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turbine generators includes combustible materials such as oil. It is conceivable, though unlikely, that a fire could penetrate the nacelle, allowing burning materials to fall to the ground. Similarly, ground-level equipment or maintenance activities could be a source of ignition.

5.8.3.1 Mitigation

Fire hazards associated with the operation of wind farms can be minimized through a variety of measures that are typically incorporated within modern wind project designs and operating procedures. Probably the single most effective fire hazard avoidance measure is to place electrical wiring between turbines and the project substation underground. Other typical mitigation measures include fire prevention plans, special training programs for local firefighters, regular maintenance and monitoring of equipment, and adherence to proper operation and maintenance procedures. A fire protection and emergency response plan should be provided to all on-site personnel. Strong relationships and communication with local fire departments, many of which are voluntary, should be maintained throughout the operation of the project. Members of the fire department should be educated on the equipment and facility layout and may need access keys to some areas of the project site.

Strong relationships and communication with local fire departments, many of which are voluntary, should be maintained throughout the operation of the project.

5.8.4 Stray Voltage

The grounding of electrical systems results in some current flow through the earth. A small voltage develops at each point where the system is grounded. Stray voltage is measured between two points that can be simultaneously accessed by a person or animal. Stray voltages can arise from unbalanced neutral currents flowing into the earth through ground rods, pipes, or other conducting objects, or from faulty wiring or faulty grounding of conducting objects in a facility. Thus, stray voltage is generally associated with the distribution system that conducts electric power to and from an area.

5.8.4.1 Mitigation

Electric power from a wind turbine project should normally be balanced three-phase power that is fed directly into the electric transmission system. In the balanced three-phase system there should be very little or no unbalanced current to return through the earth. In addition, the power collection and interconnection system should be separate from the distribution system serving the local area, and should not contribute to currents associated with that system. Consequently, stray voltage effects from a wind farm installation would not be anticipated and no mitigation would be required if standard industry practices are followed.

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5.8.5 Electromagnetic Fields

Electromagnetic Fields (EMF) emanate from any wire carrying electricity. Members of the general public are routinely exposed to these fields in their everyday lives. Possible effects associated with the electric and magnetic fields from transmission lines (or similar electrical sources) fall into two categories:

- short-term effects that can be perceived and may represent a nuisance
- possible long-term health effects.

The issue of whether there are long-term health effects associated with exposure to fields from transmission lines and other sources has been investigated for several decades. There is little evidence that electric fields cause long-term health effects. Estimates of magnetic-field exposures have been associated with certain health effects in studies of residential and occupational populations. Research in this area is continuing to determine whether such associations might reflect a causal relationship. National and international organizations, such as IEEE, formerly known as the Institute of Electrical and Electronics Engineers, have established public and occupational EMF exposure guidelines on the basis of short-term stimulation effects, rather than long-term health effects. In so doing, these organizations did not find data sufficient to justify the setting of a standard to restrict long-term exposures to electric or magnetic fields. From what is known about short-term effects, EMF levels generally decrease exponentially as one moves away from the electrical wires.

The U.S. Department of Energy prepared a booklet in 2002 on EMF entitled "Questions and Answers: Electric and Magnetic Fields Associated with the Use of Electric Power."

Example

5.8.5.1 Mitigation

The electromagnetic fields produced by the generation and export of electricity from a wind farm do not pose a threat to public health. Typically, electric cabling between wind turbines is buried in the ground, effectively eliminating EMF exposure to the public. Grid connection is normally made at no more than 132 kilovolts (kV), similar to the voltages used by utilities in existing residential distribution networks. In addition, project developers generally design the entire electrical system to adhere to applicable state guidelines and industry standards to minimize EMF exposure from any new overhead transmission lines.

5.8.6 Lightning Strikes

Lightning strike frequency varies depending on location, ranging from the relatively high rate of occurrence in Florida (8 to 16 flashes per sq. km per year), to the near average rate in Texas (1 to 8 flashes per sq.

