Canadian Renewable Energy Association
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Wind Energy Operations & Maintenance

Wind Turbine

Technician Core Competencies

This document provides a set of entry-level competencies for consideration when embarking on an exciting new career as a wind turbine technician.

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Canadian Renewable Energy Association (CanREA) Wind Turbine Technician Core Competencies

The CanREA Wind Turbine Technician Core Competencies were developed by Canadian wind power facility operators, wind turbine manufacturers and a network of stakeholders including Colleges, training organizations, wind energy service providers and other organizations working to support wind turbine technicians. This document is intended to provide a set of basic, entry level competencies that are important for wind turbine technicians to be successful as they embark on a new career. It is aimed at achieving three distinct purposes:

- College training uniformity
- Contractor training uniformity
- Experienced workforce skills gap identification

The wind turbine technician core competencies encompass a wide range of topics demonstrating the diverse nature of the wind turbine technician role. The competencies provided in this document were developed to help training institutions and employers to identify the skills desired by wind energy employers. The lists and key headings indicate the baseline expectation of wind energy site owners, operators and service providers when hiring or contracting for work in general. However, the lists of competencies should not act as a barrier to entry into wind energy operations and maintenance. Instead, they should highlight important areas for development and focused training to ensure a solid foundation for those who are already in the industry as well as recent graduates seeking employment and employed workers. Similarly, for the skilled workforce looking to enter the wind industry, the core competencies provided should serve to focus attention on any gaps in experience for personal skill set improvement and not be perceived as prerequisites and therefore deterrents to entry into this rewarding and diverse field. The core competencies can serve to target areas for professional development for existing wind turbine technicians to ensure that solid foundation encouraged by the industry.

The Canadian wind industry encourages all motivated persons to apply themselves in understanding the core competencies of the wind turbine technician role to enable entry into the operations and maintenance of low cost, clean, renewable electricity generation.

Application Details

The core competencies are articulated to complete the statement:

“An entry level wind turbine technician is able to...”

This provides practical statements that can be applied to learning objectives, worker-evaluation and identifying gaps. The first three tiers of Bloom’s Taxonomy of learning objectives are used: Remember, Understand, and Apply. The text uses words indicating which tier is associated with the core competency being described. By focusing on the first three levels, this document deliberately retains entry level applicability and allows trainers to develop learning objectives consistent with minimum industry expectations without demanding an excessive depth of knowledge and skill. The document does not provide tools for assessing higher levels of competency beyond the basics. It is expected that on-site training by an employer remains an essential component of a wind turbine technician’s entry into the industry and therefore the core competencies do not include this site-specific learning.

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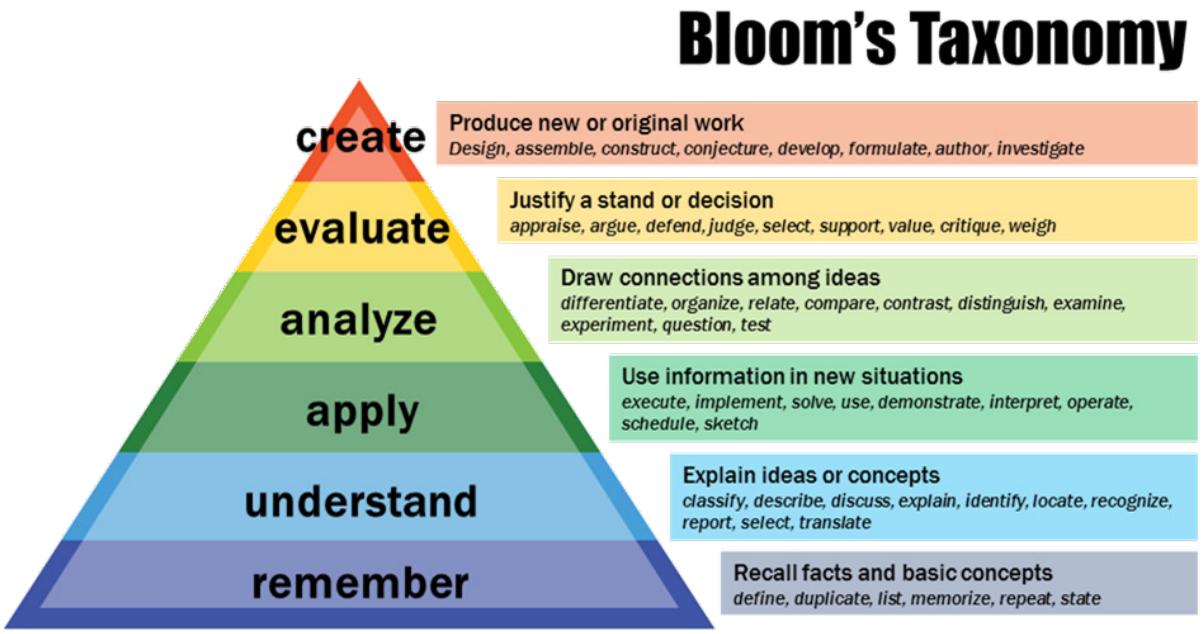

Source: https://cft.vanderbilt.edu/guides-sub-pages/blooms-taxonomy, April 2019

Terminology

The terms *wind turbine technician, wind technician and technician* are referred to interchangeably throughout the document. These terms are analogous with "entry-level wind turbine technician" and for the purposes of this document refers to anyone who is engaged in, or planning to be engaged in, the repair, maintenance and operation of wind turbine generators and supporting equipment. It does not refer to competencies necessary to complete the work of a qualified electrician or experienced wind turbine technician.

A *wind power facility, wind farm or wind park* refers to the collection of components that aggregate to form an independent electrical power production facility.

The term "*typical wind farm*" refers to a site of two or more wind turbines with power output aggregated into a substation and transmitted to a transmission or distribution connection point. There are one or more employees responsible for the site and external contractors and original equipment manufacturer (OEM) teams are employed to assist with operations and maintenance.

