BEFORE THE
PENNSYLVANIA PUBLIC UTILITY COMMISSION

APPLICATION OF PENNSYLVANIA ELECTRIC COMPANY FOR APPROVAL TO LOCATE AND CONSTRUCT THE BEDFORD NORTH-CENTRAL CITY WEST 115 KILOVOLT TRANSMISSION LINE PROJECT IN CENTRAL CITY BOROUGH AND SHADE TOWNSHIP, SOMERSET COUNTY, AND NAPIER, EAST ST. CLAIR, AND BEDFORD TOWNSHIPS, BEDFORD COUNTY, PENNSYLVANIA	:	**Docket No. A-2016-2565296**

REBUTTAL TESTIMONY OF

SHAWN T. STANDISH

ON BEHALF OF

PENNSYLVANIA ELECTRIC COMPANY

REBUTTAL STATEMENT NO. 7

Re: Vegetation Maintenance

Dated: February 20, 2017

INTRODUCTION AND PURPOSE OF TESTIMONY

Q. Please state your name and business address.

A. Shawn Thomas Standish, 501 Parkway Boulevard, York, Pennsylvania.

Q. By whom are you employed and in what capacity?

A. I am employed by FirstEnergy Service Company, which provides services to the operating companies and other entities owned by FirstEnergy Corp. Pennsylvania Electric Company ("Penelec"), is one of those wholly owned operating companies of FirstEnergy. I am presently Manager of Program Management and Oversight for the Transmission Vegetation Management program. The FirstEnergy service territory is across the states of Pennsylvania, New Jersey, Ohio, Maryland, West Virginia, New York, and Virginia. The overall transmission system owned by FirstEnergy Company contains approximately 17,000 circuit miles of transmission line, ranging in voltages from 69,000 volts up to 500,000 volts.

Q. Please describe your professional experience and educational background.

A. I've worked on FirstEnergy system for nearly 12 years, working as a contract employee for approximately one and a half years and for over ten years as a company employee. I've served in roles as field specialist, responsible for implementation of the vegetation maintenance program, then as supervisor and since 2008, as a manager.

I received my Bachelor of Science in Forest Science from Pennsylvania State University in 1999.

Q. Do you hold any professional licenses or certifications?

A. Yes. I currently hold certifications as a Certified Arborist and Certified Utility Arborist. I am licensed as a Pennsylvania Pesticide Applicator and am a member of the International Society of Arboriculture and the Utility Arborist Association.

Q. What is involved in obtaining and retaining the licenses?

A. All licenses require relevant experience and a certification exam. All of the licenses require annual continuing education credits to stay current.

Q. Please describe your responsibilities in your current position?

A. I am responsible for the design and implementation of the Transmission Vegetation Management ("TVM") Program, for all of FirstEnergy's service territories, including abatement of vegetation along the transmission corridor, permits for construction, vegetation work on new construction and rebuild of existing facilities, administration of our forestry contracts with all the contractors doing the work, and ensuring compliance with regulatory standards. I'm also responsible for communicating with State and Federal Regulatory Boards regarding our TVM practices. In addition to the contract employees, I have 19 employees in my group that report to me, and we support 52 employees in our Transmission of Vegetation Management Program who are in the field implementing our program. As I mentioned, the FirstEnergy service territory is across seven states, including Pennsylvania, and contains approximately 17,000 circuit miles of transmission line.

Q. On whose behalf are you providing this testimony?

A. I am providing this testimony on behalf of Penelec for approval to locate and construct the Bedford North-Central City West 115 kV Transmission Line ("Project").

Q. What is your role in the Bedford North – Central City West Transmision Project?

A. As Manager of Program Management and Oversight for Transmission Vegetation Management, I am in charge of our New Construction group, which will be performing all initial clearing activities for the Project.

The Project will involve construction of both new right-of-way (ROW), as well as rebuilding of existing transmission line within existing Penelec-owned ROW. All of the new right-of-way will require initial clearing of vegetation, and the rebuild will require vegetation maintenance to ensure there are no reliability issues.

Q. What is the purpose of your testimony?

A. I will testify regarding FirstEnergy's Transmission Vegetation Maintenance program and, in particular, the initial clearing activities for the Project. Additionally, I'm providing testimony as regarding the practices of the Transmission Vegetation Management program, Federal standards, and Best Management Practices.

Q. Have you sponsored direct testimony in this proceeding?

A: No, I have not.

Q. Are you sponsoring any exhibits with your rebuttal testimony?

A. Yes, as follows:

ANSI A300: Standard Practices Integrated Vegetation Maintenance for utility ROWs: This document presents performance standards for the care and maintenance of trees, shrubs and other woody plants. It is intended as a guide in the drafting of maintenance specifications. The purpose was to provide standards for developing specifications to implement an integrated approach to management of vegetation. Exhibit STS-1.

IVM Best Management Practices, Integrated Vegetation Management 2nd Edition: Best management practices is to use the IVM Integrated Vegetation Management technique to control or remove all incompatible vegetation within the entire transmission corridor that has the potential to interfere with the safe and efficient operation of the transmission system. IVM uses a combination of methods to create sustainable communities while managing incompatible vegetation. Exhibit STS-2.

FAC-003-4: The purpose is "To maintain a reliable electric transmission system by using a defense-in-depth strategy to manage vegetation located on transmission 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." (FAC-003-4) Exhibit STS-3.

ANSI A300 (Part 1): Standard Practices Tree, Shrub, and Other Woody Plan Management Exhibit STS-4.

Q. Please describe FirstEnergy's Transmission Vegetation Maintenance Program.

A. The objective of the transmission vegetation management program is to maintain safe, reliable electric service by ensuring vegetation with the potential to interfere with the electric transmission lines is managed to prevent outages from vegetation located on the transmission corridor and minimize outages from vegetation located adjacent to the transmission corridor. All incompatible vegetation is managed to ensure there are no encroachments from vegetation on or adjacent to the corridor.

I'll define the corridor as the right-of-way that the utility line is traversing the property.

Penelec's corridors are on a five-year maintenance cycle. That means that vegetation, once every five years, is on scheduled maintenance. During each scheduled maintenance cycle any incompatible vegetation on the corridor is identified and a control method is selected. The choice of control method is based on the anticipated effectiveness, environmental impact, site characteristics, safety, and other factors.

Also during scheduled maintenance we identify Priority Trees and will trim or remove the tree based on its condition and/or the work needed on the tree. Priority Trees include those trees that are dead, dying, diseased, structurally defective, leaning or significantly encroaching where the transmission facilities are at risk of arcing or falling should the tree or portions of the tree fall near or into the transmission facilities or grow towards or into the transmission facilities.

Q. What do you mean by incompatible vegetation?

A. Incompatible vegetation refers to all vegetation that may grow tall enough to interfere with overhead electric facilities, impede access and/or the ability to visually inspect the transmission corridor from structure to structure to assure continued safe and reliable transmission service.

Q. How does TVM control incompatible vegetation?

A. All incompatible vegetation must be removed with an herbicide or be removed mechanically along with an herbicide application the vegetation from prevent re-sprouting.

Q. Why doesn't the Company trim incompatible vegetation?

A. According to the TVM program, the only absolute way to control incompatible vegetation is to cut and treat with herbicide. If we just cut or mow, the vegetation will resprout and regrow denser and faster than before, unless herbicides are used to control it.

Q. To what extent does the company remove vegetation within its transmission right of way for new construction projects?

A. For initial New Construction projects, access is paramount. Therefore, all incompatible vegetation on the corridor will be removed and controlled in the transmission ROW. Additionally trees adjacent to the right of way will be inspected and any Priority Trees will be will be trimmed or removed based on the tree condition. Any tree with greater than 25 percent of its crown extending into the corridor shall be removed consistent with the ANSI A300 standards. (Part 1 - (6.1.4 & 7.5.2).

Q. Is there a national standard for electric utilities regarding transmission line right of way vegetation maintenance?

A. Yes, the ANSI A300 Standards. ANSI is the American National Standard Institute.

Q. Please describe the ANSI A300.

A. ANSI is attached hereto as Exhibit No. STS-1. ANSI A300 an industry-wide accepted standard. ANSI A300 provides performance standards for the care and maintenance of trees, shrubs and other woody plants. It is intended as a guide in the drafting of maintenance specifications for federal, state, municipal and private authorities, including property owners, property managers and utilities. The application is applicable to any person or entity engaged in the business, trade, performance or of preparing, maintaining or preserving trees, shrubs and other woody plants. The purpose was to provide standards for developing specifications to implement an integrated approach to management of vegetation. The standard is utilized in the United States and Canada specifically.

Q. Please explain the role of ANSI A300 in formulating the Company's vegetation maintenance program?

A. FirstEnergy's program is designed to comply with ANSI A300, which incorporates the industry's best management practices, and those of ANSI.

Q. Does ANSI A300 (Part 7) address herbicides?

A. Yes. Section 73.5.4.3, Selective management at page 11, specifically states that when incompatible vegetation with the potential for re-sprouting is manually controlled, herbicides should be applied to the remaining stump.

Q. Have you been involved with the formation of the company's vegetation maintenance program, and if so, for how long?

A. I am presently Manager of Program Management and Oversight for Transmission Vegetation Management and have been in that position for about a year and a half. Throughout my time as a Supervisor and Manager I have been involved in the development and implementation of our TVM Program.

Q. Who published the document identified as Exhibit STS-2?

A. ISA, the International Society of Arboriculture.

Q. What is the relationship of ANSI to the ISA?

A. They are the national authorities on vegetation management industry best practices.

Q. Mr. Mattei mentions in his direct testimony the applicability of NERC Reliability Standard FAC-003-4. Please describe FAC-003-4 further.

A. FirstEnergy's Transmission and Generation Facilities are subject to the FAC-003-4. Specifically, FirstEnergy Transmission Owner Facilities include Overhead transmission lines operated at 200kV and above (FE has transmission lines operated at 230kV, 345kV, and 500kV), overhead transmission lines operated below 200kV identified as an element of an Interconnection Reliability Operating Limit (IROL) under NERC Standard FAC-014 by PJM (FE has transmission lines operated at 138kV identified as an element of an IROL), and all above-referenced lines located outside the fenced area of the switchyard, station, or substation or crossing the substation fence.

For FirstEnergy Generation Owner Facilities, overhead transmission lines that extend greater than one mile or 1.609 kilometers beyond the fenced area of the generating station switchyard to the point of interconnection with the TO's facility and are 200kV and above and other designated lines deemed critical.

Q What is the North American Electric Reliability Corporations, or NERC, and what is its role in Transmission Vegetation Maintenance?

A. North American Electric Reliability Corporation is designated by the Federal Energy Regulatory Commission to develop transmission reliability standards. NERC developed the requirements that all these transmission owners have to follow, including the FAC-003-4 Transmission Vegetation Management Standard.

Q. Why does FirstEnergy use herbicides to maintain rights of way as opposed to manual cutting?

A. Cutting and mowing alone of the incompatible species does not eliminate the plant. You can cut a plant every year, but you're not going to affect the root system. As a result, as long as the root system remains in place, it will continue to regrow. The company's goal is to remove all incompatible species with in the right-of-way. The company also has to control that particular root system from re-sprouting in order to permit a compatible vegetation to grow in its place.

It may take more than one application of herbicide to control incompatible vegetation and convert the floor to a compatible low-growing habitat. In addition, the size and density of the brush can be a factor so that the first application may simply reduce the height or density of the brush.

Q. What happens if you do not prevent the incompatible vegetation from re-sprouting root systems?

A. It will continue to grow even more vigorously. The reason for that is that the root system has gotten so big and it needs to be able to sustain itself. For example, taking into consideration the height and width of the tree, when you cut a stem, five, or sometimes ten stems regrow in that place.

Q. Describe the herbicide products used by the company for its TVM?

A. We use carefully selected products with plant specific chemistries. We select the product formulations with the manufacturers so that we can limit variability in the field.

Q. Are the products approved for use by a licensing agency of the state or federal government? Please describe.

A. Yes. The USEPA reviewed, approved, and registered all the products. Only herbicides that have been approved and registered by USEPA are permitted to be commercially used in US.

Q. What operating manuals or instructions are used for the applications?

A. The manufacturer's Pesticide Label and the Safety Data Sheet are followed for each product.

Q. Who actually performs the application of the herbicides?

A. TVM utilizes a contracted workforce to apply products in the field.

Q. Are the applicators licensed to apply herbicides? Please explain?

A. Yes. Only a PA certified pesticide applicators who are specifically trained are permitted by law to apply herbicides. All TVM Contractors hold the necessary credentials, for applying pesticides in the Commonwealth of Pennsylvania, at a minimum.

Q. What precautions are taken to make sure the herbicides are applied in the prescribed manner?

A. All herbicides are applied in accordance with the manufacturer's pesticide label and all Federal, State and Local laws governing the use of herbicide. All Contractors implement our Closed Chain of Custody Supplemental Specification for the application of herbicides, apply the pesticide under the direct supervision of a state certified/licensed commercial applicator and, in accordance with the manufacturer's pesticide label, take necessary measures and precautions to avoid spills during handling and transporting of herbicides.

Q. Please describe the initial pre-construction right of way clearing for the project?

A. Initial clearing of the ROW will include removal of all incompatible vegetation to a width of 100 feet or 130 feet depending on the ROW. Some properties have agriculture and open fields. Such areas which will require have no clearing but may be utilized for access. Some have mixed hardwood stands of oak, hickory, ash, and maple that will need to be cleared within the limits of the ROW. In addition, priority trees off ROW will be removed or trimmed. Stump treatment will be applied to all trees or brush that are removed, except the white pine, through direct application via backpack or, if the ROW is mown, with a cut stubble treatment.

Q. Will the vegetation management practices of the company allow for the cultivation of crops within the right of way?

A. Yes, cultivation of crops is permitted to the extent that crop cultivation does not impede access to the facilities or pose a reliability risk.

Q. Will the vegetation management practices of the company allow for the cultivation of fruit orchards or Christmas tree farms within the right of way?

A. We do not encourage property owners to plant trees species on the right of way. However, yes, we would allow fruit orchards and Christmas tree cultivation to the extent that they do not impede access to the facilities or pose any potential reliability risk. Typically, the vegetation should be kept to ten feet or less by the property owner. We would be willing to meet with the property owner to ensure that the proposed vegetation is compatible.

Q. Are you familiar with the properties along the route of the proposed project?

A. Yes.

Q. With specific reference to the properties of the landowners who have voiced concerns about the vegetation removal in general, can you address the likely vegetation practices that will be employed for each property?

A. Yes. With specific respect to the properties of Albert Stiles, Gary Lambert and Shirley Huston, Kathy and Jeffrey Kelley, Katherine L. Zeigler, Fritz Land Holdings LP, Martha Lorraine and John S. Anderson, James and Nancy Macrae, and Keith Lohr, the pre-construction activities will completed as I described earlier. The post-construction activities will be dependent on the vegetation that is present at that time.

The ROW width will be 100 feet for the properties, with the exception of the Zeigler property and the Kelley property. The Zeigler property ROW will have a width of 130 feet, and the Kelley property ROW will be 100 feet for the majority of the ROW, and a 130-foot width for the section on top of the mountain.

Q. Please describe the pre-construction clearing or maintenance activities that will be performed on the properties?

A. Initial clearing of the ROW will include removal of all incompatible vegetation to a width of 100 feet. In general the properties have mixed hardwoods of oak, hickory, ash, and maple that will need removed within the ROW. In addition, priority trees off ROW will be removed or trimmed. Stump treatment will be applied to all trees or brush that are removed, through direct application via backpack or, if the ROW is mown, with a cut stubble treatment.

Q. Please describe the post-construction vegetation maintenance that you would foresee for the properties?

A. TVM will perform follow-up touch-up and maintenance on a 5 year cycle. The goal is to create and sustain a compatible, stable and low-growing plant community on the transmission ROW. The Company's end goal is to eliminate all on-corridor reliability issues by removing and controlling incompatible vegetation and minimize off corridor outages.

Q. Does this complete your rebuttal testimony?

A. Yes it does. I would like to reserve the right to supplement my testimony if necessary.

ANSI A300 (Part 7)-2012
Revision of ANSI A300 (Part 7)-2006

for Tree Care Operations –

Tree, Shrub, and Other Woody Plant Management – Standard Practices (Integrated Vegetation Management a. Utility Rights-of-way)

TCIA®
VOICE OF TREE CARE

Approved American National Standard
ANSI

ANSI A300 (Part 7)-2012 Integrated Vegetation Management a. Utility Rights-of-way
Revision of ANSI A300 (Part 7)-2006

American National Standard
for Tree Care Operations –

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Secretariat
Tree Care Industry Association, Inc.

Published by
Tree Care Industry Association, Inc.
136 Harvey Road – Ste 101
Londonderry, NH 03053
800-733-2622
603-314-5380
Fax: 603-314-5386
Email: RRouse@tcia.org
Web: www.tcia.org

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American National Standards Institute, Inc.
Headquarters:
1899 L Street, NW
11th Floor
Washington, DC 20036
New York Office:
25 West 43rd Street
4th Floor
New York, NY 10036

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Foreword This foreword is not part of American National Standard A300 (Part 7)-2012 *Integrated Vegetation Management (IVM)* standards.

ANSI A300 Standards are divided into multiple parts, each focusing on a specific aspect of woody plant management (e.g. Pruning, Soil Management, Supplemental Support Systems, etc.)

These standards are used to develop written specifications for work assignments. They are not intended to be used as specifications in and of themselves. Management objectives may differ considerably and therefore must be specifically defined by the user. Specifications are then written to meet the established objectives and must include measurable criteria.

ANSI A300 standards apply to professionals who provide for, or supervise the management of, trees, shrubs, and other woody landscape plants. Intended users include businesses, government agencies, property owners, property managers, and utilities. The standard does not apply to agriculture, horticultural production, or silviculture, except where explicitly noted otherwise.

This standard has been developed by the Tree Care Industry Association (TCIA), an ANSI-accredited Standards Developing Organization (SDO). TCIA is secretariat of the ANSI A300 standards, and develops standards using procedures accredited by the American National Standards Institute (ANSI).

Consensus for standards writing was developed by the Accredited Standards Committee on Tree, Shrub, and Other Woody Plant Management Operations – Standard Practices, A300 (ASC A300).

Prior to 1991, various industry associations and practitioners developed their own standards and recommendations for tree care practices. Recognizing the need for a standardized, scientific approach, green industry associations, government agencies and tree care companies agreed to develop consensus for an official American National Standard.

The result – ANSI A300 standards – unify and take authoritative precedence over all previously existing tree care industry standards. ANSI requires that approved standards be developed according to accepted principles, and that they be reviewed and, if necessary, revised every five years.

TCIA was accredited as a standards developing organization with ASC A300 as the consensus body on June 28, 1991. ASC A300 meets regularly to write new, and review and revise existing, ANSI A300 standards. The committee includes industry representatives with broad knowledge and technical expertise from residential and commercial tree care, utility, municipal and federal sectors, landscape and nursery industries, and other interested organizations.

Suggestions for improvement of this standard should be forwarded to: ANSI A300 Secretary, c/o Tree Care Industry Association, Inc., 136 Harvey Road - Suite 101, Londonderry, NH 03053.

ANSI A300 (Part 7)-2012 *Integrated Vegetation Management a. Utility Rights-of-Way* was approved as an American National Standard by ANSI on August 23, 2012. ANSI approval does not require unanimous approval by ASC A300.

(Continued)

The ASC A300 had the following members as of August 23, 2012:

Dane Buell, Chair
(SavATree, Inc.)

Bob Rouse, Secretary
(Tree Care Industry Association, Inc.)

Organizations Represented
Alliance for Community Trees
American Forests

American Nursery and Landscape Association

American Society of Consulting Arborists

American Society of Landscape Architects
Asplundh Tree Expert Company

Bartlett Tree Expert Company

Davey Tree Expert Company

International Society of Arboriculture

Professional Grounds Management Society
Professional Land Care Network

Society of Municipal Arborists

Tree Care Industry Association

USDA Forest Service

Utility Arborist Association

Name of Representative
Carrie Gallagher (Alt.)
Guy Meilleur
Joseph Murray (Alt.)
Warren Quinn
Craig J. Regelbrugge (Alt.)
Stephen Miller
Donald Godi (Alt.)
Ron Leighton
Geoff Kempter
Peter Fengler (Alt.)
Peter Becker
Dr. Thomas Smiley (Alt.)
Chris Klinas
Grant Jones (Alt.)
Dr. Richard Hauer
Sharon Lilly (Alt.)
Thomas Shaner
Alice Carter
Sabeena Hickman (Alt.)
Gordon Mann
Nolan Rundquist (Alt.)
Mark Stennes
Steve Mays Jr. (Alt.)
Keith Cline
Ed Macie (Alt.)
Matthew Simons
Bill Rees (Alt.)

Additional organizations and individuals:

Michael Galvin (Observer)
Peter Gerstenberger (Observer)
Sabeena Hickman (Observer)
Andy Hillman (Observer)
Myron Laible (Observer)
National Park Service (Observer)
Beth Palys (Observer)
Richard Rathjens (Observer)
Mary Reynolds (Observer)
Richard Roux (NFPA-780 Liaison)
Don Zimar (Observer)

ASC A300 mission statement:

Mission: To develop consensus performance standards based on current research and sound practice for writing specifications to manage trees, shrubs, and other woody plants.

American National Standard
for Tree Care Operations –

Part 7 Integrated Vegetation Management (IVM)
a. Utility Rights-of-way

Subclause 1.1 to 1.3 excerpted from ANSI A300 (Part 1) – 2008 *Pruning*

1 ANSI A300 standards

1.1 Scope

ANSI A300 standards present performance standards for the care and management of trees, shrubs, and other woody plants.

1.2 Purpose

ANSI A300 performance standards are intended for use by federal, state, municipal and private entities including arborists, property owners, property managers, and utilities for developing written specifications.