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km per year), to a negligible rate of occurrence on the west coast. Without lightning protection systems, wind towers or blades might attract lightning and pose a threat to nearby persons or dwellings.

5.8.6.1 Mitigation

Protection against lightning strikes is built into the electrical systems of all wind energy projects.

Protection against lightning strikes is built into the electrical systems of all wind energy projects. All wind turbines have a lightning protection system that includes grounding of each tower. The grounding system installed as part of the foundation is also used for lightning protection. These lightning protection systems act to dissipate lightning strokes into the ground. Consequently, a person standing next to a turbine when a lightning strike occurred would be at some risk that a ground potential rise could result in a voltage between the ground and the tower or between two spots on the ground. Project operations workers are probably at highest risk. This risk should be counteracted by safety procedures instructing workers (or others) not to stand near turbines during lightning activity.

A wind project would not increase long-term lightning hazards for residents in the project vicinity. In addition, the electrical system of a wind turbine project is normally completely independent of the residential distribution system in the project vicinity. Therefore, any faults or surges on the project's electrical system due to lightning strike or other causes would not extend to the local distribution system that provides power to residences in the area.

5.9 Communications

Wind projects may impact communications signals in two ways. Wind turbines and their associated transmission lines can generate electromagnetic noise, which can interfere with telecommunications services, or, more commonly, wind turbines create physical obstructions that distort communications signals. The types of communications systems that may be affected include microwave systems, off-air TV broadcast signals, land mobile radio (LMR) operations, and mobile telephone services.

5.9.1 Impact Analysis

5.9.1.1 Microwave and Radar Systems

Microwave telecommunication systems are wireless point-to-point links that communicate between two sites (antennas) and require clear line-of-site conditions between each antenna. Obstructions between transmitters reduce the reliability of the transmission.

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A Licensed Microwave Search and Worst Case Fresnel Zone (WCFZ) Analysis can be carried out to identify microwave paths within a project area. The results of this analysis provide a map that shows the location of the microwave paths and the WCFZ around each path. Structures within a WCFZ could obstruct microwave transmission.

Consultation with federal agencies such as the National Telecommunications Information Administration (NTIA) and the National Weather Service is necessary to identify federal government microwave communication systems (*Section 4.1.6*). NTIA maintains a classified database, the Government Master File (GMF), that contains all of the government telecommunications systems. The NTIA notifies federal agencies operating telecommunication systems in areas near wind project sites. This notification method consists of sending site maps and a letter that describes the wind energy project and the turbines to be used, including turbine locations if known. The NTIA distributes the letter to the Interdepartmental Radio Advisory Committee (IRAC), which is made up of government agencies that operate telecommunication or radar systems. These agencies typically include the FAA, the DOD, the Department of Justice, and the Department of Homeland Security. The NTIA normally responds to a consultation request within approximately thirty days. The response either will state that government telecommunications concerns within the project area have not been identified or will identify potential impacts that will have to be addressed in coordination with the relevant federal agencies. However, the IRAC consultation process may not reach all relevant federal entities and does not eliminate the possibility that a federal agency may raise concerns about impacts to radar systems.

Although the FAA receives the NTIA letter, the FAA primarily depends on its FAA Form 7460-1 (*Section 4.1.5*) to analyze air safety issues and any potential degradation or obstruction of communication, navigation, or radar operations, including secondary radar relied upon by the military but operated by the FAA. The FAA has created a Long Range Radar Tool for preliminary radar clearance analyses. Project site coordinates can be entered to determine whether the site is in a no problem area (green zone), a possible problem area (yellow zone) or a definite problem area (red zone). Placement of turbines in yellow or red zones would require further consultation with the FAA and other relevant federal agencies to determine the proper mitigation measures to accommodate their radar and communication requirements.

