Exhibit 3.2.2

Patrick Engineering 345 kV Transmission Line Conceptual Design and Project Estimate

Taylorville 345kV Transmission Line

Conceptual Design & Project Estimate

Prepared For

TENASKA®

December 18, 2009

Prepared By
Patrick Engineering Inc.

Project # 20903.038

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Appendices

Taylorville 345kV Transmission Line
Conceptual Design & Project Estimate

INTRODUCTION

Patrick Energy Services (Patrick) conducted a preliminary engineering study to develop a conceptual design for the proposed route of a 345kV transmission line extending from the Taylorville Energy Center to a local transmission utility's existing Kincaid substation. This report includes a general description of the project, the assumptions made during engineering, and a detailed description of the preliminary design developed during this project. There is also an opinion of probable cost for the project included with this study which identifies specific subcontractor activities and the associated costs for each.

PROJECT DESCRIPTION

The purpose of this project is to develop a conceptual design and provide opinion of probable costs to Tenaska in order to prepare a project cost estimate. The proposed 345kV transmission line starts at the dead end structure of the Taylorville Energy Center to the fence of Kincaid Substation. The line will be designed to support two circuits but only one circuit will be installed for this study. The line will cross over privately owned properties as well as lakes and highways. The line will skirt the cities of Bulpitt, Tovey, and Taylorville, IL. Tenaska has requested Patrick to provide a +/- 30% cost estimate for the complete project.

The proposed line route was selected by Tenaska from a previous study performed by Patrick. The study is attached to this report in Appendix A. The line study performed evaluated various transmission line routes from the Taylorville Energy Center to the Kincaid substation. After studying the options, Patrick developed three proposed routes and an additional connection route. Tenaska selected a combination of the North and Direct routes connected by the Alternate route. Patrick and Tenaska agreed that the combined route impacted the least amount of residents. Appendix A includes a map of the various options along with a map of the final route.

ASSUMPTIONS

Some notable assumptions were made during the preliminary engineering of this line. Descriptions of these are listed here:

- Conceptual Design – The contents of this report are for conceptual and budgetary purposes only and are not intended to be used for final design purposes.
- Local transmission utility Standards – Structure type, conductor and shield wire types as well as stringing strength and ruling spans conform to local transmission utility standards.

- Land Acquisition – Land Acquisition was not included as part of this project. Tenaska will be providing land acquisition services for both permanent and construction services. A value of $332 per rod was supplied by Tenaska for 150ft wide right of way and multiplied by the 14 mile line to arrive at lump sum price located in the project cost summary.
- Wetland Delineation – Tenaska has already preformed some wetland studies in the region for other projects and will perform similar studies for transmission line activities.

CONCEPTUAL LINE DESIGN

Patrick performed the conceptual line design with Tenaska's direction. A picture of final line route can be seen in Appendix C. The proposed line utilizes local transmission utility standards. The standards referenced can be found in Appendix B. Patrick created plan and profile drawings which are located in Appendix C. Patrick designed single pole steel structures to support the double circuit line. The tangent structure used is Transmission Overhead Material specification number EM10561. Patrick used dead end specification number EM10566. Both of the specifications are located in Appendix B. At this time, not all the individual angle structures were modeled but this will be completed in a final design.

The structures were modeled in Power Line Systems' PLS Pole, a design software to design poles and attach equipment that can later be placed in a working model for ultimate design purposes. The poles were designed to a height of 115 feet from ground level to top of structure. They were then height adjusted as needed in the model. For the tangent structure the top arm has a length of 26 feet and secures the shield wire and top phase. The lower two arms are 16.5 feet in length, each supporting a single phase. For the dead end structure the top arm has a length of 30 feet and secures the shield wire. The lower three arms are 19 feet in length, each supporting a single phase.

Conductors were selected per local utility's standards Table III in EM10561. The conductor selected was a T2 BlueJay. The T2 conductor represents a twisted pair of standard BlueJay conductors. This conductor type reduces effects from galloping in the conductors. Galloping is an oscillation due to wind in the conductors that causes more stress on the transmission line and is prevalent in this area of the country. Patrick performed a three phase power equation to calculate the ampacity of the line to ensure it would be sufficient for Tenaska's needs. This calculation can be seen in Appendix C. The conductor information can be found in specification EM28061 which can be found in Appendix B. This appendix describes the physical attributes as well as the blowout characteristics of the conductor. As part of this study Patrick investigated the blowout of this conductor to determine the right of way width needed. The drawbacks of this conductor are increased cost for the construction company to string the conductor, increased material needs, and it has limited availability. This is due to the twisted multi conductor design.

The shield wire proposed is a 24 fiber optical ground wire. The shield wire attribute information can be found in specification EM28062. Patrick recommends the use of fiber optics in this situation due to increasing demands for communication on transmission lines.

The transmission line was modeled in PLS CADD. The model utilizes a basic digital elevation model purchased by Patrick. A more detailed model would be obtained by aerial survey which would be used to produce a final design. Elevation and global plane information was used to create a three dimensional map where the PLS pole structures are placed. The aerial maps were then viewed and structures were moved along the decided path to avoid existing obstacles.

Patrick traveled to Taylorville to verify preliminary structure locations and take pictures of areas of concern. After all the locations of the poles were confirmed, the conductors were placed into the model and poles were height adjusted to satisfy ground clearance requirements. In a final engineering model, new structures for each height will be placed in the model to obtain reactions to pass on to a material supplier for design and fabrication. Conductors were strung with maximum tensions found in Case A of Table III in the EM10561 specification. Ground clearance in the model is 27 feet from bottom phase to ground. This number was taken from the local transmission utility Design Clearances for Overhead Transmission Lines ESP 1.3.1.1 which can be found in Appendix B. Table 4.1.1 in ESP 1.3.1.1 states a minimum ground clearance of 24.6 feet which Patrick rounded up and added an additional two foot buffer per common industry practice. Both circuits were strung in the model to ensure that poles will be designed to support future expansion as requested by Tenaska.

After structures were modeled, a typical foundation size was calculated. Local transmission utility design standards require steel poles for 345kV lines are placed on caisson foundations. Different size structures have different size foundations. A structure check was performed inside the PLS CADD model to obtain base reactions on a typical tangent structure. These base reactions were inserted into PLS Caisson along with some conservative values for soil properties. The resulting output from PLS Caisson was a six foot diameter caisson with a length of 20 feet and is included in Appendix C. The size of dead end foundations will be larger. Both tangent and dead end foundations will need to be designed with specific soil properties obtained from a geotechnical study.

FINAL TRANSMISSION LINE ENGINEERING

The final transmission line engineering will be done in accordance with the local transmission utility standards and/or applicable codes such as NESC and ASCE. This work will expand on the conceptual design discussed above and develop the complete and final transmission line design. The design will include such items as:

- Route verification
- Survey coordination
- Structure placement
- Structure loading
- Foundation design
- Conductor stringing

- Material selection
- Permit coordination
- Construction coordination
- Project close out including as-builts

Engineering deliverables would include:

- Stringing charts
- Staking reports
- Specifications
    - Material procurement
    - Construction
    - Geotechnical
- Bill of materials
- Drawings
    - Structure load and design
    - Plan and profile
    - Hardware assemblies

Patrick has developed an estimate to complete this design. A spreadsheet outlining Patrick's anticipated hours to be spent on final engineering activities for this project can be found in Appendix C. This estimate incorporates all tasks and deliverables mentioned above. It also includes time and expenses for meeting attendance, phone conferences, site visits, and contacting and supporting other subcontractors. Anticipated site visits would include; initial route walk down, follow up review of areas that require special considerations, and verification of staking locations. The total project cost for this can be found in the cost summary of this document.

AERIAL SURVEY

Various companies were contacted to provide estimates for aerial survey and topographic mapping activities for the final engineering. An aerial survey company will provide color digital imagery of line area and data files for PLS model production. The current survey map used for PLS CADD model is accurate enough for proposals but the data is spread out and of a general variety. It is important when designing large expensive structures that the information used is as accurate as possible because small discrepancies can result in expensive redesign. Two different methods to produce this survey information are Photogrammetry and Lidar.

Photogrammetry is a method of obtaining topographic information using aerial photograph to develop terrain information. Lidar is a traditional method for collecting topographic information using a laser to scan the area to produce point coordinates. Both technologies have the ability to develop elevation contours in one foot intervals. They take the collected data and convert it into a format that can be placed into a PLS CADD model. It also separates out the different ground points into various features such as vegetation, roads, ground features, and bodies of water.

There are many other features that can be collected by aerial survey companies which can be viewed in Appendix D. Some of these features include taking video of the route, taking still pictures of structures in the line area, converting data to a GIS format and many other services. Approximate price for aerial survey can be seen in the cost summary. The final number used was produced using the highest budgetary estimate to be conservative. We feel that the budgetary estimate submitted by the contractor is applicable to this work scope.

SITE SURVEY

Site survey is another necessary activity of design and construction of the final transmission line. Survey activities will include:

- Real-estate investigation
- Survey and determine property lines & owners
- New easement exhibits for the owners
- Verification of aerial obstacles
- Staking activities for the right of way as well as two occasions of construction staking

Various companies were contacted to provide budgetary estimates for site survey activities which can be seen in Appendix E. The approximate price for site survey can be seen in the cost summary. To be conservative the highest budgetary estimate was used.

GEOTECHNICAL SERVICES

Various companies were contacted to provide estimates for soil boring and soil lab activities. It is important to perform testing on soils in the location of each structure because soil conditions vary from location to location. Different locations will show different conditions over the 14 mile line and a foundation could be sufficient for one location and not for another. Standard practice is to obtain a general condition that works for a majority of the tangent structures and custom design the dead end foundations and other outliers.

To obtain estimates, contractors were asked to estimate costs of approximately 100 soil borings to a depth of 50 feet or refusal. The typical foundation depth will not be greater than 30 feet, but deeper foundations will be utilized at dead end locations. The contractors were asked to include all associated cost with producing a geotechnical report of the encountered conditions and provide foundation recommendations.

Subcontractors were informed that all locations would be staked, cleared and that access approvals would be provided to perform work. The estimates we received covered a wide range therefore a calculated cost was derived by averaging the highest two estimates to be conservative. Adjustments can be made to the scope of soil study such as soil borings can be taken at less frequent intervals to cut costs. The approximate price for geotechnical services is included in the cost summary.

MATERIAL SUPPLIERS

Various companies were contacted to provide estimates for total material cost. The materials included in these estimates are conductors, optical shield wire, poles, grounding, insulators, and other hardware. It is important to note that prices of these items will fluctuate, especially the steel poles. Materials also vary by when delivery is needed. Prices in this section reflect a projected value of steel for mid 2010 with an average delivery time, approximately 20 weeks. The most significant cost will be the steel poles.

The estimated cost is shown in the cost summary. This cost has been divided into two values due to the significance of the cost of the steel poles. The steel poles have been shown independently and other materials are combined into a material category. Some specific material details can be found in Appendix G. From the estimates we received, one contractor appeared to have the best understanding of the needs for this project. Therefore, their value was used for all hardware. For steel poles a cost was averaged from suppliers with similar estimates.

CONSTRUCTION SERVICES

Various companies were contacted to provide estimates for construction services. Construction activities are as follows:

- Unloading and storage of materials
- Constructing foundations
- Framing poles
- Setting poles
- Pull/string conductor
- Restoration of area

Included with construction costs is the clearing cost. Patrick contacted clearing subcontractors and obtained a cost of clearing from two different contractors. The right of way must be cleared for various reasons, one of the most important being electrical clearance. Trees represent hazards to the transmission line. Construction, surveying, and soil boring activities are all greatly impeded by non cleared locations.

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Construction costs will differ depending on soil conditions and structure size. Poor soil conditions will result in larger foundations. Large structure sizes result in larger foundations as well as added difficulty in placement. Some contractors have broken up estimates for specific activities such as pole framing and pole setting while other contractors elected to submit an estimate as a cost per mile of construction. Approximate price for construction services can be seen on the cost summary. In determining the final budgetary estimate one contractor was abnormally low and was therefore not included in our determination. The remaining two contractors' numbers were similar and were averaged and combined with the clearing cost.

EPC PROJECT MANAGEMENT

Project management for this project consists of working with all parties communicating Tenaska's needs. The engineer will purchase required materials and contract the subcontractors. Project management would also develop and maintain a construction schedule. The estimated total time to complete this project is 24 to 30 months. One of the most critical tasks is ordering the materials. The lead time on steel poles alone is approximately 20 weeks. Other crucial tasks include aerial and site survey because they need to be completed before most of the engineering can be done. The anticipated construction schedule can be seen in Appendix J. The total cost of this activity is a percentage of the various project activities and can be viewed in the project cost summary.

