OVERHEAD TRANSMISSION LINE ENGINEERING

Transmission Line Design
from route to Issued-for-Construction

Advanced engineering for reliable, efficient and future-ready power infrastructure — routing and corridor optimization, structural and conductor design, sag-tension analysis and code-compliant construction packages for MV, HV and EHV lines.

A transmission line is a structural problem, an electrical problem and a permitting problem at the same time — and the three of them share one set of drawings.

Keentel Engineering delivers complete overhead transmission line design for utilities, transmission developers, renewable and storage projects, EPC contractors and industrial owners — new build, rebuild, reconductoring and uprating. Route selection through detailed structural and electrical design, digital modeling and Issued-for-Construction packages, with field support through construction. Because the same firm carries the interconnection studies and the substation design, the line design reflects the ratings, clearances and protection the system analysis actually requires.

30+	4	3D	4
YEARS ACROSS TRANSMISSION, DISTRIBUTION & RENEWABLES	DESIGN STAGES — CONCEPT, 60%, 90%, IFC	INTELLIGENT MODELS AND AUTOMATED CALCULATIONS	U.S. OFFICES — TAMPA, AUSTIN, SACRAMENTO, BALTIMORE

MV · HV · EHV | 13.8 kV | 34.5 kV | 69 kV | 115 / 138 kV | 230 kV | 345 kV | 500 kV+

THE ENGINEERING PROCESS

01
Project definition
Scope, load and system requirements, voltage and capacity, design criteria.

02
Conceptual design
Route selection, preliminary structure family and spotting, feasibility.

03
Detailed engineering
Structural and electrical design, sag-tension, grounding and protection.

04
Digital modeling
2D and 3D model development, validation, cross-discipline coordination.

05
Construction set
IFC drawings, material lists, engineering reports and calculations.

06
Project support
Review during construction, field issue resolution, design updates.






START A SCOPE ›› Send your endpoints, voltage, circuit configuration and the design criteria — we return a scoped fee and schedule, and can start from a partial data set.

NSPE | D·U·N·S REGISTERED | IEEE SENIOR MEMBER | BBB ACCREDITED A+

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CAPABILITY — PART ONE

Route, Corridor & Survey

The route decides the cost, the schedule and most of the risk. Every hour spent before the alignment is fixed is repaid several times over.

Line Routing & Corridor Optimization

- **Terrain-based route optimization.** Alignment developed against topography, access, grading and construction cost rather than drawn straight and priced later.
- **Environmental & right-of-way analysis.** Wetlands, waters of the U.S., habitat, cultural resources, parcel counts and acquisition difficulty carried as route criteria from the start.
- **Constraint mapping.** Roads, railroads, rivers, airports, pipelines, existing lines, urban and residential zones, and jurisdictional boundaries.
- **GIS-integrated alignment studies.** Route models built on real spatial data so alternatives can be compared on the same basis.
- **Multi-route comparison & feasibility.** Alternatives scored on length, structure count, crossings, environmental exposure, ROW acquisition, constructability and schedule risk.
- **Angle and dead-end minimization.** Every avoidable angle structure removed is capital, foundation and schedule saved.
- **Access and constructability review.** Pull and tension site locations, matting, crane access and laydown considered while the route can still move.

Design Criteria Development

- **Governing code edition and adoption.** The NESC edition adopted in the project's jurisdiction, plus the utility's own overlay, established and documented before design begins.
- **Grade of construction and load cases.** District, extreme wind and extreme ice cases, construction and maintenance loads, and any utility-specific reliability case.
- **Clearance basis.** Governing temperature and loading condition for each clearance check, and the crossing-specific requirements that go beyond code minimum.
- **Structure family and framing standards.** Selected against the route, the utility's standards and long-lead availability.

Survey, LiDAR & Existing-Condition Modeling

- **Airborne and mobile LiDAR.** Classified point clouds giving ground, existing wires, structures, vegetation and encroachments — the basis for any credible rebuild or reconductor design.
- **Photogrammetry & orthoimagery.** Draped imagery for route review, stakeholder presentation and encroachment identification.
- **Ground survey integration.** GPS and total station data, control, and crossing surveys tied into the same model.
- **Wire fitting to the point cloud.** Recovering true as-operated sag and tension on an existing line rather than assuming the original design values still hold.
- **As-built model reconciliation.** Record drawings checked against what is actually in the field, with the differences documented rather than absorbed.
- **Encroachment and clearance audit.** Existing violations identified before they become a construction change order or a compliance finding.

Why the survey basis matters more on a rebuild

On an existing line the record drawings are frequently wrong — conductor replaced, structures moved, spans re-sagged, ground regraded. A design built on the record set and not the point cloud produces clearances that pass on paper and fail in the field.

