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0.2 Amendment Record

Rev No.	Date (YYYY-MM-DD)	Description of Change	Prepared by (Name & Signature)	Approved by (Name & Signature)
0	2015-05-26	New Issue	Michael Apudo	Dr. Eng. Peter Kimemia

FOREWORD

This specification has been prepared by the Standards Department in collaboration with Network Management Division both of The Kenya Power & Lighting Company Ltd (abbreviated as KPLC) and it lays down requirements for self-supported (non-stayed) steel poles. It is intended for use by KPLC in procurement.

The bid shall be submitted complete with information that confirms satisfactory service experience of the supplier with products which fall within the scope of this specification.

1. SCOPE

1.1. This specification is for design, manufacture, supply, delivery, installation and commissioning of uniformly tapered self-supported (non-stayed) steel tubular poles (including the foundation/base) for use as upright supports for multi-circuit three (3) phase overhead power lines operating at voltages of upto 72.5 kV 50Hz.

1.2. Design of the self-supported steel tubular poles and foundations shall be done for the required applications on the line that includes the following:

a) Line Poles
b) Angle Poles
c) Section Poles
d) Deadend Poles

1.3. The specification also covers inspection and test of the materials of manufacture of the steel monopoles as well as schedule of Guaranteed Technical Particulars to be filled, signed by the supplier and submitted for tender evaluation.

1.4. The specification stipulates the minimum requirements for self-supported steel tubular poles acceptable for use in the company and it shall be the responsibility of the supplier to ensure adequacy of the design, good workmanship and good engineering practice in the design, manufacture, supply, delivery, installation and commissioning of uniformly tapered self-supported steel poles (including the foundation/base) for The Kenya Power & Lighting Company Ltd.

The specification does not purport to include all the necessary provisions of a contract.

Other project requirements including scope of works and applicable standards will be contained in the bid document and specifications for other materials and fittings to be used on the overhead lines to be constructed using the self-supported steel poles.

The bid document to be used with this specification shall include information on the route of the line, voltage levels, required clearances, number of circuits, conductor size and clamping as well as insulation.

2. REFERENCES

The following standards contain provisions which, through reference in this text constitute provisions of this specification. Unless otherwise stated, the latest editions (including amendments) apply.

ISO 1461:	Metallic Coatings – Hot dip galvanized coatings on fabricated ferrous products – Requirements.
ISO 12944:	Paints and varnishes — Corrosion protection of steel structures by protective paint systems —Part 5: Protective paint systems
IEC 60826:	Design criteria of overhead transmission lines
IEC 60652:	Loading tests on overhead line structures
BS EN 1990:	Basis of structural design
BS EN 1993:	Design of steel structures; --Part 1-1: General rules and rules for buildings; -- Part 1-8: Design of joints; --Part 3-1: Towers, masts and chimneys – Towers and masts;
BS EN 10025:	Hot rolled products of structural steels — Part 2: Technical delivery conditions for non-alloy structural steels
ASCE 48-11:	Design of Steel Transmission Pole Structures.
AWS D1.1/D1.1M:	Structural Welding Code – Steel. Published by the American Welding Society
IEEE C-2:	National Electrical Safety Code
CAN/CSA G40.20/G40.21:	General Requirements for Rolled or Welded Structural Quality Steel/ Structural Quality Steel

BS 5328: Concrete. Specification for the procedures to be used in producing and transporting concrete

BS 4251: Specification for truck type concrete mixers

BS EN 206: Concrete. Specification, performance, production and conformity

BS EN 12620: Aggregates for concrete

PD 970: Wrought steels for mechanical and allied engineering purposes. Requirements for carbon, carbon manganese and alloy hot worked or cold finished steels

BS EN 197-1: Cement. Composition, specifications and conformity criteria for common cements

3. TERMS AND DEFINITIONS

Terms and definitions given in the reference standards and the following shall apply.

(i) **ASCE** – American Society of Civil Engineers.
(ii) **AWS** - American Welding Society
(iii) **HD bolts** – Holding down bolts
(iv) **Base Plate** - Steel plate fixed to the base of the pole to stop it from sinking into the ground when planted and it helps prevent it from overturning.
(v) **Planting Depth** - The length of the pole below the intended ground level.
(vi) **Raking** - The construction of strain poles in an off-plumb orientation, in order to reduce apparent pole deflection due to service loads.

4. REQUIREMENTS

4.1. Service Conditions

4.1.1. Physical Conditions

The uniformly tapered steel tubular poles shall be suitable for continuous use outdoors in tropical areas at:

a) Humidity of up to 90%,
b) Average ambient temperature of +30°C with a minimum of -1°C and a maximum of +40°C and
c) Heavy saline conditions along the coast.
d) Altitudes of 2200m above sea level
e) Isokeraunic level i.e. Average number of Thunder storm – Days/annum : 15
f) Maximum wind pressure.(kg/Sq. meters) : 200

g) Seismic level i.e. Earthquake Acceleration
   (i) Horizontal Seismic Co-efficient (acceleration) – g (Zone – 5) : 0.08
   (ii) Vertical Seismic Co-efficient (acceleration) – g (Zone – 5) : 0.84

4.1.2. System Conditions

4.1.2.1. Electrical Clearances

The following minimum clearances shall be maintained to supporting structures, under all conditions as per Table 1.:

Table 1: Minimum clearances

Clearance	11kV	33kV	66kV
Phase to Earth	255mm	350mm	690mm
Phase to Phase	255mm	400mm	800mm

4.1.2.2. System particulars

The design of the poles shall take into consideration the following system particulars in KPLC distribution network as per Table 2:

Table 2: System particulars for the design of the steel poles

			Units	12	36	72.5
Design requirements		Voltage Grade,				
		Type of Monopole	Steel tubular – circular or polygonal			
		Basic Span	m	100-120	120-150	150-200
		Wind Span	m	115-145	125-165	165-235
		Weight Span	m	130-150	145-180	175-260
		Deflection Angle of Monopole, Line/Deadend	°C	0-15		
		Deflection Angle of Monopole, Section pole	°C	0-90		
		Deflection Angle of Monopole, Angle pole	°C	0-90		
		Cross-section in shape:	Circular or polygonal			
		Coupling method	Flange joint			
		Quantity of monopole shaft	To be specified in the tender			
		Cross-arm frame	No cross-arm			
Nominal Height		Total height of the monopole	To be specified in the tender			
		Space between cross-arms	As per clearances (Table1) with safety factor of 1.5			
Characteristics of Conductor Wire and Ground Wire	Conductor	Number of phase conductor	No.	3	3	3
		Code word	Name	RACOON	WOLF/UPAS	UPAS
		Appx. calculated break load	kN	65.2	69.2/101.5	101.5
		Type	Type	ACSR	ACSR/AAAC	AAAC/UPAS

		Area of Section	mm^2	75/150	150/300	300
		Ultimate Tensile Strength-UTS	kN/mm^2	27.05	27.05/69.25	69.25
		Diameter	mm	12.27	18.13	24.71
		Weight:	Kg/Km	319	726	997
		Modulus of Elasticity	kN/m^2	79	79	58.6
		Safety Factor	No	4		
	Earth Wire	Quantity of Earth Wire	No	1	1	2
		Appx. Calculated break load	kN	27		
		Type	Type	Galvanised steel – Grade 700		
		Area of section:	mm^2	54.55		
		Ultimate Tensile Strength-UTS	kN	56		
		Diameter:	mm	9.45		
		Weight:	Kg/Km	300		
		Modulus of Elasticity:	Kg/mm^2	16,200		
		Safety Factor:	No	4		

4.2. General Requirements

4.2.1. The steel poles shall be self-supported, also referred to as non-stayed/un-guyed type.

4.2.2. The poles shall be jointed type using bolted connections with double flanges to join two pieces together.

4.2.3. The poles shall be circular or polygonal in cross-section, tapered with excellent resistance to bending.

4.2.4. Each section shall incorporate lifting lugs with minimum ultimate capacity equal to twice the dead weight of the complete structure. Individual sections weighing more than 3 tons shall be equipped with lifting lugs.

4.2.5. The design shall incorporate features to deter vandalism. Such features may include grouting and tuck welding of the easily accessible bolts, shear bolts and nuts.

4.3. Specific Requirements

4.3.1. General design

4.3.1.1. The design of the uniformly tapered steel tubular jointed poles shall be in accordance with IEC 60826, IEC 60652, BS EN 1990 and BS EN 1993-1-1. The design shall also comply with the provisions of ASCE Standard 48-11.

4.3.1.2. The rules for resistances, serviceability and durability given in the various parts of BS EN 1993 and IEC 60826 shall also apply in the design of these poles.

4.3.1.3. The pole design and execution shall be in such a way that it will not be damaged by events such as explosion, impact, and the consequences of human errors, to an extent disproportionate to the original cause.

4.3.1.4. The maximum allowable stress on the pole shall be related to the width to thickness ratio for structures with circular cross-sections, and the deflection shall be limited to one or one half percent (1 or ½%) of the structure height under construction loading to eliminate the need for back guying structures during construction.

4.4. Fabrication of the Steel Poles

4.4.1. General Fabrication

4.4.1.1. The fabrication of steel poles shall comply with the provisions of ASCE Standard 48-11.

4.4.1.2. The pole shall be in modular construction and shall comprise of the following steps:

a) Providing two or more than two hollow tapered pole section modules, each module having a first open end and an opposed second open end, with a cross-sectional area of the second end being less than a cross-sectional area of the first end. Each module shall comprise of a reinforcement at the base of composite material produced by filament winding of resin impregnated fibrous; and
b) Stacking the two or more than two modules to form an elongated modular pole structure of a selected length by jointing the second end of a first module with the first end of a second module;
c) Jointing shall be by bolted flanges.

4.4.1.3. The elongated modular pole structure shall include a cap positioned at top most end of the extended modular pole structure, thereby inhibiting entry of debris or moisture into the pole structure.

4.4.1.4. The modules by design shall have different flexural strength, compressive strength, resistance to buckling, shear strength, outer shell durability or a mixture of different structural properties.

4.4.1.5. The finished product shall have a smooth external surface free from steel splinters and welding splatter. All surfaces shall be clean and shall present a neat appearance. All sharp corners shall be rounded with no sharp edges.

4.4.1.6. Flanged joints shall be manufactured with a jig set up in the manufacturer's workshop to ensure squareness of the flange onto the pole. Flanges and base plates shall be free from distortion after welding.

4.4.1.7. Junction plates and other welded mating surfaces requiring exact tolerances to accommodate bolted subassemblies shall be fabricated using appropriate jigs and shall be checked for dimensional accuracy.

4.4.1.8. Base plates shall be fabricated from a single steel plate, (i.e. bases plates shall not consist of multiple parts welded into a single plate).

4.4.2. **Steel requirements**

4.4.2.1. The tubular steel poles shall be manufactured from S355J0 plate with minimum tensile strength of 490N/mm^2 and minimum yield strength of 355N/mm^2 conforming to EN 10025-2. Alternative steel grades of higher strengths are acceptable, provided that they comply with requirements of EN 10025-2.

4.4.2.2. The minimum thickness of the steel plate used for manufacture of poles shall be as per Table 5 for corresponding tube diameter and slenderness guideline.

