Attachment 4

NATIONAL GRID[1]
Third Party Pole Loading Analysis Criteria for Sub-Transmission Poles

**Please note this document is only an Attachment to the 'Transmission Pole Aerial Third Party Attachment Requirements' document. Be sure to review the entire document and associated attachments before commencing any work.

Analysis of National Grid (NGrid) Sub-Transmission (69 kV and below) structures for the addition of new communication cables and other 3rd party attachments shall be done using a NGrid approved finite element computer analysis program. The program must be capable of performing analyses on both guyed and unguyed wood pole structures. NGrid has approved the use of two software programs:

Ocalc	Osmose Utilities Services, Inc. 980 Ellicott Street Buffalo, New York 14209 Ph: (800) 877-POLE Fax: (716) 882-5139
PLS-Cadd	Power Line Systems, Inc. 918 University Bay Drive Madison, WI 53705, U.S.A. Phone: (608) 238-2171 Fax: (608) 238-9241

Criteria

The analysis shall be completed in accordance with the following codes and standards:

National Electrical Safety Code 2012 (or Latest Edition)
ANSI O5.1 - 2008 Specifications and Dimensions for Wood Poles (or Latest Edition)
National Grid (Niagara Mohawk) Overhead Electric Transmission Standards
Overhead Construction Standards (Distribution Blue Book)

The loading criteria shall be as follows:

- NESC 250B - Heavy
- NESC 250C – Extreme Wind
- NESC 250D – Extreme Ice (use 1" for Upstate NY) w/Concurrent Wind

[1] Niagara Mohawk Power Corporation, d.b.a. National Grid.

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Grade B Construction shall be used for all poles, including poles below 60'. In accordance with NESC Rule 243: Any additional conductor/cable attachments on Sub-Transmission poles must be analyzed under Grade B Construction.

Unless overruled by a NGrid Structural Engineer, pole strength reductions shall be applied as follows:

Age of existing poles:
05 – 12 years: 0 - 0.5%
13 – 30 years: 0.5% - 2.0%
31 – 80 years: 2.0% - 6.0%

Note: Interpolation is allowed.

Any pole defects found during the structural inspection of the pole shall be evaluated and an appropriate additional reduction in moment capacity shall be applied. Pole defects can be, but not limited to: woodpecker holes, shell rot, insect damage, excessive checking, and external pockets or split pole top. Please identify all pole strength reductions used within an analysis in the report.

- If using PLS-Cadd: Age reduction factors should be applied within PLS-Cadd under the Structure Loads Criteria: 'Strength for Wood Poles' in order to apply unanimously across the entire pole. Any additional pole defects should be applied within PLS-Pole as Wood Pole Defects, placed at the appropriate locations on the pole.

Pole height, class, and age should be identified from the appropriate line drawing(s), field inspection(s), and/or accounting book(s) (black books). Contact G.Ryder for assistance if needed. The height and class of the pole(s) along with guy anchor locations are to be verified during the pre-construction survey. For the line drawings please reference associated index, drawing, and sheet numbers used within the report, or attach electronic or hard copies of the associated drawing(s) with the submittal.

Conductor/cable properties, including diameter, weight, and design tensions, are to be provided by the appropriate utility for new and existing attachments, if unavailable then manufacturer's data shall be used. In the case when an existing attachee cannot provide the info or if contact cannot be made (documentation of attempted contacts should be included in report), then a hypothesis may be used, but must be supported with reasonable assumptions. The report is to identify the source(s) used to obtain this information and also distinguish the structure numbers that each conductor type applies to when applicable.

Here are some alternative methods the may be used to hypothesize design types for different attachment types in the case that the design tension information cannot be obtained from either the utility or manufacturer:

- Sub-Transmission conductors:
    - Design tensions provided on line drawings.
    - Standard design tensions. Exhibit 3 is a list of design tensions for a majority of the conductors used for Sub-Transmission. If necessary, contact G.Ryder for more information.
- Distribution conductors:

    - Overhead Construction Standards (Distribution blue book) recommended design tensions, indicated by: *, the Design Specification Constraint.
- Communication cables supported by a messenger:
    - Design tension based on messenger support cable properties; see Exhibit 5 for further details.
- Communication cables self supported (no messenger cable):
    - The design tension may be calculated using a program such as Sag10, based on field measurements of the attachment locations and mid-span sag, incorporating the time and temperature that the height measurements were taken.

** These are general recommendations for each conductor type, each case should be looked at individually and good engineering practice used when applying hypothesized tensions.
- NGrid recommends the use of a utility contractor to field measure conductor/cable properties and tensions when unknown. Notification must be made to the local NGrid Performance Supervisor from the area of the required measurements prior to conducting work.
- Reduced design tensions are to be taken into account for slack spans and service drops.
- Please identify in the report when slack spans are used in an analysis.
- The report is to state all approaches used to obtain the design tension information.

The easement(s)/right(s) must be reviewed to verify that the new conductor/cable can be added to the structure under the existing terms along with any additional equipment such as guy wires/anchors required for the Applicants attachment. The appropriate ROW personnel will need to be contacted for this information.

