
SUPPORTING STEEL STRUCTURES
FOR GRID STATION EQUIPMENT



PAKISTAN
WATER AND POWER DEVELOPMENT AUTHORITY
DESIGN DEPARTMENT (IGG)

C O N T E N T S

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PRINTING HISTORY

First draft on March, 1986.

First revised approved edition Nov. 1991.

SPECIFICATION P-102/91
SUPPORTING STEEL STRUCTURES
FOR GRID STATION EQUIPMENT

0 FORWARD

0.1 This standard has been introduced by WAPDA and has been prepared by the Standard & Research Section of the office of the Chief Engineer Design (T&S).

0.2 This standard is intended only for the purpose of technical specification to facilitate fabrication of supporting steel structures for Grid Station Equipment and does not include provision of contract.

0.3 This standard is prepared to resolve difficulties experienced by the field staff in replacing gridstation switchyard equipment viz isolators, circuit breakers, CTs, PTs & L.As which is a problematic and time consuming job requiring preparation of new drawings accommodating the foundations within the limited available space and minimum of power supply interruptions. To overcome these problems, steel supporting structures have been standardised which will result in rapid on-site replacement of the equipment irrespective of its type or make, minimising interruptions to power supply and financial saving as well.

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

1 SCOPE

1.1 This specification covers fabrication, galvanizing, testing and packing of supporting steel structures for Grid Station equipment.

2 STEEL

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.

Element	Composition Percent	
	Mild Steel	High Tensile S
Carbon	0.26	0.30
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 2.2.2.3. 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 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 25mm	1
High Tensile Steel	Upto 25mm	2

3

NUTS AND BOLTS

All bolts and nuts shall be hexagonal type made from mild steel to WAPDA Specification P-19. These bolts shall be provided with one flat washer under each nut. All grouting bolts for fixing the structure to the foundation shall be from High Tensile Steel. 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 the following drawings:

- | | |
|--|--|
| 1. Supporting steel structure for circuit breaker | Dwg. No. PDW/TS-32117
OR
PDW/TS-3198 |
| 2. Supporting steel structure for Isolator
(Parallel Arrangement) | PDW/TS-3201
OR |
| (Serial Arrangement) | PDW/TS-32119
PDW/TS-3218 |
| 3. Supporting steel structure for Current & Voltage Transformers | PDW/TS-3204 |
| 4. Supporting steel structure for Lightning Arrester | PDW/TS-3203 |

The dimensions indicated on the above mentioned drawings are for guidance only. The manufacturer shall supply their own design drawings alongwith foundation drawings with his offer without affecting the interchangeability requirement of the foundation bolts as indicated in detail 'B' of the drawings.

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 cause for rejection.

4.2

In shearing and punching only sharp dies and punches shall be used, shearing and punching shall be done to gauge 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.

3. Bolt holes shall be 1.5 mm to 2 mm larger than the normal bolt diameter. Bolt holes shall be cylindrical and perpendicular to members, shall be cleaned 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.

For the high tensile steel (yield point equal or higher than 35 kg/cm²) holes shall be directly drilled at the definitive diameter or punched and reamed out; The difference between the punched and reamed diameter shall be not less than the minimum 4 mm.

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.

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.

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.

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.

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 punch thickness, with a maximum of 1.2 mm. For the thickness lower than 5 mm, maximum difference is fixed at 5 mm.

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 attachment holes. The enamel around the holes shall be protected by means of fibre washers.

7 TESTS

7.1 Manufacturer'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 Section 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 Section and Plates

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

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.

8.1 Chemical Composition

To indicate adequately, the chemical composition of a heat or 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.

8 ACCEPTANCE AND REJECTION

8.1 Chemical Composition

To indicate adequately, the chemical composition of a heat or 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
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If a test piece fails to meet the requirement the lot shall be rejected.

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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.

9.8 Impact Tests

The test shall be performed in accordance with ISO 630.

10 PACKING

10.1 All material shall be suitably packed to final destination. Heavy pieces may be packed separately or in bundles. With all pieces in the bundle having the same mark of the same structure. All bundles of angles shall be secured, 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

Footings 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 with relation to the centre of the structure.

