

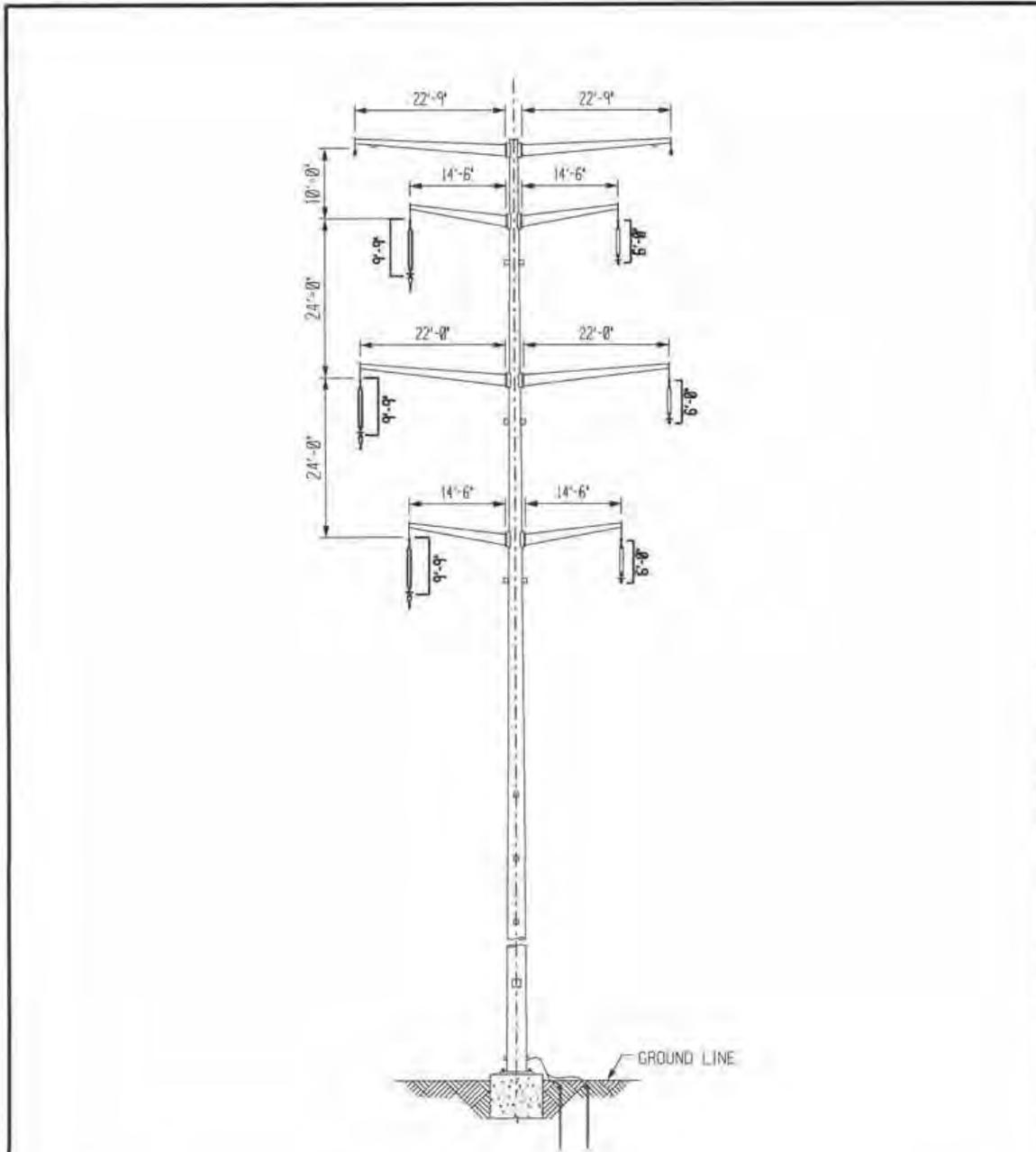
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ITC Midwest's DEIS Comment Letter

Schedule 6
 Coeur Direct
 PUC Docket Nos. ET6675/CN-12-1053 and ET6675/TL-12-1337
 OAH Docket No. 60-2500-30782

TB-VE.01.01



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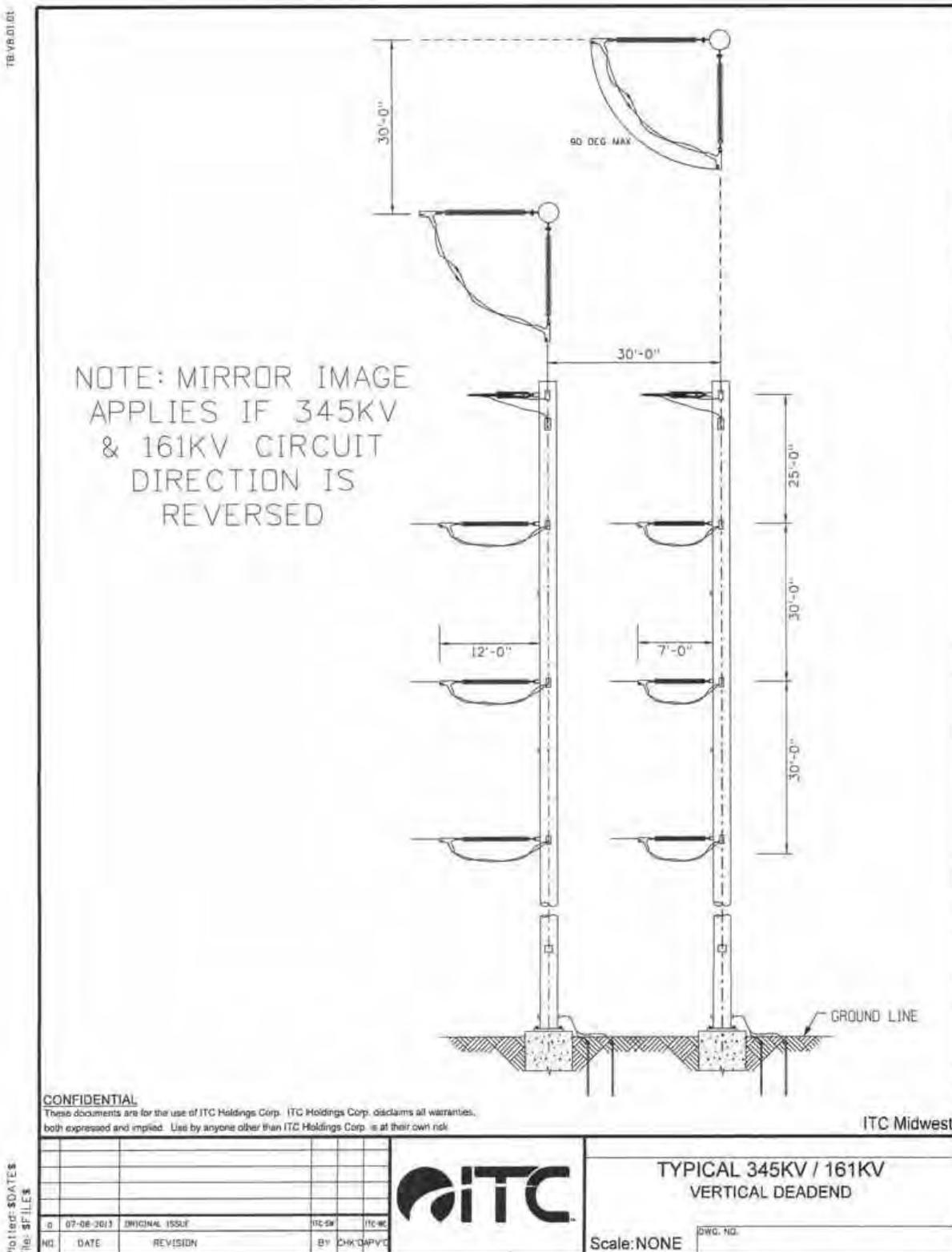
MN-IA 345KV TRANSMISSION PROJECT
 Typical 345kV-161kV Vertical Tangent Structure Drawing

Scale:

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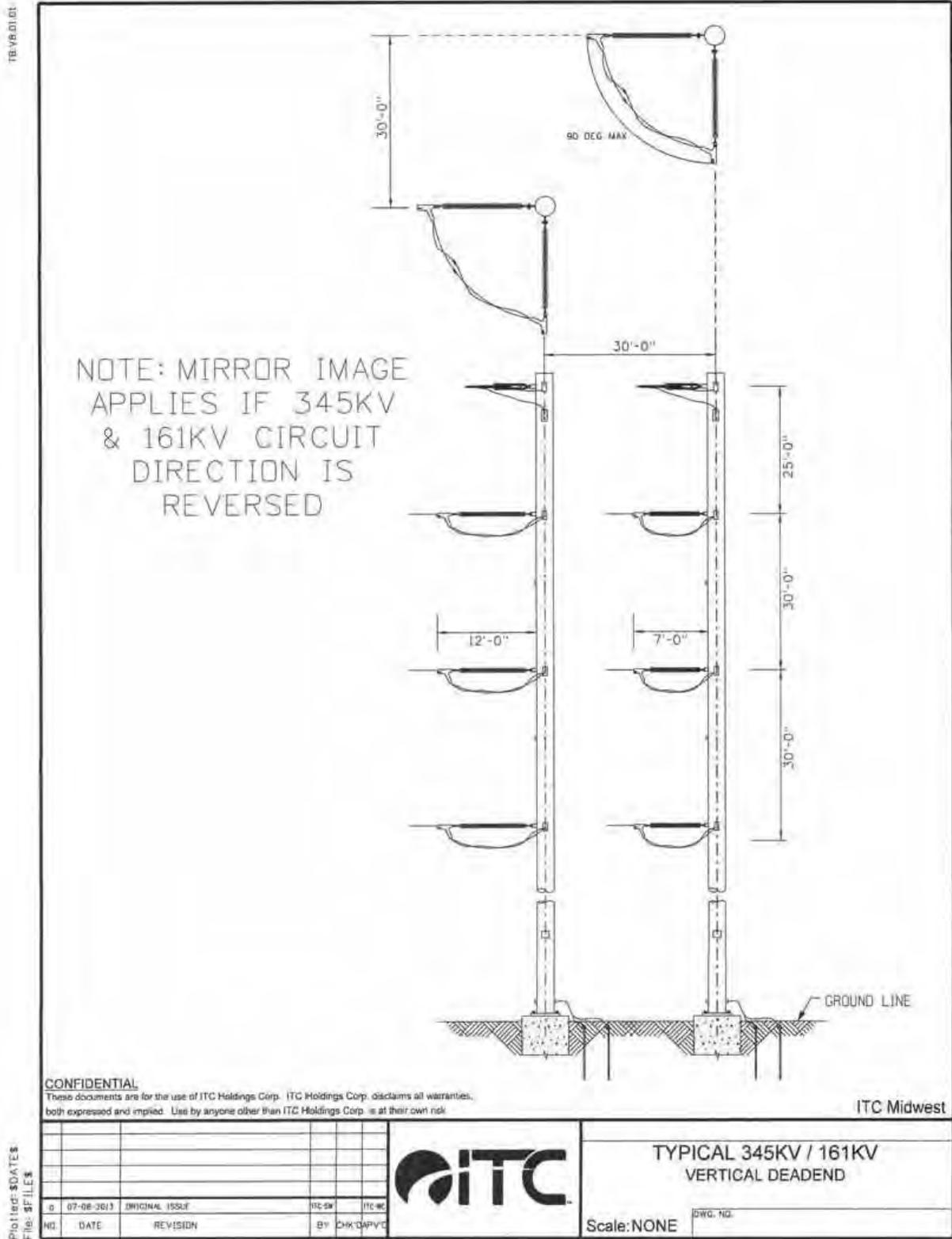
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ITC Midwest's DEIS Comment Letter

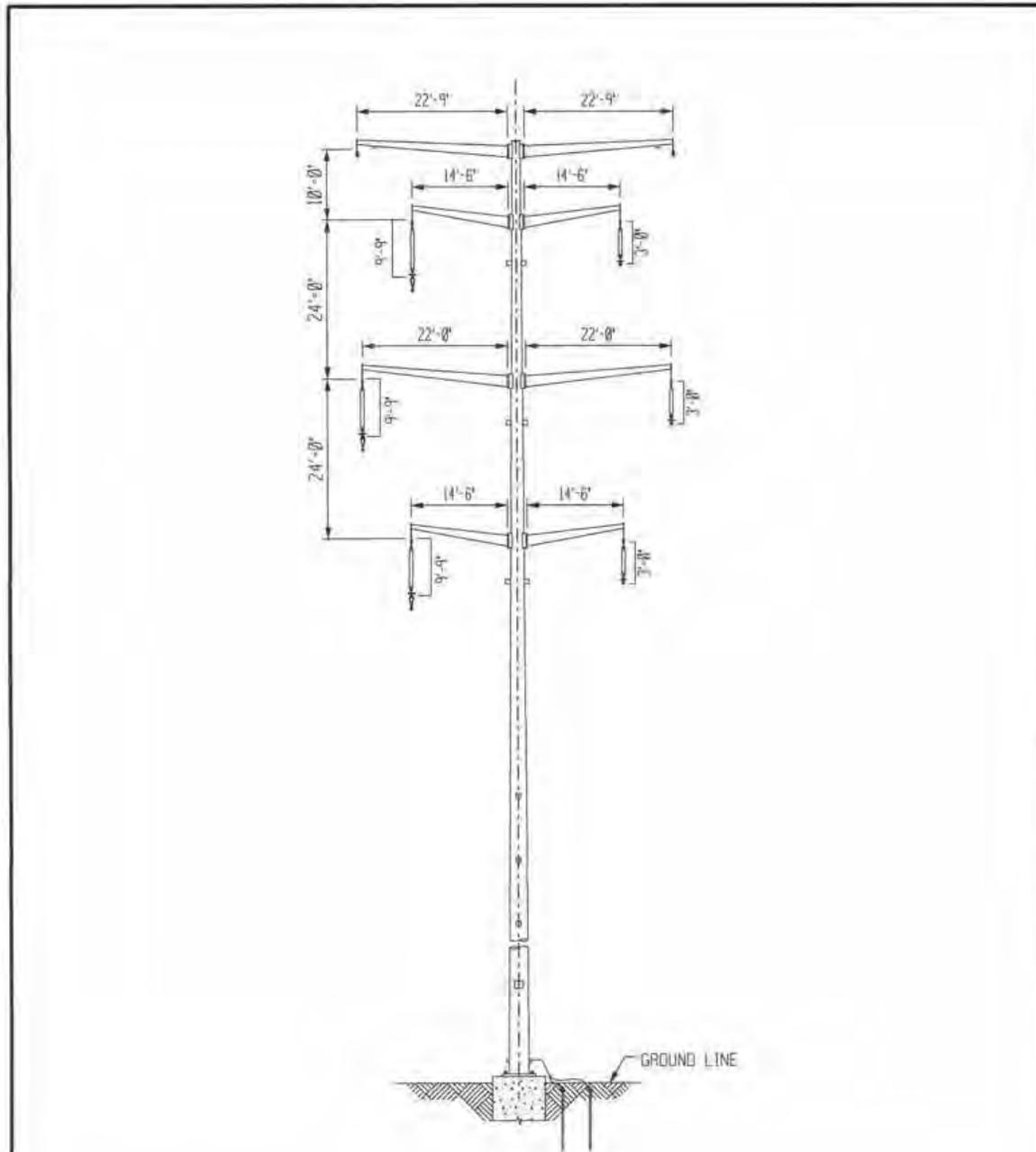
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MN-IA 345kV TRANSMISSION PROJECT
Typical 345kV-161kV Vertical Tangent
 345kV-69kV CIRCUITS
 Structure Drawing

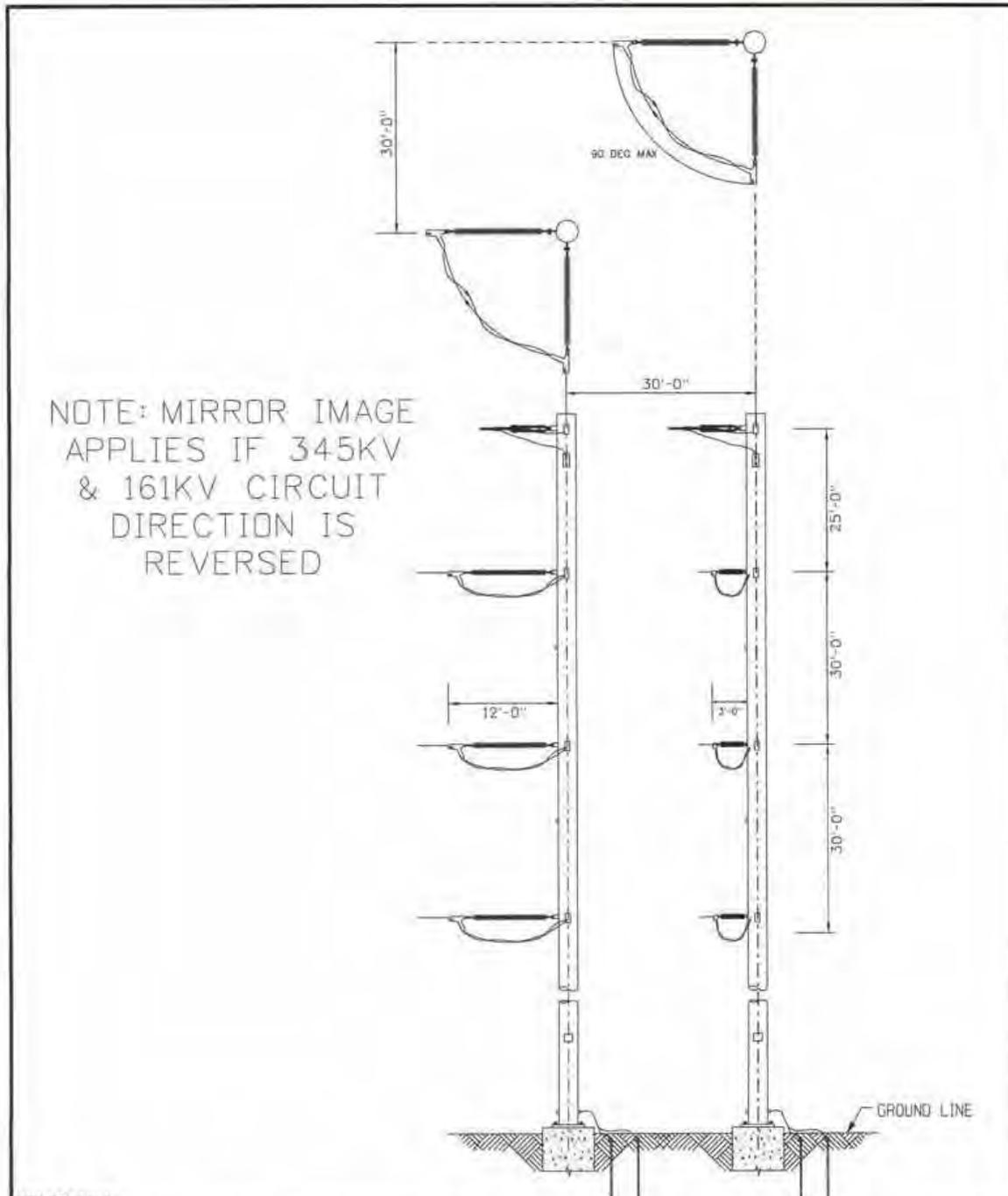
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0	07-08-2013	ORIGINAL ISSUE	ITE-SH	ITE-WC	



**TYPICAL 345KV / 69KV
 VERTICAL DEADEND**

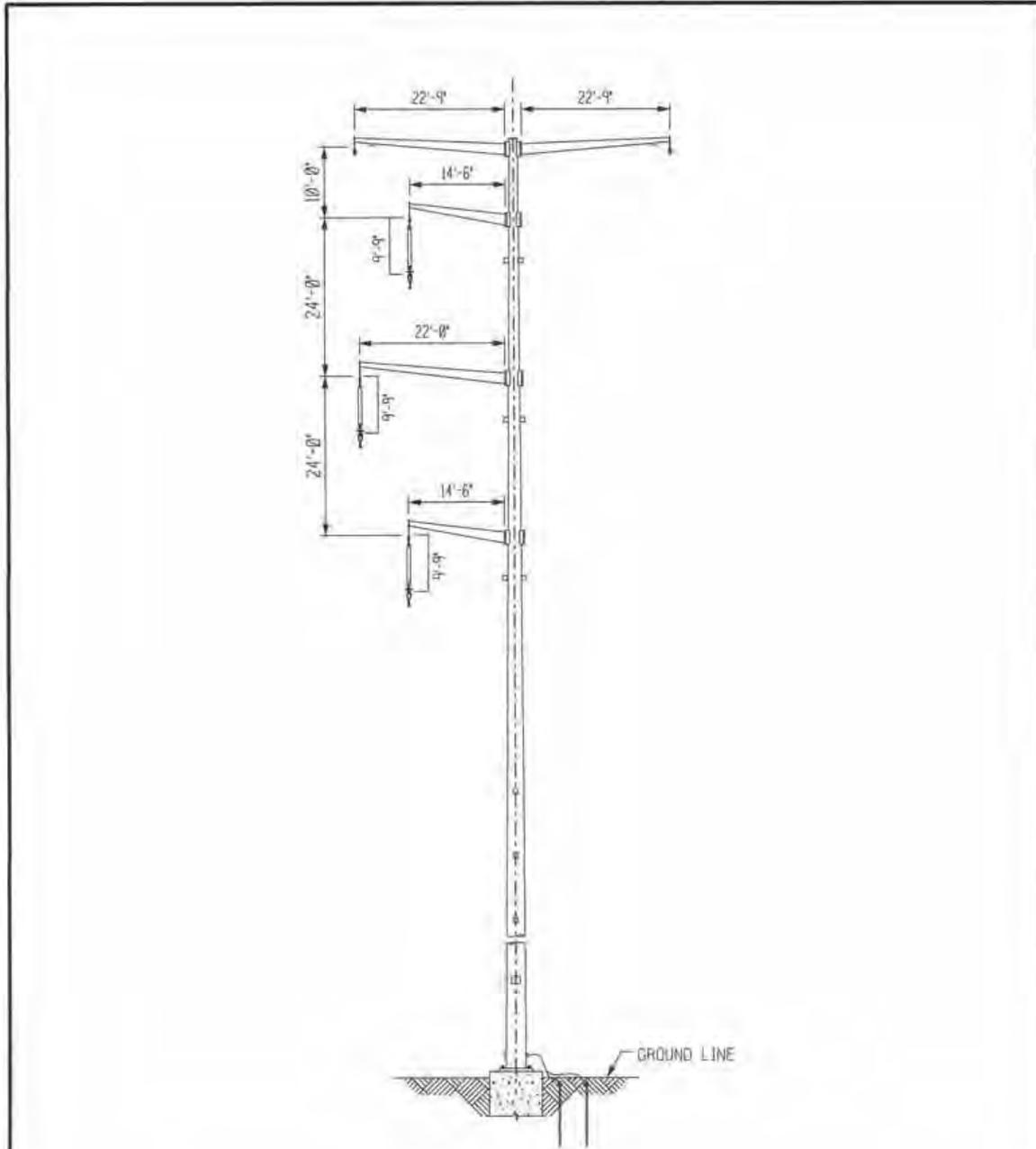
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NO.	DATE	REVISION	BY	CHK/APPV'D



MN-1A 345kV TRANSMISSION PROJECT
Typical 345kV-161kV Vertical Tangent
 345kV ONLY
 Structure Drawing