Existing 3rd party attachment owners must be identified and stated within the report. If necessary, please use T.Mitchell as a point of contact for this information; also in many cases Sub-Transmission poles with Under-built Distribution can be referenced in the Distribution GIS Smallworld system for existing Attachee and pole ownership information. Determining the owners of existing attachments is necessary to certify who to contact for conductor/cable properties and tensioning information. If the pole is identified as being a joint owned pole with a telephone company, please note of in the report, the joint owner should also be contacted and given the option to be involved in the Attachee application process (see main document for details).

Any changes to existing conditions such as rearrangement of existing attachments on a pole must be approved by the affected party prior to conducting the changes resulting from the pole loading analysis.

Please note: electric wires and communication wires (in the communication space) carried on the same poles must have minimum clearances of 40" at the pole and 30" anywhere in the span and as voltages increase, required clearances shall also increase. See NESC for any exceptions to this rule.

Any existing violations in the field, such as inadequate clearance between cables/conductors, should be identified within the report.

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Exhibit 4 is a copy of National Grid's loading analysis field inspection survey sheet which may be used to ensure all necessary data is captured. For an electronic version (.xls) of this document - contact G.Ryder.

Procedure

All pole loading analysis calculations and reporting shall be performed under the direction of a professional engineer, licensed and registered by the state where such facility is located, all of which shall be subject to review and acceptance by NGRID Engineering. The analysis and report must have a stamp of approval by the overseeing professional engineer.

Three separate loading analyses will be conducted for each structure:

- RUN 1: The first will analyze solely NGrid attachments on the existing structure with zero strength reduction factors applied to the pole; each proceeding analysis should apply strength reduction factors as outlined in the previous section.
- RUN 2: The second run will analyze the existing structure with all existing loads/attachments to determine the capacity of the structure to accept additional loads.
- RUN 3: A third run will model the existing structure with the new communication loads applied. Similar structure configurations, with same loading conditions, may be modeled and analyzed using allowable span runs.

The following are the scenarios that can happen:

Runs 1 and 2 pass (stress < 100%)	Run 3 passes (stress < 100%)	**OK**
Runs 1 and 2 pass (stress < 100%)	Run 3 fails (stress > 100%)	**Fix @ Customer expense**
Run 1 or 2 fails (stress > 100%)		**Fix @ NGrid expense**

Once the above analyses have been approved by NGRID Engineering, the Design Contractor is to contact the Applicant to deliver the results for each structure analyzed (pass or fail) and for failures: state the stage of failure to identify the party responsible for replacement costs. At this stage, the Applicant must determine if they would like to proceed with the application and have a design completed of the make-ready work for the poles that fail OR the application may be canceled or placed on hold until further notice (rules within main document apply).

If proceeding with the process, the applicant's design contractor will not be the default designer to determine a design of the required make-ready work~~,~~. The NGRID Sub-Transmission supervisor will delegate the appropriate personnel to complete this work. When a fix is required, the design solution may be in the form of a new pole, rehabilitated pole, additional poles (mid-span), or new guy(s). The stress level required for a design fix involving the replacement or addition of any new poles must be 85% or less. If a design solution involves action such as relocating or adding additional guys then the required stress level must be less than 100%. NGrid Engineering must approve any proposed design solution(s).

Additional PLS Notes:

- When setting up line files:

- Order by: Sub-T conductor, Distribution Primary, Distribution Secondary, Existing 3rd Party Attachments, and then the Applicants conductor/cable.
- The conductor/cable colors should remain unique and consistent throughout all pole loading analyses on a single application.

Reports

All analyses files, photos, field survey reports, and other supporting documentation shall be sent to National Grid for review. In addition, a final report shall summarize the findings; the report may be modeled after the attached example (Exhibit 1).

Note: Appendices within the report detailing the complete results for each structure may be withheld from the report under the contingency that the electronic analyses files are provided in which the same information may be viewed.

Hardcopies shall be sent via mail to:

Gregory Ryder
National Grid USA
Building B-2
Sub-Transmission Design NY
300 Erie Boulevard West
Syracuse, NY 13202

An email shall also be sent to the TAG Email Address at: nmnytele@us.ngrid.com to notify the Telecom Attachments Group that the Pole Loading Analysis and accompanying documentation has been delivered to the Sub-Transmission Design NY department.

Payment for National Grid Review

The National Grid TAG department will invoice the Third Party pole attachment Applicant for the prepayment of National Grid's services to review pole loading analysis reports. The entity performing the pole loading analysis on behalf of itself or the Third Party pole attachment Applicant shall coordinate with the Applicant to ensure that the prepayment is made (as noted on the invoice) in advance of National Grid's review.

