the hammer head to swing freely through an arc from vertical position to strike the horizontal surface. As illustrated in fig 2 the test shall consist of two or more standard blows forming parallel impressions with 6.5 mm spacing along a common axis so located that no part of an impression shall be closer than 13.0 mm to the edge of the member. Removal or lifting of the coating in the area between the impressions shall constitute failure. An extruded ridge less than 3 mm wide shall be disregarded. The specimen shall be tested in several places throughout its length.

4.5.4 Articles covered under Class A, Class B and Class C - Small and Light Materials.

4.5.4.1 Small and light materials which are liable to deflect or deform under the hammer blow and curved or round articles which cannot be hammered properly should be tested by this method.

4.5.4.2 The adherence of zinc coating to the surface of the base metal shall be determined by cutting or prying with a stout knife, applied with considerable pressure in a manner tending to remove a portion of the coating. It shall only be possible to remove small particles of the coating by paring or whittling and it shall not be possible to peel any portion of the coating so as to expose the base metal.

4.6 Uniformity of Coating Test

4.6.1 Test Solution

4.6.1.1 The copper sulphate solution shall be made by dissolving approximately 36 parts by weight of commercial copper sulphate crystals in 100 parts by weight of distilled water. Heat may be used to complete the solution of copper sulphate crystals. If heated, the solution shall be allowed to cool. The solution shall then be agitated with an excess of powdered cupric hydroxide $\text{Cu}(\text{OH})_2$ about 0.81 gms/litre of solution. The presence of an excess of cupric hydroxide will be shown by the sediment of this reagent at the bottom of the vessel. The neutralized solution shall be allowed to stand for 24 hour and then filtered or decanted.

4.6.1.2 The test solution shall have a specific gravity of 1.186 at 18°C. To adjust a solution of improper specific gravity, add distilled water when the specific gravity is high, and add a copper sulphate solution of a higher specific gravity when the test solution is low in specific gravity.

4.6.1.3 Wire specimens shall be tested in a glass container at least 50mm in inside diameter for 2.5 mm dia wire and smaller, and at least 75.0 mm in inside diameter for wire larger in diameter than 2.5 mm dia. The container shall be filled with fresh test solu-

tion to a depth of at least 100.0 mm. This quantity of solution shall be used for the simultaneous testing of one to seven test specimens. The solution shall be discarded after completion of the test and fresh solution used for any additional tests.

4.6.1.4 For testing articles other than wire, the quantity of copper sulphate solution required for each test will depend on the superficial area of the test specimen and the weight of coating. The quantity should not be less than 40 ml per gm of zinc coating on the specimen and shall be sufficient to cover the specimen so that the top surface of the solution is at least 13 mm above the top of the section of the specimen under test. The solution shall be discarded after completion of the test and fresh solution used for any additional tests.

4.6.2 Test Samples

4.6.2.1 The specimens selected for test shall be free from abrasion or cuts in the zinc coating, except those which may occur during manufacture or the preparation of the specimen for testing. Specimens of wire may be hand straightened.

4.6.2.2 The specimens shall be cleaned with a volatile organic solvent such as carbon tetrachloride, gasoline, or benzene, then rinsed with alcohol, and finally, thoroughly washed with clean water and wiped dry with clean cotton cloth. Test specimens shall be brought to a temperature of 15° to 21°C prior to beginning of the test.

4.6.2.3 Abnormal cases may arise when, by reason of unusual surface conditions, the copper sulphate solution will not act normally on the zinc coating. If there is any question of abnormality of performance of test specimens, the specimens shall be discarded and new ones selected. The new specimen shall be cleaned in alcohol, rinsed and wiped dry and then immersed for 3 minutes in a solution consisting of 1 part by volume of ammonium hydroxide (sp. gravity 0.90) and nine parts of water. The specimens may be scrubbed with cotton cloth during this immersion. After cleaning the specimens shall be washed and wiped dry and then tested in accordance with the procedure laid down below.

4.6.3 Test Method

4.6.3.1 The test specimen shall be immersed in the copper sulphate solution, which shall be maintained at a temperature of 16 to 20°C. The specimens shall remain in a fixed position in the solution for exact 1 minute. If a ½ minute dip is specified, it shall be given to the specimens after completion of all of the 1 min dip. There shall be no agitation of the solution during the immersion period and the specimen shall not be allowed to touch each other or the sides of the container. After each dip, the specimens shall be washed immediately in the rinsed water, and a fibre bristle brush shall be used to remove

any copper deposit that may have formed on the zinc coating. Before returning the specimens to the test solution they shall be well drained of excess rinse water and wiped dry with a clean cloth.

- 4.6.3.2 Successive dips of 1 min. each shall be continued, with washing and wiping of the test specimens after each dip, until the specimens have withstood the required number of dips specified in table-II or until the end point has been reached.

TABLE-II: WEIGHT OF COATING AND NUMBER OF DIPS

Weight of Coating gm/sqm	No of Dips	
	1 minute	half minute
300 and above	4	-
270 to 299	3	1
240 to 269	3	-
180 to 239	2	-
140 to 179	1	1
90 to 139	1	-
75 to 89	-	1

- 4.6.3.3 A recommended device for holding test specimens of wire in a fixed position is shown in fig 1. A similar device may be used for holding specimens of other small articles that are not required to be fully immersed in the test solution. Specimens that are completely immersed may be suspended by a string.

4.7 Visual Inspection

- 4.7.1 The galvanized surface shall be free from such imperfection as lumps, uneven coatings, blisters, gritty areas, uncoated spots, ash and flux inclusions, globules or heavy deposits of zinc which will interfere with the intended use of the material will not be permitted.
- 4.7.2 Following is the list of defects, their significance and possible remedies:-

Condition	Causes	Recommended Actions	Ground for Rejection
Bare Spots	Paint, grease or oil residues	Check cleaning particles	Materials may be
	Scale or rust residues	Check pickling particles	accepted
	Residual welding slag	Blast-clean welds, Avoid coated rods.	where bare spots are
	Breakdown of pre-flux coating	Check preflux and drying conditions	in accordance with clause 4.7.2.

