

Ref:	NR/L2/ELP/27212
Issue:	3
Date:	26 August 2008
Compliance date:	26 August 2008

Level 2

Maintenance of Mark I overhead line equipment

Endorsement and Authorisation

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Published and Issued by Network Rail, 40 Melton Street, London NW1 2EE.

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Issue record

Issue	Date	Comments
1	December 2004	Formerly EHQ/ST/O/001, Issue 2, 12/05 1992. Transcribed to current Network Rail format with no technical changes
2	April 2006	Re-issued as a SAF3 Business Process Document (formerly RT/E/S/27212)
3	August 2008	Responsibilities amended for phase 2A re-organisation

Compliance

This Network Rail standard is mandatory and shall be complied with by Network Rail and its contractors if applicable from 26 August 2008.

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Reference documentation

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1 Introduction

This Specification details the maintenance tolerances for Mark I design Overhead Line Equipment and shows the background information and method of formulation.

2 Definitions

Blow-off

Blow-off is the maximum distance through which the contact wire is blown-off across track at mid-span under full wind conditions with no mast deflection. See Appendix A, sketch 3.

Electrical clearance - Passing

Passing clearance is the clearance between live parts of the overhead equipment or pantograph and any earthed material or the loading gauge for a brief period under the worst conditions of motion, operation and maintenance.

Electrical clearance - Static

Static clearance is the clearance between the live parts of the overhead equipment when not subject to pantograph pressure and an overhead structure or earthed parts of the overhead equipment. It is also, at places where rolling stock habitually stands for more than a brief period (as in terminal stations, stabling lines, etc.), the clearance between the live parts of the overhead equipment when not subject to pantograph pressure and the loading gauge, or between such live parts when uplifted by pantograph pressure and an overhead structure or earthed parts of the overhead equipment.

Permissible deviation

Permissible deviation is the maximum allowable distance which the contact wire may be from the centre line of the static pantograph under full wind conditions at any point in the span, with no mast deflection. See Appendix A, sketch 2.

Permissible mid-span offset

Permissible midspan offset is the maximum allowable distance which the contact wire may be from the centre line of the static pantograph under still air conditions at mid-span. See Appendix A, sketch 1.

Stagger effect

Due to stagger the maximum contact wire deviation may not occur at mid-span. Stagger effect is the distance that should be added to the value of "blow-off" measured at mid-span to determine the maximum distance through which the contact wire is blown-off across track at any point in span under full wind conditions. See Appendix A, sketch 4.

Sweep

Sweep is the lateral movement of the contact wire across the pantograph in the course of its travel between any two registration points and is the total of such movement, either from one side to the other, or from one side towards the centre and back towards the same side. See Appendix A, sketches 5 and 6.

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3 Technical data governing position of contact wire

3.1 Contact wire stagger

Normal permissible deviation = 19" (480 mm)

In exposed areas desirable maximum in-span deviation = 16.75" (425 mm)

The figures are to be reduced by 0.5" (15 mm) per ft. (300 mm) rise in contact wire height above 16' (4.87 m).

The nominal staggers for the equipment are:-

- Tangent Track : 9" (230 mm) normal;
- Curved Track : 15" (380 mm) maximum.

The adjustment criterion shall be Mid-Span Offset under still air conditions rather than nominal staggers at structures.

NOTE Curves and complicated areas - staggers as required to obtain the permissible mid-span offset or less.

A working tolerance of $\pm 0.5"$ ($\pm 15\text{mm}$) will be permissible on the above figures.

Stagger effect shall be taken into account when assessing mid-span offset in the case of tangent or curved track with unequal staggers and allowance has been made for this in the accompanying tables.

For blow-off values see Section 7.1; for maximum deviation formula see Section 7.2.

The tables in Section 7.3 give the permissible mid-span offset of contact wire at various heights. For automatic tensioned equipment 1" (25 mm) has been deducted from the figures to allow for the effect of temperature movement.