The term *equipment* is used to describe any hardware that may be found at a wind energy facility including large machinery such as yaw motors, hydraulic pitch rams, etc. or small devices like circuit boards, oil filters, borescopes, tools, etc.

Original equipment manufacturers (OEMs) represent the company responsible for the design and manufacture of the wind turbine and affiliated service teams engaged in the maintenance of the turbines.

Notice and Disclaimer

The Canadian Renewable Energy Association ("CanREA") assumes no liability or responsibility for reliance on the contents of the Wind Turbine Technician Core Competencies (the "Materials"), which are intended for educational and informational purposes only. CanREA makes no representation or warranty about the suitability of the information offered in these Materials, including for legal

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- CanREA members and their contractors should be mindful that the Materials are not intended to be, and are not, a substitute for a health and safety management system or training curriculum, and that any suggested program elements herein should be evaluated on a case-by-case basis and may need to be revised or supplemented to ensure legal compliance or suitable practices for a particular site.
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- Materials are not intended to offer, nor should they be construed as, medical advice. Health care professionals should be consulted where appropriate.

Limitations

The Materials have been developed with reference to industry related publications. However, it is not exhaustive and hence the reader should defer to applicable laws and standards for guidance. Furthermore, this document is neither written to be a compliance standard nor intended to be a protocol for the audit of a training program.

Regulations

Each province, territory and the federal government in Canada outlines a regulatory framework for Occupational Health and Safety (OH&S). In general, with some exceptions, the federal legislation applies to employees of the federal government, federal corporations, as well as workers in federally regulated industries. The provincial or territorial legislation applies to most other workplaces. Many of the basic elements such as rights and responsibilities of trainers, workers, employers, and supervisors, are similar in all the jurisdictions across Canada. However, the details of the OH&S legislation and how the laws are enforced vary from one jurisdiction to another.

CanREA members should review any applicable OH&S laws, as they may change from time to time, including any such laws relating to training of workers, to determine whether they require changes to the core competencies or other matters described in the Materials.

Core Competencies

The core competencies are divided into five main sections:

- General
- Safety
- Electrical
- Mechanical
- Operational

Each section provides several subsections. The subsections contain a list of key competencies and a brief description of the subsection topic.

The description for each set of competencies is aimed at clarifying the intent of the competencies provided in the lists, providing the end user with added confidence that any learning objectives developed have accomplished the main purpose of the subsection. Descriptions may also provide examples of what a core competency is not.

The g*eneral section* informs the broad competencies that are not specific to any one discipline and can be used as an overview of some of the qualities of a wind technician.

The *safety section* is focused on multiple aspects of wind farm safety including, general, electrical and mechanical as well as some specific areas uniquely relevant to wind energy.

The *electrical, mechanical and operational sections* prioritize the technical aspects of the occupation emphasizing areas of importance for new entries into the field and delimiting those from areas requiring more advanced experience.

In the instance of duplicate core competencies across multiple sections there is no elevation of one occurrence over the other. The competencies may be repeated with different wording to refine applicability in a specific section or to ensure it is not overlooked if a reader refers to one section without cross-referencing with other sections of overlapping relevance.

Qualities of a wind turbine technician are of special note and were highlighted by stakeholders during the core competencies development process. Technician supervisors seek out employees who show an eagerness to learn, pride in their work and exhibit autonomy while being able to lead and work in a larger team. Every site and employer will require unique skills and process-knowledge, increasing the importance of these “self-starter” qualities. In addition, employees who are punctual, have the required fitness for work, exhibit a healthy lifestyle and value organization and cleanliness are highly sought after. Demonstration of these qualities provides confidence in good work habits when supervision is and is not provided.

Finally, it is important to note that not all employers require competency in the lists provided in this document. This consensus work attempts to balance expectations from a diverse set of stakeholders with each having a unique set of requirements that apply to their operations. Entry level wind technicians should review the lists provided below and acknowledge any gaps in their own understanding. However, this should not discourage motivated, safety conscious individuals from pursuing work in this field.

General

Wind Power Facility

Key Competencies:

- Identify and describe the different areas of a wind power facility's electrical systems including: the point of interconnect, sub-station, collector system, individual wind turbine transformer and wind turbine. Describe the demarcation of the balance of plant from the wind turbines.
- Illustrate knowledge of wind power facility infrastructure including public, private and service roads, Operations and Maintenance (O&M) buildings, parts storage facilities, parking lots, communication networks both above and underground, meteorological towers and utility poles.
- Identify and describe the major components of a wind turbine including the blades, hub, pitch mechanism, rotor assembly, nacelle, environmental sensors, main shaft, main bearing, gearbox, high speed shaft, generator, vibration mounts, oil filtration systems, lighting systems, electrical cabinets, yaw system, power cables, up-tower, down-tower and pad-mount transformers.
- Identify and describe the function of the basic life cycle of a wind turbine. Distinguish between replaceable parts and non-replaceable structure. Contrast self-performed maintenance strategies with "full-wrap" and hybrid maintenance service agreements.
- Identify the differences between wind farm construction and operation as well as work crews and responsibilities, operational hand-off, land ownership, and typical warranty periods.
- Recall environmental sensitivities of renewable energy operations including anti-idling concerns, oils, solvents, lubricants, and other chemical handling and spill remediation, wildlife conservation, minimal water usage and impacts on the land.
- Discuss concepts such as site culture, safe work attitude, team work within diverse crews such as independent service teams, specialized contractors, OEM teams and direct hire employees.
- Describe typical work day concepts including shift work, on-call, remote work, lone work, safety sensitive positions, external contractors and taking breaks in the field.
- Demonstrate the value of cleanliness both personally and around the site such as the replacement of tools to correct locations and clear, organized documentation.