	Aluminium content of bath too high	Regulate aluminium additions	
	Rolling defects in basis steel	Check steel supply	
	Articles in contact during galvanizing	Keep articles separated.	
General Roughness	Analysis or original surface condition of steel.	Check steel supply	Material may be accepted provided adhesion is good and degree of roughness is not too critical.
	Overpickling	Reduce pickling use inhibitor.	
	High galvanizing temperature and/or long immersion time.	Adjust galvanizing conditions	
Pimples	Entrapped dross particles	Avoid agitation of dross layer check carry-over of pickle salts.	Material with finally disposed pimples covering not more than 0.5% of the area may be accepted.
Lumpiness and Runs	Withdrawal speed too high	Remove work slowly	Materials of class ABC may be accepted whereas of class D,E, F rejected.
	"Cold" galvanizing bath	Increase temperature	
	Delayed run-off from seams, joints bolt holes, etc.	Remove work slowly	
	Articles in contact during withdrawal.	Keep articles separated	
Flux Inclusion	Steel flux burnt on during dipping	Refresh or renew flux blanket	Materials shall not be accepted.
	Surface residues on steel	Check steel preparation	
	Flux picked up from top of bath	Skim before withdrawal.	

4.7.3 Articles covered under class A, B & F shall be completely free from uncoated spots. However small localized uncoated spots on fabricated pressed, forged and casted articles covered under class A, B & C may be ignored upto maximum of 0.25% of the total area. The area of such individual spots shall not exceed 0.5 square cm. Uncoated spots shall be patched with galvanizing repair paint.

4.8 Embrittlement Tests

4.8.1 Galvanized Angle Test (for angle irons only)

4.8.1.1 Test Requirements

- i) The elongation measured in accordance with clause 4.8.1.2 (i) shall not be less than 5 percent except as specified in para 4.8.1.2 (ii).
- ii) When the specimen does not show 5 percent elongation, the reduction in thickness shall be measured in accordance with clause 4.8.1.2 (ii). The sum of the percentage of elongation plus the average percentage reduction of thickness shall not be less than 10.

4.8.1.2 Test Procedure

- i) For determining the elongation after fracture, a 51 mm gauge length (Fig 2) shall be prick-punched in the middle of the edge of the vertical leg of the angle along a line parallel to its length and centred directly under the hole. After the test, the sum of the distance along this line from each punch mark to the corresponding edge of the fracture shall be measured to 0.25 mm with a flexible scale, and the percentage of elongation calculated. For specimens under 13.0 mm in thickness or those in which the distance from the edge of the hole to the edge of the angle is less than 10 mm, the elongation shall be measured over a 25 mm gauge length.
- ii) For determining the percentage reduction of thickness after fracture, the reduction shall be measured with a ball point micrometer at the 3 locations indicated in fig 3; namely (a) outer side of hole, (b) inner side of hole, (c) middle of leg. The percentage reduction of thickness shall be calculated on the basis of the original thickness of the angle and the average of the three values at a, b and c.

- iii) The length of the test specimen and the distance between the supports are shown in the following table:-

Length of angle L (mm)	Length between supports	Minimum length
	L_1 (mm)	L_2 (mm)
Upto 100 mm incl.	356.0	457.0
Over 100 mm to 150mm incl.	508.0	610.0
Over 150 mm to 200mm incl.	762.0	915.0

- iv) The kind of hole, punched, sub punched and reamed, or drilled, shall be that employed in the fabricated material which the specimen represents. The dimensional values, diameter, and location of hole, shall be not less than those employed in the structural details. Care shall be taken not to place the hole near stamped or rolled in identification marks.
- v) The test shall be made upon galvanized specimens having a temperature not below 60° and not over 90° F when tested.
- vi) The test may be made in a universal testing machine, or by other means such as a press or bulldozer with the load applied slowly.

4.8.2 Embrittlement Tests for Materials covered under class B, C & D.

- 4.8.2.1 The test is suitable for galvanized steel hardware of such shape and size that permit bending such as bolts, tower steps, insulator clevises, braces, rods etc. Clamp one end of the article in a vice and bend the other end through an angle of 90 degree of about a diameter equal to the dia or thickness of the article under test. A suitable length of pipe may be used as a lever to assist bending. The article after bending shall show no cracks on the outside surface of bend. If such a test is made on threaded articles, it shall be made on un-threaded portion. In case of completely threaded articles, the threads shall be removed and the 90 degrees bend shall be about a diameter equal to the reduced diameter of the article.
- 4.8.2.2 Castings and steel hardware of such shape or size that they do not permit bending, may be struck a sharp blow with a hammer of suitable weight. If the material is not embrittled, it should not crack under such a blow. However, if the article is tested to destruction, a white lustrous, coarse grain appearance of the resulting fracture is indicative of embrittlement and shall be cause for rejection.

5 TESTS

- 5.1 Tests on galvanized shall be carried out as per table - III below or otherwise specified in the relevant standard. Tests where applicable are marked 'O'.