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List of Exhibits

- Exhibit 1 – Design Report Example
- Exhibit 2 – Employee Contact Info
- Exhibit 3 – Messenger supported Comm. Cable Tensioning
- Exhibit 4 – Field Data Survey Sheet
- Exhibit 5 – Typical Sub-T Conductor Design Tensions

Exhibit 1 – Sample Report

Ellicott Road Sub-Transmission Pole Loading Analysis

Structures 270 ½, 271, 272, 273, 274-281
On Sub-Transmission Line: Attica – N. Leroy #208

Communication Company: Company name
Attn: Contact Name

Analysis by: Consultant Company
Attn: Name

Address

and

Engineer Name

Address

Project Number – 159111
Date: September 2, 2008

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Information:

Time Warner has requested to attach a CATV cable to sub-transmission poles #270.5-281 near and on Ellicott Road in the Town of Pavilion, New York. These poles are on a 34.5kV line called Attica – North Leroy #208. Poles #270.5 & #273-281 already are under-built with three-phase distribution (on cross-arm construction), telephone, and 1/0 secondary. Please note there is a railroad crossing between poles #279 & #280. Time Warner would like to attach 12" above existing telephone attachment. Line drawing D-60974-W, Sh.1 (Index: 8.1-A4-M5) was referenced for information on this portion of the line. All conductors/cables listed below are attached to every structure analyzed (Note: if particular conductor/cable is not attached to all poles analyzed – must distinguish which structures that it is attached to within the conductor properties below)

Time Warner Fiber Data: Conductor Diameter: .625"
Conductor/Cable Weight: .163 lbs/ft.
Suspension Strand Diameter: .25"
Suspension Strand Weight: .128 lbs/ft.
Conductor/Cable Design stringing tension: 3500#

- Fiber data provided by TW within the application.

Transmission Conductor: Conductor Diameter: .684" (336.4 KCM – "Merlin")
Conductor/Cable Weight: .365 lbs/ft.
Conductor/Cable Design stringing tension: 3000#

- Conductor property information contained on line drawing listed above.

Distribution Conductor: Conductor Diameter: .665" (336.4 KCM AAC – "Tulip")
(Primary) Conductor/Cable Weight: .135 lbs/ft.
Conductor/Cable Design stringing tension: 2000#

Distribution Conductor: Conductor Diameter: .98" (Neritina Poly Triplex)
(Secondary) Conductor/Cable Weight: .419 lbs/ft.
Conductor/Cable Design stringing tension: 2000#

- Conductor type obtained from Distribution GIS. Stringing tension obtained from Distribution
Construction Standards (Design Spec Constraint *)

Telephone Conductor: Conductor Diameter: 1"
Conductor/Cable Weight: .35 lbs/ft
Conductor/Cable Design stringing tension: 400#@60°F

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- Cable data calculated based on height measurements taken in field. See e-mails included with report showing attempts to obtain cable information from Frontier. Attached with email are calculations & assumptions.

**Be sure to list properties for all conductors/cables on ANY of the affected poles. Colors should correlate with conductor colors used in every analysis.

Loading Criteria:

- NESC Heavy – Rule 250B per NESC Code – latest edition
- Extreme Wind – Rule 250C per NESC Code – latest edition
- Extreme Ice – Rule 250D per NESC Code – latest edition (1" Ice used)

Analysis:

- Appendix A – Shows structure 270.5 solely with NGRID loadings applied. It is a 50' cl-3, D-1211A with distribution primary and secondary underbuilt. There is no line angle on the sub-t, but the line angle for everything else is 90 degrees. The distribution primary and secondary are in-line with the sub-t back span, but change direction on pole 270.5. There are 2 existing guys for distribution primary and secondary, all are oriented against the long span. Structure fails at 162.1%
- Appendix B – Shows structure 270.5 as it exists in the field. The only additional existing attachment is 1 Verizon telephone cable. Structure fails at 173.3%
- Appendix C – Shows structure 270.5 as it would exist in the field with the new CATV in same direction as the sub-t circuit. Structure fails at 180.1%.
- Appendix D – Shows structure 271 solely with NGRID loadings applied. It is a 45' cl-3, D-1220A with distribution primary in line with sub-t front span. Structure 271, sub-t has an 8°30' line angle. Structure passes at 81%.
- Appendix D – Shows structure 271 as it exists in the field. The only additional existing attachment is 1 Verizon telephone cable. Structure passes at 83%.
- Appendix E – Shows structure 271 as it would exist in the field with the new CATV. Structure passes at 87 %.

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Summary:

Structure Number	NGRID loadings	Original Existing	Existing In Field w/ CATV
270.5	162.1% Pole fails	173.3% Pole fails	180.1%. Pole fails
271	81% Pole passes	83% Pole passes	87% Pole passes
272	54.6% Pole passes	61.4% Pole passes	63.5% Pole passes
273	208.34% Pole fails	214.16% Pole fails	236.05% Pole fails
274-281	186.6% Pole fails	197.1% Pole fails	208.3% Pole fails