Description:

These competencies are aimed at a general understanding and application of work-day dynamics at a typical wind power facility. Entry level wind technicians are expected to describe the parts of the wind park and how they aggregate into an operational power generation facility. Each site will be unique in equipment branding, selection and layout. Therefore, expectations are focused on a general understanding and ability to apply knowledge increasing the rate of site-specific learning. An overall awareness of the factors that affect where and how tasks are completed is important including desk work and maintenance of operations buildings. Keeping equipment and buildings clean and organized is a highly valued priority.

Schematics and Drawings (electrical, hydraulic, mechanical)

Key Competencies:

- **Identify and describe the various types of electrical drawings (schematic, wiring, single line, etc.).**

- **Interpret and use common terminology, symbols, formats, etc. used in electrical, hydraulic and mechanical schematic drawings.**
- **Demonstrate ability to distinguish between pieces of physical hardware and features in drawings and schematics.**
- **Identify hazardous energy sources and other obstruction hazards represented in facility schematics.**

Description:

As an important part of power plant operations, schematics and drawings should be recognized and readable by a wind technician. This competency is used regularly in work planning, troubleshooting faults and for developing a more advanced understanding of the equipment and infrastructure of a site. The ability to adapt documents and create new drawings and schematics is not a core competency.

Electronic Devices

Key Competencies:

- Use a personal computer for email, word processing, PDF form completion, service manual navigation and internet research.
- Use multiple communication devices including cell phones and two-way radios. Recall phonetic alphabet and etiquette for professional communications.
- Recognize mobile devices used for digital record keeping, checklists, service manuals and other documentation such as smart phones, tablets and field laptops.
- Demonstrate the use of a digital multimeter for voltage, amperage and impedance measurements.

Description:

As with many occupations, the wind technician role is becoming increasingly digital. The use of conventional communication devices such as telephones and radios remains important while proficiency with smart phones, tablets and computers is now considered a core competency. Simple navigation of pre-set applications, various file types and voice/text communication is expected. The ability to write, debug or identify elements of computer coding is not a core competency.

Troubleshooting, Logical Deduction

Key Competencies:

- Demonstrate a basic ability to identify and isolate a problem within electrical and mechanical systems. Execute basic logical deductions to work backwards from a problem and propose potential solutions.
- Identify and explain when more information is required to solve a problem.
- Identify sources of information used in problem solving of wind power plant issues.
- Exhibit basic abilities to transfer troubleshooting capabilities between multiple types of problems.

Description:

Troubleshooting and logical deduction skills, or at a minimum, the capacity to develop these skills are vital to wind technician work. The identification, reasoning through and solving of problems is necessary from major failures on site to minor, routine maintenance activities. Due to the remote nature of the work and inability to retrieve additional tools and materials for a job, technicians must be prepared and

versatile as they set out to complete a task or they risk significant lost time and productivity. Experience solving specific issues is not a core competency, the ability to logically deduce solutions is.

Basic Math/Conversion Units

Key Competencies:

- Recognize and apply standard SI Units for length, mass, volume, electrical current, temperature.
- Recognize and apply basic electrical units: volts, amps, ohms, watts.
- Use addition, subtraction, multiplication and division of basic SI and electrical units.
- Convert units within the metric system such as millilitres to litres.

Description:

By having a basic understanding and ability to apply mathematical principles and units of measure a wind technician can begin completing many other problem-solving tasks. Without this baseline, it is very challenging to learn the additional skills required at the outset of this new career. The expectation is not that the entry-level technician will be able to apply advanced concepts such as integration, mental conversion between different systems of units, or solving for multiple variables.

Safety

General

Key Competencies:

- Thoroughly demonstrate the importance of health and safety on site including physical, mental, and emotional health and safety as the highest priority. Implement the unique, safety sensitive nature of the wind turbine technician role.
- Explain the concepts of a pre-job safety assessment (JSA), work planning for safety purposes, reducing climb time when possible, and utilizing available data to inform safety sensitive decisions.
- Explain various terms used for work planning such as a job hazard analysis (JHA), job planning form, tail board, etc.
- Identify their own personal limits for work refusal and when to call a stop to work based on their understanding and comfort level.
- Describe fitness for work requirements, the effects of substance abuse on safety as well as safety sensitive roles.
- Identify and describe chemical hazards in the workplace, the Workplace Hazardous Materials Information System (WHMIS), Safety Data Sheets (SDS) and the Global Harmonized System (GHS) for classification and labeling of chemicals.
- Describe safety concepts including site safety plans, the safety chain, safety hierarchy and reporting of incidents, recordable incidents, and near-miss scenarios.
- Identify and explain wind turbine approach hazards: ice throw, ice fall, snow drifts: damaged transformers, doors, stairs, and ground shifting from environmental conditions. Damage caused by vandalism, theft, and forceful entry by unauthorized people.

- Apply safety awareness by informing workers on site of their approach to a turbine, departure from a turbine and departure from the site. Good communication practices through efficient and precise language.

- Identify and describe hazards associated with hoisting & rigging of tools and equipment. Knowledge of tag lines, remaining clear of the drop zone, accommodating for wind, heavy crane operations and internal crane operations and basic hand signals for hoisting and rigging.

- Define lightning hazard awareness and action: Lightning activity monitoring, policies regarding evacuation of the turbine and the site.

- Demonstrate compliance with posted speed limits and reduced speeds during hazardous conditions including loss of traction (ice, snow, oil and water), obstructions (trees, land/rock slides, dropped objects from other vehicles), wildfires, flooding, snow drifts and wildlife. Awareness of implications of shared roads such as oversized vehicles, farming equipment, logging trucks and other land users.

- Demonstrate safe driving behaviour by preventing distracted driving, parking outside of a wind turbine drop zone, reversing into parking spaces or parking to provide rapid exit from a location, performing vehicle inspections, and using good load tie down practices.

- Recall environmental hazards such as ticks, bugs, bears, wolves, etc. as well as extreme temperatures and sun stroke.