Routing is where the permit is won or lost

Wetland crossings, federal project interfaces, listed species habitat and airport surfaces all attach to specific points on the ground. Moving the alignment during routing costs a redraw; moving it during permitting costs a season.

HOW WE SCORE ROUTE ALTERNATIVES

Length & structure count	Angle and dead-end count	Terrain & grading effort	Access and matting extent
Parcels and ROW acquisition	Wetland and waters crossings	Habitat and species exposure	Cultural resource risk
Road, rail and line crossings	Airport surfaces and FAA exposure	Visual and residential proximity	Constructability and schedule risk

APPLIES TO Greenfield transmission · Generation and BESS gen-tie · Collector and MV feeder lines · Rebuild and reconductoring · Line relocations · Distribution underbuild · 13.8 kV through 500 kV+

CAPABILITY — PART TWO

Structures & Structural Loading

Code minimum is the floor, not the design. The governing case is usually the one the utility's own criteria adds on top of it.

Structural Design & Modeling

- **Transmission structures.** Steel and concrete monopoles, lattice towers, H-frames, guyed and self-supporting configurations, tangent through heavy dead-end.
- **Distribution and lower-voltage poles.** Wood, steel, concrete and fiber-reinforced polymer, including underbuild and joint-use configurations.
- **Framing & geometry.** Phase spacing, insulator assembly selection, shield wire position and shielding angle, and the clearance envelope that results.
- **Insulator assemblies & hardware.** Suspension, dead-end, post and braced-post assemblies with hardware sized to the governing load case.
- **Structural integrity validation.** Every structure checked against its governing case and reported as a percentage of capacity, not a pass/fail.

Load Cases We Design To

- **District loading.** The NESC combined ice, wind and temperature case for the applicable loading district, with the code's added constant and load factors.
- **Extreme wind.** The NESC extreme wind case applied where structure height triggers it, on maps derived from current ASCE wind data.
- **Extreme ice with concurrent wind.** The companion extreme case, on the same height trigger.
- **Construction & maintenance loads.** Stringing, sagging, worker and equipment loads at the points where they actually occur.
- **Longitudinal & failure containment.** Broken conductor, unbalanced ice and cascade-limiting cases where the owner's criteria require them.
- **Reliability-based cases.** Return-period loads per ASCE guidance where the owner's criteria exceed the legislated minimum.

Governing Design References

- **NESC (ANSI/IEEE C2).** The 2023 edition is the current code, with the next edition scheduled to publish in 2027 — and state adoption lags the edition year, so the governing edition is a project-specific question we settle in writing at the start.
- **Grades of construction.** Grade B and Grade C assignment by crossing and circumstance, with the strength, load and overload factors that follow.
- **ASCE MOP 74** — *Guidelines for Electrical Transmission Line Structural Loading*, 4th edition, for weather and non-weather loads, load factors and reliability-based design.
- **ASCE 48** for steel pole structures and **ASCE 10** for latticed steel transmission structures.
- **ASCE MOP 141** for wood pole structures and **ASCE MOP 123** for prestressed concrete poles.
- **ASCE MOP 91** for guyed structures; **ASCE MOP 113** at the substation interface.
- **IEC 60826** where the project is governed by an international design basis rather than the NESC.

Where structural surprises come from

Three things account for most of them: a code edition change between the original design and the present one; a structure height that crosses the extreme-wind trigger and pulls in a case the original design never ran; and a conductor change that raises ice and wind area on structures sized for the old one. All three are cheap to find in analysis and expensive to find in the field.

STRUCTURE FAMILY — HOW WE CHOOSE

TYPE	WHERE IT FITS	TRADE-OFF
Steel monopole	Constrained ROW, urban and roadside corridors, most modern HV and EHV tangent and angle applications	Narrow footprint; larger foundation moment
Lattice tower	Long spans, heavy EHV and double-circuit, remote corridors with assembly access	Lower steel weight per capacity; wider base and four foundations
H-frame	Rural corridors with ROW width available, single circuit at moderate voltage	Economical and low-profile; needs width and often guys
Wood / laminated wood	Lower voltage, distribution underbuild, rural rebuild of an existing wood line	Lowest cost; condition, decay and inspection burden over life

DELIVERABLES FROM THIS SCOPE Structure loading trees for every governing case · Structure list and framing schedule · Capacity usage reporting per structure · Vendor loading data for fabrication quotation · Hardware and insulator assembly schedules