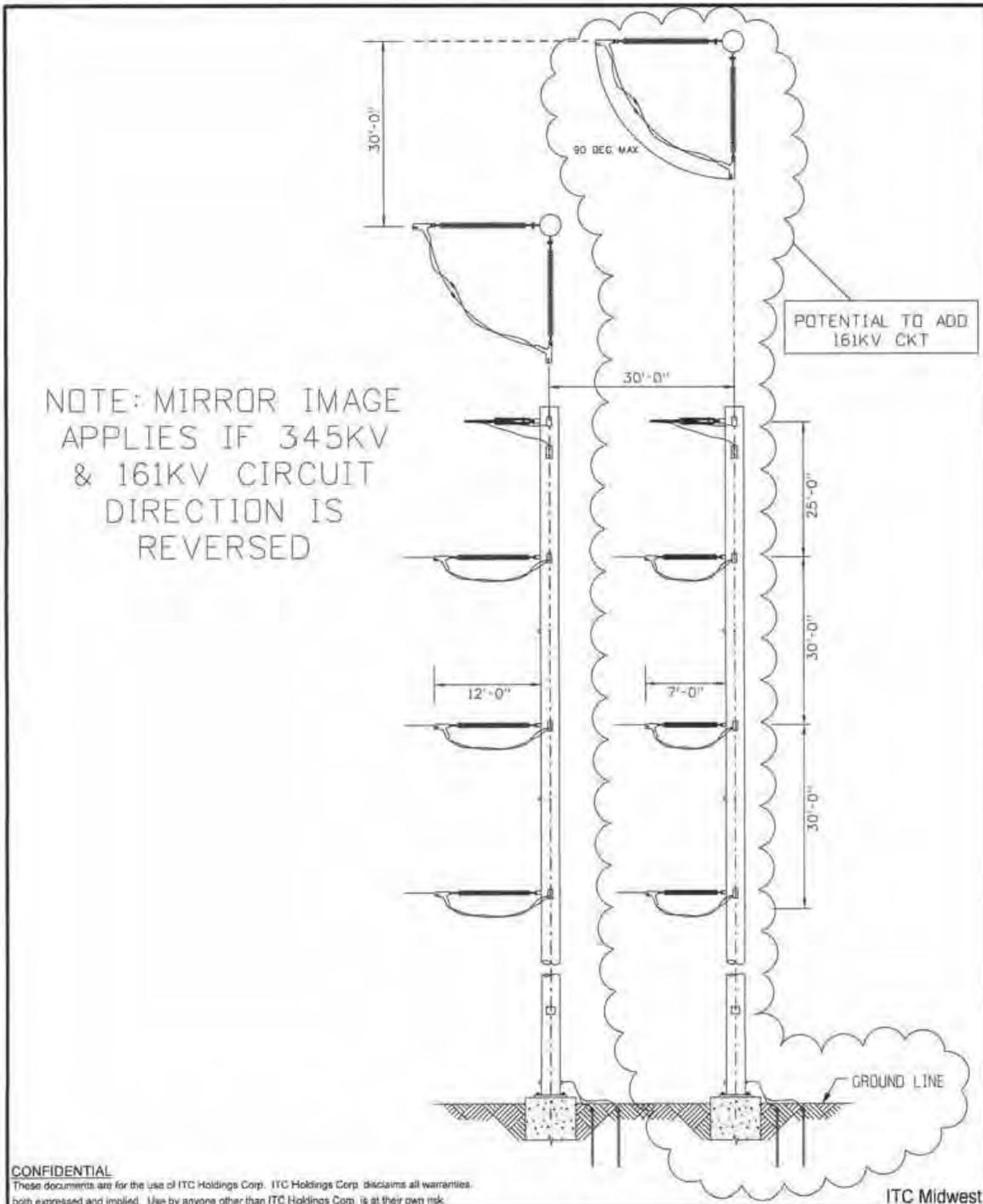
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0	07-08-2013	ORIGINAL ISSUE			



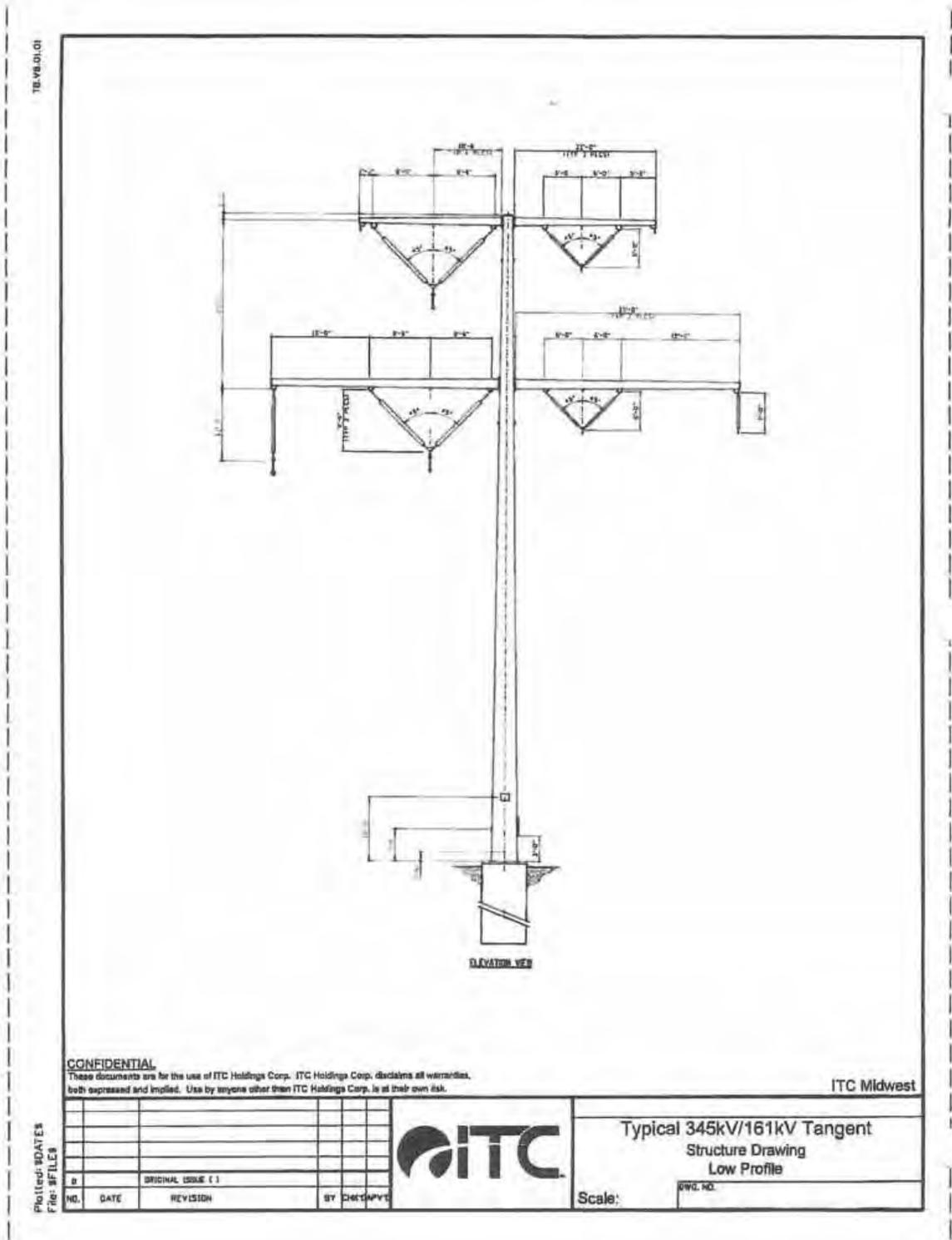
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 VERTICAL DEADEND

Scale: NONE

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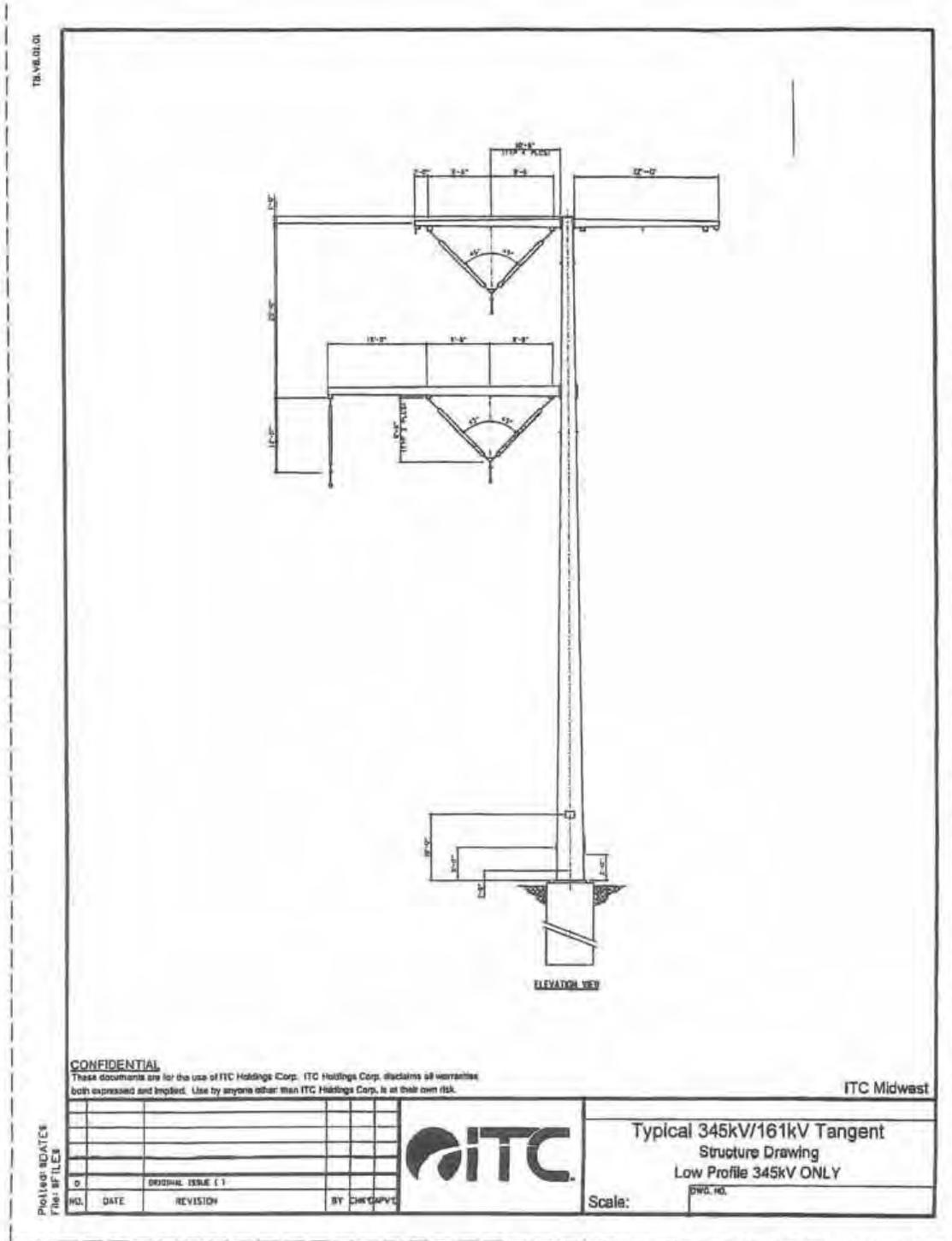
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 PUC Docket Nos. ET6675/CN-12-1053 and ET6675/TL-12-1337
 OAH Docket No. 60-2500-30782



ITC Midwest's DEIS Comment Letter

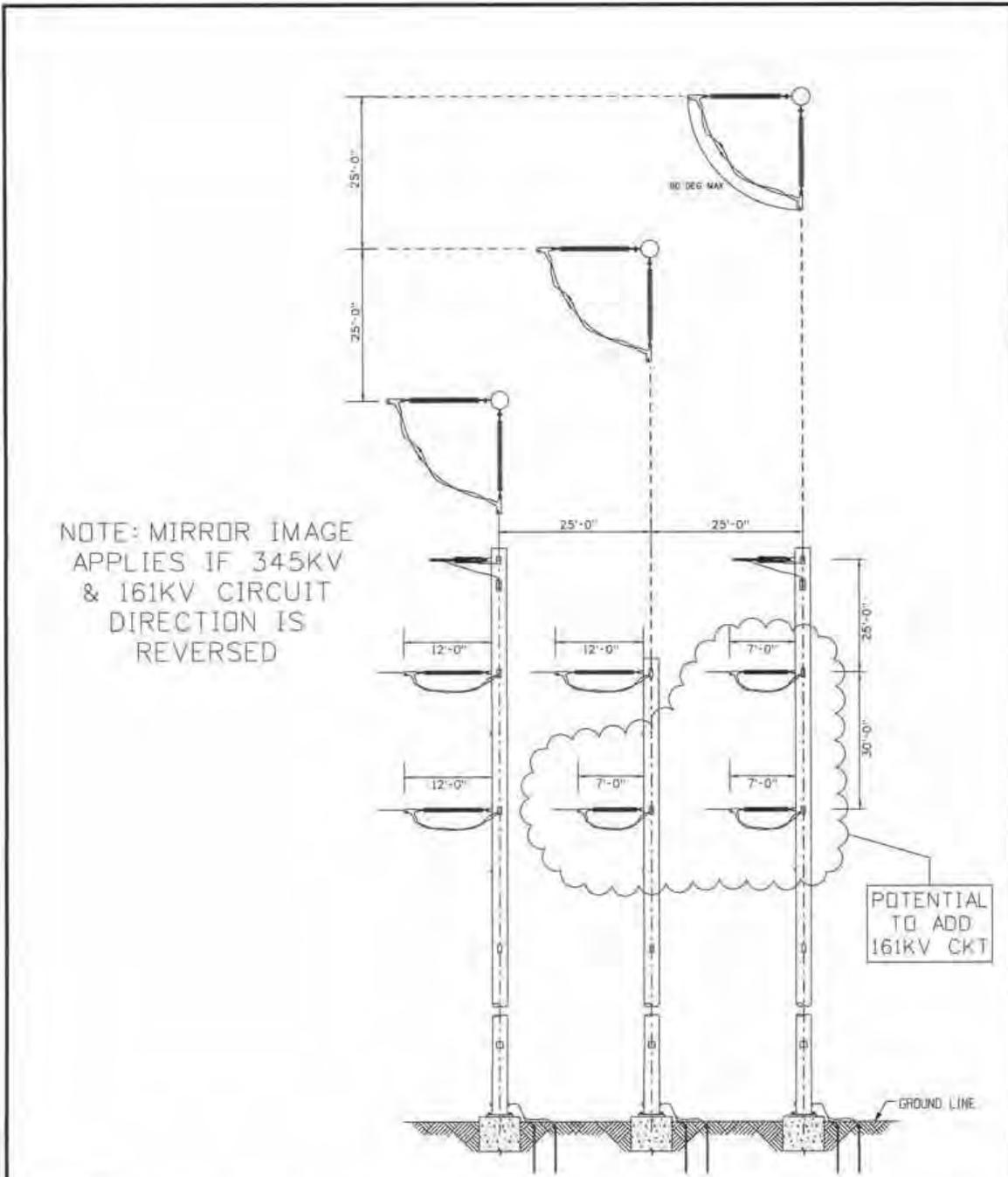
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 OAH Docket No. 60-2500-30782

TR-VB-01.01



NOTE: MIRROR IMAGE
 APPLIES IF 345KV
 & 161KV CIRCUIT
 DIRECTION IS
 REVERSED

POTENTIAL
 TO ADD
 161KV CKT

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0	07-08-2013	ORIGINAL ISSUE	110-98	ITC-MC
NO.	DATE	REVISION	BY	CHK/DAP/VD



TYPICAL 345KV / NONE
 VERTICAL DEADEND
 LOW PROFILE

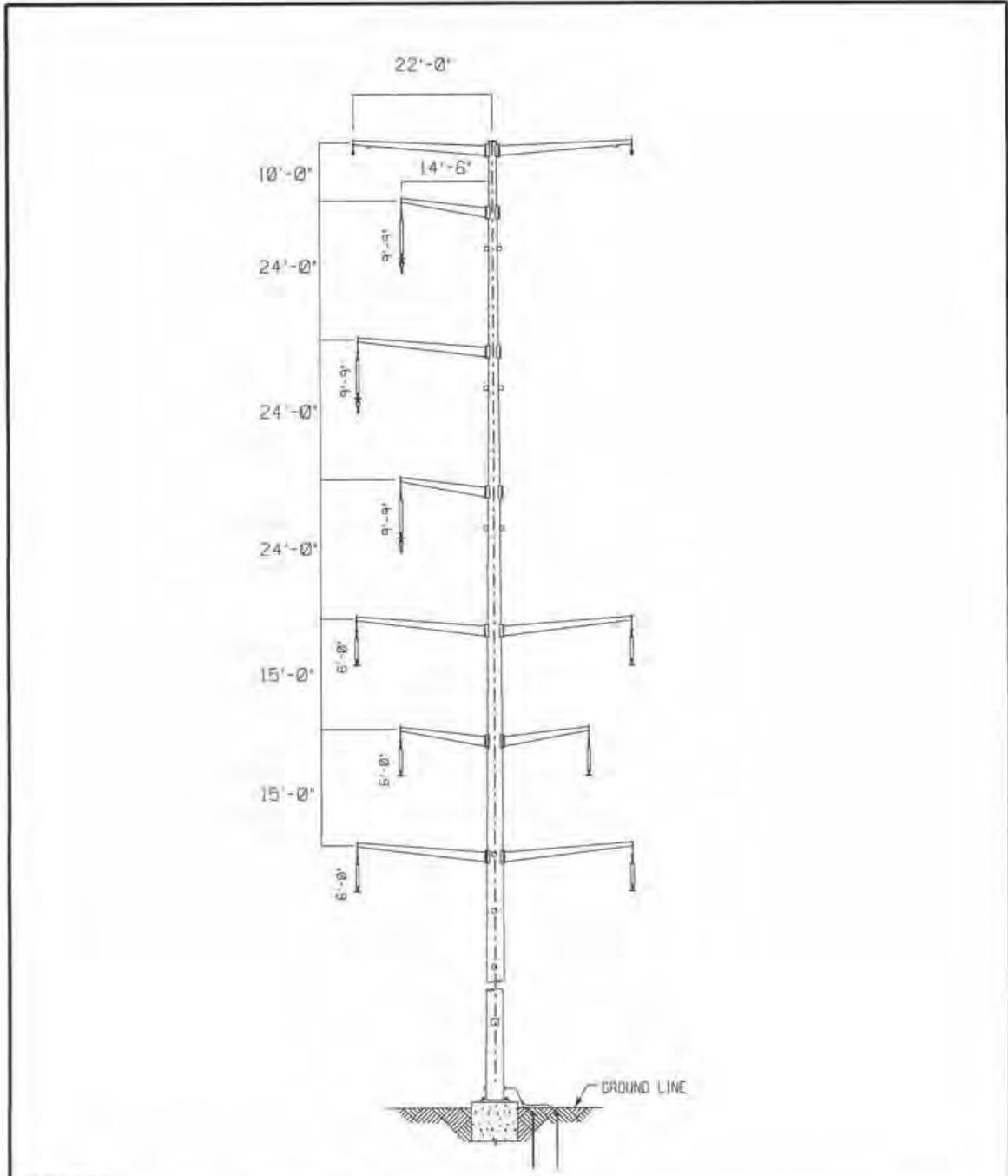
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DWG. NO.

ITC Midwest's DEIS Comment Letter

Schedule 6
 Coeur Direct
 PUC Docket Nos. ET6675/CN-12-1053 and ET6675/TL-12-1337
 OAH Docket No. 60-2500-30782

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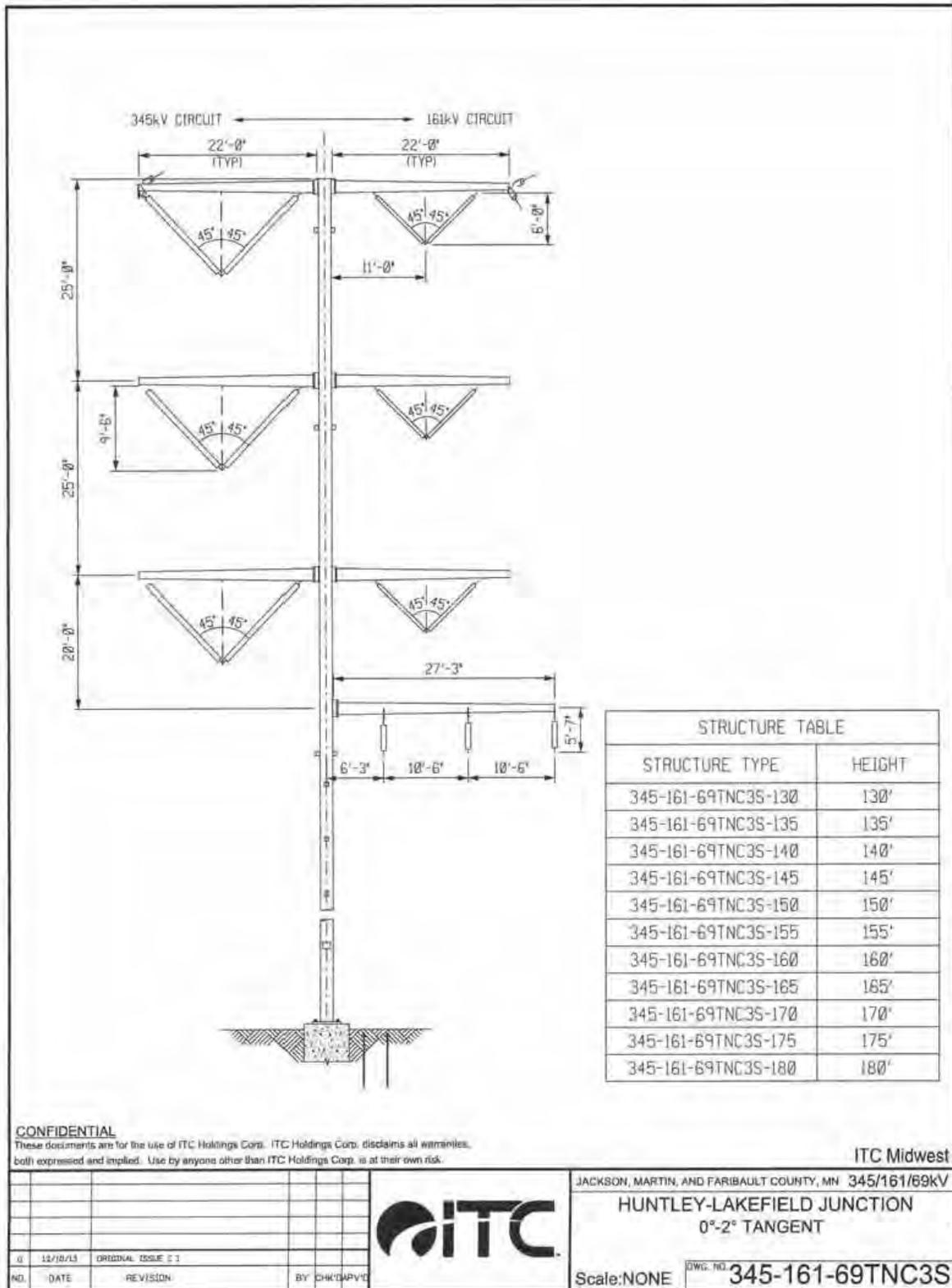
MN-1A 345kV TRANSMISSION PROJECT
Typical 345kV-161kV-161kV
 Typical Circuit Structure

Scale:

DWG. NO.