TABLE-III: TESTS ON GALVANIZING

Test	Class	Class	Class	Class	Class	Class	Articles galvanized by electrodeposit method
	A	B	C	D	E	F	
Visual Inspection	O	O	O	O	O	O	O
Wt. of zinc coating (on hot dip articles)	O	O	O	O	O	O	X
Thickness of zinc coating	X	X	X	X	X	X	O
Uniformity of coating test	O	O	O	O	O	O	X
Adherence of coating test	O	O	O	X	O	O	O
Embrittlement test	O	O	O	O	X	X	X

6 TEST SAMPLES - ACCEPTANCE AND REJECTION

- 6.1 The manufacturer shall provide all necessary facilities including testing equipment for carrying out tests free of cost to WAPDA. The cost of test samples destroyed during tests shall be borne by the manufacturer.
- 6.2 The WAPDA representatives shall have access at all times while work on WAPDA's contract is being performed. The manufacturer shall afford the WAPDA representative all reasonable facilities to satisfy him that the galvanizing is being furnished in accordance with the specification.
- 6.3 For visual inspection, articles shall be grouped into lots and test specimens shall be selected from a lot at random in accordance with table-IV. If the number of defective units does not exceed one, the lot shall be accepted. If the number of defective units exceeds two, the entire lot shall be rejected. In case the defective being two, another sample of double the quantity given in table-IV shall be selected at random and the test repeated. In case of any failure from the second selection, the entire lot shall be rejected.
- 6.4 Test specimens from each sample for determination of compliance to the tests specified in clause 5.2, 5.3, 5.4 and 5.5 shall be taken from each lot. The lot shall consist of a quantity

TABLE - IV

Material Description	Lot	Visual Inspection	No. OF S A M P L E S			Embrittlement Test
			Wt. of galvanizing test or thickness of zinc coatings	Uniformity and adherence of coating test		
1. Class A, B, C & D						
i) Fabricated, rolled, pressed, forged and cast articles covered under class A,B, C & D not more than 300 mm in length.	1000 units	100 units	3 units	3 units	3 units	
ii) Fabricated, rolled, pressed, forged and cast articles covered under class A,B, C & D more than 300 mm in length	500 units	100 units	3 units	3 units	3 units	
2. Class E						
Galvanized steel wires, barbed wires binding wires etc.	100 coils or 10 km in length of wire of same size in form of coils whichever is less.	10 coils	3 sample coils shall be selected from each lot and test specimens shall be cut from each coil as per cl. 6.5 of this specification.	3 sample coils shall be selected from each lot and test specimen shall be cut from each coil as per cl. 6.6 of this specification		
3. Class F						
Galvanized steel sheets.	500 sheets of same size or 1000 kg in wt. whichever is less.	25 sheets	3 sample sheets shall be selected from each lot and test specimens shall be cut from each coil as per clause 6.5 of this specification	3 sample coils shall be selected from each lot and test specimen shall be cut from each coil as per clause 6.6 of this specification		

Galvanized articles
by electrodeposit
method.

The procedure for sampling shall be the same as described above
for hot dip galvanized articles.

as specified in Table-IV below or as otherwise specified in the relevant specification. If any sample fails to comply with the requirements laid down in this standard, another set of samples as per table-IV shall be taken from the remaining lot and test repeated. In case of any failure in the second set of samples, the whole lot shall be rejected.

6.5 Test samples from sheets or coils (Class E,F) for determination of weight of zinc coating shall be obtained as follows:

- i) When cut from coil, one sample from the centre and two samples from both ends of coil shall be taken.
- ii) When cut from sheet, one sample from the centre and two samples from diagonally opposite corners shall be taken.

6.6 Test specimens from each sample sheets and coils for determination of adherence and uniformity of coating shall be obtained as follows:

- i) When cut from coil, sample shall be selected from one end of the coil.
- ii) When cut from sheet, sample shall be taken from one corner of the sheet.

7 PASSIVATION TREATMENT

7.1 Zinc coatings applied by electrodeposit method shall be given full passivation treatment for maximum protection from corrosion by the following process.

7.2 The zinc plated components shall be well rinsed, then immersed for 5 to 10 seconds in a passivation solution of following composition:

Sodium dichromate 182 g/litre

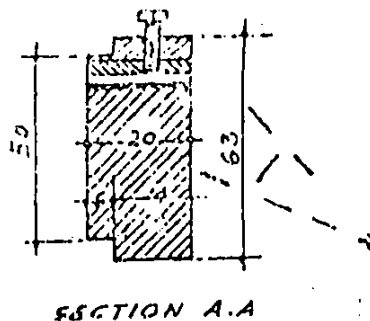
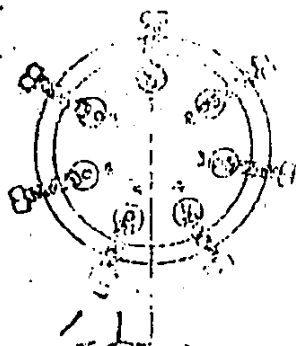
Free sulphuric acid 6 ml/litre

After passivation the components shall be well rinsed in running water and then dried in warm air.

7.3 Passivation process other than one specified above, may be used subject to prior approval by WAPDA.

Encls: Figures 1,2,3, 4 and table IV.