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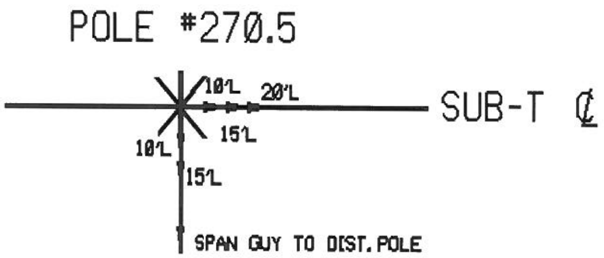
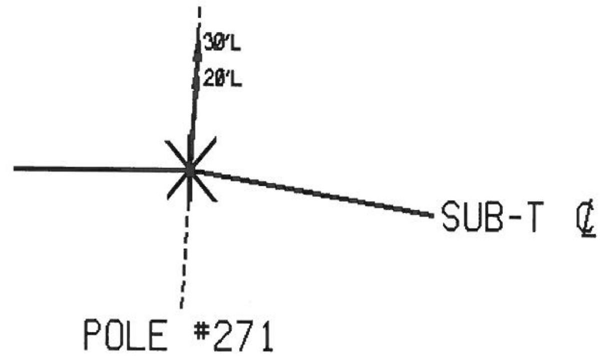
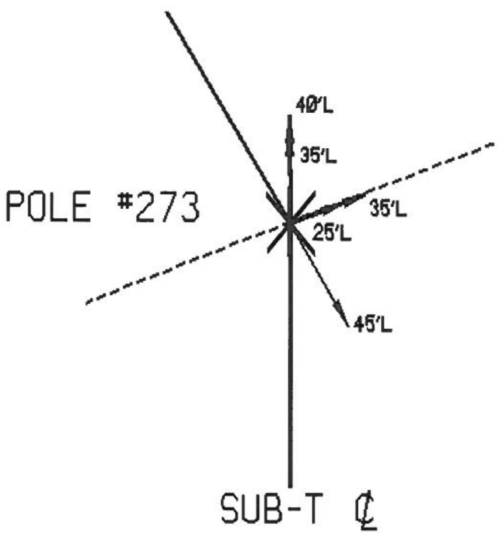
New Staking Diagrams:







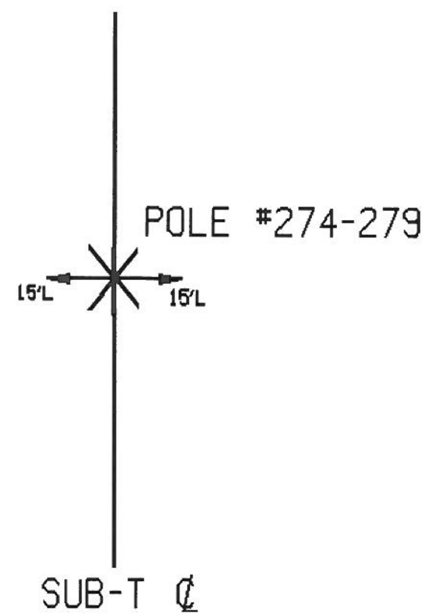


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Exhibit 2 -Contact List

Third Party Attachments		thirdparty@nationalgrid.com
TAG		nmnytele@us.ngrid.com

(* - indicates primary contact to use in each dept.)

Exhibit 3 – Telephone Stringing Tensions

- It is attached to a pole carrying an isolated telephone cable (i.e., a length of aerial cable inserted in an open wire line) which is not effectively grounded.

Grounding is the preferred treatment for exposed guys, except for the following cases in which they must be insulated:

- Where exposed to trolley facilities.
- Within 1/2 mile of a power station (see Practice 919–120–560).
- Where electrolytic corrosion of anchors has occurred (unexposed guys, in this case, must be separated from the cable strand at the pole, and electrical connection through hardware must be avoided.)

A single anchor or ground rod ordinarily is not an adequate ground. Adequate grounding for telephone guys may be obtained through connection to any of the following:

- Vertical grounding conductor of power system multigrounded neutral (with permission of the power company).
- Suspension strand of grounded telephone cable.
- Common anchor rod with a power guy that is connected to the multigrounded neutral.

CABLE – SAGS AND TENSIONS

Suspension Stand

Practice 627–200–015

Galvanized suspension strand is available in two types. Class A is for general use under normal field conditions. Class C is for use where severe corrosion problems exist, e.g., in industrial or coastal areas.

The 6.6M strand is made of extra high–strength steel and is smaller, lighter, and less expensive than 6M strand. For guying, they are interchangeable. As suspension strands, however, they are limited to different span lengths, as shown on Pages 10–41 through 10–46. *

The 2.2M strand should not be used to support aerial cable, except small cables in pole–to–building or building–to–building construction.

NOTE: * Refer to BR 627–070–015 (Issue 2, 11/89).
Refer to BR 918–117–090 (Issue 6, 12/89).
Also refer to Section 11 of the Manual.

GALVANIZED STRAND			
Size	Breaking Strength (Lb)	Diameter (In.)	Weight (Lb/Ft)
2.2M	2400	3/16	0.077
6M	6000	5/16	0.225
6.6M	6650	1/4	0.121
10M	11500	3/8	0.270
16M	18000	7/16	0.390
25M	25000	1/2	0.510

Stringing Tension for Strand

Practices 627–210–018, 919–565–400

The proper stringing tension is a compromise between high tension (which causes cable bowing and creeping) and low tension (which results in excessive sag and requires taller poles to obtain clearances). Recommended stringing tensions for supporting strand are shown in the following table.

