

ENGINEERING STANDARD
FOR
OVERHEAD TRANSMISSION
AND
DISTRIBUTION LINES

CONTENTS :

PAGE No.

0. INTRODUCTION	3
1. SCOPE	4
2. GENERAL	4
3. STANDARDS	4
4. PLANNING OF OVERHEAD LINES.....	5
4.1 Laying Down the Route of Line & Fixing Positions of Supports.....	5
4.2 Selection of Insulators and Fittings.....	5
4.3 Selection of Towers	5
4.4 Tower Identification, Danger Warning Notices and Phase Markings.....	5
5. TENSION AND SAG.....	5
6. SELECTION OF CONDUCTORS.....	6
7. JOINTS	8
8. GENERAL CLEARANCES	8
9. ACCESSORIES	8
9.1 Surge Arresters (General)	8
9.2 Section Switches	8
9.3 Vibration Dampers	9
9.4 Tower Identification, Danger Warning Notices and Phase Marking.....	9
9.5 Selection of Conductors.....	9
9.5.1 Material and make up of conductors.....	9
9.5.2 Steel cored aluminum conductors (ACSR).....	9
9.6 Factor of Safety	9
9.7 Anti Climbing Devices and Steps.....	9
9.8 Indicating Balls.....	10
9.9 Stay's Insulators	10
9.10 Pole Setting	10
9.11 Guys	10
9.12 Earthing Associated With Overhead Lines.....	10
10. LOW VOLTAGE DISTRIBUTION OVERHEAD LINES.....	10
10.1 Steel Poles	10
10.2 Insulators	11
11. 11 kV AND 20 kV OVERHEAD LINES.....	11

12. 33 kV AND 66 kV OVERHEAD LINES.....	11
12.1 Tower Supports.....	11
12.2 Insulators and Fittings.....	11
13. ENVIRONMENTAL CONDITIONS.....	11
14. SELECTION OF ROUTE OF TRANSMISSION LINE.....	12
15. TRANSMISSION LINE DESIGN DATA SUMMARY.....	12
16. SURVEY	16
17. RULES FOR PREPARATION OF PLAN AND PROFILE.....	17
18. RELEVANT USEFUL LITERATURE.....	18

APPENDICES:

APPENDIX A RIGHT OF WAY (R.O.W) FROM PIPELINES.....	20
APPENDIX B RIGHT OF WAY (R.O.W) FROM ROADS	22

0. INTRODUCTION

Because of the high capital investment in distribution system they must be designed and constructed for maximum reliability in conjunction with reasonable economy.

When planning a network the most satisfactory arrangement from the technical and economic point of view is determined by calculation or modeling, based on the anticipated operating conditions.

Factors to be considered include the following:

- No part of the installation shall be unduly stressed in service either at peak or low load.
- All consumers must be supplied with energy at an adequate voltage.
- Fault should not disturb the operation of network. The number of consumers affected should be limited and any interruption of supply should be of short duration.
- The relative economic, importance of the cost of losses, cost of equipment and expenditure on ensuring reliability of supply must be considered.
- The network should be suitable for the loading conditions at the time and also capable of easy extension to meet growth of load in future.

1. SCOPE

This Specification covers the requirements for power transmission and distribution lines at medium and low voltages.

2. GENERAL

The design of transmission line has to be satisfactory from electrical as well as mechanical considerations. The line should have sufficient current carrying capacity so that the required power transfer can take place without excessive voltage drop or over heating.

As far as mechanical aspects are concerned the line conductors supports and cross arms should have sufficient mechanical strength to cope with the worst probable weather conditions.

The line conductor supports and cross arms must be strong enough to give satisfactory service over a long period of time without necessity of too much maintenance. The tension in the conductor shall be well below the breaking load and a reasonable factor of safety should be used. To achieve this an appreciable amount of sag has to be allowed and adequate clearance between the lowest line and ground must be maintained.

