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Kings Lynn OH Line Design Check

David Miller Technical Format

Kings Lynn Overhead Line Design Check — New Installation

275kV Double-Circuit Lattice Suspension Tower — Loads Design Check

Illustrative Capability Example — Metric Units — Assumed Data

This example is prepared as a professional capability demonstration using assumed data. It is not a formal design certificate and must not be used for construction without project-specific drawings, conductor data, span data, weather data, ground information, client specifications and competent engineering approval.

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2. Purpose of Check

This document presents an illustrative loads design check for a 275kV overhead line (OHL) suspension structure, prepared in David Miller's technical reporting format. Its purpose is to demonstrate the calculation presentation, engineering review approach and construction-risk thinking applied to HV overhead line civil and structural work.

The check works through the principal load actions on a suspension tower — vertical (dead) wire load, transverse wind, longitudinal imbalance, ice sensitivity and construction load — and summarises support reactions, foundation and temporary works interfaces, CDM 2015 design risk, and the actions required to convert this illustrative exercise into a real, verified check.

Professional context: David Miller has experience supporting HV / overhead line civil engineering, construction methodology, risk assessment and technical reporting, including works in the Kings Lynn area involving Babcock while working with Carillion. No unverified project facts are stated; all line, conductor, span, weather, ground and capacity values used here are assumed for illustration.

3. Scope and Limitations

In scope

- Illustrative load actions on a single 275kV double-circuit suspension tower and its attachment points.
- Presentation of vertical, transverse wind, longitudinal, ice-sensitivity and construction load cases with full metric workings.
- Support-reaction summary, foundation/civils interface review, temporary works and access review, CDM 2015 design-risk review, and RAMS/ITP commentary.

Out of scope / limitations

- This is not a structural adequacy certificate. Member-by-member tower analysis, connection design, conductor sag-tension modelling, and full geotechnical foundation design are not performed.
- All input data is assumed. Capacities used in utilisation checks are nominal placeholders and must be replaced with verified structure and foundation capacities.
- No statement of approval, verification, compliance or fitness for construction is made. Electrical clearances, earthing and live-working controls are the responsibility of the appointed authorised persons and are not assessed here.
- Wind, ice and load-factor treatment is simplified for illustration and framed against the EN 50341 family and its UK National Annex; the current published editions and the project specification govern any real check.

4. Assumed Project Data

All values below are assumed for illustration only.

Parameter	Assumed value	Unit / note
Voltage	275	kV, double circuit (assumed)
Structure type	Steel lattice suspension tower	Assumed; not angle/terminal

Parameter	Assumed value	Unit / note
Tower height (to top crossarm)	28	m (assumed)
Number of phases	6	3 phases × 2 circuits
Conductor	Twin-bundle ACSR (Zebra-equivalent)	Assumed
Subconductors per phase	2	Twin bundle
Conductor diameter	28.6	mm (assumed)
Conductor mass	1.621	kg/m per subconductor (assumed)
Working tension per subconductor	30	kN (assumed everyday tension)
Earthwire	1 × 11.0 mm, 0.59 kg/m	Assumed
Ruling / wind span	350	m (assumed)
Weight span	380	m (assumed)
Basic wind speed	26	m/s (assumed UK lowland)
Air density	1.25	kg/m³
Ice (base case)	Nil	12 mm radial as sensitivity only
Terrain / exposure	Open, flat (Cat. II-type)	Assumed
Foundation type	Pad-and-chimney	Assumed; pile alt. noted
Load factor approach	Limit-state / partial factors	Illustrative; γW = 1.4 assumed
Client specification	[insert if known]	Assumed governing if provided

5. Information Required for a Real Check

A real Kings Lynn OHL design check would require the following verified information before any result could be relied upon:

- Approved line route, profile and structure schedule with actual wind spans, weight spans and deviation (line) angles per structure.
- Verified conductor and earthwire data: type, diameter, mass, RTS, and the conductor sag-tension study across the specified weather cases.
- Tower outline and verified factored capacities (member and panel), crossarm geometry and attachment positions.
- Site-specific wind data and ice/combined ice-and-wind cases per the project specification and EN 50341 UK National Annex.
- Ground investigation: soil profile, design parameters, groundwater, and allowable bearing / uplift for the foundation type.
- Client / asset-owner specification, broken-wire and security load cases, and the required design and check categories.
- Construction methodology, stringing arrangement, plant data and the Temporary Works Register.