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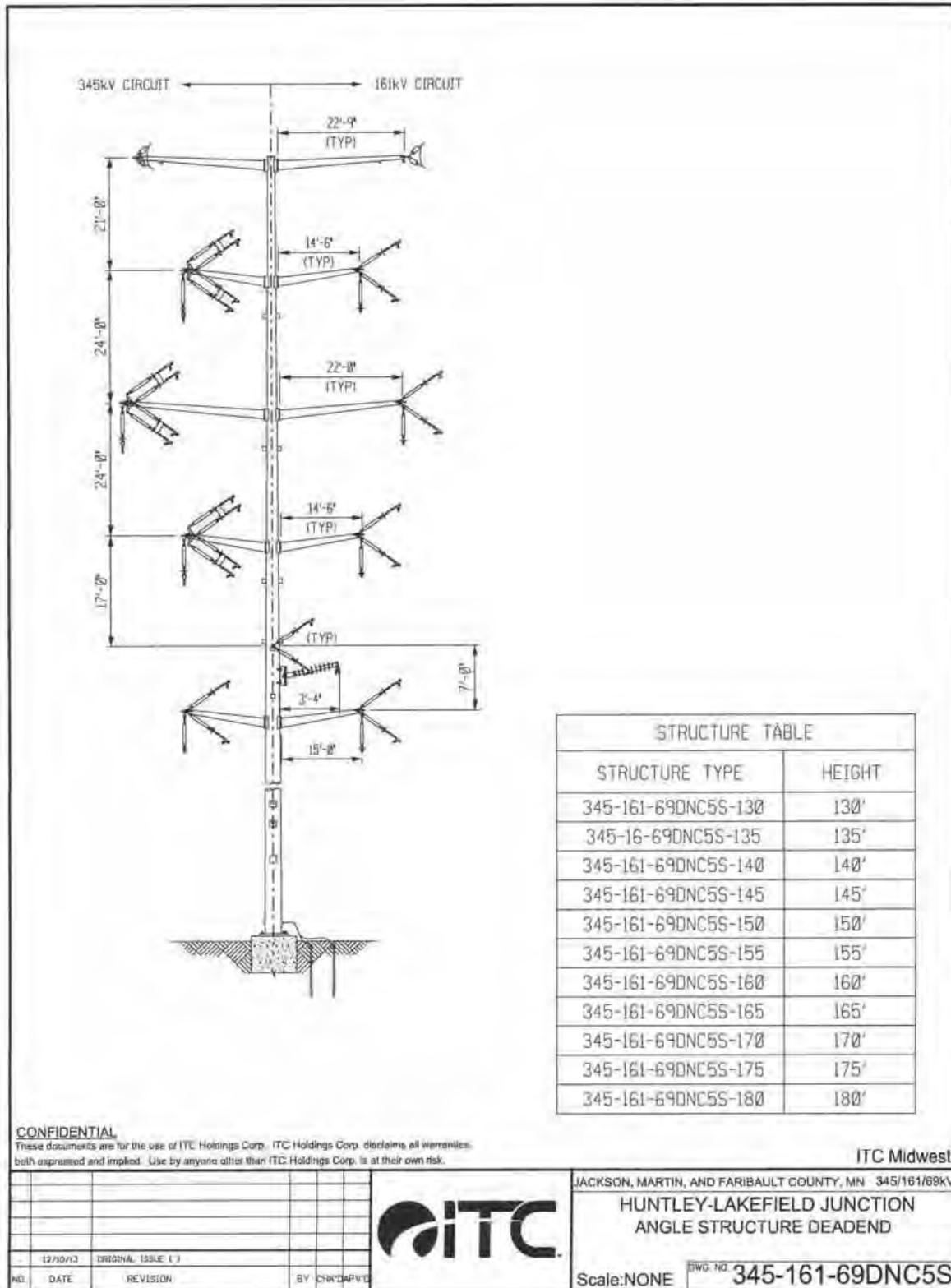


JACKSON, MARTIN, AND FARIBAUT COUNTY, MN 345/161/69kV
 HUNTLEY-LAKEFIELD JUNCTION
 0°-2° TANGENT

Scale: NONE DWG. NO. 345-161-69TNC3S

ITC Midwest's DEIS Comment Letter
Attachment F

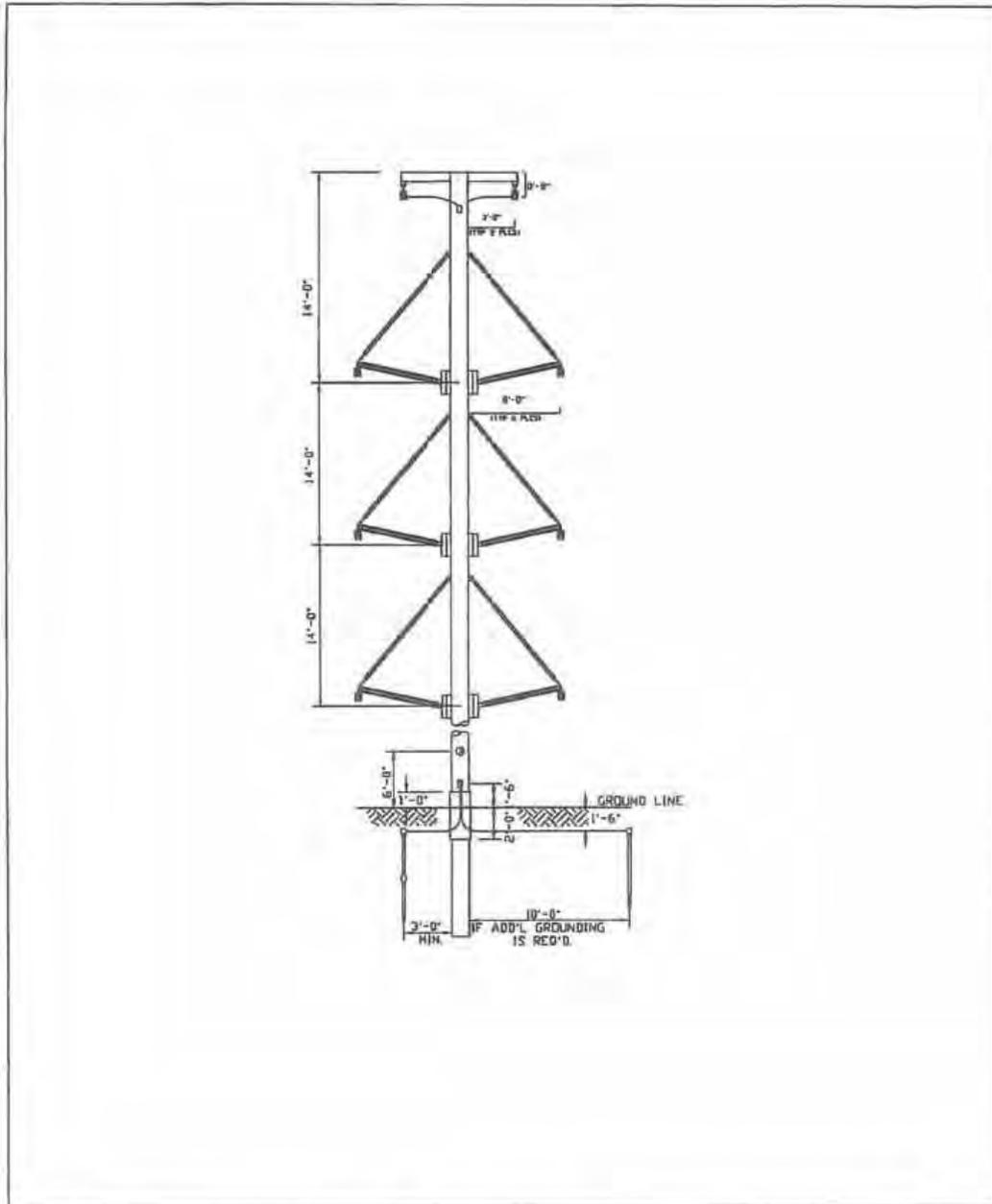
Schedule 6
Coeur Direct
PUC Docket Nos. ET6675/CN-12-1053 and ET6675/TL-12-1337
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ITC Midwest's DEIS Comment Letter

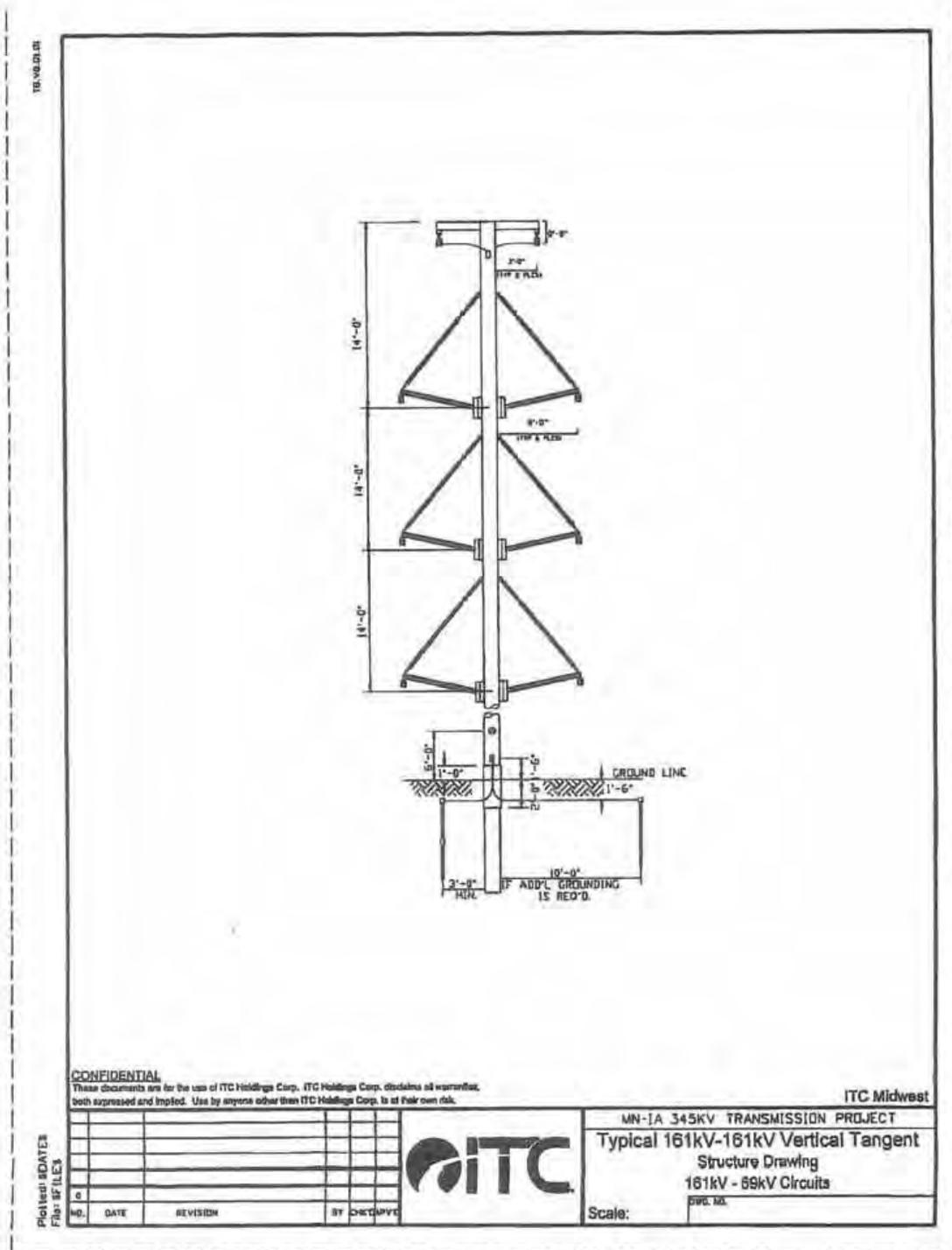
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				Scale: NONE	
NO.	DATE	REVISION	BY	CHK	DWG. NO.

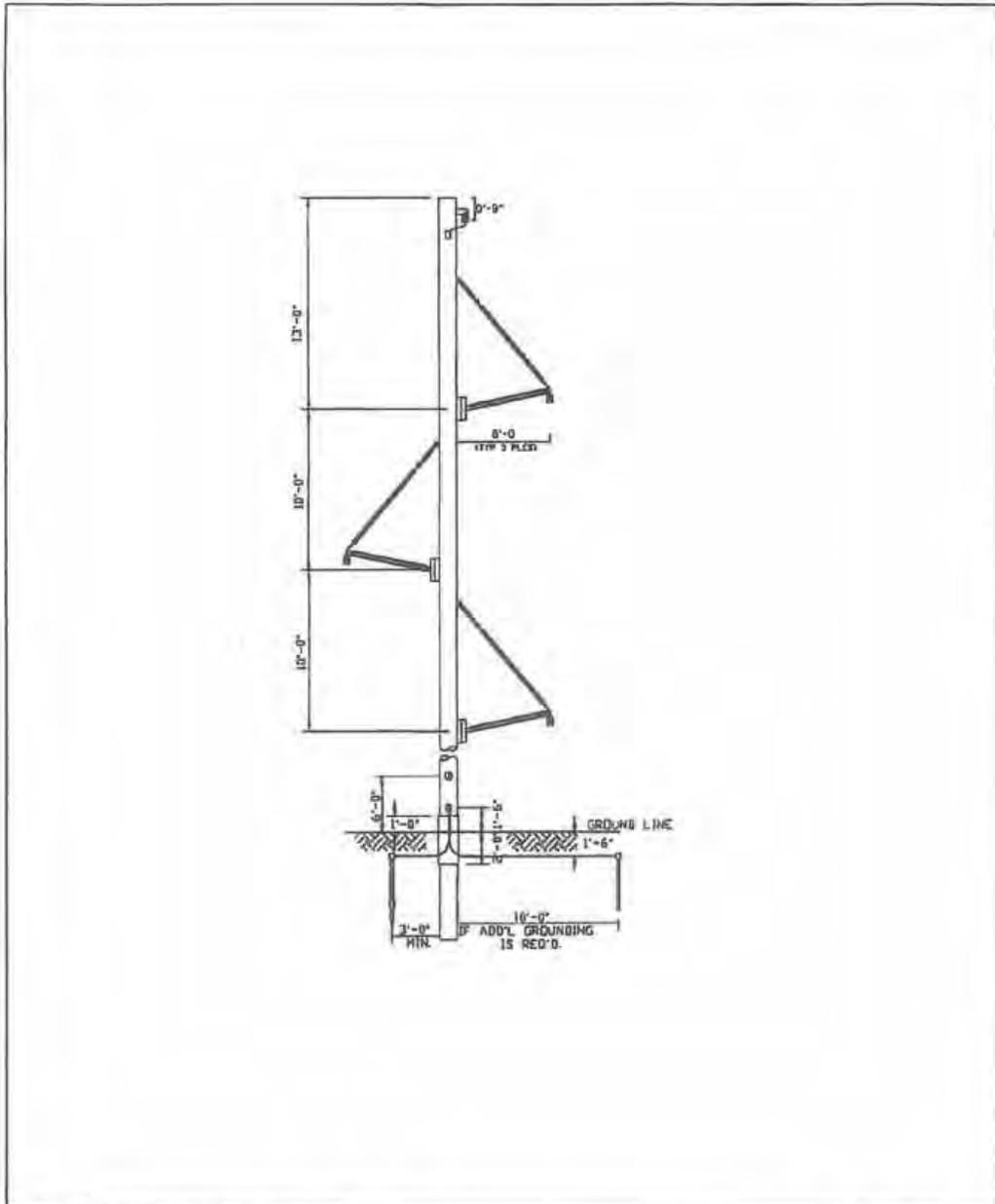
ITC Midwest's DEIS Comment Letter

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10-1A 345KV TRANSMISSION PROJECT

**TYPICAL 161KV TANGENT
 STRUCTURE DRAWING**

DWG. NO. _____

Scale: NONE

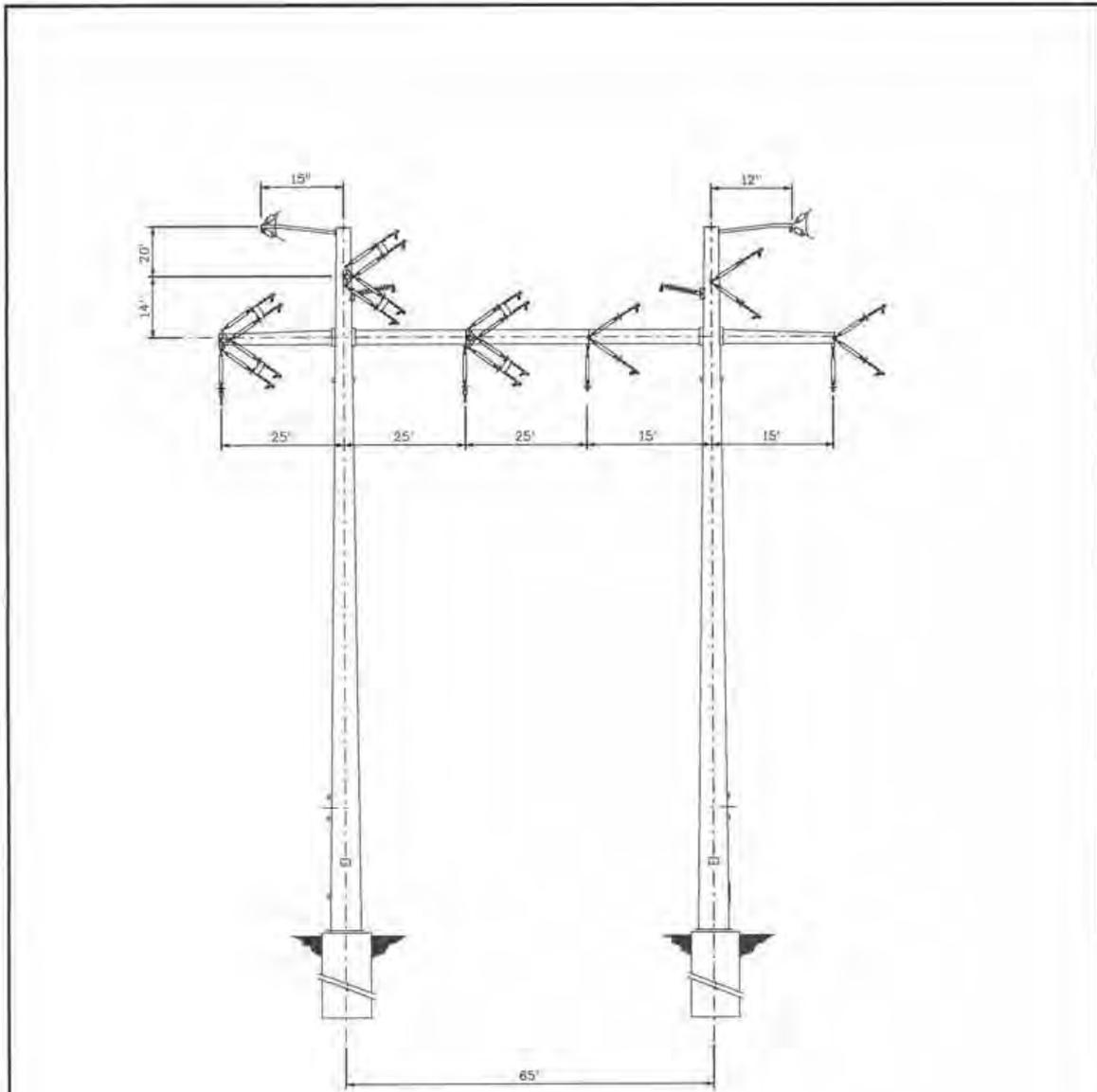
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Schedule 6
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 PUC Docket Nos. ET6675/CN-12-1053 and ET6675/TL-12-1337
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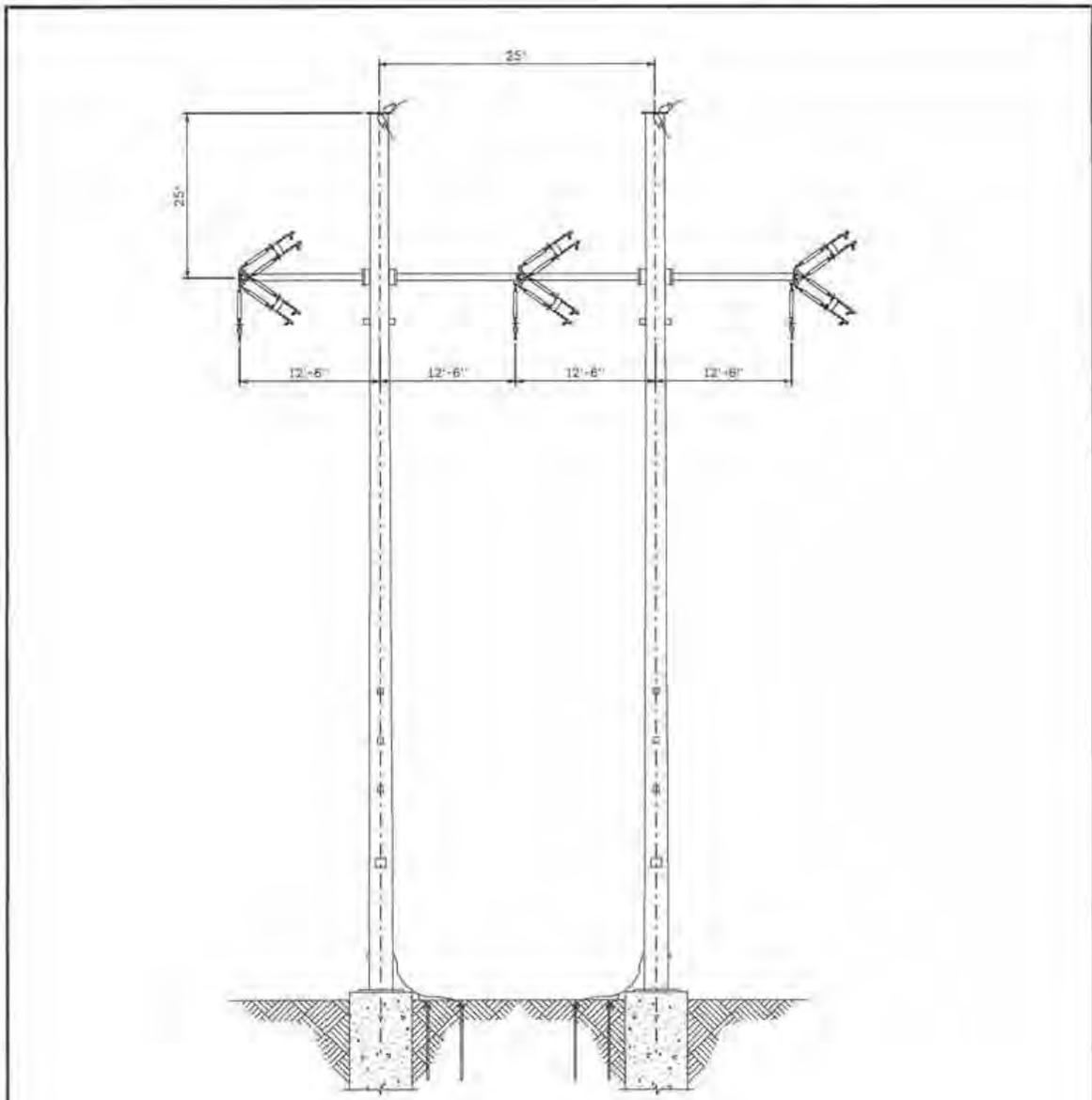
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					HUNTLEY-LAKEFIELD JCT 345/161kV	
					DOUBLE CIRCUIT STEEL H-FRAME WATER CROSSING STRUCTURE	
NO.	DATE	REVISION	BY	CHK'D/APPR'D	Scale: NONE	DWG. NO. 345-161DDNH5S
	11/25/13	DRGCHG. ISSUE 1.1				

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Schedule 6
 Coeur Direct
 PUC Docket Nos. ET6675/CN-12-1053 and ET6675/TL-12-1337
 OAH Docket No. 60-2500-30782



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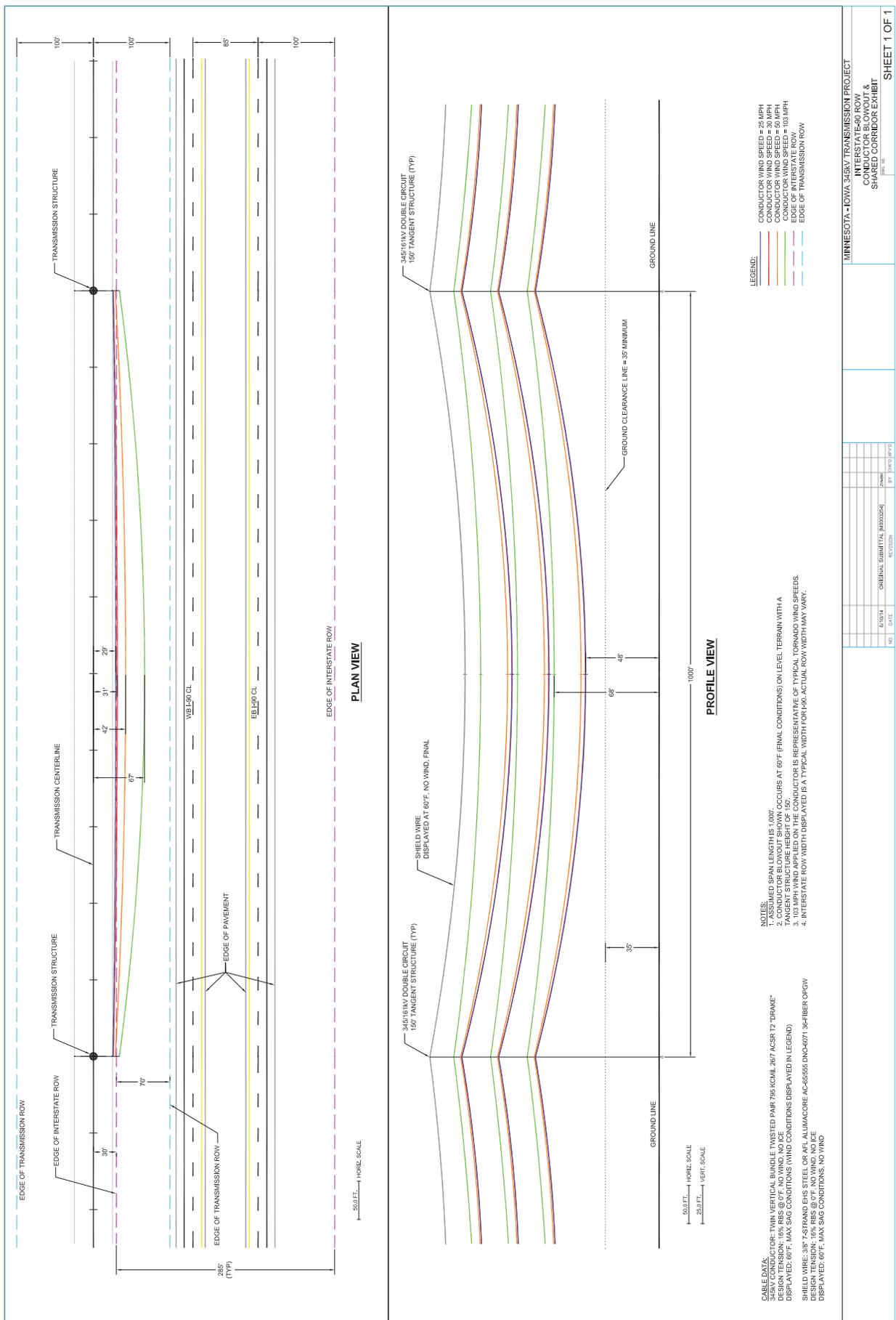
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				JACKSON, MARTIN, AND FARIBAUT COUNTY, MN		345kV
				SINGLE CIRCUIT STEEL H-FRAME WATER CROSSING STRUCTURE		
				Scale: NONE	DWG. NO.	345-DNH5S
NO.	DATE	REVISION	BY			
0	12/19/13	ORIGINAL ISSUE				



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The North American Electric Reliability Corporation (NERC) reliability standards for the bulk electric systems of North America are available on-line at: <http://www.nerc.com/pa/stand/Pages>. These standards include standards for facilities design, connection and maintenance (FAC). Select portions from the FAC section of the standards are included in this appendix.