3. STANDARDS

The latest revision of the following standards to be considered in design of overhead lines:

IEC 207	"Aluminum Alloy Stranded Conductor"
IEC 208	"Aluminum Conductor Steel Reinforced"
BS 137	"Insulators of Ceramic Materials or Glass for Overhead Lines with a Nominal Voltage Greater Than 1000 Volt"
BS 7430	"Code of Practice for Earthing"
BS 8100	"Lattice Towers and Masts"
ANSI A 14.1	"Safety Code for Portable Wood Ladders"
ANSI B 15.1	"Safety Code for Mechanical Power Apparatus"
ANSI 53-1	"Safety Color Code for Marking Hazard and Identification of Certain Equipment"
ANSI C 135.1	"Bolt Insulators"
ANSI C 135.2	"Anchor Rods and Nuts"
ANSI C 135.4 135/38	"Bolts and Nuts"
ANSI C 135.5	"Eyenuts and Eyelets"
ANSI C 135.6	"Cross Arm Braces"
ANSI C 135.14	"Staples"
ANSI C 135.17	"Insulator Pins"
ANSI C 135.30	"Ground Rods"
ANSI C 135.42	"U. Guards"
ANSI C 136 .20	"Fiber Reinforced Plastic Poles"
ANSI/IEEC C 3763	"Electrical Line Sectionalizer"

4. PLANNING OF OVERHEAD LINES

The engineering and construction of an overhead line requires accurate planning which include the following:

4.1 Laying Down the Route of Line and Fixing Positions of Supports

The route selected is determined mainly by natural obstacles which restrict the choice of positions for supports. In many cases account must also be taken of mutual inductive effects from traction, telecommunication and power lines, running on parallel routes.

Supports positions shall be fixed with the aid of longitudinal and transverse profile of the line to be erected, bearing in mind relevant regulations, the most suitable kinds of support, and advantageous utilization of natural features of the landscape.

4.2 Selection of Insulators and Fittings

Suspension and tension insulator units shall be of the cap and pin type with ball and socket fittings.

Interlocking of ball and socket shall be such as to prevent the possibility of such parts becoming separated accidentally either during or after erection they shall be of phosphor bronze or other tough materials.

Insulators shall be toughened glass, and shall be unaffected by atmospheric conditions due to weather, fumes, acid, alkalis, dust or changes of temperature, they shall consist of sufficient number of units to ensure satisfactory operation under all climatic conditions and possible dust deposits.

All clamps shall be designed so as to avoid any possibility of deforming the Standard conductors and where applicable, the clamps shall be lined with soft pure aluminum liner to prevent damage to conductors. The factor of safety of insulator and fittings when supporting the maximum working load shall not be less than 2.5.

4.3 Selection of Towers

The towers shall be of standard design. The compression and tension members consisting of rolled steel sections or flat, they shall be suitable for the angles of deviation and for the breakage of conductors. The tower shall be designed so that the tower height when required, may be increased by standard extensions. All tower members shall be galvanized.

4.4 Tower Identification, Danger Warning Notices and Phase Markings

Conspicuous danger and tower number plates of anticorrosive materials shall be fixed to all towers of 11000 Volt and above. The number plates shall be inscribed in persian script and English numerals. Tower footings at a height of about 2 meters shall be painted red, yellow and blue respectively, to indicate the line conductor phases on each circuit.

5. TENSION AND SAG

The stringing of conductors on an overhead system presents other problems than those created by their dead weight and the effect of wind and ice on them.

If they are stretched too tightly between poles, the stresses imposed on the pole structure (including pin, insulators, cross arms, racks and hardware) would be such as to render them impractical. The stresses on conductor themselves increase rapidly as remaining sag is eliminated, causing them to exceed their elastic limits by any small movement of the pole on conductors; the result would be greater permanent elongation, a reduction in overall cross section of the conductor and a greater possibility of conductor failure, on other hand if they are stretched too loosely. The swaying or deflection of the conductors would necessitate exceedingly wide spacing in both the horizontal and vertical planes with the support sys-

tem approaching impracticability. The final construction should, therefore, provide sufficient sag, so that elastic limit of the conductors will not be exceeded by a sufficient margin while maintaining clearances that may be required under the probable conditions.

The tension in a conductor may be controlled by maintaining a proper sag in it, the tension being approximately inversely proportional to the sag. The sag in a conductor must be determined not only by the loading condition i.e. light medium or heavy, but also by probable temperature variation, local physical conditions and restriction of codes and regulations must also be taken into consideration.

It is strongly recommended to obtain data sheet such as span, sag, and temperature including template from Vendor for special conductor under consideration for overhead line.

6. SELECTION OF CONDUCTORS

Conductors shall be selected from:

Table 1 For data.