Strand	Span Length (Ft)	Stringing Tension (Lb) at Temperature (°F)					
		0°	20°	40°	60°	80°	100°
6M	Up to 250	1550	1400	1250	1100	900	825
	250—450	1475	1350	1225	1100	1000	900
	Over 450	1375	1275	1175	1100	1025	950
6.6M	Up to 250	900	800	700	600	500	425
	250—450	850	750	675	600	525	475
	Over 450	775	700	650	600	550	525
10M	Up to 400	2675	2475	2275	2100	1900	1725
	Over 400	2600	2425	2250	2100	1925	1800
16M	Any	4425	4150	3875	3600	3325	3075
25M	Any	9125	8800	8400	8000	7625	7250

The proper stringing tension for self-supporting cable depends not only on temperature and span lengths, but also on cable weight. The tables for self-supporting cables are too voluminous to be included here. See Practice 627-700-011.

Cable Sags

Practice 627-210-018

Cable sags at **100°F** are shown on the next five pages. They are based on the supporting strand being placed at the tensions given above.

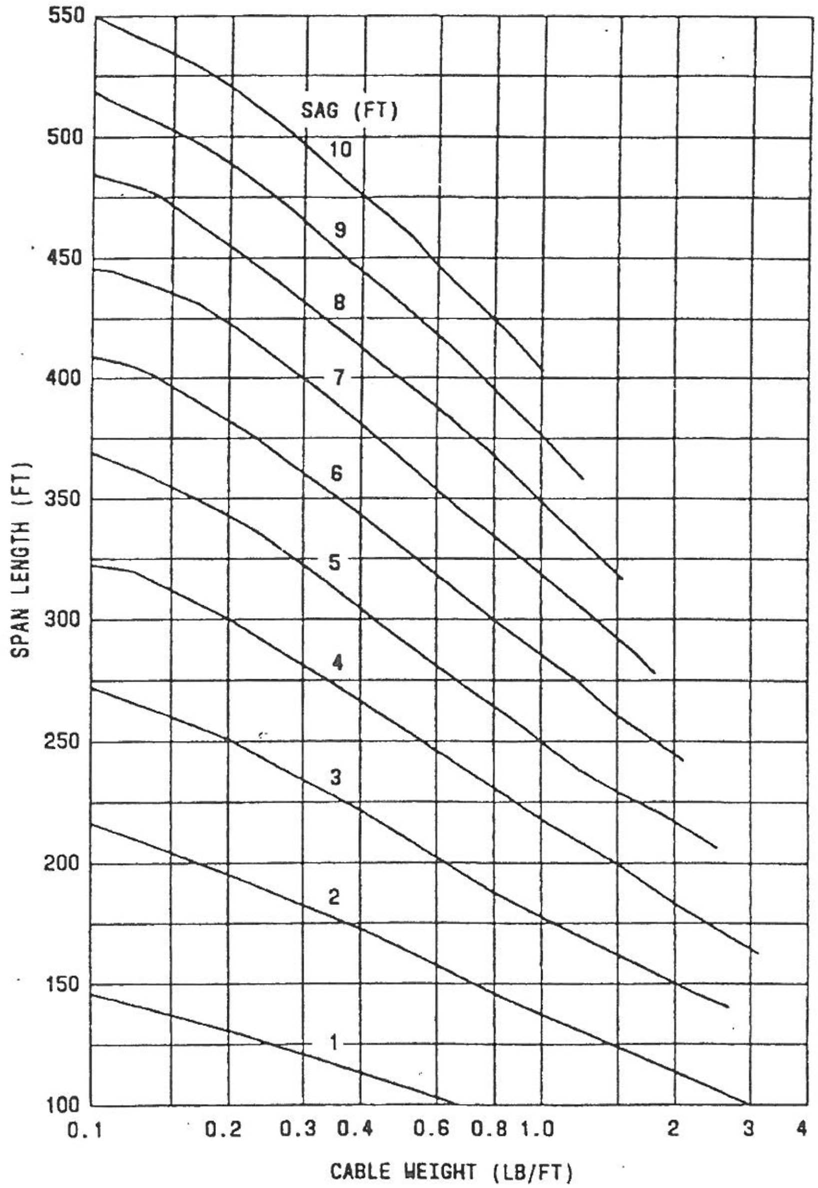
To use the tables, locate the cable weight and span length. Where these lines intersect, the approximate sag is indicated. **Example:** A 0.4lb/ft cable weight for a 200-foot span shows approximately 2-1/2 feet sag.

Cable sags at various degrees Fahrenheit are shown on tables in Practice 627-210-018. Those tables are too voluminous to be giver here. *