In exposed areas it is desirable to take advantage of any tolerance to reduce the maximum permissible in-span deviation from 19" (480 mm) to 16.75" (425 mm) therefore separate tables have been produced for normal and exposed areas. In exposed areas where it is not possible to work within the limits of the exposed area tables, the matter shall be referred to the Principal Maintenance Support Engineer (M&E) or nominated representative.

3.2 Contact wire height - Load gauge 13'1" (3.99 m)

Type of Clearance		25 kV	
Normal Minimum	Running (Passing)	13'10"	4.215m
	Standing (Static)	14'0"	4.270m
Absolute Minimum	Running (Passing)	13'8"	4.165m
	Standing (Static)	13'9"	4.190m
Maximum		19'6"	5.94m

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All the above values are after the application of all agreed tolerances.

The absolute minimum clearance for 25 kV must not be adopted without the authority of the Principal Maintenance Support Engineer (M&E) or nominated representative.

NOTE When employing low contact wire heights and at level crossings and overbridges, the degree of tolerance is limited and the wire must be maintained so that it lies within the specified limits under all conditions. See Section 4.4 for electrical clearances and Section 7.4 for rise and fall of contact wire at mid-span and structure due to ice loading and the temperature variations.

Between maximum and minimum height a tolerance of 3" (75 mm), on open route, can be accepted for normal contact wire height providing the contact wire gradient between registration points is no steeper than 1 in (5 x maximum speed) in mile/h or 1 in (3 x maximum speed) in km/h. The best possible grading shall be achieved at bridges, with no sudden changes in gradient.

When carrying out the adjustment, the aim shall be to maintain standard catenary/contact wire separation and standard dropper lengths.

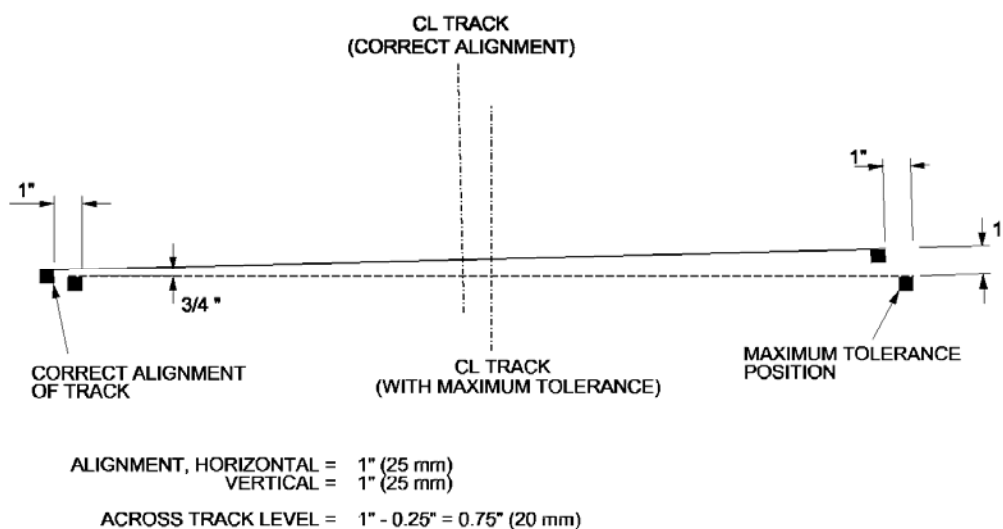
4 Limits of mechanical and electrical clearances

4.1 Track tolerances

Misalignment allowance = $\pm 1"$ (25 mm) vertical and horizontal.

Across track level = $\pm 0.75"$ (20 mm)

NOTE At bridges and tunnels these allowances are reduced to 0.5" (15 mm) in each case.