4.4.2.3. Impact properties in the longitudinal direction of all structural plate or coil materials shall be determined in accordance with the Charpy V-notch test. Charpy V-notch requirements at a minimum, shall meet the requirements of 27 J at 0°C, i.e. equivalent to J0 category steels according to EN 10025-2

4.4.2.4. Silicon and Phosphorous content of steel shall be limited as follows:

a) "Aluminium Killed Steel": Silicon (Si) = 0.01 to 0.04%, Phosphorous (P) < 0.015% maximum

b) "Silicon Killed Steel": Silicon (Si) = 0.15 to 0.25% and Phosphorous (P) < 0.02% maximum

4.4.2.5. The use of both "Aluminium Killed Steel" and "Silicon Killed Steel" on the same galvanised component may cause the galvanising take up to vary beyond acceptable limits. The fabricator shall ensure that the mixing of such steel types are avoided.

4.4.2.6. The fabricator shall maintain traceability between fabricated components and mill test certificates for mechanical characteristics and chemical composition of sheet steels. Original mill certificates shall be kept at the fabrication facility and shall be made

available during inspection. Duplicate copies shall be forwarded with the tender for tender evaluation.

4.4.3. Dimensional Tolerances

The following tolerances are permissible, provided that the structure complies with hole spacing edge distances and general structural requirements.

4.4.3.1. Pole Members

The permitted variation (tolerance) from a stated dimension, length of pole members, outside diameter, straightness shall be as follows:

a) Mean outside diameters, measured at joint level:± 0.5 % with ± 2 mm minimum
b) Ovalisation: The dimensional percentage noted for two measurements taken between two perpendicular diameters at joint level: less than 3 % [(Dmax-Dmin)/Dmax < 3 %].
c) Length of pole sections: ± 50 mm
d) Members' straightness: less than 0.3 % of 1 meter member length (3 mm per meter). Straightness is taken as the maximum distance measured between the centerline of the faces of the pole being measured, at any point along the length of the pole, to a line drawn from the centre of the tip of the pole to the centre of the butt of the pole. The measurements shall be done on at least two faces of the pole which are at 90° to each other.

4.4.3.2. Base and Flange Plates

a) Outside and inside diameters: ± 5 mm
b) Drilling diameter: ± 1 mm
c) Location of holes for anchor bolts: ± 1 mm
d) Center of base plate w.r.t. centerline of pole: ± 4 mm

4.4.4. Joints

4.4.4.1. All joints shall have a design resistance such that the structure is capable of satisfying all the basic design requirements of BS EN 1993-1-8 and BS EN 1993-1-1.

4.4.4.2. In addition, the following applies to the base and flange plate connections:
(i) Flexural stresses in the base or flange plates shall not exceed the specified minimum yield stress of the plate material.

(ii) Base and flange plate connection shall be designed to resist the maximum forces and movements at the connection.

(iii) As a minimum, the base and flange plate connection shall be designed to resist 50% of the moment capacity of the lowest strength tube.

4.4.4.3. All connections made with bolts shall fully comply with the requirements of clause 3 of BS EN 1993-1-8. These connections shall include shear connections (bearing type, slip-resistant at serviceability and at ultimate loads) and tension connections (preloaded and non-preloaded) as shown in Table 3;

Table 3: Category of bolted connections

Category of bolted connection	Remarks
Shear connections	
A-bearing type	No preloading required. Bolt classes from 4.6 to 10.9 may be used.
B - Slip resistant at serviceability	Preloaded 8.8 or 10.9 bolts shall be used.
C – Slip resistant at ultimate	Preloaded 8.8 or 10.9 bo1ts shall be used.
Tension connections	
D - Non-preloaded	No preloading required. Bolt classes from 4.6 to 10.9 may be used.
E - Preloaded	Preloaded 8.8 or 10.9 bolts shall be used.
Bolts subjected to both shear force and tensile force shall also satisfy the criteria given in Table 3.4 of BS EN 1993-1-8	

4.4.5. **Welding**

4.4.5.1. The welding of steel poles shall comply with the provisions of AWS D1.1/D1.1M 2010 Structural Welding Code – Steel. The design for the welds shall conform to Tables 6.3 to 6.6 of ASCE 48-11 and Table 4.1 of AWS D1.1/D1.1M.

4.4.5.2. Through-thickness stresses shall have an average design stress of 248MPa for all grades of steel.

4.4.5.3. Sections joined by circumferential welds shall have a complete penetration (100%) welds whereas longitudinal welds within 76mm of circumferential welds shall have a complete fusion through the section thickness and complete joint penetration for processing using weld metal.

4.4.5.4. Flange and base plate to pole shaft welds shall be complete penetration (100%) groove welds with reinforcing fillet to satisfy the requirements for through-thickness stresses in the flange or base plates. Longitudinal welds within 76mm of a flange plate or base plate weld shall have complete fusion through the section thickness and a complete joint penetration for processes using weld metal.

4.4.5.5. Finished welds shall be smooth and free from slag with no sharp edges. Welds shall be of a strength that does not change the designed proof load, ultimate load or crippling load.

4.4.5.6. Only qualified welding personnel shall perform welding.

4.4.5.7. **Inspection and Testing of Welds**

4.4.5.7.1. This shall be done on critical welds that shall include circumferential welds on base plates and flange plates, and longitudinal welds within allowable overlapping zones on friction joints. The fabricator shall specify the % of critical welds and % of other welds which shall be tested in his quality plan.

4.4.5.7.2. Welds shall be tested by qualified level two (2) inspectors in accordance with AWS D1.1/D1.1M. Critical welds will be tested using ultrasonic testing. Fabricators shall indicate in their quality plans the test methods used for other welds. A certificate of confirmation of tests on the welds shall be submitted to KPLC for tender evaluation.

4.4.6. **Attachment Points and Bolt Holes**

4.4.6.1. Strain plates shall be sized in accordance with the ultimate tensile strength (UTS) of the supported conductor bundle, and shall include 3 bolt holes per side. The minimum edge distance in the direction of applied load shall be 1.5 bolt diameters. Plate and hole sizes for strain plates shall be as follows:

a) 120kN strain plates: 16mm plate, 18mm holes
b) 210kN strain plates: 20mm plate, 22mm holes
c) 300kN strain plates: 22mm plate, 24mm holes
d) 450kN strain plates: 30mm plate, 32mm holes

4.4.6.2. The fabricator shall ensure that attachment points are compatible with proposed hardware arrangements. Detailed design drawings for the associated components including cross-arms (for various voltage levels) shall be submitted with the bid and at the design approval stage.

4.4.6.3. All openings (e.g. bolt holes, slots etc.) shall be made in the poles during the manufacture of the poles before galvanization. These openings shall be required for the attachment of cross-arms and other equipment. Bolt-hole diameter tolerances shall be + 6 mm for foundation bolts and + 2 mm for all other bolts

4.4.7. Base plate and holding down bolt arrangement

4.4.7.1. Base plates design shall incorporate gussets. These shall be designed to:

a) Provide positive support to the base plate allowing a commensurate reduction in base plate thickness,
b) Withstand local buckling in the gusset web itself, and
c) Transfer stresses safely with no risk of punching into or deforming the pole shaft wall.
d) Gussets shall as far as possible be positioned at the apex of bend lines.

4.4.7.2. The holding down (HD) bolt arrangement will respect minimum spacing distances specified in ASCE 48-11, as well as clear distances from the gusset and pole wall faces to enable tightening.

4.4.7.3. Alternative holding down (HD) bolt arrangements shall incorporate bolts of a grade and/or diameter different to that specified, provided that the overall embedment depth does not exceed 900mm. The arrangement shall be designed and dimensioned to safely transfer stresses into the reinforced concrete column.

4.4.7.4. The allowable bond stress on smooth embedded rods shall be limited to 1.4MPa. The allowable compressive stress on embedded plates and rods shall be limited to 12.5MPa.

4.4.8. Earthing

4.4.8.1. The standard earthing system to be installed on bolted footings shall incorporate a single electrical connection between the holding down bolt arrangement and the foundation reinforcement (where present).

4.4.8.2. The connection shall be made with an offcut of earthwire used on the project or conductor capable of carrying the stated earthwire current capacity.

4.4.8.3. Straight HD bolts shall be used by drilling the template to accommodate an M12 bolt for the internal earthing connection as per Figure 1 below.

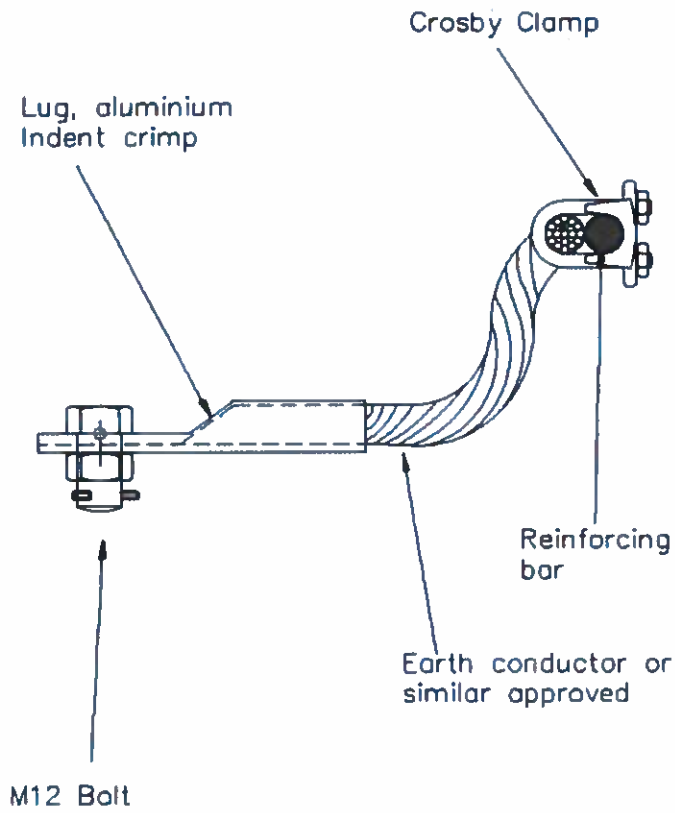

Figure 1: Connection of reinforcing to straight HD bolts

4.4.8.4. There shall be an incorporation of a 50mm long, 50 x 50 x 5 angle welded close to the base of the pole, – Earth lug for accommodation of additional earthing.

NOTE: *A superior earthing design system shall be accepted but shall be approved by KPLC before implementation.*

4.4.9. **Ladders/Climbing system**

4.4.9.1. The pole shall be designed with brackets for removable single stile ladder. This shall be vertically spaced at 300mm and configured such that the climber has a comfortable climbing path. The brackets shall permit easy installation of the ladder without becoming trapped or wedged into the brackets. Each steel pole shall be complete with removable single stile ladder, able to support a 140kg worker.

4.4.9.2. The brackets on the structure shall start at approximately 3m above ground level. This lower portion shall be accessed by means of a standard portable ladder and will

prevent unauthorized persons climbing the structures. Anti-climbing devices shall be provided in this lower section.

4.4.10. **Corrosion protection and finish considerations**

4.4.10.1. The steel poles will be used in all environments, from coastal regions to inland areas. All poles shall be hot dip galvanized to ISO 1461 and shall have a minimum coating thickness of 85 microns for inland applications and 105 microns for coastal applications as specified by the KPLC.

4.4.10.2. All structures shall be suitably straightened after galvanizing without causing damage to the galvanizing surface or to the structure itself. No curved, bent or twisted structures will be accepted.

4.4.10.3. Poles to be planted shall be bitumen treated from 200 mm above the ground line to the entire section below ground line. The bitumen product used shall be Viscosity grade Bitumen or similar with minimum 80-100 penetration at 25^0C.