6. Design Basis and Reference Guidance

The check is framed using widely recognised overhead-line and structural-loading principles. Reference is made only — no copyrighted text is reproduced — to:

- The EN 50341 family for overhead electrical lines exceeding AC 1 kV, together with the relevant UK National Annex, where applicable and where supplied.
- The Eurocodes and their UK National Annexes for actions, structural steel and geotechnical design, where applicable.
- Recognised transmission-line structural-loading guidance (e.g. ASCE manuals) used as background learning on load actions and load cases only.
- CDM 2015 for design risk; BS 5975 for temporary works procedures; and HSE guidance for excavation, lifting and work near live electrical apparatus, where applicable.

Where the project specification, asset-owner standard or a current published edition differs from the simplified treatment used here, those documents govern.

7. Structure Type and Line Arrangement

Assumed arrangement: a 275kV double-circuit steel lattice suspension tower carrying six phases (two vertical circuits of three phases) on twin-bundle ACSR, with a single overhead earthwire at the peak. Suspension towers carry the line on suspension insulator sets and are intended for predominantly straight-line (near-zero deviation angle) positions; the dominant lateral action is therefore transverse wind rather than a steady line-angle pull.

A suspension structure is sensitive to longitudinal (along-line) actions arising from unbalanced spans and broken-wire events. These are considered in Section 13. Angle and terminal towers, which carry sustained longitudinal and resultant line-angle loads, are outside the scope of this illustrative suspension check.

8. Conductor / Wire Data

Item	Phase conductor	Earthwire
Type (assumed)	Twin-bundle ACSR (Zebra-equiv.)	Single steel/ACSR
Subconductors	2	1
Diameter (mm)	28.6	11.0
Mass (kg/m, per subconductor)	1.621	0.59
Bundle mass (kg/m)	3.242	0.59
Working tension (kN, per subcond.)	30 (bundle 60)	[insert]

Bundle self-weight line load (used below): $w = n \times m \times g = 2 \times 1.621 \times 9.81 = 31.80$ N/m per phase.

9. Span Geometry

Span parameter	Assumed value	Use in check
Wind span (m)	350	Transverse wind on wires
Weight span (m)	380	Vertical (dead) wire load

Span parameter	Assumed value	Use in check
Deviation (line) angle	0° (suspension)	No steady line-angle pull
Adjacent span imbalance	Assumed for broken-wire case	Longitudinal action

Wind span governs transverse wind; weight span governs vertical load. The two differ on real lines because of terrain and tower siting; assumed values are used here.

10. Load Cases Considered

Case	Description	Governing action
LC1 — Dead/vertical	Self-weight of wires, insulators and fittings (still air)	Vertical
LC2 — Maximum wind	Transverse wind on conductors, earthwire and structure	Transverse
LC3 — Broken wire	Longitudinal imbalance from one bundle break (suspension)	Longitudinal
LC4 — Ice / combined (sensitivity)	Radial ice on wires; combined ice + wind	Vertical + transverse
LC5 — Construction	Stringing/sagging loads with dynamic allowance	Vertical (local)

11. Vertical Load Check (LC1)

11.1 Vertical load per phase attachment

Formula	`V_phase = n × m × g × L_w`
Inputs	`n = 2; m = 1.621 kg/m; g = 9.81 m/s²; L_w (weight span) = 380 m`
Substitution	`V_phase = 2 × 1.621 × 9.81 × 380 = 12 086 N`
Result	`V_phase = 12.09 kN per phase`
Engineering comment	Bare-wire still-air vertical load at one phase support point.
Status	**Requires validation (assumed span/mass)**

11.2 Earthwire vertical load

Formula	`V_ew = n × m × g × L_w`
Inputs	`n = 1; m = 0.59 kg/m; g = 9.81; L_w = 380 m`
Substitution	`V_ew = 1 × 0.59 × 9.81 × 380 = 2 199 N`
Result	`V_ew = 2.20 kN`
Engineering comment	Single earthwire at tower peak.
Status	**Requires validation**