The National Electric Safety Code (NESC) provides guidance on safeguarding persons from the hazards of electrical supply systems. The NESC is published by the Institute of Electrical and Electronics Engineers, Inc. and is available for purchase at: <http://standards.ieee.org/about/nesc/>. Select portions of the NESC are included in this appendix.

NERC

NORTH AMERICAN ELECTRIC
RELIABILITY CORPORATION

Reliability Standards for the Bulk Electric Systems of North America

Updated May 16, 2014

RELIABILITY | ACCOUNTABILITY



3353 Peachtree Road NE
Suite 600, North Tower
Atlanta, GA 30326
404-446-2560 | www.nerc.com

Standard FAC-003-1 — Transmission Vegetation Management Program

A. Introduction

1. **Title:** **Transmission Vegetation Management Program**
2. **Number:** FAC-003-1
3. **Purpose:** To improve the reliability of the electric transmission systems by preventing outages from vegetation located on transmission rights-of-way (ROW) and minimizing outages from vegetation located adjacent to ROW, maintaining clearances between transmission lines and vegetation on and along transmission ROW, and reporting vegetation-related outages of the transmission systems to the respective Regional Reliability Organizations (RRO) and the North American Electric Reliability Council (NERC).
4. **Applicability:**
 - 4.1. Transmission Owner.
 - 4.2. Regional Reliability Organization.
 - 4.3. This standard shall apply to all transmission lines operated at 200 kV and above and to any lower voltage lines designated by the RRO as critical to the reliability of the electric system in the region.
5. **Effective Dates:**
 - 5.1. One calendar year from the date of adoption by the NERC Board of Trustees for Requirements 1 and 2.
 - 5.2. Sixty calendar days from the date of adoption by the NERC Board of Trustees for Requirements 3 and 4.

B. Requirements

- R1.** The Transmission Owner shall prepare, and keep current, a formal transmission vegetation management program (TVMP). The TVMP shall include the Transmission Owner's objectives, practices, approved procedures, and work specifications¹.
- R1.1.** The TVMP shall define a schedule for and the type (aerial, ground) of ROW vegetation inspections. This schedule should be flexible enough to adjust for changing conditions. The inspection schedule shall be based on the anticipated growth of vegetation and any other environmental or operational factors that could impact the relationship of vegetation to the Transmission Owner's transmission lines.
- R1.2.** The Transmission Owner, in the TVMP, shall identify and document clearances between vegetation and any overhead, ungrounded supply conductors, taking into consideration transmission line voltage, the effects of ambient temperature on conductor sag under maximum design loading, and the effects of wind velocities on conductor sway. Specifically, the Transmission Owner shall establish clearances to be achieved at the time of vegetation management work identified herein as Clearance 1, and shall also establish and maintain a set of clearances identified herein as Clearance 2 to prevent flashover between vegetation and overhead ungrounded supply conductors.
- R1.2.1.** Clearance 1 — The Transmission Owner shall determine and document appropriate clearance distances to be achieved at the time of transmission vegetation management work based upon local conditions and the expected time frame in which the Transmission Owner plans to return for future

¹ ANSI A300, Tree Care Operations – Tree, Shrub, and Other Woody Plant Maintenance – Standard Practices, while not a requirement of this standard, is considered to be an industry best practice.

Standard FAC-003-1 — Transmission Vegetation Management Program

vegetation management work. Local conditions may include, but are not limited to: operating voltage, appropriate vegetation management techniques, fire risk, reasonably anticipated tree and conductor movement, species types and growth rates, species failure characteristics, local climate and rainfall patterns, line terrain and elevation, location of the vegetation within the span, and worker approach distance requirements. Clearance 1 distances shall be greater than those defined by Clearance 2 below.

R1.2.2. Clearance 2 — The Transmission Owner shall determine and document specific radial clearances to be maintained between vegetation and conductors under all rated electrical operating conditions. These minimum clearance distances are necessary to prevent flashover between vegetation and conductors and will vary due to such factors as altitude and operating voltage. These Transmission Owner-specific minimum clearance distances shall be no less than those set forth in the Institute of Electrical and Electronics Engineers (IEEE) Standard 516-2003 (*Guide for Maintenance Methods on Energized Power Lines*) and as specified in its Section 4.2.2.3, Minimum Air Insulation Distances without Tools in the Air Gap.

R1.2.2.1 Where transmission system transient overvoltage factors are not known, clearances shall be derived from Table 5, IEEE 516-2003, phase-to-ground distances, with appropriate altitude correction factors applied.

R1.2.2.2 Where transmission system transient overvoltage factors are known, clearances shall be derived from Table 7, IEEE 516-2003, phase-to-phase voltages, with appropriate altitude correction factors applied.

R1.3. All personnel directly involved in the design and implementation of the TVMP shall hold appropriate qualifications and training, as defined by the Transmission Owner, to perform their duties.

R1.4. Each Transmission Owner shall develop mitigation measures to achieve sufficient clearances for the protection of the transmission facilities when it identifies locations on the ROW where the Transmission Owner is restricted from attaining the clearances specified in Requirement 1.2.1.

R1.5. Each Transmission Owner shall establish and document a process for the immediate communication of vegetation conditions that present an imminent threat of a transmission line outage. This is so that action (temporary reduction in line rating, switching line out of service, etc.) may be taken until the threat is relieved.

R2. The Transmission Owner shall create and implement an annual plan for vegetation management work to ensure the reliability of the system. The plan shall describe the methods used, such as manual clearing, mechanical clearing, herbicide treatment, or other actions. The plan should be flexible enough to adjust to changing conditions, taking into consideration anticipated growth of vegetation and all other environmental factors that may have an impact on the reliability of the transmission systems. Adjustments to the plan shall be documented as they occur. The plan should take into consideration the time required to obtain permissions or permits from landowners or regulatory authorities. Each Transmission Owner shall have systems and procedures for documenting and tracking the planned vegetation management work and ensuring that the vegetation management work was completed according to work specifications.

Standard FAC-003-1 — Transmission Vegetation Management Program

- R3.** The Transmission Owner shall report quarterly to its RRO, or the RRO's designee, sustained transmission line outages determined by the Transmission Owner to have been caused by vegetation.
- R3.1.** Multiple sustained outages on an individual line, if caused by the same vegetation, shall be reported as one outage regardless of the actual number of outages within a 24-hour period.
- R3.2.** The Transmission Owner is not required to report to the RRO, or the RRO's designee, certain sustained transmission line outages caused by vegetation: (1) Vegetation-related outages that result from vegetation falling into lines from outside the ROW that result from natural disasters shall not be considered reportable (examples of disasters that could create non-reportable outages include, but are not limited to, earthquakes, fires, tornados, hurricanes, landslides, wind shear, major storms as defined either by the Transmission Owner or an applicable regulatory body, ice storms, and floods), and (2) Vegetation-related outages due to human or animal activity shall not be considered reportable (examples of human or animal activity that could cause a non-reportable outage include, but are not limited to, logging, animal severing tree, vehicle contact with tree, arboricultural activities or horticultural or agricultural activities, or removal or digging of vegetation).
- R3.3.** The outage information provided by the Transmission Owner to the RRO, or the RRO's designee, shall include at a minimum: the name of the circuit(s) outaged, the date, time and duration of the outage; a description of the cause of the outage; other pertinent comments; and any countermeasures taken by the Transmission Owner.
- R3.4.** An outage shall be categorized as one of the following:
- R3.4.1.** Category 1 — Grow-ins: Outages caused by vegetation growing into lines from vegetation inside and/or outside of the ROW;
- R3.4.2.** Category 2 — Fall-ins: Outages caused by vegetation falling into lines from inside the ROW;
- R3.4.3.** Category 3 — Fall-ins: Outages caused by vegetation falling into lines from outside the ROW.
- R4.** The RRO shall report the outage information provided to it by Transmission Owner's, as required by Requirement 3, quarterly to NERC, as well as any actions taken by the RRO as a result of any of the reported outages.

C. Measures

- M1.** The Transmission Owner has a documented TVMP, as identified in Requirement 1.
- M1.1.** The Transmission Owner has documentation that the Transmission Owner performed the vegetation inspections as identified in Requirement 1.1.
- M1.2.** The Transmission Owner has documentation that describes the clearances identified in Requirement 1.2.
- M1.3.** The Transmission Owner has documentation that the personnel directly involved in the design and implementation of the Transmission Owner's TVMP hold the qualifications identified by the Transmission Owner as required in Requirement 1.3.
- M1.4.** The Transmission Owner has documentation that it has identified any areas not meeting the Transmission Owner's standard for vegetation management and any mitigating measures the Transmission Owner has taken to address these deficiencies as identified in Requirement 1.4.

Standard FAC-003-1 — Transmission Vegetation Management Program

- M1.5.** The Transmission Owner has a documented process for the immediate communication of imminent threats by vegetation as identified in Requirement 1.5.
- M2.** The Transmission Owner has documentation that the Transmission Owner implemented the work plan identified in Requirement 2.
- M3.** The Transmission Owner has documentation that it has supplied quarterly outage reports to the RRO, or the RRO's designee, as identified in Requirement 3.
- M4.** The RRO has documentation that it provided quarterly outage reports to NERC as identified in Requirement 4.

D. Compliance

1. Compliance Monitoring Process

1.1. Compliance Monitoring Responsibility

RRO
NERC

1.2. Compliance Monitoring Period and Reset

One calendar Year

1.3. Data Retention

Five Years

1.4. Additional Compliance Information

The Transmission Owner shall demonstrate compliance through self-certification submitted to the compliance monitor (RRO) annually that it meets the requirements of NERC Reliability Standard FAC-003-1. The compliance monitor shall conduct an on-site audit every five years or more frequently as deemed appropriate by the compliance monitor to review documentation related to Reliability Standard FAC-003-1. Field audits of ROW vegetation conditions may be conducted if determined to be necessary by the compliance monitor.

2. Levels of Non-Compliance

2.1. Level 1:

- 2.1.1.** The TVMP was incomplete in one of the requirements specified in any subpart of Requirement 1, or;
- 2.1.2.** Documentation of the annual work plan, as specified in Requirement 2, was incomplete when presented to the Compliance Monitor during an on-site audit, or;
- 2.1.3.** The RRO provided an outage report to NERC that was incomplete and did not contain the information required in Requirement 4.

2.2. Level 2:

- 2.2.1.** The TVMP was incomplete in two of the requirements specified in any subpart of Requirement 1, or;
- 2.2.2.** The Transmission Owner was unable to certify during its annual self-certification that it fully implemented its annual work plan, or documented deviations from, as specified in Requirement 2.
- 2.2.3.** The Transmission Owner reported one Category 2 transmission vegetation-related outage in a calendar year.

Standard FAC-003-1 — Transmission Vegetation Management Program**2.3. Level 3:**

- 2.3.1.** The Transmission Owner reported one Category 1 or multiple Category 2 transmission vegetation-related outages in a calendar year, or;
- 2.3.2.** The Transmission Owner did not maintain a set of clearances (Clearance 2), as defined in Requirement 1.2.2, to prevent flashover between vegetation and overhead ungrounded supply conductors, or;
- 2.3.3.** The TVMP was incomplete in three of the requirements specified in any subpart of Requirement 1.

2.4. Level 4:

- 2.4.1.** The Transmission Owner reported more than one Category 1 transmission vegetation-related outage in a calendar year, or;
- 2.4.2.** The TVMP was incomplete in four or more of the requirements specified in any subpart of Requirement 1.

E. Regional Differences

None Identified.

Version History

Version	Date	Action	Change Tracking
Version 1	TBA	<ul style="list-style-type: none"> 1. Added “Standard Development Roadmap.” 2. Changed “60” to “Sixty” in section A, 5.2. 3. Added “Proposed Effective Date: April 7, 2006” to footer. 4. Added “Draft 3: November 17, 2005” to footer. 	01/20/06

Effective Dates

There are two effective dates associated with this standard.

The first effective date allows Generator Owners time to develop documented maintenance strategies or procedures or processes or specifications as outlined in Requirement R3.

In those jurisdictions where regulatory approval is required, Requirement R3 applied to the Generator Owner becomes effective on the first calendar day of the first calendar quarter one year after the date of the order approving the standard from applicable regulatory authorities where such explicit approval for all requirements is required. In those jurisdictions where no regulatory approval is required, Requirement R3 becomes effective on the first day of the first calendar quarter one year following Board of Trustees' adoption or as otherwise made effective pursuant to the laws applicable to such ERO governmental authorities.

The second effective date allows entities time to comply with Requirements R1, R2, R4, R5, R6, and R7.

In those jurisdictions where regulatory approval is required, Requirements R1, R2, R4, R5, R6, and R7 applied to the Generator Owner become effective on the first calendar day of the first calendar quarter two years after the date of the order approving the standard from applicable regulatory authorities where such explicit approval for all requirements is required. In those jurisdictions where no regulatory approval is required, Requirements R1, R2, R4, R5, R6, and R7 become effective on the first day of the first calendar quarter two years following Board of Trustees' adoption or as otherwise made effective pursuant to the laws applicable to such ERO governmental authorities.

Effective dates for individual lines when they undergo specific transition cases:

1. A line operated below 200kV, designated by the Planning Coordinator as an element of an Interconnection Reliability Operating Limit (IROL) or designated by the Western Electricity Coordinating Council (WECC) as an element of a Major WECC Transfer Path, becomes subject to this standard the latter of: 1) 12 months after the date the Planning Coordinator or WECC initially designates the line as being an element of an IROL or an element of a Major WECC Transfer Path, or 2) January 1 of the planning year when the line is forecast to become an element of an IROL or an element of a Major WECC Transfer Path.
2. A line operated below 200 kV currently subject to this standard as a designated element of an IROL or a Major WECC Transfer Path which has a specified date for the removal of such designation will no longer be subject to this standard effective on that specified date.

3. A line operated at 200 kV or above, currently subject to this standard which is a designated element of an IROL or a Major WECC Transfer Path and which has a specified date for the removal of such designation will be subject to Requirement R2 and no longer be subject to Requirement R1 effective on that specified date.
4. An existing transmission line operated at 200kV or higher which is newly acquired by an asset owner and which was not previously subject to this standard becomes subject to this standard 12 months after the acquisition date.
5. An existing transmission line operated below 200kV which is newly acquired by an asset owner and which was not previously subject to this standard becomes subject to this standard 12 months after the acquisition date of the line if at the time of acquisition the line is designated by the Planning Coordinator as an element of an IROL or by WECC as an element of a Major WECC Transfer Path.

A. Introduction

1. **Title:** Transmission Vegetation Management
2. **Number:** FAC-003-3
3. **Purpose:** To maintain a reliable electric transmission system by using a defense-in-depth strategy to manage vegetation located on transmission rights of way (ROW) and minimize encroachments from vegetation located adjacent to the ROW, thus preventing the risk of those vegetation-related outages that could lead to Cascading.

4. Applicability

4.1. Functional Entities:

4.1.1. Applicable Transmission Owners

4.1.1.1 Transmission Owners that own Transmission Facilities defined in 4.2.

4.1.2 Applicable Generator Owners

4.1.2.1 Generator Owners that own generation Facilities defined in 4.3

4.2. Transmission Facilities: Defined below (referred to as “applicable lines”), including but not limited to those that cross lands owned by federal¹, state, provincial, public, private, or tribal entities:

4.2. 1 Each overhead transmission line operated at 200kV or higher.

4.2.2 Each overhead transmission line operated below 200kV identified as an element of an IROL under NERC Standard FAC-014 by the Planning Coordinator.

4.2.3 Each overhead transmission line operated below 200 kV identified as an element of a Major WECC Transfer Path in the Bulk Electric System by WECC.

4.2.4 Each overhead transmission line identified above (4.2.1 through 4.2.3) located outside the fenced area of the switchyard, station or substation and any portion of the span of the transmission line that is crossing the substation fence.

4.3. Generation Facilities: Defined below (referred to as “applicable lines”), including but not limited to those that cross lands owned by federal², state, provincial, public, private, or tribal entities:

4.3.1 Overhead transmission lines that (1) extend greater than one mile or 1.609 kilometers beyond the fenced area of the generating station switchyard to the point of interconnection with a Transmission Owner’s Facility or (2) do not have a clear line

¹ EPAAct 2005 section 1211c: “Access approvals by Federal agencies.”

² *Id.*

of sight³ from the generating station switchyard fence to the point of interconnection with a Transmission Owner's Facility and are:

4.3.1.1 Operated at 200kV or higher; or

4.3.1.2 Operated below 200kV identified as an element of an IROL under NERC Standard FAC-014 by the Planning Coordinator; or

4.3.1.3 Operated below 200 kV identified as an element of a Major WECC Transfer Path in the Bulk Electric System by WECC.

Enforcement:

The Requirements within a Reliability Standard govern and will be enforced. The Requirements within a Reliability Standard define what an entity must do to be compliant and binds an entity to certain obligations of performance under Section 215 of the Federal Power Act. Compliance will in all cases be measured by determining whether a party met or failed to meet the Reliability Standard Requirement given the specific facts and circumstances of its use, ownership or operation of the bulk power system.

Measures provide guidance on assessing non-compliance with the Requirements. Measures are the evidence that could be presented to demonstrate compliance with a Reliability Standard Requirement and are not intended to contain the quantitative metrics for determining satisfactory performance nor to limit how an entity may demonstrate compliance if valid alternatives to demonstrating compliance are available in a specific case. A Reliability Standard may be enforced in the absence of specified Measures.

Entities must comply with the "Compliance" section in its entirety, including the Administrative Procedure that sets forth, among other things, reporting requirements.

The "Guideline and Technical Basis" section, the Background section and text boxes with "Examples" and "Rationale" are provided for informational purposes. They are designed to convey guidance from NERC's various activities. The "Guideline and Technical Basis" section and text boxes with "Examples" and "Rationale" are not intended to establish new Requirements under NERC's Reliability Standards or to modify the Requirements in any existing NERC Reliability Standard. Implementation of the "Guideline and Technical Basis" section, the Background section and text boxes with "Examples" and "Rationale" is not a substitute for compliance with Requirements in NERC's Reliability Standards."

5. Background:

This standard uses three types of requirements to provide layers of protection to prevent vegetation related outages that could lead to Cascading:

³ "Clear line of sight" means the distance that can be seen by the average person without special instrumentation (e.g., binoculars, telescope, spyglasses, etc.) on a clear day.

- a) Performance-based — defines a particular reliability objective or outcome to be achieved. In its simplest form, a results-based requirement has four components: *who, under what conditions (if any), shall perform what action, to achieve what particular bulk power system performance result or outcome?*
- b) Risk-based — preventive requirements to reduce the risks of failure to acceptable tolerance levels. A risk-based reliability requirement should be framed as: *who, under what conditions (if any), shall perform what action, to achieve what particular result or outcome that reduces a stated risk to the reliability of the bulk power system?*
- c) Competency-based — defines a minimum set of capabilities an entity needs to have to demonstrate it is able to perform its designated reliability functions. A competency-based reliability requirement should be framed as: *who, under what conditions (if any), shall have what capability, to achieve what particular result or outcome to perform an action to achieve a result or outcome or to reduce a risk to the reliability of the bulk power system?*

The defense-in-depth strategy for reliability standards development recognizes that each requirement in a NERC reliability standard has a role in preventing system failures, and that these roles are complementary and reinforcing. Reliability standards should not be viewed as a body of unrelated requirements, but rather should be viewed as part of a portfolio of requirements designed to achieve an overall defense-in-depth strategy and comport with the quality objectives of a reliability standard.

This standard uses a defense-in-depth approach to improve the reliability of the electric Transmission system by:

- Requiring that vegetation be managed to prevent vegetation encroachment inside the flash-over clearance (R1 and R2);
- Requiring documentation of the maintenance strategies, procedures, processes and specifications used to manage vegetation to prevent potential flash-over conditions including consideration of 1) conductor dynamics and 2) the interrelationships between vegetation growth rates, control methods and the inspection frequency (R3);
- Requiring timely notification to the appropriate control center of vegetation conditions that could cause a flash-over at any moment (R4);
- Requiring corrective actions to ensure that flash-over distances will not be violated due to work constrains such as legal injunctions (R5);
- Requiring inspections of vegetation conditions to be performed annually (R6); and
- Requiring that the annual work needed to prevent flash-over is completed (R7).

For this standard, the requirements have been developed as follows:

Performance-based: Requirements 1 and 2

Competency-based: Requirement 3

Risk-based: Requirements 4, 5, 6 and 7

R3 serves as the first line of defense by ensuring that entities understand the problem they are trying to manage and have fully developed strategies and plans to manage the problem. R1, R2, and R7 serve as the second line of defense by requiring that entities carry out their plans and manage vegetation. R6, which requires inspections, may be either a part of the first line of defense (as input into the strategies and plans) or as a third line of defense (as a check of the first and second lines of defense). R4 serves as the final line of defense, as it addresses cases in which all the other lines of defense have failed.

Major outages and operational problems have resulted from interference between overgrown vegetation and transmission lines located on many types of lands and ownership situations. Adherence to the standard requirements for applicable lines on any kind of land or easement, whether they are Federal Lands, state or provincial lands, public or private lands, franchises, easements or lands owned in fee, will reduce and manage this risk. For the purpose of the standard the term “public lands” includes municipal lands, village lands, city lands, and a host of other governmental entities.