PROJECT COST SUMMARY

	December 2009 Overnight Cost Estimate
Subcontractor Category	Total Price
Land Acquisition	$1,487,360
Engineering	$1,049,360
Lidar/Aerial Survey	$34,145
Site Survey	$169,940
Geotechnical Services	$150,000
Steel Poles	$6,124,980
Other Materials	$1,789,255
Construction	$10,800,000
EPC Project Management	$2,055,570
Total	$23,660,610

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CONCLUSION

Patrick has concluded that the route proposed by Tenaska is a viable route. After conducting a conceptual study Patrick has developed a conceptual design that incorporates 98 structures over the 14 mile line. Utilizing local transmission utility standards, Patrick collected required information and distributed it to various subcontractors in an effort to achieve a budget estimate within 30% accuracy. The approximate cost for this project is estimated at $23,660,610.

The following pages contain the appendices referenced in this section. Any questions about this report or the line design should be directed to Patrick Engineering.

Patrick Engineering Inc.

Christopher P. Dietzler, P.E.
Vice President

Appendix A

Tenaska Transmission Line Study

Tenaska Transmission Line Study

Patrick was charged with the task of performing a transmission line routing study into/from the Taylorville Energy Center. The project consisted of four tasks: propose routes, outline structure types, highlight constructability issues, and examine ROW requirements. These tasks are covered in this summary of findings.

Proposed Route Plans

- North Route – 13.26 miles. This plan starts to the north of the Kincaid Substation. It follows a line of existing Transmission Lines. The line follows apparent parcel lines and stays within the township border crossing through backyards. This path crosses two bodies of water and one highway. There are 4 major angles all less than 45 degrees.

- Direct Route – 12.21 miles. This route parallels the existing power lines running east to west. The route angles slightly north to avoid the towns of Bulpitt and Kincaid. The route then is located on the apparent parcel lines crossing the highway before terminating in the Taylorville Energy Center. This path crosses two bodies of water and one highway. There are 4 major angles all less than 45 degrees and smaller than the angles required for the North Route.

- South Route – 13.14 miles. This route is the least preferred but is provided in case there are rationale we are not aware of that Tenaska sees as advantages of the southern route. It starts south of the Kincaid Substation. This path weaves through fields and south of Tovey, Bulpitt, Kincaid and Jeisyville. The path crosses Springfield St. 104 southeast of Jeisyille and continues across apparent parcel lines before crossing a second highway. This path crosses two bodies of water and two highways. There are 6 major angles all less than 45 degrees.

- Alternate Route – This path is a connector. There are two existing lines that appear to be a large enough distance apart that a 345kV line could run in between the lines. This will have to be investigated further if Tenaska prefers this route. This route then could connect to any of the aforementioned routes.

<u>Structure types</u>
Tenaska requested both wood and steel pole supporting structures for the proposed double circuit 345kV line. The plan involves energizing one circuit and having a second circuit available for expansion. Since this line will be attaching to a [redacted] substation, and therefore should conform to [redacted] standards, it was determined that there are no standard [redacted] wood structures that would support a double circuit 345kV line. There are two options for steel monopole structures. Both structures utilize a 725-foot ruling span. One structure is a vertical design (EM10561) with a minimum height of 110 feet. The other structure (EM10431) utilizes a V-string support on the lower phase for an overall shorter structure minimum height of 85 feet.

Constructability issues

The terrain maps of the area show no significant elevation changes. The constructability issues ultimately hinge on the route selected. There are some water crossings and highway crossings that require attention. There are some areas that are classified as wetlands that all paths cross. The lines can be designed to span these areas and they should not affect the choice of route. Patrick recommends that proposed lines be field examined to determine if any other obstacles exist that are not apparent in aerial photos.

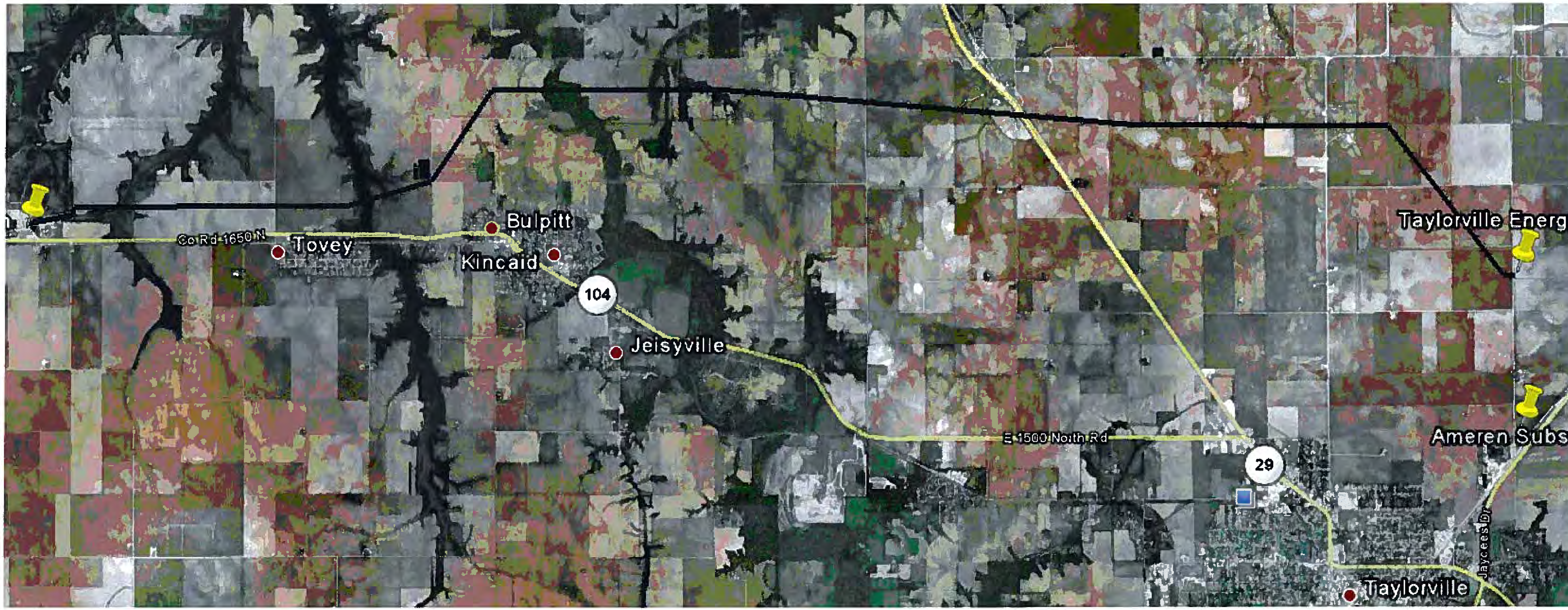
Right Of Way

Standards indicate that a 345kV double circuit single pole structure could require approximately 75 feet on each side of the line. The interaction between buildings, bridges, bodies of water, and electrical lines will need to be examined on a case by case basis. The calculated minimum design width is 113 feet but also requires that margins of safety be incorporated. Since there are unknowns along the pathway at this time, we recommend to plan on a 150-foot wide ROW.

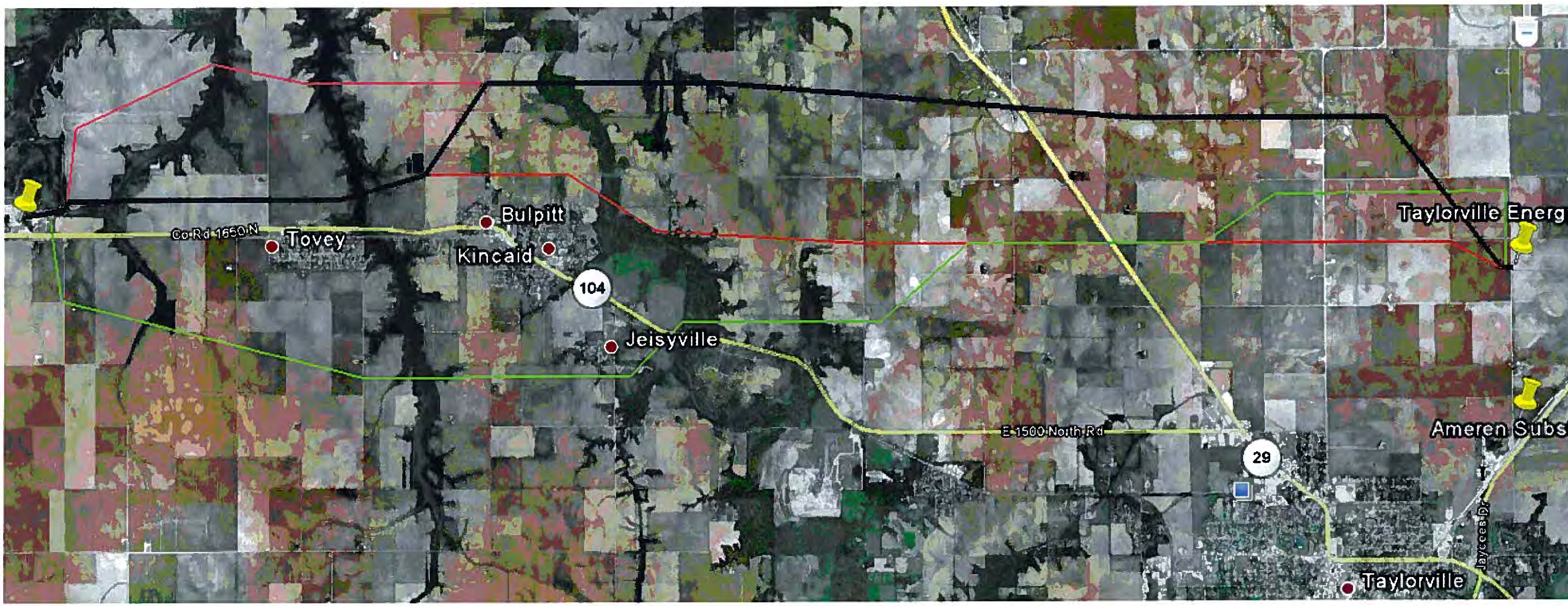
Summary

While all routes appear to be viable options, further study will be required to determine if obstructions exist in the field. The direct route is recommended. Patrick recommends that before final selection is made the proposed line should be examined in the field. All routes were prepared to avoid houses and other structures. The two pole styles that can be utilized for tangent structures are [redacted] standard structures EM10431 and [redacted] EM10561. Constructability issues are not significantly different from route to route. Right of Way requirements for the line will likely be 150 feet in total width.