11.3 Insulator / fittings allowance (per phase)

Formula	`V_ins = m_ins × g`
Inputs	`m_ins = 250 kg (assumed heavy DC suspension set + fittings)`
Substitution	`V_ins = 250 × 9.81 = 2 453 N`
Result	`V_ins = 2.45 kN per phase`
Engineering comment	Assumed; confirm actual insulator set and hardware mass.
Status	**Assumed — confirm**

11.4 Total vertical at tower (LC1)

Formula	V_total = 6 × (V_phase + V_ins) + V_ew
Inputs	V_phase = 12.09 kN; V_ins = 2.45 kN; V_ew = 2.20 kN; phases = 6
Substitution	V_total = 6 × (12.09 + 2.45) + 2.20 = 89.43 kN
Result	V_total ≈ 89.4 kN (still air, bare)
Engineering comment	Vertical reaction excludes ice; see LC4 for ice sensitivity.
Status	**Requires validation**

12. Transverse Wind Load Check (LC2)

12.1 Dynamic wind pressure

Formula	q = ½ × ρ × V²
Inputs	ρ = 1.25 kg/m³; V = 26 m/s
Substitution	q = 0.5 × 1.25 × 26² = 422.5 Pa
Result	q = 0.422 kPa
Engineering comment	Basic dynamic pressure; gust/terrain factors simplified to 1.0 for illustration.
Status	**Requires validation (site wind data)**

12.2 Wind on conductor (per phase)

Formula	W_c = q × C_d × (n × d) × L × G
Inputs	q = 422.5 Pa; C_d = 1.0; n = 2; d = 0.0286 m; L (wind span) = 350 m; G = 1.0
Substitution	W_c = 422.5 × 1.0 × (2 × 0.0286) × 350 × 1.0 = 8 458 N
Result	W_c = 8.46 kN per phase
Engineering comment	Projected area uses subconductor diameters; shielding between subconductors neglected (conservative).
Status	**Requires validation**

12.3 Wind on earthwire

Formula	W_ew = q × C_d × d × L
Inputs	q = 422.5 Pa; C_d = 1.0; d = 0.011 m; L = 350 m
Substitution	W_ew = 422.5 × 1.0 × 0.011 × 350 = 1 627 N
Result	W_ew = 1.63 kN
Engineering comment	Single earthwire.
Status	**Requires validation**

12.4 Total transverse wind from wires

Formula	W_wires = 6 × W_c + W_ew
Inputs	W_c = 8.46 kN; W_ew = 1.63 kN
Substitution	W_wires = 6 × 8.46 + 1.63 = 52.38 kN
Result	W_wires ≈ 52.4 kN
Engineering comment	Sum of conductor and earthwire transverse wind.

Status	**Requires validation**

13. Wind on Structure and Longitudinal / Imbalance Check

13.1 Wind on structure (LC2)

Formula	`W_s = q × C_d,s × A_s`
Inputs	`q = 422.5 Pa; C_d,s = 2.8 (lattice, assumed); A_s = 18 m² (assumed effective projected area)`
Substitution	`W_s = 422.5 × 2.8 × 18 / 1000 = 21.29 kN`
Result	`W_s ≈ 21.3 kN`
Engineering comment	Effective projected face area and solidity must come from the actual tower outline.
Status	**Assumed — confirm tower data**

13.2 Longitudinal broken-wire load (LC3, one phase)

Formula	`L_bw = r_bw × T_bundle ;  T_bundle = n × T_sub`
Inputs	`n = 2; T_sub = 30 kN → T_bundle = 60 kN; residual factor r_bw = 0.5 (suspension, assumed)`
Substitution	`L_bw = 0.5 × 60 = 30.0 kN`
Result	`L_bw = 30.0 kN applied longitudinally at one phase`
Engineering comment	Residual factor is a placeholder; the project specification defines the broken-wire/security case and applicable factor.
Status	**Requires validation (spec-defined case)**

Longitudinal imbalance is the critical robustness case for suspension towers. The assumed residual factor and single-phase application are illustrative; real checks apply the asset owner's defined broken-wire/containment cases.