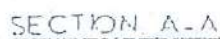
11.2.4 Bills of Material

Bills of material for each structure 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.

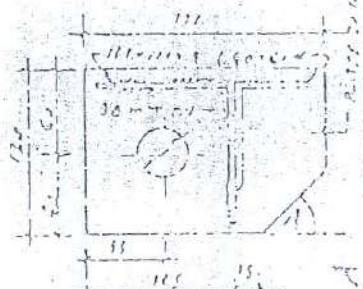
Note:

- i) The scope of supply includes the foundation bolts (Rag Bolts) for grouting the steel structures.
- ii) Suitable clamps shall be provided at appropriate places on the structures to hold the earth wires of the equipment at every 1000 mm.
- iii) the following drawings are enclosed herewith:

1. Dwg. No. PDW/TS-3205 (1st revised dated 14.9.91)
2. " " PDW/TS-3204 - do -
3. " " PDW/TS-3219 - do -
4. " " PDW/TS-3217 - do -
5. " " PDW/TS-3218 - do -
6. " " PDW/TS-3198 - do -
7. " " PDW/TS-3201 - do -



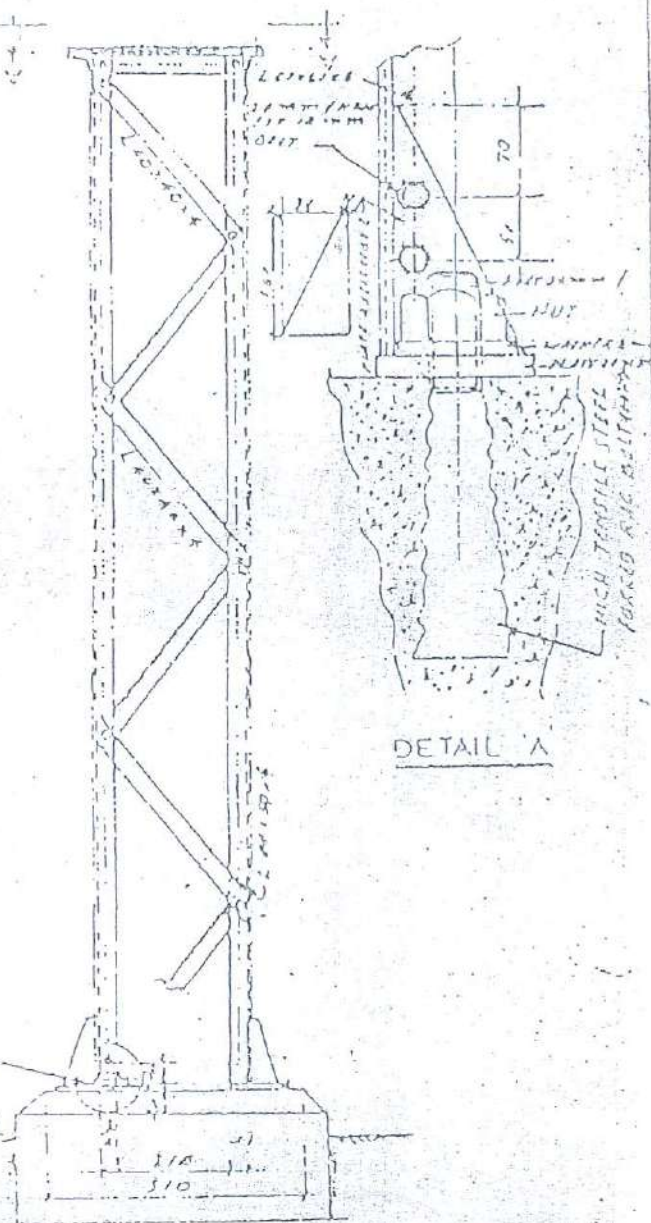
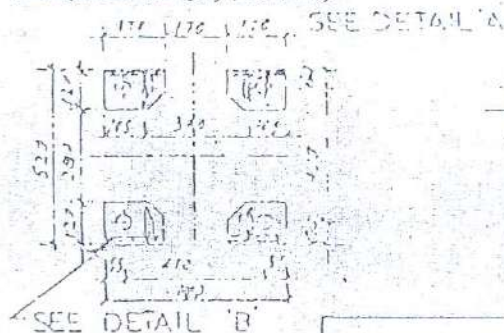
VOLTAGE	A
33 KV	2320
66 KV	3155
132 KV	4340