CAPABILITY — PART THREE

Conductor, Sag-Tension & Clearance

CONDUCTOR FAMILIES AND WHAT DRIVES THE CHOICE

TYPE	CHARACTER	TYPICAL APPLICATION	WATCH ITEM
ACSR	Aluminium over a steel core; the reference conductor for strength, cost and well-characterised creep and self-damping	General transmission and gen-tie; the default unless something displaces it	Ampacity limited by sag at high temperature
AAC / AAAC	All-aluminium and all-aluminium-alloy; better conductivity or better strength-to-weight and corrosion resistance	Shorter spans, coastal and industrial-atmosphere corridors	Lower strength than ACSR at equal diameter
ACSS	Fully annealed aluminium supported by the steel core; continuous operation at markedly higher temperature	Uprating an existing structure family without rebuilding it	Different self-damping — vibration design must be re-issued
ACSS/TW	Trapezoidal strand: more aluminium at the same diameter, or the same aluminium at a smaller diameter	Clearance or structure capacity is the binding constraint	Availability and stringing hardware compatibility
ACCC and composite-core HTLS	Non-metallic core — lightest, lowest thermal expansion, least high-temperature sag, lowest losses for a given diameter	Reconductoring where sag governs; new lines where structure height is constrained	Handling, stringing practice and terminations differ
Shield wire & OPGW	Overhead ground wire for shielding and fault-current return; OPGW adds fiber for protection and SCADA communications	All shielded lines; OPGW wherever the line carries protection communications	Fault current duty and splice/entry design

Selection is driven by required steady-state and emergency ampacity, sag at maximum operating temperature and the clearance it produces, the ice and wind load the resulting diameter puts on structures and foundations, aeolian vibration and galloping behavior, surface gradient and audible noise at EHV, and total lifetime losses. Thermal ratings are calculated to **IEEE 738** and, where the project requires it, the CIGRE method.

Sag-Tension & Mechanical Analysis

- **Sag and tension under every design condition.** Initial and final, with creep, across the full temperature range and every ice and wind case.
- **Ruling span and finite-element methods.** Finite-element sag-tension where the ruling-span approximation breaks down — broken conductor, unbalanced ice, steep terrain, marker balls.
- **Maximum allowable span.** Governed by clearance, structure capacity, insulator swing or uplift, whichever binds first.
- **Tension limits.** Initial and final unloaded tension limits and the everyday-stress basis for vibration control.
- **Uplift and insulator swing.** Checked at every structure across the design cases, not only at the obvious ones.
- **Aeolian vibration & galloping.** Damper design and spacing, galloping ellipse checks and phase separation.
- **Stringing charts & sagging tables.** Issued in a form the crew can actually use in the field, with stringing practice per IEEE 524.

Clearance Verification

- **Vertical clearance to ground and surfaces.** Checked at the governing final sag condition — maximum operating temperature or ice load, whichever produces the worst case — against the NESC clearance rules and the voltage adder.
- **Crossings.** Roads, railroads, navigable and non-navigable water, other transmission and distribution lines, and communications, each with its own governing rule and often an owner requirement above code.
- **Buildings, signs and structures.** Vertical, horizontal and any-direction cases, including wind-displaced conditions.
- **Clearance between conductors.** Same structure and different structures, including swing and blowout.
- **Vegetation clearance.** Designed against the NERC minimum vegetation clearance distance, not merely the code minimum, so the line is maintainable in service.
- **Altitude correction.** Applied where elevation requires it.

DELIVERABLES FROM THIS SCOPE Sag-tension tables for every condition · Stringing charts and sagging tables · Clearance report by span and crossing · Insulator swing and uplift results · Galloping ellipse checks · Damper design and placement · Thermal rating calculations

CAPABILITY — PART FOUR

Foundations & Geotechnical Interface

The foundation is where the structural design meets the ground conditions someone else measured — and where the schedule usually gets decided.

FOUNDATION TYPES WE DESIGN AND EVALUATE

Drilled pier / caisson — cast-in-place reinforced concrete; the default for moment-governed poles

Direct embedment — augered hole with compacted granular or flowable backfill; fastest where soils allow

Vibratory caisson — driven steel casing where drilling spoil or groundwater is the problem

Micropiles — restricted access, rock, and high-uplift retrofits on existing structures

Pile groups and caps — lattice legs, heavy angles and dead-ends, weak or variable soils

Grillages — lattice tower legs in competent soil

Guy anchors — helical, plate, grouted rock and swamp anchors

Retrofits — collars, added piles and reinforcement where an existing foundation is short of the new load

Rock sockets — where competent rock is shallow and lateral capacity comes from the socket

Foundation Engineering Scope

- **Load derivation from the structure model.** Foundation reactions taken from the governing structural case, not a generic assumption — shear, moment, uplift, compression and torsion together.
- **Moment-governed shaft design.** Drilled pier and direct-embed depth determination for single-shaft poles using the industry-standard lateral-load models.
- **Uplift and compression capacity.** Lattice legs, guy anchors and heavy dead-end structures.
- **Reinforcement and anchor bolt design.** Cage design, development, base plate and anchor bolt cluster coordination with the pole vendor.
- **Foundation strength factors.** Applied per the code and the owner's overlay, typically more conservative for overturning and uplift than for compression.
- **Constructability review.** Access, drilling method, spoil handling, casing, dewatering and concrete delivery reviewed against the real site.
- **Existing foundation assessment.** Re-check of installed foundations against new loads on rebuild and reconductor projects.