Selected Route



Route Options



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Appendix B

Local Transmission Utility Design Standards

345KV DOUBLE CIRCUIT
0° - 2° SMALL ANGLE SUSPENSION STRUCTURE WITH ORNAMENTAL ARMS 725' DESIGN RULING SPAN

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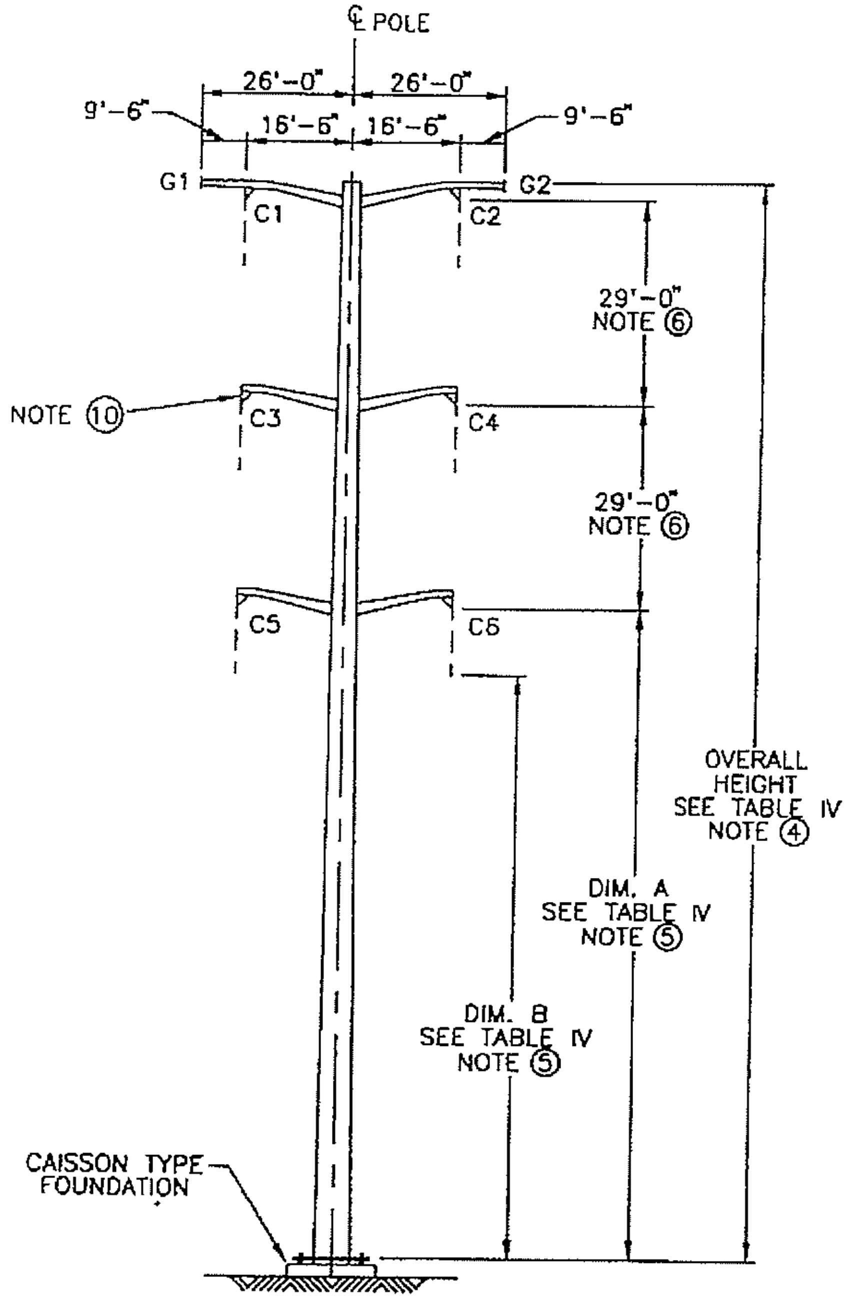

ELEVATION

REV.	ENGINEER	REVIEWED	PROJECT	DATE	COMMENTS
0	N.F. KAUP	H.D. MURRAY	ADDED S.I. ND'S. FOR 150 TO 160 TOTAL HEIGHT POLES	3-17-00	
1	C.H. PRIEBE	N.F. KAUP	CHANGED EXTREME WIND LOADS FROM 21 PSF TO 24 PSF	4-18-01	

LINES ENGINEERING

[redacted]
SYSTEM STANDARD

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TABLE I – ULTIMATE DESIGN LOADS

CASE	LOADING COMBINATION	LOAD DIRECTION	OVERLOAD FACTORS USED IN WIRE LOADS	CONCENTRATED WIRE LOADS AT EACH POINT (KIPS) C1-C6	CONCENTRATED WIRE LOADS AT EACH POINT (KIPS) G1-G2	DISTRIBUTED LOADS AND OVERLOAD FACTORS FOR STRUCTURES
A	NESC HEAVY: 1/2" ICE, 4# WIND, 0 DEG F., K=0.30 INITIAL TENSIONS	VERTICAL	1.50	7.44	2.40	DEAD WEIGHT x 1.50
		TRANSVERSE	3.00 WIND, 1.65 TENSION	3.47	1.51	0.004 KSF x AREA x 3.00
		LONGITUDINAL	NOT APPLICABLE	0.00	0.00	NOT APPLICABLE
B	HEAVY ICE: 1 1/2" ICE, 4# WIND, 32 DEG F. INITIAL TENSIONS	VERTICAL	1.00	10.10	4.79	DEAD WEIGHT x 1.00
		TRANSVERSE	1.00	2.28	1.28	0.004 KSF x AREA x 1.00
		LONGITUDINAL	NOT APPLICABLE	0.00	0.00	NOT APPLICABLE
C	EXTREME WIND (NOTE 17): NO ICE, 24# WIND, 0 DEG F. INITIAL TENSIONS	VERTICAL	1.10	3.67	1.03	DEAD WEIGHT x 1.10
		TRANSVERSE	1.10	4.21	1.13	0.035 KSF x AREA x 1.10
		LONGITUDINAL	NOT APPLICABLE	0.00	0.00	NOT APPLICABLE
D	BROKEN CONDUCTOR (NOTE 12): NO ICE, 4# WIND, 0 DEG F. INITIAL TENSIONS	VERTICAL	1.10	3.67	1.03	DEAD WEIGHT x 1.10
		TRANSVERSE	1.10	1.14	0.28	0.004 KSF x AREA x 1.10
		LONGITUDINAL	1.10	10.70	0.00	NOT APPLICABLE
E	BROKEN STATIC WIRE (NOTE 12): 1/2" ICE, 4# WIND, 0 DEG F., K=0.30 INITIAL TENSIONS	VERTICAL	1.10	5.46	1.76	DEAD WEIGHT x 1.10
		TRANSVERSE	1.10	1.62	0.66	0.004 KSF x AREA x 1.10
		LONGITUDINAL	1.10	0.00	6.44	NOT APPLICABLE
F	NORMAL, EVERYDAY CONDITION (NOTE 15): NO ICE, NO WIND, 50 DEG F. 1 DEG. LINE ANGLE, FINAL TENSIONS	VERTICAL	1.00	2.83	0.44	DEAD WEIGHT x 1.00
		TRANSVERSE	1.00	0.17	0.04	NOT APPLICABLE
		LONGITUDINAL	NOT APPLICABLE	0.00	0.00	NOT APPLICABLE
G	NORMAL, EVERYDAY CONDITION (NOTE 15): NO ICE, NO WIND, 50 DEG F. 2 DEG. LINE ANGLE, FINAL TENSIONS	VERTICAL	1.00	2.83	0.44	DEAD WEIGHT x 1.00
		TRANSVERSE	1.00	0.34	0.08	NOT APPLICABLE
		LONGITUDINAL	NOT APPLICABLE	0.00	0.00	NOT APPLICABLE

TABLE II – DESIGN SPANS AND LINE ANGLES

DESIGN RULING SPAN (FT.)	725
MAX. DESIGN WIND SPAN (FT.)	750
MAX. DESIGN WEIGHT SPAN (FT.)	1,000
MIN. DESIGN LINE ANGLE (DEG.)	0
MAX. DESIGN LINE ANGLE (DEG.)	2

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TABLE III -- DESIGN WIRE TYPES AND TENSIONS

CASE	LOADING COMBINATION	DESIGN TENSIONS (POUNDS) FOR EACH WIRE TYPE	
		345KV CONDUCTOR T-2 BLUEJAY 2Ø 1113 KCMIL, 45/7 ACSR (C1-C6)	7#6 ALUMOWELD OR 24-FIBER OPGW (NOTE (16)) STATIC WIRE (G1-G2)
A	NESC HEAVY: 1/2" ICE, 4# WIND, 0 DEG F., K=0.30 INITIAL TENSIONS	20,350	5,850
B	HEAVY ICE: 1 1/2" ICE, 4# WIND, 32 DEG F. INITIAL TENSIONS	29,176	11,013
C	EXTREME WIND: NO ICE, 24# WIND, 0 DEG F. INITIAL TENSIONS	20,910	4,891
D	BROKEN CONDUCTOR: NO ICE, 4# WIND, 0 DEG F. INITIAL TENSIONS	14,916	3,111
E	BROKEN STATIC WIRE: 1/2" ICE, 4# WIND, 0 DEG F., K=0.30 INITIAL TENSIONS	20,350	5,850
F & G	NORMAL, EVERYDAY CONDITION: NO ICE, NO WIND, 50 DEG F. FINAL TENSIONS	9,818	2,262

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TABLE IV - STRUCTURE HEIGHTS			
STORES ITEM NUMBERS	OVERALL HEIGHT (FEET)	APPROX. DIM. A (FEET)	APPROX. DIM. B (FEET)
386270	110	47.3	37.5
386271	115	52.3	42.5
386272	120	57.3	47.5
386273	125	62.3	52.5
386274	130	67.3	57.5
386275	135	72.3	62.5
386276	140	77.3	67.5
386277	145	82.3	72.5
388731	150	87.3	77.5
388732	155	92.3	82.5
388733	160	97.3	87.5

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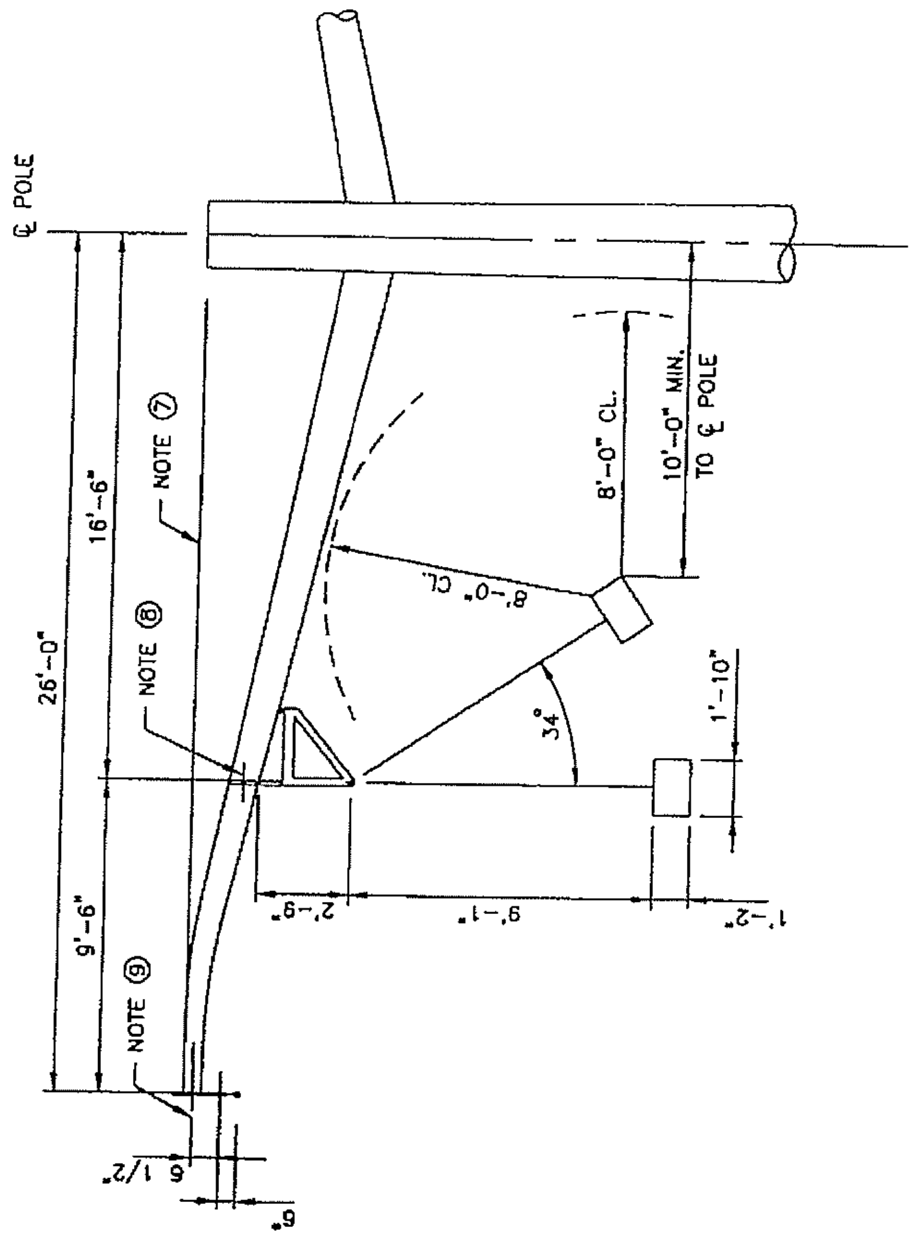

DETAIL 1
TYPICAL 345KV CLEARANCE REQUIREMENTS
(TOP CROSSARM)