Table 2 For physical characteristic.

TABLE 1 - FOR DATA TRANSMISSION LINES

NAME OF CONDUCTOR	VOLTAGE IN kV.	NUMBER OF CIRCUITS	NUMBER OF CONDUCTOR PER CIRCUIT	MAX. PERMISSIBLE CURRENT IN EACH PHASE	MAX. PERMISSIBLE REAL POWER	KILOMETER MEGAWATT*	
				AMPS	MEGA WATT	5% VOLT-DROP	10% VOLT-DROP
Fox	20	1	1	192	5.98	5 × 6	4.4 × 4.4
Mink	20	1	1	298	8.98	7.5 × 7.5	5.5 × 5.5
Dog	20	1	1	417	13	9 × 9	6.5 × 6.5
Partridge	20	1	1	460	14.34	10 × 10	7 × 7
Partridge	63	1	1	460	45.17	29 × 29	21 × 21
Lynx	63	1	1	549	53.9	32 × 32	23 × 23
Oriole	63	1	1	530	52	31 × 31	23 × 23
Hawk	63	1	1	670	65.8	34 × 34	25 × 25
Drake	132	1	1	900	185.2	74 × 74	55 × 55

* Note:

Kilometer mega watts which is shown as a product of two equal integers is only for ease of usage, and the product should be considered.

TABLE 2 - PHYSICAL CHARACTERISTICS OF ALUMINUM CONDUCTOR
STEEL REINFORCED (ACSR)

NAME OF CONDUCTOR	LOCAL REINFORCING NUMBER mm		EXTERNAL DIA. mm	CROSS SECTION AREA							TENSILE BREAKING FORCE kg	RESISTANCE Ω/km					IMPEDANCE IN Ω/km	NOMINAL CURRENT AMP	MODULUS OF ELASTICITY kg/mm^2	COEFFICIENT OF LINEAR EXPANSION $\times 10^{-6}/^{\circ}C$
	ALUMINUM STEEL			ALUMINUM		STEEL		WY (CM) kg/cm	TENSILE BREAKING FORCE kg	dc		ac								
mm ²	mm ²	mm ²	mm ²	mm ²	mm ²	mm ²	mm ²	30°C	50°C	50°C										

Fox	6 x 2.97	1 x 2.97	8.37	36.72	72.4	42.7	84.3	149	1346	0.7827	0.8273	0.7828	0.8774	0.2835	192	8100	19.1
Nink	6 x 3.66	1 x 3.66	10.98	6.38	124.5	36.7	145.3	255	2223	0.4531	0.509	0.4521	0.50916	0.2664	368	8100	19.1
Dog	6 x 4.72	7 x 1.57	14.15	105	207.3	118.5	233.9	394	3335	0.2733	0.3063	0.2736	0.3066	0.2506	417	7700	19.8
Partridge	26 x 1.57	7 x 2	16.30	135.2	266.8	156.4	309.6	516	5107	0.2133	0.2392	0.2137	0.2392	0.2405	460	7700	18.9
Lyons	30 x 2.79	7 x 2.79	19.53	183.4	361.9	226.2	446.4	842	8137	0.1576	0.1766	0.1581	0.1773	0.2277	549	8300	17.8
Orville	30 x 2.69	7 x 2.69	18.82	170.5	336.4	210.3	415	783	7736	0.1696	0.1901	0.1701	0.1901	0.2305	530	8200	17.8
Ugash	26 x 1.44	7 x 1.68	21.80	241.7	477	281	554.6	977	8812	0.1197	0.1342	0.1204	0.1342	0.2224	630	7700	18.9
Drake	26 x 1.44	7 x 1.45	28.14	403	795	468.6	924.8	1638	14165	0.0714	0.08	0.0725	0.08	0.2063	940	7700	18.9
Canary	54 x 1.28	7 x 1.28	29.52	456	960	515.1	1016.6	1714	14664	0.0635	0.0712	0.0648	0.073	0.2038	930	7000	19.3
Cardinal	54 x 1.38	7 x 1.28	30.38	463.4	952	546	1077.5	1828	18527	0.0598	0.067	0.0611	0.0695	0.2020	1010	7000	19.3
Cardew	54 x 1.515	7 x 1.515	31.65	523.3	1033.5	591.2	1106.7	1980	16843	0.0551	0.0618	0.0566	0.0637	0.1995	1060	7000	19.3
Merlin	54 x 1.018	19 x 2.41	36.7	682.6	1351	771.6	1522.8	2584	21610	0.0472	0.0473	0.0441	0.492	0.1908	1250	6800	19.4

7. JOINTS

Joints in sections shall be kept to an absolute minimum, no joint shall be closer than 3 meters to a point of support however for 33 and 66 kV overhead lines, no tension joints shall be used unless specially approved.