- Recognize the role of authorities having jurisdiction, regulations and standards governing safety as well as recognition of differences between geographical regions.

Description:

The general safety competencies span a range of hazards that are not universal and apply specifically to workers who are outdoors, traveling significant distances off of main roads and performing physically demanding tasks. The most important competency, however, is an overarching awareness and safety sensitivity that routinely produces a safe approach to these unique tasks regardless of whether they have been encountered before. For example, lifting a tool bag is not unique to the workplace or to the wind industry. However, injuries caused by improper lift techniques can be worsened if you have tight muscles from 30 minutes of sitting in a vehicle, climbing a 70-metre ladder and repeating the lifting task five times. A holistic approach to safety from home, to travel, to maintenance building, to turbine and back again is emphasized for the wind turbine technician role. In addition, to remain compliant with local authorities having jurisdiction, the wind technician should have an awareness of differences in legislation and terminology from one region to the next. Site specific policies, procedures and tools are conveyed by the employer and are not a core competency.

Personal Protective Equipment (PPE)

Key Competencies:

The following personal protective equipment, its proper use and associated hazard awareness is considered a core competency. It is not expected that wind technicians own all of the equipment, however a working knowledge of hazard identification and application of the correct equipment is important.

- Footwear – Steel/carbon fiber toe protection, water resistance in damp environments, temperature ratings for hot and cold environments, anti-slip tread, weight considerations for climbing, ankle protection.

- Face protection – Types of safety glasses: anti-fogging, metal work, cold climates in exposed vehicles, sun protection, welding. Arc flash protective face masks and when to use face shield in combination with glasses.

- Hearing protection – General use in-ear, high noise over ear. Safety awareness with reduced hearing.
- Breathing protection – Dust mask ratings for airborne contaminants, full respirators for fiberglass work and extreme situations, independent oxygen supply for confined space situations.
- Hand protection – Importance for injury prevention, types of gloves: mechanical work, metal work, chemical handling and arc flash protection. Hydraulic injection injuries and prevention.
- Gas monitors – Purpose and spaces where gas monitoring is needed, 3, 4 and 5 gas monitors, typical safe gas levels, the importance of record keeping.
- Helmets – Types for various tasks: construction, climbing, dropped object injury prevention, importance of chin straps, cold weather applications with winter hats.
- Clothing – Arc flash ratings, fire ratings, organic fibers vs. synthetic fibers, effects of grease, oil, dirt, holes, etc. on protection levels. Appropriate clothing for climatic conditions, heat, cold, humidity, solar radiation.
- Fall arrest equipment – Purpose and types for: climbing, construction, short term use and full day use, suspended work, rail vs. cable grab systems, typical fall distances while wearing equipment, inspection and maintenance of gear, effects of soiling, hanging body weight and damage due to fall arrest incident.
- Positioning lanyards – Applications and limitations and their role in fall prevention.
- Tool restraints, climb bag closure and pocket empty/closure for dropped object prevention.
- Recognize the role of authorities having jurisdiction, regulations and standards governing safety as well as recognition of differences between geographical regions.

Description:

Similar to the general safety core competencies, a basic PPE understanding is governed by an overall awareness of the need for different equipment for different tasks. Demonstrating the ability to apply the correct PPE for the situation and to ask questions when a new scenario is encountered is critical. Employers require confidence that their employees will approach every situation with a safety mindset and apply the proper tools before proceeding. They need to know that an employee will stop work if they are unsure of their own ability to safely complete the task. A working knowledge of PPE will set the ground work for learning site specific policies and the confidence to question any perceived gaps in their own personal protection. In-depth experience of all safety sensitive tasks and variations of tasks such as confined space rescue and internal blade repairs is not a core competency.

Electrical Safety

Key Competencies:

- Demonstrate the ability to identify electrical hazards associated with the different areas of a wind power facility and areas designated as restricted.
- Identify and describe when higher qualifications and teams are required to enter a restricted space such as the sub-station and demonstrate a willingness to learn from more qualified employees and contractors.
- Identify that entry level wind technicians must remain outside of the sub-station building and fenced area until the employer has trained, evaluated and provided permission to enter.
- Describe the qualified operator worker (QOW) role as being permitted to observe and inspect the sub-station interior. In this role no tools are to be used but the QOW may conduct a walk-around inspection

based on an ability to identify and describe hazards and entry permission is provided by the site supervisor.

- Describe the qualified electrical worker (QEW) role as a person certified to perform work in restricted zones and conduct live work in alignment with advanced training and supervisor's permission to enter and perform work.
- Recall that there are differences in regulation between jurisdictions regarding electrical work qualifications.
- Illustrate knowledge of pad-mount transformer hazards: exposed or compromised electrical equipment from ice fall or other damage, elevated dissolved gasses internally and risk of arc fault.
- Demonstrate the ability to safely test for the presence and absence of alternating and direct current and voltage in a variety of circuits.
- Demonstrate knowledge of lock-out/tag-out systems for control of hazardous electricity sources. Single lock, single key systems and the responsibility of the supervisor if an individual is unable to remove their lock.
- Describe hazards of live electrical equipment, residual energy sources after isolation and stored electrical energy in pitch batteries, capacitors and power conditioning storage devices as well as proper grounding techniques.
- Perform an inspection of a cable to identify the presence of damage.
- Demonstrate rights of work refusal and work stoppage if the situation is or has become unsafe or if the technician is asked to operate outside of their training.
- Describe the concept of common switchgear found in the industry.

Description:

Safety, including electrical safety, is of primary importance for wind turbine technicians. It should not be emphasized as a stand-alone topic but an integrated part of every task at the wind power facility. From balance of plant, to up tower work technicians must be aware of the hazards and general safe work practices required to prevent injury or damage to equipment. Expectations are restricted to recognition of the wind technician's personal limits in order to stop or refuse work for which they are not qualified or is unsafe. In addition, awareness of the potential for regulatory differences between regions that govern electrical worker qualifications is a basic expectation.