1.3 Application

ANSI A300 performance standards shall apply to any person or entity engaged in the management of trees, shrubs, or other woody plants.

70 Part 7 – Integrated Vegetation Management (IVM) standards

70.1 Purpose

The purpose of this document is to provide standards for developing specifications to implement an integrated approach to management of vegetation on utility rights-of-way.

70.2 Reasons for Integrated Vegetation Management (IVM)

The reason for integrated vegetation management is to create, promote, and conserve sustainable plant communities that are compatible with the intended use of the site, and discourage incompatible plants that may pose concerns, including safety, security, access, fire hazard, utility service reliability, emergency restoration, visibility, line-of-sight requirements, regulatory compliance, and environmental, or other specific concerns.

70.3 Implementation

70.3.1 Specifications for integrated vegetation management should be written and administered by a vegetation manager.

70.3.2 IVM specifications shall be adhered to.

70.4 Safety

70.4.1 IVM shall be implemented by a qualified vegetation manager, familiar with the practices and hazards of vegetation management and the equipment used in such operations.

70.4.2 This standard shall not take precedence over applicable industry safe work practices.

70.4.3 Operations shall comply with applicable Federal and State Occupational Safety and Health standards, ANSI Z133, as well as federal, state and local laws and regulations.

71 Normative references

ANSI A300 for Tree Care Operations – Tree, Shrub, and Other Woody Plant Management – Standard Practices

ANSI Z133, Arboriculture – Safety Requirements

29 CFR 1910, General Industry

29 CFR 1910.268, Telecommunications

29 CFR 1910.269, Electric Power Generation & Distribution

29 CFR 1910.331-335, Electrical Safety

FIFRA (Federal Insecticide, Fungicide, and Rodenticide Act)

NERC Standard FAC-003-1, Transmission Vegetation Management Program

72 Definitions (The definitions are considered part of the ANSI A300 Part 7 standard)

72.1 action threshold: A point at which the level of incompatible plant species, density, height, location or condition threatens the stated management objectives and requires the implementation of a control method(s).

72.2 biological control methods: Management of vegetation by establishment and conservation of compatible, stable plant communities using plant competition, allelopathy, animals, insects, or pathogens.

72.3 chemical control methods: Management of incompatible vegetation through the use of herbicides or growth regulators.

72.4 cultural control methods: Management of vegetation through alternative use of right-of-way that precludes the growth of incompatible vegetation through the use of crops, pastures, parks or other managed landscapes.

72.5 integrated vegetation management (IVM): A system of managing plant communities in which compatible and incompatible vegetation is identified, action thresholds are considered, control methods are evaluated, and selected control(s) are implemented, to achieve a specific objective. Choice of control methods is based on effectiveness, environmental impact, site characteristics, safety, security and economics.

72.6 maintenance cycle: Planned interval between vegetation management activities.

72.7 manual control method: Control of vegetation using hand-operated tools.

72.8 mechanical control methods: Control of vegetation using equipment-mounted saws, mowers, or other devices.

72.9 non-selective management: Methods used to control vegetation within a prescribed area without regard to retaining compatible vegetation.

72.10 right-of-way reclamation: Reestablishing IVM on a right-of-way that is not currently managed to the full extent of its easement or ownership rights and intended purpose. Conditions on a right-of-way in need of reclaiming include tall, dense amounts of undesirable vegetation, and utility facilities that are inaccessible. Reclamation usually involves initial non-selective methods of mowing or hand-cutting, or broadcast application of herbicides.

72.11 selective management: Methods used to control specific vegetation within a prescribed area while retaining compatible vegetation.

72.12 shall: As used in this standard denotes a mandatory requirement.

72.13 should: As used in this standard denotes an advisory recommendation.

72.14 specifications: A detailed, measurable plan or proposal for performing a work activity or providing a product, usually a written document.

72.15 standard, ANSI A300: The performance parameters established by industry consensus as a rule for the measure of extent, quality, quantity, value or weight used to write specifications.

72.16 utility facilities: Any privately, publicly, or cooperatively owned line, structure, or system for producing, transmitting, or distributing communications, power, electricity, light, heat, gas, oil, crude products, water, steam, waste, or storm water, which directly or indirectly serves the public.

72.17 utility right-of-way: A corridor of land over or through which utility facilities are located. The utility may own the land in fee, own easements, or have certain franchise, prescription, or license rights to construct and maintain utility facilities.

72.18 vegetation, compatible: Vegetation that is desirable and/or suitable to the intended use of the site.

72.19 vegetation, incompatible: Vegetation that is undesirable, presents a safety hazard, or is unsuitable to the intended use of the site.

72.20 vegetation manager: An individual engaged in the profession of vegetation management who, through appropriate experience, education, and related training, possesses the competence to provide for or supervise an integrated vegetation management program.

73 IVM a. Utility Rights-of-way practices

73.1 Communication

73.1.1 Communication with various stakeholders such as underlying or adjacent property owners, customers, and regulators regarding IVM activities should be proactive; and shall be in compliance with federal, state, and local regulations.

73.2 Set IVM objectives

73.2.1 The vegetation manager (VM) shall define the objectives based on the intended purpose and use of the site.

73.3 Evaluate site

73.3.1 The site shall be inspected to evaluate existing conditions to determine what type of control method(s), if any, is appropriate to meet defined objectives.

73.3.2 Pre-control evaluations should consider right-of-way use, type of utility facility, general conditions, ownership, intended uses of the site, adjacent land use, existing vegetation, topography, soils, fire risk, sensitive or protected areas, water resources, sensitive or protected species, and regulations.

73.3.3 Vegetation that is compatible or incompatible with the objectives should be identified.

73.3.4 Post-control evaluations should monitor efficacy and appropriateness of methods used, general site conditions, other impacts of treatments, and provide recommendations for future actions.

73.3.5 The results of site evaluation should be documented.

73.4 Determine action thresholds

73.4.1 The vegetation manager shall define action thresholds that initiate implementation of control methods to achieve management objectives.

73.5 Evaluate and select control methods

73.5.1 Efficacy of IVM control methods should be considered when scheduling implementation.

73.5.2 Control methods should promote compatible vegetation.

73.5.3 The vegetation manager shall choose from available management/control methods and specify appropriate management/methods.

73.5.3.1 Control method selection should be

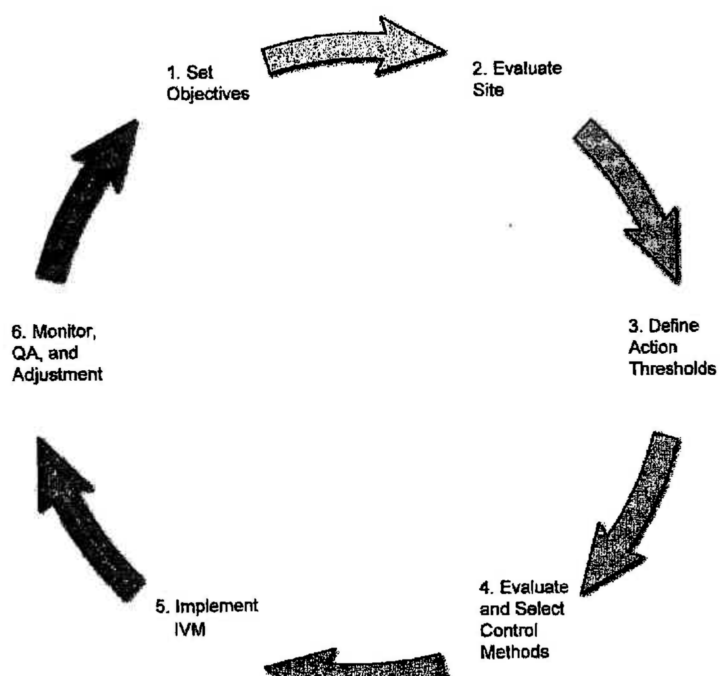

Figure 1: The following IVM flow chart illustrates the IVM process as represented in the ANSI A300 Part 7 standard. Each element is explained in this standard.

based on pre-control evaluations, expected growth rates, utility facility priority, economics, regulations, and specified objectives.

73.5.4 Selective management

73.5.4.1 The vegetation manager should employ selective management of vegetation whenever there is sufficient compatible vegetation actively growing on the right-of-way.

73.5.4.2 Where rights-of-way cross surface water resources, selective management should be utilized to create a buffer, retaining as much compatible vegetation as possible.

73.5.4.3 When incompatible vegetation with the potential for re-sprouting is manually-controlled, herbicide should be applied to the remaining stump.

73.5.5 Non-selective management

73.5.5.1 Right-of-way reclamation utilizing non-selective methods should be implemented as an initial step toward developing selective management on the site as conditions allow.

73.5.6 Mechanical control methods

73.5.6.1 When performing non-selective management, including right-of-way reclamation, mechanical clearing methods should be considered.

73.5.6.2 Where rights-of-way cross surface water resources, selective management should be utilized to create a buffer, retaining as much compatible vegetation as possible.

73.5.7 Chemical control methods

73.5.7.1 Materials

73.5.7.2 Materials shall be used in accordance with federal, state, and local laws and regulations.

73.5.7.3 Materials shall be applied according to manufacturers' labels.

73.5.7.4 Consideration shall be given to utilizing products that minimize the risk to humans and the environment.

73.5.7.5 Consideration shall be given to reducing the amount of materials utilized over time.

73.5.7.6 Materials and methods should be selected to reduce the chance of target vegetation (or organism) developing resistance.

73.5.8 Cultural control methods

73.5.8.1 Cultural control methods should be implemented as incompatible vegetation is controlled, and as conditions allow.

73.5.9 Biological control methods

73.5.9.1 Biological control methods should be implemented as site conditions allow.

73.6 IVM implementation

73.6.1 All local, state, and Federal laws and regulations regarding public and worker safety shall be followed.

73.6.2 Specifications developed for IVM shall be adhered to.

73.6.3 Maintenance cycles should be based on existing vegetation, expected growth rates, past control methods, and action thresholds.

73.7 Monitoring, Quality Assurance, and Adjustment

73.7.1 An IVM program shall include monitoring and quality assurance to ensure that best practices are followed, objectives of IVM are met, and that all specifications are adhered to.

73.7.2 The results of IVM treatments and of the quality assurance program should be clearly documented.

73.7.3 Results and findings from monitoring and quality assurance shall be used to adjust and improve the IVM program.

74 IVM application

74.1 Initial clearing of rights-of-way

74.1.1 When planning, designing, and constructing new rights-of-way, consideration should be given to future vegetation management needs.

74.1.2 When rights-of-way are being initially established, written easements should be secured defining rights to implement IVM methods as necessary to meet objectives.

74.2 Tools and equipment

74.2.1 IVM equipment used to implement the program shall be in proper working condition.

74.2.2 Equipment shall be used according to manufacturers' instructions.

75 Tree pruning and tree removal

75.1 Tree pruning shall comply with the Utility Pruning subclause in the ANSI A300 Part 1 – *Pruning* standard.

75.2 Trees and tree branches with the potential to affect utility facilities should be monitored for risk, and pruned or removed as appropriate (refer to ANSI A300 Part 9 – *Tree Risk Assessment*). Monitoring intervals, action thresholds, and methods for mitigation shall be determined by the type of facility, regulatory requirements, and available resources.

Annex A - Wire Zone – Border Zone Concept (This annex is not part of the ANSI A300 Part 7 standard)

The wire zone – border zone concept is a proven IVM method that ensures the reliability of electric supply lines while promoting stable, compatible plant communities and improved wildlife habitat on suitable electric utility rights-of-way. This concept delineates the portion of the right-of-way beneath the conductors (wire zone) from the portion on either side (border zone), and prescribes different management strategies for each area. Annex A provides supplemental information about this concept.

A-1 Annex A Glossary

A-1.1 border zone: Portion of electric utility right-of-way on either side of the wire zone and extending to the outer edge of the established right-of-way, selectively managed to include a mix of compatible herbaceous and woody vegetation below a specified height.

A-1.2 wire zone: Portion of electric utility right-of-way directly beneath electric supply lines and extending outward to a utility-specified distance, managed to promote only low-growing, primarily herbaceous vegetation.

A-2 The wire zone – border zone concept requires the use of separate management strategies for the wire zone and border zone, which may not be optimum for all sites. The concept is especially useful in areas where ecological concerns, such as visual impact and wildlife diversity, are a consideration. When properly implemented, use of the wire zone – border zone concept will not affect the reliability of utility facilities. The vegetation manager must determine the suitability of a particular site or right-of-way for management using the wire zone – border zone concept, taking into account topography, fire risk, and other factors.

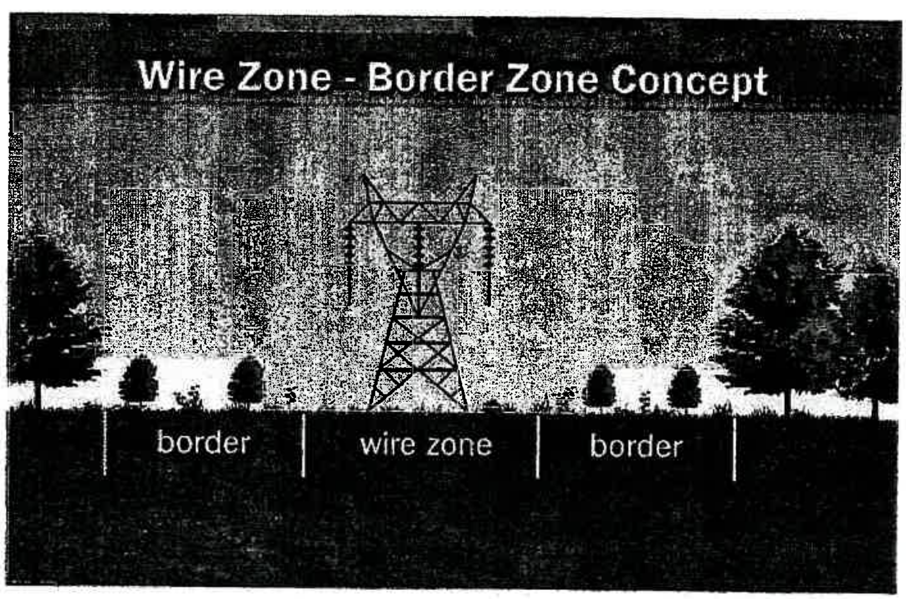

Figure A-2: Wire Zone – Border Zone Concept: This diagram is provided for informational purposes only and is not drawn to scale or intended for use as a specification detail.

During initial establishment, especially on rights-of-way that have not been regularly maintained, or contain minimal or no compatible vegetation, non-selective methods may be used; however, the effect of these methods on surrounding land owners and other stakeholders must be carefully considered.

A-3 In the border zone, incompatible vegetation is selectively controlled, and compatible vegetation that will not grow above a specified height is conserved. By retaining a greater variety of vegetation types, wildlife habitat is improved, and the visual impact to the right-of-way is softened.

A-4 In the wire zone, maintaining low-growing, primarily herbaceous cover allows access to utility infrastructure for inspection, repair, and maintenance, and for inspection of vegetation on and off the right-of-way. In addition, the wire zone is often ideal for wildlife species that prefer a meadow-like habitat.

A-5 When wire height is adequate, selected woody vegetation may be incorporated into the wire zone as facilities cross deep valleys, canyons, mountainsides or other similar terrain. Additionally, such vegetation may be retained as buffers for bodies of water, visual screening, or for other specified reasons, as long as vegetation management objectives are met.

A-6 Over the long term, the wire zone – border zone concept increasingly makes use of cultural and biological control methods to develop relatively stable plant communities in each zone, thus minimizing the need for other IVM control methods. These plant communities attract and aid in the establishment of stable wildlife populations, which in turn may further enhance biological controls. The wire zone – border zone concept can be implemented in most areas; however, the need for additional control methods, as well as the species of flora and fauna present, will vary depending on local climate and site conditions.

Annex B - Applicable ANSI A300 Part 7 interpretations (This annex is not part of the ANSI A300 Part 7 standard)

The following interpretations apply to the ANSI A300 Part 7 IVM standard.

B-1 Interpretation of "shall"

"A mandatory requirement" is the common definition of "shall" used in the standards development community and the common definition of "shall" used in ANSI standards. A mandatory requirement is not optional and must be followed for ANSI A300 compliance.

B-2 Interpretation of "should"

"An advisory recommendation" is the common definition of "should" used in the standards development community and the common definition of "should" used in ANSI standards. An advisory notice is not a mandatory requirement. Advisory recommendations may not be followed when defensible reasons for non-compliance exist.

B-3 Use of the terms "hazard tree" and "danger tree"

B-3.1 In electric utility vegetation management, the terms "hazard tree" and "danger tree" are frequently used to describe trees that pose discernable risk to utility facilities.

B-3.2 Annex B Glossary

B-3.2.1 hazard tree: A structurally unsound tree that could strike a target when it fails. As used here, the target of concern is electrical supply lines.

B-3.2.2 danger tree: A tree on or off the right-of-way that could come into contact with electric supply lines by growing into, falling into, swaying into, or sagging.

B-3.3 While this glossary reflects industry consensus, there remain regional differences in interpreting the meaning of "hazard tree" and "danger tree." ANSI A300 standards promote tree risk management and discourage the use of the term "hazard," preferring instead to refer to specific levels of risk posed (see ANSI A300 Part 9 – *Tree Risk Assessment*) following general risk assessment concepts outlined in international standards (ISO).

B-3.4 Trees identified as hazard or danger trees may be pruned or removed as appropriate.

Best Management Practices

INTEGRATED VEGETATION MANAGEMENT FOR UTILITY RIGHTS-OF-WAY

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Randall H. Miller

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Editorial Coordinator: Wes Kocher
Production Coordinator: Amy Theobald
Cover Composition and Layout: Kathy Ashmore
Illustrations by Bryan Kotwica
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International Society of Arboriculture
P.O. Box 3129
Champaign, Illinois 61826-3129, USA
+1(217) 355-9411
www.isa-arbor.com
permissions@isa-arbor.com

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Purpose

The International Society of Arboriculture (ISA) has developed a series of Best Management Practices (BMPs) for the purpose of interpreting tree care standards and providing guidelines of practice for arborists, tree workers, and the people who employ their services.

Because trees and other plants are unique living organisms, and they—as well as the ecosystems in which they live—are variable by nature, not all practices can be successfully applied in all cases. A qualified arborist or utility vegetation manager should write or review contracts and specifications using national standards and this BMP. Departures from the standards should be made with careful consideration of the objectives and with supporting rationale.

This BMP is for the selection and application of methods and techniques for vegetation control for electric rights-of-way projects and gas pipeline rights-of-way. It also serves as a companion publication for the integrated vegetation management portion of the *American National Standard for Tree Care Operations—Tree, Shrub, and Other Woody Plant Management—Standard Practices* (*Integrated Vegetation Management a. Utility Rights-of-Way*) (ANSI A300, Part 7).

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The Integrated Vegetation Management Best Management Practices Review Committee (Second Edition)

Paul Appelt, Environmental Consultants, Stoughton, Wisconsin, USA
Jennifer Arkett, Duquesne Light Co., Pittsburgh, Pennsylvania, USA
Richard Johnstone, Integrated Vegetation Management Partners, Inc., Newark, Delaware, USA
Geoffrey P. Kempter, Asplundh Tree Experts, Willow Grove, Pennsylvania, USA
Mike Neal, Arizona Public Service, Phoenix, Arizona, USA
Chris Nowak, State University of New York, EFS, Syracuse, New York, USA
William Rees, Baltimore Gas and Electric, Baltimore, Maryland, USA
Matt Simons, Atlantic City Electric, Mays Landing, New Jersey, USA
Derek Vannice, CN Utility Consulting, Sebastopol, California, USA

Introduction

Unmanaged vegetation growing near utility rights-of-way can damage utility facilities and cause problems with safety, reliability, access, emergency service restoration, regulatory compliance, security, and lines-of-sight. It can also compromise compliance with environmental, legal, regulatory, and other requirements.

Vegetation interference with power lines is one of the most common causes of electrical outages on distribution systems, and has initiated transmission grid failures that have subjected millions of people to lengthy blackouts. Vegetation can cause electric service interruptions when it contacts overhead high voltage conductors or comes sufficiently close to create a spark-over. Vegetation and conductors can come too close together when they are blown into one another by high winds, or when lines stretch and sag due to high temperatures, heavy snow, or ice buildup (Figure 1). During dry conditions, vegetation sparking-over with power lines can start wildfires. Trees may also provide access for children, workers, and others to high voltage lines overhead, potentially resulting in direct or indirect contact that can cause serious injury or death.

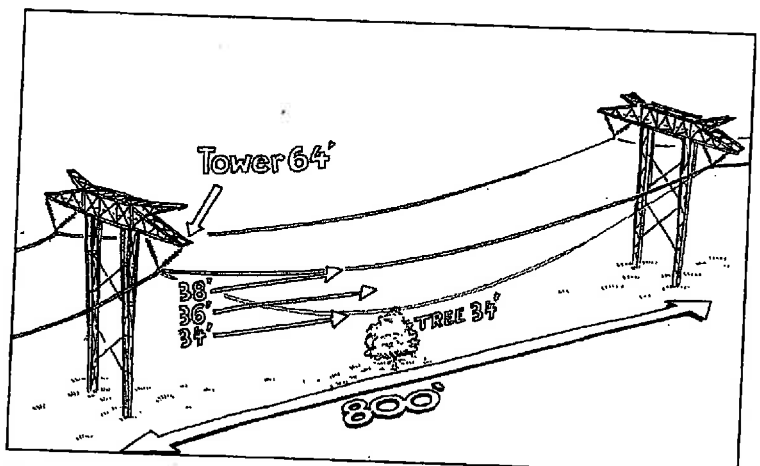

Figure 1. Line sag.