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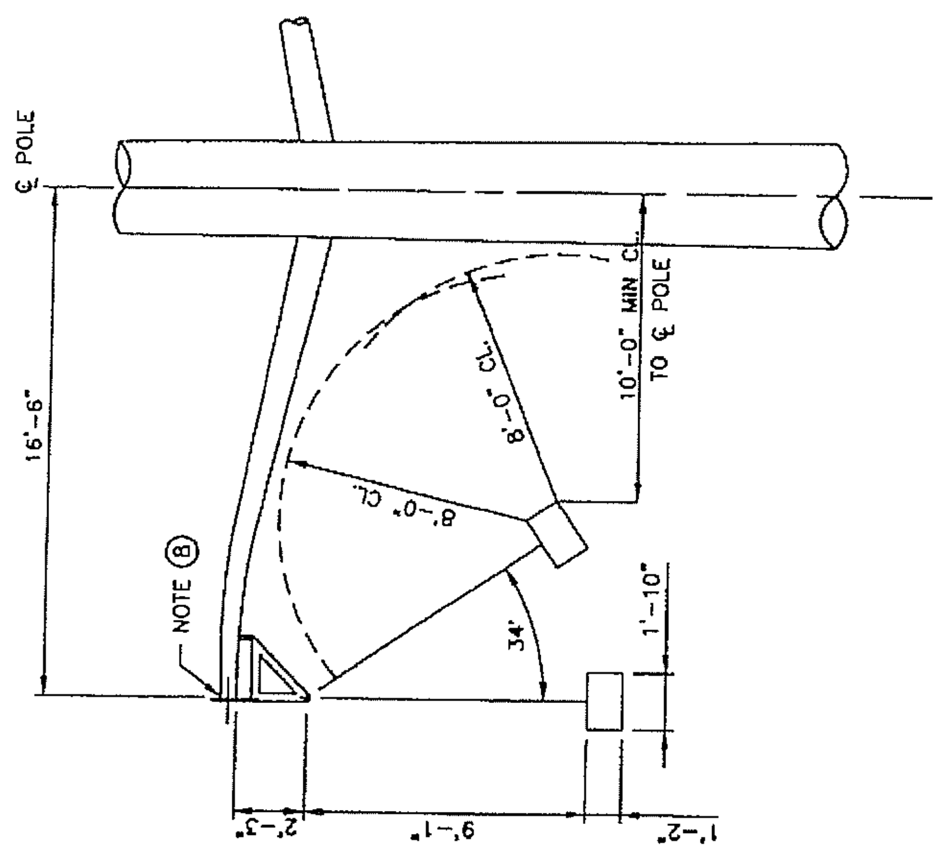

DETAIL 2
TYPICAL 345KV CLEARANCE REQUIREMENTS
(BOTTOM & MIDDLE CROSSARMS)

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NOTES:

1. THIS SPECIFICATION COVERS GEOMETRY AND LOADING REQUIREMENTS FOR DESIGN OF A TUBULAR STEEL POLE TRANSMISSION LINE STRUCTURE. IT SHALL BE USED IN CONJUNCTION WITH THE OWNER'S SPECIFICATION EM10361, WHICH COVERS GENERAL REQUIREMENTS AND DETAILS NOT SPECIFICALLY COVERED HEREIN. WHERE THIS SPECIFICATION IS IN CONFLICT WITH EM10361, THE REQUIREMENTS OF THIS SPECIFICATION SHALL TAKE PRECEDENCE.

2. STRUCTURE HEIGHT SHALL BE AS INDICATED BY THE STORES ITEM NUMBER (SEE TABLE IV). UNLESS OTHERWISE STATED, STRUCTURE SHALL BE PAINTED THE FOLLOWING COLOR: SKY GRAY.

3. ALL CROSSARMS SHALL BE "ORNAMENTAL" ARMS WITH UPSWEEP ANGLE AND RADIUSED BEND. REFER TO EM10361 FOR TYPICAL "ORNAMENTAL" ARM GEOMETRY. UPSWEEP ANGLE OF ARMS SHALL BE 12 DEGREES.

4. OVERALL HEIGHTS ARE FROM THE TOP OF BASEPLATE TO THE TOP OF POLE SHAFT. SEE TABLE IV.

5. DIMENSION "A" IS FROM THE TOP OF BASEPLATE TO THE LOWEST ATTACHMENT HOLES ON THE BOTTOM CROSSARM. DIMENSION "B" IS FROM THE TOP OF BASEPLATE TO THE LOWEST CONDUCTOR SUSPENSION CLAMP. SEE TABLE IV FOR APPROXIMATE DIMENSIONS.

6. THESE DIMENSIONS ARE BETWEEN HOLES FOR ATTACHMENT OF INSULATOR ASSEMBLIES, AS INDICATED.

7. TOP OF POLE SHAFT SHALL BE (APPROXIMATELY) AT THE ELEVATION OF THE TOP OF THE UPPERMOST ARMS.

8. FABRICATOR SHALL PROVIDE ATTACHMENT HOLES ON THE SIDES OF THE CROSSARMS DIRECTLY ABOVE EACH CONDUCTOR I-STRING HANGER BRACKET THESE HOLES ARE INTENDED AS WORKING HOLES OR FOR TEMPORARY DEAD-ENDING OF THE CONDUCTOR DURING CONSTRUCTION AND MAINTENANCE OPERATIONS. THE WORKING HOLE BRACKETS SHALL BE CAPABLE OF SUPPORTING ALL LOADS AS SHOWN FOR THE CONDUCTOR IN TABLE I.

9. STATIC WIRE ATTACHMENT BRACKETS SHALL BE DESIGNED FOR BOTH SUSPENDING AND DEAD-ENDING THE STATIC WIRE. REFER TO EM10361 FOR TYPICAL DETAILS.

10. ALL HANGER BRACKETS SHALL HAVE VERTICAL DIMENSIONS APPROXIMATELY AS SHOWN AND SHALL BE FREE TO SWING (UP TO 90 DEGREES FROM THE VERTICAL) IN THE LONGITUDINAL DIRECTIONS. REFER TO EM10361 FOR TYPICAL HANGER BRACKET DETAILS AND REQUIREMENTS.

11. NOT USED.

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NOTES: (CONT.)

(12) LONGITUDINAL UNBALANCE LOADS INDICATED FOR THE VARIOUS WIRE TYPES IN THE BROKEN WIRE LOADING COMBINATIONS IN TABLE I ARE TO BE APPLIED AT ANY ONE WIRE ATTACHMENT POINT (ANY ONE PHASE CONDUCTOR OR ANY ONE STATIC WIRE LOCATION BUT NOT TWO OR MORE LOCATIONS SIMULTANEOUSLY). ALL OTHER (INTACT) WIRE POSITIONS ON THE STRUCTURE SHALL HAVE THE VERTICAL AND TRANSVERSE FORCES SHOWN FOR THESE LOAD COMBINATIONS APPLIED WITH NO LONGITUDINAL UNBALANCE AT THOSE LOCATIONS.

13. STRUCTURE IS TO BE DESIGNED FOR INSTALLATION OF EITHER BOTH CIRCUITS OR FOR INSTALLATION OF ONLY ONE CIRCUIT ON ONE SIDE OF THE POLE SHAFT (FOR EXAMPLE, WIRES G2, C2, C4 AND C6 INSTALLED, WITH NO WIRES ON THE OPPOSITE SIDE OF THE POLE).

14. ALL VERTICAL WIRE LOADS (WITH THE EXCEPTION OF THE NORMAL, EVERYDAY CONDITION) INCLUDE A WORKING LOAD OF 500 POUNDS. ALL VERTICAL CONDUCTOR LOADS INCLUDE THE WEIGHT OF INSULATOR ASSEMBLIES USING PORCELAIN BALL & SOCKET INSULATORS. 345KV SUSPENSION ASSEMBLIES ARE ASSUMED TO HAVE 18 INSULATORS PER STRING. ASSUMED WEIGHTS OF INSULATORS ARE AS FOLLOWS.

CONDITION	ICED WEIGHT OF EACH INSULATOR
NO ICE	18 POUNDS
1/2" ICE	20 POUNDS
1 1/2" ICE	23 POUNDS

(15) THE NORMAL, EVERYDAY LOADING COMBINATIONS ARE INCLUDED FOR INFORMATION TO DETERMINE IF AND HOW MUCH THE STRUCTURE IS TO BE RAKED BY THE ERECTION CONTRACTOR.

(16) STATIC WIRE LOADS ARE BASED ON THE (LARGER) DIAMETER AND UNIT WEIGHT OF THE 24-FIBER OPTICAL GROUNDWIRE; HOWEVER, MOST OF THE DESIGN TENSIONS USED IN COMPUTING STATIC WIRE LOADS ARE BASED ON THE 7#6 ALUMOWELD (WHICH ARE SLIGHTLY HIGHER THAN THE OPTICAL GROUNDWIRE TENSIONS). THIS WAS DONE TO ENSURE THAT THE STRUCTURES WOULD ACCOMMODATE EITHER WIRE TYPE.

(17) DUE TO THE FACT THAT THE STRUCTURES COVERED BY THIS SPECIFICATION ARE NEARLY ALL GREATER THAN 110 FEET IN HEIGHT, THE EXTREME WIND LOADING COMBINATION WIRE LOADS AND DISTRIBUTED LOADS ON STRUCTURE HAVE BEEN COMPUTED BASED ON A WIND PRESSURE ON WIRES OF 24 PSF AND A WIND PRESSURE ON STRUCTURE OF 35 PSF (AS OPPOSED TO THE COMED STANDARDS OF 21 PSF AND 30 PSF, RESPECTIVELY).

18. TRANSVERSE LOADS ACT FROM LEFT TO RIGHT IN THE ELEVATION VIEW OF THE STRUCTURE, UNLESS OTHERWISE INDICATED.

19. NOTE FOR DESIGN ENGINEER--- WHEN PREPARING STRINGING CHARTS FOR STATIC WIRE USING 7#6 ALUMOWELD OR 12#9 ALUMOWELD 24-FIBER OPTICAL GROUNDWIRE, NESC HEAVY INITIAL TENSIONS SHALL BE BASED ON MAXIMUM 12% WIRE RATED TENSILE STRENGTH (RTS) FINAL TENSIONS UNDER 0 DEGREE, NO ICE AND NO WIND LOADING CONDITION. FOR EXAMPLE, FOR 725 FOOT DESIGN RULING SPAN, NESC HEAVY INITIAL TENSIONS FOR 7#6 ALUMOWELD AND 12#9 ALUMOWELD 24-FIBER OPTICAL GROUNDWIRE ARE 5850 LBS AND 5700 LBS RESPECTIVELY.

EQUIPMENT SPECIFICATION
NEW SPECIFICATION

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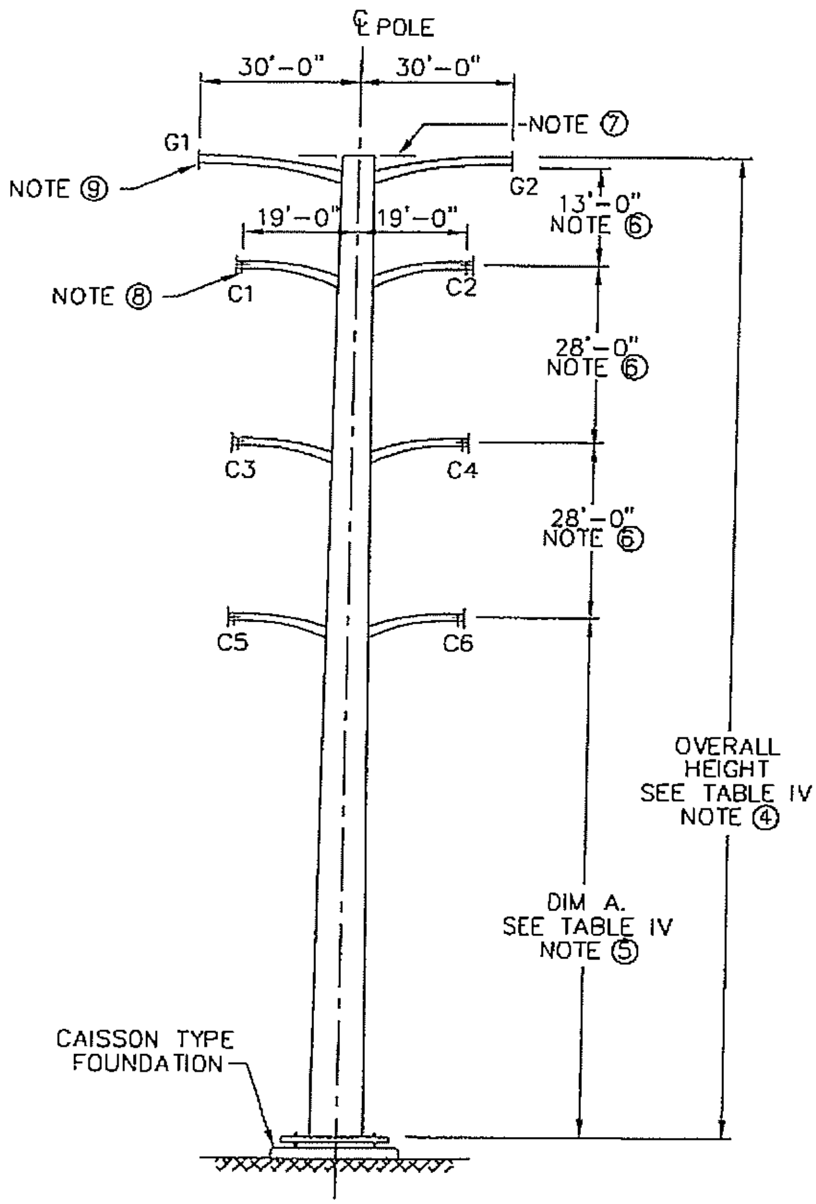
345KV DOUBLE CIRCUIT
60°-90° TERMINAL/HEAVY ANGLE STRUCTURE WITH ORNAMENTAL ARMS 725' DESIGN RULING SPAN