As described in *Section 4.1.6*, the Long Range Radar Tool allows for a preliminary screening of only Air Defense and Homeland Security long range radar systems. A number of agencies have jurisdiction over other

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radar facilities that may be of concern at a particular wind project. Consultants that are familiar with FAA regulations, DOD radar concerns, and other radar systems can conduct screening analyses to examine the potential for interference with federal radar. Consultation with agencies such as the FAA and NTIA early in the development process may also identify potential impacts to radar systems.

5.9.1.2 Off-Air TV Broadcast Signal Distortion

Off-air stations are television broadcasters that transmit signals that can be received from terrestrially located broadcast facilities on a television receiver. Off-air television signals are subject to distortion by the reflections from the turbine blades and by the attenuation of the signal passing through the wind turbines. The reflections may cause multipath distortion and ghosting. Blade motion may cause the contrast and brightness of the signal to vary. These effects apply to Analog modulated television signals and do not affect digital signals in the same way.

The off-air television signal environment will change as of February 2009 when broadcast TV will be required to switch to digital format . This change should lessen the potential for wind projects to impact off-air television signals.

A TV Broadcast Off-Air Reception Analysis can be done prior to development of a project to characterize the baseline signal strength and reception conditions within the project area. The study is used to identify the potential impacts from project development. The extent of the impacts would vary based on factors identified by the study, such as the pre-existing signal strength and the use of cable and satellite television in the area. If this baseline study is performed, problems or changes in signal quality can be compared with the baseline measurements to evaluate whether the wind project may be causing or contributing to reception problems.

5.9.1.3 AM/FM Broadcast Signals

Wind turbines generally do not affect AM/FM radio broadcast signals as they affect microwave and television signals. Radio transmitters are often omni-directional, which means that the signal spreads out in several directions. The spreading prevents a structure such as a wind turbine from obstructing the signal. Wind turbines could obstruct radio signals if located in close proximity to a broadcast antenna.

5.9.1.4 LMR Operations

A LMR system is a collection of portable and stationary radio units designed to communicate with each other over predefined frequencies. LMR operations in the vicinity of wind projects include public safety organizations, such as police departments, fire departments, and medical responders, as well as private sector activities such as construction, building maintenance, and site security. In typical LMR systems, a central dispatch console or base station controls

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communications to the disparate handheld or mobile units in the field. These communications are usually between vehicles or people on the move using walking and fixed stations. The range of the communications coverage is extended by using repeaters located on towers and other tall structures.

5.9.2 Mitigation

Identification of communication systems near a wind project can avoid interference with signal transmission. Moving turbines outside of microwave paths and away from antennas would avoid obstructing microwave transmissions and radio broadcasts. The following mitigation measures are available when turbines cannot be moved to accommodate communication systems.

- Adding transmitters and receivers to the communication system
- Installing satellite TV service
- Installing cable television services when available
- Installing directive reception television antenna with amplifier
- Setting up wireless television distribution system for a cluster of homes affected by a wind project
- Repositioning LMR repeaters or adding repeaters to the LMR system

Example

Studies in the United Kingdom and elsewhere show that while wind turbines can cause "clutter" on radars, there are engineering solutions that can be implemented and explored further. For example, the British Wind Energy Association conducted a study in 2003 entitled "Feasibility of Mitigating the Effects of Windfarms on Primary Radar."

5.10 Ground Transportation and Traffic

Ground transportation and traffic impacts associated with wind energy projects typically include impacts on the transportation system itself (e.g., the physical properties of the road system) and impacts on traffic that uses the transportation system. Such impacts arise almost entirely during the construction period.

5.10.1 Transportation Impacts Analysis

The means for transporting the components of a wind energy project to the project site should be determined early in the development process to accurately identify risks, potential impacts, and applicable regulatory requirements. This includes identifying the origin of the components and the most efficient route to the location of the site. Knowing the origin of the components helps to identify an appropriate delivery port (if coming from an international location) as well as the nearest major artery or