4.2 Sway of pantograph

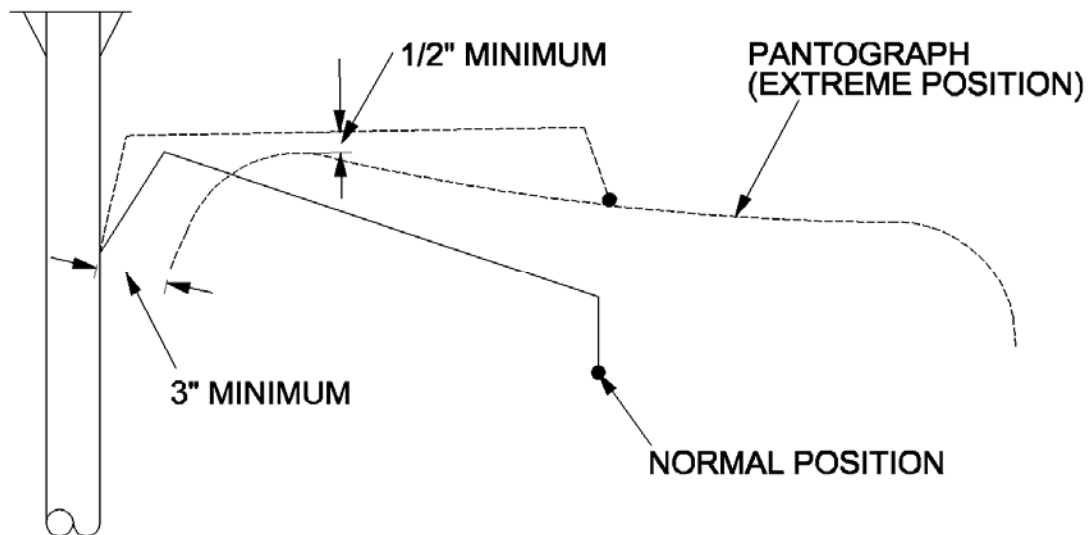
The sway of the Pantograph is limited to 5" at 14' (125 mm at 4.27 m) with an increase of 0.5" per ft. (40 mm/m) in contact wire height.

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4.3 Mechanical clearance

4.3.1 In addition to the sway a minimum mechanical clearance of 3" (75 mm) is required between pantograph and any fixed live equipment (e.g. drop bracket) after allowing for 1" (25 mm) misalignment of track and 0.75" (20 mm) variation in across track level.

4.3.2 A minimum clearance of 0.5" (15 mm) is required between the pantograph and the steady arm under all conditions (i.e. worn pantograph and worn contact wire).



4.3.3 Section 7.5 takes into consideration a pantograph sway figure of 7.5" (190 mm) at 14" (4.27 m) with an increase of 0.5" per foot (40 mm/m) rise in contact wire height.

4.3.4 Where these figures cannot be applied the 5" (125 mm) sway figure may be used subject to the discretion of the Principal Maintenance Support Engineer (M&E) or nominated representative.

4.3.5 At bridges and tunnel locations the 5" (125 mm) figure shall apply.

4.4 Electrical clearance - Live equipment to earth

	Static Clearance	Passing Clearance
Normal	11" (270 mm)	8" (200 mm)
Reduced - where authorised by the Principal Maintenance Support Engineer (M&E) (or nominated representative)	8" (200 mm)	6" (150 mm)
Special Clearances	-	3" (80 mm)

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The special clearance applies to brick and masonry over-bridges, between pantograph horn and bridge only; not between equipment and bridge. This may only be used where the Principal Maintenance Support Engineer (M&E) or nominated representative has obtained dispensation from the HMRI.

Pantograph sway, uplift and track tolerance must be allowed for where applicable.

4.5 Clearance from in-span pantograph (Other than bridges and tunnels)

The contact wire height to be used when checking the above electrical/mechanical clearance is:-

Actual contact wire height plus a composite allowance for uplift and temperature variation of 9" (230 mm) for Automatic Tensioned Equipment.

An allowance of 11" (270 mm) shall be made for Fixed Termination Equipment.

5 Heel settings and mechanical clearances to steady arms

5.1 Automatic tensioned equipment

The accepted tolerance on steady arm heel settings is: +0.5" (15 mm).