Geotechnical Inputs We Work From

- **Subsurface profile per structure or soil zone**, with SPT or CPT data and stratigraphy.
- **Strength parameters** — undrained shear strength, drained friction angle and cohesion, unit weights.
- **Groundwater depth** and seasonal variation.
- **Rock quality** — RQD, unconfined compressive strength and socket parameters where rock governs.
- **Frost depth**, seismic site class, and expansive or collapsible soil identification.
- **Corrosivity** — resistivity, pH, chlorides and sulfates for below-grade steel and concrete durability.
- **Scour** where structures sit in a floodplain or channel migration zone.

Where the geotechnical program should land

Borings taken before the structures are spotted usually land in the wrong places; borings taken after the design is complete arrive too late to change it. We define the geotechnical scope against the preliminary spotting, so the data supports the foundations that will actually be built.

WHAT DECIDES THE FOUNDATION TYPE

- Governing moment, shear and uplift
- Soil strength and stratigraphy
- Depth to rock and rock quality
- Groundwater and dewatering need
- Site access for drill rigs
- Spoil handling and disposal
- Wetland and environmental limits
- Concrete delivery logistics
- Schedule and outage window
- Corrosivity and durability
- Frost depth and seismic class
- Existing foundation reuse potential

DELIVERABLES FROM THIS SCOPE Foundation design calculations and reaction summaries · Foundation schedule by structure · Reinforcement and anchor bolt details · Embedment depth tables · Construction details and inspection requirements

CAPABILITY — PART FIVE

Electrical Design & System Integration

The half of line design that does not show up in the structure model — and the half a system planner will ask about first.

Insulation Coordination & Lightning

- **Insulation coordination.** BIL and switching impulse withstand selection, insulator string length, contamination and creepage class for the site environment.
- **Shielding design.** Shield wire position and shielding angle set so the exposure is what the design intends, not what the geometry happened to produce.
- **Backflashover analysis.** Footing resistance, coupling and flashover rate assessment to a target lightning performance.
- **Structure grounding.** Counterpoise and ground rod design to achieve the footing resistance the lightning performance assumes.
- **Surge arrester application.** Line arresters where the performance target or the terminal equipment requires them.
- **Switching surge and TRV interface.** Coordination with the terminal substations and breaker duty.

Grounding & Bonding

- **Structure and shield wire grounding.** Continuity, connection details and materials for the soil environment.
- **Fault current return path.** Shield wire and OPGW duty under the line's fault current and clearing time.
- **Step and touch potential.** Assessed at structures in accessible areas and at terminal interfaces.
- **Interference with buried utilities.** Induced voltage on parallel pipelines and communications, and mitigation where required.

Ratings, Performance & Field Effects

- **Ampacity and thermal ratings.** Steady-state, emergency and seasonal ratings calculated to IEEE 738, with the assumptions on ambient, wind, emissivity and absorptivity stated and defensible.
- **Ambient-adjusted and dynamic ratings.** Line ratings prepared for the ambient-adjusted rating framework now in force, and dynamic line rating evaluation where the owner is pursuing it.
- **Corona, audible noise and radio interference.** Conductor surface gradient, bundle configuration and hardware selection reviewed against the applicable limits and the owner's criteria.
- **Electric and magnetic fields.** Profiles computed at the right-of-way edge against the applicable state limit or prudent-avoidance policy, and used to inform phasing and ROW width.
- **Phasing and transposition.** Circuit phasing for unbalance, field cancellation and induced-voltage management on double-circuit and parallel corridors.
- **Losses.** Resistive and corona loss evaluation as an input to conductor selection and life-cycle cost.
- **Voltage profile and reactive behavior.** Line impedance and charging characterised for the system studies that use them.

Facility rating is a design output

The rating that ends up in the transmission owner's database has to be traceable to the most limiting element on the line — conductor, hardware, terminal equipment or a clearance-limited span. We produce that basis as part of the design rather than leaving it to be reconstructed later.