8. GENERAL CLEARANCES

The minimum height above the ground for the line conductors at condition of maximum temperature shall be as follows:

a) Upto and Including 11 kV Systems

At points where the lines cross roads or railways the minimum height shall be 6 meters in other locations i.e. parallel to roads the minimum height shall be 5.5 m.

Where lines cross totally desert regions where no traffic is possible the minimum height may be reduced to 5.5 m.

b) 20 kV 33 and 66 kV

In all location the minimum height above the ground shall be 6 m.

For more information see:

9. ACCESSORIES

9.1 Surge Arresters (General)

Lightning or surge arresters serve to bleed a high voltage surge to ground before it reaches the line or equipment which they are to protect. They do this by presenting a lower impedance path to ground than that presented by the line or equipment. The voltage surge breaks down the insulation of the arrester momentarily allowing the surge to go to ground and dissipate itself; the insulation of arrester then recovers its properties, preventing further current from flowing to ground and returning the arrester to a state ready for another operation.

9.1.1 Installation

Surge arresters shall be installed as close as possible to the equipment or line to be protected so that the resistance of connection to ground may be held to a minimum. If possible the arrester should have its own ground in addition to connection to other grounds. Since the arrester is to protect the insulation of the line or equipment associated with its insulation should be coordinated with that of the line or equipment.

9.1.2 Rating

Standard arresters are rated not only on the nominal voltage class of the line to which they are to be connected but also to the crest voltage (the basic impulse insulation voltage they can withstand).

9.2 Section Switches

Consideration shall be given to the provision of off load section switches on lines where there are a number of tee-off points in order to maintain at least part of the supply in the event of a fault.

Section switches shall also be considered for inclusion on long lines as a means of assisting in fault location.

Alternatively "Gang" type outdoor switch fuses may be considered.

9.3 Vibration Dampers

Vibration dampers shall be provided and designed on power lines over 132 kV; to absorb the vibration of conductors. The most common type being the stock-bridge which has no application in oil industry.

9.4 Tower Identification, Danger Warning Notices and Phase Marking

Conspicuous danger and tower number plates of anticorrosive material shall be fixed to all towers of 11000 Volt and above. The number plates shall be inscribed in Persian Script and English numerals on tower footing at a height of about 2 meters shall be painted red, yellow and blue respectively to indicate the line conductor phases on each circuit.

9.5 Selection of Conductors

Because of the long distribution distances generally involved, the proportioning of an overhead line depends not on permissible thermal loading but on the permissible values for voltage drop and power loss.

In the lower voltage ranges and specially with small conductors the resistance represents a considerable components of the line impedance. With increasing system voltage the line impedance is determined mainly by the reactance, which depends on the ratio of the mean conductor spacing to the conductor diameter.

In the case of short lines with high power transferability it is necessary to check the thermal loading. Bare overhead-line conductors carrying load continuously should not reach a temperature exceeding 80°C as otherwise the strength of the wires will be impaired.

9.5.1 Material and make up of conductors

For conductors, copper and aluminum are used; alloys of these metals (bronze, aldrey) are also used to some extent.

Depending on their cross section, conductors are made as bare, solid wire upto 16 mm² or as bare strand (consisting of individual wires); an inner wire core is then surrounded by one to three layers of wires with the lay of alternative layers reversed. The outer are being clockwise.

9.5.2 Steel cored aluminum conductors (ACSR)

Steel cored aluminum conductors are being used to an increasing extent. They consist of one ore more layers of stranded aluminum wires surrounding by a steel core to increase the tensile strength. The ratio of cross sections "St: Al" for standardized conductors is 1: 7.7, 1:6, 1:4.3 and 1: 1.7. The direction of lay is as for single material conductors.

The steel core consists of one or more galvanized steel wire.