Vegetation can interfere with access to, and maintenance of, pipelines. For example, underground pipelines can be obstructed by vegetation, making it impossible to detect leaks from the ground or air.

Utilities must comply with federal, state or provincial, and local regulations that require vegetation control in proximity to electric and gas facilities. For example, in the United States, the North American Electric Reliability

Corporation (NERC) *Transmission Vegetation Management Program* standard contains clearance requirements for critical transmission lines. Moreover, the Energy Policy Act of 2005[1] contains provisions for electric system reliability standards, including those for vegetation management. Based on this provision, the Federal Energy Regulatory Commission has adopted the NERC *Transmission Vegetation Management Program* standard (NERC 2008), which essentially gives the NERC standard the force of law. Another important regulation is the National Electrical Safety Code (NESC [IEEE 2012]), section 218, of which requires utilities to prune or remove trees that may damage ungrounded supply conductors.

Many utilities manage millions of trees across thousands of miles (kilometers) of line. That means in every mile (1.6 km) of line, a utility can potentially have hundreds of trees, any one of which could compromise public safety and electrical service reliability. It is impossible to completely secure an electrical system from that level of exposure. Nevertheless, vegetation managers have a responsibility to make a reasonable effort to maintain vegetation to reduce risks to both the public and utilities. The integrated vegetation management (IVM) best management practices outlined in this publication are tools for use toward that objective.

The intent of this publication is to serve as a companion to ANSI A300 Part 7: *Tree, Shrub, and Other Woody Plant Maintenance—Standard Practices (Integrated Vegetation Management a. Electric Utility Rights-of-Way)* (ANSI 2012). It is designed to provide practitioners with what industry experts consider to be the most appropriate integrated vegetation management (IVM) techniques to apply to utility right-of-way projects. Integrated vegetation management best practices can also be used to fulfill other objectives, such as vegetation control on gas pipeline rights-of-way, and activities outside the scope of utility right-of-way management—including restoring ecosystems, improving wildlife habitat, preserving cultural resources, protecting successional plant species, controlling invasive weeds, and other actions. Determining the best technique for a particular project takes experience and knowledge because natural conditions are dynamic. Therefore, this publication is not intended as a substitute for the expertise of a utility vegetation manager.

[1] United States Congress. P.L. 109-58, enacted August 8, 2005, section 1211

A utility vegetation manager is an individual engaged in the profession of vegetation management, who through education and related training, has the competence to design, implement, or supervise an IVM program. The expertise of a utility vegetation manager contrasts with that of an arborist insofar as the utility vegetation manager focuses on ecosystems, while arborists concentrate on individual trees. For the purposes of this publication, the utility vegetation manager is a utility employee or their contract representative who will set objectives, evaluate site conditions, make decisions on action thresholds and control methods, and perform quality assurance once work is complete.

IVM Defined

ANSI A300 Part 7 defines IVM as a system of managing plant communities in which managers set objectives, identify compatible and incompatible vegetation, consider action thresholds, and evaluate, select, and implement the most appropriate control method or methods to achieve their established objectives. The choice of control method or methods is based on considerations of their environmental impact and anticipated effectiveness, along with site characteristics, security, economics, current land use, and other factors.

Nowak (2013) offers a more in-depth definition of IVM, as a system for controlling undesirable vegetation that is consistent with principles and practices of Integrated Pest Management (IPM), designed to achieve specific management objectives, and continually improve processes. It is used to systematically choose, justify, selectively implement, and monitor different types of vegetation management treatments. Treatment selection is based on the control method's effectiveness, economic viability, and environmental impact, along with its suitability for safety, site characteristics, security, socio-economics, and other factors. IVM uses combinations of methods to promote sustainable plant communities that are compatible with the intended use of the site, and to control, discourage, or prevent establishment of incompatible plants that may pose safety, security, access, fire hazard, utility service reliability, emergency restoration, visibility, line-of-sight requirements, regulatory compliance, environmental, or other specific concerns.

The key steps of IVM consistent with IPM are:

1) Gaining science-based understanding of incompatible vegetation and ecosystem dynamics;

2) Setting management objectives and tolerance levels based on institutional requirements and broad stakeholder input;

3) Selecting treatments from a variety of options, including biological, chemical, manual, mechanical, and cultural control methods—and applying them to promote desirable desired plant communities, with an emphasis on management through biological controls, and

4) Monitoring treatments to determine their necessity and effectiveness in creating desired plant communities and achieving management objectives. IVM is a sustainable management method for utility rights-of-way because it balances socioeconomic and environmental considerations.

IVM is not a set of rigid prescriptions based upon set time periods, repeated unselective mowing, or broadcast spraying across entire right-of-way widths without the objective of establishing diverse, compatible plant communities.

Safety

Utility vegetation management operations can be dangerous without rigorous training and strict adherence to proper safety procedures. For that reason, utility vegetation managers need to inspire a culture of safety throughout their organizations. They should employ only qualified professionals who have demonstrated their ability to work according to accepted safe practices, or qualified trainees dedicated to learning safe work practices.

In the United States, the Occupational Safety and Health Administration (OSHA) requires employers to train their workers in electric safety[2]. Annex B of the *American National Standard for Arboricultural Operations—Safety Requirements* (ANSI Z133-2012) contains guidelines for standard performance and safety training for qualified line clearance arborists. OSHA 1910.269 and ANSI Z133 complement one another on governing electric safety in arboricultural operations, with OSHA 1910.269 requiring electric safety training and ANSI Z133 offering guidance on how that training should be provided.

[2] OSHA. United States Department of Labor. 1910.269. Electric Power Generation, Transmission and Distribution. Accessed August 2013 <http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9868>

I. Communication

Communication is essential to planning and implementing a successful vegetation management program. Proper communication should be open and interactive. It involves a formal, documented communication strategy for each phase of planning and implementation. The plan needs to entail more than just relating work instructions to vegetation crews. It should designate primary and secondary objectives and involve all stakeholders: management, other utility departments, planners, contractors, vegetation management crews, property owners, public land managers, appropriate governmental officials, members of organizations dedicated to related causes, and others.

Internal Communication

Communication within a utility's vegetation management department needs to be clear and concise to ensure everyone understands the desired results. Specifications and performance goals should delegate decision-making authority throughout the organization.

Communication among utility decision makers, including executives, engineers, corporate communications, operations managers, vegetation management staffs, and other utility departments should include why, where, when, and how IVM projects will be conducted. The discussion should emphasize the importance of the benefits of implementing IVM best practices. This is important because people within an organization but outside of the vegetation management department can help set priorities, anticipate and prevent potential problems, expand the communication network, and provide historical perspectives. Communicating with operations staff during work can also add a margin of safety. By knowing there is a vegetation management job underway, they may be able to respond more quickly to incidents and accidents than they would if they were unaware of the project.

Communication among utility vegetation managers, contract general foremen, supervisors, and workers should be both written and verbal. Written instructions ought to include the information needed to successfully complete a project, including specifications, policies and procedures, details about known stakeholders, locations of environmentally or culturally sensitive areas, applicable laws and regulations, and any other considerations of consequence. Debriefings should be planned to review challenges and lessons learned for future projects.

Communication with External Stakeholders

Public land managers, property owners, regulators, interest groups, and other affected parties often have legitimate concerns in utility vegetation management activities. It is important to communicate with them about the need for, benefits of, and science behind IVM to clarify expectations. Members of the vegetation management team, including crew members, should know the facts about the program, and be prepared to answer basic questions and refer more complex issues through proper channels. Communication should begin well in advance of work and involve listening to and understanding people's specific concerns. Modifications may be implemented to address legitimate issues, and these secondary objectives may be achieved provided those changes do not sacrifice primary management objectives of safety, reliability, and access.

Affected property owners and known stakeholders should be notified of upcoming work. Notification can be electronic or by mail, public notice, door hanger, personal visit, or other manner. In some cases, the best approach uses a combination of methods. Notification should include a brief explanation of when work is planned, why it needs to be done, its general location, a description of the project (e.g., mowing, herbicide, manual or other method), potential crew types, crew numbers, and other information that might help people understand the job. If property owners cannot be met in person, electronic or written notices may be used that contain contact numbers for use by those who need more information. In most cases, notification can be a proactive effort that informs stakeholders of the benefits of an IVM program.

Work on governmentally-managed property can involve administrative procedures that take months of advance work, including navigating through permit processes and the concerns of specialists who have responsibility for stewardship over public lands. Vegetation managers should educate land specialists on how IVM helps balance stewardship considerations with the need for providing safe, reliable service.

2. Planning and Implementation

ANSI A300, Part 7 offers a systematic way of planning and implementing a vegetation management program. It is applicable to distribution as well as transmission projects and consists of six elements:

1. Set Objectives
2. Evaluate the Site
3. Define Action Thresholds
4. Evaluate and Select Control Methods
5. Implement Control Methods
6. Monitor Treatment and Quality Assurance

Decisions are required in setting objectives, defining action thresholds, and evaluating and selecting control methods. The process is cyclical (Figure 2), because managing dynamic systems is ongoing. Managers must have the flexibility to adjust their plans at each stage as new information becomes available and circumstances evolve.

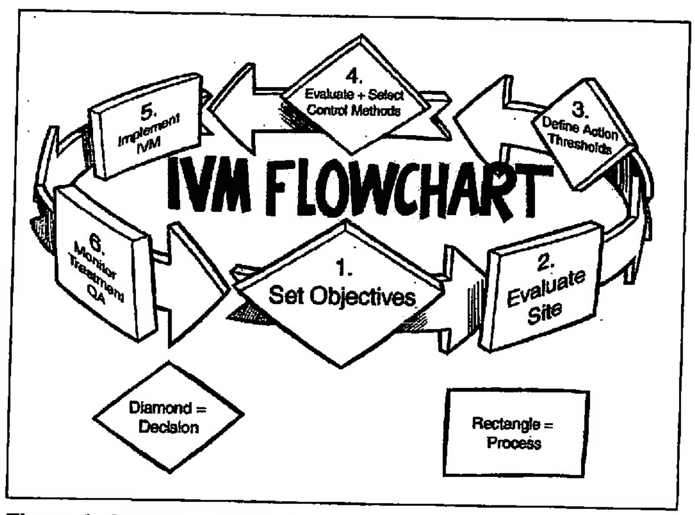

Figure 2. A300 Part 7 IVM flowchart.

Set Objectives

Objectives should be clearly defined and documented by the vegetation manager and be based on the intended purpose and use of the site. They should be SMART: specific, measurable, attainable, realistic, and timely. It is best to establish objectives that are precise and explain exactly what needs to be done, who needs to do it, and where it needs to be done. The objectives are measurable so progress can be impartially determined. Unattainable or irrelevant goals are pointless, and timeliness requires deadlines to drive completion of the goal (Duran 1981).

Examples of objectives for electric utilities can include promoting safety, preventing outages caused by vegetation growing into transmission facilities and minimizing them from trees growing outside the right-of-way, maintaining regulatory compliance, protecting structures and security, restoring electric service during emergencies, maintaining access and clear lines of sight, protecting the environment, and facilitating cost effectiveness. Metrics should be applied to each goal. For instance, a dollar per mile or acre goal could be set for a particular control method's cost effectiveness.

Objectives for pipelines can involve safety, route identification, testing, encroachments, and maintenance and inspection, particularly aerial and ground patrol needed for leak detection. Route identification is particularly important for underground facilities, which are only identified by above-ground markers or valves, and measuring stations adjacent to the pipeline, which can be easily hidden by unmaintained vegetation that has become overgrown. On gas pipeline rights-of-way, it's often best to select smaller, lower-growing plant species that are typically more sensitive to gas than larger, taller-growing trees in order to facilitate early gas leak detection. Border zone (see *Wire-border Zone Concept*) species could be selected that do not interfere with access for inspection, maintenance, or cause root obstruction. Tree roots may interfere with underground pipelines by compromising the coating integrity of some lines (Stedman and Brockbank 2012). A comparison of electric and pipeline rights-of-way concerns is presented in Table 1.

Objectives should be based on site factors, such as vegetation type, in addition to human, equipment, and financial resources. Objectives will vary from utility to utility and project to project, depending on line voltage or pipeline capacity and criticality, as well as logistical, topographical, environmental, fiscal, social, and political considerations. However, where it is appropriate, the overriding focus should be on environmentally-sound, cost-effective control of species that could potentially conflict with the facility, while promoting compatible, early successional, sustainable, plant communities.

Table 1. Electric vs. pipeline rights-of-way concerns (adapted from Appelt and Gartman 2004)

Electric rights-of-way	Pipeline rights-of-way
Electric right-of-way identification is obvious with lines and tall structures	Pipeline right-of-way identification for underground facilities is by markers, valves, and measuring stations that are easily obstructed by vegetation
Tree height under and to the side of lines, as well as distance to the side, effects safety and reliability	Trees block access and obstruct views
	Root intrusion (integrity of pipeline coating)

Site Evaluations

Site evaluations are used to assess field conditions for planning purposes. Planning can range from establishing programmatic strategies to setting detailed, tactical operational requirements for individual projects. The data can be applied to establishing or modifying objectives, setting budgets, or determining human, material and equipment resource requirements. Careful preparation is needed to ensure that valuable time and resources are directed toward obtaining useful information, but not wasted collecting unnecessary details. Site evaluations can identify a variety of factors, including potential safety issues, applicable regulations, workload, line or pipe type, voltage and criticality, funding, labor and equipment resource availability, height of the wire from the ground, right-of-way width, land ownership and use, fire risk, vulnerable or protected areas, presence of species of concern, water resources, archeological or cultural sites, topography, soils, and other matters.

Evaluations provide information on site characteristics that exist at the time an assessment is conducted. On dynamic systems such as those associated with IVM, information can quickly become out-of-date; meaning regularly-scheduled updates are required. Schedules should be based on anticipated vegetation growth, line design and construction, predominate species of vegetation, environmental factors, political considerations, budgetary parameters, and operational issues.

Work Load Evaluations

Workload evaluations are inventories of vegetation that could have a bearing on management objectives. Depending on those objectives and available resources, utilities can either conduct comprehensive or point sample evaluations. Workload assessments can collect data on an array of vegetation characteristics, such as location, height, density, species, size, condition, tree risk, and clearance from conductors. Evaluations should be conducted considering voltage, conductor sag from ambient temperatures and loading, and the potential influence of wind on line sway.

Comprehensive Evaluations

Comprehensive evaluations account for all vegetation that could potentially affect management objectives. Program level comprehensive evaluations can be made of all target vegetation on a system, while project level evaluations focus on vegetation relevant to a specific job. Comprehensive evaluations provide the advantage of supplying a complete set of data upon which to base management decisions. On the other hand, comprehensive surveys can be impractical for utilities with large numbers of trees, limited human and financial resources, or both.

Tree Risk Assessment

Utilities should conduct assessments to identify trees or tree parts that could fail and threaten their facilities. Large numbers of trees managed by utilities present challenges in tree risk assessment and risk mitigation. Utilities often manage hundreds of trees for each mile (1.6 km) of right-of-way. Given the constraints that resource limitations can impose, it is unreasonable to expect them to monitor every tree that could potentially conflict with utility facilities, identify all those with existing defects that pose an unacceptable level of risk, and proactively remedy the risks they present. Moreover, utilities may be hindered from reducing potential tree risks by property owner opposition. The only plausible course of action is for utilities to manage risk rather than eliminate it (UAA 2009).

Utilities should develop and implement plans for patrolling and inspecting trees that could affect their facilities on a regularly scheduled basis. Standard inspections cover the strike zone, and identify trees with obvious defects among those trees sufficiently tall to hit facilities should they fall. FAC-003 (NERC 2008) requires North American utilities to inspect designated lines annually[3]. Evaluations may be conducted by ground, air, or both. Aerial inspections may be made using light detection and ranging (LiDAR [UAA 2009]). These inspections serve as level 1, or limited visual assessments. Level 1 assessments are conducted from a specified perspective to identify

[3] Lines 200 kV or greater or those designated by a planning coordinator as an element of an interconnection reliability operating limit or by the Western Electricity Coordinating Council (WECC) as an element of a major designated by or as an element of a WECC major critical path (NERC 2008).

trees among a large population that have an imminent or probable likelihood of failure (Smiley, Matheny, and Lilly 2011).

If an initial level 1 assessment identifies a need for greater scrutiny, utilities may specify more detailed inspections or patrols, including a level 2, or basic assessment (Smiley, Matheny, and Lilly 2011). For utility application, a level 2 assessment is a detailed, 360-degree, ground-based visual inspection of the above-ground portion of a tree and its surrounding site to identify structural defects that could affect utility facilities. For the sake of efficiency, level 1 and level 2 assessments can be conducted simultaneously for trees requiring additional scrutiny.

Trees that have been identified as posing an unacceptable level of risk require an abatement plan. Each utility should have a plan and procedure in place for assessing and addressing high-risk trees, which specifies responsibility for prescribing and executing the plan (UAA 2009). When trees that pose an imminent threat to subject transmission facilities are identified, FAC-003 (NERC 2008) requires transmission owners to notify the appropriate switching authority that vegetation is likely to cause an outage at any moment.

Utility arborists interested in more detailed tree risk assessment information are directed to the *Utility Best Management Practices Tree Risk Assessment and Abatement for Fire-prone States and Provinces in the Western Region of North America* (UAA 2009) and the International Society of Arboriculture's *Best Management Practices: Tree Risk Assessment* (Smiley, Matheny, and Lilly 2011).

Point Sample Evaluations

Point sampling offers an alternative for utilities for which comprehensive inventories are impractical. While point sampling is inappropriate for hazard tree mitigation, it is cost effective, and has a proven track record for reasonable accuracy for other types of workload evaluation. It can be used to project the total amount of work from a representative sample. A common method involves dividing a management area (a system or project) into equal-sized units and selecting a random sample sufficient to statistically represent the total work quantity. Random selection eliminates the chance of bias on the part of the investigator. Every plant or plant community of interest within each selected area is inventoried, with collected data used to forecast the total workload.

Define Action Thresholds

Vegetation managers shall define action thresholds that initiate implementation of control methods to achieve management objectives. Action thresholds are vegetation height, density, location, or condition targets that trigger specific control methods. Since thresholds will vary from utility to utility and project to project, they should be set by a utility vegetation manager. Thresholds should be established in advance to meet objectives and be based on the results of site evaluations. A cycle based on an established period of time is often not an appropriate action threshold, because changes in growth rates, facility use, and land development will affect when vegetation needs to be controlled. Consequently, inspection and maintenance schedules should be based on existing vegetation, expected growth rates, past control methods, and action thresholds.

Minimum Clearances

Minimum clearance requirements may be established by regulatory oversight, or by individual utilities, to achieve management objectives. When establishing minimum clearances for energized conductors, practitioners must at least consider:

- the potential growth of vegetation
- the combined movement of vegetation and conductors in high wind
- sag of conductors due to elevated temperatures or icing

Vegetation managers must be aware that IVM requires a broader, more preventative approach than simply maintaining minimum clearances.

The objective of most IVM programs includes preventing the establishment of incompatible vegetation. Trees that have grown to the point where spark-over or an interruption to service is likely at any moment indicate a breakdown of the IVM program. Action thresholds in IVM are used to determine when incompatible vegetation control is necessary long before it has the potential to violate minimum clearance requirements or cause a service interruption. Using an IVM approach is both economically and environmentally sound because preventing establishment of incompatible vegetation is both less costly and less intrusive than removing or pruning large, established trees.

Evaluate and Select Control Methods

Control methods are the processes through which managers achieve objectives. The most suitable control methods are those that best achieve management objectives at a particular site. Many cases call for a combination of methods. Managers have a variety of controls from which to choose, including manual, mechanical, chemical (herbicide and tree growth regulators), biological, and cultural options. The ultimate objective is to maintain a desirable plant community with available tools, emphasizing biological and ecological control.

Manual Control Methods

Manual methods are performed by workers using hand-carried tools, such as chain saws, handsaws, pruning shears, and other devices to control incompatible vegetation. The advantage of manual techniques is that they are selective and can be applied where others may not be appropriate. On the other hand, manual techniques can be inefficient, less safe, more intrusive, more expensive, and not as environmentally friendly as other methods.

Mechanical Control Methods

Mechanical controls are done using machines. They are efficient and cost effective, particularly for clearing dense vegetation during initial right-of-way establishment or for reclaiming neglected or overgrown rights-of-way. On the other hand, machines may have a greater negative environmental impact than other control methods. Mechanical control methods can be nonselective; destroy compatible vegetation; disturb sensitive areas such as wetlands, archeologically rich localities or developed areas; establish a seedbed for and dispersal of incompatible plants through ground agitation; and carry seasonal restrictions to prevent harm to nesting wildlife and the environment. Machines can leave behind petroleum products from normal operations, leaks, and spills. Furthermore, heavy equipment use can be risky to use on steep terrain, where it can be unstable and contribute to erosion. To safely achieve desired end results, machinery must be properly maintained and run by skilled equipment operators.

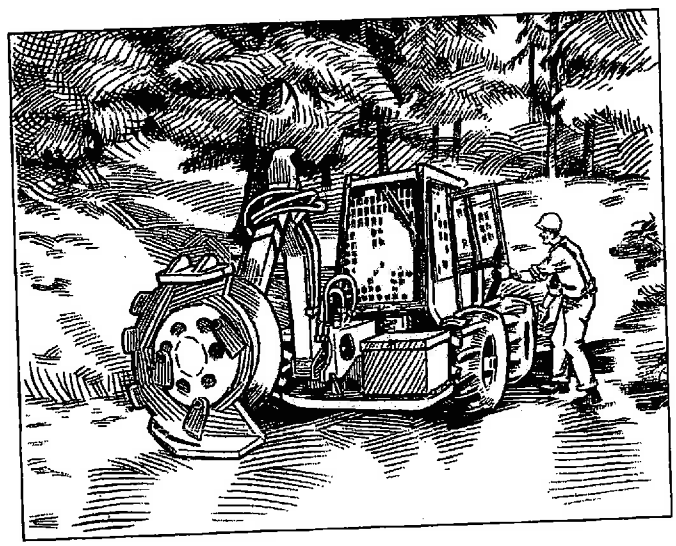

Figure 3. Tractor-mounted mower.