4.4.11. **Deflection Limits**

4.4.11.1. The following deflection limitations shall apply during steel pole testing as per ASCE/SEI 48-11:

a) Ultimate wind loads: Allowable lateral deflection at pole top = 5.5% of pole height above ground level.
b) Broken conductor loads: Allowable lateral deflection at pole top = 7% of pole height above ground level.
c) Working loads: Allowable lateral deflection at pole top = 2.2% of pole height above ground level.
d) Permanent set deflection limits, after removal of ultimate load: Allowable lateral deflection at pole top = 1% of pole height above ground level.

4.4.11.2. A further deflection limit of 1.5% (applicable during construction after stringing) shall apply to the lateral deflection of the pole top from base center. This is not a design limit, and poles predicted by theoretical calculation to deflect past 1.0% under service load conditions may be raked.

4.5. Aesthetic and Geometric Considerations

4.5.1. Slenderness limits

Lower height to width limits

a) Since tubular steel poles are often prescribed for use in environmentally sensitive or highly visible areas, the designer shall take care to ensure, reasonable practicability, to achieve aesthetically acceptable designs.

b) The use of thin-walled, large diameter sections can result in structurally efficient designs, albeit at the expense of aesthetic appeal. The height to width (H_p/D_b) ratios to determine lower limits shall be as per Table 4, where
H_p = total height of structure above ground
D_b= diameter at base (across flats)

Table 4: Lower Slenderness Limits (Guideline)

Maximum line deviation angle	Minimum H_p/D_b Ratio
Suspension structures	22
Moderate angles up to 40 degrees	18
Heavy angles and terminal structures	14

Upper Slenderness limits

a) Poles with large slenderness ratios may be prone to buckling instability, service load deflections and wind induced vibration. In addition, vortex shedding of wind forces by structures and structure members can result in oscillation of slender arms, poles, or other elements. This phenomenon is exacerbated in structures employing long, constant diameter sections.

b) For truss members subjected to tension-compression forces only, the recommended upper slenderness ratio (KL/r) shall be 200 as per ASCE 48-11 applies.

c) For permanently loaded members carrying both compressive and flexural loads, the KL/r limit shall be 150. This limit may only be exceeded where testing and dynamic response analysis reveals no adverse structural effects or deflections beyond those specified in 4.4.11, and where compliance to the structural capacity in terms of ASCE 48-11 is demonstrated. K, L and r, are defined as follows:

K= Effective length factor, as defined by recommended value in Figure 2
L = Unbraced length (in mm)
r = Radius of gyration (in mm)

Buckled shape of column is shown by dashed line	(a)	(b)	(c)	(d)	(e)	(f)
Theoretical *K* value	0.5	0.7	1.0	1.0	2.0	2.0
Recommended design value when ideal conditions are approximated	0.65	0.80	1.2	1.0	2.10	2.0
End condition code		Rotation fixed and translation fixed Rotation free and translation fixed Rotation fixed and translation free Rotation free and translation free				

Figure 2: Determination of effective length factor

4.5.2. **Tube Size Limits**

Lower Tube Diameter Limits

The minimum diameter for tapered tubes as governed by fabrication limitations shall be given in Table 5. The designer shall adopt adjustment to these limits as advised by the relevant fabricator.

Table 5: Lower Tube Diameter Limits (tapered, fabricated sections)

Sheet Thickness (mm)	Min tube diameter across flats (mm)
4.5	150
5	200
6	250
8	300
10	325
12	350
14	375
16 and above	400

Maximum Tube Length Limits

Tube section lengths shall be based on transportation limits, available stock sizes, and galvanizing bath limits as per Table 6.

Table 6: Tube section length limit

Transport Mode	Tube length limit (m)
Containerized (40 ft. container) or non-containerized	11.9
Break bulk / non containerized	13.7

4.6. **Classes of steel poles**

4.6.1. The steel pole classes shall be in accordance with ANSI 05.1-2012 and Table 7.

4.6.2. The equivalent design load for steel pole shall be obtained by multiplying the working load by the steel safety factor (2.5) after calculating the equivalent working loads for wood by dividing ultimate strength of wooden pole by 4 as shown in Table 7.

Table 7: Horizontal load applicable to different strength classes of utility poles

Strength Class (ANSI 05.1-2002)	Ultimate Horizontal Load for Wood (N)	Working Loads (N)	Equivalent Horizontal Load for Steel (N)	Length Range m	Minimum tip circumference mm
H6	50,710	12,677.5	31,694	13.7 - 38.1	940
H5	44,480	11,120	27,800	12.2 - 38.1	889
H4	38,700	9,675	24,188	12.2 – 38.1	838.2
H3	33,360	8,340	20,850	10.7 – 38.1	787.4
H2	28,470	7,117.5	17,794	10.7 – 38.1	736.6
H1	24,020	6,005	15,013	10.7 – 38.1	685.8
1	20,020	5,005	12,513	6.1 – 38.1	635
2	16,500	4,125	10,313	6.1 – 27.4	584.2
3	13,300	3,325	8,313	6.1 – 21.3	533.4
4	10,680	2,670	6,675	6.1 - 15.2	482.6

4.6.3. If a range of different pole sizes and different pole strength classes are required, then this shall be specified in the tender and the combinations shall be as per Annex C. The pole designation shall be based on the strength class and the length in metres denoted as strength class-length i.e. H1-18m.

4.7. Erection of Steel Poles

4.7.1. Erection Tolerances

4.7.1.1. An absolute construction 1.5% deflection limit (of pole length) applies to erected poles after stringing.

4.7.1.2. The supplier may be required to rake terminal or bend point structures that are predicted by theoretical calculation to deflect by more than 1.0% of pole length. The location and magnitude of raking on poles shall be confirmed by the line designer, based on everyday service loads at zero Pa wind, and initial conductor tensions at 15 degrees C.

4.7.1.3. Raking of poles may be achieved through tilting of base plates or tilting of the HD bolts arrangement.

4.7.1.4. The orientation of HD bolts and templates must be checked prior to concreting to ensure correct orientation of cross-arms

4.7.2. Tightening of Bolts

4.7.2.1. HD bolts shall be fitted with two (2) washers per bolt, placed above and below the base plate.

4.7.2.2. Exposed nuts (including those fitted to flange plates) shall be tightened using heavy duty anaerobic thread-locking compound such as Loctite 271, 3M TL70, or similar approved.

4.7.2.3. The minimum torque applied to bolts shall render a "snug tight" fit. Snug tight is defined as the tightness that exists when the plies of the joint are in firm contact. This may be obtained by the full effort of a man using an ordinary spud wrench.

4.7.3. Assembly of Poles

4.7.3.1. Flanged joints shall be aligned such that there is minimum pole deflection around the joint.

4.7.3.2. Small repairs to damaged galvanizing shall be effected by the erector preferably after assembly and prior to lifting of poles.

4.7.4. General Erection Requirements

4.7.4.1. Structures erected shall be plumb, or to the required raking angle, and care shall be taken to ensure that insulators are perpendicular to the direction of the line and at 180 degrees to each other on opposite sides of the structures.

4.7.4.2. Non- terminal strain poles shall be adequately back-stayed to prevent longitudinal deflections during stringing and erection.

4.7.4.3. Ladders, where installed, shall be oriented consistently in the same side of each pole on the line

4.8. Steel pole foundation specification

4.8.1. Overview

4.8.1.1. Foundations shall be of any of the 3 types depending on site conditions where supplier deems necessary as shown in Fig.3, 4 & 5.

4.8.1.2. Concrete specification shall be class 25 (20) in accordance with BS EN 206-1:2002.

4.8.1.3. All foundations which are not to standard will be designed specifically to suit earth conditions applicable.

4.8.1.4. The cable entry hole for the earthing system shall be designed to be approximately 300mm from the planting depth marking or from the surface of the foundation in case of a flanged based concrete (Type 1) or pad foundation (Type 3).