DETAIL 13

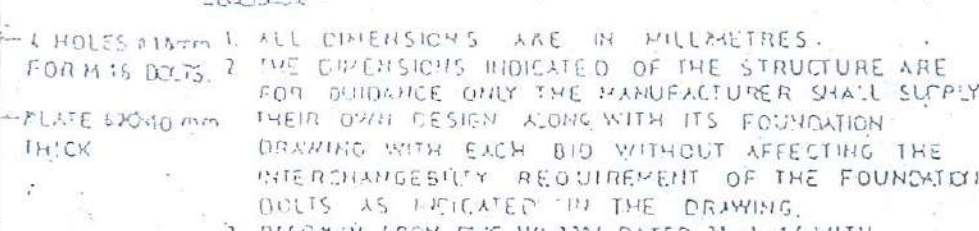
NOTES

1. THE DIMENSIONS ARE IN INCHES
1. THE DIMENSIONS INDICATED ON THE
STRUCTURE ARE THE GUIDANCE
AND THE MANUFACTURER MUST
TAKE OWN DESIGN ALONG WITH THE
FOUNDATION DRAWING OVER EACH
SIO WITHOUT AFFECTING THE
INTERCONNECTIVITY REQUIREMENTS OF
THE FOUNDATION BUILT AS INDICATED IN
THE DRAWING.
3. GENERAL FORM AND SIZE SHALL BE IN ACCORDANCE
WITH THE DESIGN DRAWING.



DETAIL 'A'

SEE DETAIL 'B'		PAKISTAN WATER AND POWER DEVELOPMENT AUTHORITY		DESIGN DEPARTMENT (IT & G) POWER	
		DRAWN	ARSHAD SIDDI	SUPPORTING STEEL STRUCTURE FOR LIGHTNING ARRESTER	
		CHECKED	M. A. QURESHI		
		ASSISTANT ENGINEER	MASAIL AKHMAN		
		DEPUTY DIRECTOR	M. SAUD		
11/19/91	REDRAWN AS PER NOTE 3	DIRECTOR	M. ISMAIL	SCALE: 1:1	DATE: 28-1-96
NO DATE	REVISIONS			DWG. NO. PDH/TS. 3205	



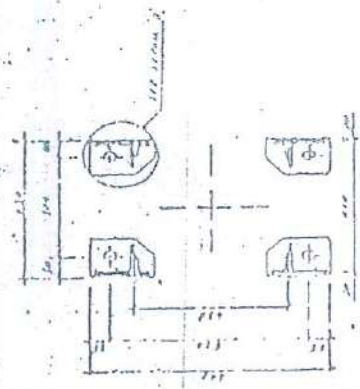
PAKISTAN		DESIGN
WATER AND POWER DEVELOPMENT AUTHORITY		DEPARTMENT (TUG) POWER
DRY	ARSHAD SAEED	SUPPORTING STEEL STRUCTURE FOR 132 & 66 K.V CURRENT & POTENTIAL TRANSFER
CHECKED	M A GHAFSHI	
ASSISTANT DIRECTOR	HASAN AHMAD	
DEPUTY DIRECTOR	M DAUD	
DIRECTOR	M ISMAIL	SCALE AS SHOWN
		DATE 28-1-85
		DWG NO. PDW/TS. 3204