LINE ELECTRICAL PARAMETERS WE PRODUCE

Positive and zero sequence impedance	Line charging susceptance	Steady-state and emergency ratings	Seasonal and ambient-adjusted ratings
Conductor temperature versus current	Resistive and corona losses	Surface gradient and audible noise	Radio interference profile
Electric and magnetic field profiles	Footing resistance and shielding angle	Estimated lightning outage rate	Facility rating limiting element

These are the numbers the system planner, the protection engineer and the model builder all need — and they come out of the same line model that produced the drawings, so the study case and the built line describe the same asset.

DELIVERABLES FROM THIS SCOPE Insulation coordination and shielding calculations · Lightning performance assessment · Grounding design and details · Thermal rating calculations and assumptions · EMF, corona and audible noise profiles · Facility rating basis documentation

CAPABILITY — PART SIX

Digital Modeling & the Drawing Package

One intelligent model carrying terrain, structures, wires, loads and electrical parameters — every drawing and report generated from it, so they cannot disagree.

Integrated 3D Line Modeling

- **One model, all disciplines.** Terrain, alignment, structures, wires, hardware, loads and clearances in a single 3D model rather than a set of separate calculations.
- **Linked structural models.** Pole and lattice tower models linked to the line model so a change in span, framing or conductor immediately reports as a change in structure usage.
- **Automated clearance checking.** Every span checked against every governing condition, with violations reported by station rather than found by eye.
- **Structure spotting and optimization.** Automated spotting against terrain, clearance and cost, with engineering judgment applied on top of it.
- **Data-rich digital twin.** Geometry and electrical parameters carried together, so the model remains useful for ratings, maintenance and future uprating.
- **Clash detection and coordination.** Against crossings, existing utilities, access roads and adjacent disciplines.
- **Visualization.** Terrain-integrated 3D views, construction sequencing and stakeholder presentation material generated from the same model.

Automated Engineering Calculations

- Sag-tension reports across every design condition
- Wind, ice and mechanical load calculations per governing case
- Structure loading trees and capacity usage reports
- Clearance reports by span, crossing and obstacle
- Thermal rating calculations
- Bill of materials generation from the model
- Design summaries and compliance documentation

The Drawing & Report Package

- Plan and profile sheets, generated from the model and issued to the owner's title block and drafting standard
- Structure list and spotting list — station, structure type, height, class, framing, embedment and foundation type
- Structure loading trees for every governing case, in the form a fabricator can quote from
- Sag-tension tables, stringing charts and sagging tables
- Staking table and survey control
- Clearance report and crossing details
- Foundation schedule, calculations and details
- Grounding details and counterpoise layout
- Assembly and framing drawings, hardware and insulator schedules
- Bill of materials and material take-off
- Access, matting and pull-site plan where in scope
- Demolition and removal drawings on rebuild work
- Design criteria document and calculation package
- Issued-for-Construction package, revision controlled through construction

P.E. review & professional engineering oversight available

Keentel is a Florida-registered engineering firm (Reg. No. 36853) with multi-state licensure. Professional engineering review and sealed deliverables are available where required and within applicable licensure — tell us the jurisdiction and we will confirm before we scope.

HOW THE MODEL STAYS TRUSTWORTHY

One design basis governs

Code edition, loading district, grade of construction, temperatures and factors are fixed in a design criteria document, and every calculation is checked back to it.

Independent check of the model

Structure capacities, sag-tension results and clearances are verified against hand calculations and independent runs rather than accepted because the software produced them.

Field changes come back into the model

RFI responses and construction changes are carried back into the line model, so the as-built record and the rating basis stay correct.

DESIGN STAGES Concept / 10–30% › 60% Design › 90% Review Set › IFC / 100% Construction Documents — each a defined, revision-controlled deliverable rather than a progress percentage

THE FASTEST-GROWING PART OF THE WORK

Reconductoring, Rebuild & Uprating

Getting more out of a corridor that already exists — because the corridor is the part that takes years to obtain.

WHY IT IS ON EVERY UTILITY'S PLAN

The Corridor Is the Scarce Asset

Load growth, interconnection queues and data center demand are outrunning existing thermal ratings, while greenfield siting takes the better part of a decade. Advanced conductors and reconductoring turn an existing right-of-way into additional capacity on a construction schedule instead of a permitting schedule — which is why federal policy has moved toward them.