Mechanical Safety

Key Competencies:

- Identify and describe potential sources of hazardous mechanical energy including the rotor and drive train components, yaw action, internal crane operation, service lift and climb assist operation, hatches, and doors.
- Demonstrate knowledge of mechanical energy lockout systems such as the rotor lock, blade lock, pitch block/lock, pneumatic valves, and liquid valves.
- Describe other positional hazards such as entrapment between objects, pinch, crush, slips, trips, falls, low hanging obstructions.
- Identify and describe all exposed gear surfaces in the nacelle/rotor.

- Identify and describe high-pressure fluid systems and associated hazards: hydraulic injection, rapid pressure release, burst.
- Identify, describe, and demonstrate the safe use of mechanical tools (wrenches, pry bars, screw drivers, and pliers) and torque wrenches.
- Identify, describe, and demonstrate the safe use of hydraulic torque wrenches and associated equipment.
- Identify, describe, and demonstrate the use of the in-turbine mechanical hoist. Describe the hazards of chains, wire rope, and rope under tension in the hazard of a bight in the line.
- Identify and describe the hazards of dropped objects and the means and methods of tool retention.

Description:

Working on large industrial equipment can produce hazards for workers. Wind technicians should be able to identify the rotating equipment which can sometimes be exposed and begin to rotate without notice if not properly locked out. Stored energy in hydraulic and pneumatic systems, torqueing tools and gravity are critical for basic awareness. Due to the frequency of working at heights and therefore potential for dropped objects and hazards associated with hoisting equipment are also important core competencies. Awareness of these hazards along with those that come from maneuvering in tight spaces around heavy machinery such as becoming trapped, trips, overhead impacts, etc. is very important. Full maintenance capability of these mechanical systems is not an expectation, simply an awareness of the potential for injury.

First aid/CPR/AED

Key Competencies:

- Perform basic first aid including:
  - Treatment of cuts both minor and major, broken bones, bruising, burns.
  - Treatment of head and eye injuries.
  - Treatment of shock, hypothermia, heat-stroke, exhaustion, cramps, frostbite, dehydration, poisoning.
  - Treatment of emergencies such as asthma, anaphylaxis, seizures, diabetic emergencies, stroke, cardiovascular diseases.
  - Cardio Pulmonary Resuscitation (CPR) and remote location protocols.
  - Use of an Automated External Defibrillator (AED).
- Demonstrate when professional medical attention is required and how to call for help as well as basic transportation methods in a vehicle.
- Demonstrate ability to use concise language to communicate injuries to medical authorities and or wind site staff as well as stability criteria used when communicating with medical authorities.
- Demonstrate awareness of rescue devices such as immobilization and extrication devices and importance of learning site specific protocols.

Description:

Wind turbine technicians typically work in teams. On remote sites, up-tower, or on the road a teammate may be the first responder, and only medical support in the area, if an incident occurs. A basic knowledge of first aid practices is important for stabilizing an injured worker while medical help arrives. Understanding the environmental accelerants to medical conditions such as metal flooring during

hypothermia or being outdoors while in shock is also important. As specified in the competencies list, expectations are focused on basic skills and knowing when and how to call for professional help.

Climb and Rescue Training

Key Competencies:

- Demonstrate an ability to select, inspect and adjust the appropriate climb harness for the wind technician role.
- Apply knowledge of fall arrest systems including cable and rail systems, cable grabs, rail sliders, shock absorber, carabiners. Identify and describe proper tie-off locations and anchor points both inside the tower and turbine and on top of the nacelle and hub.
- Describe and demonstrate rescue procedures and devices for various scenarios: basement or vault, on the ladder, disabled service lift, nacelle interior, fall over the side of the nacelle and hub including risk of suspension trauma and body loading applied during a restrained fall.
- Recall the integration of potential rescue situations into the job hazard analysis and work planning process.
- Demonstrate proper maintenance and care for harnesses, lanyards, fall arrest equipment and rescue equipment.
- Identify and describe the difference between a Y and V fall arrest system and tie off techniques.
- Identify and describe the difference between fall arrest and fall prevention including the proper use of work positioning lanyards.
- Apply good lifting and climbing practices: ergonomic body positioning, three points of contact, 100% tie-off, secured loads, team awareness, opening and closing hatches, transitioning to and from platforms to the ladder, lift, decks, etc.
- Describe the use of service lifts and climb assist technologies. Awareness of guard rails, service lift openings, covers and ladder hatches.
- Explain the importance of having non-sealing pockets emptied prior to climbing and dropped object prevention techniques such as tool tie-off lanyards, secure climb bags and use of helmet chin straps.
- Recognize that additional training may be required to enter certain locations in the turbine such as the hub and blades. Awareness of restricted and confined space practices and team rescue plans. Recall that each wind turbine model may require a unique entry, exit and emergency rescue plan.
- Recall hub and blade entry practices including: counting all tools and materials upon entry and exit to ensure nothing is left behind, acceptable step and hand hold locations, 100% tie-off at all times.

Description:

Climb and rescue training is critical and somewhat unique to the wind technician role. As an entry-level technician it is acknowledged that experience may not be extensive however, an introduction to the competencies listed will set a good foundation to begin work in the tower. As discussed in the previous section, the technician team members are frequently the first responder on site and in the case of tower rescues, the only qualified person in the area to extract a co-worker from the turbine. A foundation of rescue procedures helps an employer to integrate a new technician into the routine, advanced rescue training on site with the equipment on hand.

While some competencies appear minor or less critical it is important to note that hazards associated with working at heights require special attention to detail. For example, an unzipped pocket containing a bolt can cause harm to someone working below or damage to equipment. In addition, the physical exertion and time spent accessing some locations requires forethought of any possible situation that may arise.