Machine Types

There are many machines that can be used for IVM. Machines efficiently remove undesirable vegetation on large-scale operations, such as initial right-of-way clearing or reclamation. Examples include:

- *Mowers* (Figures 3 and 4) not only remove and grind brush, but they can also fell small trees. Grinding and scattering improves aesthetics, facilitates debris decomposition, reduces fuel loads, and minimizes fire hazard. Appropriate timing and frequency can affect plant community development.

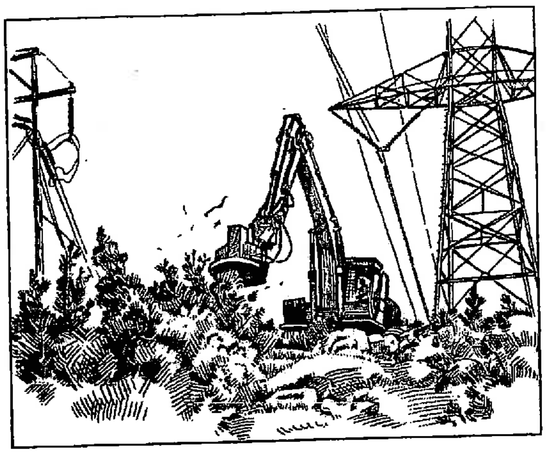

Figure 4. Excavator-mounted mower.

- *Shears* are whole tree removal devices mounted on heavy equipment. Shears can fell, lift, and stack trees (Figure 5).
- Mechanized *pruning* can be done with all-terrain vehicles equipped with an extendable boom (commonly 75 ft or 25 m) that can extend a circular saw blade (Figure 6). It can also be done with an array of blades slung beneath a helicopter. These devices can prune trees quickly and efficiently. However, it can be difficult to be precise with mechanized pruning equipment. Wounds that result are inappropriate for landscape or high-value trees. Consequently, mechanical pruning equipment use should be limited to rural or remote areas.

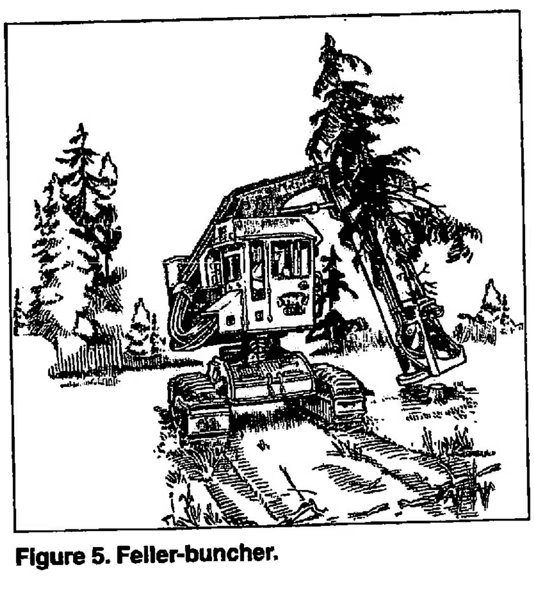

Figure 5. Feller-buncher.

- *Aerial lifts* can provide production efficiencies and safety. They can be mounted on a variety of chassis, from trucks to all-terrain vehicles, which can work off road (Figure 7).

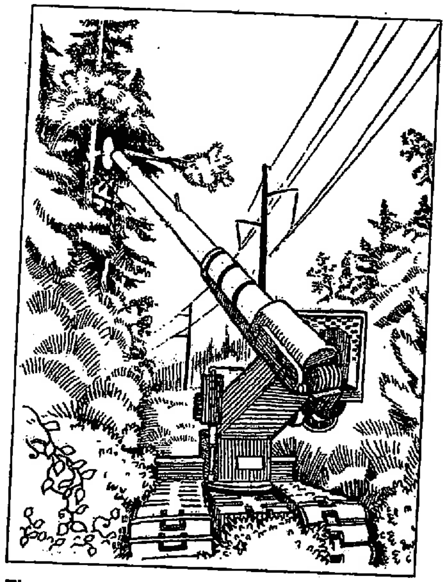

Figure 6. Mechanical pruner.

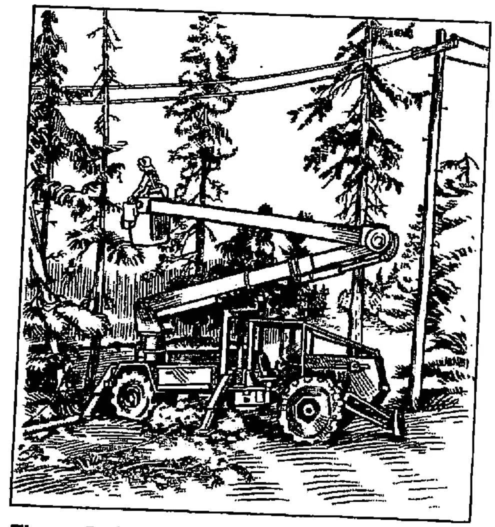

Figure 7. Off-road aerial lift.

Chemical Control Methods

Chemicals must be applied by qualified applicators according to label directions. Applicators are not only required to read and comply with label instructions, but also all other laws and regulations pertaining to chemical use. Label instructions for personal protective equipment (PPE) are particularly important. Most commonly used herbicide formulations only require long-sleeved shirts, long pants, and shoes and socks. Some formulations require resistant gloves and protective eye wear. Preference should be given to using chemicals that minimize risk to humans and the environment. Emphasis shall also be given to techniques that reduce the amount of material applied over time.

Tree Growth Regulators

Tree growth regulators (TGRs) are substances designed to reduce growth rates by interfering with natural plant processes. By slowing growth rates of some fast-growing species, TGRs can be helpful where removals or cover type conversion are prohibited or impractical, such as in urban forest applications. TGRs have not been demonstrated to be economically effective on large-scale, rural transmission facilities; however, they have proven useful in specific locations, primarily on distribution lines.

Herbicides

Herbicides control plants by interfering with specific botanical biochemical pathways. There are a variety of herbicides, each of which affect plants in different ways and behave variously in the environment, depending on the formulation and characteristics of the active ingredient. While appropriate herbicide use reduces the need for future intervention, misused herbicides can carry environmental risks due to drift, leaching, and volatilization.

When properly applied, herbicides are effective and efficient, while minimizing soil disturbance and enhancing plant and wildlife diversity. Herbicide application can benefit wildlife by improving forage as well as escape and nesting cover. In some instances, noxious weed control is a desirable objective on utility rights-of-way that can be satisfied through herbicide treatment.

Herbicide use can control individual plants that are prone to re-sprout or sucker after removal. When trees that re-sprout or sucker are removed without herbicide treatment, dense thickets develop—impeding access, swelling workloads, increasing costs, blocking lines-of-site, and degrading wildlife habitat (Figure 8). Treating suckering plants allows compatible early successional species to dominate the right-of-way and out-compete incompatible species, ultimately reducing work.

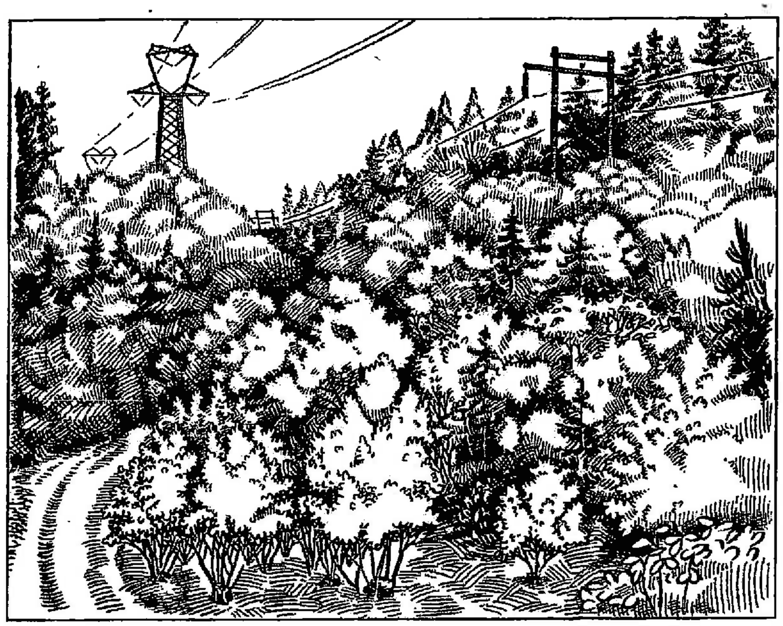

Figure 8. Sprouting from cut stumps.

Closed Chain of Custody

Traditionally, herbicides have been supplied in concentrated forms in non-returnable containers. This requires handling open containers of concentrate on job sites for mixing and loading. Advances in chemistry and application methods have significantly reduced the volume of herbicide solutions applied. These advances have made it practical to adopt a closed chain of custody concept in which ready-to-use and diluted concentrate formulations are utilized in closed delivery systems (Figure 9)—a practice that further protects the applicator and environment (Goodfellow and Holt 2011).

The closed chain of custody concept includes herbicide shipping, distribution, storage, and mixing, and includes returning empty containers for refilling and reuse. It involves four cycles (Goodfellow and Holt 2011):

- *Container cycle*: supply containers are returned, refilled, and reused
- *Integrity cycle*: closed connections at the transfer points between supply containers, mix tank, and application equipment
- *Documentation cycle*: a container tracking system that establishes an auditable record documenting movement of herbicides and containers
- *Herbicide cycle*: use of customer blends containing the required active ingredient and adjuvants

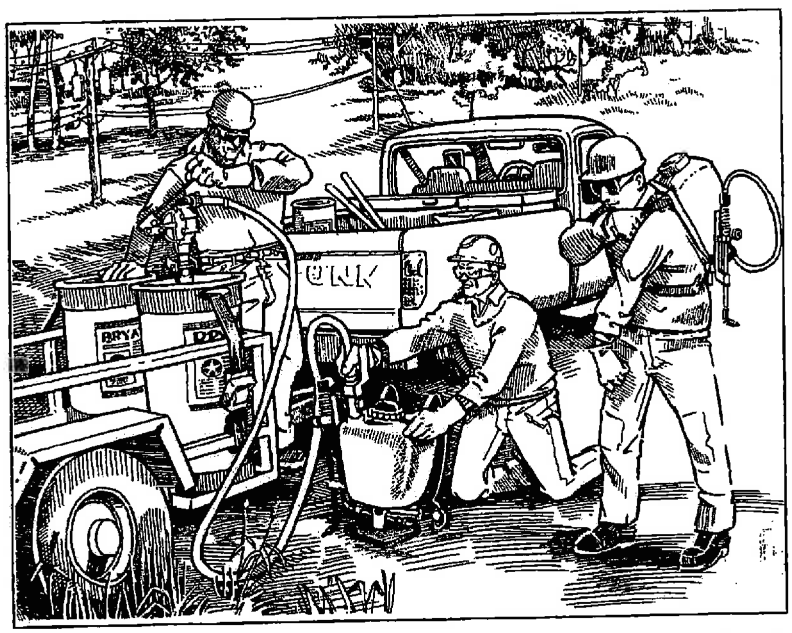

Figure 9. An interlocking valve connection between fill hose and backpack is preferred.

The Utility Arborist Association (UAA) and ISA have produced best management practices for closed chain of custody for herbicides in the utility vegetation management industry (Goodfellow and Holt 2011). Readers are encouraged to consult these best practices for further information on the subject.

Selectivity

Herbicides can be selective or nonselective depending on their type. Selective herbicides only control specific kinds of plants when applied according to the label. For example, synthetic auxins are a class of selective herbicides that control broadleaved plants, but do not harm grass species. By contrast, nonselective herbicides work on both broadleaved plants and grasses.

Application techniques can be either selective or nonselective. Selective applications are used against specific plants or pockets of plants. Nonselective techniques target areas rather than individual plants (see *Herbicide Application Methods*). Nonselective use of nonselective herbicides eliminates all plants in the application area. Nonselective use of a selective herbicide controls treated plants that are sensitive to the herbicide, without affecting plants with low sensitivity. Selective use of either would only control targeted vegetation. Selective use is preferable unless target vegetation density is high.

Herbicide Application Methods

Herbicide application methods are categorized by the quantity of herbicide used, the character of the target, vegetation density, and site parameters. Dyes can be used in the herbicide mix to mark areas that have been treated. Application methods include individual stem, broadcast, and aerial treatments.

Individual Stem Treatment

Individual stem treatments are selective applications. They include stump, basal, injection, frill (hack and squirt), selective foliar, and side-pruning applications (Table 2). Because they are applied selectively, proper individual

Table 2. Herbicide treatment methods.

Individual Stem	Broadcast	Aerial
Stump	High volume foliar	Fixed wing
Basal	Low volume foliar	Rotary wing
Injection	Cut stubble	
Frill	Bare ground	
Selective foliar (low and high volume)		
Sidepruning		

stem applications work well to avoid damage to sensitive or off target plants. However, this treatment is impractical for large areas or for sites dominated by undesirable species.

Stump applications are a common individual stem treatment in which herbicides are applied to the cut stump surface around the cambium and top side of the bark (Figure 10). Water-based formulations require immediate stump treatment, while vegetable oil-based herbicides can be put on hours, days, or even weeks after cutting.

Figure 10. Stump treatments are a common individual stem treatment where herbicides are applied to the cut stump surface around the cambium and top side of the bark.

Injection involves injecting herbicide into a tree, while frill treatments consist of herbicide application into wounds made in the trunk. Injections or frill treatments are especially useful against large incompatible trees to be left standing for wildlife.

Basal applications often use an herbicide in a vegetable oil carrier applied to the base and encircling stems and the root collars (Figure 11). The vegetable oil penetrates the bark, carrying the herbicide into the plant. Although basal applications can be made year round, dormant treatment is often best on deciduous

Figure 11. Basal application

plants, when they do not have foliage that can obstruct access to individual stems and are not covered by snow or ice.

Selective foliar applications are done by spraying foliage and shoots of specific target plants (Figure 12). They can be either low or high volume treatments. For low volume applications, comparatively high concentrations of herbicide active ingredient are made in lower volumes of water than would be used with high volume treatment. Foliar applications are only made during the active growing season, normally late spring to early fall.

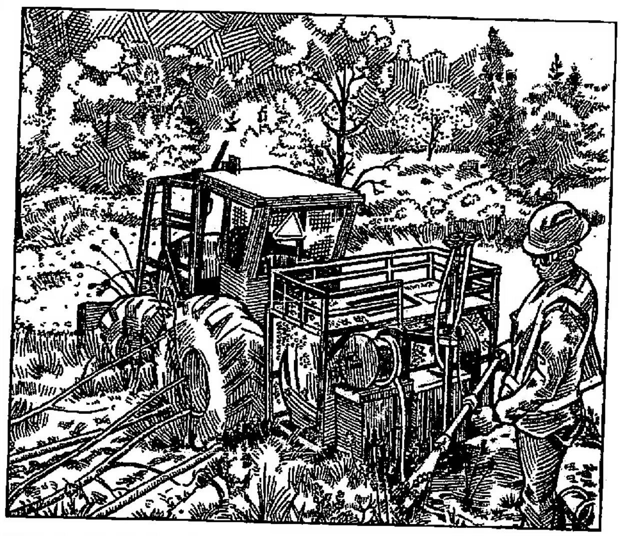

Figure 12. Selective foliar application.

Chemical side pruning is a technique where non-translocatable herbicides are applied to foliage of specific branches growing toward the electric facility, causing them to defoliate and eventually be shed by the tree.

Broadcast Treatment

Broadcast treatments are nonselective because they control all plants sensitive to a particular herbicide in a treatment area. They can provide a degree of selectivity if used with selective herbicides. Even then, broadcast treatments do not differentiate between compatible and incompatible plants that the herbicide controls. Broadcasting is particularly useful to control large infestations of incompatible vegetation (including invasive species) in rights-of-way or along access roads.

Broadcast techniques include high- or low-volume foliar, cut-stubble, and bare-ground applications. High-volume foliar applications are similar to high-volume selective foliar applications. The difference is that broadcast high-volume foliar treatments target a broad area of incompatible species rather than individual plants or pockets of plants. Low-volume foliar treatments are applied similarly, but with specialized nozzles and thin inversion formulations that minimize volume and spray drift.

Cut-stubble applications are made (using either high- or low-volume broadcast treatments) over areas that have just been mowed. Bare-ground treatments are used for clearing all plant material in a prescribed area, such as in substations or around poles, to protect against fire. Bare-ground applications are usually granular or liquid applications following mechanical removal of vegetation, or used as a pre-emergent in maintaining graveled areas, such as substation enclosures.

Aerial Treatments

Aerial treatments are made by helicopter (rotary wing) or small airplane (fixed wing). Rotary wing aircraft provide the most accuracy, because helicopters can hover, are more maneuverable, and can fly more slowly than airplanes. However, airplanes are less expensive to operate than helicopters. Aerial control methods are nonselective, but may provide a level of selectivity if used with proper herbicides. Aerial applications can be useful in remote or difficult-to-access sites, and can be quick and cost effective, especially if large areas need to be treated. They can also be used where incompatible vegetation dominates a right-of-way or vegetation height limits ground-based treatments. The primary disadvantage of aerial application is that it carries the threat of off-target drift. To limit drift, work must be performed under low-wind conditions with specialized nozzles and formulations.

Biological Control Methods

Biological control is management of vegetation by establishing and conserving compatible, stable plant communities, using plant competition, animals, insects, or pathogens. For example, some plants, including certain grasses, release chemicals that suppress other plant species growing around them. Known as allelopathy, this characteristic can serve as a type of biological control against incompatible species. Promoting wildlife populations is also a form of biological control. Birds, rodents, and other animals can encourage compatible plant communities by eating seeds or shoots of undesirable plants.

A biological control known as cover-type conversion provides a competitive advantage to short-growing, early successional plants, allowing them to thrive and successfully compete against unwanted tree species for sunlight, essential elements, and water. Early successional plant communities are relatively stable and tree-resistant. This control method reduces the amount of work, including herbicide application, with each successive treatment. While it is a type of biological control, cover-type conversion may require the use of one or more other control methods—such as manual, mechanical, herbicide, or cultural—depending on conditions.

Tree-resistant communities are often created in two stages.The first involves nonselectively clearing the right-of-way of undesirable trees using the best applicable control method or combination of methods. The second stage involves developing a tree-resistant plant community using selective techniques, including herbicide applications, that opens an area to sunlight and encourages an often long-dormant seed reservoir of compatible species to germinate. In the long run, this type of biological control is the most desirable method, at least where it can be done effectively.

Cultural Control Methods

Cultural methods modify habitat to discourage incompatible vegetation and establish and manage desirable, early successional, and other compatible plant communities. Examples of cultural control include seeding, planting low-growing crops, and establishing pastures, prairies, compatible landscapes, and other managed areas. Fertilization and irrigation are techniques that may be used to help establish low-growing, compatible plant communities.

Engineering Solutions

While they are not vegetation control methods, engineering solutions can provide relief from vegetation-power line conflicts. They can include relocating, reconstructing, or burying lines. The disadvantage of engineering solutions is that they are often unaffordable for adjacent property owners or not cost-effective for utilities and their ratepayers. They can also have detrimental environmental impacts if inappropriately applied (Goodfellow 1995).

Wire-Border Zone Concept

The wire-border zone concept is a management philosophy that can be applied through cultural control. W.C. Bramble and W.R. Byrnes developed the concept in the mid-1980s out of research begun in 1952 on a transmission right-of-way in the Pennsylvania State Game Lands 33 Research and Demonstration project (Yahner and Hutnick 2004).

The wire zone is the section of a utility transmission right-of-way under the wires and extending on both sides to a specified distance (Bramble, Yahner and Byrnes 1992). The standard way to establish the wire zone is by a set measure (e.g., 10 ft [3 m] or another length) on each side of the wires. Goodfellow (2013) suggests demarcating the wire zone under the wires at a distance equal to 60% of phase-to-phase spacing on the border side of the outside conductors. The wire zone is managed to promote a low-growing plant community dominated by grasses, herbs, and small shrubs (e.g., under 3 ft [1 m] in height at maturity).

The border zone is the remainder of the right-of-way (Figure 13). It is managed to establish small trees and tall shrubs (under 25 ft [7.5 m] in height at maturity). The concept may be modified to accommodate side slope (Figure 14). When properly managed, diverse, tree-resistant plant communities develop in wire and border zones. These plant communities not only protect the electric facility and reduce long-term maintenance, but also enhance wildlife habitat, forest ecology, and aesthetic values.

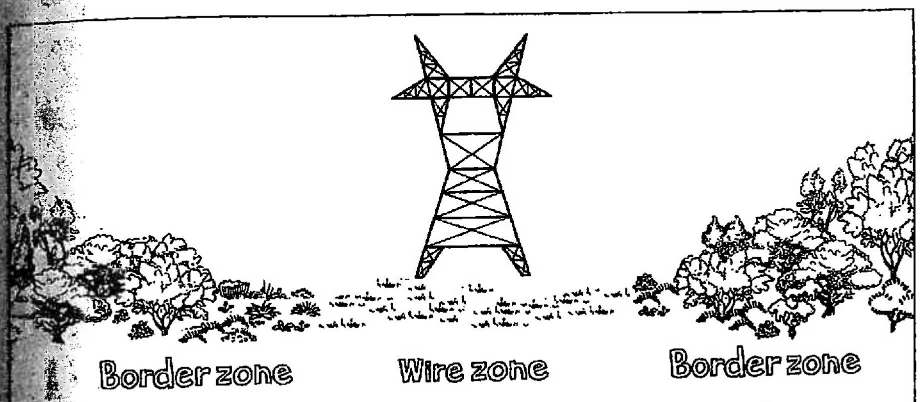

Figure 13. Wire-border zone.