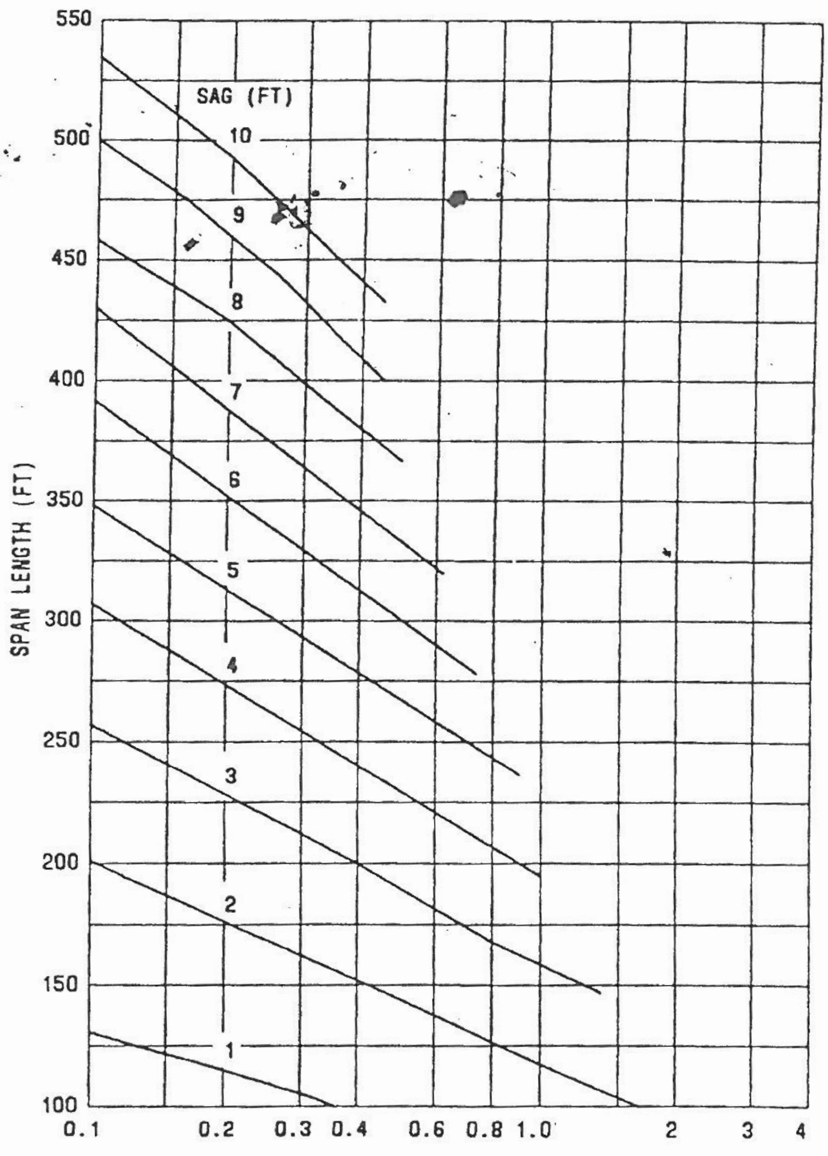
Sag data for self-supporting cable is too voluminous to be given here. Refer to Practice 627-700-011.

Cable weights are shown in Practices 626-101-005 and 626-101-010.

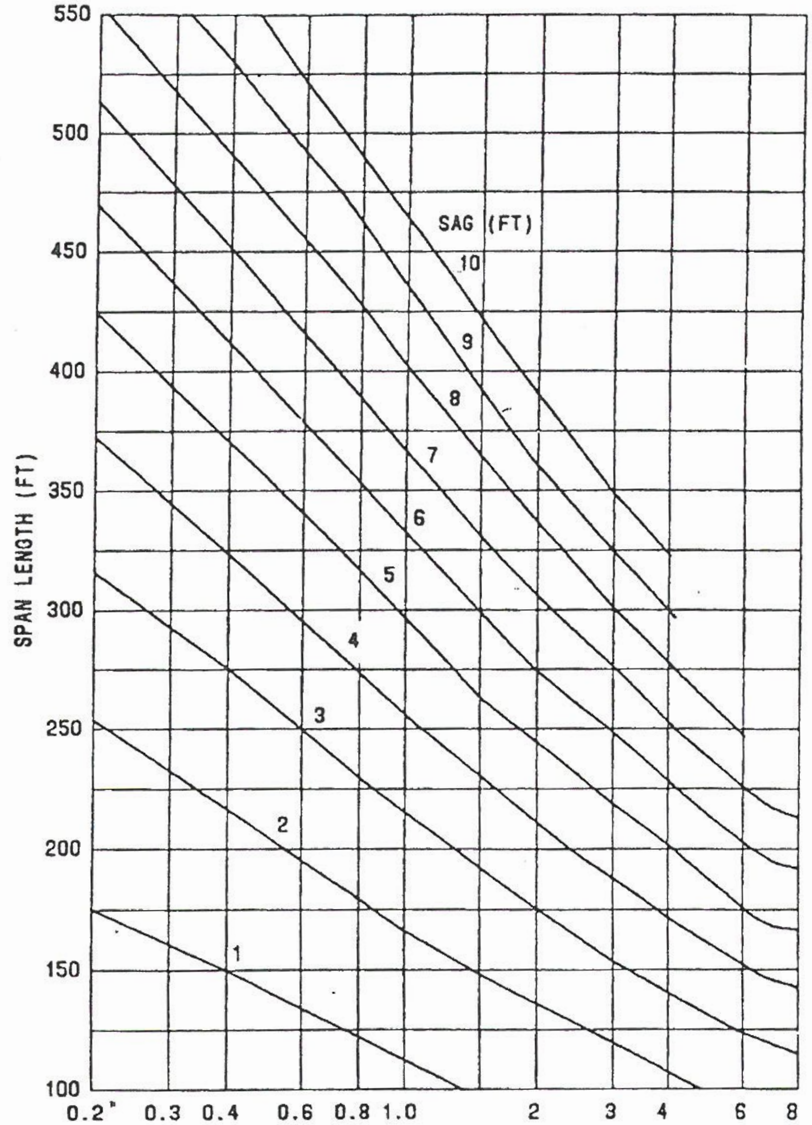
* Refer to Note on Page 10-33.