This standard addresses vegetation management along applicable overhead lines and does not apply to underground lines, submarine lines or to line sections inside an electric station boundary.

This standard focuses on transmission lines to prevent those vegetation related outages that could lead to Cascading. It is not intended to prevent customer outages due to tree contact with lower voltage distribution system lines. For example, localized customer service might be disrupted if vegetation were to make contact with a 69kV transmission line supplying power to a 12kV distribution station. However, this standard is not written to address such isolated situations which have little impact on the overall electric transmission system.

Since vegetation growth is constant and always present, unmanaged vegetation poses an increased outage risk, especially when numerous transmission lines are operating at or near their Rating. This can present a significant risk of consecutive line failures when lines are experiencing large sags thereby leading to Cascading. Once the first line fails the shift of the current to the other lines and/or the increasing system loads will lead to the second and subsequent line failures as contact to the vegetation under those lines occurs. Conversely, most other outage causes (such as trees falling into lines, lightning, animals, motor vehicles, etc.) are not an interrelated function of the shift of currents or the increasing system loading. These events are not any more likely to occur during heavy system loads than any other time. There is no cause-effect relationship which creates the probability of simultaneous occurrence of other such events. Therefore these types of events are highly unlikely to cause large-scale grid failures. Thus, this standard places the highest priority on the management of vegetation to prevent vegetation grow-ins.

B. Requirements and Measures

R1. Each applicable Transmission Owner and applicable Generator Owner shall manage vegetation to prevent encroachments into the MVCD of its applicable line(s) which are either an element of an IROL, or an element of a Major WECC Transfer Path; operating within their Rating and all Rated Electrical Operating Conditions of the types shown below⁴ [*Violation Risk Factor: High*] [*Time Horizon: Real-time*]:

1. An encroachment into the MVCD as shown in FAC-003-Table 2, observed in Real-time, absent a Sustained Outage,⁵
2. An encroachment due to a fall-in from inside the ROW that caused a vegetation-related Sustained Outage,⁶
3. An encroachment due to the blowing together of applicable lines and vegetation located inside the ROW that caused a vegetation-related Sustained Outage⁷,
4. An encroachment due to vegetation growth into the MVCD that caused a vegetation-related Sustained Outage.⁸

M1. Each applicable Transmission Owner and applicable Generator Owner has evidence that it managed vegetation to prevent encroachment into the MVCD as described in R1. Examples of acceptable forms of evidence may include dated attestations, dated reports containing no Sustained Outages associated with encroachment types 2 through 4 above, or records confirming no Real-time observations of any MVCD encroachments. (R1)

R2. Each applicable Transmission Owner and applicable Generator Owner shall manage vegetation to prevent encroachments into the MVCD of its applicable line(s) which are not either an element of an IROL, or an element of a Major WECC Transfer Path; operating within its Rating and all Rated Electrical Operating Conditions of the types shown below⁹ [*Violation Risk Factor: High*] [*Time Horizon: Real-time*]:

1. An encroachment into the MVCD, observed in Real-time, absent a Sustained Outage,¹⁰

⁴ This requirement does not apply to circumstances that are beyond the control of an applicable Transmission Owner or applicable Generator Owner subject to this reliability standard, including natural disasters such as earthquakes, fires, tornados, hurricanes, landslides, wind shear, fresh gale, major storms as defined either by the applicable Transmission Owner or applicable Generator Owner or an applicable regulatory body, ice storms, and floods; human or animal activity such as logging, animal severing tree, vehicle contact with tree, or installation, removal, or digging of vegetation. Nothing in this footnote should be construed to limit the Transmission Owner's or applicable Generator Owner's right to exercise its full legal rights on the ROW.

⁵ If a later confirmation of a Fault by the applicable Transmission Owner or applicable Generator Owner shows that a vegetation encroachment within the MVCD has occurred from vegetation within the ROW, this shall be considered the equivalent of a Real-time observation.

⁶ Multiple Sustained Outages on an individual line, if caused by the same vegetation, will be reported as one outage regardless of the actual number of outages within a 24-hour period.

⁷ *Id.*

⁸ *Id.*

⁹ See footnote 4.

¹⁰ See footnote 5.

2. An encroachment due to a fall-in from inside the ROW that caused a vegetation-related Sustained Outage,¹¹
 3. An encroachment due to blowing together of applicable lines and vegetation located inside the ROW that caused a vegetation-related Sustained Outage,¹²
 4. An encroachment due to vegetation growth into the line MVCD that caused a vegetation-related Sustained Outage¹³
- M2.** Each applicable Transmission Owner and applicable Generator Owner has evidence that it managed vegetation to prevent encroachment into the MVCD as described in R2. Examples of acceptable forms of evidence may include dated attestations, dated reports containing no Sustained Outages associated with encroachment types 2 through 4 above, or records confirming no Real-time observations of any MVCD encroachments. (R2)
- R3.** Each applicable Transmission Owner and applicable Generator Owner shall have documented maintenance strategies or procedures or processes or specifications it uses to prevent the encroachment of vegetation into the MVCD of its applicable lines that accounts for the following:
- 3.1** Movement of applicable line conductors under their Rating and all Rated Electrical Operating Conditions;
 - 3.2** Inter-relationships between vegetation growth rates, vegetation control methods, and inspection frequency.
[Violation Risk Factor: Lower] [Time Horizon: Long Term Planning]
- M3.** The maintenance strategies or procedures or processes or specifications provided demonstrate that the applicable Transmission Owner and applicable Generator Owner can prevent encroachment into the MVCD considering the factors identified in the requirement. (R3)
- R4.** Each applicable Transmission Owner and applicable Generator Owner, without any intentional time delay, shall notify the control center holding switching authority for the associated applicable line when the applicable Transmission Owner and applicable Generator Owner has confirmed the existence of a vegetation condition that is likely to cause a Fault at any moment [Violation Risk Factor: Medium] [Time Horizon: Real-time].
- M4.** Each applicable Transmission Owner and applicable Generator Owner that has a confirmed vegetation condition likely to cause a Fault at any moment will have evidence that it notified the control center holding switching authority for the associated transmission line without any intentional time delay. Examples of evidence

¹¹ See footnote 6.

¹² *Id.*

¹³ *Id.*

may include control center logs, voice recordings, switching orders, clearance orders and subsequent work orders. (R4)

- R5.** When a applicable Transmission Owner and applicable Generator Owner is constrained from performing vegetation work on an applicable line operating within its Rating and all Rated Electrical Operating Conditions, and the constraint may lead to a vegetation encroachment into the MVCD prior to the implementation of the next annual work plan, then the applicable Transmission Owner or applicable Generator Owner shall take corrective action to ensure continued vegetation management to prevent encroachments [*Violation Risk Factor: Medium*] [*Time Horizon: Operations Planning*].
- M5.** Each applicable Transmission Owner and applicable Generator Owner has evidence of the corrective action taken for each constraint where an applicable transmission line was put at potential risk. Examples of acceptable forms of evidence may include initially-planned work orders, documentation of constraints from landowners, court orders, inspection records of increased monitoring, documentation of the de-rating of lines, revised work orders, invoices, or evidence that the line was de-energized. (R5)
- R6.** Each applicable Transmission Owner and applicable Generator Owner shall perform a Vegetation Inspection of 100% of its applicable transmission lines (measured in units of choice - circuit, pole line, line miles or kilometers, etc.) at least once per calendar year and with no more than 18 calendar months between inspections on the same ROW¹⁴ [*Violation Risk Factor: Medium*] [*Time Horizon: Operations Planning*].
- M6.** Each applicable Transmission Owner and applicable Generator Owner has evidence that it conducted Vegetation Inspections of the transmission line ROW for all applicable lines at least once per calendar year but with no more than 18 calendar months between inspections on the same ROW. Examples of acceptable forms of evidence may include completed and dated work orders, dated invoices, or dated inspection records. (R6)
- R7.** Each applicable Transmission Owner and applicable Generator Owner shall complete 100% of its annual vegetation work plan of applicable lines to ensure no vegetation encroachments occur within the MVCD. Modifications to the work plan in response to changing conditions or to findings from vegetation inspections may be made (provided they do not allow encroachment of vegetation into the MVCD) and must be documented. The percent completed calculation is based on the number of units actually completed divided by the number of units in the final amended plan (measured in units of choice - circuit, pole line, line miles or kilometers, etc.) Examples of reasons for modification to annual plan may include [*Violation Risk Factor: Medium*] [*Time Horizon: Operations Planning*]:

¹⁴ When the applicable Transmission Owner or applicable Generator Owner is prevented from performing a Vegetation Inspection within the timeframe in R6 due to a natural disaster, the TO or GO is granted a time extension that is equivalent to the duration of the time the TO or GO was prevented from performing the Vegetation Inspection.

- Change in expected growth rate/ environmental factors
- Circumstances that are beyond the control of an applicable Transmission Owner or applicable Generator Owner¹⁵
- Rescheduling work between growing seasons
- Crew or contractor availability/ Mutual assistance agreements
- Identified unanticipated high priority work
- Weather conditions/Accessibility
- Permitting delays
- Land ownership changes/Change in land use by the landowner
- Emerging technologies

M7. Each applicable Transmission Owner and applicable Generator Owner has evidence that it completed its annual vegetation work plan for its applicable lines. Examples of acceptable forms of evidence may include a copy of the completed annual work plan (as finally modified), dated work orders, dated invoices, or dated inspection records. (R7)

C. Compliance

1. Compliance Monitoring Process

1.1 Compliance Enforcement Authority

The Regional Entity shall serve as the Compliance Enforcement Authority unless the applicable entity is owned, operated, or controlled by the Regional Entity. In such cases the ERO or a Regional entity approved by FERC or other applicable governmental authority shall serve as the CEA.

For NERC, a third-party monitor without vested interest in the outcome for NERC shall serve as the Compliance Enforcement Authority.

1.2 Evidence Retention

The following evidence retention periods identify the period of time an entity is required to retain specific evidence to demonstrate compliance. For instances where the evidence retention period specified below is shorter than the time since the last audit, the Compliance Enforcement Authority may ask an entity to provide other evidence to show that it was compliant for the full time period since the last audit.

The applicable Transmission Owner and applicable Generator Owner retains data or evidence to show compliance with Requirements R1, R2, R3, R5, R6 and R7, Measures M1, M2, M3, M5, M6 and M7 for three calendar years unless directed by its Compliance Enforcement Authority to retain specific evidence for a longer period of time as part of an investigation.

¹⁵ Circumstances that are beyond the control of an applicable Transmission Owner or applicable Generator Owner include but are not limited to natural disasters such as earthquakes, fires, tornados, hurricanes, landslides, ice storms, floods, or major storms as defined either by the TO or GO or an applicable regulatory body.

The applicable Transmission Owner and applicable Generator Owner retains data or evidence to show compliance with Requirement R4, Measure M4 for most recent 12 months of operator logs or most recent 3 months of voice recordings or transcripts of voice recordings, unless directed by its Compliance Enforcement Authority to retain specific evidence for a longer period of time as part of an investigation.

If a applicable Transmission Owner or applicable Generator Owner is found non-compliant, it shall keep information related to the non-compliance until found compliant or for the time period specified above, whichever is longer.

The Compliance Enforcement Authority shall keep the last audit records and all requested and submitted subsequent audit records.

1.3 Compliance Monitoring and Enforcement Processes:

Compliance Audit

Self-Certification

Spot Checking

Compliance Violation Investigation

Self-Reporting

Complaint

Periodic Data Submittal

1.4 Additional Compliance Information

Periodic Data Submittal: The applicable Transmission Owner and applicable Generator Owner will submit a quarterly report to its Regional Entity, or the Regional Entity's designee, identifying all Sustained Outages of applicable lines operated within their Rating and all Rated Electrical Operating Conditions as determined by the applicable Transmission Owner or applicable Generator Owner to have been caused by vegetation, except as excluded in footnote 2, and including as a minimum the following:

- The name of the circuit(s), the date, time and duration of the outage; the voltage of the circuit; a description of the cause of the outage; the category associated with the Sustained Outage; other pertinent comments; and any countermeasures taken by the applicable Transmission Owner or applicable Generator Owner.

A Sustained Outage is to be categorized as one of the following:

- Category 1A — Grow-ins: Sustained Outages caused by vegetation growing into applicable lines, that are identified as an element of an

- IROL or Major WECC Transfer Path, by vegetation inside and/or outside of the ROW;
- Category 1B — Grow-ins: Sustained Outages caused by vegetation growing into applicable lines, but are not identified as an element of an IROL or Major WECC Transfer Path, by vegetation inside and/or outside of the ROW;
 - Category 2A — Fall-ins: Sustained Outages caused by vegetation falling into applicable lines that are identified as an element of an IROL or Major WECC Transfer Path, from within the ROW;
 - Category 2B — Fall-ins: Sustained Outages caused by vegetation falling into applicable lines, but are not identified as an element of an IROL or Major WECC Transfer Path, from within the ROW;
 - Category 3 — Fall-ins: Sustained Outages caused by vegetation falling into applicable lines from outside the ROW;
 - Category 4A — Blowing together: Sustained Outages caused by vegetation and applicable lines that are identified as an element of an IROL or Major WECC Transfer Path, blowing together from within the ROW.
 - Category 4B — Blowing together: Sustained Outages caused by vegetation and applicable lines, but are not identified as an element of an IROL or Major WECC Transfer Path, blowing together from within the ROW.

The Regional Entity will report the outage information provided by applicable Transmission Owners and applicable Generator Owners, as per the above, quarterly to NERC, as well as any actions taken by the Regional Entity as a result of any of the reported Sustained Outages.

Table of Compliance Elements

R#	Time Horizon	VRF	Violation Severity Level			
			Lower	Moderate	High	Severe
R1	Real-time	High			The responsible entity failed to manage vegetation to prevent encroachment into the MVCD of a line identified as an element of an IROL or Major WECC transfer path and encroachment into the MVCD as identified in FAC-003-Table 2 was observed in real time absent a Sustained Outage.	The responsible entity failed to manage vegetation to prevent encroachment into the MVCD of a line identified as an element of an IROL or Major WECC transfer path and a vegetation-related Sustained Outage was caused by one of the following: <ul style="list-style-type: none"> • A fall-in from inside the active transmission line ROW • Blowing together of applicable lines and vegetation located inside the active transmission line ROW • A grow-in
R2	Real-time	High			The responsible entity failed to manage vegetation to prevent encroachment into the MVCD of a line not identified as an element of an IROL or Major WECC transfer path and encroachment into the MVCD as identified in FAC-003-Table 2 was observed in real time absent a Sustained Outage.	The responsible entity failed to manage vegetation to prevent encroachment into the MVCD of a line not identified as an element of an IROL or Major WECC transfer path and a vegetation-related Sustained Outage was caused by one of the following: <ul style="list-style-type: none"> • A fall-in from inside the active transmission line

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						<p>ROW</p> <ul style="list-style-type: none"> • Blowing together of applicable lines and vegetation located inside the active transmission line ROW • A grow-in
R3	Long-Term Planning	Lower		The responsible entity has maintenance strategies or documented procedures or processes or specifications but has not accounted for the inter-relationships between vegetation growth rates, vegetation control methods, and inspection frequency, for the responsible entity's applicable lines. (Requirement R3, Part 3.2)	The responsible entity has maintenance strategies or documented procedures or processes or specifications but has not accounted for the movement of transmission line conductors under their Rating and all Rated Electrical Operating Conditions, for the responsible entity's applicable lines. Requirement R3, Part 3.1)	The responsible entity does not have any maintenance strategies or documented procedures or processes or specifications used to prevent the encroachment of vegetation into the MVCD, for the responsible entity's applicable lines.
R4	Real-time	Medium			The responsible entity experienced a confirmed vegetation threat and notified the control center holding switching authority for that applicable line, but there was intentional delay in that notification.	The responsible entity experienced a confirmed vegetation threat and did not notify the control center holding switching authority for that applicable line.
R5	Operations Planning	Medium				The responsible entity did not take corrective action when it was constrained from performing planned vegetation work where an applicable line was put at potential risk.
R6	Operations	Medium	The responsible entity	The responsible entity failed	The responsible entity failed to	The responsible entity failed to

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	Planning		failed to inspect 5% or less of its applicable lines (measured in units of choice - circuit, pole line, line miles or kilometers, etc.)	to inspect more than 5% up to and including 10% of its applicable lines (measured in units of choice - circuit, pole line, line miles or kilometers, etc.)	inspect more than 10% up to and including 15% of its applicable lines (measured in units of choice - circuit, pole line, line miles or kilometers, etc.)	inspect more than 15% of its applicable lines (measured in units of choice - circuit, pole line, line miles or kilometers, etc.)
R7	Operations Planning	Medium	The responsible entity failed to complete 5% or less of its annual vegetation work plan for its applicable lines (as finally modified).	The responsible entity failed to complete more than 5% and up to and including 10% of its annual vegetation work plan for its applicable lines (as finally modified).	The responsible entity failed to complete more than 10% and up to and including 15% of its annual vegetation work plan for its applicable lines (as finally modified).	The responsible entity failed to complete more than 15% of its annual vegetation work plan for its applicable lines (as finally modified).

D. Regional Differences
None.

E. Interpretations
None.

F. Associated Documents
Guideline and Technical Basis (attached).

Guideline and Technical Basis

Effective dates:

The first two sentences of the Effective Dates section is standard language used in most NERC standards to cover the general effective date and is sufficient to cover the vast majority of situations. Five special cases are needed to cover effective dates for individual lines which undergo transitions after the general effective date. These special cases cover the effective dates for those lines which are initially becoming subject to the standard, those lines which are changing their applicability within the standard, and those lines which are changing in a manner that removes their applicability to the standard.

Case 1 is needed because the Planning Coordinators may designate lines below 200 kV to become elements of an IROL or Major WECC Transfer Path in a future Planning Year (PY). For example, studies by the Planning Coordinator in 2011 may identify a line to have that designation beginning in PY 2021, ten years after the planning study is performed. It is not intended for the Standard to be immediately applicable to, or in effect for, that line until that future PY begins. The effective date provision for such lines ensures that the line will become subject to the standard on January 1 of the PY specified with an allowance of at least 12 months for the applicable Transmission Owner or applicable Generator Owner to make the necessary preparations to achieve compliance on that line. The table below has some explanatory examples of the application.

<u>Date that Planning Study is completed</u>	<u>PY the line will become an IROL element</u>		<u>Effective Date</u>	
	<u>Date 1</u>	<u>Date 2</u>	<u>The latter of Date 1 or Date 2</u>	
05/15/2011	2012	05/15/2012	01/01/2012	05/15/2012
05/15/2011	2013	05/15/2012	01/01/2013	01/01/2013
05/15/2011	2014	05/15/2012	01/01/2014	01/01/2014
05/15/2011	2021	05/15/2012	01/01/2021	01/01/2021

Case 2 is needed because a line operating below 200kV designated as an element of an IROL or Major WECC Transfer Path may be removed from that designation due to system improvements, changes in generation, changes in loads or changes in studies and analysis of the network.

Case 3 is needed because a line operating at 200 kV or above that once was designated as an element of an IROL or Major WECC Transfer Path may be removed from that designation due to system improvements, changes in generation, changes in loads or changes in studies and analysis of the network. Such changes result in the need to apply R1 to that line until that date is reached and then to apply R2 to that line thereafter.

Case 4 is needed because an existing line that is to be operated at 200 kV or above can be acquired by an applicable Transmission Owner or applicable Generator Owner from a third party

such as a Distribution Provider or other end-user who was using the line solely for local distribution purposes, but the applicable Transmission Owner or applicable Generator Owner, upon acquisition, is incorporating the line into the interconnected electrical energy transmission network which will thereafter make the line subject to the standard.

Case 5 is needed because an existing line that is operated below 200 kV can be acquired by an applicable Transmission Owner or applicable Generator Owner from a third party such as a Distribution Provider or other end-user who was using the line solely for local distribution purposes, but the applicable Transmission Owner or applicable Generator Owner, upon acquisition, is incorporating the line into the interconnected electrical energy transmission network. In this special case the line upon acquisition was designated as an element of an Interconnection Reliability Operating Limit (IROL) or an element of a Major WECC Transfer Path.

Defined Terms:

Explanation for revising the definition of ROW:

The current NERC glossary definition of Right of Way has been modified to include Generator Owners and to address the matter set forth in Paragraph 734 of FERC Order 693. The Order pointed out that Transmission Owners may in some cases own more property or rights than are needed to reliably operate transmission lines. This modified definition represents a slight but significant departure from the strict legal definition of “right of way” in that this definition is based on engineering and construction considerations that establish the width of a corridor from a technical basis. The pre-2007 maintenance records are included in the revised definition to allow the use of such vegetation widths if there were no engineering or construction standards that referenced the width of right of way to be maintained for vegetation on a particular line but the evidence exists in maintenance records for a width that was in fact maintained prior to this standard becoming mandatory. Such widths may be the only information available for lines that had limited or no vegetation easement rights and were typically maintained primarily to ensure public safety. This standard does not require additional easement rights to be purchased to satisfy a minimum right of way width that did not exist prior to this standard becoming mandatory.

The Project 2010-07 team further modified that proposed definition to include applicable Generator Owners.

Explanation for revising the definition of Vegetation Inspections:

The current glossary definition of this NERC term is being modified to include Generator Owners and to allow both maintenance inspections and vegetation inspections to be performed concurrently. This allows potential efficiencies, especially for those lines with minimal vegetation and/or slow vegetation growth rates.

The Project 2010-07 team further modified that proposed definition to include applicable Generator Owners.

Explanation of the definition of the MVCD:

The MVCD is a calculated minimum distance that is derived from the Gallet Equations. This is a method of calculating a flash over distance that has been used in the design of high voltage transmission lines. Keeping vegetation away from high voltage conductors by this distance will prevent voltage flash-over to the vegetation. See the explanatory text below for Requirement R3 and associated Figure 1. Table 2 below provides MVCD values for various voltages and altitudes. Details of the equations and an example calculation are provided in Appendix 1 of the Technical Reference Document.

Requirements R1 and R2:

R1 and R2 are performance-based requirements. The reliability objective or outcome to be achieved is the management of vegetation such that there are no vegetation encroachments within a minimum distance of transmission lines. Content-wise, R1 and R2 are the same requirements; however, they apply to different Facilities. Both R1 and R2 require each applicable Transmission Owner or applicable Generator Owner to manage vegetation to prevent encroachment within the MVCD of transmission lines. R1 is applicable to lines that are identified as an element of an IROL or Major WECC Transfer Path. R2 is applicable to all other lines that are not elements of IROLs, and not elements of Major WECC Transfer Paths.

The separation of applicability (between R1 and R2) recognizes that inadequate vegetation management for an applicable line that is an element of an IROL or a Major WECC Transfer Path is a greater risk to the interconnected electric transmission system than applicable lines that are not elements of IROLs or Major WECC Transfer Paths. Applicable lines that are not elements of IROLs or Major WECC Transfer Paths do require effective vegetation management, but these lines are comparatively less operationally significant. As a reflection of this difference in risk impact, the Violation Risk Factors (VRFs) are assigned as High for R1 and High for R2.

Requirements R1 and R2 state that if inadequate vegetation management allows vegetation to encroach within the MVCD distance as shown in Table 2, it is a violation of the standard. Table 2 distances are the minimum clearances that will prevent spark-over based on the Gallet equations as described more fully in the Technical Reference document.

These requirements assume that transmission lines and their conductors are operating within their Rating. If a line conductor is intentionally or inadvertently operated beyond its Rating and Rated Electrical Operating Condition (potentially in violation of other standards), the occurrence of a clearance encroachment may occur solely due to that condition. For example, emergency actions taken by an applicable Transmission Owner or applicable Generator Owner or Reliability Coordinator to protect an Interconnection may cause excessive sagging and an outage. Another example would be ice loading beyond the line's Rating and Rated Electrical Operating Condition. Such vegetation-related encroachments and outages are not violations of this standard.