9.6 Factor of Safety

Each standard type of towers shall be designed so that no failure or permanent distortion shall occur in any part of the tower when tested with applied forces equivalent to 2.5 times the maximum working load. Under broken wire conditions the factor of safety shall not be less than 1.5.

For more and detail information reference to be made to ANSI 2 Section 26 Clause 260.

9.7 Anti Climbing Devices and Steps

All towers shall be fitted with an anti climbing device the height of the device shall be adjustable between a level of 2.5 and 3.5 meters from ground level.

Two diagonally opposite legs on each tower shall be provided with steps at not more than 35 cm centers starting immediately above the anticlimbing device and continuing to the top line conductor.

9.8 Indicating Balls

Indicating balls shall be used on overhead lines where circumstances dictates.

9.9 Stay's Insulators

Stay's insulators shall be fitted in stay wires on poles. No part of the stay insulator should be less than 3 meters above ground; it should be fitted as high up as possible, but the stay insulator should be so positioned that there can be no contact below the stay insulator, between the stay wire, any phase conductor, (including a jumper connection); and live equipment should either of them break or become loose.

9.10 Pole Setting

Foundations and settings of unguied poles shall be such as to withstand the loads assumed in Rules 252. A, 252 B and 253 C of ANSI 2 American National Standard Safety Code.

9.11 Guys

The general requirements for guys are covered in Rules 282 and 283 of ANSI 2.

9.12 Earthing Associated With Overhead Lines

Overhead distribution systems shall be provided with an overhead earth continuity wire arranged above the conductors so as to afford a maximum measure of protection against lightning and also to bond the towers in intermediate positions, the conductor shall be bonded to top of the towers or poles by a clamp of the approved type.

In terminal positions the wire shall be made of round an approved eyelet. The eyelet being bolted to the tower or pole by the aforementioned standard clamps, then secured through the clamp providing on electrical connection. In addition to the aerial earth-wire the towers or poles shall be earthed at intervals of three points per kilometers by means of driven earthing rods.

The maximum resistance to earth of the earthed tower shall not exceed 10 ohms. Conductors between the rods and the towers shall be stranded galvanized earth conductors buried in the ground.

10. LOW VOLTAGE DISTRIBUTION OVERHEAD LINES

LV overhead lines, shall be by means of high conductivity copper stranded conductors carried by pin or shackle type insulators supported by steel poles.

In general only single circuit overhead lines shall be used.

10.1 Steel Poles

Steel poles shall be in two sizes preferably:

8.5 m long 7.5 cm dia at top, and

11 m long 11.5 cm dia at top.

10.2 Insulators

Insulator shall be of vitreous porcelain pin or shackle type.

11. 11 kV AND 20 kV OVERHEAD LINES

11 kV and 20 kV distribution lines shall be by means of high conductivity stranded ACSR conductors carried by toughened glass suspension and or tension insulator unit supported from lattice steel towers.

12. 33 kV AND 66 kV OVERHEAD LINES

- Line Conductor and Joints

The line conductors shall in all cases consist of steel cored aluminum alloy conductor and comply in all respects with BS 215 (IEC 209).

No tension joints shall be used unless specially approved.

Aluminum to copper connectors for use at line termination or else where shall be of approved types and so designed as to prevent electrolytic action between dissimilar metal.

12.1 Tower Supports

The towers shall be of standard design the compression and tension members consisting of rolled steel sections or flats.

They shall be suitable for the angles of deviation.

The tower height when required may be increased by standard extensions.

All tower members shall be galvanized. A factor of safety of 2.5 to be considered.

12.2 Insulators and Fittings

Suspension and tension insulator units shall be with ball socket fittings, interlocking of ball and socket shall be such as to prevent the possibility of such parts becoming separated accidentally either during or after erection. They shall be of phosphor bronze or other tough materials.

13. ENVIRONMENTAL CONDITIONS

13.1 Site elevation: ----- meter above sea level.

13.2 Maximum ambient air temperature: ----- degree centigrade.

(Bare metal directly exposed to the sun can at times reach a surface temperature of ----- degree centigrade).

13.3 Minimum air temperature : ----- degree centigrade.

13.4 Relative humidity: ----- Percent.

13.5 Atmosphere: Saliferous, dusty corrosive and subject to dust storms with concentration of 70-1412 mg cubic meter, H₂S may be present.