m.y



SECTION A-A

FIG. 1

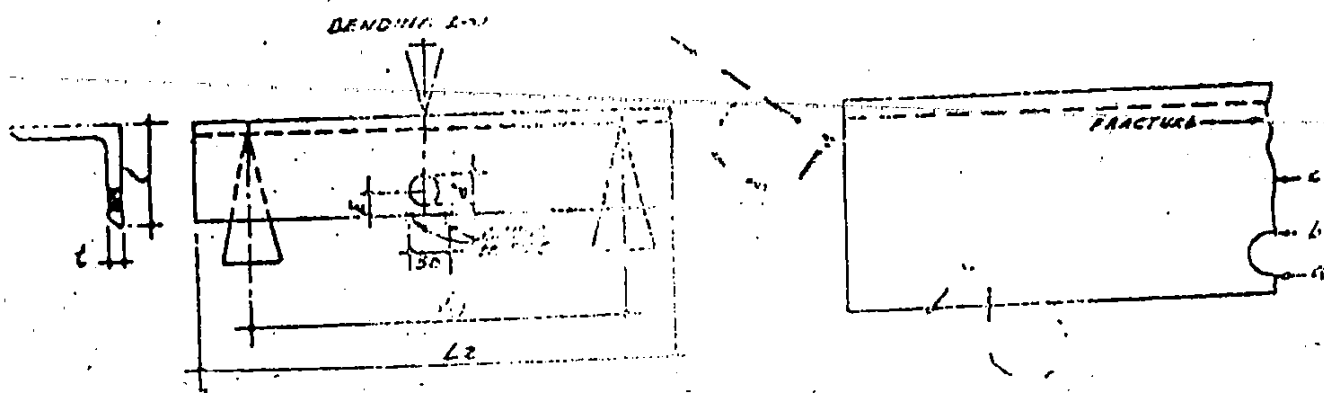


FIG. 3

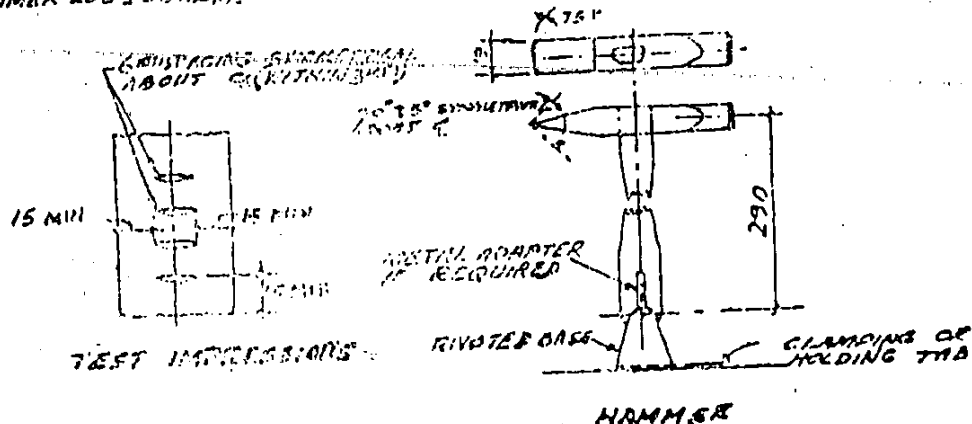
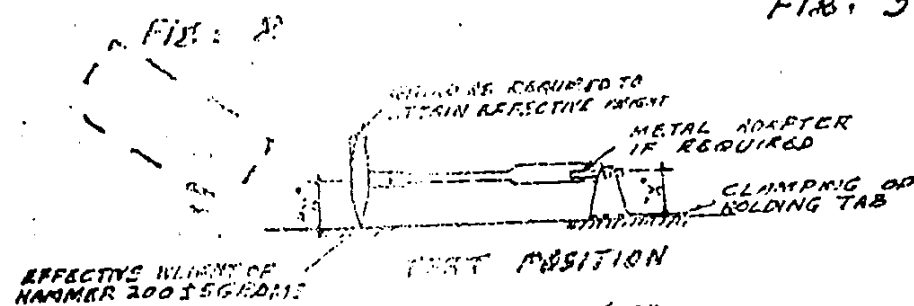
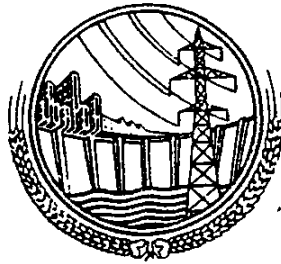


FIG. 2

SPECIFICATION P-162: 81
(UDC 621.315.52)

BARBED WIRE



PAKISTAN
WATER AND POWER DEVELOPMENT AUTHORITY
DESIGN DEPARTMENT, POWER WING

SPECIFICATION P-162:81

BARBED WIRE

AMENDMENT NO.1 DATED: 5TH JANUARY, 1989.

1. Delete 10% minimum elongation in 250 mm
from table-1 under clause 3.1.

C O N T E N T S

0. Foreword
1. Scope
2. Material
3. Dimensions, Characteristics and Tolerances
4. Construction Requirements
5. Galvanizing
6. Finish
7. Sampling, Acceptance and Rejection
8. Tests
9. Test Methods
10. Packing and Marking

PRINTING HISTORY

First edition , December, 1981

Amendment No. 1 dated 5th January, 1989.

SPECIFICATION P-162: 81

(UDC 621.315.52)

BARBED WIRE

0 FOREWORD

- 0.1 This standard specification has been prepared by the Standards and Research Directorate of the Design Department (Power), WAPDA, Lahore.
- 0.2 This specification is intended only for the purpose of procurement of material and does not include the provisions of contract.
- 0.3 This specification is subject to revision as and when required.
- 0.4 This specification supersedes PD-76 on Barbed Wire.

1 SCOPE

- 1.1 Barbed wire is used on 11 kV steel structures and 11kV reinforced concrete poles for anticlimbing purposes.

2 MATERIAL

- 2.1 The base metal of the barbed wire shall be of good commercial quality of steel wire made from steel produced by the open hearth, basic oxygen or electric furnace process.

3 DIMENSIONS, CHARACTERISTICS AND TOLERANCES

- 3.1 The size and characteristics of the zinc coated barbed wire shall be as given in table-I.

TABLE - I

Nominal diameter of zinc coated barbed wire.	Minimum breaking strength single wire	Minimum elongation in 250 mm	Net weight of barbed wire on each reel	Shape of Barbs
mm	Kg		Kg	
2.00	115	10%	50	Round

- 3.2 The permissible variation from the nominal diameter of barbed wire shall be ± 0.13 mm.
- 3.3 The average spacing of barbs shall not exceed the specified spacing and no individual spacing shall vary from

the specified spacing by more than 19 mm, when measured from the edge of one barb at the strand to the corresponding edge of the adjacent barb.

4 CONSTRUCTION REQUIREMENTS

4.1 The barbed wire shall be formed from two strand galvanized wires complying with the requirements of clause 3 twisted together with an approximate lay of 50 mm, with four point barbs spaced at 100 mm intervals as shown in Fig.1. The barbs shall be wrapped around two strand wires once and round a single strand once, making in all, two turns round the strand wires. The barbs shall be wrapped around the strand wires by a method which prevents slipping to expose the four barbs approximately 90° apart in a plane at right-angles to the strand wire. The point of the barbs shall have a length of 13 ± 3 mm and shall be sharp and cut at an angle not greater than 35° to the axis of the barb.