Evidence of failures to adequately manage vegetation include real-time observation of a vegetation encroachment into the MVCD (absent a Sustained Outage), or a vegetation-related encroachment resulting in a Sustained Outage due to a fall-in from inside the ROW, or a vegetation-related encroachment resulting in a Sustained Outage due to the blowing together of

the lines and vegetation located inside the ROW, or a vegetation-related encroachment resulting in a Sustained Outage due to a grow-in. Faults which do not cause a Sustained outage and which are confirmed to have been caused by vegetation encroachment within the MVCD are considered the equivalent of a Real-time observation for violation severity levels.

With this approach, the VSLs for R1 and R2 are structured such that they directly correlate to the severity of a failure of an applicable Transmission Owner or applicable Generator Owner to manage vegetation and to the corresponding performance level of the Transmission Owner's vegetation program's ability to meet the objective of "preventing the risk of those vegetation related outages that could lead to Cascading." Thus violation severity increases with an applicable Transmission Owner's or applicable Generator Owner's inability to meet this goal and its potential of leading to a Cascading event. The additional benefits of such a combination are that it simplifies the standard and clearly defines performance for compliance. A performance-based requirement of this nature will promote high quality, cost effective vegetation management programs that will deliver the overall end result of improved reliability to the system.

Multiple Sustained Outages on an individual line can be caused by the same vegetation. For example initial investigations and corrective actions may not identify and remove the actual outage cause then another outage occurs after the line is re-energized and previous high conductor temperatures return. Such events are considered to be a single vegetation-related Sustained Outage under the standard where the Sustained Outages occur within a 24 hour period.

The MVCD is a calculated minimum distance stated in feet (or meters) to prevent spark-over, for various altitudes and operating voltages that is used in the design of Transmission Facilities. Keeping vegetation from entering this space will prevent transmission outages.

If the applicable Transmission Owner or applicable Generator Owner has applicable lines operated at nominal voltage levels not listed in Table 2, then the applicable TO or applicable GO should use the next largest clearance distance based on the next highest nominal voltage in the table to determine an acceptable distance.

Requirement R3:

R3 is a competency based requirement concerned with the maintenance strategies, procedures, processes, or specifications, an applicable Transmission Owner or applicable Generator Owner uses for vegetation management.

An adequate transmission vegetation management program formally establishes the approach the applicable Transmission Owner or applicable Generator Owner uses to plan and perform vegetation work to prevent transmission Sustained Outages and minimize risk to the transmission system. The approach provides the basis for evaluating the intent, allocation of appropriate resources, and the competency of the applicable Transmission Owner or applicable Generator Owner in managing vegetation. There are many acceptable approaches to manage vegetation and avoid Sustained Outages. However, the applicable Transmission Owner or applicable Generator Owner must be able to show the documentation of its approach and how it conducts work to maintain clearances.

An example of one approach commonly used by industry is ANSI Standard A300, part 7. However, regardless of the approach a utility uses to manage vegetation, any approach an

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applicable Transmission Owner or applicable Generator Owner chooses to use will generally contain the following elements:

1. *the maintenance strategy used (such as minimum vegetation-to-conductor distance or maximum vegetation height) to ensure that MVCD clearances are never violated.*
2. *the work methods that the applicable Transmission Owner or applicable Generator Owner uses to control vegetation*
3. *a stated Vegetation Inspection frequency*
4. *an annual work plan*

The conductor's position in space at any point in time is continuously changing in reaction to a number of different loading variables. Changes in vertical and horizontal conductor positioning are the result of thermal and physical loads applied to the line. Thermal loading is a function of line current and the combination of numerous variables influencing ambient heat dissipation including wind velocity/direction, ambient air temperature and precipitation. Physical loading applied to the conductor affects sag and sway by combining physical factors such as ice and wind loading. The movement of the transmission line conductor and the MVCD is illustrated in Figure 1 below. In the Technical Reference document more figures and explanations of conductor dynamics are provided.

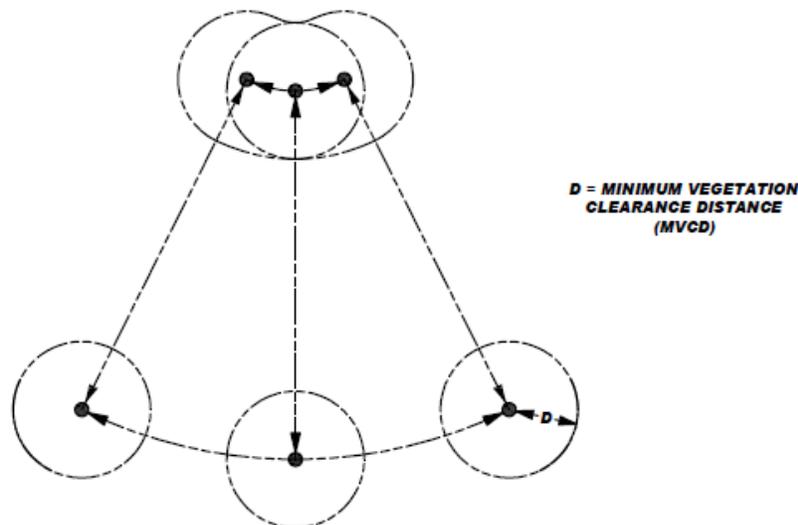


Figure 1

A cross-section view of a single conductor at a given point along the span is shown with six possible conductor positions due to movement resulting from thermal and mechanical loading.

Requirement R4:

R4 is a risk-based requirement. It focuses on preventative actions to be taken by the applicable Transmission Owner or applicable Generator Owner for the mitigation of Fault risk when a vegetation threat is confirmed. R4 involves the notification of potentially threatening vegetation conditions, without any intentional delay, to the control center holding switching authority for that specific transmission line. Examples of acceptable unintentional delays may include

communication system problems (for example, cellular service or two-way radio disabled), crews located in remote field locations with no communication access, delays due to severe weather, etc.

Confirmation is key that a threat actually exists due to vegetation. This confirmation could be in the form of an applicable Transmission Owner or applicable Generator Owner employee who personally identifies such a threat in the field. Confirmation could also be made by sending out an employee to evaluate a situation reported by a landowner.

Vegetation-related conditions that warrant a response include vegetation that is near or encroaching into the MVCDD (a grow-in issue) or vegetation that could fall into the transmission conductor (a fall-in issue). A knowledgeable verification of the risk would include an assessment of the possible sag or movement of the conductor while operating between no-load conditions and its rating.

The applicable Transmission Owner or applicable Generator Owner has the responsibility to ensure the proper communication between field personnel and the control center to allow the control center to take the appropriate action until or as the vegetation threat is relieved. Appropriate actions may include a temporary reduction in the line loading, switching the line out of service, or other preparatory actions in recognition of the increased risk of outage on that circuit. The notification of the threat should be communicated in terms of minutes or hours as opposed to a longer time frame for corrective action plans (see R5).

All potential grow-in or fall-in vegetation-related conditions will not necessarily cause a Fault at any moment. For example, some applicable Transmission Owners or applicable Generator Owners may have a danger tree identification program that identifies trees for removal with the potential to fall near the line. These trees would not require notification to the control center unless they pose an immediate fall-in threat.

Requirement R5:

R5 is a risk-based requirement. It focuses upon preventative actions to be taken by the applicable Transmission Owner or applicable Generator Owner for the mitigation of Sustained Outage risk when temporarily constrained from performing vegetation maintenance. The intent of this requirement is to deal with situations that prevent the applicable Transmission Owner or applicable Generator Owner from performing planned vegetation management work and, as a result, have the potential to put the transmission line at risk. Constraints to performing vegetation maintenance work as planned could result from legal injunctions filed by property owners, the discovery of easement stipulations which limit the applicable Transmission Owner's or applicable Generator Owner's rights, or other circumstances.

This requirement is not intended to address situations where the transmission line is not at potential risk and the work event can be rescheduled or re-planned using an alternate work methodology. For example, a land owner may prevent the planned use of chemicals on non-threatening, low growth vegetation but agree to the use of mechanical clearing. In this case the applicable Transmission Owner or applicable Generator Owner is not under any immediate time

constraint for achieving the management objective, can easily reschedule work using an alternate approach, and therefore does not need to take interim corrective action.

However, in situations where transmission line reliability is potentially at risk due to a constraint, the applicable Transmission Owner or applicable Generator Owner is required to take an interim corrective action to mitigate the potential risk to the transmission line. A wide range of actions can be taken to address various situations. General considerations include:

- Identifying locations where the applicable Transmission Owner or applicable Generator Owner is constrained from performing planned vegetation maintenance work which potentially leaves the transmission line at risk.
- Developing the specific action to mitigate any potential risk associated with not performing the vegetation maintenance work as planned.
- Documenting and tracking the specific action taken for the location.
- In developing the specific action to mitigate the potential risk to the transmission line the applicable Transmission Owner or applicable Generator Owner could consider location specific measures such as modifying the inspection and/or maintenance intervals. Where a legal constraint would not allow any vegetation work, the interim corrective action could include limiting the loading on the transmission line.
- The applicable Transmission Owner or applicable Generator Owner should document and track the specific corrective action taken at each location. This location may be indicated as one span, one tree or a combination of spans on one property where the constraint is considered to be temporary.

Requirement R6:

R6 is a risk-based requirement. This requirement sets a minimum time period for completing Vegetation Inspections. The provision that Vegetation Inspections can be performed in conjunction with general line inspections facilitates a Transmission Owner's ability to meet this requirement. However, the applicable Transmission Owner or applicable Generator Owner may determine that more frequent vegetation specific inspections are needed to maintain reliability levels, based on factors such as anticipated growth rates of the local vegetation, length of the local growing season, limited ROW width, and local rainfall. Therefore it is expected that some transmission lines may be designated with a higher frequency of inspections.

The VSLs for Requirement R6 have levels ranked by the failure to inspect a percentage of the applicable lines to be inspected. To calculate the appropriate VSL the applicable Transmission Owner or applicable Generator Owner may choose units such as: circuit, pole line, line miles or kilometers, etc.

For example, when an applicable Transmission Owner or applicable Generator Owner operates 2,000 miles of applicable transmission lines this applicable Transmission Owner or applicable Generator Owner will be responsible for inspecting all the 2,000 miles of lines at least once during the calendar year. If one of the included lines was 100 miles long, and if it was not inspected during the year, then the amount failed to inspect would be $100/2000 = 0.05$ or 5%. The "Low VSL" for R6 would apply in this example.

Requirement R7:

R7 is a risk-based requirement. The applicable Transmission Owner or applicable Generator Owner is required to complete its an annual work plan for vegetation management to accomplish the purpose of this standard. Modifications to the work plan in response to changing conditions or to findings from vegetation inspections may be made and documented provided they do not put the transmission system at risk. The annual work plan requirement is not intended to necessarily require a “span-by-span”, or even a “line-by-line” detailed description of all work to be performed. It is only intended to require that the applicable Transmission Owner or applicable Generator Owner provide evidence of annual planning and execution of a vegetation management maintenance approach which successfully prevents encroachment of vegetation into the MVCD.

For example, when an applicable Transmission Owner or applicable Generator Owner identifies 1,000 miles of applicable transmission lines to be completed in the applicable Transmission Owner’s or applicable Generator Owner’s annual plan, the applicable Transmission Owner or applicable Generator Owner will be responsible completing those identified miles. If a applicable Transmission Owner or applicable Generator Owner makes a modification to the annual plan that does not put the transmission system at risk of an encroachment the annual plan may be modified. If 100 miles of the annual plan is deferred until next year the calculation to determine what percentage was completed for the current year would be: $1000 - 100$ (deferred miles) = 900 modified annual plan, or $900 / 900 = 100\%$ completed annual miles. If an applicable Transmission Owner or applicable Generator Owner only completed 875 of the total 1000 miles with no acceptable documentation for modification of the annual plan the calculation for failure to complete the annual plan would be: $1000 - 875 = 125$ miles failed to complete then, 125 miles (not completed) / 1000 total annual plan miles = 12.5% failed to complete.

The ability to modify the work plan allows the applicable Transmission Owner or applicable Generator Owner to change priorities or treatment methodologies during the year as conditions or situations dictate. For example recent line inspections may identify unanticipated high priority work, weather conditions (drought) could make herbicide application ineffective during the plan year, or a major storm could require redirecting local resources away from planned maintenance. This situation may also include complying with mutual assistance agreements by moving resources off the applicable Transmission Owner’s or applicable Generator Owner’s system to work on another system. Any of these examples could result in acceptable deferrals or additions to the annual work plan provided that they do not put the transmission system at risk of a vegetation encroachment.

In general, the vegetation management maintenance approach should use the full extent of the applicable Transmission Owner’s or applicable Generator Owner’s easement, fee simple and other legal rights allowed. A comprehensive approach that exercises the full extent of legal rights on the ROW is superior to incremental management because in the long term it reduces the overall potential for encroachments, and it ensures that future planned work and future planned inspection cycles are sufficient.

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When developing the annual work plan the applicable Transmission Owner or applicable Generator Owner should allow time for procedural requirements to obtain permits to work on federal, state, provincial, public, tribal lands. In some cases the lead time for obtaining permits may necessitate preparing work plans more than a year prior to work start dates. Applicable Transmission Owners or applicable Generator Owners may also need to consider those special landowner requirements as documented in easement instruments.

This requirement sets the expectation that the work identified in the annual work plan will be completed as planned. Therefore, deferrals or relevant changes to the annual plan shall be documented. Depending on the planning and documentation format used by the applicable Transmission Owner or applicable Generator Owner, evidence of successful annual work plan execution could consist of signed-off work orders, signed contracts, printouts from work management systems, spreadsheets of planned versus completed work, timesheets, work inspection reports, or paid invoices. Other evidence may include photographs, and walk-through reports.

FAC-003 — TABLE 2 — Minimum Vegetation Clearance Distances (MVCD)¹⁶
For **Alternating Current** Voltages (feet)

(AC) Nominal System Voltage (KV)	(AC) Maximum System Voltage (kV) ¹⁷	MVCD (feet) Over sea level up to 500 ft	MVCD (feet) Over 500 ft up to 1000 ft	MVCD feet Over 1000 ft up to 2000 ft	MVCD feet Over 2000 ft up to 3000 ft	MVCD feet Over 3000 ft up to 4000 ft	MVCD feet Over 4000 ft up to 5000 ft	MVCD feet Over 5000 ft up to 6000 ft	MVCD feet Over 6000 ft up to 7000 ft	MVCD feet Over 7000 ft up to 8000 ft	MVCD feet Over 8000 ft up to 9000 ft	MVCD feet Over 9000 ft up to 10000 ft	MVCD feet Over 10000 ft up to 11000 ft
765	800	8.2ft	8.33ft	8.61ft	8.89ft	9.17ft	9.45ft	9.73ft	10.01ft	10.29ft	10.57ft	10.85ft	11.13ft
500	550	5.15ft	5.25ft	5.45ft	5.66ft	5.86ft	6.07ft	6.28ft	6.49ft	6.7ft	6.92ft	7.13ft	7.35ft
345	362	3.19ft	3.26ft	3.39ft	3.53ft	3.67ft	3.82ft	3.97ft	4.12ft	4.27ft	4.43ft	4.58ft	4.74ft
287	302	3.88ft	3.96ft	4.12ft	4.29ft	4.45ft	4.62ft	4.79ft	4.97ft	5.14ft	5.32ft	5.50ft	5.68ft
230	242	3.03ft	3.09ft	3.22ft	3.36ft	3.49ft	3.63ft	3.78ft	3.92ft	4.07ft	4.22ft	4.37ft	4.53ft
161*	169	2.05ft	2.09ft	2.19ft	2.28ft	2.38ft	2.48ft	2.58ft	2.69ft	2.8ft	2.91ft	3.03ft	3.14ft
138*	145	1.74ft	1.78ft	1.86ft	1.94ft	2.03ft	2.12ft	2.21ft	2.3ft	2.4ft	2.49ft	2.59ft	2.7ft
115*	121	1.44ft	1.47ft	1.54ft	1.61ft	1.68ft	1.75ft	1.83ft	1.91ft	1.99ft	2.07ft	2.16ft	2.25ft
88*	100	1.18ft	1.21ft	1.26ft	1.32ft	1.38ft	1.44ft	1.5ft	1.57ft	1.64ft	1.71ft	1.78ft	1.86ft
69*	72	0.84ft	0.86ft	0.90ft	0.94ft	0.99ft	1.03ft	1.08ft	1.13ft	1.18ft	1.23ft	1.28ft	1.34ft

* Such lines are applicable to this standard only if PC has determined such per FAC-014 (refer to the Applicability Section above)

¹⁶ The distances in this Table are the minimums required to prevent Flash-over; however prudent vegetation maintenance practices dictate that substantially greater distances will be achieved at time of vegetation maintenance.

¹⁷ Where applicable lines are operated at nominal voltages other than those listed, the applicable Transmission Owner or applicable Generator Owner should use the maximum system voltage to determine the appropriate clearance for that line.

TABLE 2 (CONT) — Minimum Vegetation Clearance Distances (MVCD)⁷
For Alternating Current Voltages (meters)

(AC) Nominal System Voltage (KV)	(AC) Maximum System Voltage ⁸ (kV)	MVCD meters Over sea level up to 152.4 m	MVCD meters Over 152.4 m up to 304.8 m	MVCD meters Over 304.8 m up to 609.6m	MVCD meters Over 609.6m up to 914.4m	MVCD meters Over 914.4m up to 1219.2m	MVCD meters Over 1219.2m up to 1524m	MVCD meters Over 1524 m up to 1828.8 m	MVCD meters Over 1828.8m up to 2133.6m	MVCD meters Over 2133.6m up to 2438.4m	MVCD meters Over 2438.4m up to 2743.2m	MVCD meters Over 2743.2m up to 3048m	MVCD meters Over 3048m up to 3352.8m
765	800	2.49m	2.54m	2.62m	2.71m	2.80m	2.88m	2.97m	3.05m	3.14m	3.22m	3.31m	3.39m
500	550	1.57m	1.6m	1.66m	1.73m	1.79m	1.85m	1.91m	1.98m	2.04m	2.11m	2.17m	2.24m
345	362	0.97m	0.99m	1.03m	1.08m	1.12m	1.16m	1.21m	1.26m	1.30m	1.35m	1.40m	1.44m
287	302	1.18m	0.88m	1.26m	1.31m	1.36m	1.41m	1.46m	1.51m	1.57m	1.62m	1.68m	1.73m
230	242	0.92m	0.94m	0.98m	1.02m	1.06m	1.11m	1.15m	1.19m	1.24m	1.29m	1.33m	1.38m
161*	169	0.62m	0.64m	0.67m	0.69m	0.73m	0.76m	0.79m	0.82m	0.85m	0.89m	0.92m	0.96m
138*	145	0.53m	0.54m	0.57m	0.59m	0.62m	0.65m	0.67m	0.70m	0.73m	0.76m	0.79m	0.82m
115*	121	0.44m	0.45m	0.47m	0.49m	0.51m	0.53m	0.56m	0.58m	0.61m	0.63m	0.66m	0.69m
88*	100	0.36m	0.37m	0.38m	0.40m	0.42m	0.44m	0.46m	0.48m	0.50m	0.52m	0.54m	0.57m
69*	72	0.26m	0.26m	0.27m	0.29m	0.30m	0.31m	0.33m	0.34m	0.36m	0.37m	0.39m	0.41m

* Such lines are applicable to this standard only if PC has determined such per FAC-014 (refer to the Applicability Section above)

TABLE 2 (CONT) — Minimum Vegetation Clearance Distances (MVCD)⁷
For Direct Current Voltages feet (meters)

(DC) Nominal Pole to Ground Voltage (kV)	MVCD meters	MVCD meters	MVCD meters	MVCD meters	MVCD meters	MVCD meters	MVCD meters	MVCD meters	MVCD meters	MVCD meters	MVCD meters	MVCD meters
	Over sea level up to 500 ft (Over sea level up to 152.4 m)	Over 500 ft up to 1000 ft (Over 152.4 m up to 304.8 m)	Over 1000 ft up to 2000 ft (Over 304.8 m up to 609.6m)	Over 2000 ft up to 3000 ft (Over 609.6m up to 914.4m)	Over 3000 ft up to 4000 ft (Over 914.4m up to 1219.2m)	Over 4000 ft up to 5000 ft (Over 1219.2m up to 1524m)	Over 5000 ft up to 6000 ft (Over 1524 m up to 1828.8 m)	Over 6000 ft up to 7000 ft (Over 1828.8m up to 2133.6m)	Over 7000 ft up to 8000 ft (Over 2133.6m up to 2438.4m)	Over 8000 ft up to 9000 ft (Over 2438.4m up to 2743.2m)	Over 9000 ft up to 10000 ft (Over 2743.2m up to 3048m)	Over 10000 ft up to 11000 ft (Over 3048m up to 3352.8m)
±750	14.12ft (4.30m)	14.31ft (4.36m)	14.70ft (4.48m)	15.07ft (4.59m)	15.45ft (4.71m)	15.82ft (4.82m)	16.2ft (4.94m)	16.55ft (5.04m)	16.91ft (5.15m)	17.27ft (5.26m)	17.62ft (5.37m)	17.97ft (5.48m)
±600	10.23ft (3.12m)	10.39ft (3.17m)	10.74ft (3.26m)	11.04ft (3.36m)	11.35ft (3.46m)	11.66ft (3.55m)	11.98ft (3.65m)	12.3ft (3.75m)	12.62ft (3.85m)	12.92ft (3.94m)	13.24ft (4.04m)	13.54ft (4.13m)
±500	8.03ft (2.45m)	8.16ft (2.49m)	8.44ft (2.57m)	8.71ft (2.65m)	8.99ft (2.74m)	9.25ft (2.82m)	9.55ft (2.91m)	9.82ft (2.99m)	10.1ft (3.08m)	10.38ft (3.16m)	10.65ft (3.25m)	10.92ft (3.33m)
±400	6.07ft (1.85m)	6.18ft (1.88m)	6.41ft (1.95m)	6.63ft (2.02m)	6.86ft (2.09m)	7.09ft (2.16m)	7.33ft (2.23m)	7.56ft (2.30m)	7.80ft (2.38m)	8.03ft (2.45m)	8.27ft (2.52m)	8.51ft (2.59m)
±250	3.50ft (1.07m)	3.57ft (1.09m)	3.72ft (1.13m)	3.87ft (1.18m)	4.02ft (1.23m)	4.18ft (1.27m)	4.34ft (1.32m)	4.5ft (1.37m)	4.66ft (1.42m)	4.83ft (1.47m)	5.00ft (1.52m)	5.17ft (1.58m)

Notes:

The SDT determined that the use of IEEE 516-2003 in version 1 of FAC-003 was a misapplication. The SDT consulted specialists who advised that the Gallet Equation would be a technically justified method. The explanation of why the Gallet approach is more appropriate is explained in the paragraphs below.

The drafting team sought a method of establishing minimum clearance distances that uses realistic weather conditions and realistic maximum transient over-voltages factors for in-service transmission lines.

The SDT considered several factors when looking at changes to the minimum vegetation to conductor distances in FAC-003-1:

- avoid the problem associated with referring to tables in another standard (IEEE-516-2003)
- transmission lines operate in non-laboratory environments (wet conditions)
- transient over-voltage factors are lower for in-service transmission lines than for inadvertently re-energized transmission lines with trapped charges.

FAC-003-1 uses the minimum air insulation distance (MAID) without tools formula provided in IEEE 516-2003 to determine the minimum distance between a transmission line conductor and vegetation. The equations and methods provided in IEEE 516 were developed by an IEEE Task Force in 1968 from test data provided by thirteen independent laboratories. The distances provided in IEEE 516 Tables 5 and 7 are based on the withstand voltage of a dry rod-rod air gap, or in other words, dry laboratory conditions. Consequently, the validity of using these distances in an outside environment application has been questioned.

FAC-003-01 allowed Transmission Owners to use either Table 5 or Table 7 to establish the minimum clearance distances. Table 7 could be used if the Transmission Owner knew the maximum transient over-voltage factor for its system. Otherwise, Table 5 would have to be used. Table 5 represented minimum air insulation distances under the worst possible case for transient over-voltage factors. These worst case transient over-voltage factors were as follows: 3.5 for voltages up to 362 kV phase to phase; 3.0 for 500 - 550 kV phase to phase; and 2.5 for 765 to 800 kV phase to phase. These worst case over-voltage factors were also a cause for concern in this particular application of the distances.