The undermentioned tables have been produced giving the minimum stagger settings for each arm:

5.1.1 Desirable minimum stagger settings

Based on 7.5" sway at 14' (190 mm at 4.27 m). The aim should be to obtain these values whenever carrying out modifications to the overhead line equipment especially at higher speed sections.

Section 7.5.1. Pull-off and push-pull-off registration.

Section 7.5.2 Direct push-off registration.

5.1.2 Absolute minimum stagger settings

In the event of the desirable stagger settings being unobtainable the Principal Maintenance Support Engineer (M&E) or nominated representative should be informed. This should be done with a view to using the desirable stagger settings based on 5" sway at 14' (130 mm at 4.27 m).

5.2 Fixed termination equipment

The standard values of steady arm heel setting should be adhered to at all temperatures between 40°F and 60°F (4°C and 15°C); 1" (25 mm) should be subtracted if the temperature falls below 40°F (4°C) at the time of final registration and 1" (25 mm) added if the temperature rises above 60°F (15°C).

The accepted tolerance on steady arm heel settings is:- +0.5" (15 mm).

Instructions for steady arms peculiar to fixed termination equipment are stated in Section 7.6.

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5.3 Adjustable steady arms

In the case of the substitution of an adjustable steady arm for a fixed length steady arm, or of the adjustment of length of an existing arm, check that clearances to pantographs are adequate.

5.4 Registration adjustments and effect on adjacent equipment

It is essential when carrying out adjustments to check that the requirements of Sections 4.2, 4.3, 4.4 and 4.5 are not infringed by a pantograph on an adjacent line and/or crossover and/or junction.

5.5 Support arms at overbridges

Section 7.7 has been produced to give the minimum stagger setting for each assembly.

6 Other requirements

6.1 Sweep ratio

Sweep ratio may vary between the limits of 1: 50 and 1: 400, where sweep ratio = sweep/span length. Values beyond these limits shall be reported to the Principal Maintenance Support Engineer (M&E) or nominated representative.

6.2 Catenary clearances - Automatic tensioned equipment

6.2.1 Twin cantilever structure

1" (25 mm) is the absolute minimum clearance, at all temperatures, between catenary and non-associated cantilever assembly (Top tie/strut tubes).

6.2.2 In-span

Minimum clearance between catenaries is 9" (230 mm) mid-span of 240' (73 m) span and 3" (75 mm) in the case of a 60' (18 m) span. The clearance may be reduced proportionately when the crossing point is not mid-span but 3" (75 mm) is the absolute minimum acceptance figure. Chafing sleeves are to be fitted to the catenaries when the clearance is within 3" (75 mm) of the minimum value for the position in the span concerned.

6.3 Section insulators

It is desirable that whenever the stagger/ in-span permissible deviation allows, the centre line of a section insulator is adjusted to zero offset. The maximum permissible offset for each type of section insulator is:-

B.I.C.C. Porcelain 25 kV (Symmetrical Unit)	3"	(75 mm)
Brown Boveri Porcelain 25 kV	4"	(100 mm)
B.I.C.C. toughened glass runner	12"	(300 mm)
B.I.C.C. Glass Fibre (ceramic collar) 25 kV	12"	(300 mm)

The values apply for section insulators within 40' (12 m) of the registration assembly (structure). Cases outside the above tolerances must be referred to the Principal Maintenance Support Engineer (M&E) or nominated representative.

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6.4 Clearance to return conductors

Clearance between Return Conductors and the overhead equipment, including pantographs shall be a minimum of 8" (200 mm).

Clearance between Return Conductors and structures, lineside fixtures or other fixed earth installations shall be a minimum of 2" (50 mm) except in respect of a structure to which the Return Conductor is attached, when a minimum figure of 1.5 " (40 mm) shall apply.

The above minimum clearances shall be available after allowing pantograph movement, track tolerances, blow-off, rise and fall due to temperature change, where applicable.