4.2 The barbs shall be made from 2 mm dia galvanized steel wire complying with the requirements of clause 3.

4.3 Splicing of individual strand wires by means of a wrap joint or an electric butt weld is permitted, before galvanizing. Not more than three joints shall be allowed in one length of wire on the reel.

4.4 Splicing or joints shall be made in a workmanlike manner.

5 GALVANIZING

5.1 The wire shall be hot dip galvanized in accordance with WAPDA specification P-82 "Zinc Coating". The weight of zinc coating shall be 200 gms/sq meter.

6 FINISH

6.1 The zinc coated steel wires shall be clean, smooth and free from harmful defects prior to being stranded.

7 SAMPLING, ACCEPTANCE AND REJECTION

7.1 Each consignment shall be divided into lots containing 50 reels in each lot. A sample of 5 reels shall be drawn at random from each lot.

7.2 The sample shall be subjected to visual examination and verification of dimensions. If the number of defective reels is one, the lot shall be accepted. If the number of defective reels is two, another sample of 5 reels shall be drawn at random and subjected to tests. If the number

of defective reels is again two or more, the lot shall be rejected.

- 7.3 Specimen shall be cut from all the reels selected as per clause 7.1 for galvanizing test and breaking strength and elongation test. If one specimen fails the lot shall be accepted. If the number of failures is more than one, the lot shall be rejected.

8 TESTS

The following tests shall be carried out:

1. Visual examination
2. Verification of Dimensions
3. Galvanizing Test
4. Breaking Strength & Elongation Test

9 TEST METHODS

9.1 Visual Examination

Barbed wire shall be visually examined for defects given below in Table-2.

TABLE-2 VISUAL EXAMINATION

Examination	Defects
1. Material	Not as specified
2. Construction	Strands not uniformly twisted, Barbs not sharp, not tightly wrapped and uniformly spaced as per clause 4.
3. Finish	Galvanizing not proper

9.2 Verification of Dimensions

The diameter of individual wires shall be measured at four different points on each reel. The measurements shall be within the specified values with the permissible variations given in clause 3.

9.3 Galvanizing Test

The galvanizing test shall be carried out on individual strand wires in accordance with Wapda Specification P-82 "Zinc Coating".

9.4 Breaking Strength & Elongation Test

The breaking strength & elongation of individual strand wires shall be tested using suitable Tensile Testing Machine.

10 PACKING AND MARKING

10.1 The barbed wire shall be supplied, on wooden reels. The reels shall be made from high quality wood and shall be of sound construction, as such shall be able to withstand the usual rigours of transportation and handling in the field.

10.2 There shall be only one length of barbed wire on each reel.

10.3 The manufacturer shall provide the following markings on the outer side of flanges in a legible and indelible manner.

1. Wapda Specification Number
2. Manufacturer's Name or Trade Mark
3. Serial Number of the Reel
4. Address of the Consignee

10.4 The manufacturer shall stamp the following information on metallic plates which shall be nailed to both sides of the reel.

1. Size of barbed wire
2. Net weight and gross weight in Kg.
3. Serial number of the reel.

10.5 Both sides of the reel shall have an arrow marking indicating the direction of rolling.

Encls: Fig. 1.

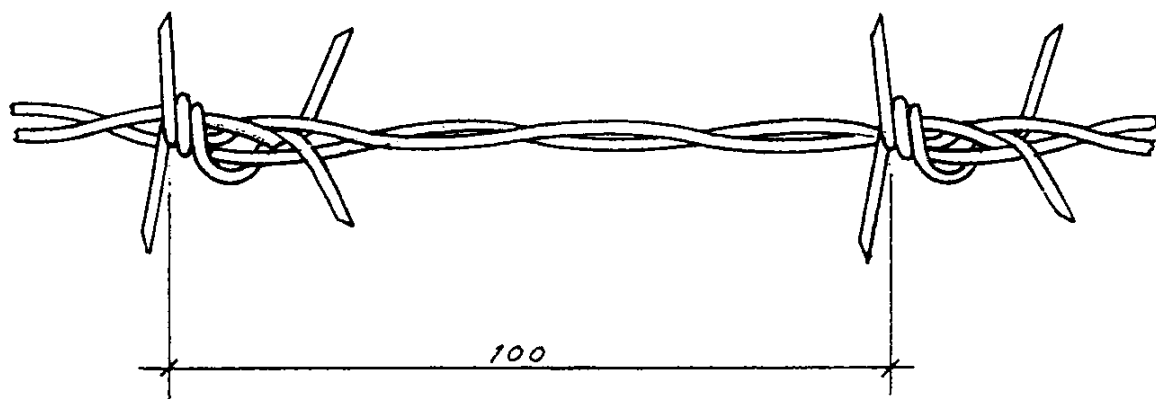
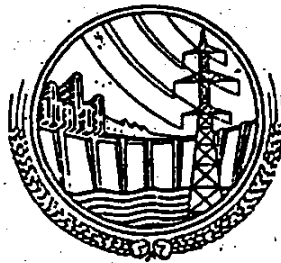


FIG. 1

DANGER AND SIGN PLATES



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

SPECIFICATION P-104: 76

DANGER AND SIGN PLATES

AMENDMENT NO. 1 DATED 12TH DECEMBER, 1981

1. Clause 4.2: a) Delete the following words in 2nd and 3rd line:

" galvanising and thermal shock".

-
- b) Add clause 4.3 after clause 4.2 as under:

"Clause 4.3 Three random samples of danger, number and phase plates selected from a lot of 1000 units shall be subjected to resistance to thermal shock test. Similarly three random samples of fixtures shall be subjected to galvanising test. If two or more than two units fail to meet the requirements, the entire lot shall be rejected. If one unit fails another group of three samples shall be selected at random from the same lot and above tests repeated. If any sample from the second group fails, the entire lot shall be rejected".