14. Ice / Weather Loading Consideration (LC4 — Sensitivity)

The base case assumes no ice (UK lowland). A radial ice sensitivity case is shown to illustrate the effect on vertical load.

14.1 Ice mass on conductor (12 mm radial, sensitivity)

Formula	`m_ice = π × (R² − r²) × ρ_ice ;  R = r + t`
Inputs	`r = 0.0143 m; t = 0.012 m → R = 0.0263 m; ρ_ice = 900 kg/m³`
Substitution	`m_ice = π × (0.0263² − 0.0143²) × 900 = 1.378 kg/m per subconductor`
Result	`m_ice ≈ 1.38 kg/m per subconductor (2.76 kg/m per bundle)`
Engineering comment	Ice roughly doubles the bundle line mass in this illustration.
Status	**Sensitivity only — spec governs**

14.2 Vertical load per phase with ice

Formula	`V_phase,ice = n × (m + m_ice) × g × L_w`
Inputs	`n = 2; m = 1.621; m_ice = 1.378 kg/m; g = 9.81; L_w = 380 m`
Substitution	`V_phase,ice = 2 × (1.621 + 1.378) × 9.81 × 380 = 22 360 N`
Result	`V_phase,ice ≈ 22.4 kN (vs 12.1 kN bare)`

Engineering comment	An ~85% increase in vertical per phase — shows why the spec weather case must be confirmed. Combined ice-and-wind would also raise transverse load via increased projected diameter.
Status	**Requires validation**

15. Construction and Maintenance Load Consideration (LC5)

15.1 Stringing/sagging load (one phase, with dynamic allowance)

Formula	`P_constr = (V_phase + P_string) × ϕ_dyn`
Inputs	`V_phase = 12.09 kN; P_string = 5.0 kN (assumed block/sagging); ϕ_dyn = 1.5`
Substitution	`P_constr = (12.09 + 5.0) × 1.5 = 25.63 kN`
Result	`P_constr ≈ 25.6 kN local vertical at the attachment`
Engineering comment	Stringing imposes local, often eccentric, loads with dynamic effects. Confirm against the actual stringing method, plant and the Temporary Works Register.
Status	**Requires validation (method-dependent)**

Maintenance loads (worker plus equipment, and any temporary attachment) should be added per the asset owner’s requirements; not all such cases are shown here.

16. Support Structure Reaction Summary

Indicative reactions and an illustrative ULS combination. Partial factors are assumed (γG = 1.0 permanent, γW = 1.4 wind) for demonstration only.

Action	Characteristic	Partial factor	ULS (factored)
Vertical, V (LC1)	89.4 kN	γG = 1.0	89.4 kN
Transverse wind, wires (LC2)	52.4 kN	γW = 1.4	73.3 kN
Transverse wind, structure (LC2)	21.3 kN	γW = 1.4	29.8 kN
Transverse total, H (LC2)	73.7 kN	γW = 1.4	103.1 kN
Longitudinal, L (LC3, one phase)	30.0 kN	per spec	[spec-defined]

16.1 Indicative base overturning moment (transverse)

Formula	`M ≈ H_uls × (k × h)`
Inputs	`H_uls = 103.1 kN; assumed resultant lever k×h = 0.6 × 28 m = 16.8 m`
Substitution	`M ≈ 103.1 × 16.8 = 1 733 kN·m`
Result	`M ≈ 1 730 kN·m (illustrative)`
Engineering comment	Very approximate; the true resultant height depends on conductor and structure wind distribution. For foundation interface discussion only.
Status	**Requires validation**

16.2 Design utilisation summary (vs ASSUMED capacities)

Capacities below are nominal placeholders to show the method — they must be replaced with verified factored capacities.

Action	ULS demand	Assumed capacity	Utilisation	Status
Transverse, H	103.1 kN	120 kN	0.86	**Requires validation**
Vertical, V	89.4 kN	350 kN	0.26	**Requires validation**
Longitudinal, L	[spec] kN	[insert] kN	[insert]	**Requires validation**

The transverse utilisation of 0.86 against an assumed capacity is shown only to demonstrate how the result would be interpreted. It is not a statement of adequacy.