13.6 Lightning storm isoceraunic level: ----- storm days/year.

13.7 Maximum intensity of earthquake: ----- richters.

Note:

Blanks to be filled by client.

14. SELECTION OF ROUTE OF TRANSMISSION LINE

In selection of route for power transmission line the following shall be considered.

- 1)** The shortest route should be selected.
- 2)** It shall be tried to avoid unnecessary angles.
- 3)** Mountainous route with steep slope shall be avoided.
- 4)** In urban districts with high intensity of population; development of residential areas, highways, airport etc. shall be in mind.
- 5)** Safety requirements shall be considered in passing through the military zones where military activities are exercised.
- 6)** Railways, parkways, and water lines, oil and gas pipe lines to be crossed at right angles as far as possible. Where power transmission line is in parallel with pipe lines, and telecommunication lines there shall be reasonable distance to minimize the influence of power line.
- 7)** Valleys, rivers and flood ways, shall be crossed at locations where the width is minimum, and with an angle of 90° as far as possible.
- 8)** The route to be accessible for inspection and maintenance purpose.
- 9)** The route entries and exits to power posts shall be convenient for present and future developments.
- 10)** Future development shall be possible and future projects to be in mind.
- 11)** Type of earth and its mechanical and electrical resistance to be investigated.
- 12)** In mountaneous location consideration shall be given to rock and sand drift and avalanche.
- 13)** The route shall not pass over the marshes.
- 14)** The route shall not pass over contaminated areas where there is possibility of pollution of insulators.
- 15)** To avoid damage to farmers and natural resources, it shall be tried to avoid passing the power line through the farms, gardens forests, villages etc. as far as practicable, because all the trees shall be cut and buildings shall be demolished within first degree right of way.

15. TRANSMISSION LINE DESIGN DATA SUMMARY

-Project Designation.....

-Length km

Voltage.....Phase.....Frequency

- Mechanical Data:

ITEMS	TRANSMISSION CONDUCTOR	OVERHEAD GROUND WIRE
Sizes Stranding Diameter in mm Area in mm ² Weight in kg/m Ultimate strength in kg		

- Loading Zone:

- Ice Thickness..... mm
- Wind Force kg
- Temperature Degree Centigrade

- Design Data

- Ice and Wind Loads:

LOADS	TRANSMISSION CONDUCTOR	OVERHEAD GROUND WIRE
Vertical kg/m Transverse kg/m Resultant kg/m		

- Initial Temperature Degrees C

- Final Temperature..... " "
- Maximum Temperature " "

- Length of Spans:

- Average meters
- Maximum..... "
- Ruling "

- Sag and Tension Chart No.

- Name of Company Producing charts.

- Minimum Conductor Ground Clearance at °C Final Sag

NATURE OF CLEARANCE	TRANSMISSION (m)
Rail road High ways Areas accessible to pedestrian Cultivated fields Along roads in rural districts	

- Base Pole / Structure

- Height m
- Size m
- Depth of Setting m

- Cross Arm Dimensions

- Width mm
- Height mm

- Line Angles

- Average number of line angles per km.
- Maximum working load at anchor kg
- Guy slope (length to height)
- Max. design tension in guy wire kg

- Conductor Clearance

- Normal to support m
- Minimum to support m
- Minimum to guy m

- Conductor Separation at Support

- Horizontal m
- Vertical m
- From OHGW m

- Conductor Separation Mid-Span

	AVERAGE LENGTH SPAN m	MAX. LENGTH SPAN m
a - Normal conductor Transmission line to OHGW		
b - ICED OHGW to Transmission line at 0°C		
c - Same as b plus kg wind		

- Wind Pressure:

- On bare conductor kg/sq. m
- On iced conductor kg/sq. m

- Allowable Angle of Swing for Insulator String

TYPE OF STRUCTURE	NUMBER OF INSULATION UNITS	MAX.	NORMAL	MIN.

- Lightning Arrester:

.....

.....

.....

.....

- Earthing:

.....

.....

.....

- Climbing Facility on Pole or Structures:

.....

- Warning, Numbering and Phasing Signs.

.....

- Indicating Balls:

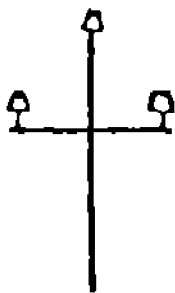
.....