In general, the worst case transient over-voltages occur on a transmission line that is inadvertently re-energized immediately after the line is de-energized and a trapped charge is still present. The intent of FAC-003 is to keep a transmission line that is *in service* from becoming de-energized (i.e. tripped out) due to spark-over from the line conductor to nearby vegetation. Thus, the worst case transient overvoltage assumptions are not appropriate for this application. Rather, the appropriate over voltage values are those that occur only while the line is energized.

Typical values of transient over-voltages of in-service lines, as such, are not readily available in the literature because they are negligible compared with the maximums. A conservative value for the maximum transient over-voltage that can occur anywhere along the length of an in-

service ac line is approximately 2.0 per unit. This value is a conservative estimate of the transient over-voltage that is created at the point of application (e.g. a substation) by switching a capacitor bank without pre-insertion devices (e.g. closing resistors). At voltage levels where capacitor banks are not very common (e.g. Maximum System Voltage of 362 kV), the maximum transient over-voltage of an in-service ac line are created by fault initiation on adjacent ac lines and shunt reactor bank switching. These transient voltages are usually 1.5 per unit or less.

Even though these transient over-voltages will not be experienced at locations remote from the bus at which they are created, in order to be conservative, it is assumed that all nearby ac lines are subjected to this same level of over-voltage. Thus, a maximum transient over-voltage factor of 2.0 per unit for transmission lines operated at 302 kV and below is considered to be a realistic maximum in this application. Likewise, for ac transmission lines operated at Maximum System Voltages of 362 kV and above a transient over-voltage factor of 1.4 per unit is considered a realistic maximum.

The Gallet Equations are an accepted method for insulation coordination in tower design. These equations are used for computing the required strike distances for proper transmission line insulation coordination. They were developed for both wet and dry applications and can be used with any value of transient over-voltage factor. The Gallet Equation also can take into account various air gap geometries. This approach was used to design the first 500 kV and 765 kV lines in North America.

If one compares the MAID using the IEEE 516-2003 Table 7 (table D.5 for English values) with the critical spark-over distances computed using the Gallet wet equations, for each of the nominal voltage classes and identical transient over-voltage factors, the Gallet equations yield a more conservative (larger) minimum distance value.

Distances calculated from either the IEEE 516 (dry) formulas or the Gallet “wet” formulas are not vastly different when the same transient overvoltage factors are used; the “wet” equations will consistently produce slightly larger distances than the IEEE 516 equations when the same transient overvoltage is used. While the IEEE 516 equations were only developed for dry conditions the Gallet equations have provisions to calculate spark-over distances for both wet and dry conditions.

While EPRI is currently trying to establish empirical data for spark-over distances to live vegetation, there are no spark-over formulas currently derived expressly for vegetation to conductor minimum distances. Therefore the SDT chose a proven method that has been used in other EHV applications. The Gallet equations relevance to wet conditions and the selection of a Transient Overvoltage Factor that is consistent with the absence of trapped charges on an in-service transmission line make this methodology a better choice.

The following table is an example of the comparison of distances derived from IEEE 516 and the Gallet equations.

**Comparison of spark-over distances computed using Gallet wet equations vs.
IEEE 516-2003 MAID distances**

(AC) Nom System Voltage (kV)	(AC) Max System Voltage (kV)	Transient Over-voltage Factor (T)	Clearance (ft.) Gallet (wet) @ Alt. 3000 feet	Table 7 (Table D.5 for feet) IEEE 516-2003 MAID (ft) @ Alt. 3000 feet
765	800	2.0	14.36	13.95
500	550	2.4	11.0	10.07
345	362	3.0	8.55	7.47
230	242	3.0	5.28	4.2
115	121	3.0	2.46	2.1

Rationale:

During development of this standard, text boxes were embedded within the standard to explain the rationale for various parts of the standard. Upon BOT approval, the text from the rationale text boxes was moved to this section.

Rationale for Applicability (section 4.2.4):

The areas excluded in 4.2.4 were excluded based on comments from industry for reasons summarized as follows: 1) There is a very low risk from vegetation in this area. Based on an informal survey, no TOs reported such an event. 2) Substations, switchyards, and stations have many inspection and maintenance activities that are necessary for reliability. Those existing process manage the threat. As such, the formal steps in this standard are not well suited for this environment. 3) Specifically addressing the areas where the standard does and does not apply makes the standard clearer.

Rationale for Applicability (section 4.3):

Within the text of NERC Reliability Standard FAC-003-3, “transmission line(s) and “applicable line(s) can also refer to the generation Facilities as referenced in 4.3 and its subsections.

Rationale for R1 and R2:

Lines with the highest significance to reliability are covered in R1; all other lines are covered in R2.

Rationale for the types of failure to manage vegetation which are listed in order of increasing degrees of severity in non-compliant performance as it relates to a failure of an applicable Transmission Owner's or applicable Generator Owner's vegetation maintenance program:

1. This management failure is found by routine inspection or Fault event investigation, and is normally symptomatic of unusual conditions in an otherwise sound program.
2. This management failure occurs when the height and location of a side tree within the ROW is not adequately addressed by the program.
3. This management failure occurs when side growth is not adequately addressed and may be indicative of an unsound program.
4. This management failure is usually indicative of a program that is not addressing the most fundamental dynamic of vegetation management, (i.e. a grow-in under the line). If this type of failure is pervasive on multiple lines, it provides a mechanism for a Cascade.

Rationale for R3:

The documentation provides a basis for evaluating the competency of the applicable Transmission Owner's or applicable Generator Owner's vegetation program. There may be many acceptable approaches to maintain clearances. Any approach must demonstrate that the applicable Transmission Owner or applicable Generator Owner avoids vegetation-to-wire conflicts under all Ratings and all Rated Electrical Operating Conditions. See Figure

Rationale for R4:

This is to ensure expeditious communication between the applicable Transmission Owner or applicable Generator Owner and the control center when a critical situation is confirmed.

Rationale for R5:

Legal actions and other events may occur which result in constraints that prevent the applicable Transmission Owner or applicable Generator Owner from performing planned vegetation maintenance work.

In cases where the transmission line is put at potential risk due to constraints, the intent is for the applicable Transmission Owner and applicable Generator Owner to put interim measures in place, rather than do nothing.

The corrective action process is not intended to address situations where a planned work methodology cannot be performed but an alternate work methodology can be used.

Rationale for R6:

Inspections are used by applicable Transmission Owners and applicable Generator Owners to assess the condition of the entire ROW. The information from the assessment can be used to determine risk, determine future work and evaluate recently-completed work. This requirement sets a minimum Vegetation Inspection frequency of once per calendar year but with no more than 18 months between inspections on the same ROW. Based upon average growth rates across North America and on common utility practice, this minimum frequency is reasonable.

Transmission Owners should consider local and environmental factors that could warrant more frequent inspections.

FAC-003-3 — Transmission Vegetation Management

Rationale for R7:

This requirement sets the expectation that the work identified in the annual work plan will be completed as planned. It allows modifications to the planned work for changing conditions, taking into consideration anticipated growth of vegetation and all other environmental factors, provided that those modifications do not put the transmission system at risk of a vegetation encroachment.

Version History

Version	Date	Action	Change Tracking
3	September 29, 2011	Using the latest draft of FAC-003-2 from the Project 2007-07 SDT, modified proposed definitions and Applicability to include Generator Owners of a certain length.	Revision under Project 2010-07
3	May 9, 2012	Adopted by Board of Trustees	
3	September 19, 2013	A FERC order was issued on September 19, 2013, approving FAC-003-3. This standard becomes enforceable on July 1, 2014 for Transmission Owners. For Generator Owners, R3 becomes enforceable on January 1, 2015 and all other requirements (R1, R2, R4, R5, R6, and R7) will become enforceable on January 1, 2016.	
3	November 22, 2013	Updated the VRF for R2 from “Medium” to “High” per a Final Rule issued by FERC.	

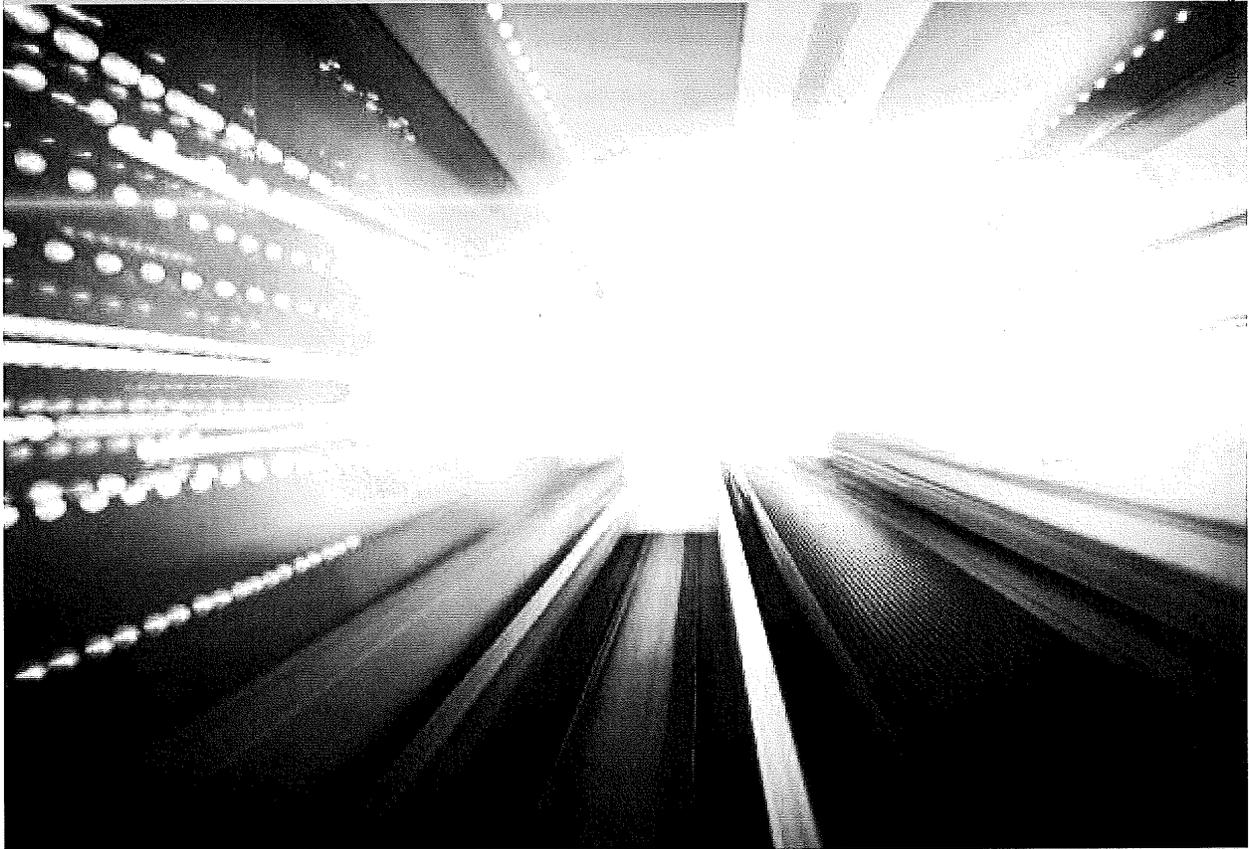
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C2-2012

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National Electrical Safety Code®

Secretariat
Institute of Electrical and Electronics Engineers, Inc.

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American National Standards Institute

2012 Edition

Abstract: This Code covers basic provisions for safeguarding of persons from hazards arising from the installation, operation, or maintenance of (1) conductors and equipment in electric supply stations, and (2) overhead and underground electric supply and communication lines. It also includes work rules for the construction, maintenance, and operation of electric supply and communication lines and equipment. The Code is applicable to the systems and equipment operated by utilities, or similar systems and equipment, of an industrial establishment or complex under the control of qualified persons. This Code consists of the introduction, definitions, grounding rules, list of referenced and bibliographic documents, and Parts 1, 2, 3, and 4 of the 2012 Edition of the National Electrical Safety Code.

Keywords: communications industry safety; construction of communication lines; construction of electric supply lines; electrical safety; electric supply stations; electric utility stations; high-voltage safety; operation of communications systems; operation of electric supply systems; power station equipment; power station safety; public utility safety; safety work rules; underground communication line safety; underground electric line safety

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1 August 2011

STDPT97085

ft

Table 233-2— (continued)

Clearance between supply wires, conductors, and cables in Rule 233A and 233C3b(1)
(This clearance shall be increased 3% for each 1000 ft in excess of 1500 ft above mean sea level.)

Higher-voltage circuit		Lower-voltage circuit						
Maximum operating voltage phase to phase (kV)	Switching-surge factor (per unit)	Maximum operating voltage phase to phase (kV)						
		121 (ft)	145 (ft)	169 (ft)	242 (ft)	362 (ft)	550 (ft)	800 (ft)
550	1.8	11.9 [Ⓢ]	11.9 [Ⓢ]	11.9 [Ⓢ]	11.9 [Ⓢ]	11.9 [Ⓢ]	13.6	
	2.0	11.9 [Ⓢ]	11.9 [Ⓢ]	11.9 [Ⓢ]	11.9 [Ⓢ]	12.5	15.3	
	2.2	11.9 [Ⓢ]	11.9 [Ⓢ]	11.9 [Ⓢ]	12.4	14.1	17.0	
	2.4	12.2	12.6	12.9	14.0	15.8	18.8	
	2.6	13.5 [Ⓢ]	14.0 [Ⓢ]	14.4	15.6	17.5	20.7	
800	1.6	16.7 [Ⓢ]	16.7 [Ⓢ]	16.7 [Ⓢ]	16.7 [Ⓢ]	16.7	18.2	22.5
	1.8	16.7 [Ⓢ]	16.7 [Ⓢ]	16.7 [Ⓢ]	16.7 [Ⓢ]	17.7	20.9	25.4
	2.0	16.7 [Ⓢ]	16.8	17.2	18.4	20.4	23.7	28.5
	2.2	18.3 [Ⓢ]	18.8 [Ⓢ]	19.2 [Ⓢ]	20.6 [Ⓢ]	22.9 [Ⓢ]	26.6 [Ⓢ]	31.4 [Ⓢ]

Ⓢ Shall be not less than that required by Rule 233C3c, including the altitude correction for lines above 1000 m (3300 ft) elevation as specified in Rule 233C2b.

Ⓢ Need not be greater than the values specified in Rules 233C1 and 233C2.

Table 233-3—Reference heights
(See Rule 233C3a.)

Reference height	(m)	(ft)
(1) Supply lines	0	0
(2) Communication lines	0.60	2

234. Clearance of wires, conductors, cables, and equipment from buildings, bridges, rail cars, swimming pools, and other installations

A. Application

In each of Rules 234B, 234C, and 234D, horizontal clearance requirements are specified for two conditions: (1) the conductor without wind displacement (at rest), and (2) the conductor with wind displacement. In each case, the clearance requirements for both conditions shall be satisfied.

1. Vertical and horizontal clearances (no wind displacement)

234A1a

Part 2: Safety Rules for Overhead Lines

234B1a

The vertical and horizontal clearances specified in Rules 234B, 234C, 234D, 234E, 234F, and 234I apply under whichever conditions of the following conductor temperature and loading conditions produces the closest approach. Rules 234A1a, 234A1b, and 234A1c apply above and alongside subject installations; Rule 234A1d applies below and alongside subject installations.

- a. 50 °C (120 °F), no wind displacement, final sag.
- b. The maximum conductor temperature for which the line is designed to operate, if greater than 50 °C (120 °F), no wind displacement, final sag.
- c. 0 °C (32 °F), no wind displacement, final sag, with radial thickness of ice, if any, specified in Table 230-1 for the zone concerned.
- d. The minimum conductor temperature for which the line is designed, no wind displacement, initial sag.

EXCEPTION: Vertical or lateral conductors or cables attached directly to the surface of a supporting structure in accordance with other rules are not subject to the provisions of this rule.

NOTE: The phase and neutral conductors of a supply line are normally considered separately when determining the sag of each due to temperature rise.

2. Horizontal clearances (with wind displacement)

Where consideration of horizontal displacement under wind conditions is required, the wires, conductors, or cables shall be considered to be displaced from rest toward the installation by a 290 Pa (6 lb/ft²) wind at final sag at 15 °C (60 °F). The displacement of a wire, conductor or cable shall include deflection of suspension insulators. The displacement of a wire, conductor, or cable shall also include deflection of a flexible structure if the highest wire, conductor, or cable attachment is 18 m (60 ft) or more above grade.

EXCEPTION: Where the entire span is so close to a building, terrain feature, or other obstacle as to be sheltered from the wind flowing across the line in either direction, the wind pressure may be reduced to a 190 Pa (4 lb/ft²) wind. Trees are not considered to shelter a line.

3. Transition between horizontal and vertical clearances

The horizontal clearance governs above the level of the roof or top of an installation to the point where the diagonal equals the vertical clearance requirement. Similarly, the horizontal clearance governs above or below projections from buildings, signs, or other installations to the point where the diagonal equals the vertical clearance requirement. From this point the transitional clearance shall equal the vertical clearance as shown in Figures 234-1(a) and 234-1(b). This rule should not be interpreted as restricting the installation of a trolley-contact conductor over the approximate center line of the track it serves.

EXCEPTION: When the horizontal clearance is greater than the vertical clearance, the vertical clearance governs beyond the roof or top of an installation, or projections from an installation, to the point where the diagonal equals the horizontal clearance requirement, as shown in Figure 234-1(c).

B. Clearances of wires, conductors, and cables from other supporting structures

Wires, conductors, or cables of one line passing near a lighting support, traffic signal support, a supporting structure of a second line, or intermediate poles in skip-span construction, without being attached thereto, shall have clearance from any part of such structure not less than the following:

NOTE: Skip-span construction: Lines where upper conductors are not attached to intermediate poles.

1. Horizontal clearances

- a. A horizontal clearance, without wind, of 1.50 m (5.0 ft) for voltages up to 50 kV.

EXCEPTION: For effectively grounded guys and messengers, insulated communication conductors and cables, neutrals meeting Rule 230E1, and cables of 300 V or less to ground meeting the requirements of Rule 230C1, 230C2, or 230C3, the horizontal clearance may be reduced to 900 mm (3 ft).

234B1b

Part 2: Safety Rules for Overhead Lines

234C1b

- b. When the following conductors and cables are displaced from rest under the wind conditions of Rule 234A2, horizontal clearances from such conductors or cables to other supporting structures shall be not less than those shown below:

Conductor or cable	Horizontal clearance required when displaced by wind	
	(m)	(ft)
Open supply conductors, 0 to 750 V [ⓐ]	1.1	3.5
230C2 cable, above 750 V	1.1	3.5
230C3 cable, above 750 V	1.1	3.5
Open supply conductors, over 750 V to 22 kV	1.4	4.5

[ⓐ]Does not include neutral conductors meeting Rule 230E1.

2. Vertical clearances

A vertical clearance of 1.40 m (4.5 ft) for voltages below 22 kV and a vertical clearance of 1.70 m (5.5 ft) for voltages between 22 kV and 50 kV. *EXCEPTIONS 1* and *2* shall not be applied cumulatively.

EXCEPTION 1: For effectively grounded guys and messengers, insulated communication conductors and cables, and neutrals meeting Rule 230E1 and for cables of 300 V or less to ground meeting the requirements of Rule 230C1, 230C2, or 230C3, the vertical clearance may be reduced to 600 mm (2 ft).

EXCEPTION 2: The vertical clearances may be reduced by 600 mm (2 ft) if both of the following conditions are met:

- (a) The wires, conductors, or cables above and the supporting structure of another line below are operated and maintained by the same utility
- (b) Employees do not work above the top of the supporting structure unless:
 - (1) The upper circuit is de-energized and grounded per Rule 444D or temporarily insulated or repositioned, or
 - (2) Other equivalent measures are taken.

NOTE: Clearances of wires, conductors, and cables from adjacent line structure guy wires are given in Rule 233.

C. Clearances of wires, conductors, cables, and rigid live parts from buildings, signs, billboards, chimneys, radio and television antennas, tanks, flagpoles and flags, banners, and other installations except bridges

1. Vertical and horizontal clearances

a. Clearances

Unguarded or accessible wires, conductors, cables, or rigid live parts may be located adjacent to buildings, signs, billboards, chimneys, radio and television antennas, tanks, flagpoles and flags, banners, and other installations and any projections therefrom. The vertical and horizontal clearances of such rigid and nonrigid parts shall be not less than the values given in Table 234-1 when at rest under the conditions specified in Rule 234A1. These facilities may be installed beside, over or under buildings, building projections and other installations, as illustrated in Figures 234-1(a), 234-1(b), and 234-1(c).

b. Horizontal clearances under wind displacement conditions

When the following conductors and cables are displaced from rest under the wind conditions of Rule 234A2, horizontal clearances from such conductors or cables to buildings, signs, billboards, chimneys, radio and television antennas, flagpoles and flags, banners, and other installations shall be not less than those shown below:

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234C2

Part 2: Safety Rules for Overhead Lines

234C3d(1)

Conductor or cable	Horizontal clearance required when displaced by wind	
	(m)	(ft)
Open supply conductors, 0 to 750 V ^①	1.1	3.5
230C2 cable, above 750 V	1.1	3.5
230C3 cable, above 750 V	1.1	3.5
Open supply conductors, over 750 V to 22 kV	1.4	4.5

^①Does not include neutral conductors meeting Rule 230E1. See Footnotes 9 and 10 to Table 234-1.

2. Guarding of supply conductors and rigid live parts

Where the clearances set forth in Table 234-1 cannot be obtained, supply conductors and rigid live parts shall be guarded. Supply cables meeting Rule 230C1a are considered to be guarded within the meaning of this rule.

3. Supply conductors attached to buildings or other installations

Where the permanent attachment of supply conductors of any class to a building or other installation is necessary for an entrance, such conductors shall meet the following requirements over or along the installation to which the conductors are attached:

a. Energized service drop conductors, including splices and taps, shall be insulated or covered in accordance with the following:

- (1) For 0 to 750V, Rule 230C or 230D
- (2) For over 750 V, Rule 230C1

This rule does not apply to neutral conductors meeting Rule 230E1.

b. Conductors of more than 300 V to ground shall not be carried along or near the surface of the installation unless they are guarded or made inaccessible.

c. Wires or cables attached to and run along side the installation shall have clearances from the surface of the installation not less than 75 mm (3 in).

EXCEPTION: For open supply circuits of 0 to 750 V and supply cables of all voltages meeting Rule 230C1, 230C2, or 230C3, the clearance at the attachment points may be reduced to 25 mm (1 in). No clearance from the served structure is specified for such conductors anywhere else in the span where they are physically restrained by a suitable bracket from abrasion against the served structure.

d. Service-drop conductors, including drip loops shall have a clearance of not less than the following:

- (1) 3.0 m (10 ft) vertical clearance from the highest point of roofs, balconies, porches, or attached decks over which they pass

EXCEPTION 1: For clearances above railings, walls, or parapets around balconies, decks, or roofs, use the clearances required for row 1b(1), Table 234-1. For such clearances where an outside stairway exists to provide access to such balconies, decks, or roofs, use the clearances required for row 2b(2), Table 234-1.

EXCEPTION 2: Where the voltage between conductors meeting Rule 230D does not exceed 300 V, or where the voltage of cables meeting Rule 230C2 or 230C3 does not exceed 750 V, or where the cable meets Rule 230C1, and the roof or balcony is not readily accessible, the clearance over the roof or balcony, including the drip loop shall be not less than either of the following:

- (a) 900 mm (3 ft)

234C3d(2)

Part 2: Safety Rules for Overhead Lines

234D1b

- (b) 457 mm (18 in) for a horizontal distance of 1.8 m (6 ft) from an approved raceway or support located not more than 1.2 m (4 ft) from the edge of the roof and not less than 900 mm (3 ft) for the remainder of the horizontal distance that the cable or conductor passes over the roof or balcony

A roof, balcony, porch, or attached deck is considered readily accessible to pedestrians if it can be casually accessed through a doorway, window, ramp, stairway, or permanently mounted ladder by a person, on foot, who neither exerts extraordinary physical effort nor employs tools or devices to gain entry. A permanently mounted ladder is not considered a means of access if its bottom rung is 2.45 m (8 ft) or more from the ground or other permanently installed accessible surface.