Confined Space

Key Competencies:

- Identify when a space is or is not considered confined based on provincial regulations: atmospheric hazards, difficult ingress/egress, designed for continuous human occupancy, permit, non-permit, etc.
- Identify when confined space hazards are present and describe hazard mitigation strategies to prevent injury.
- Identify and describe the function of a rescue team:
- The use of gas monitors and acceptable gas levels (oxygen, carbon monoxide, lower explosive limit, hydrogen sulfide) for human occupancy.
- Identify and describe sulfur hexafluoride hazards present in wind turbine lower levels due to the presence of specific circuit breakers used in some wind turbines.
- Identify and describe the increased risk of elevated carbon dioxide levels from extended work periods in spaces with insufficient ventilation.
- Identify potential hazards such as rapid nitrogen discharge from accumulators, battery off-gassing, and exposure to chemicals.
- Recall the need to check weather forecasts for lightning or other forecasted events prior to confined space entry to prevent compounding hazards.
- Identify other hazards such as mold, pests and feces, and aerial application of chemicals (crop dusting).

Description:

Confined space regulations may prescribe a variety of actions depending on the jurisdiction in which the work is being performed. An overall safe practices approach will assist the technician both in compliance but more importantly in remaining safe at all times. There are several areas on a wind site where confined spaces may be encountered and a basic ability to identify and stay out of these spaces is important. Working in a confined space and confined space rescue are considered to be advanced skills.

Electrical

Theory (AC and DC)

Key Competencies:

- Use basic laws of electricity to solve simple problems including: Ohm’s Law and Kirchoff’s Rules.
- Demonstrate ability to use a multimeter to measure voltage, current, resistance, continuity and capacitance.

- Explain and discuss alternating and direct currents, capacitance, inductance, resistance.
- Describe Voltage, Current, Resistance, Power and their relationship.
- Describe a simple circuit.
- Describe Series, Parallel and combination circuits.
- Define Work, Energy, and Power.
- Describe the fundamentals of magnetism with relation to electricity including permanent and temporary magnets.
- Describe Power Factor as it relates to electricity.
- Explain what frequency means regarding electricity and why is it important.
- Describe a Sine Wave as it relates to electricity.
- Identify specific components within the electrical cabinet (capacitor, resistor, battery, power supply, diode, sensor, etc.
- Troubleshoot when circuit board replacement is required and when repairs may be possible.

Description:

Working on a power generation facility requires some theoretical knowledge of electricity to build on as experience is gained. The fundamentals described here allow entry level technicians to begin identifying circuits and understanding the stress place on electrical equipment. Most importantly, these basics provide insight into electrical hazards that may not be intuitive.

Program Logic Controllers

Key Competencies:

- Explain what Analog and Digital means in relation to electrical signals.
- Describe the function of a PLC.
- Describe the major components of a PLC system.
- Identify the methods of installing PLCs.
- Demonstrate Timing and sequencing of PLCs.
- Describe the various types of PLCs (shoebox, modular).
- Distinguish between power and control logic programming and voltages.
- Troubleshoot PLCs using indicator lights on the PLC cards and a schematic to determine what should be happening.

Description:

Entry level technicians should be able to navigate through a PLC and grasp which sensor is controlling which output. They should be able to determine if the signals are digital or analog and why one piece of equipment has to start to begin the sequence. Basic tasks such as replacing damaged components in the PLC system should be familiar or at a minimum not a new concept. Programming and advanced troubleshooting is not a core competency.

Breakers and Fuses

Key Competencies:

- Describe the purpose of breakers and fuses as they relate to power production, grid connection and safety.
- Define instantaneous trip and time limiting breakers.
- Describe trip, phase to phase and ground fault current values.
- Define what an overload is and variations of overloads.
- Define what a DC is and its purpose.
- Describe what a Motor Controller Switch is and how it differs from a DC.
- Describe consequences of wrong fuse selection.

Description:

The frequency of interaction that wind technicians have with breakers and fuses requires some knowledge of the purpose and function of these devices. Understanding overcurrent scenarios is a basic competency while changing settings, replacing components and adapting solutions is not consider core experience.

Fiber Optics and CANBUS Communication

Key Competencies:

- Identify basic electronic communication and control systems.
- Describe data transfer mediums: ethernet, fiber optic, wireless.
- Describe Supervisory Control and Data Acquisition (SCADA) system functions and major connection points such as generator, gearbox, weather monitoring, up and down-tower control cabinets, central data collection and storage.
- Describe built in and stand-alone condition monitoring systems (CMS) and their purpose as supplemental data collection.
- Describe how fiber optics communicate and why they are used in industry.
- Recall that there are ways to repair and splice fiber optics.

- Describe necessary precautions when handling fiber optic cables.

Description:

Fiber optic systems are an integral part to a distributed power generation facility such as a wind farm. While entry level technicians are not expected to install, repair or customize fiber networks, an ability to identify the main components, handle cables and connections with the appropriate level of care and explain the purpose and function of the systems is a core competency.

Meters and Meggers

Key Competencies:

- Identify and describe the various meters used in the industry and their components (Megger, multimeter, Clamp-on ammeter, motor tester, oscilloscope, two-pole tester).
- Demonstrate proper use and connection of various meters on conductors and busbars.
- Analyze readings on the various meters for troubleshooting purposes.
- Apply proper steps to safely measure conductors.

Description:

Electrical measurement devices are a frequently used tool for wind technicians. Used not only for troubleshooting issues and testing equipment, meters are used to determine the status and therefore safety of working around electrical equipment. With these core competencies, as with others, it is important for entry level technicians to understand the limits of their electrical knowledge in determining when to stop work. Proper use of measuring devices are an important tool to know if that limit has been reached.

Transformers

Key Competencies:

- Identify and describe basic types, functions, and power ratings of transformers including: wind turbine generator output, turbine transformer, substation transformer.
- Identify and describe the use of oils in transformers and maintenance practices, oil vaults and spill containment.
- Identify and describe basic failure modes such as low oil levels, poor installation or material quality, insulation failures, kinked cables, copper theft, and improperly rated equipment.
- Awareness of differences in OEM transformer maintenance practices, warranty requirements, predictive and preventive maintenance strategies.
- Recall transformer faults such as damage from ground heave, flooding, dropped objects, ice fall and extreme heat.