- Transposition:

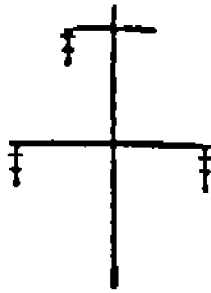
.....

Phase Arrangement

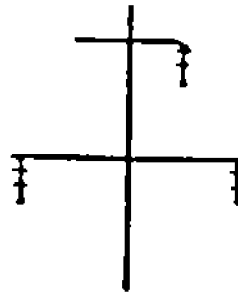
a) Tangent Type Structures



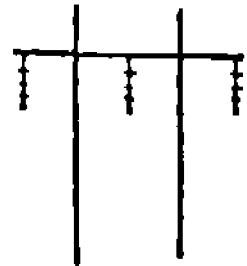
(1)



(2)



(3)



(4)

b) Tangent to Vertical Type Structures



16. SURVEY

The general route may be selected from survey maps followed by a preliminary walk-over survey which may be integrated with preliminary wayleave negotiations. Aerial survey has been found of use overseas for this preliminary work, particularly in difficult country and has been used on rare occasions for the ultimate survey.

A final detailed survey must be made with adjustments on any outstanding angle positions and general alignment between these positions with the setting of line pegs at regular points. Ground level readings are taken at regular and frequent intervals for the preparation of a profile along the whole center line of the route.

This work involves the use of a theodolite, level, leveling staff, chain and ranging rods. The profile is subsequently plotted on squared paper to a suitable scale 1 cm = 2.5 m vertically and 1 cm = 25 m horizontally are common incorporating information such as side slope either side of the center line. Details of road and power line crossings and notes on superficial ground conditions etc.

The purpose of the profile is to enable each intermediate position and support height generally to be determined, with due regard to provision of minimum statutory ground clearances and special requirements arising from crossings of roads, railways, etc. The limiting factors of support design, maximum wind span, weight spans etc., must also be taken into account. The support positions and curve of the bottom conductor at maximum sag (i.e. at maximum temperature) are plotted and for this purpose it is necessary to prepare a 'sag template'. A similar template, for the sag at minimum temperature in still air, is also used to check for 'uplift' conditions. These are devices for drawing the conductor curve based upon the profile scales, and can be made from cardboard or a transparent material when both the minimum and maximum curves can be incorporated on the same template. A set of say six templates may be required to cover the range of equivalent spans encountered in suitable steps either side of the standard span. On completion, a schedule is prepared with details of support height and types, span lengths, insulators and fittings, etc., for the dual purpose of ordering materials and construction.

The final survey operations are to pegout the support positions on site, and in case of broad base towers the excavation boundaries for the foundation.

17. RULES FOR PREPARATION OF PLAN AND PROFILE

The National Cartography Organization of Islamic Republic of Iran has recommended the following rules for uniformity of drawings:

- 1) Type of paper : Tracing milimetric
- 2) Dimension of paper : Length 2m, width 75 cm for mountaneous area and 35 cm for plain fields,
- 3) Title block : In title blocks the following shall be reflected:
 - Sheet No.
 - Name of project.
 - Voltage.
 - Type of conductor and ground wire (if any).
 - maximum permissible tension.
 - Equipment span.
 - Height scale.
 - Longitudinal scale.
 - Kilometers of length of route in the sheet.
 - Name of client.
 - Name of consultant.
 - Name of contractor.
- 4) Thickness of drawing lines : From 0.13 to 0.4 mm as relevant.
- 5) The following information shall be given in plan and profile drawings:
 - Height for all points.
 - Distance between stations.
 - Number of stations.
 - Length of routes.
 - Distance between towers.
 - No., type and height of towers.
 - Type of insulator.
 - Type of foundation.
 - Overlap:
 - Every sheet is overlapped by succeeding and preceding sheet for an amount of 100 meters of route.

Match Line

Match line shall be drawn on right and left side of each drawing for matching of succeeding sheets.

Symbols

Two kinds of symbols are used.

a) Symbols for profile

These symbols are limited to those for heights, natural barriers and sides profile.

b) Symbols for plans

The symbols for plan covers all natural and artificial factors.

Note:

For specimen check list for review of plan and profile see Table 3.

18. RELEVANT USEFUL LITERATURE

For more detail information and from harmonization point of view the book of design of power transmission line written by Engineer Amir-mansoor Ghazi and Dr Ali-mohammad Ranjbar in Ministry of Water and Power is strongly recommended.