NOTE: See Figure 234-2.

- (2) 900 mm (3 ft) in any direction from windows, doors, porches, decks, fire escapes, or similar locations.

EXCEPTION 1: This does not apply to service-drop conductors meeting Rule 230C3 above the top level of a window.

EXCEPTION 2: This does not apply to windows that are not designed to open.

4. Communication conductors attached to buildings or other installations

Communication conductors and cables may be attached directly to buildings or other installations.

5. Ladder space

Where buildings or other installations exceed three stories [or 15 m (50 ft)] in height, overhead lines should be arranged where practical so that a clear space or zone at least 1.8 m (6 ft) wide will be left either adjacent to the building or beginning not over 2.45 m (8 ft) from the building to facilitate the raising of ladders where necessary for fire fighting.

EXCEPTION: This requirement does not apply where it is the unvarying rule of the local fire departments to exclude the use of ladders in alleys or other restricted places that are generally occupied by supply conductors and cables.

D. Clearance of wires, conductors, cables, and unguarded rigid live parts from bridges

1. Vertical and horizontal clearances

a. Clearances

Unguarded or accessible wires, conductors, cables, or rigid live parts may be located adjacent to or within a bridge structure. The vertical and horizontal clearances of such rigid and nonrigid parts shall be not less than the values given in Table 234-2 when at rest under the conditions specified in Rule 234A1, as illustrated in Figures 234-1(a) and 234-1(b).

EXCEPTION: This rule does not apply to insulated communication cables, effectively grounded guys, span wires, and surge protection wires; neutrals meeting Rule 230E1; and supply cables meeting Rule 230C1.

b. Horizontal clearances under wind displacement conditions

When the following conductors and cables are displaced from rest under the wind conditions of Rule 234A2, horizontal clearances from such conductors or cables to bridges shall be not less than those shown below:

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234D2

Part 2: Safety Rules for Overhead Lines

234E2

Conductor or cable	Horizontal clearance required when displaced by wind	
	(m)	(ft)
Open supply conductors, 0 to 750 V ^①	1.1	3.5
230C2 cable, above 750 V	1.1	3.5
230C3 cable, above 750 V	1.1	3.5
Open supply conductors, over 750 V to 22 kV	1.4	4.5

^①Does not include neutral conductors meeting Rule 230E1.
See Footnotes 8 and 9 to Table 234-2.

2. Guarding trolley-contact conductors located under bridges
 - a. Where guarding is required

Guarding is required where the trolley-contact conductor is located so that a trolley pole leaving the conductor can make simultaneous contact between it and the bridge structure.
 - b. Nature of guarding

Guarding shall consist of a substantial inverted trough of nonconducting material located above the contact conductor, or of other suitable means of limiting the likelihood of contact between the trolley support and the bridge structure.
- E. Clearance of wires, conductors, cables, or unguarded rigid live parts installed over or near swimming areas with no wind displacement
 1. Swimming pools

Where wires, conductors, cables, or unguarded rigid live parts are over a swimming pool or the surrounding area, the clearances in any direction shall be not less than those shown in Table 234-3 and illustrated in Figure 234-3.

EXCEPTION 1: This rule does not apply to a pool fully enclosed by a solid or screened permanent structure.

EXCEPTION 2: This rule does not apply to communication conductors and cables, effectively grounded surge-protection wires, neutral conductors meeting Rule 230E1, guys and messengers, supply cables meeting Rule 230C1, and supply cables of 0 to 750 V meeting Rule 230C2 or 230C3 when these facilities are 3 m (10 ft) or more horizontally from the edge of the pool, diving platform, diving tower, water slide, or other fixed, pool-related structures.

NOTE: For NESC clearance purposes, spas (including whirlpools, hot-tubs, jacuzzis, or other similar installations not suitable for swimming) are not considered as swimming pools covered by Rule 234E, Table 234-3. Note that this rule and table refer to swimming areas and swimming pools. Table 234-3 clearances allow for use of skimmer and rescue poles.

Spas, etc., not suitable for swimming, are usually installed as part of a building or as a similar installation. Clearances for such installations are found in Table 234-1. Vertical clearance should be from the highest point of the installation upon which people can stand. See row 1, Buildings, in Table 234-1 for installations that are part of buildings, such as a raised spa on an open deck. See row 2, other installations, in Table 234-1 for free-standing installations.

For portable wading pools, see Table 232-1, row 5.
 2. Beaches and waterways restricted to swimming

Where rescue poles are used by lifeguards at supervised swimming beaches, the vertical and horizontal clearances shall be not less than those shown in Table 234-3. Where rescue poles are not used, the clearances shall be as specified in Rule 232.

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3. Waterways subject to water skiing
The vertical clearance shall be the same as that specified in Rule 232.
- F. Clearances of wires, conductors, cables, and rigid live parts from grain bins
1. Grain bins loaded by permanently installed augers, conveyers, or elevator systems
All portions of grain bins that are expected to be loaded by the use of a permanently installed auger, conveyor, or elevator system shall be considered as a building or other installation under Rule 234C for the purpose of determining appropriate clearances of wires, conductors, cables, and rigid live parts. In addition, the following clearances shall also apply without wind displacement. See Figure 234-4(a).
 - a. A clearance of not less than 5.5 m (18 ft) in all directions above the grain bin shall be maintained from each probe port in the grain bin roof for all wires, conductors, and cables.
 - b. A horizontal clearance of not less than 4.6 m (15 ft) shall be maintained between grain bins and open supply conductors, 0 to 22 kV. This clearance does not apply to a neutral conductor meeting Rule 230E1.
 2. Grain bins loaded by portable augers, conveyers, or elevators (with no wind displacement)
 - a. The clearance of wires, conductors, cables, and rigid live parts from grain bins that are expected to be loaded by the use of a portable auger, conveyor, or elevator shall be not less than the values illustrated in Figure 234-4b.
EXCEPTION: Clearances of the following items on the nonloading side of grain bins shall be not less than those required by Rule 234C for clearances from buildings:
 - (a) Support arms; effectively grounded equipment cases
 - (b) Insulated communication conductors and cables, messengers, surge-protection wires, grounded guys, neutral conductors meeting Rule 230E1, and supply cables meeting Rule 230C1
 - (c) Supply cables of 0 to 750 V meeting Rule 230C2 or 230C3
 - b. Any side of a grain bin is considered to be a nonloading side if it is so designated, or if it is so closely abutting another structure or obstruction, or so close to a public road or other right-of-way that a portable auger, conveyor, or elevator is not reasonably anticipated to be used over that side or portion to fill the grain bin.
 - c. Where an agreement excludes the use of portable augers, conveyers, or elevators from a designated portion of a grain bin, such portion is considered to be a nonloading side.
- G. Additional clearances for voltages exceeding 22 kV for wires, conductors, cables, and unguarded rigid live parts of equipment
Greater clearances than specified in Rules 234B, 234C, 234D, 234E, 234F, and 234J shall be provided where required as follows:
1. For voltages between 22 and 470 kV, the clearance specified in Rules 234B, 234C, 234D, 234E, 234F, and 234J shall be increased at the rate of 10 mm (0.4 in) per kV in excess of 22 kV. For voltages exceeding 470 kV, the clearance shall be determined by the method given in Rule 234H. All clearances for lines over 50 kV shall be based on the maximum operating voltage.
EXCEPTION 1: Where a clearance value is given for the 22 kV to 50 kV range, the voltage adder of Rule 234G1 applies to the voltage in excess of 50 kV.
EXCEPTION 2: For voltages exceeding 98 kV ac to ground or 139 kV dc to ground, clearances less than those required above are permitted for systems with known maximum switching-surge factor. (See Rule 234H.)
 2. For voltages exceeding 50 kV, the additional clearance specified in Rule 234G1 shall be increased 3% for each 300 m (1000 ft) in excess of 1000 m (3300 ft) above mean sea level.
 3. For voltages exceeding 98 kV ac to ground, either the clearances shall be increased or the electric field, or the effects thereof, shall be reduced by other means, as required, to limit the steady-state current due to electrostatic effects to 5 mA, rms, if an ungrounded metal fence, building, sign, billboard, chimney, radio or television antenna, tank or other installation, or any

ungrounded metal attachments thereto, were short-circuited to ground. For this determination, the conductor shall be at a final unloaded sag at 50 °C (120 °F).

H. Alternate clearances for voltages exceeding 98 kV ac to ground or 139 kV dc to ground

The clearances specified in Rules 234B, 234C, 234D, 234E, 234F, 234G, and 234J may be reduced for circuits with known switching-surge factors, but shall be not less than the alternate clearance, which is computed by adding the reference distance from Rule 234H2 to the electrical component of clearance from Rule 234H3.

1. Sag conditions of line conductors

The vertical, horizontal, and diagonal clearances shall be maintained under the conductor temperature and loading conditions given in Rule 234A.

2. Reference distances

The reference distance shall be selected from Table 234-5.

3. Electrical component of clearance

a. The electrical component (D) shall be computed using the following equations. Selected values of D are listed in Table 234-4.

$$D = 1.00 \left[\frac{V \cdot (PU) \cdot a}{500K} \right]^{1.667} bc \quad (\text{m})$$

$$D = 3.28 \left[\frac{V \cdot (PU) \cdot a}{500K} \right]^{1.667} bc \quad (\text{ft})$$

where

V = maximum ac crest operating voltage to ground or maximum dc operating voltage to ground in kilovolts

PU = maximum switching-surge factor expressed in per-unit peak voltage to ground and defined as a switching-surge level for circuit breakers corresponding to 98% probability that the maximum switching surge generated per breaker operation does not exceed this surge level, or the maximum anticipated switching-surge level generated by other means, whichever is greater

a = 1.15, the allowance for three standard deviations

b = 1.03, the allowance for nonstandard atmospheric conditions

c = the margin of safety:
1.2 for vertical clearances
1.0 for horizontal clearances

K = 1.15, the configuration factor for conductor-to-plane gap

b. The value of D shall be increased 3% for each 300 m (1000 ft) in excess of 450 (1500 ft) above mean sea level.

4. Limit

The alternate clearance shall be not less than the clearance of Rule 234B, Table 234-1, 234-2, or 234-3, as applicable, computed for 98 kV ac rms to ground by Rule 234G1.

I. Clearance of wires, conductors, and cables to rail cars

Where overhead wires, conductors, or cables run along railroad tracks, the clearance in any direction shall be not less than that shown in Figure 234-5. The values of V and H are as defined as follows:

V = vertical clearance from the wire, conductor, or cable above the top of the rail as specified in Rule 232 minus 6.1 m (20 ft), the assumed height of the rail car

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234J2c

H = horizontal clearance from the wire, conductor, or cable to the nearest rail, which is equal to the required vertical clearance above the rail minus 4.6 m (15 ft) as computed by the lesser of the following:

1. Rules 232B1 and 232C1
2. Rule 232D

These clearances are computed for railroads handling standard rail cars as common carriers in interchange service with other railroads. Where wires, conductors, or cables run along mine, logging, and similar railways that handle only cars smaller than standard freight cars, the value of H may be reduced by one-half the difference between the width of a standard rail car [3.3 m (10 ft, 8 in)] and the width of the narrower car.

J. Clearance of equipment mounted on supporting structures

1. Clearance to unguarded rigid live parts of equipment

The horizontal and vertical clearances of unguarded rigid live parts such as potheads, transformer bushings, surge arresters, and short lengths of supply conductors connected thereto, which are not subject to variation in sag, shall be not less than those required by Rule 234C or 234D, as applicable.

2. Clearance to equipment cases

Equipment shall be mounted so that clearances are not less than that given by Rules 234J2a, 234J2b, and 234J2c.

- a. Effectively grounded equipment cases may be located on or adjacent to buildings, bridges, or other structures provided that clearances for unguarded rigid live parts of such equipment, as specified in Rule 234J1, are maintained.
- b. Equipment cases that are not effectively grounded shall be located so that the clearances of Rule 234C or 234D, as applicable, are maintained.
- c. Equipment cases shall be located so as not to serve as a means of approach to unguarded rigid live parts by unqualified persons.

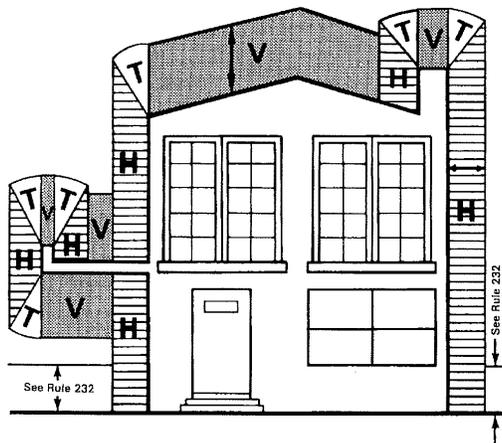
NOTE: Rule 234J is not subject to the loading conditions of Rule 234A.

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F-234-1(a)

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F-234-1(a)



LEGEND

Regions Where Conductors Are Prohibited	Controlling Clearance
H	Horizontal
V	Vertical
T	Transitional = Vertical (Arc)

Figure 234-1(a)—Clearance diagram for building

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F-234-1(b)

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F-234-1(c)

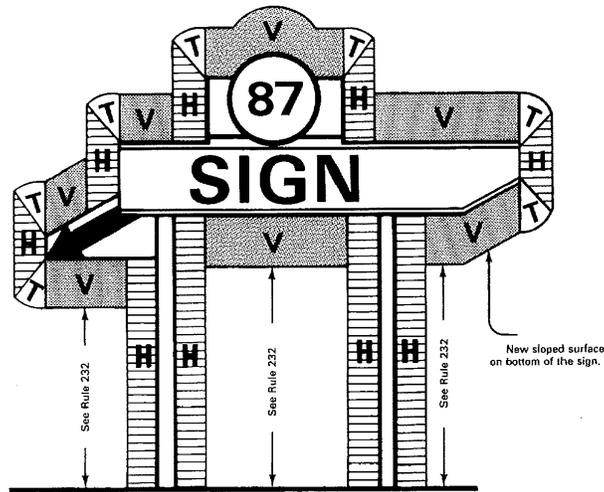


Figure 234-1(b)—Clearance diagram for other structures

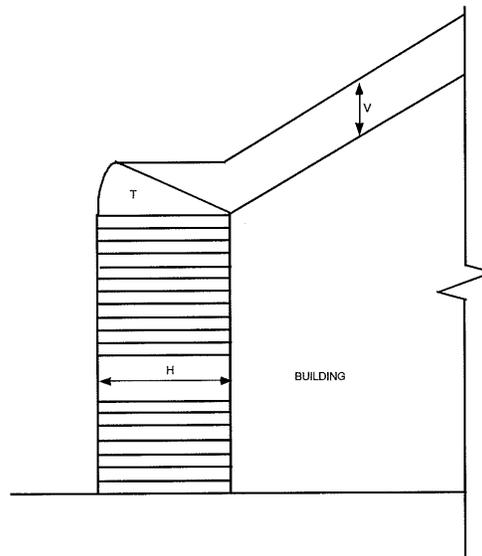


Figure 234-1(c)—Transitional clearance when H is greater than V

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F-234-2

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F-234-3

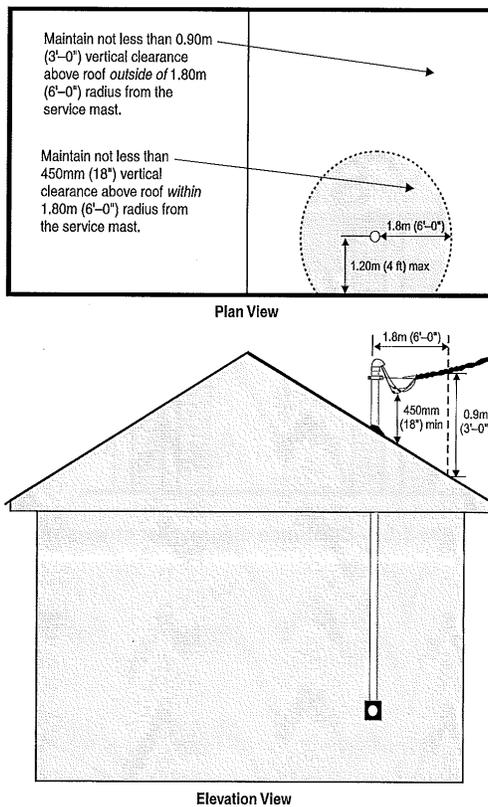


Figure 234-2—Clearances of service drop terminating on support mast

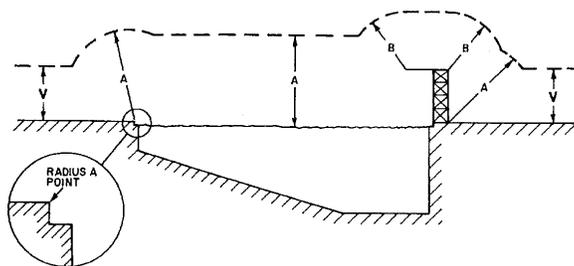


Figure 234-3—Swimming pool clearances

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F-234-4(a)

Part 2: Safety Rules for Overhead Lines

F-234-4(a)

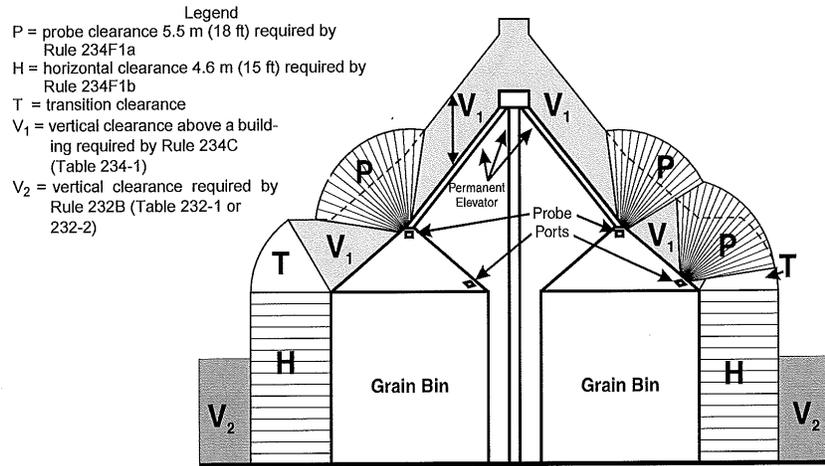


Figure 234-4(a)—Clearance envelope for grain bins filled by permanently installed augers, conveyors, or elevators

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F-234-4(b)

Part 2: Safety Rules for Overhead Lines

F-234-5

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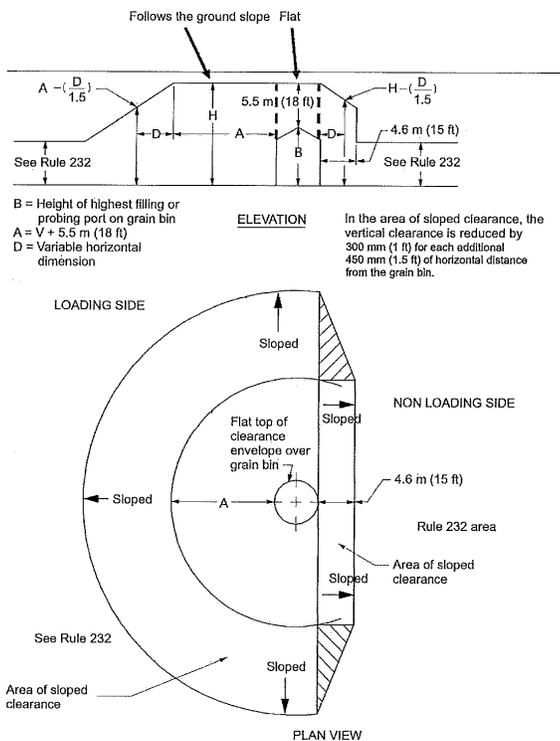


Figure 234-4(b)—Clearance envelope for grain bins filled by portable augers, conveyors, or elevators

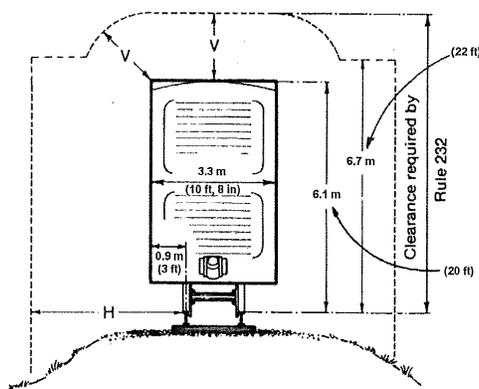


Figure 234-5—Rail car clearances

**Table 234-4—
Electrical component of clearance of buildings, bridges, and other installations**
[This clearance shall be increased 3% for each 300 m (1000 ft) in excess of 450 m (1500 ft) above mean sea level. See Rules 234H3a and 234H3b.]

Maximum operating voltage phase to phase (kV)	Switching-surge factor (per unit)	Switching surge (kV)	Electrical component of clearances			
			Vertical		Horizontal	
			(m)	(ft)	(m)	(ft)
242	2.0	395	0.84	2.8	0.70	2.3
	2.2	435	0.98	3.3	0.82	2.7
	2.4	474	1.14	3.8	0.95	3.1
	2.6	514	1.30	4.3	1.08	3.6
	2.8	553	1.47	4.8	1.22	4.0
362	3.0	593	1.64	5.4	1.37	4.5
	1.8	532	1.38	4.5	1.15	3.8
	2.0	591	1.64	5.4	1.37	4.5
	2.2	650	1.92	6.3	1.60	5.3
	2.4	709	2.22	7.3	1.85	6.1
550	2.6	768	2.53	8.3	2.11	6.9
	2.8	828	2.87	9.4	2.39	7.9
	3.0	887	3.3	10.6	2.68	8.8
	1.6	719	2.27	7.5	1.86	6.2
	1.8	808	2.76	9.1	2.30	7.6
800	2.0	898	3.3	10.8	2.74	9.0
	2.2	988	3.9	12.7	3.3	10.5
	2.4	1079	4.5	14.6	3.8	12.2
	2.6	1168	5.1	16.7	4.3	13.9
	1.6	1045	4.3	13.9	3.6	11.6
800	1.8	1176	5.2	16.9	4.3	14.1
	2.0	1306	6.2	20.1	5.2	16.7
	2.2	1437	7.2	23.6	6.0	19.6
	2.4	1568	8.4	27.2	7.0	22.7

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Table 234-5—Reference distances
(See Rule 234H2.)

Reference distance	Vertical		Horizontal	
	(m)	(ft)	(m)	(ft)
a. Buildings	2.70	9	0.90	3
b. Signs, chimneys, radio and television antennas, tanks, and other installations not classified as bridges or buildings	2.70	9	0.90	3
c. Superstructure of bridges ^① ^②	2.70	9	0.90	3
d. Supporting structures of another line	1.80	6	1.50	5
e. Dimension <i>A</i> of Figure 234-3	5.5	18	—	—
f. Dimension <i>B</i> of Figure 234-3	4.3	14	4.3	14

^①Where over traveled ways on or near bridges, the clearances of Rule 232 apply also.

^②Where the bridge has moving parts, such as a lift bridge, the required clearances shall be maintained throughout the full range of movement of the bridge or any attachment thereto.

235. Clearance for wires, conductors, or cables carried on the same supporting structure

A. Application of rule

1. Multiconductor wires or cables

Cables, and duplex, triple, or paired conductors supported on insulators or messengers meeting Rule 230C or 230D, whether single or grouped, for the purposes of this rule are considered single conductors even though they may contain individual conductors not of the same phase or polarity.

2. Conductors supported by messengers or span wires

Clearances between individual wires, conductors, or cables supported by the same messenger, or between any group and its supporting messenger, or between a trolley feeder, supply conductor, or communication conductor, and their respective supporting span wires, are not subject to the provisions of this rule.

3. Line conductors of different circuits

a. Unless otherwise stated, the voltage between line conductors of different circuits shall be the greater of the following:

(1) The phasor difference between the conductors involved

NOTE: A phasor relationship of 180° is considered appropriate where the actual phasor relationship is unknown.

(2) The phase-to-ground voltage of the higher-voltage circuit

b. When the circuits have the same nominal voltage, either circuit may be considered to be the higher-voltage circuit.

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