Where the Return Conductor crosses over live equipment and the vertical clearance is less than:

3' (914 mm) for un-insulated conductor

4' (1.22 m) for insulated conductor

then the actual clearance must be calculated so that 8" (200 mm) is available at 100°F (38°C) allowing for catenary uplift.

The Return Conductor shall be insulated at all locations where the clearance to the Return Conductor is suspect and where it presents a hazard under maintenance.

6.5 Setting of overlaps

On tangent track the "in-running" staggers must be 9" (230 mm) on both sides of the centre line of the track. On curved track the stagger of the "in-running" equipment at each end of the overlap must be to the outside of the curve and must be equal to the string line in the overlap span up to a maximum of 15" (380 mm). A tolerance of plus or minus 1" (25 mm) can be allowed on these staggers and on the minimum horizontal distance between the equipments at mid-span which, at 60°F (15°C), are as follows:

25 kV insulated overlaps - 1'9" (530 mm)

6.25 kV insulated and all un-insulated overlaps - 1'3" (380 mm)

It is essential that a minimum vertical clearance of 9" (230 mm) is maintained between "out-of-running" equipment at the contact wire cut-in insulation and a line at "in-running" contact wire level parallel to the track. In high speed sections (where the speed is in excess of 100 mile/h (160 km/h)) the dimension should be increased to 11" (280 mm).

6.6 Balance weight settings

The balance weights should be adjusted if necessary, to enable free movement over the temperature range 0°F to 100°F. (-18°C to 38°C). Stops are to be removed if fitted, except in certain localities where they may be retained at the discretion of the Principal Maintenance Support Engineer (M&E) or nominated representative.

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6.7 Catenary alignment

6.7.1 Simple catenary equipment

For a catenary to contact wire distance of 4' (1.22 m) or more the catenary may be offset, from the vertical centre line of the contact wire, by $\pm 3"$ (75 mm). If the catenary to contact wire distance is less than 4' (1.22m) the catenary/contact wire offset must be made proportionately less.

6.7.2 Compound equipment

Catenary/contact wire alignment should be as described for simple equipment except that the auxiliary catenary must be registered vertically above the contact wire so that the loop droppers will lift vertically due to the passage of pantographs.

7 Technical information and tables

7.1 Blow off tables (Steady wind speed of 60 miles/h)

7.1.1 Compound automatic tensioned equipment

Span Feet	Blow-off inches	Span Feet	Blow-off inches	Span Feet	Blow-off inches	Span Feet	Blow-off inches
240	18	204	13.50	165	9	116	4.50
238	17.75	202	13.25	163	8.75	112	4.25
236	17.50	200	13	160	8.50	109	4
234	17.25	198	12.75	158	8.25	105	3.75
232	17	195	12.50	156	8	101	3.50
230	16.75	193	12.25	153	7.75	97	3.25
228	16.50	191	12	151	7.50	93	3
226	16.25	189	11.75	148	7.25	89	2.75
224	16	187	11.50	145	7	85	2.50
222	15.75	185	11.25	143	6.75	81	2.25
220	15.50	183	11	140	6.50	77	2
218	15.25	181	10.75	137	6.25	71	1.75
216	15	179	10.50	134	6	66	1.50
214	14.75	177	10.25	131	5.75	61	1.25
212	14.25	174	10	128	5.50	55	1
210	14.25	172	9.75	125	5.25	48	0.75
208	14	170	9.50	122	5	39	0.50
206	13.75	168	9.25	119	4.75	25	0.25

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7.1.2 Simple automatic tensioned equipment