Description:

Live and de-energized transformer work should only be performed by a qualified electrical worker with permission from the site supervisor. Entry level technicians should be able to identify a transformer and understand the differences in voltage ratings and basic maintenance practices. However, each manufacturer will have a different design and approach to servicing this equipment and voltage levels are in the medium to high range, therefore conducting service tasks is not a core competency but remains the responsibility of the site operator to approve qualifications prior to work.

Generators

Key Competencies:

- Describe the main principle of operation of an electrical power generator.
- Describe the main components of a generator (armature, rotor, stator, windings, terminal box, bearings, slip-rings).
- Describe different types and classification of common wind turbine generators (Permanent Magnet, Induction, Doubly-Fed Induction, Singly-fed Induction, A-Synchronous).
- Describe the frequency of electrical power consumed and produced by a generator.
- Explain active and reactive power output of a generator in single and three-phase.
- Describe the development of a sine wave from the output voltage of a generator.

Description:

Principle concepts such as induced current, rotor motion, alternating current and power factor are important to understand at a basic level. An awareness that not all generators operate in the same manner or produce the same output is valuable as a starting point for troubleshooting and remaining safe up-tower. Isolating the generator circuits and removing parts of the equipment for repair are not considered core competencies. The focus remains on knowing when to stop work due to the complexity of the electrical circuitry.

Motors

Key Competencies:

- Identify and describe AC and DC motor functions.
- Identify the different types of DC motors: single phase, three-phase.
- Explain the function of a safety relays.
- Describe the operation of a relay, contactor, motor starter.
- Identify the main components of a motor starter.

Description:

An entry level technician should be able to identify a motor, read the name plate and understand the ratings provided. A basic knowledge of electrical and mechanical connection points and where motors can be found within the wind farm provides a foundation to build on service and operational skills. Deconstructing and repairing motors is not a core competency.

Instrumentation

Key Competencies:

- Identify instrumentation such as sensors, wiring and control boards throughout a wind power facility.
- Identify and describe the various types of sensors used in the industry.
- Demonstrate ability to replace sensors, wiring and control boards as directed in a safe manner.
- Identify differences between medium and low voltage wiring such as shielding and wire gage.

Description:

Instrumentation is used throughout the wind facility to monitor and control mechanical, electrical and hydraulic components. Attention should be given by a new entry into the occupation to the various sensors, wiring and control boards employed in the daily operation of a wind facility. The ability to replace certain sensors and damaged wires safely is an expectation of entry level technicians. Troubleshooting, programming controls and customizing instrumentation is not a core competency.

Mechanical

Basic Theory (bearings, gears, rotating equipment)

Key Competencies:

- Explain mechanical concepts such as inertia, friction, heat transfer, hydraulic pressure, aerodynamic lift and potential energy.
- Explain the basic pathway of mechanical energy from the rotor blades to the generator.
- Explain the principle function of gearing and the effects of changing gear ratios.
- Describe the function of the mechanical braking system and typical maintenance requirements such as measuring and replacing brake pads.
- Explain rotor lock procedures and controlled rotation.
- Recall the function of the main bearing, types of bearings used and typical maintenance procedures.
- Explain the purpose of a seal and describe different types of seals.
- Describe the function of a Condition Monitoring System and how it relates to the Gearbox, Generator and Main Bearing.

Description:

These core competencies ensure that a wind technician is prepared to apply their understanding of the major rotating components in a wind turbine nacelle. Familiarity with physical concepts such as inertia and heat transfer provide a basis for hazard awareness produced by a large wind turbine rotor in

motion. Prior to starting work as a wind technician, new entries are expected to be aware of basic bearings and energy transfer devices. The ability to repair and replace these devices is not a core competency.

Fasteners, Torqueing & Tensioning

Key Competencies:

- Identify and describe metric and imperial systems for fasteners and tools.
- Identify and describe the difference between types of fasteners and hardware: screw, bolt, nail, nut, lock-nut, washer, lock-washer, pipe fittings.
- Demonstrate proper, safe use of hand tools including: screwdrivers (Philips, Robertson, Torx, Allen/Hex, Flat), side cutters (wire cutters, cable cutters, zip-tie snips), channel locks, wrenches, socket/ratchet, multimeter.
- Identify and describe the purpose of bolt torqueing and its application in a wind turbine: tower sections, nacelle, foundation, blades.
- Demonstrate the proper use of electric and hydraulic torqueing tools.
- Describe differences between torqueing and tensioning.
- Recall that there is extensive use of specialized equipment in the wind industry requiring specialized training. Entry level wind technicians are not expected to have this type of training.

Description:

A basic mechanical aptitude and familiarity with common fasteners and tools is important. Due to the extensive use of torqueing and tensioning performed in the industry, an awareness of these tools and their application is also valued for entry level technicians. It should be understood that specialized equipment requires appropriate training and their use is not a core competency.

Gearboxes, Bearings and Oil Sampling

Key Competencies:

- Recall the purpose and function of a wind turbine gearbox.
- Outline oil types used in typical wind turbine gearboxes.
- Identify and describe oil filtration systems, oil filter change frequency and methodology, importance of oil health, laboratory testing of samples, condition monitoring through oil sampling.
- Recall the purpose and function of the main bearing and gearbox bearings: Load support, thrust, types.
- Outline lubrication grease and maintenance techniques: grease sampling and replenishment.
- Explain the importance and methods of spill clean up.

Description:

Routine maintenance includes a significant amount of time servicing gearboxes and specifically lubrication systems. A basic working knowledge of the types of systems that may be present on a wind farm and an understanding of the tasks involved in servicing them is a core competency.