C O N T E N T S

0. *Foreword*
1. *Scope*
2. *Construction Requirements & Design*
3. *Tests*
4. *Sampling, Acceptance & Rejection*
5. *Test Methods*
6. *Marking and Packing*

PRINTING HISTORY

First approved on 24th April, 1976

First amendment on 12th Dec. 1981

DANGER AND SIGN PLATES

0 FOREWORD

0.1 This specification has been prepared by the Standards and Research Directorate of the Design Department (Power) WAPDA, Lahore.

0.2 This specification is intended only for the purpose of procurement of material and does not include the provision of the contract.

0.3 A specification on danger plate was issued in July, 1965 in the form of SDI-33. Then in January, 1972 a product description "PD-127" was issued on this subject.

Now a self-contained detailed specification is being issued under the Wapda Specification series which supercedes the above two publications namely SDI-33 & PD-127.

1 SCOPE

1.1 This specification covers vitreous enamelled danger and sign plates for use on distribution and transmission lines. It also covers the fixture for 11 KV and 33 KV danger plates.

2 CONSTRUCTION REQUIREMENTS AND DESIGN

2.1 Material

2.1.1 The danger and sign plates shall be made of high grade sheet steel of thickness 1.5 mm.

2.1.2 The fixture for danger plate for 11 and 33 KV shall be manufactured from mild steel.

2.2 Vitreous Enamelling

2.2.1 The danger and sign plates shall be enamelled on both sides and they shall be thoroughly cleaned before enamelling.

2.2.2 The enamel shall be of even thickness, reasonably free from cracks, patches, pin holes, blisters and shall have a uniform gloss.

2.2.3 Number of Coats of Vitreous Enamel Three coats of vitreous enamel shall be applied on the danger and number plates. The first coating of black enamel shall be applied on both sides of the plates. The other two coats of white vitreous enamel shall be applied on the front side of the plates only.

In case of phase plates, three coats of vitreous enamel shall be applied. The first coat of the black enamel shall be applied on both sides. The other two coats of red, yellow and blue colour shall be applied as specified

on both sides of the plate.

- 2.2.4 Lettering The lettering both of English and Urdu on the danger plates shall be red enamelled and the sizes of the lettering shall be as given in drawing No.PDW/DF-205. The danger symbol shall also be enamelled in red colour and its size shall be as marked on the drawing.

The height of lettering for "Number Plate" shall be 75 mm and the width shall be 25 mm. The letters shall be spaced at 6 mm from each other.

2.3 Danger Plate

- 2.3.1 The danger plate shall be vitreous enamelled and made of high grade sheet steel of 1.5 mm thickness.

- 2.3.2 The size of the plate shall be 260 x 200 x 1.5 mm and shall be manufactured in accordance with the drawing No. PDW/DF-205. The holes shall be provided as shown in the drawing.

- 2.3.3 The danger plates shall be marked with the voltage value i.e. 11000, 33000, 66000, 132000, 220000 and 500000. This marking should appear at the place shown in the drawing.

2.4 Number Plate

- 2.4.1 The number plate shall be of 200 x 150 x 1.5 mm size and shall be made in accordance with the drawing No.PDW/DF-207. Two nos holes shall be provided as shown in the drawing.

- 2.4.2 The code of the line and the tower number shall be red enamelled and shall be provided as specified. The code and tower number shown on the drawing are only for reference.

- 2.4.3 The assembly of the number and danger plate to be fixed on the tower has also been shown in drawing No.PDW/DF-207 for reference.

2.5 Phase Plate

- 2.5.1 The phase plate shall be of 115mm diameter with a hole of 12mm diameter as shown in the drawing PDW/DF-207. These plates shall be red, blue and yellow enamelled as specified.

2.6 Fixture for Danger Plates

- 2.6.1 The danger plate fixture is to be supplied only with 11KV & 33 KV danger plates and shall be manufactured in accordance with the dimensions given in drawing No. PDW/DF-206.

- 2.6.2 The fixture shall be hot dip galvanised in accordance with WAPDA Specification P-82. The average and minimum weight of coating shall be 610 and 550 gm/sq meter respectively. This corresponds to a thickness of 0.086mm and 0.077 mm respectively. The holes shall be drilled before galvanising.
- 2.6.3 The finish of the fixture shall conform to best commercial practice. The galvanising shall be completely free from lumps, blisters, uncoated or porous spots, black spots, dross, flux or other imperfection.
- 2.6.4 Four Nos bolts and nuts shall be supplied with each fixture as shown in the drawing in accordance with WAPDA Specification P-19 and plain steel washers shall be supplied in accordance with WAPDA Specification P-20.
- 2.6.5 Bolts, nuts and washers to be supplied with the fixture shall be electro-galvanised in accordance with WAPDA Specification P-82. The minimum thickness of coating shall be as follows:-

Local thickness	0.025 mm
Average thickness	0.038 mm

3 TESTS

- 3.1 The following sample tests shall be carried out on the samples selected for testing as per clause 4.
- 1) Visual examination
 - 2) Verification of dimensions
 - 3) Galvanising test (on fixture only)
 - 4) Resistance to thermal shock (vitreous enamel finish)

4 SAMPLING, ACCEPTANCE AND REJECTION

- 4.1 Danger, number, phase plates and fixtures offered for acceptance shall be divided into lots containing upto 1000 units in each lot. A sample of 50 units shall be drawn at random from each lot.
- 4.2 The selected samples shall be subjected to the visual examination, verification of dimensions, galvanising and thermal shock tests. If the number of defective units is four, the lot shall be accepted. If the number of defective units is more than five the lot shall be rejected. If the number of defective units is five, another sample of 50 units shall be selected at random and subjected to tests. If the number of defective units is again five or more the lot shall be rejected and if the number of defective units is four or less the lot shall be accepted.