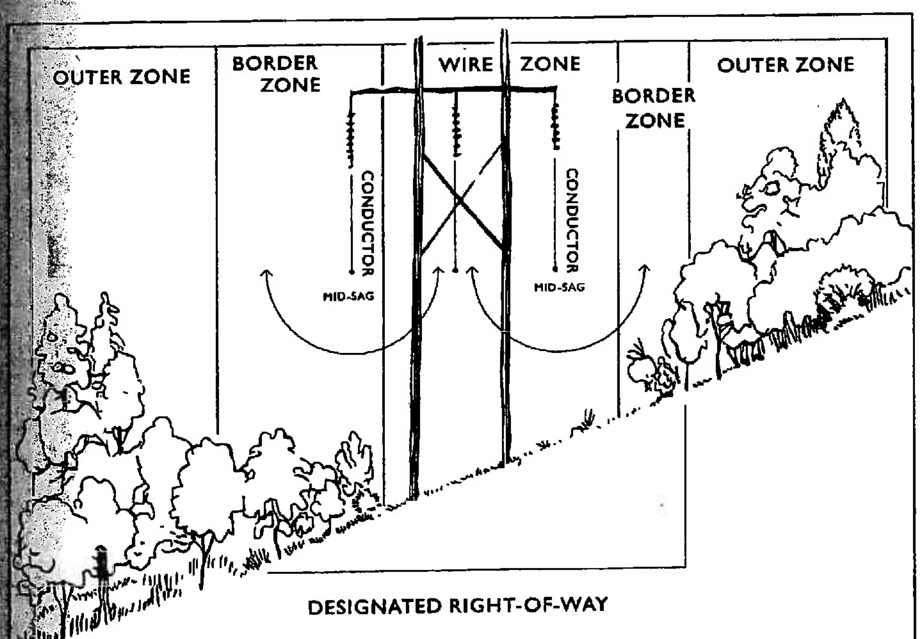

Figure 14. Modification of wire-border zone for side slope.

Although the wire-border zone concept is a best practice in many instances, it is not necessarily universally suitable. For example, standard wire-border zone prescriptions may be unnecessary where lines are high off the ground, such as across low valleys or canyons. One way to accommodate topography changes is to vary zones based on wire height. For example, vertical zones could be established over low valleys, or canyon bottoms, or other areas where conductors are high above the ground (e.g., 100 ft [30 m], or height mangers deem appropriate for a specific region), where only a few trees are likely to be tall enough to conflict with the lines (Figure 15). In those instances, trees that potentially interfere with transmission lines can be removed selectively on a case-by-case basis. In areas where the wire is lower, perhaps between 50-100 ft (15-30 m) over the ground, a border zone community could be developed throughout the right-of-way. Where the line is lower, less than 50 ft (15 m) off the ground, for example, managers could apply a full wire-border zone prescription. These modifications have many advantages. Removing fewer trees in valleys and canyons has environmental benefits. Streams often course through the valleys and canyons where lines are likely to be elevated. Leaving timber or border zone communities in valley and canyon bottoms helps shelter this valuable riparian habitat (see *Stream Protection*). It also has economic benefits, as unnecessarily removing trees is a waste of money.

Strict adherence to wire-border zone methodology may also be inappropriate in some fire protection jurisdictions, where border zone establishment is often discouraged out of concern it could provide ladder fuels to the adjacent forest. In these and other cases, management objectives could call for a perennial meadow or prairie plant community throughout the right-of-way. Meadows and

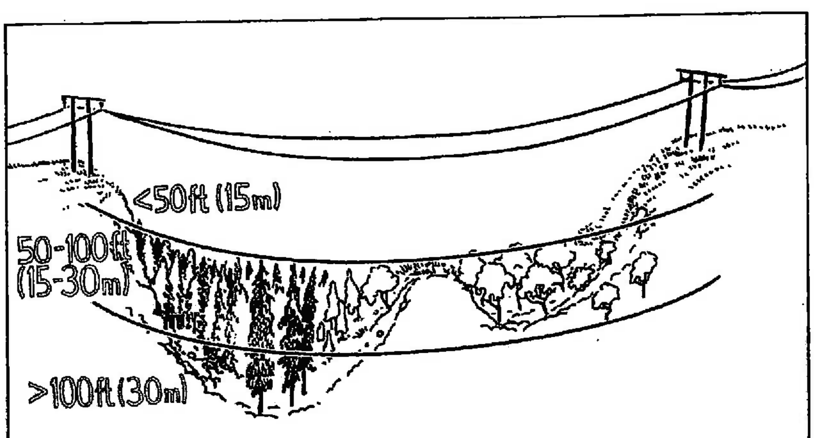

Figure 15. Wire-border zone for elevation of wire off ground.

prairies are legitimate, tree-resistant plant communities that can be established through IVM. The wire-border zone concept is a useful tool in situations where it meets management objectives as determined by utility vegetation managers.

Pipe zone-border zone

The wire-border zone concept can be modified to meet IVM objectives on many pipeline rights-of-way (Figure 16). The height and type of vegetation should meet management objectives. Over the pipe zone, native prairie forbs and grasses may be encouraged. Dense, low-growing, gas-sensitive, green cover could also be introduced into the pipe zone if desired. Taller-growing, compatible vegetation can be managed on the edges of the pipeline right-of-way, where it will not interfere with maintenance or pipe integrity. If prairie or other grasses are so tall that they interfere with testing or maintenance, a narrow path directly over the pipe can be mowed, without disturbing the remainder of

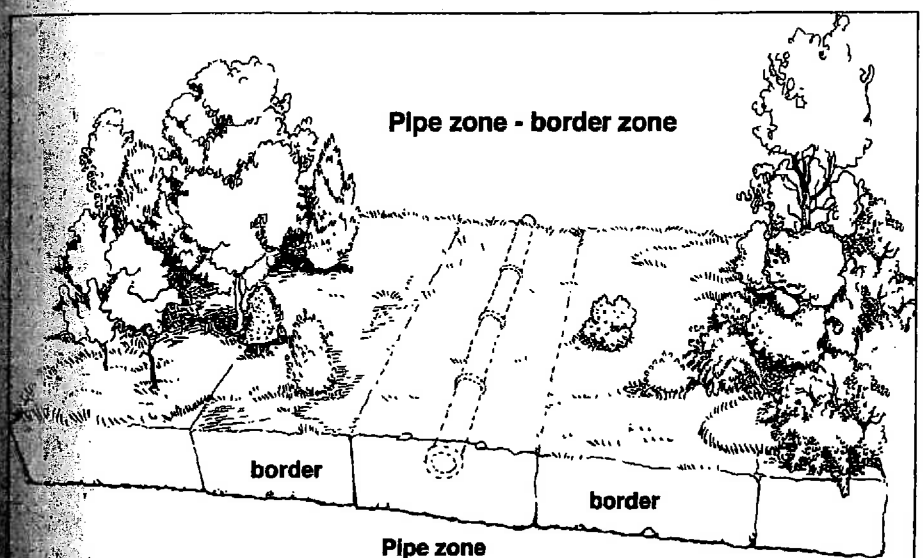

Figure 16. Pipe-border zone.

the right-of-way. This would result in the need for periodic strip-mowing, with low economic and environmental costs and greater benefits for certain wildlife species (Stedman and Brockbank 2012, Johnstone 2012).

Implement Control Methods

All laws and regulations governing IVM practices and specifications written by utility vegetation mangers must be followed. Integrated vegetation management control methods should be implemented on regular work schedules, which are based on established objectives and completed assessments. Work should progress systematically, using control measures determined to be best for varying conditions at specific locations along a right-of-way. Some considerations used in developing schedules include the importance and type of line, vegetation clearances, workloads, growth rate of predominant vegetation, geography, accessibility, and in some cases, time elapsed since the last scheduled work.

Initial Clearing and Reclamation

Initial clearing of new and reclaiming of neglected rights-of-way requires nonselective techniques, at least in areas dominated by incompatible vegetation. Subsequent projects on those rights-of-way can selectively target incompatible plants, working toward cover-type conversion.

Clearances

The system operator should establish and document appropriate clearance distances or vegetation heights to be achieved at the time of work. A utility vegetation manager should determine appropriate vegetation conditions, including clearances, throughout the system. Following work, vegetation on the right-of-way should consist of a height and species mix that meets management objectives, including reducing electric and gas safety and service-reliability threats, protecting the environment, and controlling costs. Achieving mandated minimum vegetation clearance distances (such as the minimum vegetation clearance distance [MVCD] in FAC-003 [NERC 2008]), while technically in compliance with regulations, is not in and of itself a best management practice. Nor should it be used as a limitation for managing vegetation on a right-of-way, or evaluating the efficacy of IVM operations. Doing so would allow the establishment of incompatible trees on the right-of-way, which would require periodic topping or severe pruning. In addition to creating unacceptable ongoing risk to facilities, tree maintenance operations can unnecessarily place workers at risk. Managers should bear in mind that clearances are just one objective out of many. The best practice is to remove incompatible trees, encourage compatible vegetation, and ensure— through ongoing monitoring and maintenance— that trees do not become established in these areas or have opportunities to violate minimum clearance requirements.

Debris Disposal

Debris such as logs and slash that result from IVM operations should be handled in a manner compatible with adjoining land use, terrain, aesthetics, wildlife habitat, and fire risk. Logs may be recoverable for firewood or timber products, and are often best left for the property owner or as wildlife habitat. Slash can be placed into piles, windrowed along rights-of-way edges, or lopped and scattered. Some jurisdictions may limit the height and length of slash piles. Neither slash nor logs should be placed below the high water mark of streams or other bodies of water, unless requested by a competent authority. Logs should not be moved from the work site if they are likely to be infested with an epidemic-causing disease or insect pest. Where appropriate (e.g., in remote areas or in wildlife management areas), dead standing timber that cannot strike the line or violate mandated minimum clearance requirements can be left as wildlife habitat.

Monitor Treatment and Quality Assurance

An effective IVM program must have documented processes to evaluate results. Evaluations can involve quality assurance while work is underway and after it is completed. Monitoring for quality assurance should begin shortly after work begins to correct any possible miscommunication or misunderstanding on the part of crew members. Early and consistent observation and evaluation also provides an opportunity to modify the plan, if necessary, in time for a successful outcome.

Utility vegetation management programs should have systems and procedures in place for documenting and verifying that vegetation management work was completed to specifications. Post-control reviews can be comprehensive or based on a statistically representative sample. The results should be compared to objectives, referencing the baseline surveys completed earlier in the planning process. A review of environmental, customer, archeological, or other outcomes may also be necessary, along with property owner and stakeholder surveys. This final review can identify additional work to be completed or highlight opportunities for improved management. The first step in the IVM process of planning and setting objectives then begins again (Figure 2).

Record Keeping

Records are necessary for quality assurance and future planning. The type of information needed is best determined by the utility vegetation manager. Relevant data commonly includes details on land ownership, the date of pre-notification, and access routes. Records should be digitized and reflect dates of communication, names of stakeholders, and the nature of discussions with them, including any commitments. Records should also be maintained on the type and voltage of line or pipeline capacity, along with work dates, methods, and location. Where appropriate, records should be maintained on threatened and endangered species and other considerations.

Herbicide records are required by law. Applicators should identify themselves, note the herbicide trade name, the active ingredient, and in the United States, the EPA number. Applicators also need to track the amount of herbicide applied, the location of the application, weather conditions at the time of treatment, how many trees or acres were treated, and other relevant factors.

3. IVM Application

Environmental Protection

Species of Concern

Vegetation management should not disturb or harm species of concern (i.e., rare, threatened, endangered, or otherwise protected species). Utility vegetation managers need to obey appropriate guidelines and regulations. Often, simple adjustments can be made to protect sensitive species without compromising desired outcomes.

Wetlands

Wetlands should be worked using suitable control methods. If herbicides are to be applied, only those labeled for use over water may be used in wetlands.

Stream Protection

To protect streams, incompatible vegetation may need to be selectively pruned or removed, or treated with appropriate herbicide to gradually establish a compatible riparian plant community. Equipment may only use existing or designated stream crossings.

Buffers

Stream crossings of right-of-way corridors, surface water supply reservoirs, and drinking water wells and springs need to be protected by buffers. Buffers should retain as much compatible vegetation as possible. If herbicides are needed within the buffer, only those appropriate for the site should be applied. Machine work should be avoided in buffers as equipment may leak or spill petroleum products, causing pollution or erosion. Utility vegetation managers, working along with competent authorities, should determine appropriate distances for particular buffers.

Archeological or Cultural Sites

Vegetation management activities should not disturb known archaeological or cultural sites. When necessary, archeological sites should be located and marked, and a plan established to adequately protect them during work. Field data inventories of known sites should be kept on file. Practices that won't damage the sites, such as manual cutting and backpack or aerial herbicide applications, should be considered for use at these locations.

4. Tree Pruning and Removal

Pruning for clearance of trees within pipeline and electric transmission rights-of-way is generally inconsistent with IVM management objectives. However, it may be necessary in rare cases involving legal restrictions. Electric distribution lines are often maintained with pruning as a part of an overall IVM strategy. When pruning is necessary, it should be conducted according to the most current version of the ANSI A300, Part 1: *Tree, Shrub, and Other Plant Management—Standard Practices (Pruning)* and ISA's *Best Management Practices: Utility Pruning of Trees* (Kempter 2004). Structurally unsound or dead trees located off the right-of-way in remote areas may be left for wildlife by reducing them in height so they will no longer strike the electric facility should they fall.

5. Summary

Integrated vegetation management—as presented in ANSI A300 Part 7 (ANSI 2012), and when implemented according to principles established by the work of peer-reviewed researchers, long-standing demonstration projects, and successful utility programs—offers a systematic way of planning and implementing a comprehensive, cost-effective, environmentally-sound vegetation management program that meets primary utility objectives and addresses legitimate stakeholder concerns. It consists of six elements:

1. Set Objectives
2. Evaluate the Site
3. Define Action Thresholds
4. Evaluate and Select Control Methods
5. Implement Control Methods
6. Monitor Treatment and Quality Assurance

Managers should select control options to best promote management objectives. Tree-resistant plant communities can be a desirable objective to reduce long-term workloads and costs because, once established, they out-compete incompatible plants. When effectively applied, IVM is a systematic, preventive strategy that results in site-specific treatments to meet management objectives. A sound program includes documented processes to evaluate results, which should involve both monitoring for quality assurance while work is underway and after it is completed. However, the overriding focus should be on environmentally-sound, cost-effective control of species that potentially conflict with the electric facility, while promoting compatible, early successional, sustainable plant communities.

6. Glossary

abatement plan–a process for reducing vegetation risk.

action thresholds–a point at which the level of incompatible plant species, density, height, location, or condition threatens the stated management objectives and requires implementation of a control method(s).

allelopathy–the production of chemicals by one plant species that can suppress or kill other species.

ANSI A300–the *American National Standard for Tree Care Operations—Tree, Shrub, and Other Woody Plant Management—Standard Practices*. American national arboricultural consensus standard series for tree care operations.

biological methods–management of vegetation by establishment and conservation of compatible, stable plant communities using plant competition, allelopathy, animals, insects, or pathogens. Cover-type conversion is a type of biological control.

best management practices–in the context of utility vegetation management, a best management practice is the most effective, safe, economical, and environmentally-sound procedure or procedures for maintaining utility rights-of-way. *Best Management Practices* is also the title of a series of booklets produced and published by the International Society of Arboriculture, which serve as companion documents to the ANSI A300 series.

border zone–a section of a transmission or pipeline right-of-way that extends from the wire or pipe zone to the right-of-way edge. The border zone is managed to promote a low-growing plant community of forbs, tall shrubs, and low-growing trees below a specified height (e.g., 25 ft or 7.5 m).

brush–standing woody stems (live or dead) less than 4 in (10 cm) in diameter at breast height (4.5 ft [1.35 m]).

bulk transmission–see *transmission lines*.

chemical control methods–management of incompatible vegetation through the use of herbicides or growth regulators.

closed chain of custody–an end-to-end process of documented ownership for herbicides, adjuvants, and containers from manufacturer through application, and the return of returnable, reusable containers to a customer blender for refilling and reuse (Goodfellow and Holt 2011).

compatible vegetation–vegetation that is desirable or consistent with the intended use of the site. For example, plant species that will never grow sufficiently close to violate minimum clearance distances with electric conductors.

cover-type conversion–a type of biological control where a stable, tree-resistant plant community is developed using selective techniques that opens an area to sunlight and encourages desirable plants to out-compete undesirable vegetation in a right-of-way.

cultural methods–management of vegetation through alternative use of the right-of-way that precludes growth of incompatible vegetation through establishment of crops, pastures, prairies, parks, successful cover-type conversion, or other managed landscape.

debris–material such as slash, logs, or chips left after right-of-way clearing or maintenance operations.

distribution lines–high voltage lines generally energized between 4kV and 22kV, but can range from 600v to 35kV. Distribution lines usually serve commercial and residential customers.

early-successional plant communities–plant communities that first develop following disturbance. Succession is the replacement of one plant community by another. Cover-type conversion in a utility context inhibits successional progress past an early stage.

frilling–a method of herbicide application where tools are used to remove the bark of target woody plants, and herbicide is applied to the wound.

hack and squirt–see *frilling*.

hazard tree–a tree that has been assessed and found to be likely to fail and cause an unacceptable degree of injury, damage, or disruption. Hazard trees pose a high or extreme risk (Smiley, Matheny and Lilly 2011).

herbicide–a pesticide used to kill, slow, or suppress plant growth by interfering with botanical pathways.

imminent threat–a vegetation condition that could cause damage or interruption of service to overhead energized facilities or pipelines at any moment.

incompatible vegetation–vegetation that is undesirable, unsafe, or interferes with the intended use of the site.

integrated pest management (IPM)–an ecologically-based strategy for long-term damage prevention caused by pests using a combination of techniques such as biological, cultural, chemical, and genetic control.

integrated vegetation management (IVM)–a system of managing plant communities based in IPM, where managers identify compatible and incompatible vegetation, consider action thresholds, evaluate control methods, and select and implement controls to achieve specific objectives. The choice of control methods is based on the anticipated effectiveness, environmental impact, site characteristics, safety, security, economics, and other factors.

ISA–International Society of Arboriculture.

kV–1000 volts.

level 1 or limited visual tree risk assessment–periodic, visual assessment of trees within the strike zone, in order to identify obvious defects that could cause a tree or tree part to fall directly on an overhead high-voltage conductor. Level 1 assessments are conducted from a specified perspective such as foot, vehicle, or aerial patrol to identify a tree or trees among a population that have an imminent or probable likelihood of failure (Smiley, Matheny and Lilly 2011).

level 2 or basic tree risk assessment–detailed visual inspection of a tree and surrounding site that may include the use of simple tools. It requires that a tree risk assessor walk completely around the tree trunk looking at the site, aboveground roots, trunk, and branches (Smiley, Matheny and Lilly 2011).

line–a distribution or transmission electric facility including wire, poles, and attachments.

logs–woody stems greater than 6 in (15 cm) in diameter that result from tree or large branch removal.

low-growing plant community–a population of plants that have a low mature height (e.g., 3 ft [1 m] or less). Examples include grasses, shrubs, forbs, and herbs. Low-growing plant communities can often effectively compete with trees and tall-growing shrubs for sunlight, essential elements, and moisture. Once established, low-growing plant communities are relatively self-sustaining and can be maintained with a minimum of intervention.

maintenance cycle–planned length of time that must be maintained between vegetation management activities.

manual methods–vegetation cutting or removal using tools carried by hand.

mechanical methods–vegetation removal using machines such as mowers, rubber-tire or tracked tractors, or excavators.

minimum vegetation clearance distance (MVCD)–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.

National Electrical Safety Code® (NESC)–a standard in the United States covering basic provisions for safeguarding persons from hazards resulting from installation, operation, or maintenance of conductors and equipment in electric supply stations, overhead and underground electric supply, and communication lines. It also contains work rules for construction, maintenance and operations of electric supply, and communication lines and equipment.

nonselective management–method of controlling vegetation without regard to whether or not the vegetation is desirable or undesirable.

pipe zone-border zone–an adaptation of the wire-border zone concept for pipeline rights-of-way. The pipe zone is an inspection area corresponding to the wire zone and is comprised of low-growing species (Stedman and Brockbank 2012).

right-of-way–a corridor of land used for a specific purpose such as an electric transmission or pipe line. (plural: rights-of-way.)

right-of-way reclamation–establishing IVM on a right-of-way that has not been managed to the full extent of its easement or ownership rights and intended purpose. Reclamation usually involves initial nonselective control techniques.

risk–the combination of the likelihood of an event and the severity of the potential consequences. In the context of IVM, risk is the likelihood of trees, tree parts, or other vegetation falling onto—or growing into—utility facilities, causing damage and/or interrupting utility services, combined with the severity of the potential consequences.

selective management–methods used to target undesirable vegetation while retaining desirable vegetation.

slash–non-standing debris less than 6 in (15 cm) in diameter left after right-of-way clearing operations.

spark-over–a luminous discharge of electricity through a gap between two conductive objects (e.g., a power line and a tree).

specification–in the context of IVM, a document containing detailed, measurable plans and requirements needed for an effective vegetation management program. Must be written by a utility vegetation manager.

stakeholder–a person or group that has a legitimate interest in a project or organization.

strike zone–360-degree area around a tree equal to that tree's height. Constitutes a space upon which a tree could fall if it failed.

subtransmission lines–high-voltage lines generally energized between 69 and 161 kV. They can be as low as 35 kV. Subtransmission lines connect bulk transmission substations to industrial customers or distribution substations.

transmission lines–high voltage lines that are critical to regional electric reliability. They are generally energized between 230 kV and 765 kV, although some transmission lines are energized as low as 69 kV. Transmission lines connect generation and bulk transmission substations.

transmission grid–interconnection of transmission lines used to deliver electricity from power plants to transmission substations or to transfer electricity to other utilities or regions.

tree growth regulator (TGR)–chemical that can be applied to trees that slows terminal growth by reducing cell elongation.

utility vegetation manager–a professional with the proper experience, education, and training to successfully establish or supervise an integrated vegetation management program.

wetland–land where water saturation is the dominant factor determining the nature of soil development and the types of plant and animal communities living in and on the soil.

windrow–in the context of utility vegetation management, slash or debris raked or stacked in a row to the side of a right-of-way. The term evokes a row of hay raked up to dry before being rolled or bailed.

wire zone–section of a utility transmission right-of-way directly under the wires, and extending to a utility specified distance (e.g., 60% of phase spacing; 10 ft or 3 m) on each side. The wire zone is typically managed to sustain a low-growing forb, grass, herb, and shrub plant community.