ELEVATION

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TABLE I – ULTIMATE DESIGN LOADS

CASE	LOADING COMBINATION	LOAD DIRECTION	OVERLOAD FACTORS USED IN WIRE LOADS	CONCENTRATED WIRE LOADS AT EACH POINT (KIPS) C1–C6		DISTRIBUTED LOADS AND OVERLOAD FACTORS FOR STRUCTURES
				C1–C6	G1–G2	
A	NESC HEAVY, ALL WIRES INSTALLED: 1/2" ICE, 4# WIND, 0 DEG F., K=0.30 90 DEG. LINE ANGLE, INITIAL TENSIONS	VERTICAL	1.50	9.60	2.40	DEAD WEIGHT x 1.50
		TRANSVERSE	3.00 WIND, 1.65 TENSION	49.10	14.50	0.004 KSF x AREA x 3.00
		LONGITUDINAL	NOT APPLICABLE	0.00	0.00	NOT APPLICABLE
B	HEAVY ICE, ALL WIRES INSTALLED: 1 1/2" ICE, 4# WIND, 32 DEG F. 90 DEG. LINE ANGLE, INITIAL TENSIONS	VERTICAL	1.00	11.70	4.79	DEAD WEIGHT x 1.00
		TRANSVERSE	1.00	42.20	16.20	0.004 KSF x AREA x 1.00
		LONGITUDINAL	NOT APPLICABLE	0.00	0.00	NOT APPLICABLE
C	EXTREME WIND, ALL WIRES INSTALLED (NOTE (17)): NO ICE, 21# WIND, 0 DEG F. 90 DEG. LINE ANGLE, INITIAL TENSIONS	VERTICAL	1.10	5.09	1.03	DEAD WEIGHT x 1.10
		TRANSVERSE	1.10	33.00	7.79	0.030 KSF x AREA x 1.10
		LONGITUDINAL	NOT APPLICABLE	0.00	0.00	NOT APPLICABLE
D	NESC HEAVY, TANGENT DEAD-END: 1/2" ICE, 4# WIND, 0 DEG F., K=0.30 0 DEG. LINE ANGLE, INITIAL TENSIONS	VERTICAL	1.50	9.60	2.40	DEAD WEIGHT x 1.50
		TRANSVERSE	3.00 WIND, 1.65 TENSION	2.30	1.17	0.004 KSF x AREA x 3.00
		LONGITUDINAL	1.65	33.60	9.65	NOT APPLICABLE
E	NESC HEAVY, ANGLE DEAD-END: 1/2" ICE, 4# WIND, 0 DEG F., K=0.30 90 DEG. LINE ANGLE, INITIAL TENSIONS	VERTICAL	1.50	9.60	2.40	DEAD WEIGHT x 1.50
		TRANSVERSE	3.00 WIND, 1.65 TENSION	25.40	7.66	0.004 KSF x AREA x 3.00
		LONGITUDINAL	1.65	23.70	6.83	NOT APPLICABLE
F	HEAVY ICE, TANGENT DEAD-END: 1 1/2" ICE, 4# WIND, 32 DEG F. 0 DEG. LINE ANGLE, INITIAL TENSIONS	VERTICAL	1.00	11.70	4.79	DEAD WEIGHT x 1.00
		TRANSVERSE	1.00	1.27	0.89	0.004 KSF x AREA x 1.00
		LONGITUDINAL	1.00	29.20	11.00	NOT APPLICABLE
G	HEAVY ICE, ANGLE DEAD-END: 1 1/2" ICE, 4# WIND, 32 DEG F. 90 DEG. LINE ANGLE, INITIAL TENSIONS	VERTICAL	1.00	11.70	4.79	DEAD WEIGHT x 1.00
		TRANSVERSE	1.00	21.50	8.42	0.004 KSF x AREA x 1.00
		LONGITUDINAL	1.00	20.60	7.79	NOT APPLICABLE
H	NORMAL, EVERYDAY CONDITION (NOTE (15)): NO ICE, NO WIND, 50 DEG F. 75 DEG. LINE ANGLE, FINAL TENSIONS	VERTICAL	1.00	4.13	0.44	DEAD WEIGHT x 1.00
		TRANSVERSE	1.00	12.00	2.75	NOT APPLICABLE
		LONGITUDINAL	NOT APPLICABLE	0.00	0.00	NOT APPLICABLE
I	NORMAL, EVERYDAY CONDITION (NOTE (15)): NO ICE, NO WIND, 50 DEG F. 90 DEG. LINE ANGLE, FINAL TENSIONS	VERTICAL	1.00	4.13	0.44	DEAD WEIGHT x 1.00
		TRANSVERSE	1.00	13.90	3.20	NOT APPLICABLE
		LONGITUDINAL	NOT APPLICABLE	0.00	0.00	NOT APPLICABLE

TABLE II – DESIGN SPANS AND LINE ANGLES

DESIGN RULING SPAN (FT.)	725
MAX. DESIGN WIND SPAN (FT.)	750
MAX. DESIGN WEIGHT SPAN (FT.)	1,000
MIN. DESIGN LINE ANGLE (DEG.)	60
MAX. DESIGN LINE ANGLE (DEG.)	90

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TABLE III – DESIGN WIRE TYPES AND TENSIONS			
CASE	LOADING COMBINATION	DESIGN TENSIONS (POUNDS) FOR EACH WIRE TYPE	
		345KV CONDUCTOR T-2 BLUEJAY 2@ 1113 KCMIL, 45/7 ACSR (C1-C6)	7#6 ALUMOWELD OR 24-FIBER OPGW (NOTE (16)) STATIC WIRE (G1-G2)
A, D & E	NESC HEAVY: 1/2" ICE, 4# WIND, 0 DEG F., K=0.30 INITIAL TENSIONS	20,350	5,850
B, F & G	HEAVY ICE: 1 1/2" ICE, 4# WIND, 32 DEG F. INITIAL TENSIONS	29,176	11,013
C	EXTREME WIND: NO ICE, 21# WIND, 0 DEG F. INITIAL TENSIONS	19,840	4,636
H & I	NORMAL, EVERYDAY CONDITION: NO ICE, NO WIND, 50 DEG F. FINAL TENSIONS	9,818	2,262

TABLE IV – STRUCTURE HEIGHTS		
STORES ITEM NUMBERS	OVERALL HEIGHT (FEET)	DIM. A (FEET)
386478	110	39.8
386331	115	44.8
386332	120	49.8
386479	125	54.8
386334	130	59.8
386335	135	64.8
386336	140	69.8
386337	145	74.8
386338	150	79.8
386339	155	84.8

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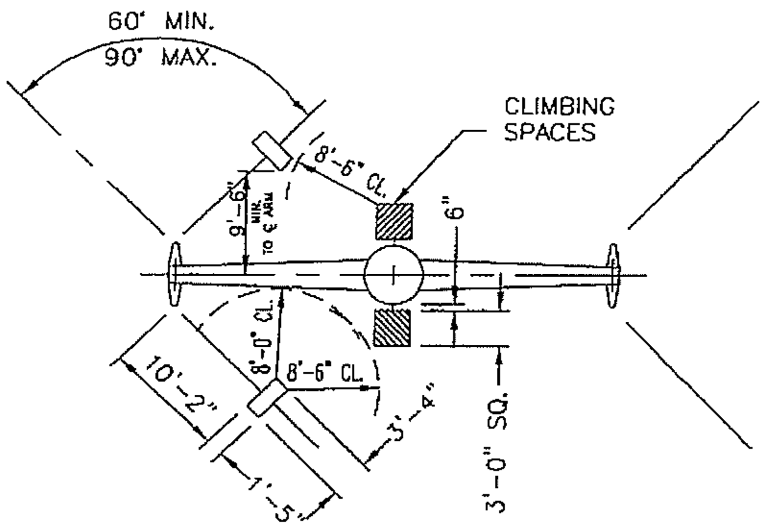

DETAIL 1

TYPICAL 345KV CLEARANCE REQUIREMENTS
(PLAN OF TOP, MIDDLE & BOTTOM CROSSARMS)

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NOTES:

1. THIS SPECIFICATION COVERS GEOMETRY AND LOADING REQUIREMENTS FOR DESIGN OF A TUBULAR STEEL POLE TRANSMISSION LINE STRUCTURE. IT SHALL BE USED IN CONJUNCTION WITH THE OWNER'S SPECIFICATION EM10361, WHICH COVERS GENERAL REQUIREMENTS AND DETAILS NOT SPECIFICALLY COVERED HEREIN. WHERE THIS SPECIFICATION IS IN CONFLICT WITH EM10361, THE REQUIREMENTS OF THIS SPECIFICATION SHALL TAKE PRECEDENCE.

2. STRUCTURE HEIGHT SHALL BE AS INDICATED BY THE STORES ITEM NUMBER (SEE TABLE IV). UNLESS OTHERWISE STATED, STRUCTURE SHALL BE PAINTED THE FOLLOWING COLOR: LIGHT GRAY.

3. ALL CROSSARMS SHALL BE "ORNAMENTAL" ARMS WITH UPSWEEP ANGLE AND RADIUSED BEND. REFER TO EM10361 FOR TYPICAL "ORNAMENTAL" ARM GEOMETRY. UPSWEEP ANGLE OF ARMS SHALL BE 12 DEGREES.

(4) OVERALL HEIGHTS ARE FROM THE TOP OF BASEPLATE TO THE TOP OF POLE SHAFT (SEE TABLE IV).

(5) DIMENSION "A" IS FROM THE TOP OF BASEPLATE TO THE LOWEST ATTACHMENT HOLES ON THE BOTTOM CROSSARMS. SEE TABLE IV FOR APPROXIMATE DIMENSIONS.

(6) THESE DIMENSIONS ARE BETWEEN HOLES FOR ATTACHMENT OF STRAIN INSULATOR ASSEMBLIES.

(7) TOP OF POLE SHAFT SHALL BE (APPROXIMATELY) AT THE ELEVATION OF THE TOP OF THE UPPERMOST ARMS.

(8) FABRICATOR SHALL PROVIDE ATTACHMENT HOLES ON THE BOTTOMS OF THE CROSSARMS DIRECTLY BELOW EACH CONDUCTOR DEAD-END BRACKET. THESE HOLES ARE INTENDED FOR ATTACHMENT OF JUMPER SUPPORT INSULATOR ASSEMBLIES.

(9) STATIC WIRE ATTACHMENT BRACKETS SHALL BE DESIGNED FOR BOTH SUSPENDING AND DEAD-ENDING THE STATIC WIRE. REFER TO EM10361 FOR TYPICAL DETAILS.

10. (NOT USED)

11. (NOT USED)

12. (NOT USED)

13. STRUCTURE IS TO BE DESIGNED FOR INSTALLATION OF EITHER BOTH CIRCUITS OR FOR INSTALLATION OF ONLY ONE CIRCUIT ON ONE SIDE OF THE POLE SHAFT (FOR EXAMPLE, WIRES G2, C2, C4, AND C6, INSTALLED, WITH NO WIRES ON THE OPPOSITE SIDE OF THE POLE).