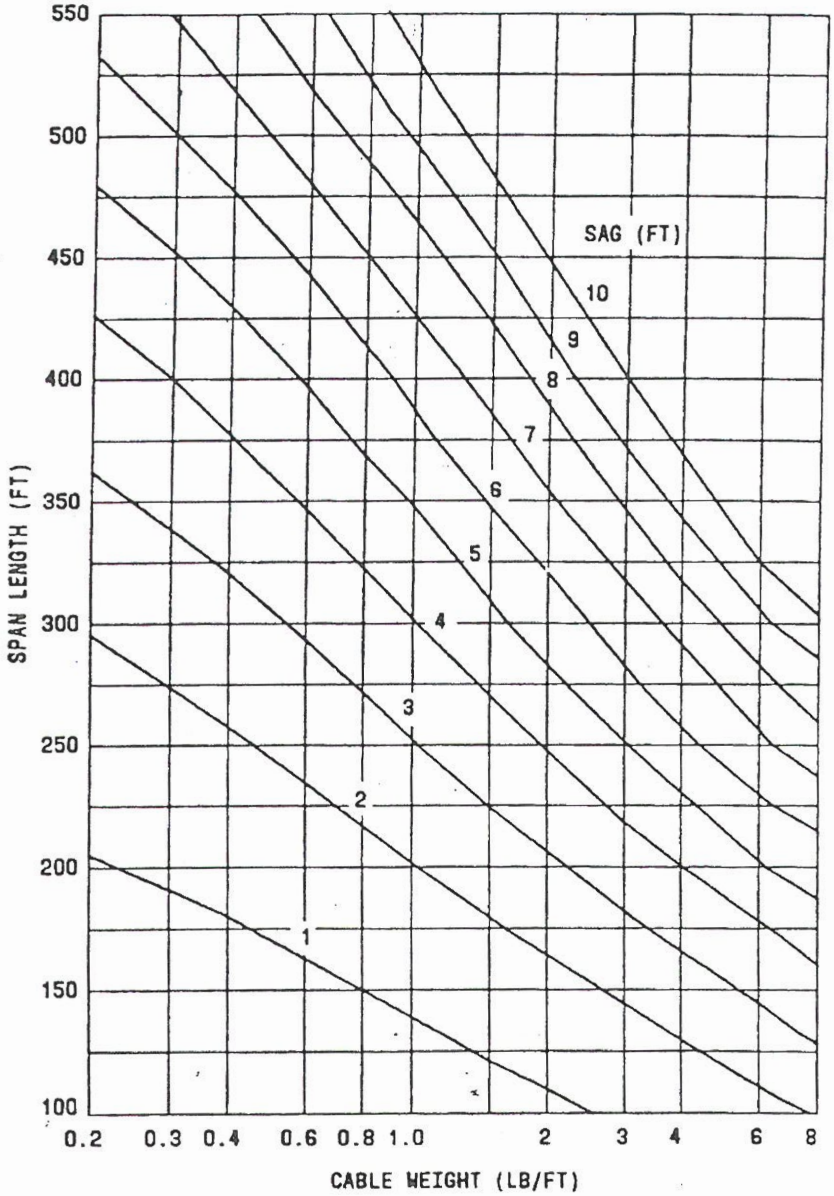
CABLE SAG FOR 6M STRAND AT 100°F



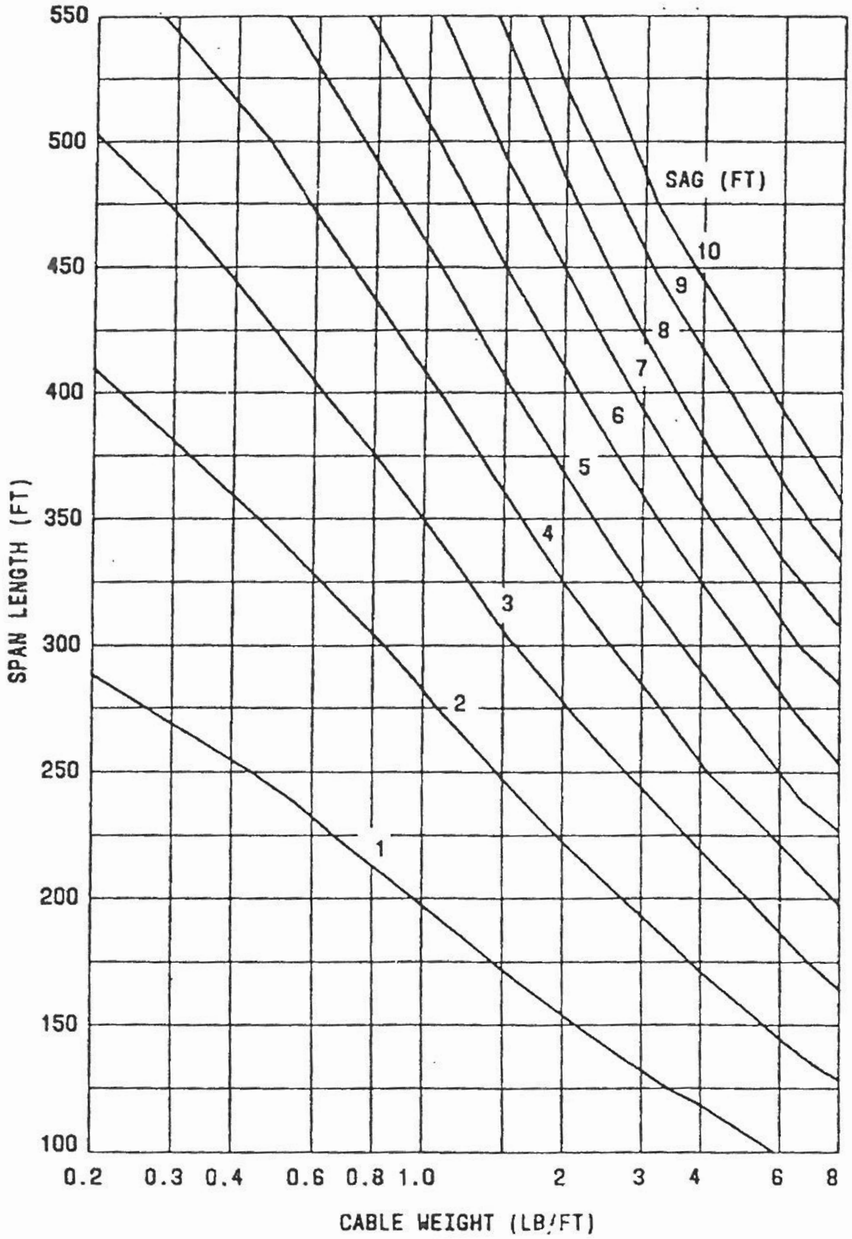
CABLE SAG FOR 6.6M STRAND AT 100°F



CABLE SAG FOR 10M STRAND AT 100°F



CABLE SAG FOR 16M STRAND AT 100°F



CABLE SAG FOR 25M STRAND AT 100°F

Exhibit 4: LOADING ANALYSIS SURVEY SHEET

Region #: Substation: Date:

Feeder #: Performed By: Phone:

Pole Data: Construction: Class:

Pole ID: Species: or Circumference

Pole ID 2: Length: at Groundline (in):

Survey Direction: Pole numbers Ascending or Descending?

Conductors:			Attach Height	Horizontal	Ahead	Back	Ahead	Back	
Power:	Qty	Diameter	Above Grd (ft)	Offset (in)	Span	Span	Angle	Angle	Tension
Communications:									

Drops:			Attach Height	Attach to	If Midspan, Distance from Pole (ft)			Back Span	
Power:	Qty	Diameter	Above Grd (ft)	Pole Y/N	Ahead Span	or	Back Span	Angle	Length
Communications:									

			Attach Height	Horizontal	Offset				
Transformers:	Qty		Above Grd (ft)	Offset (in)	Angle	Size (kva)			

			Attach Height	Horizontal	Offset	Weight	Height	Width	