- **FERC Order 881** — ambient-adjusted transmission line ratings now in force
- **FERC Order 1920** — regional planning must evaluate advanced conductors, dynamic line ratings and power flow control
- **DOE grid programs** — federal funding directed at accelerated reconductoring and advanced transmission technology
- **State cost-benefit reform** — several states now allow loss reduction and system benefits to be credited when evaluating advanced conductors

The Reconductoring Workflow

- **1 LiDAR survey and as-built model.** Existing wires, structures, ground and vegetation captured and modeled; wire fitting to the point cloud to recover true as-operated sag and tension.
- **2 Clearance audit.** Existing and proposed maximum operating temperature checked against the code clearance rules and the vegetation clearance requirement.
- **3 Conductor screening.** ACSS, trapezoidal-wire, composite-core and larger conventional options traded against ampacity, diameter, weight, high-temperature sag and tension.
- **4 Structural re-check.** Existing structures and foundations evaluated against the new conductor's loads and the **current** code edition — not the edition in force when the line was built. This is where most reconductoring projects find their real cost.
- **5 Clearance recovery.** Where sag governs: trapezoidal conductor at the same diameter, revised tension with new damping, structure raises, mid-span insertions or selective replacement.
- **6 Vibration redesign.** Annealed-aluminium conductors behave differently from conventional ones; the damper design is normally re-issued rather than carried over.
- **7 Outage and stringing plan.** Sequencing designed around the outages the operator can actually grant, with stringing practice per IEEE 524.

Related Scopes We Deliver

- **Line uprating.** Voltage or thermal uprating with the clearance, insulation and structural consequences worked through together.
- **Full rebuild.** Structure family replacement in an existing corridor, with phased construction and temporary configurations drawn explicitly.
- **Double-circuiting.** Adding a circuit to an existing corridor, including the structural, EMF and outage implications.
- **Storm hardening.** Structure and foundation upgrades to a higher reliability case, with the return-period basis documented.
- **Facility rating correction.** Re-establishing the most limiting element and correcting a rating that no longer matches the as-built line.
- **Condition-driven replacement.** Wood decay, corrosion, splice and hardware condition assessment translated into a replacement scope.
- **Relocation.** Line moves driven by road widening, development or a new substation.

The finding that surprises owners most

A line built to an older code edition, with a structure family sized for the conductor it was built with, will frequently not pass today's loading cases with a larger or heavier conductor on it — even before the new ampacity is considered. Running that check early is the difference between a reconductoring project and an unplanned rebuild.

HOW WE HELP LiDAR-based as-built modeling · Conductor screening and life-cycle comparison · Structural and foundation re-check · Clearance recovery options with cost · Damper redesign · Outage sequencing and stringing plan · Facility rating basis

CONSTRAINTS THAT ATTACH TO THE ALIGNMENT

Permitting & External Interfaces

Engineering support to the permitting effort — the drawings, calculations and technical exhibits the agencies and asset owners actually ask for.

Aviation

- **FAA obstruction evaluation.** Structures above the notice threshold, or penetrating an airport imaginary surface, require notice and evaluation — and the traverseway adjustments mean a line over an interstate or a railroad triggers at a lower structure height than the bare number suggests.
- **Marking and lighting.** Marker balls, obstruction lighting and structure painting designed to the current FAA advisory circular — note that a new revision was issued in August 2026, so anything specified against the previous version should be re-checked.
- **Marker ball loading.** Concentrated weights modeled in the sag-tension analysis rather than assumed negligible.

Water, Wetlands & Federal Works

- **Clean Water Act permits.** Discharge of fill for foundations, access roads and matting in waters and wetlands, and permits for work in navigable waters.
- **Federal civil works interfaces.** Permission where the line alters a levee, floodwall or federally authorised channel project.
- **Floodplain and scour.** Structure siting, foundation design and access designed for the hydraulic condition rather than around it.

Environmental Review

- **Federal environmental review.** Where a federal nexus exists; note that the federal framework changed materially in 2025 and 2026, so the applicable procedure is now agency-specific and should be confirmed at the outset.
- **Listed species and habitat.** Consultation and mitigation where the alignment interacts with protected species or critical habitat.
- **Cultural resources.** Survey and avoidance coordinated with the alignment.

Avian Protection

- **Raptor-safe framing.** Phase-to-phase and phase-to-ground separation, covered jumpers and insulated hardware per industry avian protection practice.
- **Collision mitigation.** Line markers and diverters in identified collision corridors, with the added loading carried in the sag-tension model.
- **Perch and nest management.** Deterrents and nest platforms designed into the structure rather than added in the field.
- **Avian protection plan support.** Design content supporting the owner's plan and any permit condition.

Crossings & Occupancy

- **Railroad crossings.** Sealed crossing plans to the railroad's utility accommodation policy — which typically requires clearance above the code minimum, a voltage adder above the base clearance, and pole setback from the track centerline that increases on curves.
- **Highway crossings and longitudinal occupancy.** State DOT utility accommodation permits, and the separate approval that controlled-access right-of-way requires.
- **Pipeline and utility crossings.** Clearance, grounding and induced-voltage coordination with the crossed asset's owner.
- **Line crossings.** Clearance and outage coordination with the crossed line's owner.