Selected References

ANSI. 2008. *ANSI A300: American National Standard for Tree Care Operations—Tree, Shrub, and Other Woody Plant Management—Standard Practices. (Pruning)* Part 1. Tree Care Industry Association, Manchester, New Hampshire, USA.

ANSI. 2011. *ANSI A300: American National Standard for Tree Care Operations—Tree, Shrub, and Other Woody Plant Management—Standard Practices (Tree Risk Assessment a.Tree Structure Assessment)* Part 9. Tree Care Industry Association. Manchester, New Hampshire, USA.

ANSI. 2012. *ANSI A300: American National Standard for Tree Care Operations—Tree, Shrub, and Other Woody Plant Management—Standard Practices (Integrated Vegetation Management a. Utility Rights-of-way)* Part 7. Tree Care Industry Association. Manchester, New Hampshire, USA.

ANSI. 2012. *ANSI Z133:*American *National Standard for Arboricultural Operations—Safety Requirements.* International Society of Arboriculture, Champaign, Illinois, USA.

Appelt, P. and D. Gartman. 2004. Integrated Vegetation Management on Natural Gas Pipeline Rights-of-way. Presentation to the *Environmental Concerns in Rights-of-Way Management 8th International Symposium.* September 12–16, 2004. Saratoga Springs, New York, USA.

Bonneville Power Administration. 2000. *Transmission System Vegetation Management Program: Final Environmental Impact Statement.* DOE/EIS. Bonneville Power Administration. Portland, Oregon, USA.

Bramble, W.C., R.H. Yahner, and W.R. Byrnes. 1992. Breeding-bird population changes following right-of-way maintenance treatments. *Journal of Arboriculture.* 18:23–32.

Childs, Shawn. 2005. *Environmental Assessment: PacifiCorp Vegetation Management in Power Line Rights-of-Way. United States Department of Agriculture U.S. Forest Service Wasatch-Cache National Forest.* SWCA Environmental. Salt Lake City, Utah, USA.

Cieslewicz, S. and R. Novembri. 2004. *Utility Vegetation Management Final Report.* Commissioned to support the Federal Investigation of the August 14, 2003 Northeast Blackout. United States Federal Energy Regulatory Commission. Washington, District of Columbia, USA.

Cieslewicz, S. and R. Novembri. 2004. *Utility Vegetation Management: Trends, Issues, and Practices.* CN Utility Consulting, LLC. Novato, California, USA.

Doran, G.T. 1981. There is a S.M.A.R.T Way to Write Management's Goals and Objectives. *Management Review.* 70(11):35–36.

Gilman, Edward F., and Sharon J. Lilly. 2002. *Best Management Practices: Tree Pruning.* International Society of Arboriculture. Champaign, Illinois, USA.

Goodfellow, J.W. 1995. Engineering and Construction Alternatives to Line Clearance Tree Work. *Journal of Arboriculture.* 21(1):41–49.

Goodfellow, J.W. and H.A. Holt. 2011. *Utility Arborist Association Best Management Practices: Field Guide to Closed Chain of Custody for Herbicides in the Utility Vegetation Management Industry.* International Society of Arboriculture. Champaign, Illinois, USA.

Goodfellow, J.W. 2013. Personal communication from the author, 5/1/2013.

Hutnik, R.J., W.C. Bramble and W.R. Byrnes. 1987. Seedbed Contents on an Electric Transmission Right-of-way. In: Byrnes, W.R. and H.A. Holt (Eds.). 1987. *Proceedings Fourth Symposium on Environmental Concerns in Rights-of-way Management.* Purdue University. West Lafayette, Indiana, USA.

Institute of Electrical and Electronics Engineers. 2012. *National Electric Safety Code.* IEEE. New York, New York, USA.

IFCI. 2000. *Urban-Wildland Interface Code™.* International Fire Code Institute. Whittier, California, USA.

Johnstone, R.A., M.R. Haggie. 2012 Regional Vegetation Management Best Practices Case Studies: An Applied Approach for Utility and Wildlife Managers. *Environmental Concerns in Rights-of-Way Management 9th*

International Symposium (editors: J.M Evans, J.W. Goodrich-Mahoney, D. Mutrie, and J. Reinemann). International Society of Arboriculture, Champaign, Illinois, USA.

Kempter, Geoff. 2004. *Best Management Practices: Utility Pruning of Trees.* International Society of Arboriculture. Champaign, Illinois, USA

Matheny, N.P. and J.R. Clark. 1994. *A Photographic Guide to the Evaluation of Hazard Trees in Urban Areas (second edition).* International Society of Arboriculture, Champaign, Illinois, USA.

Miller, Terry L (Ed.) 1993. *Oregon Pesticide Applicator Manual: A Guide to Safe Use and Handling of Pesticides.* Oregon State University Extension, Corvallis, Oregon, USA.

Miller, R.W. 1997. *Urban Forestry: Planning and Managing Urban Greenspaces (second edition).* Prentice Hall. Upper Saddle River, New Jersey, USA.

Niering, W. A. and F. E. Egler.1953. A Shrub Community of Viburnum lentago Stable for Twenty-Five Years. *Ecology 36* (2): 63–73.

North American Electric Reliability Council. 2008. *Standard Transmission Vegetation Management Standard FAC-003-2 Technical Reference.* NERC. Washington, District of Columbia, USA.

Nowak, C.A., B.D. Balard. 2005. A Framework for Applying Integrated Vegetation Management on Rights-of-way. *Journal of Arboriculture.* 31(1): 28–37.

O'Callaghan, D.P. and D. Ham. 2002. *Utility Specialist Certification Study Guide.* International Society of Arboriculture. Champaign, Illinois, USA.

Richards, N.A. 1973. *Old Field Vegetation as an Inhibitor of Tree Vegetation.* The Gary Arboretum of the New York Botanical Garden, New York, New York, USA.

Shamoun, S.F. 1999. *Application of Biological Control to Vegetation Management in Forestry.* In Proceedings of the X International Symposium on Biological Control. July 4–14 July 1999, Montana State University, Bozeman, Montana, USA.

Sharpe, Handy and Allen. 1976. *Introduction to Forestry.* McGraw-Hill. New York, New York, USA.

Shatford, J. D. Hibbs, and L. Norris. 2003. *Identifying Plant Communities Resistant to Conifer Establishment Along Utility Rights-of-way in Washington and Oregon, U.S.* Journal of Arboriculture. 29(3):172–176.

Smiley, E.T., N. Matheny and S. Lilly. 2011. *Best Management Practices: Tree Risk Assessment*, International Society of Arboriculture. Champaign, Illinois, USA.

Stedman, J. and R. Brockbank. 2012. *Integrated Vegetation Management on Pipeline Rights-of way: Part One.* Utility Arborist Newsline. 3(1):1,4–5.

U.S. Department of the Interior, Bureau of Land Management. 2005. *DRAFT: Vegetation Treatment Using Herbicides on Bureau of Land Management Lands in 17 Western States: Programmatic Environmental Impact Statements.* DES 05–56. U.S. DOI/BLM. Washington, District of Columbia, USA.

U.S. Department of Labor Occupational Safety and Health Administration. No date. *Electric Power Generation, Transmission and Distribution.* U.S. DOL/OSHA. Washington, District of Columbia, USA.

U.S. Environmental Protection Agency. 2006. Pesticide Environmental Stewardship Program; Washington, District of Columbia, USA. Accessed July 2013. http://www.epa.gov/pesp/

U.S. Environmental Protection Agency. 2004. *What Are Wetlands?* Environmental Protection Agency. Washington, District of Columbia, USA. Accessed May 2013. http://www.epa.gov/owow/wetlands/vital/what.html.

U.S. Federal Energy Regulatory Commission. 2004. *Utility Vegetation Management and Bulk Electric Reliability Report from the Federal Energy Regulatory Commission. FERC.* Washington, District of Columbia, USA.

Utililty Arborist Association. 2009. *Utility Best Management Practices: Tree Risk Assessment and Abatement for Fire-prone States and Provinces in the Western Region of North America.* Utility Arborist Association, Champaign, Illinois, USA.

Vandenbroucke, J.E., C. Gaucher, and N. Major. 2005. Biological Vegetation Management: An Alternative to Herbicide Pesticides. *Arboriculture & Urban Forestry*. 31(5):251–256.

Yahner, R.H., W.C. Bramble, and W.R. Byrnes. 2001. Effect of Vegetation Maintenance of an Electric Transmission Line Right-of-way on Reptile and Amphibian Populations. *Journal of Arboriculture*. 27:24–28.

Yahner, R.H. and R.J. Hutnik. 2004. Integrated Vegetation Management on an Electric Transmission Right-of-way in Pennsylvania, U.S. *Journal of Arboriculture*. 30:295–300.

Yahner, R.H. 2004 Wildlife *Response to more than 50 years of Vegetation Maintenance on a Pennsylvania, U.S. Right-of-way.* Journal of Arboriculture. 30(2): 123–126.

A. Introduction

1. **Title:** **Transmission Vegetation Management**
2. **Number:** **FAC-003-4**
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 federal[1], 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 federal[2], state, provincial, public, private, or tribal entities:

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[1] EPAct 2005 section 1211c: *"Access approvals by Federal agencies."*

[2] *Id.*

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 of sight[3] 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.

5. Effective Date: See Implementation Plan

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

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.

[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.

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 Minimum Vegetation Clearance Distance (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 below[4] *[Violation Risk Factor: High] [Time Horizon: Real-time]*:

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[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.

1.1. An encroachment into the MVCD as shown in FAC-003-Table 2, observed in Real-time, absent a Sustained Outage,[5]

1.2. An encroachment due to a fall-in from inside the ROW that caused a vegetation-related Sustained Outage,[6]

1.3. An encroachment due to the blowing together of applicable lines and vegetation located inside the ROW that caused a vegetation-related Sustained Outage[7],

1.4. 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 below[9] *[Violation Risk Factor: High] [Time Horizon: Real-time]*:

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

2.2. An encroachment due to a fall-in from inside the ROW that caused a vegetation-related Sustained Outage,[11]

2.3. An encroachment due to the blowing together of applicable lines and vegetation located inside the ROW that caused a vegetation-related Sustained Outage,[12]

2.4. An encroachment due to vegetation growth into the line MVCD that caused a vegetation-related Sustained Outage.[13]

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[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.
[11] See footnote 6.
[12] *Id.*
[13] *Id.*

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: *[Violation Risk Factor: Lower] [Time Horizon: Long Term Planning]:*

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.

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

R5. When an applicable Transmission Owner and an applicable Generator Owner are 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 ROW[14] [*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*]:

7.1. Change in expected growth rate/environmental factors

7.2. Circumstances that are beyond the control of an applicable Transmission Owner or applicable Generator Owner[15]

7.3. Rescheduling work between growing seasons

7.4. Crew or contractor availability/Mutual assistance agreements

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[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.

[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.

7.5. Identified unanticipated high priority work

7.6. Weather conditions/Accessibility

7.7. Permitting delays

7.8. Land ownership changes/Change in land use by the landowner

7.9. 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:
"Compliance Enforcement Authority" means NERC or the Regional Entity, or any entity as otherwise designated by an Applicable Governmental Authority, in their respective roles of monitoring and/or enforcing compliance with mandatory and enforceable Reliability Standards in their respective jurisdictions.

1.2. Evidence Retention:
The following evidence retention period(s) 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 entity shall keep data or evidence to show compliance as identified below unless directed by its Compliance Enforcement Authority to retain specific evidence for a longer period of time as part of an investigation.

- The applicable Transmission Owner and applicable Generator Owner retains data or evidence to show compliance with Requirements R1, R2, R3, R5, R6 and R7, for three calendar years.
- 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 an 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.

1.3. Compliance Monitoring and Enforcement Program
As defined in the NERC Rules of Procedure, "Compliance Monitoring and Enforcement Program" refers to the identification of the processes that will be used to evaluate data or information for the purpose of assessing performance or outcomes with the associated Reliability Standard.

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.

Violation Severity Levels (Table 1)

R #	Table 1: Violation Severity Levels (VSL)			
	Lower VSL	Moderate VSL	High VSL	Severe VSL
R1.			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-003-4-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: • *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.			The responsible entity failed to manage vegetation to prevent encroachment into the MVCD of a line not identified as an element of	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-003-4-Table 2 was observed in real time absent a Sustained Outage.	an IROL or Major WECC transfer path and a vegetation-related Sustained Outage was caused by one of the following: • *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*
R3.		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.			The responsible entity experienced a confirmed	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.	vegetation threat and did not notify the control center holding switching authority for that applicable line.
R5.				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.	The responsible entity failed to inspect 5% or less of its applicable lines (measured in units of choice - circuit, pole line, line miles or kilometers, etc.)	The responsible entity failed 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.).	The responsible entity failed to 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.).	The responsible entity failed to inspect more than 15% of its applicable lines (measured in units of choice - circuit, pole line, line miles or kilometers, etc.).
R7.	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 Variances

None.

E. Associated Documents

- FAC-003-4 Implementation Plan

Version History

Version	Date	Action	Change Tracking
1	January 20, 2006	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.	New
1	April 4, 2007	Regulatory Approval - Effective Date	New
2	November 3, 2011	Adopted by the NERC Board of Trustees	New
2	March 21, 2013	FERC Order issued approving FAC-003-2 (Order No. 777) FERC Order No. 777 was issued on March 21, 2013 directing NERC to "conduct or contract testing to obtain empirical data and submit a report to the Commission providing the results of the testing."[16]	Revisions

[16] *Revisions to Reliability Standard for Transmission Vegetation Management, Order No. 777*, 142 FERC ¶ 61,208 (2013)

2	May 9, 2013	Board of Trustees adopted the modification of the VRF for Requirement R2 of FAC-003-2 by raising the VRF from "Medium" to "High."	Revisions
3	May 9, 2013	FAC-003-3 adopted by Board of Trustees	Revisions
3	September 19, 2013	A FERC order was issued on September 19, 2013, approving FAC-003-3. This standard became enforceable on July 1, 2014 for Transmission Owners. For Generator Owners, R3 became enforceable on January 1, 2015 and all other requirements (R1, R2, R4, R5, R6, and R7) became enforceable on January 1, 2016.	Revisions
3	November 22, 2013	Updated the VRF for R2 from "Medium" to "High" per a Final Rule issued by FERC	Revisions
3	July 30, 2014	Transferred the effective dates section from FAC-003-2 (for Transmission Owners) into FAC-003-3, per the FAC-003-3 implementation plan	Revisions
4	February 11, 2016	Adopted by Board of Trustees. Adjusted MVCD values in Table 2 for alternating current systems, consistent with findings reported in report filed on August 12, 2015 in Docket No. RM12-4-002 consistent with FERC's directive in Order No. 777, and based on empirical testing results for flashover distances between conductors and vegetation.	Revisions
4	March 9, 2016	Corrected subpart 7.10 to M7, corrected value of .07 to .7	Errata
4	April 26, 2016	FERC Letter Order approving FAC-003-4. Docket No. RD16-4-000.	

FAC-003 — TABLE 2 — Minimum Vegetation Clearance Distances (MVCD)[17]

For **Alternating Current** Voltages (feet)

(AC) Nominal System Voltage (KV)[+]	(AC) Maximum System Voltage (kV)[18]	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	MVCD feet Over 11000 ft up to 12000 ft	MVCD feet Over 12000 ft up to 13000 ft	MVCD feet Over 13000 ft up to 14000 ft	MVCD feet Over 14000 ft up to 15000 ft
765	800	11.6ft	11.7ft	11.9ft	12.1ft	12.2ft	12.4ft	12.6ft	12.8ft	13.0ft	13.1ft	13.3ft	13.5ft	13.7ft	13.9ft	14.1ft	14.3ft
500	550	7.0ft	7.1ft	7.2ft	7.4ft	7.5ft	7.6ft	7.8ft	7.9ft	8.1ft	8.2ft	8.3ft	8.5ft	8.6ft	8.8ft	8.9ft	9.1ft
345	362[19]	4.3ft	4.3ft	4.4ft	4.5ft	4.6ft	4.7ft	4.8ft	4.9ft	5.0ft	5.1ft	5.2ft	5.3ft	5.4ft	5.5ft	5.6ft	5.7ft
287	302	5.2ft	5.3ft	5.4ft	5.5ft	5.6ft	5.7ft	5.8ft	5.9ft	6.1ft	6.2ft	6.3ft	6.4ft	6.5ft	6.6ft	6.8ft	6.9ft
230	242	4.0ft	4.1ft	4.2ft	4.3ft	4.3ft	4.4ft	4.5ft	4.6ft	4.7ft	4.8ft	4.9ft	5.0ft	5.1ft	5.2ft	5.3ft	5.4ft
161*	169	2.7ft	2.7ft	2.8ft	2.9ft	2.9ft	3.0ft	3.0ft	3.1ft	3.2ft	3.3ft	3.3ft	3.4ft	3.5ft	3.6ft	3.7ft	3.8ft
138*	145	2.3ft	2.3ft	2.4ft	2.4ft	2.5ft	2.5ft	2.6ft	2.7ft	2.7ft	2.8ft	2.8ft	2.9ft	3.0ft	3.0ft	3.1ft	3.2ft
115*	121	1.9ft	1.9ft	1.9ft	2.0ft	2.0ft	2.1ft	2.1ft	2.2ft	2.2ft	2.3ft	2.3ft	2.4ft	2.5ft	2.5ft	2.6ft	2.7ft
88*	100	1.5ft	1.5ft	1.6ft	1.6ft	1.7ft	1.7ft	1.8ft	1.8ft	1.8ft	1.9ft	1.9ft	2.0ft	2.0ft	2.1ft	2.2ft	2.2ft
69*	72	1.1ft	1.1ft	1.1ft	1.2ft	1.2ft	1.2ft	1.2ft	1.3ft	1.3ft	1.3ft	1.4ft	1.4ft	1.4ft	1.5ft	1.6ft	1.6ft

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

[+] *Table 2 – Table of MVCD values at a 1.0 gap factor (in U.S. customary units), which is located in the EPRI report filed with FERC on August 12, 2015. (The 14000-15000 foot values were subsequently provided by EPRI in an updated Table 2 on December 1, 2015, filed with the FAC-003-4 Petition at FERC)*

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[17] 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.

[18] 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.

[19] The change in transient overvoltage factors in the calculations are the driver in the decrease in MVCDs for voltages of 345 kV and above. Refer to pp.29-31 in the Supplemental Materials for additional information.

TABLE 2 (CONT) — Minimum Vegetation Clearance Distances (MVCD)[20]

For **Alternating Current** Voltages (meters)

(AC) Nominal System Voltage (KV)⁺	(AC) Maximum System Voltage (kV)[21]	MVCD meters Over sea level up to 153 m	MVCD meters Over 153m up to 305m	MVCD meters Over 305m up to 610m	MVCD meters Over 610m up to 915m	MVCD meters Over 915m up to 1220m	MVCD meters Over 1220m up to 1524m	MVCD meters Over 1524m up to 1829m	MVCD meters Over 1829m up to 2134m	MVCD meters Over 2134m up to 2439m	MVCD meters Over 2439m up to 2744m	MVCD meters Over 2744m up to 3048m	MVCD meters Over 3048m up to 3353m	MVCD meters Over 3353m up to 3657m	MVCD meters Over 3657m up to 3962m	MVCD meters Over 3962 m up to 4268 m	MVCD meters Over 4268m up to 4572m
765	800	3.6m	3.6m	3.6m	3.7m	3.7m	3.8m	3.8m	3.9m	4.0m	4.0m	4.1m	4.1m	4.2m	4.2m	4.3m	4.4m
500	550	2.1m	2.2m	2.2m	2.3m	2.3m	2.3m	2.4m	2.4m	2.5m	2..5m	2.5m	2.6m	2.6m	2.7m	2.7m	2.7m
345	362[22]	1.3m	1.3m	1.3m	1.4m	1.4m	1.4m	1.5m	1.5m	1.5m	1.6m	1.6m	1.6m	1.6m	1.7m	1.7m	1.8m
287	302	1.6m	1.6m	1.7m	1.7m	1.7m	1.7m	1.8m	1.8m	1.9m	1.9m	1.9m	2.0m	2.0m	2.0m	2.1m	2.1m
230	242	1.2m	1.3m	1.3m	1.3m	1.3m	1.3m	1.4m	1.4m	1.4m	1.5m	1.5m	1.5m	1.6m	1.6m	1.6m	1.6m
161*	169	0.8m	0.8m	0.9m	0.9m	0.9m	0.9m	0.9m	1.0m	1.0m	1.0m	1.0m	1.0m	1.1m	1.1m	1.1m	1.1m
138*	145	0.7m	0.7m	0.7m	0.7m	0.7m	0.7m	0.8m	0.8m	0.8m	0.9m	0.9m	0.9m	0.9m	0.9m	1.0m	1.0m
115*	121	0.6m	0.6m	0.6m	0.6m	0.6m	0.6m	0.6m	0.7m	0.7m	0.7m	0.7m	0.7m	0.8m	0.8m	0.8m	0.8m
88*	100	0.4m	0.4m	0.5m	0.5m	0.5m	0.5m	0.6m	0.6m	0.6m	0.6m	0.6m	0.6m	0.6m	0.6m	0.7m	0.7m
69*	72	0.3m	0.3m	0.3m	0.4m	0.4m	0.4m	0.4m	0.4m	0.4m	0.4m	0.4m	0.4m	0.4m	0.5m	0.5m	0.5m

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

⁺ *Table 2 – Table of MVCD values at a 1.0 gap factor (in U.S. customary units), which is located in the EPRI report filed with FERC on August 12, 2015. (The 14000-15000 foot values were subsequently provided by EPRI in an updated Table 2 on December 1, 2015, filed with the FAC-003-4 Petition at FERC)*

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[20] 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.