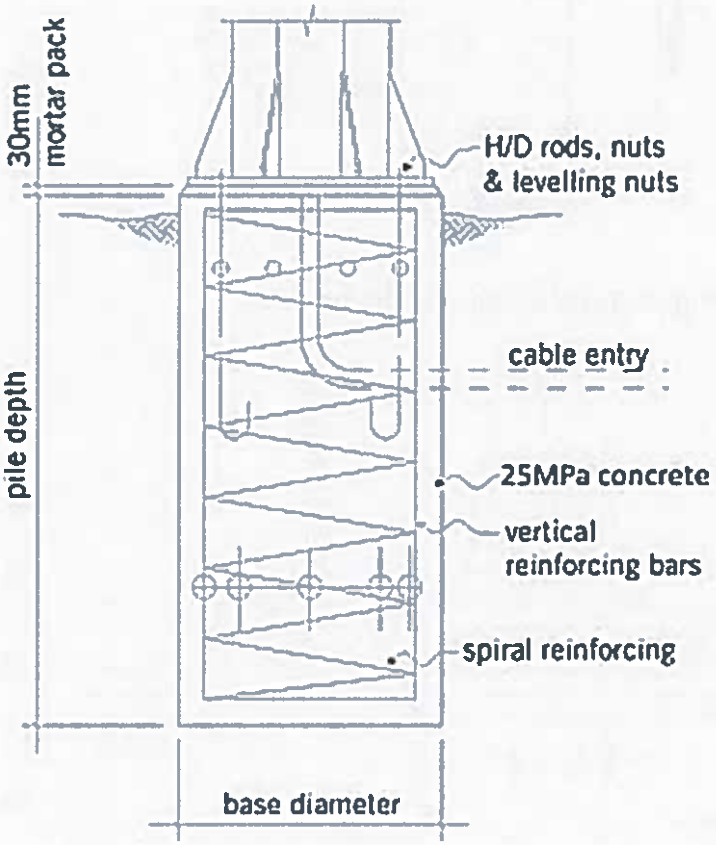

Fig. 3: Type 1-Flanged based concrete

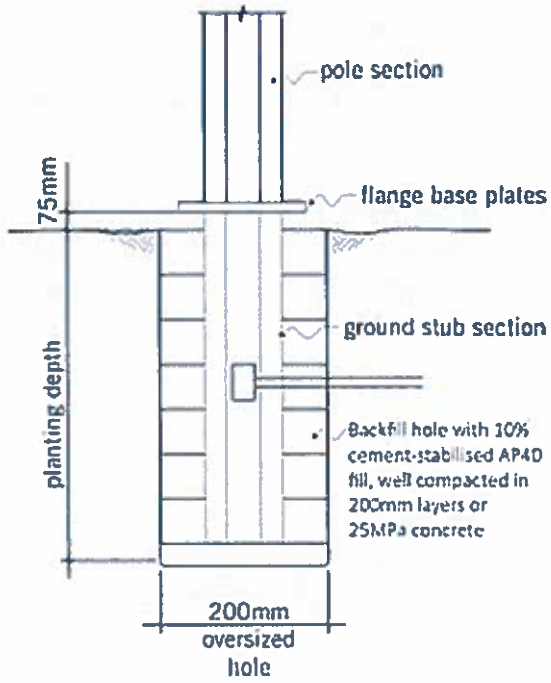

Fig. 4: Type 2-Flanged based pile

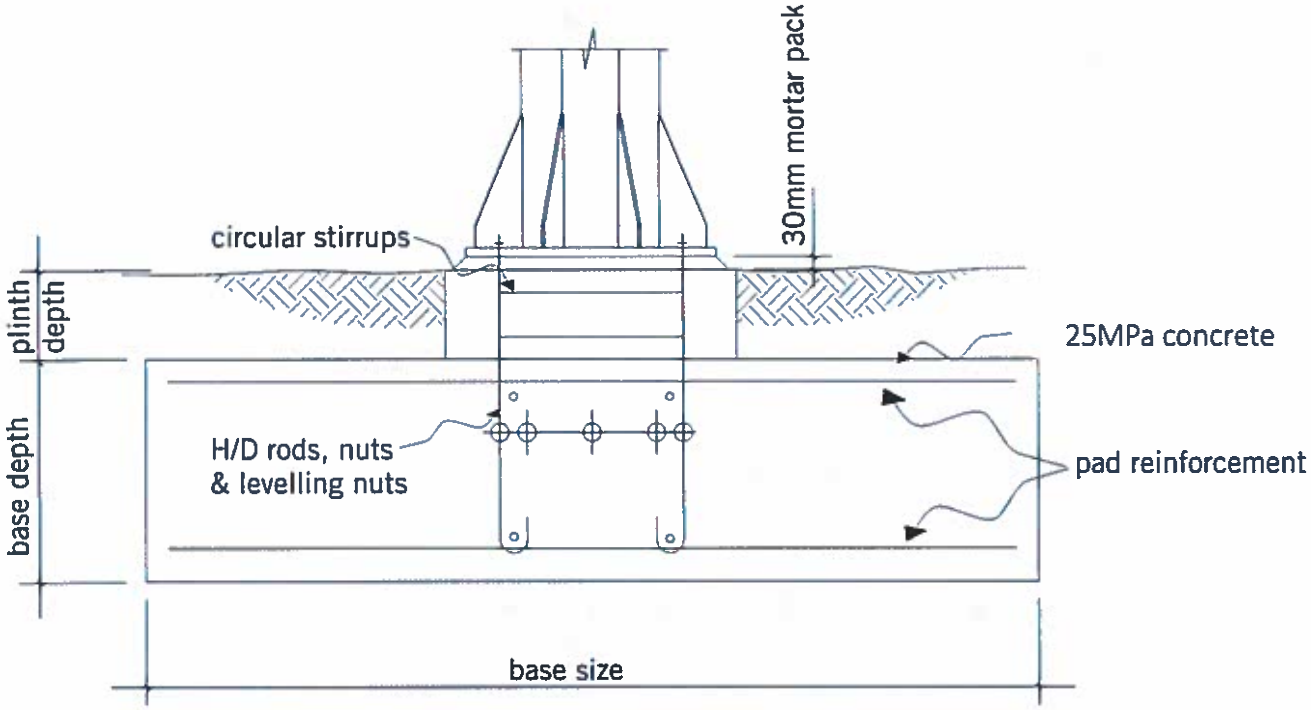

Fig. 5: Type 3 - Pad foundation

4.8.2. Concrete works specifications

4.8.2.1. Soil Investigations

4.8.2.1.1. Shall be done to ascertain the soil bearing and trial pits be done to ascertain the general soil profile

4.8.2.1.2. The sub-soil tests shall be carried out by any method as stated hereafter under the supervision of a qualified person.

4.8.2.2. Soil types

Soils types are grouped into three classes, A, B, and C as follows:

a) **Class A**: Gravel, compacted sand and rock soils not subject to large variations in volume with moisture content, which offer appreciable resistance to boring and which remain stable after boring.

Note: *If the excavation is in rock, the hole shall be just large enough to take the pole at the recommended depth, and no reinforcement is necessary in the concrete.*

b) **Class B**: Soils subject to large variations in volume with changing moisture content. Soils which offer little cohesion, ie clay.

c) **Class C**: Low bearing soil. Requires caisson to support sides during excavation. Examples are swamps, saturated soil and drift sands.

4.8.3. Shoring and Timbering of Excavation

The supplier shall be entirely responsible for the safety of all excavations, for the prevention of injury to workmen and for the stability of the faces of the excavation.

4.8.4. Disposal of Excavated Material

All material excavated under this tender shall be disposed of in accordance with the instructions issued by the KPLC engineer in charge. Selected material required for back-filling shall be removed to a tip found by the and the Supplier shall be responsible for ensuring that the required amount of spoil is set aside.

4.8.5. **Other Services**

Where trenches pass near or across other services, the Supplier shall take every precaution against damaging such services. These services shall be properly supported in the trench until back-filling is complete and the back-filling shall be thoroughly compacted under and around such services.

4.8.6. **Backfilling**

4.8.6.1. Back-filling shall be carried out either with selected spoil as set aside, or with imported selected spoil, or other material to the approval of the KPLC engineer in charge.

4.8.6.2. All back-filling shall be compacted in layers not exceeding 150 mm thick and shall be sprayed with water to bring the moisture content to the optimum for dense compaction.

4.8.7. **Tolerance**

All in-situ concrete shall be dimensionally accurate to within the following non-accumulative tolerances:-

(i) Between the centre lines of principal member stub columns and rafts .....+/- 5mm
(ii) Up to 5 metre centres .....+/- 5mm
(iii) In level of concrete finish .....+/- 5 mm/ - 3 mm of the true prescribed horizontal surface level.
(iv) In cross sectional dimensions of column, beams and walls.. +/- 5 mm/ - 3 mm
(v) In any dimensions up to 2 metres overall +/- 10 mm/ - 3 mm
(vi) Cover to reinforcement ..... + 5 mm/ - 0 of the stated covers.

4.8.8. **Concrete mix**

4.8.8.1. Ready mixed shall be supplied in accordance with B.S. 5328,

4.8.8.2. Truck mixer units comply with the requirement of B.S. 4251.

4.8.8.3. Concrete test cubes and slump tests shall be taken on site at the point and time of discharge

4.8.9. **Material**

The material requirements for the foundation shall be as follows;

a) Aggregates shall conform to BS EN 12620. With nominal size 20mm.
b) Water shall be fit to drink
c) Reinforcement steel shall conform to PD 970.
d) Cement shall conform to BS EN 197-1 or be either normal Portland or P.C. 15.

4.8.10. **Formwork**

Formwork shall be sufficient to leave the concrete finishes specified on drawings and to be within the tolerances specified in the following table and to provide an acceptable surface for applied finished, where required.

Line and Level:	1 mm per metre not exceeding 5 mm
Pockets, sleeves etc :	+/- 5 mm
Bases :	+/- 50 mm

a) The greater of the diameter of the bar or 40 mm for external un-plastered face.
b) The greater diameter of the bar or 15 mm for internal face.

NOTE: *Holding down bolts shall be supplied under the civil works part or by the main supplier if he so decides, and in any case be included in the turnkey price.*

4.8.11. **Batching**

Shall be by mass in accurately calibrated scales or be volume in soundly constructed gauge boxes making due allowance for bulking of the fine aggregate.

4.8.12. **Placing**

Shall be in a manner to prevent separation of the ingredients and continuous-no joints

4.8.13. **Compaction**

Shall be through immersion (poker) vibrator in the hands of experienced operators.

4.8.14. **Testing**

Making and sampling for test of concrete cubes to be tested by Supplier shall be under the supervision of the KPLC Engineer in Charge. The Supplier shall arrange for

transport of cubes to approved testing laboratories to be witnessed by KPLC. Cubes to be in sets of 3

4.8.15. **Curing**

Curing shall be effected by keeping the concrete in a permanently wet state.

4.8.16. **Records**

All the records shall be kept by the Supplier and duplicate copies submitted to KPLC, showing date and time of each concrete pour, the weather conditions, the temperature, the number of the cubes which represent the concrete, the slump and any other items which the Supplier and/or the KPLC Engineer in Charge consider relevant. These records are to be made available for the KPLC Engineer in Charge inspection when required.

4.9. **Quality Management System**

4.9.1. The supplier shall submit a quality assurance plan (QAP) that will be used to ensure that the steel poles design, physical properties, tests and documentation, will fulfill the requirements stated in the contract documents, standards, specifications and regulations. The QAP shall be based on and include relevant parts to fulfill the requirements of ISO 9001:2008.

4.9.2. The Manufacturer's Declaration of Conformity to applicable standards and copies of quality management certifications including copy of valid and relevant ISO 9001: 2008 certificate shall be submitted with the tender for evaluation.

5. TESTS AND INSPECTION

5.1. The steel pole structures shall be inspected and tested in accordance with the requirements of IEC 60826, IEC 60652, ISO 1461, ISO 12944-5, BS EN 1993, BS EN 10025-2, ASCE 48-11, AWS D1.1/D1.1M, IEEE C-2 standards and all the provisions of this specification. It shall be the responsibility of the supplier to perform or to have performed the tests specified and whatever other tests he normally performs at works.

5.2. Copies of previous Type Tests Reports issued by a third party testing laboratory that is accredited to ISO/IEC 17025 shall be submitted with the tender for the purpose of technical evaluation. The accreditation certificate to ISO/IEC 17025 for the same third party testing laboratory used shall also be submitted with the tender document (all in English Language).

5.3. The type tests shall conducted as per ASCE 48-11, IEC 60826 and IEC 60652 and provisions of this specification and shall include the following tests:

Test	Test procedure	Acceptance criteria
Working load test	(i) The working load test shall be completed on all structures being tested and indicates the actual loads that the structure will carry (i.e. no factors of safety). Tests shall be carried out on strong and weak planes of asymmetrical poles. The tests need only be completed in one direction on symmetrical poles. (ii) The load shall be applied to the structure in load levels as specified in Annex B. The full load shall be held for a minimum of 60 seconds and a maximum of 5 minutes before being released. Deflection readings shall be taken whilst the load is being applied and once the load has been released (permanent set).	The mast shall resist all working loads without showing signs of buckling or crippling. Any signs of member buckling, signs of buckling onset, connection failure or deflections in excess of those depicted in section 4.4.11 (Deflection requirements) of this document shall constitute the failure of the structure.
Ultimate load test	(i) The ultimate load test shall be completed on all structures being tested and shall be executed once the working load tests are done. The ultimate loads indicate the loads the structure will carry including factors of safety as specified in the OHS Act. Tests shall be carried out on strong and weak planes of asymmetrical poles. The tests need only be completed in one direction on symmetrical poles. (ii) The load shall be applied to the structure in increments of 10 % up to 90 % of the ultimate load, thereafter in increments of 5 % of the ultimate load until failure. This 100% load shall be held for 60 seconds before being released. Deflection readings shall be taken whilst the load is being applied and once the load has been released.	The structure shall withstand the applied loads for 60 seconds without failure of any component. Deflections in excess of those depicted in section 4.2.9 (Deflection requirements) of this document shall constitute the failure of the structure. These deflection limitations may be relaxed at the discretion of the KPLC and the designer. Permanent local deformations such as bowing of secondary members, ovalisation of holes and permanent deformation of bolts may be accepted for the ultimate load test only.

5.4. The steel monopoles shall be subject to acceptance tests at the manufacturer's works before dispatch. Acceptance tests will be witnessed by two Engineers appointed by The Kenya

Power and Lighting Company Limited (KPLC). Routine and Sample Test Reports for the steel poles to be supplied shall be submitted to KPLC for approval before delivery of the goods. The tests to be witnessed shall include;

(i) All poles shall be inspected for compliance with the requirements of clauses 4.2, 4.3, 4.4, 4.5 and 4.6 of this specification.
(ii) Straightness test - The overall straightness of masts (excluding thermal influences), shall be 0.1 % (h/1000).