5 TEST METHODS

5.1 Visual Examination

The plates and fixtures shall be visually examined in the light of the following table:-

TABLE - 1 VISUAL EXAMINATION

<u>Examination</u>	<u>Defects</u>
Construction	Not of the shape given in drawings. Any crack on the nuts, bolts.
Material	Not of proper material.
Finish	Galvanising of bolts, nuts, washers and fixture not proper, presence of black spots, blisters, flux, dross, un-coated areas or any other defects. Bolts and nuts, rusty. Threads marred. The plates not properly enamelled, presence of cracks, patches, pin-holes, blisters or any other defect. Letters and numbers broken or not properly enamelled.
Marking	Missing or in-complete.

5.2 Verification of Dimensions

Dimensions of the danger, number, phase plates and fixtures shall conform to those given in drawing No. PDW/DF-205, 206 and 207 with allowable tolerances as marked on the individual drawing. Any variation from the specified dimensions shall constitute a defect.

5.3 Galvanising Test

The galvanising of the bolts, nuts, washers and fixtures shall be tested in accordance with WAPDA Specification P-82, "Zinc Coatings". The weight/thickness of coating shall conform to the values given in clause 2.6.2 & 2.6.5.

5.4 Resistance to Thermal Shock

This test shall be carried out by subjecting the test specimen to radiant heat so as to reach a steady temperature of 185 - 195°C in about ten minutes. The temperature shall be measured by means of a surface pyrometer in contact with the top surface of the heated part of the specimen.

Remove the radiant heat and within 5 seconds quench the surface with 1000 ml of water at 15-20°C direct from an aspirator or other container through a 5 mm diameter tube, the end of the tube being 150 mm above the centre of the

heated portion of the test specimen. The flow rate of water shall be adjusted to 10 ml. per second. It is convenient to mark the test area to ensure that the water is correctly applied. Dry the plate, replace in the same position under radiant heat source and repeat this procedure until six cycles have been completed.

Assessment of Results. After subjecting the test specimen to the above test, the vitreous enamel surface shall be considered to be resistant to thermal shock provided that the enamel shows no signs of flaking-off or crazing.

6 MARKING AND PACKING

6.1 Danger plates & number plates for 66 KV lines and above

The danger plates and number plates shall be packed in strong wooden boxes containing 100 plates in each box. The packing shall be strong enough to withstand the rigours of transportation by rail or road.

6.2 Danger plates & fixtures for 11 & 33 KV plates

The danger plate/fixture shall be packed in strong wooden boxes with 100 plates/fixtures in each box. The packing shall be strong enough to withstand the rigours of transportation by rail or road.

6.3 Phase Plates

The phase plates shall be packed in strong wooden boxes. Each box shall contain 200 phase plates. The packing shall be strong enough to withstand the rigours of transportation by rail or road.

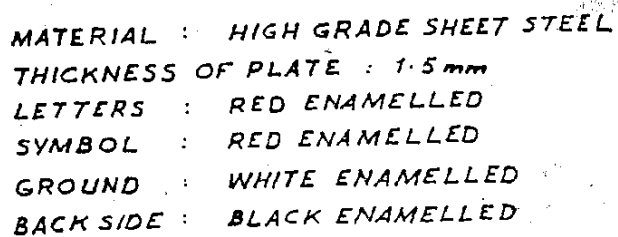
6.4 The packing box shall carry the following markings:

- (1) Wapda Specification number
- (2) Product Description with voltage rating in case of danger plates
- (3) Manufacturers' name or trade mark
- (4) Number of items in the box
- (5) Gross weight in kg
- (6) Address of consignee

6.5 Marking

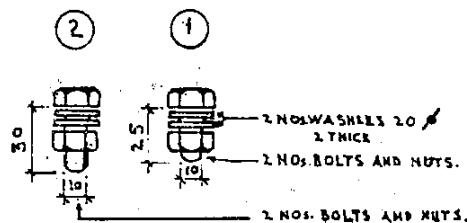
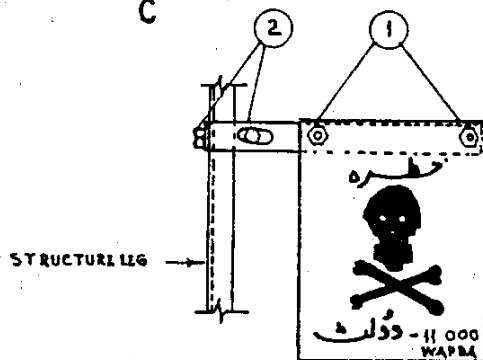
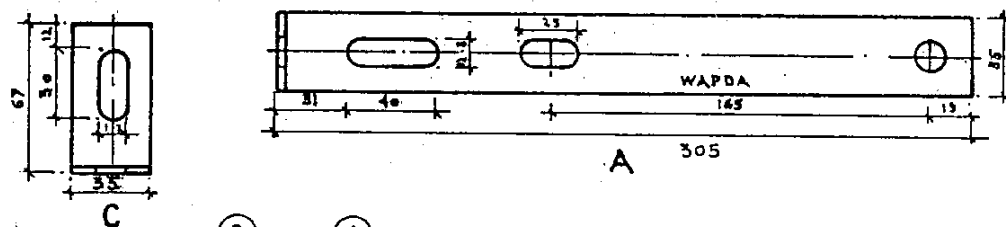
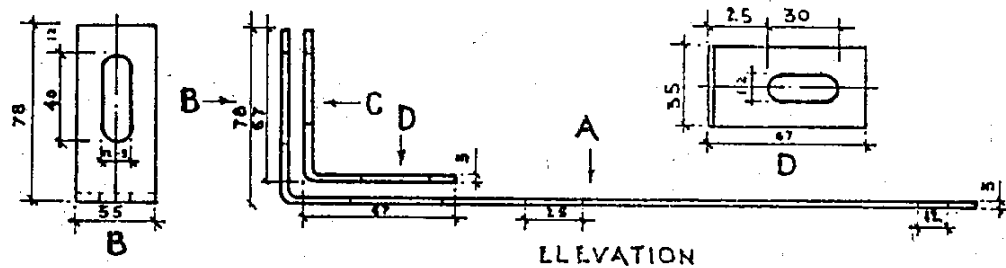
6.5.1 The plates shall be marked clearly and idelibly with the wording "WAPDA" in red enamel as shown on the individual drawing in case of danger and number plates. This marking shall be white enamelled in case of red, yellow and blue phase plates. The wording "WAPDA" shall be punched on the fixture. The size of lettering shall be 12 mm in each case.