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NOTES: (CONT.)

14. ALL VERTICAL WIRE LOADS (WITH THE EXCEPTION OF THE NORMAL, EVERYDAY CONDITION) INCLUDE A WORKING LOAD OF 500 POUNDS. ALL VERTICAL CONDUCTOR LOADS INCLUDE THE WEIGHT OF INSULATOR ASSEMBLIES USING PORCELAIN BALL & SOCKET INSULATORS. 345KV STRAIN ASSEMBLIES ARE ASSUMED TO HAVE 36 INSULATORS EACH. 345KV SUSPENSION JUMPER SUPPORT ASSEMBLIES ARE ASSUMED TO HAVE 18 INSULATORS PER STRING.
ASSUMED WEIGHTS OF INSULATORS ARE AS FOLLOWS:

CONDITION	ICED WEIGHT OF EACH INSULATOR
NO ICE	18 POUNDS
1/2" ICE	20 POUNDS
1 1/2" ICE	23 POUNDS

(15) THE NORMAL, EVERYDAY LOADING COMBINATIONS ARE INCLUDED FOR INFORMATION ON STRUCTURE DEFLECTION. DEPENDING ON THE ANTICIPATED USAGE OF A PARTICULAR STRUCTURE PURCHASED, THE OWNER MAY REQUIRE THAT THE FABRICATOR PRE-CAMBER THE POLE SHAFT TO OFFSET THE AMOUNT OF THE POLE TOP DEFLECTION UNDER THE NORMAL, EVERYDAY CONDITION FOR THE POLE IN QUESTION. UNLESS OTHERWISE DIRECTED, THE FABRICATOR IS TO ASSUME THAT POLES WHOSE TOP DEFLECTION EXCEEDS 1% OF OVERALL HEIGHT WILL BE CAMBERED. IF REQUIRED, THE OWNER WILL INFORM THE FABRICATOR OF THE PRECISE WIRE LOADS ON WHICH TO BASE THE ACTUAL PRE-CAMBER AFTER AWARD OF THE PURCHASE ORDER.

(16) STATIC WIRE LOADS ARE BASED ON THE (LARGER) DIAMETER AND UNIT WEIGHT OF THE 24-FIBER OPTICAL GROUNDWIRE; HOWEVER, MOST OF THE DESIGN TENSIONS USED IN COMPUTING STATIC WIRE LOADS ARE BASED ON THE 7#6 ALUMOWELD (WHICH ARE SLIGHTLY HIGHER THAN THE OPTICAL GROUNDWIRE TENSIONS). THIS WAS DONE TO ENSURE THAT THE STRUCTURES WOULD ACCOMMODATE EITHER WIRE TYPE.

17. (NOT USED)

18. TRANSVERSE LOADS ACT FROM LEFT TO RIGHT IN THE ELEVATION VIEW OF THE STRUCTURE, UNLESS OTHERWISE INDICATED.

19. NOTE FOR DESIGN ENGINEER-- WHEN PREPARING STRINGING CHARTS FOR STATIC WIRE USING 7#6 ALUMOWELD OR 12#9 ALUMOWELD 24-FIBER OPTICAL GROUNDWIRE, NESC HEAVY INITIAL TENSIONS SHALL BE BASED ON MAXIMUM 12% WIRE RATED TENSILE STRENGTH (RTS) FINAL TENSIONS UNDER 0 DEGREE, NO ICE AND NO WIND LOADING CONDITION. FOR EXAMPLE, FOR 725 FOOT DESIGN RULING SPAN, NESC HEAVY INITIAL TENSIONS FOR 7#6 ALUMOWELD AND 12#9 ALUMOWELD 24-FIBER OPTICAL GROUNDWIRE ARE 5850 LBS AND 5700 LBS RESPECTIVELY.

CONDUCTOR LOAD AND BLOWOUT ANGLE CHARACTERISTICS

CONDUCTOR SIZE, KCMIL	3000	2338	2335	(NOTE A) 2226	2156	1590
TYPE	ACSR/GA	ACAR	ACAR	T2-ACSR/GA	ACSR/GA	AA
STRANDING	84/19	42/19	63/28	2(45/7)	84/19	61
CODE NAME				T2-BLUEJAY	BLUEBIRD	COREOPSIS
COPPER EQUIVALENT, KCMIL	1903	1419	1418	1412	1368	1010
ASTM STANDARD	B 232	B 524	B 524	B 232	B 232	B 231
DIAMETER (INCHES)	2.079	1.762	1.762	2.061	1.762	1.454
ULTIMATE STRENGTH (LBS)	83,900	55,600	55,400	59,600	60,300	27,000
WEIGHT-BARE (LBS/FOOT)	3.495	2.19	2.213	2.51	2.511	1.493
WEIGHT-BARE (LBS/MILE)	18,450	11,560	11,680	13,252	13,258	7,883
0" ICE, 4# WIND----HORIZ	0.693	0.587	0.587	0.687	0.587	0.485
(LBS/FT) VERT	3.495	2.190	2.213	2.510	2.511	1.493
(LOW WIND) RESULTANT	3.563	2.267	2.290	2.602	2.579	1.570
ANGLE	11.22°	15.01°	14.86°	15.31°	13.17°	17.98°
0" ICE, 6# WIND---HORIZ	1.040	0.881	0.881	1.031	0.881	0.727
(LBS/FT) VERT	3.495	2.190	2.213	2.510	2.511	1.493
RESULTANT	3.646	2.351	2.382	2.713	2.661	1.661
ANGLE	16.56°	21.91°	21.71°	22.32°	19.33°	25.96°
0" ICE, 8# WIND---HORIZ	1.386	1.175	1.175	1.374	1.175	0.969
(LBS/FT) VERT	3.495	2.190	2.213	2.510	2.511	1.493
RESULTANT	3.760	2.485	2.505	2.861	2.772	1.780
ANGLE	21.63°	28.21°	27.96°	28.70°	25.07°	32.99°
0" ICE, 21# WIND---HORIZ	3.638	3.084	3.084	3.607	3.084	2.545
(LBS/FT) VERT	3.495	2.190	2.213	2.510	2.511	1.493
(HEAVY WIND) RESULTANT	5.045	3.782	3.795	4.394	3.977	2.950
ANGLE	46.15°	54.62°	54.33°	55.17°	50.84°	59.60°
0" ICE, 25# WIND---HORIZ	4.331	3.671	3.671	4.294	3.671	3.029
(LBS/FT) VERT	3.495	2.190	2.213	2.510	2.511	1.493
RESULTANT	5.565	4.274	4.286	4.974	4.447	3.377
ANGLE	51.10°	59.18°	58.92°	59.69°	55.63°	63.76°
1/2" ICE, 2.2# WIND.---HORIZ	0.564	0.506	0.506	0561	0.506	0.450
(LBS/FT) VERT	5.099	3.597	3.620	4.102	3.918	2.708
RESULTANT	5.130	3.632	3.655	4.141	3.951	2.746
ANGLE	6.32°	8.01°	7.96°	7.79°	7.36°	9.43°
1/2" ICE, 4# WIND---HORIZ	1.026	0.921	0.921	1.020	0.921	0.818
(LBS/FT) (HORIZ-2 DIA.)	---	---	---	(1.173)	---	---
(NESC HEAVY) VERT	5.099	3.597	3.620	4.102	3.918	2.708
(VERT-2 DIA.)	---	---	---	(4.387)	---	---
RESULTANT	5.201	3.713	3.735	4.227	4.025	2.829
(RESULTANT + .30)	(5.501)	(4.013)	(4.035)	(4.527)	(4.325)	(3.129)
ANGLE	11.38°	14.36°	14.27°	13.97°	13.22°	16.81°
1/2" ICE, 8# WIND---HORIZ.	2.053	1.841	1.841	2.041	1.841	1.636
(LBS/FT) VERT	5.099	3.597	3.620	4.102	3.918	2.708
RESULTANT	5.497	4.041	4.061	4.582	4.329	3.164
ANGLE	21.93°	27.11°	26.96°	26.45°	25.17°	31.13°
1 1/2" ICE, 4# WIND---HORIZ	1.693	1.587	1.587	1.687	1.587	1.485
(LBS/FT) VERT	10.173	8.277	8.300	9.155	8.598	7.005
(HEAVY ICE) RESULTANT	10.313	8.428	8.450	9.309	8.743	7.161
ANGLE	9.45°	10.86°	10.83°	10.44°	10.46°	11.97°

NOTE A:
VALUES FOR T-2 CONDUCTOR ARE BASED ON EQUIVALENT DIAMETER OF 1.637 TIMES THE DIAMETER OF ONE CONDUCTOR.
USE (HORIZ-2 DIA.) AND (VERT-2 DIA.) LOADS FOR T-2 NESC LOADS ON LOADING SCHEDULE WORK SHEETS.

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CONDUCTOR SIZE, KCMIL	5/16" SM ***	10#8AW	12#10AW	11#10AW	13#11AW	8#7AW
TYPE	GALVSTL	FOSW	FOSW	FOSW	FOSW	FOSW
STRANDING	7	24 FIBER	12 FIBER	12 FIBER	16 FIBER	16 FIBER
CODE NAME						
COPPER EQUIVALENT, KCMIL						
ASTM STANDARD	A 475	B 415	B 415	B 415	B 415	B 415
DIAMETER (INCHES)	0.312	0.5535	0.507	0.469	0.528	0.5236
ULTIMATE STRENGTH (LBS.)	5,350	18,450	17,200	16,010	15,000	11,620
WEIGHT – BARE (LBS/FOOT)	0.205	0.3971	0.352	0.317	0.336	0.3031
WEIGHT – BARE (LBS/MILE)	1,082	2,097	1,859	1,674	1,774	1,600
0" ICE, 4# WIND-----HORIZ	0.104	0.185	0.169	0.156	0.176	0.175
(LBS./FT.) VERT	0.205	0.397	0.352	0.317	0.336	0.303
(LOW WIND) RESULTANT	0.230	0.438	0.390	0.353	0.379	0.350
ANGLE	26.90°	24.92°	25.65°	26.25°	27.65°	29.93°
0" ICE, 6# WIND-----HORIZ	0.156	0.277	0.254	0.235	0.264	0.262
(LBS./FT.) VERT	0.205	0.397	0.352	0.317	0.336	0.303
(HORIZ CLEAR) RESULTANT	0.258	0.484	0.434	0.394	0.427	0.401
ANGLE	37.27°	34.87°	35.76°	36.49°	38.16°	40.82°
0" ICE, 8# WIND-----HORIZ	0.208	0.369	0.338	0.313	0.352	0.349
(LBS./FT.) VERT	0.205	0.397	0.352	0.317	0.336	0.303
(SWING ANGLE) RESULTANT	0.292	0.542	0.488	0.445	0.487	0.462
ANGLE	45.42°	42.90°	43.84°	44.61°	46.33°	49.03°
0" ICE, 21# WIND-----HORIZ	0.546	0.969	0.887	0.821	0.924	0.916
(LBS./FT.) VERT	0.205	0.397	0.352	0.317	0.336	0.303
(HIGH WIND) RESULTANT	0.583	1.047	0.955	0.880	0.983	0.965
ANGLE	69.42°	67.71°	68.36°	68.88°	70.02°	71.70°
0" ICE, 25# WIND-----HORIZ	0.650	1.153	1.056	0.977	1.100	1.091
(LBS./FT.) VERT	0.205	0.397	0.352	0.317	0.336	0.303
RESULTANT	0.682	1.220	1.113	1.027	1.150	1.132
ANGLE	72.50°	71.00°	71.57°	72.03°	73.01°	74.47°
1/2" ICE, 2.2# WIND--HORIZ	0.241	0.285	0.276	0.269	0.280	0.279
(LBS./FT.) VERT	0.710	1.052	0.978	0.920	0.975	0.940
(WHIPPING) RESULTANT	0.750	1.090	1.017	0.958	1.015	0.980
ANGLE	18.71°	15.14°	15.77°	16.32°	16.02°	16.55°
1/2" ICE, 4# WIND--HORIZ	0.437	0.518	0.502	0.490	0.509	0.508
(LBS./FT.) VERT	0.710	1.052	0.978	0.920	0.975	0.940
(NESC HEAVY) RESULTANT	0.834	1.173	1.110	1.042	1.100	1.068
ANGLE	31.63°	26.20°	27.18°	28.03°	27.57°	28.39°
1/2" ICE, 8# WIND--HORIZ	0.875	1.036	1.005	0.979	1.019	1.016
(LBS./FT.) VERT	0.710	1.052	0.978	0.920	0.975	0.940
(SWING ANGLE) RESULTANT	1.127	1.477	1.402	1.343	1.410	1.384
ANGLE	50.93°	44.54°	45.76°	46.80°	46.24°	47.22°
1 1/2" ICE, 4# WIND--HORIZ	1.104	1.185	1.169	1.156	1.176	1.175
(LBS./FT.) VERT	3.586	4.229	4.097	3.991	4.120	4.079
(HEAVY ICE) RESULTANT	3.752	4.392	4.261	4.155	4.285	4.245
ANGLE	17.11°	15.65°	15.92°	16.16°	15.93°	16.06°

NOTE *** SM IS SIEMENS MARTIN GRADE
NOTE FOSW IS FIBER OPTIC STATIC WIRE, ALSO KNOWN AS OPGW (OPTICAL GROUND WIRE)

- Rule 232, Vertical clearances of wires, conductors, cables, and equipment above ground, roadway, rail or water surfaces;
- Rule 233, Clearances between wires, conductors, and cables carried on different supporting structures;
- Rule 234, Clearances of wires, conductors, cables and equipment from buildings, bridges, rail cars, swimming pools, and other installations; and
- Rule 235, Clearances of wires, conductors, or cables carried on the same supporting structure.