SUPPORTING STEEL
STRUCTURE FOR 132 & 66 K.V
CURRENT & POTENTIAL
TRANSFOR

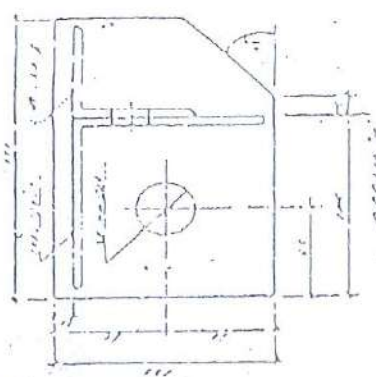
SCALE AS SHOWN	DATE 28-1-85
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DWG NO. PDH/TS. 3204

1	4.5.91	REDRAWN AS PER NOTE 3
NO	DATE	REVISIONS



SECTION 1-1

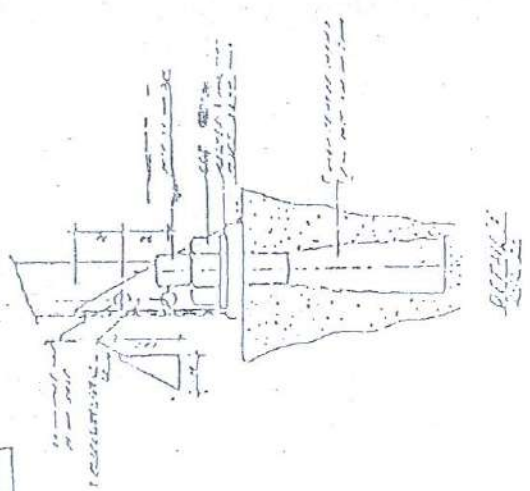


SECTION 2-2

NOTES

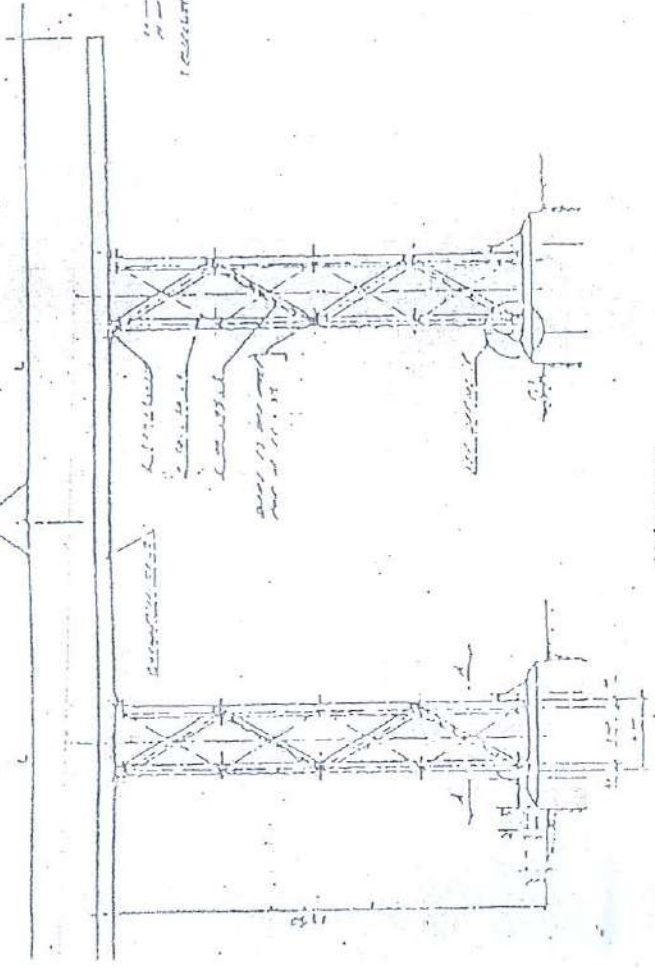
1. ALL DIMENSIONS ARE IN FEET AND INCHES.
 2. THE STRUCTURE IS TO BE CONSTRUCTED OF STEEL.
 3. THE STRUCTURE IS TO BE CONSTRUCTED OF STEEL.
 4. THE STRUCTURE IS TO BE CONSTRUCTED OF STEEL.
 5. THE STRUCTURE IS TO BE CONSTRUCTED OF STEEL.
 6. THE STRUCTURE IS TO BE CONSTRUCTED OF STEEL.
 7. THE STRUCTURE IS TO BE CONSTRUCTED OF STEEL.
 8. THE STRUCTURE IS TO BE CONSTRUCTED OF STEEL.
 9. THE STRUCTURE IS TO BE CONSTRUCTED OF STEEL.
 10. THE STRUCTURE IS TO BE CONSTRUCTED OF STEEL.