17. Foundation / Civils Interface Review

Assumed foundation: pad-and-chimney. The principal civil interfaces and checks that a real design would require:

- Vertical bearing under the assumed ~89 kN still-air vertical (rising materially under ice) — confirm allowable bearing pressure from the GI.
- Uplift and overturning resistance against the transverse/longitudinal cases and the indicative ~1 730 kN·m base moment — confirm pad size, embedment and backfill/soil uplift.
- Differential settlement across leg foundations for a lattice tower, and the effect on the structure — confirm with GI and settlement assessment.
- Groundwater, dewatering and excavation stability for the foundation type — pile or grillage alternatives may be required in poor ground (to be confirmed by GI).
- Concrete durability/exposure class, reinforcement detailing and stub/holding-down arrangement at the steel–concrete interface.

No bearing pressure, uplift capacity or soil parameters are assumed here — these must come from the ground investigation.

18. Temporary Works and Access Review

- Excavation support for foundation pits — design category and method to be confirmed; ground-dependent.
- Working platforms and crane standing / outrigger mats for tower erection and stringing — bearing pressures to be checked against ground conditions.
- Crane selection and lift planning for tower steel and stringing operations — lift plan, ground assessment and exclusion zones required.
- Temporary access roads and hardstanding to each structure — condition, gradient and load capacity to be confirmed.
- Stringing-stage temporary loads and anchors — captured on the Temporary Works Register with erect/use/inspect/alter/dismantle controls per BS 5975 procedures.
- Work near live or to-be-energised apparatus and adjacent circuits — exclusion zones, permits and authorised-person control (electrical safety not assessed here).

19. CDM 2015 Design Risk Review

Significant design risks identified for elimination, reduction or communication under CDM 2015:

- Work near live electrical apparatus — reduce by sequencing, outages and exclusion zones; communicate residual risk to the Principal Contractor and site team.
- Foundation excavation collapse and groundwater — reduce through excavation support design and dewatering; confirm by GI.
- Lifting and tower erection at height — reduce by lift planning, suitable plant and edge/fall controls.
- Stringing dynamic loads and snatch — reduce by method controls, tension management and exclusion zones.
- Buried services in foundation and access areas — reduce by service location, safe-dig and permits.
- Unverified assumptions in this illustrative check — residual risk that must be closed by obtaining verified data and competent design approval before construction.

20. RAMS / ITP Comments

- RAMS should confirm the construction sequence (excavation → foundation → erection → stringing → reinstatement), buried-services controls, permits, exclusion zones, supervision and emergency arrangements.
- RAMS should state plant loadings, crane/mat bearing assumptions and the temporary works items relied upon.
- The ITP should include hold points prior to concrete pour, prior to backfill, prior to loading/erection, prior to stringing, and prior to removal of temporary works.
- The ITP should reference inspection of foundations against the verified design, and verification of holding-down/stub setting-out before pour.
- Residual design risks should be communicated to the Principal Contractor, Temporary Works Coordinator and site team before works commence.

21. Registers

21.1 Design check table

Check item	Requirement	Calc ref	Result	Status	Comment
Vertical load	Within structure/foundation vertical capacity	11.4	89.4 kN	**Requires validation**	Rises ~85% under ice (14.2)
Transverse wind	Within transverse capacity at ULS	12, 13.1, 16	103.1 kN	**Requires validation**	Governing lateral action; U=0.86 vs assumed cap
Longitudinal	Within spec broken-wire/security case	13.2	30.0 kN	**Requires validation**	Residual factor is a placeholder
Ice sensitivity	Per spec weather case	14	22.4 kN/phase	**Requires validation**	Base case nil ice (assumed)
Construction	Local capacity under stringing	15.1	25.6 kN	**Requires validation**	Method-dependent
Foundation interface	Bearing/uplift/settlement OK	16.1, 17	M≈1 730 kN·m	**Requires validation**	Needs GI data