Encls: Drawing No PDW/DF-205
PDW/DF-206
PDW/DF-207



ALL DIMENSIONS IN MILLIMETRES

PAKISTAN WATER AND POWER DEVELOPMENT AUTHORITY		DESIGN DEPARTMENT (POWER)
DANGER PLATE FOR DISTRIBUTION AND TRANSMISSION LINES		
DWN <i>[Signature]</i>	A.E	SCALE — DATE 19.4.76
TCD	<i>[Signature]</i> A.D	DWG. NO. PDW/DF-205
CKD	DIR	

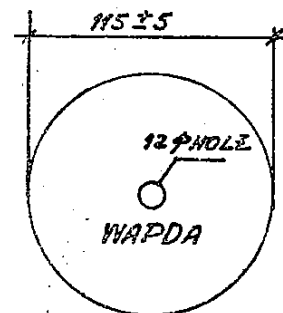
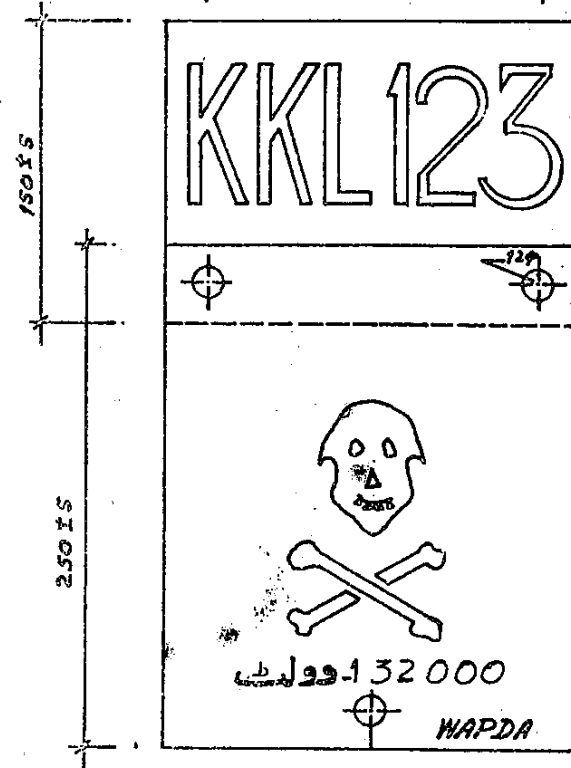
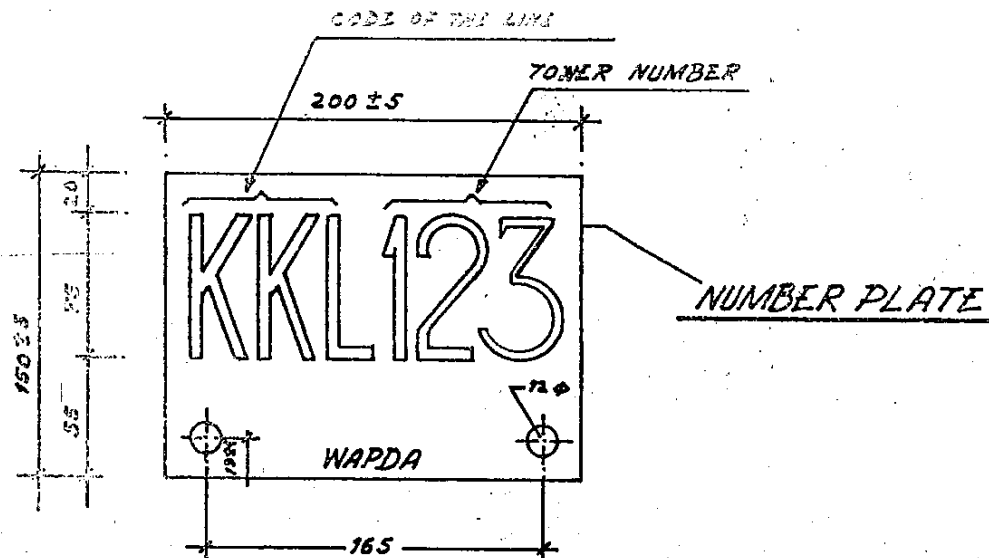


ASSEMBLY
FOR
11,000 & 33,000 VOLTS DANGER PLATE

ALLOWABLE TOLERANCE 5%
ON EACH DIMENSION

ALL DIMENSIONS IN MILLIMETRES

PAKISTAN WATER AND POWER DEVELOPMENT AUTHORITY		DESIGN DEPARTMENT POWER
FIXTURE & ASSEMBLY FOR 11KV AND 33KV DANGER PLATE		
OWN.	AL.	SCALE
TCR Astar	Sadique	DATE: 19.4.76
CKD.	DIR.	DWG NO. PDW/DF.206



PHASE PLATE
COLOUR, RED, YELLOW, & BLUE

ASSEMBLY OF NUMBER &
DANGER PLATE OF TRANSMISSION LINE.

ALL DIMENSIONS IN MILLIMETRES.

PAKISTAN WATER AND POWER DEVELOPMENT AUTHORITY		DESIGN DEPTT. POWER
<u>NUMBER PLATE & PHASE PLATE FOR TRANSMISSION LINES.</u>		
TCD. <i>Hussain</i>	A.E. SCALE:-	DATE:- 10-4-76
DWM	<i>Sadique Qureshi P.D.</i>	
CXD.	D.R.	DWG NO. PDW/DF-207