State Siting

- **Certificate proceedings.** Technical exhibits for need, route alternatives, EMF, audible noise and visual analysis in state certificate and siting proceedings.
- **Local permitting.** County and municipal approvals, floodplain development and grading permits.

TECHNICAL EXHIBITS WE PREPARE FOR PERMITTING

Route alternative comparison exhibits	Plan and profile at crossings	Structure height and obstruction data	Marking and lighting plans
Wetland and waters impact exhibits	Access and matting plans	EMF and audible noise profiles	Visual simulations and viewshed exhibits
Railroad crossing plans	Highway and DOT permit exhibits	Avian protection design details	Responses to agency conditions

SCOPE NOTE Keentel provides the engineering support to permitting — drawings, calculations, technical exhibits and design responses to conditions. Environmental studies, agency filings and legal strategy are coordinated with the owner's environmental and legal advisors rather than self-performed.

THE DESIGN BASIS

Codes, Standards & Compliance

DESIGN STANDARDS WE WORK TO

REFERENCE	WHAT IT GOVERNS	NOTE
NESC (ANSI/IEEE C2)	Clearances, loading districts, extreme wind and ice cases, grades of construction, strength and load factors, and the minimum legal design basis for the line	2023 edition current; next edition scheduled to publish in 2027. State adoption lags — the governing edition is project-specific
ASCE MOP 74	Structural loading — weather and non-weather loads, load factors, reliability-based design and failure containment	4th edition; the primary supplement to the code minimum
ASCE 48 / ASCE 10	Design of steel transmission pole structures; design of latticed steel transmission structures	The structural design standards behind the vendor's calculations
ASCE MOP 141 / MOP 123 / MOP 91	Wood pole structures; prestressed concrete poles; guyed structures	MOP 141 supersedes the older IEEE wood structure guide in practice
IEEE 738	Current-temperature relationship of bare overhead conductors — the ampacity and thermal rating method	2023 edition current
IEEE 524	Installation of overhead transmission line conductors — stringing practice, equipment and tension control	The reference for the stringing and sagging plan
IEEE lightning performance guides	Shielding, footing resistance, backflashover and line lightning performance	The long-standing IEEE guides remain the working references although they are no longer actively maintained
IEEE 1313 series	Insulation coordination definitions, principles and application	Basis for BIL and insulator selection
IEEE 539	Terminology for corona and field effects of overhead power lines	Framework for corona, RI, audible noise and field studies
IEC 60826	Design criteria of overhead transmission lines for internationally governed projects	Used where the project design basis is IEC rather than NESC
CIGRE technical brochures	Thermal rating methods, high-temperature and advanced conductor application, uprating practice	Applied where the owner's criteria call for the CIGRE method

NERC STANDARDS THAT ATTACH TO THE LINE

- **FAC-003 — Vegetation management.** Vegetation must never encroach the minimum vegetation clearance distance on applicable lines, with defined inspection frequency and annual work plan completion. It is a design input, because clearance designed only to the code minimum can leave the line unmaintainable.
- **FAC-008 — Facility ratings.** A documented rating methodology, with each facility rated to its most limiting element and consistent with the as-built configuration.
- **FAC-001 / FAC-002 — Interconnection.** Documented facility interconnection requirements, and study of the reliability impact of new or materially modified interconnections.
- **PRC-023 — Relay loadability.** Load-responsive relays set so they do not operate below a defined loadability threshold — which links directly to the line's seasonal ratings.
- **TPL-001 — Planning performance.** The planning assessments that establish why the line is needed and what it must withstand.

NOTE Standard numbers are shown without version suffixes because versions change. Editions and adoption status reflect the position as of August 2026 and must be confirmed for the governing jurisdiction and the owner's criteria before design begins.

WHO WE DESIGN FOR

Industries & Project Types

Utility Transmission & Distribution	Renewable Generation Gen-Tie	Transmission Developers	Reconductoring & Rebuild
Battery Energy Storage	Solar & Wind Collector Systems	Data Centers & Large Loads	Industrial & Manufacturing
EPC Contractors	Municipal & Cooperative Utilities	Infrastructure Developers	Grid Modernization Programs

New Build & Gen-Tie

Route through IFC for greenfield transmission and generation interconnection lines, coordinated with the POI substation and the interconnection study.

Rebuild & Reconductoring

LiDAR-based as-built modeling, structural re-check against the current code, clearance recovery and outage-driven construction sequencing.

Owner's Engineer & Review

Independent review of another firm's line design, ratings or structural analysis for a lender, an acquirer or an owner needing a second opinion.