PARTS LIST		QUANTITY	REMARKS
STEEL	11' 0"	1	SUPPORTING STEEL
STEEL	11' 0"	1	STRUCTURE FOR DRAIN
STEEL	11' 0"	1	AND GUY. ISOLATOR
STEEL	11' 0"	1	ALTERNATIVE

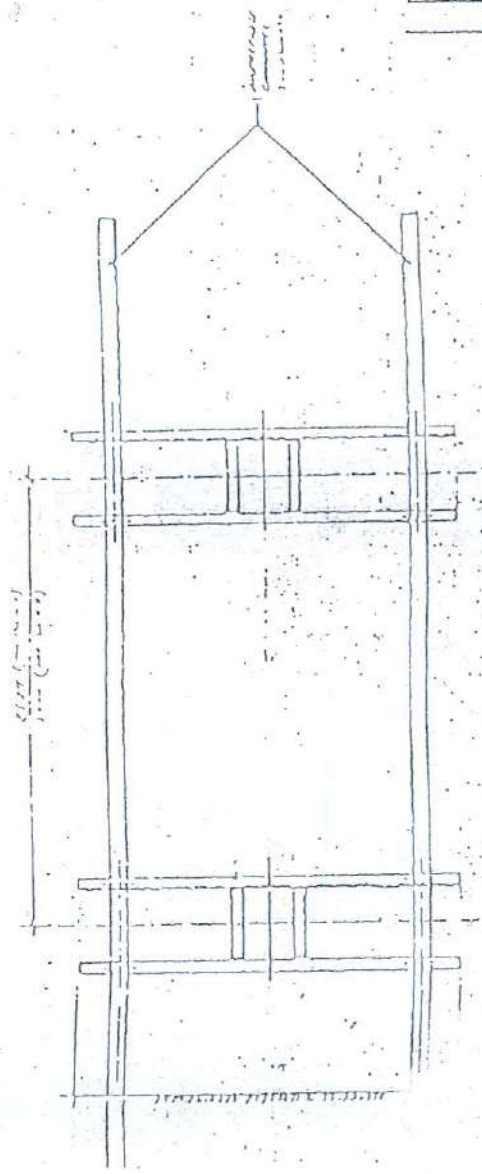


SECTION 3-3

STEEL STRUCTURE FOR DRAIN



SECTION 4-4



SECTION 5-5

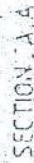
1. The first step is to identify the problem. This involves understanding the situation and the goals that need to be achieved.

2. Next, you should gather information. This includes identifying the resources available and the constraints that may be present.

3. Once you have gathered the information, you should develop a plan. This involves determining the steps that need to be taken to achieve the goals.