5.5. On receipt of the products, KPLC will inspect them and may perform any of the tests specified in order to verify compliance with this specification. The supplier shall replace without charge to KPLC steel poles which upon examination, test or use fail to meet any of the requirements in the specification.

6. MARKING AND PACKAGING

6.1. Marking

6.1.1. All steel monopoles structures and components to be uniquely identified with permanent marking which will enable the details of the structure to be established at any time after assembly. All identification marks and structure-related information are to be easily readable after the structure has been assembled. The following information shall be clearly and indelibly marked with characters at least 20mm high and indented 1mm deep. This information shall be 1.5 m above the ground line on finished poles:

a) The manufacturers name, trade name or trade mark;
b) The overall length of the pole in meters e.g. "18 m";
c) The ultimate load design e.g. " UL = 23 kN";
d) The crippling load (if applicable) e.g. "CL = 100 kN" and;
e) The month and year of manufacture e.g. "11-2014".

6.1.2. The following information shall be marked on the pole or may be in included in an erection procedure to be issued with every batch of pole dispatch to site:

a) Holding-down bolt torque requirements
b) Maximum axial slip-joint assembly load
c) Orientation of sections with respect to one another to be clearly and permanently marked
d) Pole/baseplate orientation with respect to the line to be identified

6.2. Packaging

6.2.1. All steel monopoles structures shall be suitably stacked to avoid damage during transport. Dunnage shall be used between steel members to avoid these touching and damaging each other.

6.2.2. No buckled, bent or twisted structures and associated bracketry will be accepted on site.

6.2.3. The manufacturer shall deliver to site, with the structures, adequate quantities of Zinc-fix squish packs/cold galvanizing spray to patch small areas of damaged galvanizing due to transport. Large areas of damaged galvanizing will not be accepted.

7. DOCUMENTATION

7.1 The bidder shall submit its tender complete with technical documents required by Annex A (Guaranteed Technical Particulars) for tender evaluation. The technical documents to be submitted (all in English language) for tender evaluation shall include the following:

a) Guaranteed Technical Particulars signed by the manufacturer;
b) Copies of the Manufacturer's catalogues, brochures, drawings and technical data;
c) Sales records for the last five years and at least four customer reference letters;
d) Details of manufacturing capacity and the manufacturer's experience;
e) Copies of required type test reports by a third party testing laboratory accredited to ISO/IEC 17025;
f) Copy of accreditation certificate to ISO/IEC 17025 for the third party testing laboratory;
g) Manufacturers letter of authorization, ISO 9001:2008 certificate and other technical documents required in the tender.

h) **Design Documentation:**

All documents to be submitted shall be in English Language. The units used shall be SI units. Alternative designs by the fabricator submitted at tender stage shall be accompanied by a summary document for each structure demonstrating that poles submitted meet fully the requirements of this specification. It shall indicate at minimum:

(i) Design moments at the base and at joints and at any other critical points along the pole, including the effects of the secondary moments due to deflection,
(ii) Deflections along the pole,
(iii) Calculated and allowable stresses at each level,
(iv) Ground line reactions.
(v) Foundation details for each category

i) **Outline Drawings**

Outline drawings (including alternative designs) shall be submitted by the fabricator at tender stage, based on the outline drawings for standard designs, which includes the following information:

(i) Basic design information: Conductor, Earthwire, Wind/ Weight/ Electrical Span.
(ii) Geometry: Attachment height, length, thickness, top and bottom outside diameters across flats for all pole segments.
(iii) Details of all joints.
(iv) Base plate and holding down bolt details (OD, ID, PCD, Bolt grade, diameter and number).
(v) Earth conductors shielding angles.
(vi) Design overturning moments.
(vii)Recommended raking angles for line angles in increments of 10 degrees.
(viii) Steel grade

7.2 The successful bidder (supplier) shall submit the following documents/details to The Kenya Power & Lighting Company for approval before manufacture:

a) Guaranteed Technical Particulars signed by the manufacturer;
b) Design Drawings with details of the steel poles and foundations to be manufactured for KPLC.
c) Quality assurance plan (QAP) that will be used to ensure that the design, material; workmanship, tests, service capability, maintenance and documentation will fulfill the requirements stated in the contract documents, standards, specifications and regulations. The QAP shall be based on and include relevant parts to fulfill the requirements of ISO 9001:2008
d) Detailed test program to be used during factory testing;
e) Marking details and method to be used in marking the structures;
f) Manufacturer's undertaking to ensure adequacy of the design, good engineering practice, adherence to the specification and applicable standards and regulations as well as ensuring good workmanship in the manufacture of the steel poles for The Kenya Power & Lighting Company;
g) Packaging details (including packaging materials).
h) Upon contract award, the fabricator shall submit PLS Pole files for alternative structures accepted by KPLC. The PLS Pole models shall include sufficient detailed modeling such as pole sections, junction plates, insulators and base plates.

i) Acceptance of pole models is subject to a design check by the KPLC engineers. Such acceptance shall not constitute a transfer of design risk or relieve the supplier or fabricator from the responsibility of compliance to specifications.

j) **Fabrication Drawings**:

(i) Within four weeks of contract award, fabrication drawings shall be submitted to KPLC for approval.

(ii) Acceptance of such detail designs by KPLC will constitute an acknowledgement to proceed with fabrication and will not relieve the fabricator to provide correctly designed and manufactured components.

(iii) Likewise, acceptance by KPLC of alternative designs does not relieve the responsibility of the fabricator to comply with structural requirements in this specification and to provide structures capable of resisting the stated design loads.

k) **Erection Instructions**:

Upon supply of completed structures, the erector shall be provided with handling and erection instructions from the fabricator, which is based on requirements specified. Instructions shall include:

(i) Exceptions to requirements specified
(ii) Basic assembly and erection procedures
(iii) Bolt torque requirements.

7.3 The supplier shall submit recommendations for use, care, storage and routine inspection/testing procedures, all in the English Language, during delivery of the steel monopoles to KPLC stores.

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ANNEX A: SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS FOR STEEL POLES.
(to be filled and signed by the Manufacturer and submitted together with relevant copies of the Manufacturer's catalogues, brochures, drawings, technical data, sales records, four customer reference letters, details of manufacturing capacity, the manufacturer's experience and copies of complete type test certificates and type test reports for tender evaluation, all in English Language)

TENDER NO. .....BIDDER'S NAME & ADDRESS .....

CLAUSE	DESCRIPTION	BIDDERS' OFFER *(indicate details of offer and reference document submitted)*
-	Name and address of the Manufacturer	State
	Country of manufacture	State
	Manufacturer's Letter of Authorization	Attach
	Model/Type Reference No. of the offered steel pole	State
	Manufacturer's warranty and guarantee for the offered steel poles	Attach
1	Scope: a) Design, manufacture, supply, delivery, installation and commissioning of uniformly tapered self-supported (non-stayed) steel tubular poles (including the foundation/base) for use as upright supports for multi-circuit three (3) phase overhead power lines operating at voltages of upto 72.5kV 50Hz. b) Ensure adequacy of the design, good workmanship and good engineering practice in the design, manufacture, supply, delivery, installation and commissioning of uniformly tapered self-supported steel poles (including the foundation/base) for The Kenya Power & Lighting Company Ltd	Explain the scope
2	Applicable Standards of manufacture	State
3	Terms and Definitions	State
4	Requirements	
4.1	Service Conditions	
	(i) Humidity	State the range of values applicable
	(ii) Temperature range	
	(iii) Salinity	
	(iv) Altitude range	
4.2	General requirements	
	4.2.1. Lifting lug capacity	State offered value
	4.2.2. Weight of each pole section and positioning of holes	State offered value
4.3	Specific requirements	
	4.3.1. General design	Describe
	4.3.1.1. Pole type and standards of manufacture	State
	4.3.1.2. Proof of conformity to limit state design as per BS EN 1990	
	4.3.1.3. Proof of conformity to BS EN 1993 & IEC 60826 on	Attach test reports

CLAUSE	DESCRIPTION	BIDDERS' OFFER *(indicate details of offer and reference document submitted)*
	resistances, serviceability and durability	
	4.3.1.4. Resistance to damage from explosion, impact and human errors	Attach test reports
	4.3.1.5. Maximum allowable stress	Attach test reports
4.4	Fabrication of steels	
	4.4.1. General fabrication	Describe
	4.4.1.1. Standard of fabrication	State
	4.4.1.2. Single or modular steel type	State
	4.4.1.3. Inclusion of cap on both ends	State
	4.4.1.4. Flexural, compressive and shear strengths	Attach test reports
	4.4.1.5. Free from splinters and welding splatter	Attach test reports
	4.4.1.6. Flange joints free from distortion	Explain
	4.4.1.7. Dimensional accuracy of junction plates and welded mating surfaces	Attach test reports
	4.4.1.8. Base plate fabrication	Describe
	4.4.2. Steel requirements	Attach test report
	4.4.2.1. Steel grade and standards of manufacture	Attach test report
	4.4.2.2. Thickness of steel used in mm	Attach test report
	4.4.2.3. Impact properties of steel - Charpy V-notch requirements	Attach test report
	4.4.2.4. Silicon and phosphorous contents in %	Attach test report
	4.4.2.5. Aluminium killed steel or Silicon killed steel or both	Attach test report
	4.4.2.6. Proof of traceability of fabricated components	Attach test report
	4.4.3. Dimensional requirements	
	4.4.3.1. Pole top tolerances as per this clause	Attach test report
	4.4.3.2. Base and flange plates tolerances as per this clause	Attach test report
	4.4.4. Joints	
	4.4.4.1. Design resistance loads as per BS EN 1993-1-8 and -1-1	Attach test report
	4.4.4.2. Flange joint	
	a) Base and flange plate connection	
	(i) Flexural stresses	Attach test report
	(ii) Base and flange connection type	Attach test report
	(iii) Moment capacity of the lowest strength tube	Attach test report
	4.4.4.3. Type of connection and proof of conformity to Table 1.	Attach test report
	4.4.5. Welding	
	4.4.5.1. Applicable standard	State
	4.4.5.2. Through-thickness design stress	Attach test report
	4.4.5.3. Type of welds used and design properties as per the clause	Attach test report
	4.4.5.4. Flange and base plate welds	Attach test report
	4.4.5.5. Strength of the welded parts	Attach test report

CLAUSE	DESCRIPTION	BIDDERS' OFFER *(indicate details of offer and reference document submitted)*
	4.4.5.6. Inspection and testing of welds	Attach test report
	4.4.5.6.1. % critical welds and other welds	Attach test report
	4.4.5.6.2. Test method used for the welds	Attach test report
	4.4.6. Attachment points and bolt holes	
	4.4.6.1. Ultimate tensile strength of strain plates	Attach test report
	4.4.6.2. Compatibility of attachment points	Attach test report
	4.4.6.3. Openings or bolt holes if available.	Attach test report
	4.4.6.4. Treatment of openings-galvanizing, painting or coating treatment and tolerances	Attach test report
	4.4.7. Base plate and holding down bolt arrangement	
	4.4.7.1. Base plate design	Attach a drawing
	4.4.7.2. Holding down bolt arrangement	Attach a drawing
	4.4.7.3. Alternative bolt arrangement	Attach a drawing
	4.4.7.4. Allowable bond stress and comprehensive stress	Attach test report
	4.4.8. Earthing	
	4.4.8.1. Earthing arrangement	Attach a drawing
	4.4.8.2. Connection wire and current carrying capacity	Attach a drawing
	4.4.8.3. Straight HD bolts sizes	Attach a drawing
	4.4.8.4. Provision for additional earthing points	Attach a drawing
	4.4.9. Ladders/Climbing system	
	4.4.9.1. Climbing steps design and spacing	Attach drawing
	4.4.9.2. Design of brackets on the structure	Attach drawing
	4.4.9.3. Provision of permanent or loose ladder design	Attach drawing
	4.4.9.4. Type of ladder – single stile or twin stile system.	State
	4.4.10. Corrosion protection and finish considerations	Attach test report
	4.4.10.1. Minimum coating thickness and reference standards	State
	4.4.10.2. Finishing after galvanizing	Describe
	4.4.10.3. Application of paint or coating, paint colour and reference standard for paint	Provide evidence through test reports
	4.4.10.4. Provision of light blasting before painting	
	4.4.10.5. Application of vinyl primer and paint/coating thickness	
	4.4.10.6. Application of bitumen, extent of application and type of bitumen	
	4.4.11. Deflection limits	Attach test report
	4.4.11.1. Proof of conformity to resist	Attach test report
	a) Ultimate wind loads	Attach test report
	b) Broken conductor loads	Attach test report
	c) Workings loads	Attach test report
	d) Permanent set deflection limits after removal of ultimate load	Attach test report