4.1 Vertical Clearances Above Ground, Roads, Farmland, and Bodies of Water

Table 4.1.1 Vertical Clearances under Conditions at Maximum Sag (NESC Rule 232)

Surface Beneath Conductor	Conductor Nominal Line to Line Voltage		
	138kV (ft)	+ 345kV (ft)	765kV (ft)
Ground	20.6	24.6	31.0*
Roads, Streets, Alleys, Driveways	20.6	24.6*	31.0*
Farmland	20.6	24.6	31.0*
Spaces and ways, restricted to pedestrian traffic	16.6	20.6	27.0*
Water areas not suitable for sail boating	19.1	23.1	29.5
Water areas suitable for sail boating:			
Less than 20 acres	22.6	26.6	33.0
20 to 200 acres	30.6	34.6	41.0
200 to 2000 acres	36.6	40.6	47.0
Over 2000 acres	42.6	46.6	53.0

+ Clearance of 27 ft to be conservative

Table 4.1.2 Momentary Vertical Clearances (e.g. Under Galloping Conditions)

Surface Beneath	Ref. Ht. (ft)	Conductor Nominal Line to Line Voltage		
		138kV (ft)	345kV (ft)	765kV (ft)
Ground	14.0	15.0	16.5	19.5
Roads, Streets, Alleys, Driveways	14.0	15.0	16.5	19.5
Farmland	14.0	15.0	16.5	19.5
Spaces and ways restricted to pedestrian traffic	10.0	11.0	12.5	15.5
Water areas not suitable for sail boating	12.5	13.5	15.0	18.0
Water areas suitable for sail boating: Less than 20 acres	16.0	17.0	18.5	21.5
20 to 200 acres	24.0	25.0	26.5	29.5
200 to 2000 acres	30.0	31.0	32.5	35.5
Over 2000 acres	36.0	37.0	38.5	41.5

4.1.1 General Notes for Table 4.1.1 and Table 4.1.2

1. The minimum vertical clearances for conditions of maximum sag (Table 4.1.1) shall be maintained for the following conditions that result in the greatest sag:

   a) 32°F, no wind, 1/2 inch radial thickness of ice.

   b) 120°F, no wind

   c) Maximum conductor temperature at which the line is designed to operate (normally 275^{0}F for ACSR, 230^{0}F for ACAR, 248^{0}F for copper conductors), and at 32^{0}F, 1/2 inch ice, no wind.

2. In some cases, where indicated by * in Table 4.1.1, the electrostatic induction limitations at 120 ^{0}F final conductor sag condition may control minimum heights of 345kV and 765kV lines. A model shown in Figure 4.1.1 shall be used for the electrostatic induction calculations, and Table 4.1.3 shows the required minimum vertical clearance values under that condition.

3. Design engineer should add appropriate margins of safety as suitable for the project particulars. Suggested margins of safety for vertical clearances are shown in Table 3.2.1.

4. Refer to the latest publication of "Routine Procedures for the Procurement of Easements and Permits" issued by [redacted] Real Estate Department to determine if additional clearances are required at specific crossings of roads, railroads, or other utilities.

5. In public or private land and water areas specifically posted for rigging and launching sailboats, increase the clearances in the tables by 5 feet.

Table 3.2.2 Suggested Clearance Margins of Safety to be added to the Minimum Horizontal NESC Clearances Shown in this Standard Practice

Project Particulars	Construction Tolerance/ As-Built Factor (Inches)	Survey/Line Model Accuracy Factor (Inches)	Total Suggested Horizontal Clearance "Margin of Safety" (Feet)
Without As-built Data, Survey by Airborne (Remote Sensing) Methods (+/- 1 foot)	6"	24"	2.5
Without As-built Data, Survey by Ground Methods e.g. Total Station/GPS (+/- 3 inches)	6"	6"	1
With As-built Data, Survey by Airborne (Remote Sensing) Methods (+/- 1 foot)	0"	24"	2
With As-built Data, Survey by Ground Methods e.g. Total Station/GPS (+/- 3 inches)	0"	6"	0.5

3.2.2 General Notes for Table 3.2.2

1. **There is no sag factor considered in calculating horizontal design clearances since the effects of inaccuracies in predicting sags on horizontal clearance calculations are negligible.**

2. Construction tolerances are a factor in all new construction projects. At least 6 inches be added to the desired horizontal clearances for all new projects to account for "construction tolerances". When checking clearances on existing lines for which new survey (as-built) data is obtained (eliminating any uncertainties associated with construction tolerances) this 6-inch factor may be eliminated.

3. The survey/line model factor should be based on the accuracy of survey performed and the type of model used in computing clearances. If the survey is done using aerial methods and has an inherent horizontal accuracy of plus or minus 1 foot, then the engineer should include a 2 foot factor to account for

the possibility of up to a 2 foot error in the relative positions of the conductors and adjacent obstructions. If, on the other hand, the survey is accurate to within a few inches, a more appropriate factor for survey/line model inaccuracies might be 6 inches.

3.3 Vertical Clearances of Conductors under Galloping Conditions

For design of new lines, clearances between wires and from wires to ground or objects under the lines shall be checked using the method shown in the present TOG 1-1-1 on conductor galloping clearance criteria. The minimum momentary galloping clearances shall be based upon the following:

3.3.1 Electrical Component of Clearance Requirements

	138kV	345kV	765kV
Electrical Clearance (phase to ground)	1.0 ft	2.5 ft	5.5 ft
Electrical Clearance (phase to phase)	1.5 ft	3.5 ft	8.0 ft

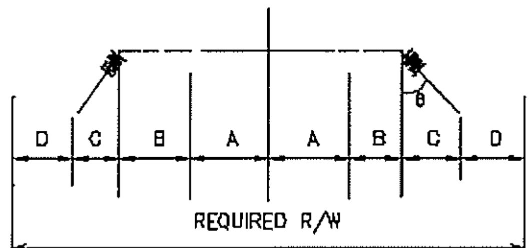
3.3.2 Object Heights

Object	Assumed Height
Ground	14 ft
Roads	14 ft
Railroads	22 ft
Distribution and Communication Wires	Assume a straight line between attachments on the supporting structures.

4.0 NESC Vertical and Horizontal Clearances for Transmission Lines

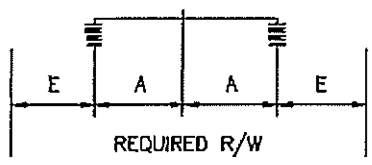
The applicable Rules of the NESC as they relate to vertical and horizontal clearances are listed below:

5.2 Right-of-Way Width Calculation



1. 2(A+B+C+D)=__FT.

2(32'+0'+ 11' + 11') = 108'



2. 2(A+E)=__FT.

(Pg5 EM10431 Detail 2) A = Distance between end of arm conductor attachment and center of structure 32 ft.

B = Structure attachment deviation due to deflection 0 ft.

C = Blowout (Calculate for point of maximum blowout). Assume suspension insulator (if any) blowout at same angle as conductor.

(Sag10) a) Max. sag within R/W 15.4 ft. (@6 lb./ft ^{2} wind, 60°F final sag).*

(Detail 2) b) Insulator String Length 9.1 ft. (suspension string only).

(Sag10) c) Vertical Force V = 1.255 lb/ft. (weight of conductor)

(Sag10) d) Horizontal force H = 6 lb./ft. ^{2} x 1.259"12 inch per foot (cond. dia.) = 0.6295 lb/ft.

e) Blowout angle θ =tan $^{-1}$ H/V = 26.6 degree

f) Blowout, C = [(a) + (b)] sin θ = 11 ft.

D =Clearance requirement to building or objects with conductor displaced by wind per NESC Rule 234: 10.8 ft.

E =Clearance requirement to buildings or objects with conductor at rest per NESC Rule 234: ___ft.

Table 5.2.1 Minimum Horizontal Separation

Conductor Nominal Line to Line Voltage	Min. Horizontal Separation (NESC)**	
	D (ft)	E (ft)
34kV	5.0	8.0
69kV	5.2	8.2
138kV	6.6	9.6
345kV	10.8	13.8
765kV	17.2	22.3

* The maximum sag within the Right-of-Way for an existing line or a known set of span lengths should reflect the greatest sag of all the known span lengths. For new construction, for which no structures have yet been spotted and span lengths have not been determined, a sag should be calculated based on a span length equal to the largest anticipated individual span length for the Right-of-Way. This is commonly estimated as the design ruling span times 1.30. 725'×1.3= 943'

** Minimum horizontal separation shown as D is for conductor with wind displacement and minimum horizontal separation shown as E is for conductor at rest. Calculate required Right-of-Way width based on clearance requirements D and E and take larger of the two. Clearance values shown do not include any margins of safety. Refer to Table 3.2.2 for appropriate margins of safety.

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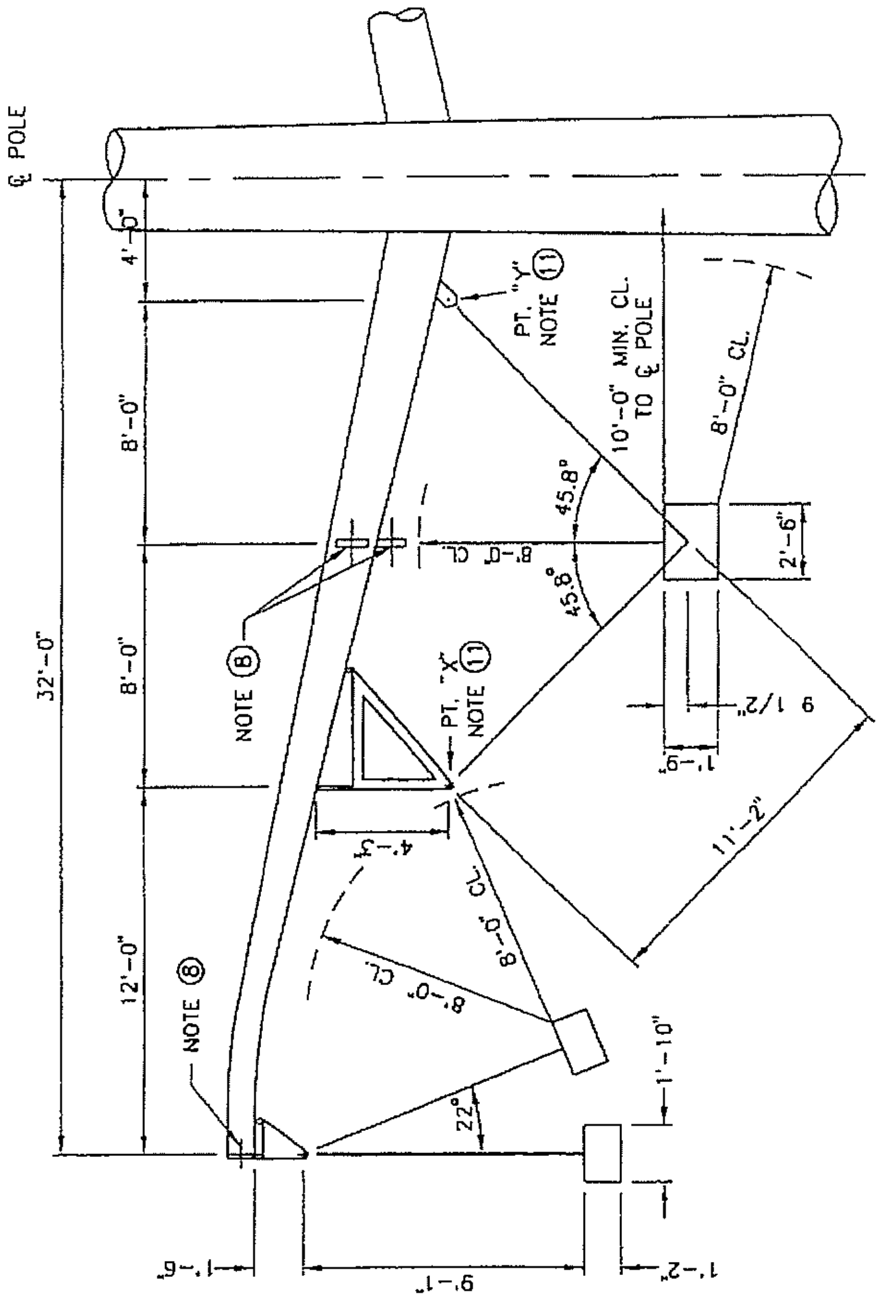