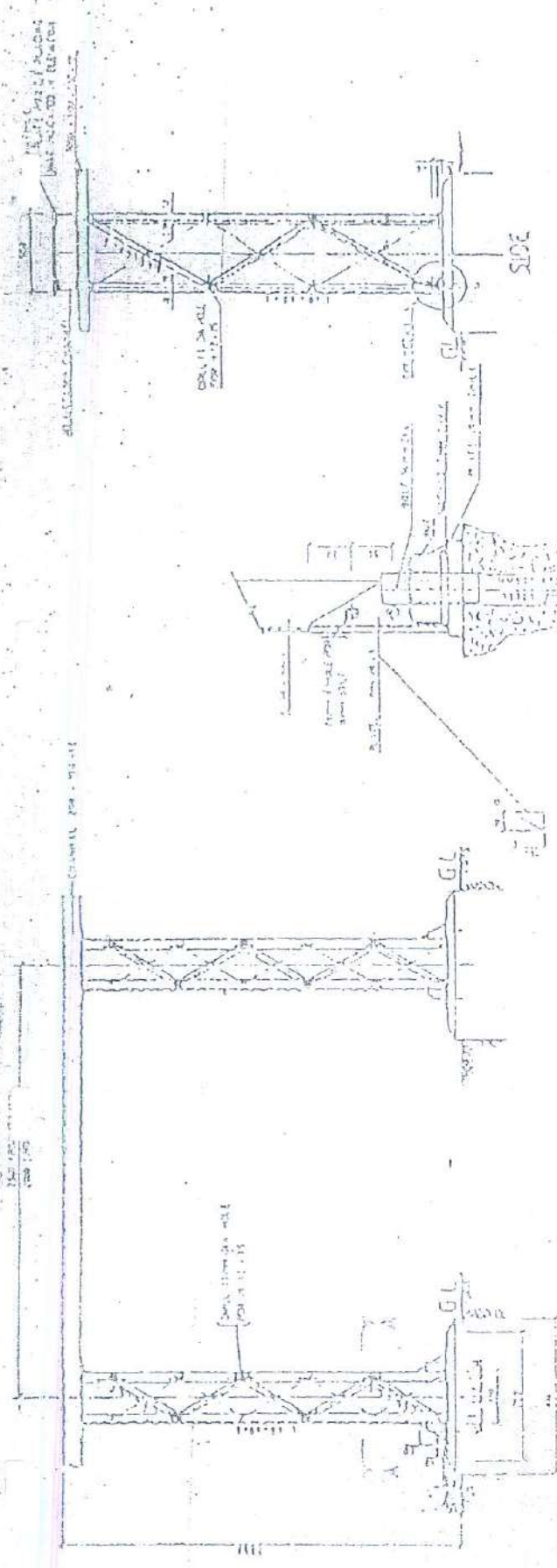
4. The next step is to implement the plan. This involves putting the plan into action and monitoring progress.

5. Finally, you should evaluate the results. This involves assessing the outcomes of the plan and determining whether the goals have been achieved.

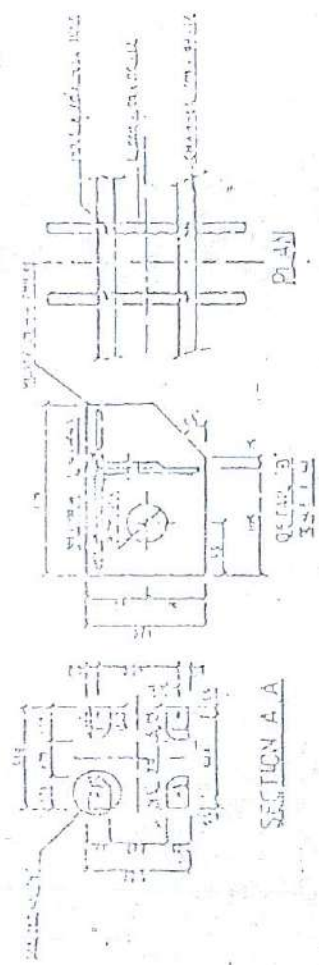


DATE	REVISIONS	BY	APPROVED AS PER AISC 341	DESIGNED BY	SCALE	DATE	DWG No.
11/1/88					1/4" = 1'-0"	11/1/88	PDW/TS-32T

WATER AND POWER DEVELOPMENT AUTHORITY				DISCA DISTRICT TECHNICAL			
DRAWN				CHECKED			
DATE				DATE			
PROJECT NO.				PROJECT NO.			
SHEET NO.				SHEET NO.			
SHEET TOTAL				SHEET TOTAL			
PROJECT NAME				PROJECT NAME			
SUPPORTING STEEL				SUPPORTING STEEL			
STRUCTURE FOR 137 / 66				STRUCTURE FOR 137 / 66			
KV CIRCUIT BREAKER				KV CIRCUIT BREAKER			
PREFERRED PROPOSAL				PREFERRED PROPOSAL			