[21] 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.

[22] The change in transient overvoltage factors in the calculations are the driver in the decrease in MVCDs for voltages of 345 kV and above. Refer to pp.29-31 in the supplemental materials for additional information.

TABLE 2 (CONT) — Minimum Vegetation Clearance Distances (MVCD)[23]

For **Direct Current** Voltages feet (meters)

(DC) Nominal Pole to Ground Voltage (kV)	MVCD meters Over sea level up to 500 ft (Over sea level up to 152.4 m)	MVCD meters Over 500 ft up to 1000 ft (Over 152.4 m up to 304.8 m	MVCD meters Over 1000 ft up to 2000 ft (Over 304.8 m up to 609.6m)	MVCD meters Over 2000 ft up to 3000 ft (Over 609.6m up to 914.4m	MVCD meters Over 3000 ft up to 4000 ft (Over 914.4m up to 1219.2m	MVCD meters Over 4000 ft up to 5000 ft (Over 1219.2m up to 1524m	MVCD meters Over 5000 ft up to 6000 ft (Over 1524 m up to 1828.8 m)	MVCD meters Over 6000 ft up to 7000 ft (Over 1828.8m up to 2133.6m)	MVCD meters Over 7000 ft up to 8000 ft (Over 2133.6m up to 2438.4m)	MVCD meters Over 8000 ft up to 9000 ft (Over 2438.4m up to 2743.2m)	MVCD meters Over 9000 ft up to 10000 ft (Over 2743.2m up to 3048m)	MVCD meters 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)

[23] 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.

Guideline and Technical Basis

Effective dates:

The Compliance section is standard language used in most NERC standards to cover the general effective date and covers the vast majority of situations. A special case covers effective dates for (1) lines initially becoming subject to the Standard, (2) lines changing in applicability within the standard.

The special case 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 2015 may identify a line to have that designation beginning in PY 2025, 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. 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.

Date that Planning Study is completed	PY the line will become an IROL element	Date 1	Date 2	Effective Date The later of Date 1 or Date 2
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

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 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 current 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.

Explanation for revising the definition of Vegetation Inspection:
The current glossary definition of this NERC term was 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.

Explanation of the derivation of the MVCD:
The MVCD is a calculated minimum distance that is derived from the Gallet equation. 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 of the Standard provides MVCD values for various voltages and altitudes. The table is based on empirical testing data from EPRI as requested by FERC in Order No. 777.

Project 2010-07.1 Adjusted MVCDs per EPRI Testing:
In Order No. 777, FERC directed NERC to undertake testing to gather empirical data validating the appropriate gap factor used in the Gallet equation to calculate MVCDs, specifically the gap factor for the flash-over distances between conductors and vegetation. See, Order No. 777, at P 60. NERC engaged industry through a collaborative research project and contracted EPRI to complete the scope of work. In January 2014, NERC formed an advisory group to assist with developing the scope of work for the project. This team provided subject matter expertise for developing the test plan, monitoring testing, and vetting the analysis and conclusions to be submitted in a final report. The advisory team was comprised of NERC staff, arborists, and industry members with wide-ranging expertise in transmission engineering, insulation coordination, and vegetation management. The testing project commenced in April 2014 and continued through October 2014 with the final set of testing completed in May 2015. Based on these testing results conducted by EPRI, and consistent with the report filed in FERC Docket No. RM12-4-000, the gap factor used in the Gallet equation required adjustment from 1.3 to 1.0. This resulted in increased MVCD values for all alternating current system voltages identified. The adjusted MVCD values, reflecting the 1.0 gap factor, are included in Table 2 of version 4 of FAC-003.

The air gap testing completed by EPRI per FERC Order No. 777 established that trees with large spreading canopies growing directly below energized high voltage conductors create the greatest likelihood of an air gap flash over incident and was a key driver in changing the gap factor to a more conservative value of 1.0 in version 4 of this standard.

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.

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. 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.

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 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.

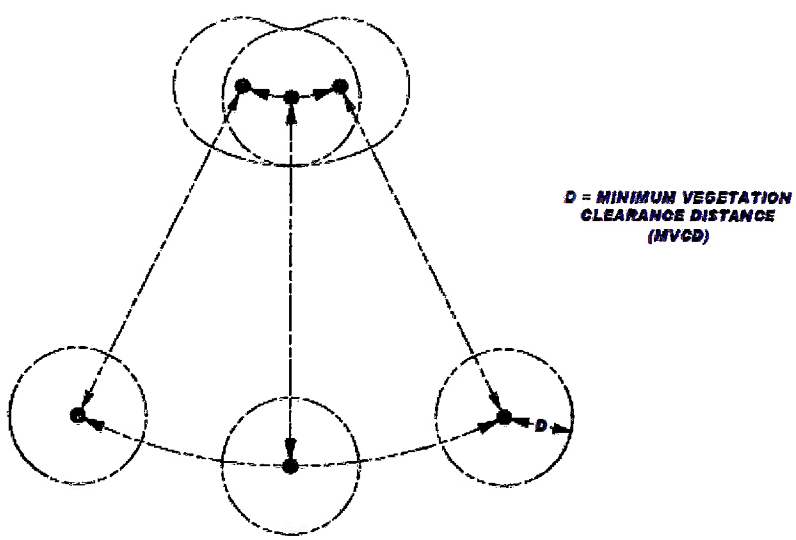

Figure 1

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 MVCD (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 herbicides to control incompatible vegetation outside of the MVCD, 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

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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 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.

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 an 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.

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.

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 used 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,

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or in other words, dry laboratory conditions. Consequently, the validity of using these distances in an outside environment application has been questioned.

FAC-003-1 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 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 was approximately 2.0 per unit. This value was 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 was 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 was 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.

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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.

Since no empirical data for spark over distances to live vegetation existed at the time version 3 was developed, 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

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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.

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.

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.

ANSI A300 (Part 1)-2008 Pruning
Revision of ANSI A300 (Part 1)-2001

American National Standard

for Tree Care Operations —
Tree, Shrub, and Other Woody Plant Management —
Standard Practices (Pruning)

TCIA®
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ANSI A300 (Part 1)-2008 Pruning
Revision of ANSI A300 (Part 1)-2001

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A300 (Part 1)-2008

for Tree Care Operations —

Tree, Shrub, and Other Woody Plant Management — Standard Practices *(Pruning)*

Secretariat
Tree Care Industry Association, Inc.

Tree Care Industry Association, Inc.
136 Harvey Road - Suite B101-B110
Londonderry, NH 03053
1-800-733-2622
(603) 314-5380
Fax: (603) 314-5386
E-mail: Rouse@tcia.org
Web: www.tcia.org

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136 Harvey Road - Suite B101-B110, Londonderry, NH 03053
Phone:1-800-733-2622 or (603) 314-5380 Fax: (603) 314-5386
E-mail: tcia@tcia.org
Web: www.tcia.org

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* The term pruning type is replaced with the term pruning method. The purpose of this is to label the processes detailed in section 6 with greater accuracy.

Foreword This foreword is not part of American National Standard A300 (Part 1)-2008 *Pruning*

ANSI A300 Standards are divided into multiple parts, each focusing on a specific aspect of woody plant management (e.g. Pruning, Fertilization, etc).

These standards are used to develop written specifications for work assignments. They are not intended to be used as specifications in and of themselves. Management objectives may differ considerably and therefore must be specifically defined by the user. Specifications are then written to meet the established objectives and must include measurable criteria.

ANSI A300 standards apply to professionals who provide for or supervise the management of trees, shrubs, and other woody landscape plants. Intended users include businesses, government agencies, property owners, property managers, and utilities. The standard does not apply to agriculture, horticultural production, or silviculture, except where explicitly noted otherwise.

This standard has been developed by the Tree Care Industry Association (TCIA), an ANSI-accredited Standards Developing Organization (SDO). TCIA is secretariat of the ANSI A300 standards, and develops standards using procedures accredited by the American National Standards Institute (ANSI).

Consensus for standards writing was developed by the Accredited Standards Committee on Tree, Shrub, and Other Woody Plant Management Operations – Standard Practices, A300 (ASC A300).

Prior to 1991, various industry associations and practitioners developed their own standards and recommendations for tree care practices. Recognizing the need for a standardized, scientific approach, green industry associations, government agencies and tree care companies agreed to develop consensus for an official American National Standard.

The result – ANSI A300 standards – unify and take authoritative precedence over all previously existing tree care industry standards. ANSI requires that approved standards be developed according to accepted principles, and that they be reviewed and, if necessary, revised every five years.

TCIA was accredited as a standards developing organization with ASC A300 as the consensus body on June 28, 1991. ASC A300 meets regularly to write new, and review and revise existing ANSI A300 standards. The committee includes industry representatives with broad knowledge and technical expertise from residential and commercial tree care, utility, municipal and federal sectors, landscape and nursery industries, and other interested organizations.

Suggestions for improvement of this standard should be forwarded to: A300 Secretary, c/o Tree Care Industry Association, Inc., 136 Harvey Road - Suite B101-B110, Londonderry, NH, 03053.

ANSI A300 (Part 1)-2008 Pruning was approved as an American National Standard by ANSI on May 1, 2008. ANSI approval does not require unanimous approval by ASC A300. The ASC A300 committee contained the following members at the time of ANSI approval:

Tim Johnson, Chair
(Artistic Arborist, Inc.)

Bob Rouse, Secretary
(Tree Care Industry Association, Inc.)

(Continued)

Organizations Represented	*Name of Representative*
American Nursery and Landscape Association	Warren Quinn
	Craig J. Regelbrugge (Alt.)
American Society of Consulting Arborists	Donald Zimar
American Society of Landscape Architects	Ron Leighton
Asplundh Tree Expert Company	Geoff Kempter
	Peter Fengler (Alt.)
Bartlett Tree Expert Company	Peter Becker
	Dr. Thomas Smiley (Alt.)
Davey Tree Expert Company	Joseph Tommasi
	R.J. Laverne (Alt.)
International Society of Arboriculture	Bruce Hagen
	Sharon Lilly (Alt.)
National Park Service	Robert DeFeo
	Dr. James Sherald (Alt.)
Professional Grounds Management Society	Thomas Shaner
Professional Land Care Network	Preston Leyshon
Society of Municipal Arborists	Gordon Mann
	Andy Hillman (Alt.)
Tree Care Industry Association	Dane Buell
	James McGuire (Alt.)
USDA Forest Service	Ed Macie
	Keith Cline (Alt.)
Utility Arborist Association	Matthew Simons
	Jeffrey Smith (Alt.)

Additional organizations and individuals:

American Forests (Observer)
Mike Galvin (Observer)
Peter Gerstenberger (Observer)
Dick Jones (Observer)
Myron Laible (Observer)
Beth Palys (Observer)
Richard Rathjens (Observer)
Richard Roux (NFPA-780 Liaison)

ASC A300 mission statement:

Mission: To develop consensus performance standards based on current research and sound practice for writing specifications to manage trees, shrubs, and other woody plants.

American National Standard for Tree Care Operations –

Tree, Shrub, and Other Woody Plant Management – Standard Practices *(Pruning)*

1 ANSI A300 standards

1.1 Scope

ANSI A300 standards present performance standards for the care and management of trees, shrubs, and other woody plants.

1.2 Purpose

ANSI A300 performance standards are intended for use by federal, state, municipal and private entities including arborists, property owners, property managers, and utilities for developing written specifications.

1.3 Application

ANSI A300 performance standards shall apply to any person or entity engaged in the management of trees, shrubs, or other woody plants.

2 Part 1 – Pruning standards

2.1 Purpose

The purpose of Part 1 – *Pruning* is to provide performance standards for developing written specifications for pruning.

2.2 Reasons for pruning

The reasons for tree pruning may include, but are not limited to, reducing risk, managing tree health and structure, improving aesthetics, or achieving other specific objectives. Pruning practices for agricultural, horticultural production, or silvicultural purposes are exempt from this standard unless this standard, or a portion thereof, is expressly referenced in standards for these other related areas.

2.3 Implementation

2.3.1 Specifications for pruning should be written and administered by an arborist.

2.3.1.1 Specifications should include location of tree(s), objectives, methods (types), and extent of pruning (location, percentage, part size, etc).

2.3.2 Pruning specifications shall be adhered to.

2.4 Safety

2.4.1 Pruning shall be implemented by an arborist, familiar with the practices and hazards of pruning and the equipment used in such operations.

2.4.2 This performance standard shall not take precedence over applicable industry safe work practices.

2.4.3 Performance shall comply with applicable Federal and State Occupational Safety and Health standards, ANSI Z133.1, Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) and other Federal Environmental Protection Agency (EPA) regulations, as well as state and local regulations.

3 Normative references

The following standards contain provisions, which, through reference in the text, constitute provisions of this American National Standard. All standards are subject to revision, and parties to agreements based on this American National Standard shall apply the most recent edition of the standards indicated below.

ANSI Z60.1, Nursery stock
ANSI Z133.1, Arboriculture – Safety requirements
29 CFR 1910, General industry [1)]
29 CFR 1910.268, Telecommunications [1)]
29 CFR 1910.269, Electric power generation, transmission, and distribution [1)]
29 CFR 1910.331 - 335, Electrical safety-related work practices [1)]

4 Definitions

4.1 arboriculture: The art, science, technology, and business of commercial, public, and utility tree care.

1) Available from U.S. Department of Labor, 200 Constitution Avenue, NW, Washington, DC 20210

4.2 arborist: An individual engaged in the profession of arboriculture who, through experience, education, and related training, possesses the competence to provide for or supervise the management of trees and other woody plants.

4.3 arborist trainee: An individual undergoing on-the-job training to obtain the experience and the competence required to provide for or supervise the management of trees and other woody plants. Such trainees shall be under the direct supervision of an arborist.

4.4 branch: A shoot or stem growing from a parent branch or stem (See Fig. 4.4).

4.4.1 codominant branches/codominant leaders: Branches or stems arising from a common junction, having nearly the same size diameter (See Fig. 4.4).

4.4.2 lateral branch: A shoot or stem growing from another branch (See Fig. 4.4).

4.4.3 parent branch or stem: A tree trunk or branch from which other branches or shoots grow (See Fig. 4.4).

4.4.4 scaffold branch: A primary branch that forms part of the main structure of the crown (See Fig. 4.4).

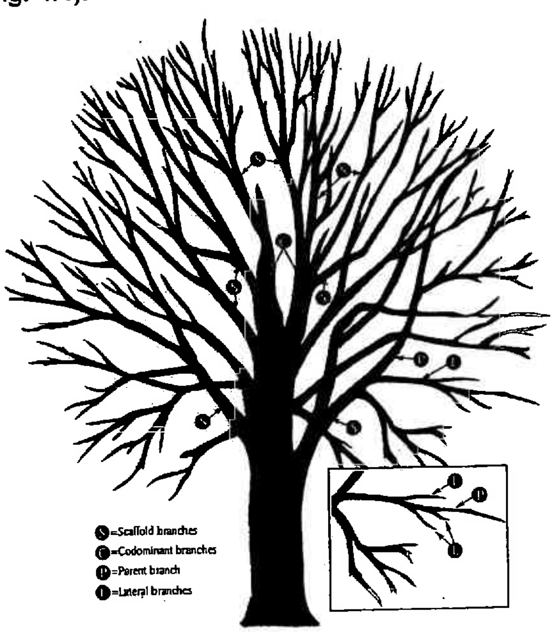


Figure 4.4 Standard branch definitions.

4.5 branch bark ridge: The raised area of bark in the branch crotch that marks where the branch and parent stem meet. (See Figs. 5.3.2 and 5.3.3).

4.6 branch collar: The swollen area at the base of a branch.

4.7 callus: Undifferentiated tissue formed by the cambium around a wound.

4.8 cambium: The dividing layer of cells that forms sapwood (xylem) to the inside and inner bark (phloem) to the outside.

4.9 clean: Selective pruning to remove one or more of the following non-beneficial parts: dead, diseased, and/or broken branches (7.2).

4.10 climbing spurs: Sharp, pointed devices strapped to a climber's lower legs used to assist in climbing trees. (syn.: gaffs, hooks, spurs, spikes, climbers).

4.11 closure: The process in a woody plant by which woundwood grows over a pruning cut or injury.

4.12 crown: Upper part of a tree, measured from the lowest branch, including all the branches and foliage.

4.13 decay: The degradation of woody tissue caused by microorganisms.

4.14 espalier: The combination of pruning, supporting, and training branches to orient a plant in one plane (6.5).

4.15 establishment: The point after planting when a tree's root system has grown sufficiently into the surrounding soil to support growth and anchor the tree.

4.16 facility: A structure or equipment used to deliver or provide protection for the delivery of an essential service, such as electricity or communications.

4.17 frond: A leaf structure of a palm.

4.18 heading: The reduction of a shoot, stem, or branch back to a bud or to a lateral branch not large enough to assume the terminal role.

4.19 interfering branches: Crossing, rubbing, or upright branches that have the potential to damage tree structure and/or health.

4.20 internode: The area between lateral branches or buds.

4.21 job briefing: The communication of at least the following subjects for arboricultural operations: work specifications, hazards associated with the job, work procedures involved, special precautions, electrical hazards, job assignments, and personal protective equipment.

4.22 leader: A dominant, typically upright, stem – usually the main trunk. There can be several leaders in one tree.

4.23 lion's tailing: The removal of an excessive number of inner and/or lower lateral branches from parent branches. Lion's tailing is not an acceptable pruning practice (6.1.7).

4.24 live crown ratio: Crown height relative to overall plant height.

4.25 mechanical pruning: A pruning technique where large-scale power equipment is used to cut back branches (9.3.2).

4.26 method: A procedure or process for achieving an objective.

4.27 peeling: The removal of dead frond bases without damaging living trunk tissue at the point they make contact with the trunk. (syn.: shaving)

4.28 petiole: A stalk of a leaf or frond.

4.29 pollarding: Pruning method in which tree branches are initially headed and then reduced on a regular basis without disturbing the callus knob (6.6).

4.30 pruning: The selective removal of plant parts to meet specific goals and objectives.

4.31 qualified line-clearance arborist: An individual who, through related training and on-the-job experience, is familiar with the equipment and hazards in line clearance and has demonstrated the ability to perform the special techniques involved. This individual may or may not be currently employed by a line-clearance contractor.

4.32 qualified line-clearance arborist trainee: An individual undergoing line-clearance training under the direct supervision of a qualified line-clearance arborist. In the course of such training, the trainee becomes familiar with the equipment and hazards in line clearance and demonstrates ability in the performance of the special techniques involved.

4.33 raise: Pruning to provide vertical clearance (7.3).

4.34 reduce: Pruning to decrease height and/or spread (7.4).

4.35 remote area: As used in the utility pruning section of this standard, an unpopulated area.

4.36 restoration: Pruning to redevelop structure, form, and appearance of topped or damaged trees (6.3).

4.37 rural area: As used in the utility pruning section of this standard, a sparsely populated place away from large cities, suburbs, or towns but distinct from remote areas.

4.38 shall: As used in this standard, denotes a mandatory requirement.

4.39 shoot: Stem or branch and its leaves, especially when young.

4.40 should: As used in this standard, denotes an advisory recommendation.

4.41 specifications: A document stating a detailed, measurable plan or proposal for provision of a product or service.

4.42 sprouts: New shoots originating from epicormic or adventitious buds, not to be confused with suckers. (syn.: watersprouts, epicormic shoots)

4.43 standard, ANSI A300: The performance parameters established by industry consensus as a rule for the measure of extent, quality, quantity, value or weight used to write specifications.

4.44 stem: A woody structure bearing buds, foliage, and giving rise to other stems.

4.45 structural pruning: Pruning to improve branch architecture (6.2).

4.46 stub: Portion of a branch or stem remaining after an internodal cut or branch breakage.

4.47 subordination: Pruning to reduce the size and ensuing growth rate of a branch or leader in relation to other branches or leaders.

4.48 sucker: Shoot arising from the roots.

4.49 thin: pruning to reduce density of live branches (7.5).

4.50 throw line: A small, lightweight line with a weighted end used to position a climber's rope in a tree.

4.51 topping: Reduction of tree size using internodal cuts without regard to tree health or structural integrity. Topping is not an acceptable pruning practice (6.1.7).

4.52 tracing: The removal of loose, damaged tissue from in and around the wound.

4.53 trunk: The main woody part of a tree beginning at and including the trunk flare and extending up into the crown from which scaffold branches grow.

4.54 trunk flare: 1. The area at the base of the plant's trunk where it broadens to form roots. 2. The area of transition between the root system and trunk (syn.: root flare).

4.55 urban/residential areas: Populated areas including public and private property that are normally associated with human activity.

4.56 utility: A public or private entity that delivers a public service, such as electricity or communications.

4.57 utility space: The physical area occupied by a utility's facilities and the additional space required to ensure its operation.

4.58 vista/view prune: Pruning to enhance a specific view without jeopardizing the health of the tree (6.4).

4.59 wound: An opening that is created when the bark of a live branch or stem is cut, penetrated, damaged, or removed.