ENGAGEMENT MODELS

Full line design package

Route through IFC as one scope, with structural, electrical, foundation and permitting-support engineering under a single revision-controlled deliverable set.

Discipline support to an EPC or owner

Sag-tension, structural analysis, foundations or modeling delivered into an existing team, on their drawing standard and their design criteria.

Assessment & recovery

Clearance audits, facility rating corrections, structural re-checks on existing lines, or picking up a design that stalled — verified first, then carried to IFC.

OUR CLIENTS

entergy · EDF power solutions · aps · AVANGRID · aypa (A Blackstone Portfolio Company) · SIEMENS energy · octa DATA CENTER · PIKE ENGINEERING · RRC · FISHER ASSOCIATES · BRASSWATER · RISK WORK

Criteria first, drawings second

The governing code edition, the owner's overlay and the load cases are agreed and documented before the first structure is spotted — which is what stops a late-stage code question from becoming a redesign.

Coordinated with the rest of the system

Ratings, clearances and protection assumptions are shared with the substation design and the interconnection studies rather than developed independently and reconciled later.

Built to be maintained

Vegetation clearance, access, inspection and future uprating headroom are design inputs, so the line is still economical to own in twenty years.

START HERE

Four Things and We Can Scope It

The endpoints — termini, approximate length and corridor status

The electrical basis — voltage, circuits, required rating and conductor if fixed

The design criteria — the utility standard and code edition it must satisfy

The stage & date — which deliverable you need and the milestone driving it

WHY KEENTEL ENGINEERING

01 Power-system engineers, not just line drafters

Line design integrated with ratings, protection, interconnection studies and grid-performance requirements — so the design reflects what the system analysis actually demands.

02 Line, substation and studies in one scope

The line, the POI substation and the interconnection studies can sit under a single scope, so ratings, clearances and protection settings agree across all three.

03 Advanced digital design

Integrated 2D and 3D modeling with automated calculations and drawing generation — fewer transcription errors, faster iteration, and a model that stays useful after construction.

04 Accuracy and code compliance

Designs aligned to the NESC edition actually adopted in the jurisdiction, the ASCE structural standards and the owner's own criteria, with the basis documented.

05 P.E. oversight

Professional engineering review and sealed deliverables where required and within applicable licensure — Florida Reg. No. 36853 with multi-state licensure.

06 We stay through construction

Engineering review during construction, field issue resolution, RFI response and design updates — not a drawing set and a handshake.

PRIMARY AUTHORITIES BEHIND THIS FLYER

NESC. ANSI/IEEE C2, National Electrical Safety Code — Sections 23 (clearances), 25 (loading) and 26 (strength and grades of construction), and the published revision schedule for the next edition.

ASCE. Manual of Practice 74, Guidelines for Electrical Transmission Line Structural Loading; ASCE/SEI 48, Design of Steel Transmission Pole Structures; ASCE/SEI 10, Design of Latticed Steel Transmission Structures; MOP 141, Wood Pole Structures; MOP 123, Prestressed Concrete Transmission Pole Structures; MOP 91, Design of Guyed Electrical Transmission Structures; MOP 113, Substation Structure Design Guide.

IEEE. IEEE 738, Calculating the Current-Temperature Relationship of Bare Overhead Conductors; IEEE 524, Installation of Overhead Transmission Line Conductors; the IEEE lightning performance guides; IEEE 1313 series, insulation coordination; IEEE 539, corona and field effects; IEEE 691, transmission structure foundation design and testing.

IEC and CIGRE. IEC 60826, Design criteria of overhead transmission lines; CIGRE Study Committee B2 technical brochures on thermal rating methods, conductors for uprating existing lines, and high-temperature conductors in new lines.

FERC. Order No. 881, transmission line ratings; Order No. 1920, regional transmission planning and cost allocation, including evaluation of alternative transmission technologies.

NERC. Reliability Standards FAC-001, FAC-002, FAC-003, FAC-008, PRC-023 and TPL-001.

Federal permitting. FAA 14 CFR Part 77 and the FAA advisory circular on obstruction marking and lighting; Clean Water Act Sections 404 and 10 and the U.S. Army Corps of Engineers Section 408 program; the Endangered Species Act, the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act; and industry avian protection practice guidance.

Other. EPRI transmission structure foundation research; RUS design bulletins; Class I railroad utility accommodation policies; state utility commission siting and EMF rules.

Editions, adoption status and regulatory positions described are current as of August 2026 and are provided for orientation only. The governing code edition, owner design criteria and permit conditions in force for a given project control.

START A SCOPE ›› contact@keentelengineering.com · 813-389-7871 · keentelengineering.com

NSPE | D·U·N·S REGISTERED | IEEE SENIOR MEMBER | BBB ACCREDITED A+

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