Span Feet	Blow-off inches	Span Feet	Blow-off inches	Span Feet	Blow-off inches	Span Feet	Blow-off inches
240	17.50	207	13	168	8.50	114	4
238	17.25	205	12.75	165	8.25	110	3.75
236	17	203	12.50	162	8	107	3.50
234	16.75	201	12.25	160	7.75	103	3.25
233	16.50	199	12	157	7.50	100	3
231	16.25	197	11.75	154	7.25	96	2.75
230	16	195	11.50	152	7	92	2.50
228	15.75	193	11.25	149	6.75	88	2.25
226	15.50	190	11	146	6.50	83	2
224	15.25	188	10.75	144	6.25	77	1.75
222	15	186	10.50	140	6	70	1.50
220	14.75	184	10.25	137	5.75	64	1.25
218	14.50	182	10	134	5.50	57	1
217	14.25	179	9.75	131	5.25	48	0.75
215	14	177	9.50	128	5	36	0.50
213	13.75	175	9.25	125	4.75	19	0.25
211	13.50	172	9	121	4.50		
210	13.25	170	8.75	118	4.25		

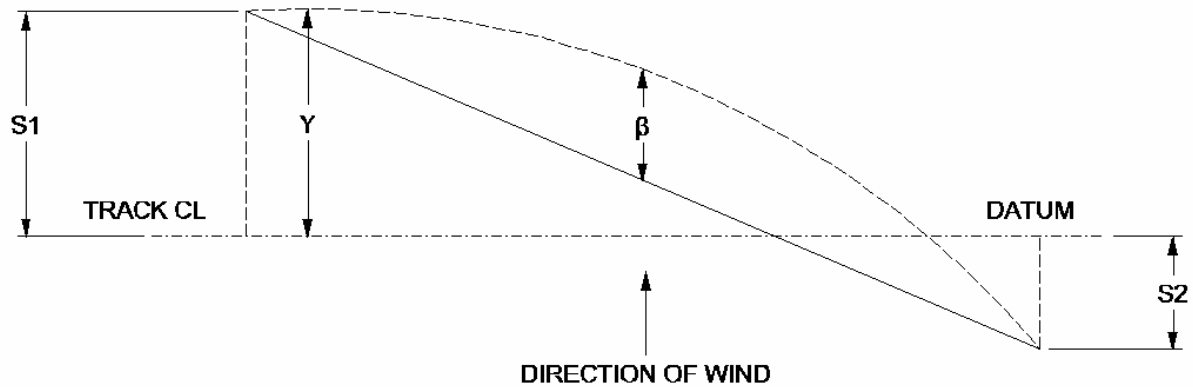
7.1.3 Fixed termination equipment

Span Feet	Blow-off inches	Span Feet	Blow-off inches	Span Feet	Blow-off inches	Span Feet	Blow-off inches
210	12	181	9	148	6	105	3
207	11.75	179	8.75	145	5.75	100	2.75
205	11.50	176	8.50	142	5.50	95	2.50
203	11.25	174	8.25	139	5.25	91	2.25
200	11	171	8	135	5	86	2
198	10.75	168	7.75	132	4.75	81	1.75
196	10.50	166	7.50	128	4.50	75	1.50
193	10.25	163	7.25	125	4.25	69	1.25
191	10	160	7	121	4	62	1
189	9.75	157	6.75	117	3.75	54	0.75
186	9.50	154	6.50	114	3.50	43	0.50
184	9.25	151	6.25	110	3.25	28	0.25

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7.2 Formulae for maximum deviation of contact wire

7.2.1 Tangent track



Y = Maximum Deviation in span

β = Blow Off at mid-span

S1 & S2 = staggers at structures

Maximum Deviation (where staggers are on opposite sides of track centre line) is given by

$$Y = \beta + \frac{(S1 + S2)}{2} + \frac{(S1 + S2)^2}{16\beta}$$

NOTE 1 Stagger Effect is given by the following formula:

$$\frac{(S1 + S2)^2}{16\beta}$$

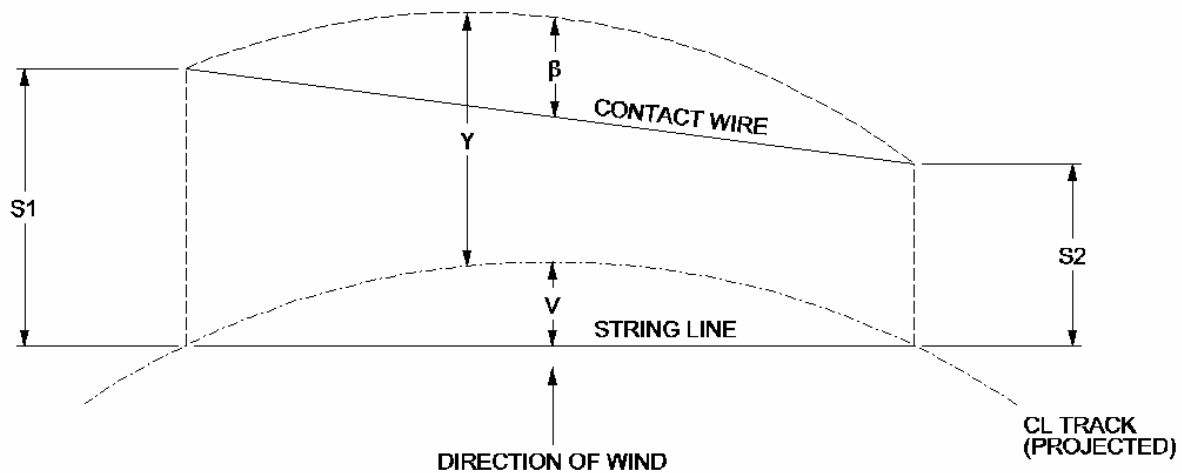
NOTE 2 If staggers are different the larger is to be S1

NOTE 3 If staggers are both on one side of the centre line of the track then Maximum Deviation is given by

$$Y = \beta + \frac{(S1 + S2)}{2} + \frac{(S1 - S2)^2}{16\beta}$$

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7.2.2 Curved track



V = Versine of curve (string line dimension); other symbols as for tangent track case.

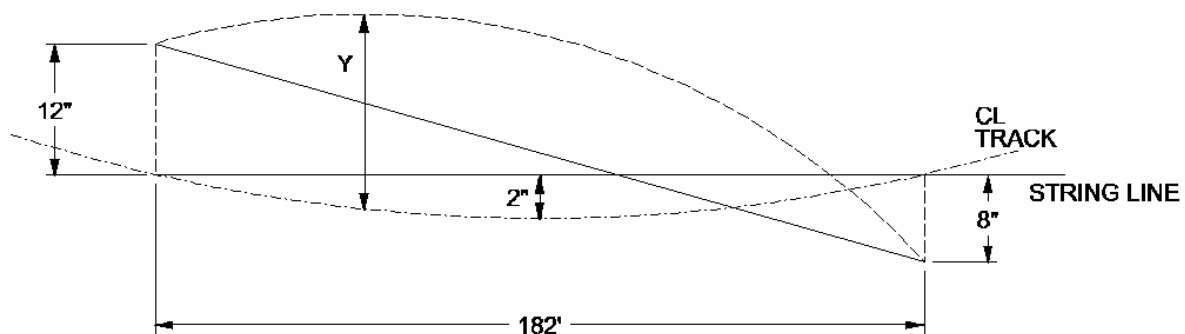
$$Y = (\beta - V) + \frac{(S1 + S2)}{2} + \frac{(S2 - S1)^2}{16(\beta - V)}$$

Note that Stagger Effect is given by the formula $\frac{(S2 - S1)^2}{16(\beta - V)}$

and is only valid when (S1-S2) is less than 4(beta-V) or 4((beta-(-V))), otherwise maximum deviation is at the structure.

EXAMPLE

Simple equipment



$$\beta = 10", V = -2", S1 = 12", S2 = -8".$$

$$Y = \beta - V + \frac{(S1 + S2)}{2} + \frac{(S2 - S1)^2}{16(\beta - V)}$$

$$Y = 10 - (-2) + \frac{(12 + (-8))}{2} + \frac{(-8 - (+12))^2}{16(10 - (-2))}$$

$$Y = 10 + 2 + 2 + 2\frac{1}{12} = 16"$$

i.e. Maximum deviation in span = 16 inches