4.60 woundwood: Partially differentiated tissue responsible for closing wounds. Woundwood develops from callus associated with wounds.

5 Pruning practices

5.1 Tree inspection

5.1.1 An arborist or arborist trainee shall visually inspect each tree before beginning work.

5.1.2 If a condition is observed requiring attention beyond the original scope of the work, the condition should be reported to an immediate supervisor, the owner, or the person responsible for authorizing the work.

5.1.3 Job briefings shall be performed as outlined in ANSI Z133.1, subclause 3.1.4.

5.2 Tools and equipment

5.2.1 Equipment, tools, and work practices that damage living tissue and bark beyond the scope of normal work practices shall be avoided.

5.2.2 Climbing spurs shall not be used when entering and climbing trees for the purpose of pruning.

Exceptions:
- when branches are more than throw-line distance apart and there is no other means of climbing the tree;
- when the outer bark is thick enough to prevent damage to the inner bark and cambium;
- in remote or rural utility rights-of-way.

5.3 Pruning cuts

5.3.1 Pruning tools used in making pruning cuts shall be sharp.

5.3.2 A pruning cut that removes a branch at its point of origin shall be made close to the trunk or parent branch without cutting into the branch bark ridge or branch collar or leaving a stub (see Figure 5.3.2).

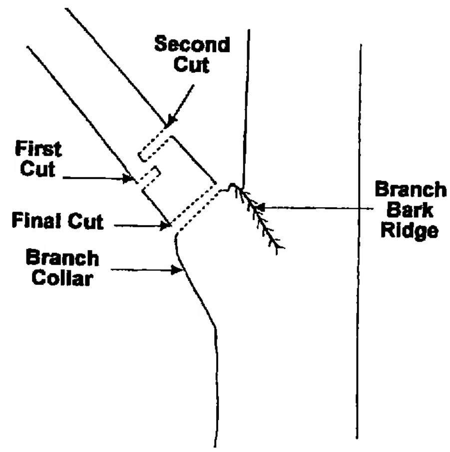


Figure 5.3.2. A cut that removes a branch at its point of origin. (See Annex A – Pruning cut guideline).

5.3.3 A pruning cut that reduces the length of a branch or parent stem shall be made at a slight downward angle relative to the remaining stem and not damage the remaining stem. Smaller cuts shall be preferred (see Fig. 5.3.3).

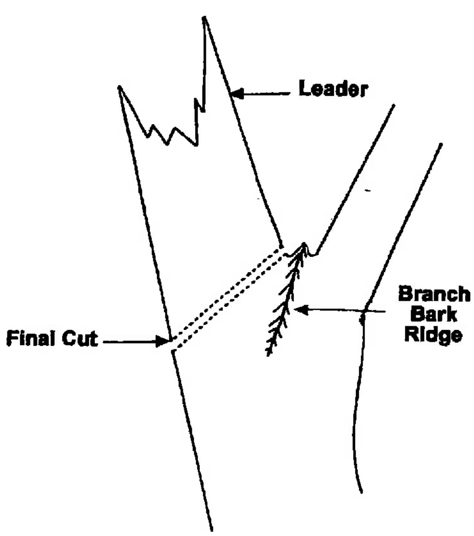


Figure 5.3.3. A cut that reduces the length of a branch or parent stem.

5.3.4 When pruning to a lateral, the remaining lateral branch should be large enough to assume the terminal role.

5.3.5 The final cut should result in a flat surface with adjacent bark firmly attached.

5.3.6 When removing a dead branch, the final cut shall be made just outside the collar of living tissue.

5.3.7 Tree branches shall be removed in such a manner so as to avoid damage to other parts of the tree or to other plants or property. Branches too large to support with one hand shall be precut to avoid splitting of the wood or tearing of the bark (see Figure 5.3.2). Where necessary, ropes or other equipment shall be used to lower large branches or portions of branches to the ground.

5.3.8 A cut that removes a branch with a narrow angle of attachment should be made from the outside of the branch to prevent damage to the parent branch (see Figure 5.3.8).

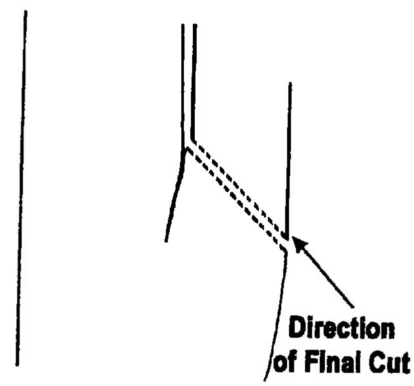


Figure 5.3.8. A cut that removes a branch with a narrow angle of attachment.

5.3.9 Severed branches shall be removed from the crown upon completion of the pruning, at times when the tree would be left unattended, or at the end of the workday.

5.4 Wound treatment

5.4.1 Wound treatments shall not be used to cover wounds or pruning cuts, except when necessary for disease, insect, mistletoe, or sprout control, or for cosmetic reasons.

5.4.2 Wound treatments that are damaging to tree tissues shall not be used.

5.4.3 When tracing wounds, only loose, damaged tissue shall be removed.

6 Pruning objectives

6.1 Pruning objectives shall be established prior to beginning any pruning operation.

6.1.1 Objectives should include, but are not limited to, one or more of the following:

- Risk reduction
- Manage health
- Clearance
- Structural improvement/correction
- View improvement/creation
- Aesthetic improvement
- Restoration

6.1.2 Established objectives should be specified in writing (See Annex B – *Specification writing guideline*).

6.1.3 To obtain the defined objective, the growth cycles, structure, species, and the extent of pruning to be performed shall be considered.

6.1.4 Not more than 25 percent of the foliage should be removed within an annual growing season. The percentage and distribution of foliage to be removed shall be adjusted according to the plant's species, age, health, and site.

6.1.5 When frequent excessive pruning is necessary for a tree to avoid conflicts with elements such as infrastructure, view, traffic, or utilities, removal or relocation of the tree shall be considered.

6.1.6 Pruning cuts should be made in accordance with section 5.3 *Pruning cuts.*

6.1.7 Topping and lion's tailing shall be considered unacceptable pruning practices for trees.

6.2 **Structural:** Structural pruning shall consist of selective pruning to improve tree and branch architecture primarily on young- and medium-aged trees.

6.2.1 Size and location of leaders or branches to be subordinated or removed should be specified.

6.2.2 Dominant leader(s) should be selected for development as appropriate.

6.2.3 Strong, properly spaced scaffold branch structure should be selected and maintained by reducing or removing others.

6.2.4 Temporary branches should be retained or reduced as appropriate.

6.2.5 Interfering, overextended, defective, weak, and poorly attached branches should be removed or reduced.

6.2.6 At planting, pruning should be limited to cleaning (7.2).

6.3 **Restoration:** Restoration shall consist of selective pruning to redevelop structure, form, and appearance of severely pruned, vandalized, or damaged trees.

6.3.1 Location in tree, size range of parts, and percentage of sprouts to be removed should be specified.

6.4 **Vista/view:** Vista/view pruning shall consist of the use of one or more pruning methods (types) to enhance a specific line of sight.

6.4.1 Pruning methods (types) shall be specified.

6.4.2 Size range of parts, location in tree, and percentage of foliage to be removed should be specified.

6.5 Espalier

6.5.1 Branches that extend outside the desired plane of growth shall be pruned or tied back.

6.5.2 Ties should be replaced as needed to prevent girdling the branches at the attachment site.

6.6 Pollarding

6.6.1 Consideration shall be given to the ability of the individual tree to respond to pollarding.

6.6.2 Management plans shall be made prior to the start of the pollarding process for routine removal of sprouts.

6.6.3 Heading cuts shall be made at specific locations to start the pollarding process. After the initial cuts are made, no additional heading cuts shall be made.

6.6.4 Sprouts growing from the cut ends of branches (knuckles) should be removed annually during the dormant season.

7 Pruning methods (types)

7.1 One or more of the following methods (types) shall be specified to achieve the objective.

7.2 **Clean:** Cleaning shall consist of pruning to remove one or more of the following non-beneficial parts: dead, diseased, and/or broken branches.

7.2.1 Location of parts to be removed shall be specified.

7.2.2 Size range of parts to be removed shall be specified.

7.3 **Raise:** Raising shall consist of pruning to provide vertical clearance.

7.3.1 Clearance distance shall be specified.

7.3.2 Location and size range of parts to be removed should be specified.

7.3.3 Live crown ratio should not be reduced to less than 50 percent.

7.4 **Reduce:** Reducing shall consist of pruning to decrease height and/or spread.

7.4.1 Consideration shall be given to the ability of a species to tolerate this type of pruning.

7.4.2 Location of parts to be removed or clearance requirements shall be specified.

7.4.3 Size of parts should be specified.

7.5 **Thin:** Thinning shall consist of selective pruning to reduce density of live branches.

7.5.1 Thinning should result in an even distribution of branches on individual branches and throughout the crown.

7.5.2 Not more than 25 percent of the crown should be removed within an annual growing season.

7.5.3 Location of parts to be removed shall be specified.

7.5.4 Percentage of foliage and size range of parts to be removed shall be specified.

8 Palm pruning

8.1 Palm pruning should be performed when fronds, fruit, or loose petioles may create a dangerous condition.

8.2 Live healthy fronds should not be removed.

8.3 Live, healthy fronds above horizontal shall not be removed. Exception: Palms encroaching on electric supply lines (see Fig. 8.3a and 8.3b).

Figure 8.3a Frond removal location.

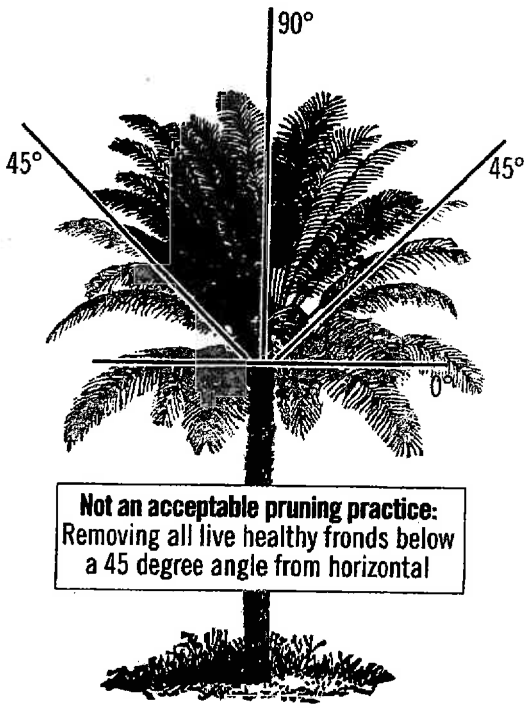


Figure 8.3b An overpruned palm (not an acceptable pruning practice).

8.4 Fronds removed should be severed close to the petiole base without damaging living trunk tissue.

8.5 Palm peeling (shaving) should consist of the removal of only the dead frond bases at the point they make contact with the trunk without damaging living trunk tissue.

9 Utility pruning

9.1 Purpose

The purpose of utility pruning is to prevent the loss of service, comply with mandated clearance laws, prevent damage to equipment, maintain access, and uphold the intended usage of the facility/utility space while adhering to accepted tree care performance standards.

9.2 General

9.2.1 Only a qualified line-clearance arborist or line-clearance arborist trainee shall be assigned to line clearance work in accordance with ANSI Z133.1, 29 CFR 1910.331 – 335, 29 CFR 1910.268 or 29 CFR 1910.269.

9.2.2 Utility pruning operations are exempt from requirements in subclause 5.1, *Tree Inspection*, for conditions outside the utility pruning scope of work.

9.2.3 Job briefings shall be performed as outlined in ANSI Z133.1, subclause 3.1.4.

9.3 Utility crown reduction pruning

9.3.1 Urban/residential areas

9.3.1.1 Pruning cuts should be made in accordance with subclause 5.3, *Pruning cuts*. The following requirements and recommendations of 9.3.1.1 are repeated from subclause 5.3 *Pruning cuts*.

9.3.1.1.1 A pruning cut that removes a branch at its point of origin shall be made close to the trunk or parent branch, without cutting into the branch bark ridge or collar, or leaving a stub (see Figure 5.3.2).

9.3.1.1.2 A pruning cut that reduces the length of a branch or parent stem shall be made at a slight downward angle relative to the remaining stem and not damage the remaining stem. Smaller cuts shall be preferred (see Fig. 5.3.3).

9.3.1.1.3 The final cut shall result in a flat surface with adjacent bark firmly attached.

9.3.1.1.4 When removing a dead branch, the final cut shall be made just outside the collar of living tissue.

9.3.1.1.5 Tree branches shall be removed in such a manner so as not to cause damage to other parts of the tree or to other plants or property. Branches too large to support with one hand shall be precut to avoid splitting of the wood or tearing of the bark (see Figure 5.3.2). Where necessary, ropes or other equipment shall be used to lower large branches or portions of branches to the ground.

9.3.1.1.6 A cut that removes a branch with a narrow angle of attachment should be made from the outside of the branch to prevent damage to the parent branch (see Figure 5.3.8).

9.3.1.2 A minimum number of pruning cuts should be made to accomplish the purpose of facility/utility pruning. The structure and growth habit of the tree should be considered.

9.3.1.3 Trees directly under and growing into facility/utility spaces should be removed or pruned. Such pruning should be done by removing entire branches or leaders or by removing branches that have laterals growing into (or once pruned, will grow into) the facility/utility space.

9.3.1.4 Trees growing next to, and into or toward, facility/utility spaces should be pruned by reducing branches to laterals (5.3.3) to direct growth away from the utility space or by removing entire branches. Branches that, when cut, will produce sprouts that would grow into facilities and/or utility space should be removed.

9.3.1.5 Branches should be cut to laterals or the parent branch and not at a pre-established clearing limit. If clearance limits are established, pruning cuts should be made at laterals or parent branches outside the specified clearance zone.

9.3.2 Rural/remote locations – mechanical pruning

Cuts should be made close to the main stem, outside of th branch bark ridge and branch collar. Precautions should be taken to avoid stripping or tearing of bark or excessive wounding.

9.4 Emergency service restoration

During a utility-declared emergency, service must be restored as quickly as possible in accordance with ANSI Z133.1, 29 CFR 1910.331 – 335, 29 CFR 1910.268, or 29 CFR 1910.269. At such times, it may be necessary, because of safety and the urgency of service restoration, to deviate from the use of proper pruning techniques as defined in this standard. Following the emergency, corrective pruning should be done as necessary.

Annex A
Pruning cut guideline

A-1 Three-cut method
Multiple cutting techniques exist for application of a three-cut method. A number of them may be used to implement an acceptable three-cut method.

A-1.1 The technique depicted in *Figure 5.3.2* demonstrates one example of a three-cut method that is common to hand-saw usage. It is not intended to depict all acceptable three-cut method techniques.

Annex B
Specification writing guideline

A300 (Part 1)-2008 *Pruning* standards are performance standards, and shall not be used as job specifications. Job specifications should be clearly detailed and contain measurable criteria.

The words "should" and "shall" are both used when writing standards. The word "shall" is used when writing specifications.

Writing specifications can be simple or complex and can be written in a format that suits your company/the job. The specifications consist of two sections.

I. General:

This section contains all aspects of the work to be performed that needs to be documented, yet does not need to be detailed.

Saying under the General section that "all work shall be completed in compliance with A300 Standards" means the clauses covering safety, inspections, cuts, etc. will be adhered to. There is no need to write each and every clause into every job specification.

Other items that may be covered in the General section could be: work hours and dates, traffic issues, disposal criteria, etc.

The second section under Job Specifications would be:

II. Details:

This section provides the clear and measurable criteria; the deliverables to the client.

This section, to be written in compliance with A300 standards, shall contain the following information:

1. **Objective – Clause 6**
   These objectives originate from/with the tree owner or manager. The arborist shall clearly state what is going to be done to achieve the objective(s).

   Objectives can be written for the entire job or individual trees. Rarely can one or two words clearly convey an objective so that all parties involved (client, sales, crew, etc.) can visualize the outcome.
2. **Method – Clause 7**
   Here the method(s) to be used to achieve the objective are stated. Again, depending on the type of job, this can be stated for the individual tree or a group of trees.
3. **Location – Clause 7.2.1, 7.3.2, 7.4.2, 7.5.3**
   This is the location in the tree(s) that the work methods are to take place.
4. **Density – Clause 7.3.1, 7.3.3, 7.5.1, 7.5.2, 7.5.4**
   This is the amount or volume of parts that are to be removed and can be stated exactly or in ranges.
5. **Size – Clause 7.2.2, 7.3.2, 7.4.3, 7.5.4**
   This is the size or range of sizes of cut(s) utilized to remove the volume specified.

   NOTE: Items # 4 & 5 are directly related to resource allocation, staffing and dollars.

SAMPLE PRUNING SPECIFICATIONS

#1. **Scope:** Large live oak on west side of pool

Objectives: Increase light penetration through east side of tree. Reduce risk potential of 1-inch-diameter branches falling.

Specifications: All broken branches and 1-inch-plus diameter dead branches shall be removed from the crown.

The three lowest 8-inch-plus diameter branches on the east side shall be thinned 25 percent with 1-inch- to 3-inch-diameter cuts.

NOTE: All work shall be completed in compliance with ANSI A300 and Z133.1 Standards.

Annex B
Specification writing guideline

#2. **Scope:** 1 Arizona ash

Objective: Enhance structure/structural development.

Specifications: General:

All pruning shall be completed in compliance with A300 Standards.

Detail:

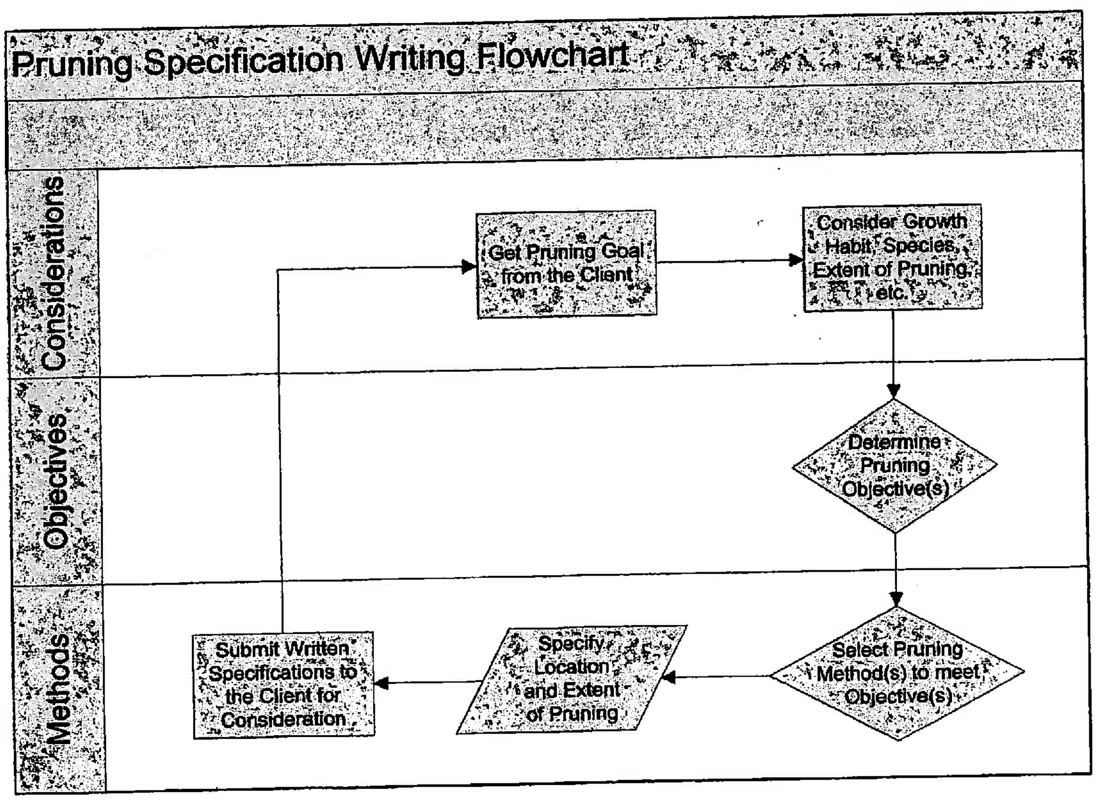
Thin crown 20-25 percent with 1-inch- to 4-inch-diameter cuts. Reduce west codominant leader by approximately 12 feet.

#3. **Scope:** Twenty-three newly installed evergreen elms

Objective: Maximize establishment – reduce nuisance while enhancing natural growth habit.

All work shall be completed in compliance with A300 Standards and the following specifications.

Specifications:
- Retain as much size as possible and 80-90 percent density of foliage.
- Lowest permanent branch will be 6 feet above grade in four to five years.
- Retain all sprout growth originating 18 inches above grade on trunk and 4 inches out from branch attachments throughout crown.
- Remove weakest rubbing branches.
- Remove dead branches.
- Reduce broken branches or branches with dead ends back to live laterals or buds. Heading cuts can be used.
- Maintain 6 inches behind adjacent edge of walks all growth that originates between 1.5 feet (18 inches) and 6 feet (72 inches) above grade. Heading cuts are acceptable.



Annex C
Applicable ANSI A300 interpretations

The following interpretations apply to Part 1 – *Pruning:*

C-1 Interpretation of "should" in ANSI A300 standards

"An advisory recommendation" is the common definition of "should" used in the standards development community and the common definition of "should" used in ANSI standards. An advisory notice is not a mandatory requirement. Advisory recommendations may not be followed when defensible reasons for non-compliance exist.

C-2 Interpretation of "shall" in ANSI A300 standards

"A mandatory requirement" is the common definition of "shall" used in the standards development community and the common definition of "shall" used in ANSI standards. A mandatory requirement is not optional and must be followed for ANSI A300 compliance.