ELEVATION

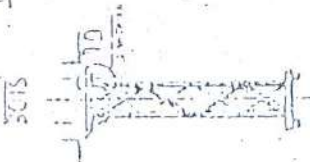
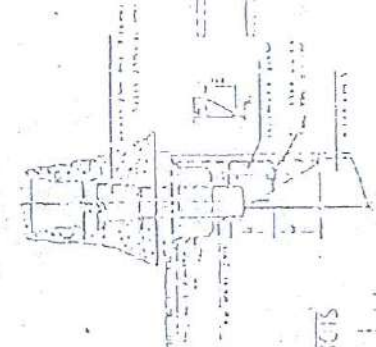
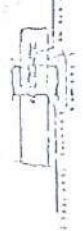
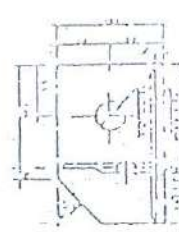
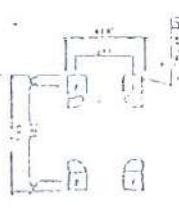
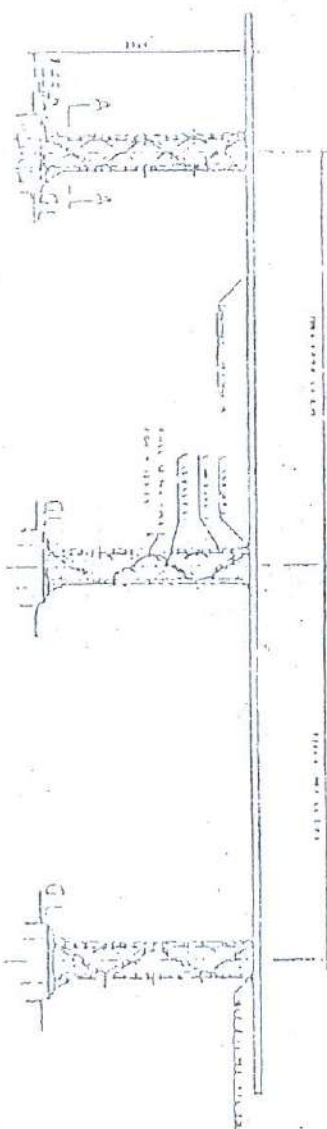


SECTION A-A

NOTES

1. The structure is to be constructed in accordance with the specifications of the Ministry of Water and Power, Government of Pakistan.
2. The structure is to be constructed in accordance with the specifications of the Ministry of Water and Power, Government of Pakistan.
3. The structure is to be constructed in accordance with the specifications of the Ministry of Water and Power, Government of Pakistan.
4. The structure is to be constructed in accordance with the specifications of the Ministry of Water and Power, Government of Pakistan.
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8. The structure is to be constructed in accordance with the specifications of the Ministry of Water and Power, Government of Pakistan.
9. The structure is to be constructed in accordance with the specifications of the Ministry of Water and Power, Government of Pakistan.
10. The structure is to be constructed in accordance with the specifications of the Ministry of Water and Power, Government of Pakistan.

DESIGN		REVISIONS	
DATE	10/10/2010	NO.	1
BY	10/10/2010	NO.	1
CHECKED	10/10/2010	NO.	1
APPROVED	10/10/2010	NO.	1
SUPPORTING STEEL STRUCTURE FOR 132 KV CIRCUIT BREAKER			
ALTERNATIVE PROPOSAL			
DWG. NO. 1150			



NOTES:

1. All dimensions are in feet and inches.
2. The steel structure is to be constructed in accordance with the specifications for steel structures and the provisions of the American Institute of Steel Construction, Inc. (AISC) Manual of Steel Construction, 9th Edition, 1989.
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PARTIAL		DETAIL	
DATE	10/10/89	BY	10/10/89
DESIGNED BY	10/10/89	CHECKED BY	10/10/89
APPROVED BY	10/10/89	APPROVED BY	10/10/89
SUPPORTING STEEL		132 & 65 KV ISOLATOR	
SERIAL ARRANGEMENT			