DETAIL 2
TYPICAL 345KV CLEARANCE REQUIREMENTS
(BOTTOM CROSSARM)

ACA CONDUCTOR ACCESSORIES, SAG AND TENSION DATA

Tensaka
ROW Calculation

Conductor BLUEJAY 1113.0 Kcmil 45/ 7 Stranding ACSR

Area= .9350 Sq. in Dia= 1.259 in Wt= 1.255 lb/ft RTS= 29800 lb
Data from Chart No. 1-957 d) e)
English Units
Using Exact Catenary Equations

Span= 943.0 feet Special Load Zone (EM10431 CaseF table III)
Creep is NOT CONSIDERED Rolled Rod

Design Points					Final		Initial	
Temp F	Ice in	Wind psf	K lb/ft	Weight lb/ft	Sag ft	Tension lb	Sag ft	Tension lb
60.	.00	6.00	.00	1.404	15.39	10150.*	15.39	10150.
0.	.00	.00	.00	1.255	10.71	13033.	10.71	13033.

* Design Condition

Certain information such as the data, opinions or recommendations set forth herein or given by AFL representatives, is intended as a general guide only. Each installation of overhead electrical conductor, underground electrical conductor, and/or conductor accessories involves special conditions creating problems that require individual solutions and, therefore, the recipient of this information has the sole responsibility in connection with the use of the information. AFL does not assume any liability in connection with such information.

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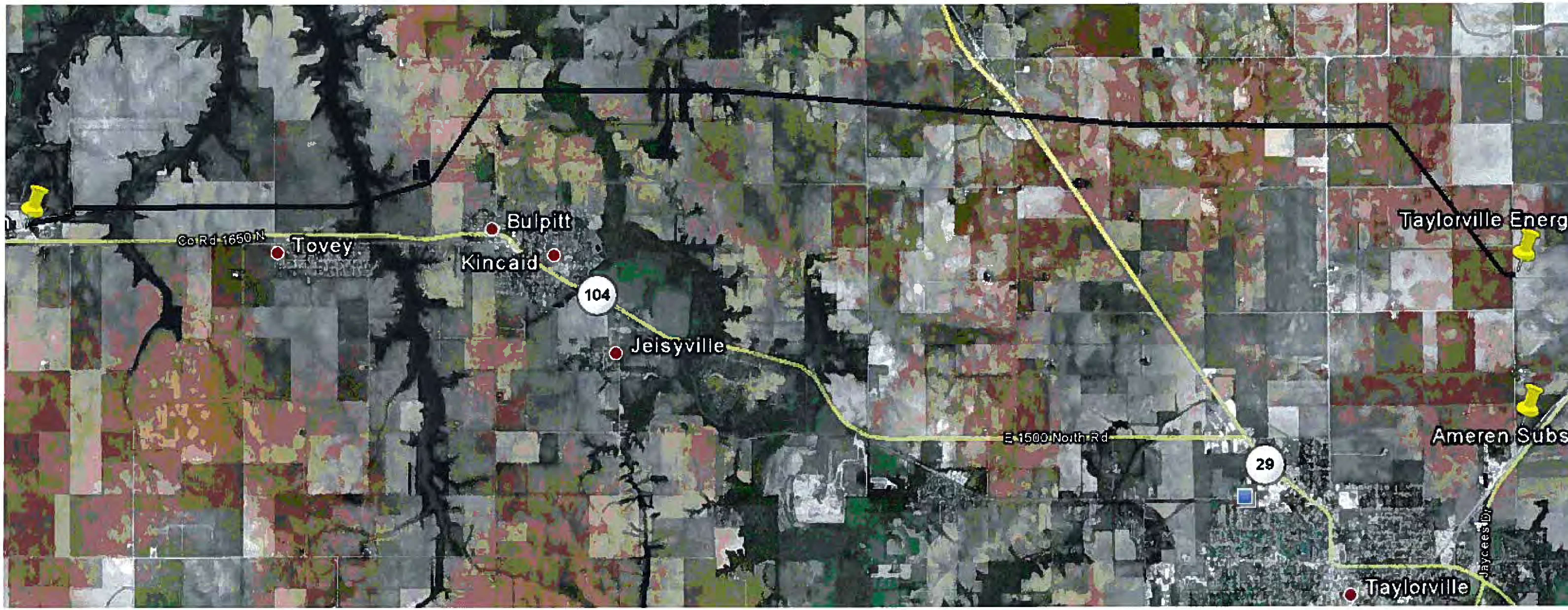
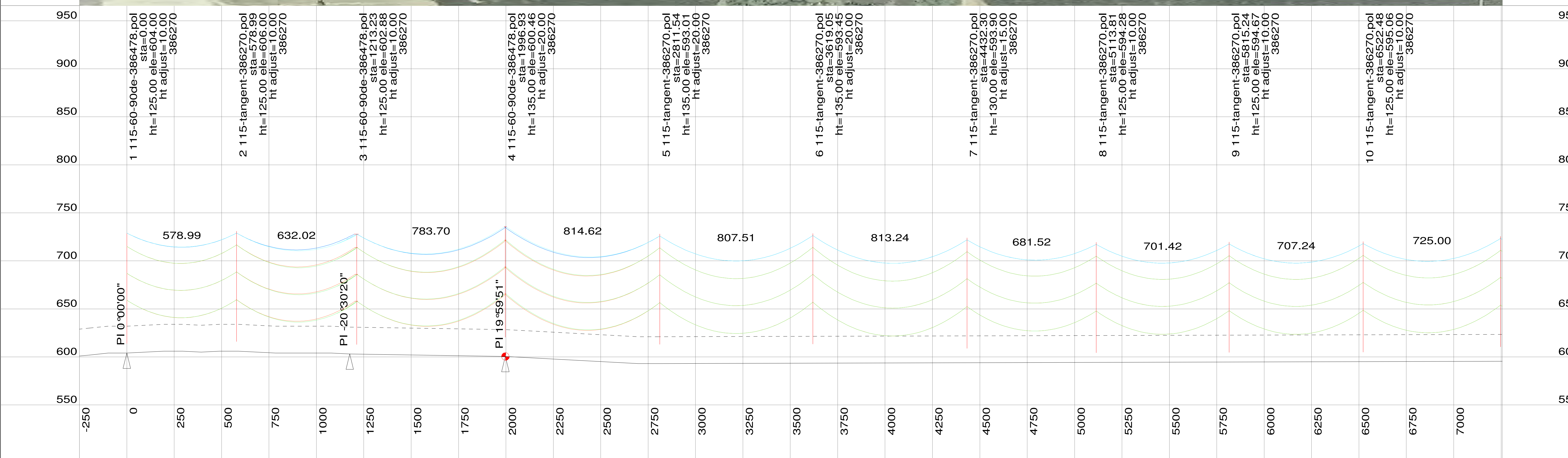
Appendix C

Conceptual Line Design



Bulpitt
Co Rd 1650 N
Tovey
Kincaid
104
Jeisyville
E 1500 North Rd
29
Taylorville Energy
Ameren Substa
Jaycees Dr
Taylorville

ADD Drawing



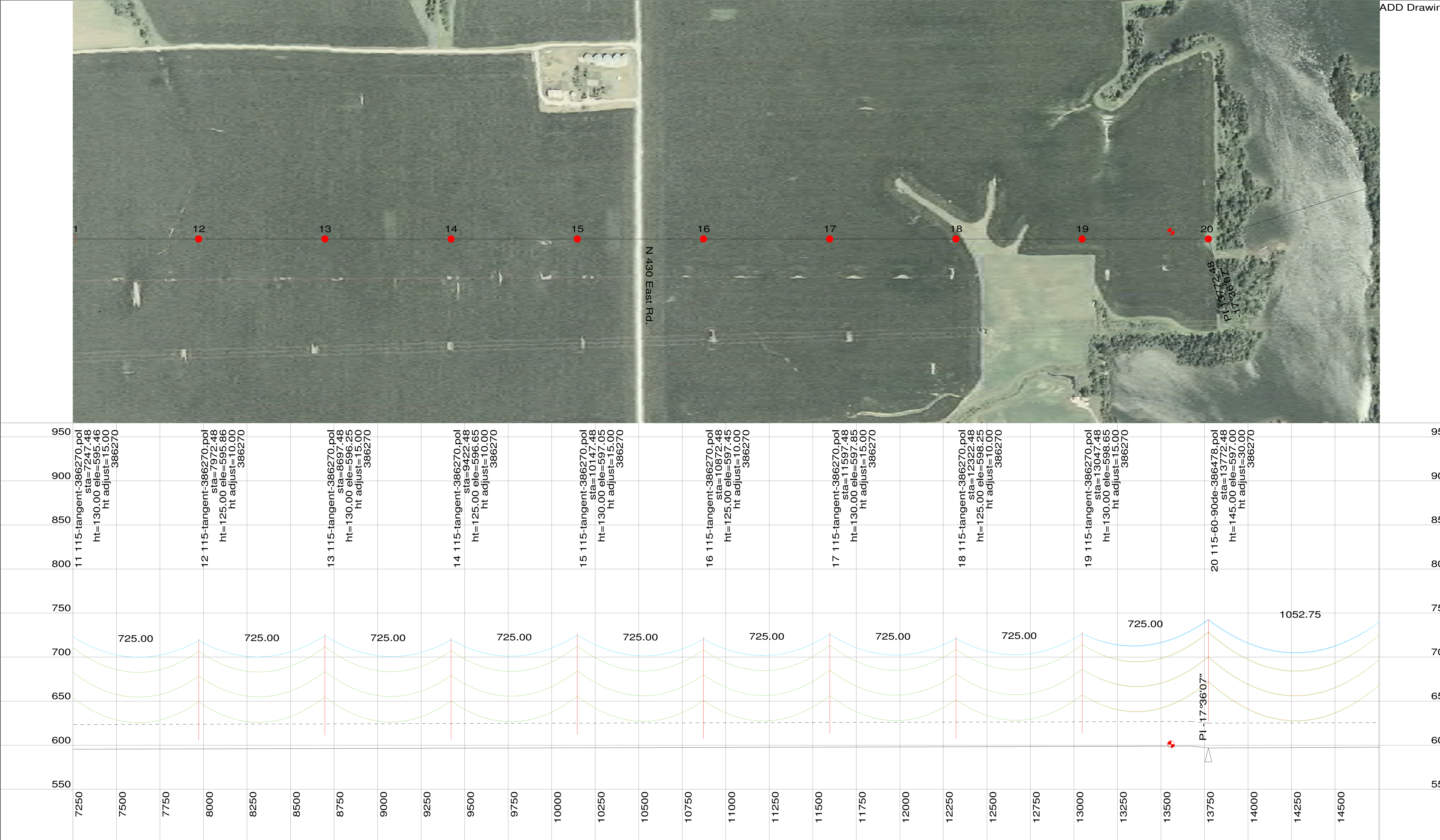
500.0 ft. Horiz. Scale

100.0 ft. Vert. Scale

North

Tenaska 345kV Transmission Line Preliminary Layout

10/27/2009



500.0 ft. Horiz. Scale

100.0 ft. Vert. Scale

North

Tenaska 345kV Transmission Line Preliminary Layout

10/27/2009