TABLE 3 - SPECIMEN CHECK LIST FOR REVIEW OF PLAN AN PROFILE

Project.....,Date

Line Identification, Voltage kV

Plan & Profile Drawing Nos., Checked by

Loading Zone, Ruling Spen , m.

Conductor Material, Size, Design Tension

OHGW Material, Size, Design Tension

Underbuild Material, Size, Design Tension

SHEET NUMBER													
PLAN:													
Property information													
Swamps, rivers, lakes, etc.													
Right of way data													
Location, buildings, schools, etc.													
Foreign utilities													
Obstructions, hazards													
Roads													
Angles													
PROFILE:													
Horizontal span length													
Vertical span length													
Type structure													
Pole strength													
Pole height													
Pole foundation stability													
Crossarm strength													
Conductor clearance:													
To ground or side hill													
To support and guys													
To buildings													
Crossing													
Conductor separation													
Conductor tension limitations													
Climbing or working space													
Guy tension													
Guy lead & height													
Anchors													
Insulator swing or uplift													
Tap off, switches, substations													
Underbuild													
Code requirements													
Remarks:													

APPENDICES

APPENDIX A RIGHT OF WAY (R.O.W) FROM PIPELINES

Accordance to common investigations carried out by the Ministry of Power and the National Iranian Gas Company in April 1973 the following right of ways have been considered:

a) Inside Towns

Minimum distance between towers of power transmission lines (external wall of foundation) from body of pipe-line in parallel routes and intersections.

TABLE 1

VOLTAGE	MINIMUM DISTANCE METERS
* 380/220 volt	0.5
20 kilo volt	2
63 kilo volt	7
132 kilo volt	10
230 and higher kilo volt	20

* Now 400/230 Volt.

Minimum distance between under ground power cable and wall of gas pipelines in parallel routes.

TABLE 2

VOLTAGE	MINIMUM DISTANCE METERS
* 380/220 volt	1
20 kilo volt	2
63 kilo volt	3

* Now 400/230 volt.

Minimum vertical distance between power cables and gas pipelines in intersections.

TABLE 3

VOLTAGE	MINIMUM DISTANCE METERS
* 380/220 volt	0.5
20 kilo volt	1
63 kilo volt	1.5

* Now 400/230 volt.

(to be continued)

APPENDIX A (continue)

b) Outside of Towns

Minimum distance of nearest foundation of distribution and transmission power lines from wall of gas pipelines in parallel routes.

TABLE 4

VOLTAGE	MINIMUM DISTANCE METERS	
KILO VOLT	IN PARALLEL POUTE +	IN PARALLEL ROUTE ×
20	20	30
63	30	40
132	40	50
230	50	60
400	60	60

Notes:

+ For distances up to 5 km.

× For distances more than 5 km.

APPENDIX B

RIGHT OF WAY (R.O.W) FROM ROADS

The Board of Ministers on April-May 1967 (ordibehesht 1346) approved the right of way for the state roads as follows:

a) Highways

The right of ways for highways is defined as the band between high way track and the lines 38 meters apart from the highway center line, so that the total width of highway track and right of way become 76 m.

By highway track we mean the land which is effected by earth work.

b) First Class State Road

The first class right of way is defined as the band between the road track and the line 22.5 meters apart from the road center line, so that the total width of road track and right of way become 45 meters.

c) Second Class State Road

The second class right of way is defined as the band between the road track and the line 17.5 meters apart from the road center line, so that the total width of road track and right of way become 35 meters.

d) Third Class State Road

The Third class right of way is defined as the band between the road track and the line 12.5 meters apart from the road center line, so that the total width of road track and right of way become 25 meters.

e) Forth Class State Road

The forth class right of way is defined as the band between the road track and the line 7.5 meters apart from the road center line, so that the total width of road track and right of way become 15 meters.

Minimum permissible distance between overhead lines and gas pipelines at intersections.

TABLE 5

VOLTAGE KILO VOLT	MINIMUM DISTANCE METERS
20	8
63	9
132	10
230	11
400	12

Minimum distance between nearest foundation of towers from gas pipelines at intersections.

TABLE 6

VOLTAGE	DISTANCE METERS
20	20
63 and higher	30