Equipment:	Qty		Above Grd (ft)	Offset (in)	Angle	Each (lb)	Each (in)	Each (in)	

			Attach Height	Pole to	Back Span				
Guys:	Qty		Above Grd (ft)	Anchor (ft)	Angle				
COMMENTS:									

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Exhibit 5 – Sub-T Conductor Design Tensions

- "Merlin" – 336.4 KCM 18/1 ACSR: 3000# @ NESC Heavy (250B)
- "Tulip" – 336.4 KCM 19 Str. AL: 2000# @ NESC Heavy (250B)
- "Linnet" – 336.4 KCM 26/7 ACSR: 3000 – 5000# @ NESC Heavy (250B) (Depending on the span lengths)
- "Raven" – 1/0 KCM 6/1 ACSR: 2000# @ NESC Heavy (250B)
- "Quail" – 2/0 KCM 6/1 ACSR: 2000 – 3000# @ NESC Heavy (250B) (Based on 5130# ultimate)
- "Penguin" – 4/0 KCM 6/1 ACSR: 3000# @ NESC Heavy (250B)
- "Pelican" – 477 KCM 18/1 ACSR: 3000# @ NESC Heavy (250B)
- "1/0 CU" – 1/0 Copper 7 Str. BSCU: 1500 – 3000# @ NESC Heavy (250B)
- "2/0 CU" – 2/0 Copper 7 Str. BSCU: 1500 – 3000# @ NESC Heavy (250B)
- "4/0 CU" – 4/0 Copper 7 Str. BSCU: 1500 – 5000# @ NESC Heavy (250B)

*Copper conductors will tend to vary – field measurements may be beneficial if drawings do not indicate design tensions.