CLAUSE	DESCRIPTION	BIDDERS' OFFER *(indicate details of offer and reference document submitted)*
	4.4.11.2. Further deflection limit of 1.5% on lateral loads	Attach test report
4.5	Aesthetic and Geometric considerations	
	4.5.1. Slenderness limits	
	a) Proof of conformity to lower height to width limits	Attach test report
	b) Proof of conformity to upper slenderness limits (KL/r)	Attach test report
	4.5.2. Tube size limits	
	a) Proof of conformity to lower tube limits and Table 2	Attach test report
	b) Proof of conformity to maximum tube length limits and Table 3	Attach test report
	4.5.3. Proof of conformity to tube taper limits and Table 4	Attach test report
4.6.	Classes of steel	
	4.6.1. Reference standard of classification	Attach test report
	4.6.2. Proof of conformity to IEEE C-2 (NESC) reference standard	Attach test report
	4.6.3. Proof of conformity to Table 5	Attach test report
	4.6.4. Pole designation as per the tender	Attach test report
4.7	Erection of steel poles	
	4.7.1. Erection tolerances	Attach test report
	4.7.1.1. Absolute construction deflection limits	Attach test report
	4.7.1.2. Provision of raking	Attach drawing
	4.7.1.3. Raking design	Attach drawing
	4.7.1.4. Orientation of HD bolts and templates	Attach drawing
	4.7.2. Tightening of bolts	Attach test report
	4.7.2.1. Provision of two (2) washers per bolt	Attach drawing
	4.7.2.2. Provision of heavy duty anaerobic thread-locking compound such as Loctite 271, 3M TL70, or similar approved	Attach drawing
	4.7.2.3. Tightening torque for "snug tight" fit	Attach test report
	4.7.3. Assembly of poles	
	4.7.3.1. Minimum pole deflection	Attach test report
	4.7.3.2. Jacking load	Attach test report
	4.7.3.3. Compression and tension loads at flange joints	Attach test report
	4.7.3.4. Provision of repair to damaged galvanizing	Attach test report
	4.7.4. Proof of conformity to general erection requirements	Attach test report
4.8	Steel pole foundation	
	4.8.1. Overview	Specify
	4.8.1.1 Type of foundation	Specify
	4.8.1.2 Concrete specification	Specify
	4.8.1.3 Design of foundation	Specify
	4.8.2 Conrete work specification	Attach test report
	4.8.2.1 Soil reinforcement	Specify
	4.8.2.1.1 Soil bearing and trial pit design	Specify

CLAUSE	DESCRIPTION	BIDDERS' OFFER *(indicate details of offer and reference document submitted)*
	4.8.2.1.2 Method of carrying soil tests	Specify
	4.8.2.2 Soil types	
	a) Class A design	Specify
	b) Class B design	Specify
	c) Class C design	Specify
	4.8.3 Shoring and timbering of excation	Specify
	4.8.4 Disposal of excavated materials	Specify
	4.8.5 Other services	Specify
	4.8.6 Backfilling	Specify
	4.8.6.1 Process of backfilling	Specify
	4.8.6.2 Compaction process	Specify
	4.8.7 Tolerance	Specify
	4.8.8 Concrete mix	
	4.8.8.1 Ready mix	Specify
	4.8.8.2 Truck mixer units	Specify
	4.8.8.3 Concrete test tubes and slump tests	Specify
	4.8.9 Materials	
	4.8.9.1 Aggregates, size 20mm	Attach test report
	4.8.9.2 Water	Attach test report
	4.8.9.3 Reinforcement steel	Attach test report
	4.8.9.4 Cement	Attach test report
	4.8.10 Formwork	Specify
	4.8.11 Batching	Specify
	4.8.12 Placing	Specify
	4.8.13 Compaction	Specify
	4.8.14 Testing	Specify
	4.8.15 Curing	Specify
	4.8.16 Records	Specify
4.5	Quality Management System	Provide
	Quality Assurance Plan	Provide
	Copy of ISO 9001:2008 Certificate	Provide
	Manufacturer's experience	Provide
	Manufacturing Capacity (units per month)	Provide
	List of previous customers	Provide
	Customer reference letters	Provide
5.1	Test standards and responsibility of carrying out tests	Provide
5.2	Copies of Type Test Reports submitted with tender	Provide
5.3	Acceptance tests to be witnessed by KPLC at factory before shipment	Provide
5.4	Test reports to be submitted by supplier to KPLC for approval	Provide

CLAUSE	DESCRIPTION	BIDDERS' OFFER *(indicate details of offer and reference document submitted)*
	before shipment	
5.5	Replacement of rejected steel poles	Provide
6.1	Markings	Provide
6.2	Packing	Provide
7.1	Documents submitted with tender	Provide
7.2	Documents to be submitted by supplier to KPLC for approval before manufacture	Provide
8.0	Statement of compliance to specification	Provide

.....

Manufacturer's Name, Signature, Stamp and Date

NOTE:

1. *All the details in the Guaranteed Technical Particulars (GTP) must be provided either through offered values supported by a test reports and test certivcates from ISO/IEC 17025 accredited laboratory or a detailed drawing with full technical details for a tenderer to qualify for technical specifications. Deviations shall be supported by full analytical proof of superiority.*

2. *Bidders who shall not provide the full details and test reports shall automatically be disqualified from participating in the technical tender evaluation.*

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ANNEX B – Loading of the poles

1. Structure Dimensions

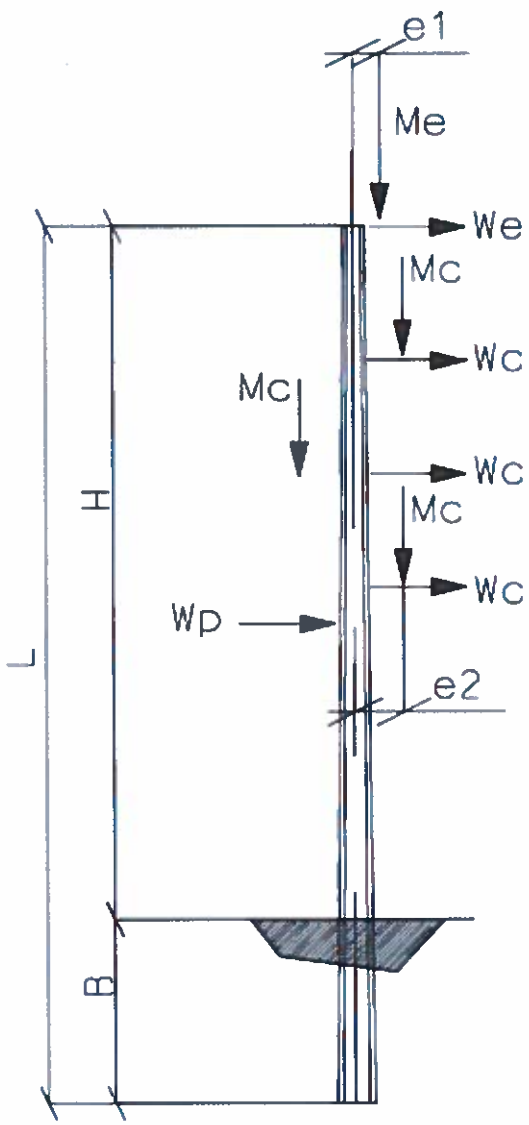

Figure 3: Pole dimensions

Me = Load due to mass of earth wire
Mc = Load due to mass of conductors
We = Wind load on earth

Wc = Wind load on conductors
Wp = Wind load on pole
L = Overall pole Length
B = Buried depth, (B = 0.1 L + 0.6 (m) guideline for intermediate freestanding structures)
H = Height of pole above theoretical ground level, H = L - B
e1 = Distance from center line of pole to vertical earth load
e2 = Distance from center line of pole to vertical conductor load

NOTE: *In the case of flanged towers, H is the overall height of the pole.*

2. Loading Parameters on Poles

2.1. The design loadings reflected to the pole top in both strong and weak direction, shall not exceed the strength of the pole in either direction.

2.2. In addition to the above, the combined loading (K) of the pole shall not exceed the factor given in the Table 6 below. The combination loading (K) is expressed as:

$$K = \frac{fs}{Fs} + \frac{fw}{Fw}$$

Where,

fs = applied load in strong direction
Fs = pole's design strength in strong direction
fw = applied load in weak direction
Fw = pole's design strength in weak direction

Table 6: K Factors for various formations

	Condition ,		K Factor
1	Sustained load conditions, without wind ,		1.0
2	Maintenance or erection condition (allow 20% of maximum wind loadings)		1.0
3	Short Duration Load conditions	All poles 1^0C with no wind	1.1
		At 15^0C plus wind	
		Line or angle pole	1.0
		Dead-end pole (Temporary or permanent)	1.5

3. Mechanical tests

2.1. Setup

NOTE: *The same manufacturing process shall be used for the test structure as used in the manufacturing of the structures for use on projects. KPLC shall advise on the surface coating of the structure prior to delivery to the test station.*

2.1.1. If possible, the butt end of the pole shall be rigidly clamped by steel or concrete cribs or similar rigid devices over length 'B' (see figure 1) with rubber inserts to protect the pole. The bearing block faces shall be of such dimension and construction that no damage is caused to the butt section.

2.1.2. The crib shall resist all longitudinal and rotational motions of the clamped portion of the pole. If this is not possible, the buried portion of the mast may be removed and the mast welded onto a base plate of adequate thickness to resist all imposed loads without deformation. This shall be discussed with the purchaser prior to commencement. This method is not a true reflection of the in-situ scenario but is an acceptable test setup.

2.1.3. Suitable brackets shall be welded onto the test structure in order to apply the required loads at the correct positions and heights. Positions of these shall be checked by the tester before testing commences.

2.2. Loading

2.2.1. Test loads shall be applied in increments to 50%, 75%, 90%, 95% and 100% of the specified loads. These levels may change depending on designer requirements. At these levels, a deflection reading shall be taken and generally a printout is drawn.

2.2.2. Loads shall be configured on the mast as they would be configured on site giving the worst loading case scenario (ie. the applied loads shall produce the maximum bending moments and/or crippling loads). For freestanding structures, the load simulating the wind load on the pole shall be applied to the tension face of the pole so that no structural stability is obtained from this point. A test-loading diagram shall be submitted to KPLC for approval before the commencement of any tests.