21.2 Risk register

ID	Risk	Cause	Consequence	Control measure	Residual	Owner
R1	Live electrical contact	Work near energised apparatus	Fatality/injury	Outages, exclusion zones, AP control, permits	Low–Med	PC / AP
R2	Excavation collapse	Unsupported/poor ground	Burial, injury	Excavation support design, GI, inspection	Low	PC / TWC
R3	Crane/lift failure	Poor ground, overload	Dropped load, injury	Lift plan, mat bearing check, exclusion zone	Low	PC / Lifting
R4	Stringing snatch/dynamic	Tension loss/snag	Structure/worker harm	Method controls, tension mgmt, zones	Low–Med	PC
R5	Buried-service strike	Unknown services	Injury, outage	Service location, safe-dig, permits	Low	PC
R6	Use of unverified data	Illustrative assumptions	Inadequate design	Obtain verified data + competent approval	High until closed	Client / Designer

21.3 Action register

ID	Issue	Required information / action	Responsible	Priority	Status
A1	Assumed line/span data	Provide structure schedule, wind/weight spans, line angles	Client / Designer	High	**Open**
A2	Assumed conductor data	Provide verified conductor data and sag-tension study	Client / Designer	High	**Open**
A3	Assumed capacities	Provide verified factored structure & foundation capacities	Designer	High	**Open**
A4	No ground data	Provide GI: bearing, uplift, groundwater, parameters	Client / Geotech	High	**Open**
A5	Weather case	Confirm spec wind/ice/combined cases & factors	Client / Designer	High	**Open**
A6	Broken-wire case	Confirm spec broken-wire/security load case	Client / Designer	High	**Open**
A7	Temporary works	Provide TW Register, stringing method, lift & plant data	PC / TWC	Medium	**Open**
A8	Approval	Obtain competent engineering check & approval before use	Designer / Checker	High	**Open**

22. Technical Conclusion

This illustrative loads check demonstrates the principal actions on a 275kV double-circuit suspension tower using assumed metric data. On these assumed inputs, transverse wind is the governing lateral action (factored H ≈ 103 kN), still-air vertical load is around 89 kN at the tower (rising by roughly 85% under the 12 mm ice sensitivity case), and the longitudinal broken-wire action is significant for a suspension structure and must follow the project specification.

The transverse utilisation shown (0.86) is against an assumed nominal capacity and is presented only to illustrate interpretation. No statement of adequacy, verification, compliance or fitness for construction is made.

All results are marked "requires validation". Before any reliance, verified line, conductor, span, weather, ground and capacity data must be obtained, the project specification and current published standards applied, and a competent engineering check and approval completed under a formal appointment.

This example demonstrates calculation presentation and engineering review approach only. A real Kings Lynn OH line design check would require verified project data and formal appointment.

23. Appendix — Workings Summary

Consolidated workings (all values assumed/illustrative; $g = 9.81$ m/s²; $\rho_{air} = 1.25$ kg/m³):

Quantity	Expression	Result
Dynamic pressure q	0.5 × 1.25 × 26²	422.5 Pa
Bundle line weight w	2 × 1.621 × 9.81	31.80 N/m
Vertical per phase V_phase	31.80 × 380	12.09 kN
Earthwire vertical V_ew	0.59 × 9.81 × 380	2.20 kN
Insulator allowance V_ins	250 × 9.81	2.45 kN
Total vertical V_total	6 × (12.09 + 2.45) + 2.20	89.43 kN
Wind/conductor W_c	422.5 × (2 × 0.0286) × 350	8.46 kN
Wind/earthwire W_ew	422.5 × 0.011 × 350	1.63 kN
Wind on wires (total)	6 × 8.46 + 1.63	52.38 kN
Wind on structure W_s	422.5 × 2.8 × 18	21.29 kN
Transverse total H (char.)	52.38 + 21.29	73.67 kN
Transverse total H (ULS)	1.4 × 73.67	103.14 kN
Broken-wire L (one phase)	0.5 × (2 × 30)	30.0 kN
Ice mass/subcond. (12 mm)	π × (0.0263² − 0.0143²) × 900	1.38 kg/m
Vertical/phase with ice	2 × (1.621 + 1.378) × 9.81 × 380	22.36 kN
Construction (one phase)	(12.09 + 5.0) × 1.5	25.63 kN
Indicative base moment M	103.14 × (0.6 × 28)	≈ 1 733 kN·m

End of example.