Hydraulic Systems/Oil Sampling

Key Competencies:

- Describe the function and principles of a hydraulic blade pitch system and high-speed brake.
- Identify and describe basic components of a hydraulic system.
- Describe hydraulic system maintenance procedures.

Description:

Hydraulic systems are not always found in a wind turbine, but many designs use this method to control power output. It should be understood that these systems are often found in the wind turbine hub which may require training beyond core competencies in order to enter. However, because of the wide spread use of hydraulics and the specific hazards they can use, a basic understanding of their components and operation is considered a core competency.

Cooling Systems

Key Competencies:

- Identify and describe generator cooling systems and related components.
- Demonstrate ability to troubleshoot basic cooling system malfunction such as blockage, leaks, freezing, and pump or fan failure.
- Describe the principles of heat exchanger function.
- Discuss common maintenance requirements of heat exchanger components.
- Maintain heat exchanger cooling fins.
- Identify coolant types and applications.

Description:

Cooling system maintenance is a fundamental role of the wind technician. Having an entry level knowledge of these systems allows a new technician to build experience with a variety of failure modes and available solutions over time. The core competencies focus on the basic principles and major components and not on the repair and replacement of parts.

Yaw Systems

Key Competencies:

- Describe the purpose and function of a nacelle yaw system: Yaw drive motors, ring gear, lubrication, location in the tower, bearings, mechanical load path.

- Describe control signal sources: wind vane, anemometer, control logic and decision making for normal operations.
- Identify presence of damage to yaw system components.
- Identify and describe yaw bearing lubrication methods and maintenance practices and its importance.

Description:

The ability to point out yaw system components and their operation is a core competency of a wind technician. This includes the ability to relate the environmental conditions such as wind direction to the function of the yaw mechanisms. Maintaining lubrication in the yaw bearing is an important task for a wind technician and is considered a core competency. Details concerning the repair and replacement of yaw drives, ring gear and other major equipment is not a core competency.

Operational

Industry Overview – Direct Drive vs. Geared Turbines, OEM Brands

Key Competencies:

- Describe the difference between and basic operation of a direct drive wind turbine and a turbine with a gearbox.
- Identify major hub components including control cabinets, pitch rams and drivers, hydraulic fluid pressure tanks and lines, access hatches and fastening methods and pitch bearings.
- Discuss the presence of different manufacturers of wind turbine and components.
- Describe the importance of tracking tools and materials when entering the turbine to prevent items from being left behind as well as potential damage that could occur from forgotten equipment.
- Discuss the importance of a clean wind turbine after work is completed and closing cabinet doors.
- Identify and describe the function of various stopping procedures including: mechanical braking, blade pitch, e-stops and emergency shut down.
- Explain the purpose of wind turbine generated faults, clearing faults and placing a turbine into operation after shut-down.

Description:

In order to learn how to install, inspect, troubleshoot and repair wind turbines and turbine internal and external components, wind turbine technicians must understand how a wind turbine works, the types of technologies used, and the work ethics needed to do the job. This sub-section builds on competencies listed elsewhere and gives entry level technicians the basics of wind turbine work. Operational core competencies cross the application of knowledge with safety considerations for physically working inside the machine. Preventing dropped objects, working around access hatches, control cabinets, cabling and hoses should all be expected by a new technician.

Predictive vs. Preventive Maintenance

Key Competencies:

- Explain how predictive indicators can assist with operational performance increases.
- Explain what preventative maintenance is and why is it important.
- Describe the different tasks of preventative maintenance (filter replacement, inspections of leaks, removal of used grease, bolt torqueing, etc.).
- Compare and contrast predictive and preventative maintenance.
- Observe and record predictive maintenance metrics.
- Describe the run to failure method and when it may be used as an asset management strategy.

Description:

Being able to list common predictive maintenance activities, track data and use preventative maintenance tasking to support efficient wind turbine operation are important wind technician tasks. Advanced analysis of failure rates and adapting maintenance schedules to prolong life or decrease costs are not core competencies.

Hoisting/Raising and Lowering of Tools & Equipment

Key Competencies:

- Explain the importance of two-way communication.
- Explain rigging safety and placing equipment in proper bags.
- Describe common lifting devices and their uses as well as the affects of different load weights and dimensions.
- Describe the risks involved with rigging and hoisting.
- Demonstrate overall safe lifting techniques.
- Describe and identify jobsite hazards associated with lifting and hoisting.
- Inspect lifting and hoisting equipment.
- Use rigging and hoisting signalling systems.
- Use portable handheld radios to support lifting activities and demonstrate awareness of basic hand signals used in lifting operations.
- Lift and support loads of various weights, dimensions and fragility as appropriate in maintenance operations.
- Demonstrate awareness of hazards and mitigation strategies associated with crane operation including lifting of hazardous material, clearing and securing the potential drop zone, required signage and site policy compliance.

Description:

Due to the nature of wind turbines, most tools and equipment must be lifted using the turbine's permanent, internal crane. Understanding the basic function and safe operation as well as an awareness of the different styles of cranes provides a foundation for essential maintenance tasks. Repair and replacement of internal cranes is not a core competency.

Blades

Key Competencies:

- Describe the difference between and basic operation of a battery and hydraulic powered blade pitch system.
- Recall basic blade construction and parts as well as repair types and materials.
- Recognize that blade maintenance activities are typically an advanced skill requiring specialized training and not considered a core competency.
- Recall blade pitch angle, principles of lift and aerodynamic energy capture.
- Identify and describe the leading edge of a blade and causes of deterioration.
- Explain basic principles of fiberglass repair and demonstrate awareness of the presence of hazardous chemicals used in repairs.
- Explain typical methods for internal and external blade inspections.

Description:

Knowledge of common blade construction types, blade function and failure modes are important basic learnings for a complete understanding of wind turbine operation. Blade entry, rope access, completing inspections, and repairs are considered advanced skills and not core competencies.