2.3. Load measurements

A load cell or other satisfactory method of load measurement shall be used. The load measuring device shall be suitably calibrated. It shall be supported in such a way that the

force required to pull it shall not add materially to the measured load on the pole and so that no damage is caused to the instrument if the pole suddenly breaks under test.

2.4. Recording of data and measurements

a) Deflections

The measurement of the pole tip deflection shall be taken as the horizontal distance from the initial position of the tip of the pole to the position of the tip when load has been applied to the pole. All deflection measurements shall be made correct to the nearest 5mm. During each load increment the maximum tip deflection shall be recorded.

b) Permanent set

Permanent set is the deflection of the mast (without loads) after undergoing a full load cycle. After a full loading cycle the permanent set shall be recorded and shall be taken correct to the nearest 5mm.

c) Loads

The load applied to the pole at the time of failure shall be recorded as accurately as possible to the nearest 0.5 Newton. This shall be referred to as the failure load.

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Annex C: Ladder Guidelines

5. General guideline for non-permanent ladders for steel monopole structures

NOTE: *Ladders shall start at an approximate height of 3m above ground level to prevent unauthorised persons climbing the structures.*

The following is a guideline only,

a) Overall ladder width = 300mm
b) Rungs: Minimum diameter = 16mm; Spacing = 300mm
c) Stringers: 40mm x 5mm
d) Brackets for the attachment of the ladder to the structure shall provide a minimum of 150mm horizontal spacing from the structure as per OHS Act requirements
e) Ladders shall be bolted onto structures on site when erected and not permanently welded onto structures. This will prevent damage to ladders during transportation.
f) If long ladders are required, the welded sections are to be bolted together
g) Back-support rings are NOT required unless specifically stated by KPLC
h) Ladder material: 300W steel of CSA G40.21 or equivalent.
i) All ladders shall be hot dip galvanised to ISO 1461

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ANNEX D: Pole Classification as per ANSI 05.1-2002.

FIGURE 1:

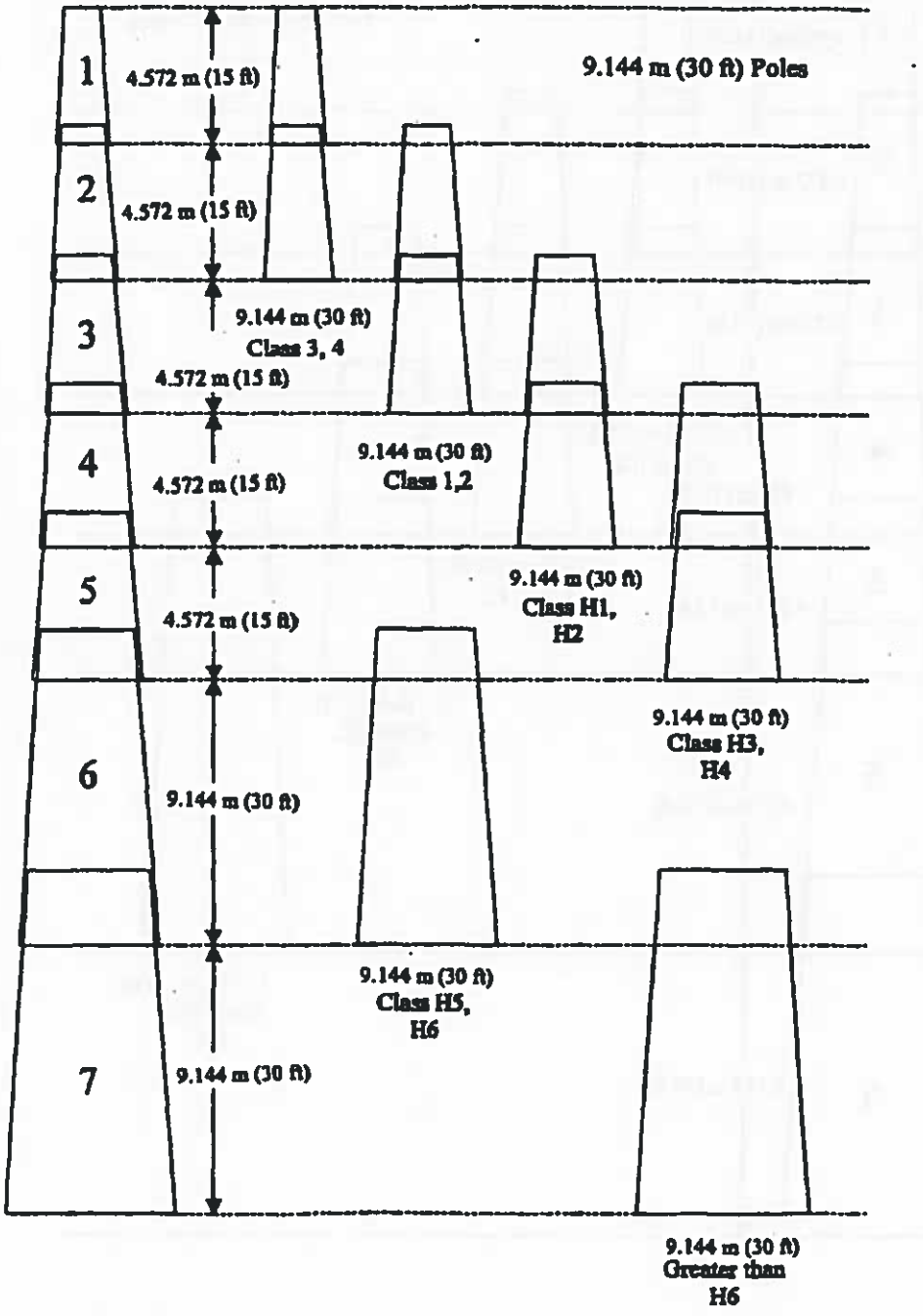


FIGURE 2:

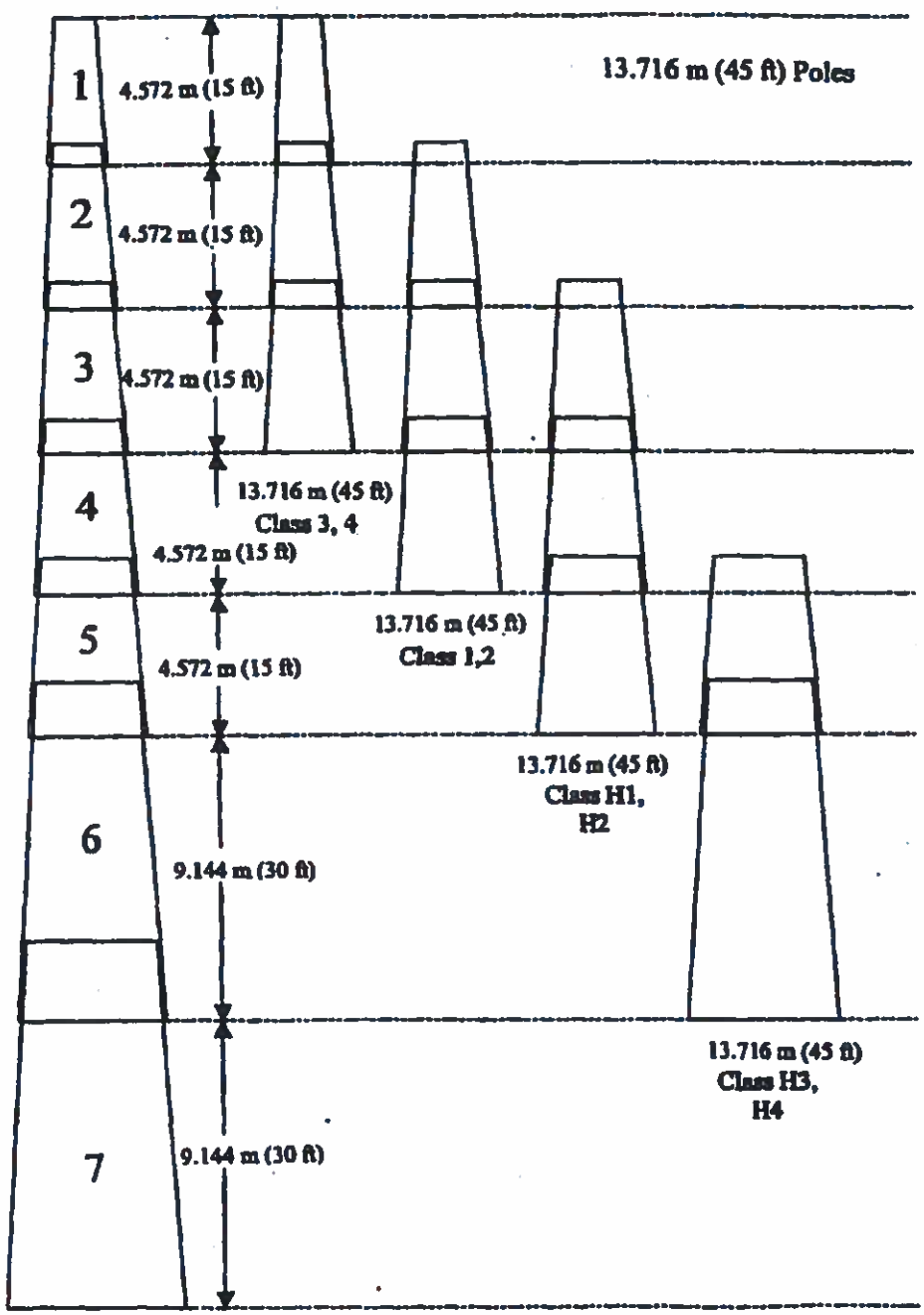

13.716 m (45 ft) Poles
1
4.572 m (15 ft)
2
4.572 m (15 ft)
3
4.572 m (15 ft)
4
13.716 m (45 ft)
Class 3, 4
4.572 m (15 ft)
5
4.572 m (15 ft)
13.716 m (45 ft)
Class 1,2
13.716 m (45 ft)
Class H1,
H2
6
9.144 m (30 ft)
13.716 m (45 ft)
Class H3,
H4
7
9.144 m (30 ft)

FIGURE 3:

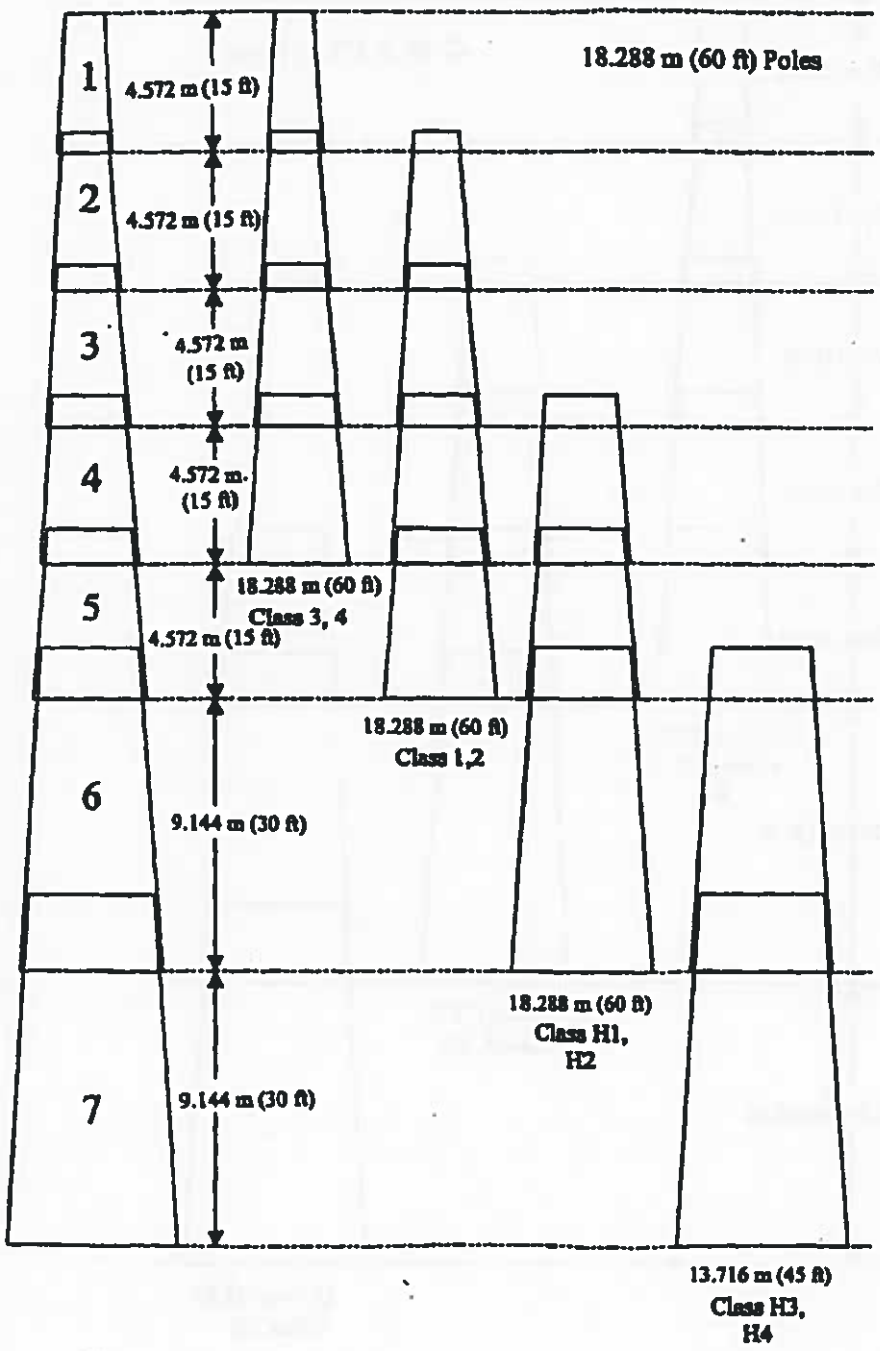

18.288 m (60 ft) Poles
1
4.572 m (15 ft)
2
4.572 m (15 ft)
3
4.572 m (15 ft)
4
4.572 m. (15 ft)
5
4.572 m (15 ft)
6
9.144 m (30 ft)
7
9.144 m (30 ft)
18.288 m (60 ft) Class 3, 4
18.288 m (60 ft) Class 1,2
18.288 m (60 ft) Class H1, H2
13.716 m (45 ft) Class H3, H4

FIGURE 4:

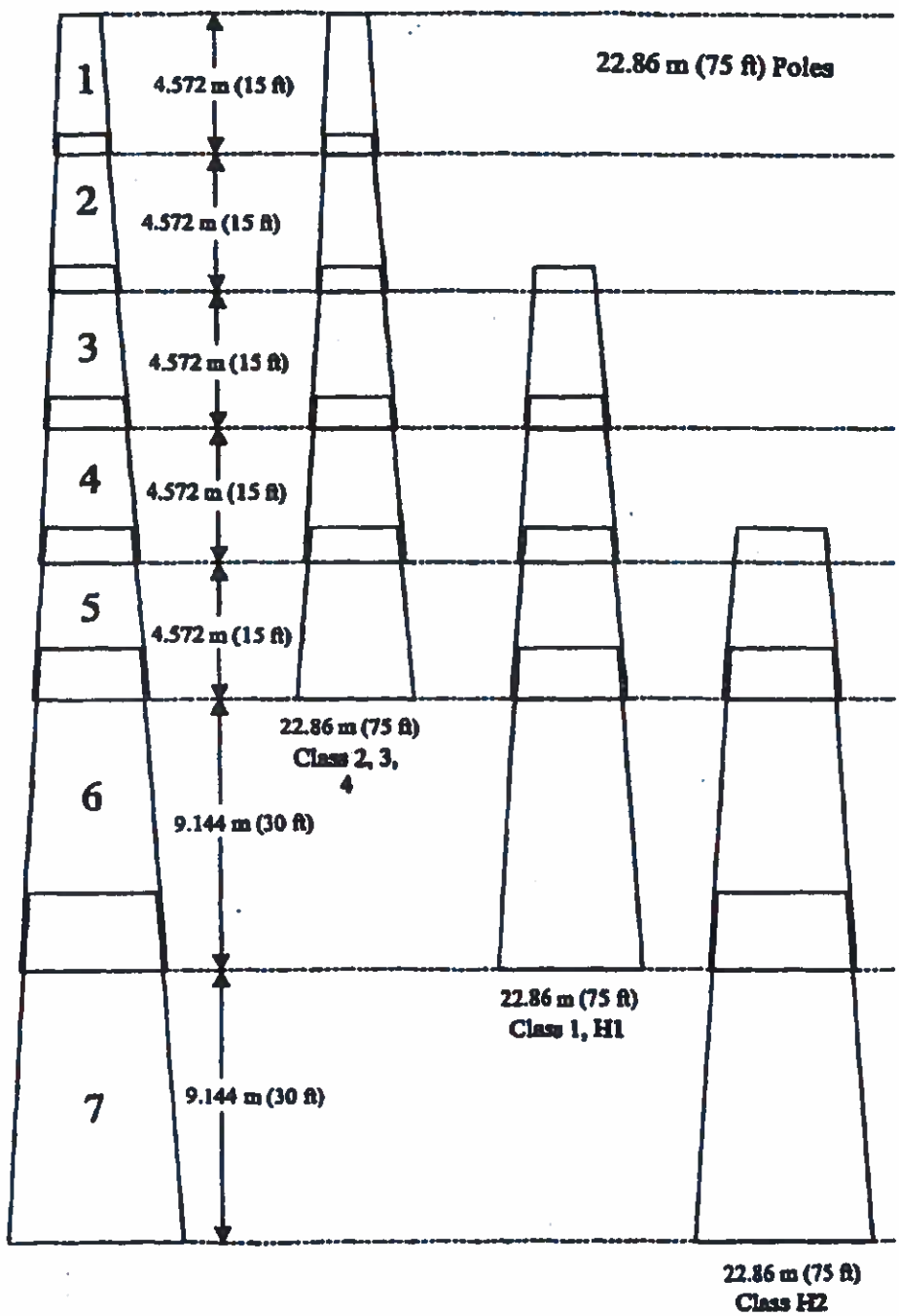
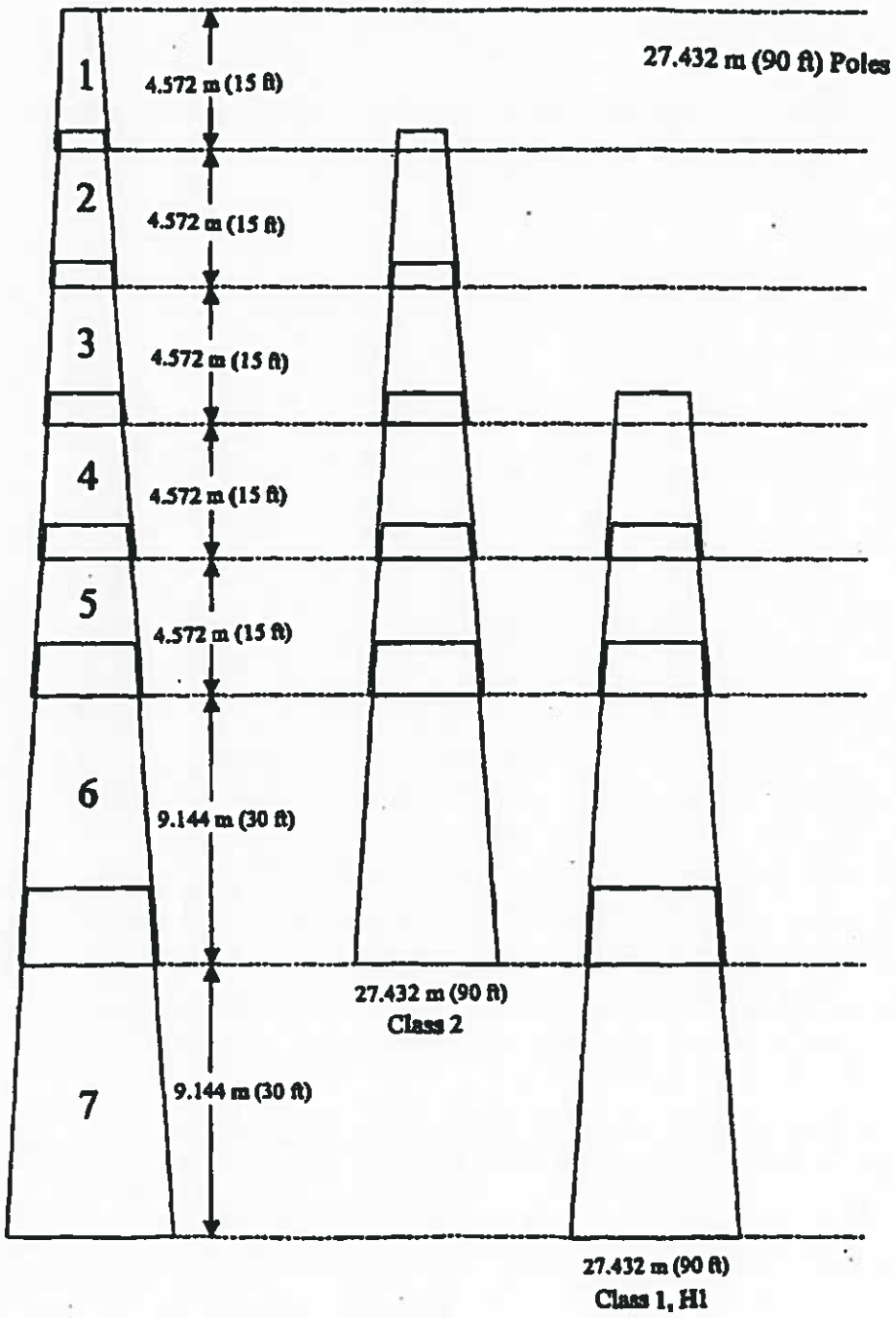

1
2
3
4
5
6
7
4.572 m (15 ft)
4.572 m (15 ft)
4.572 m (15 ft)
4.572 m (15 ft)
4.572 m (15 ft)
9.144 m (30 ft)
9.144 m (30 ft)
22.86 m (75 ft) Poles
22.86 m (75 ft)
Class 2, 3, 4
22.86 m (75 ft)
Class 1, H1
22.86 m (75 ft)
Class H2

FIGURE 5:


27.432 m (90 ft) Poles
1
4.572 m (15 ft)
2
4.572 m (15 ft)
3
4.572 m (15 ft)
4
4.572 m (15 ft)
5
4.572 m (15 ft)
6
9.144 m (30 ft)
7
9.144 m (30 ft)
27.432 m (90 ft)
Class 2
27.432 m (90 ft)
Class 1, H1