Technical Rescue in Wind Turbines

High-angle rescue training

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Kern County is located in the southern San Joaquin Valley of central California. The southeastern portion of the county is divided by the Tehachapi Mountains. On the eastern side of this range is the Mojave Desert. Winds regularly blow into Kern County from the Pacific Ocean, and as these winds blow over the Tehachapi Mountains and down into the Mojave Desert, they tend to pick up energy (speed). This is evident as all of the trees in Mojave, California, lean toward the east! As a result of the energy created by the wind, the ridges of the Tehachapi Mountains provide an excellent location for planting wind turbines.

With the increased interest in green energy in recent years, Battalion One of the Kern County Fire Department (KCFD) has seen a dramatic growth in the number of wind turbines in the response areas of Station 12 (Tehachapi), 14 (Mojave), and 15 (Rosamond), as well as a notable number of responses into the wind farms for various emergencies.

Threat Recognition

In the early 1980s, when the wind turbines first started to appear, the captains at the local stations recognized the potential for a rescue to occur in their response areas. Their foresight would prove to be noteworthy as the workers who maintain these wind turbines often experience common industrial injuries, which are compounded by working up to 300 feet above ground in a wind turbine with very restricted access.

As the wind turbines were being built, large numbers of workers were employed. Most of the workers were trained in high-angle rescue and were a valuable assistance to KCFD rescue personnel during that type of rescue.

Now that the wind turbines have been installed, fewer workers are required to maintain the wind turbines. This results in fewer wind farm personnel who are trained in high-angle rescue being available to support the emergency responders.

During the early years of the wind turbines, the operators of the wind farms provided the KCFD with rope-rescue kits as well as the opportunity to practice annually in removing workers from the wind turbines. Many of these rescue drills included participation of the department's technical rescue, or urban search and rescue (USAR), teams located on the outskirts of Bakersfield at stations 52 and 61. Additionally, the local engine companies developed response plans that included road maps for getting around the wind farms. The road maps also came in handy when responding to vehicle accidents (usually rollovers) on the narrow dirt roads and wildland fires that threatened the wind farms.

Fall Protection

The Occupational Safety and Health Administration (OSHA) requires that a worker positioned more than four to six feet (depending on state specific requirements) above the next lower working surface requires fall protection. As part of this requirement, a fall protection plan is required to identify the means for preventing or arresting a fall, training, and other items. This plan identifies four components of the fall-arrest system as used in the wind turbines: anchor points, connecting means, full-body harness, and the rescue plan.

As part of the rescue plan, employers must identify how they are going to rescue a suspended worker. The first objective is for the worker to be able to self-rescue. If the local emergency responders have a lengthy response time, generally considered to be more than four to six minutes (the recognized time frame that, should a brain not receive any oxygenated blood, can cause irreversible brain damage), then the company should also train the workers in rescue. As a result of this requirement, the first-in engine companies and technical rescue teams of the KCFD regularly train alongside the wind farm operators in the rescue of personnel from heights.

Rescue Challenges

The KCFD USAR team divides the wind turbine into two areas: the "tube" and the generator "nacelle."

The tube is the tall support structure and the nacelle is mounted on top of the tube and supports the turbine blades. Inside of the tube is a fixed ladder that extends from the ground level up to the bottom of the nacelle. The ladder is equipped with fall-protection equipment consisting of an ascender that can be attached to the rescuer's harness and then hooked onto a cable mounted on the ladder. Fire department personnel receive training in how to use this system.

Some of the ladders are equipped with a cage. One planned rescue scenario involved a person falling within the cage. The most significant obstacle was the possibility of the person "balling up" as he fell and, at some point, becoming wedged in the cage. Because the cage and ladder are mounted internally, rescuers would have to climb on the outside of the cage to gain access to the victim through the top of the cage.

The nacelle, often described as a room that is 300 feet in the air, was more straightforward in that, in most cases, when an individual needed to be rescued from the nacelle, he could be lowered to the ground using the access doors on the top and bottom.

As with any rescue operation, the priorities are to keep rescuer and patient safe, get to the patient, secure the patient against falling any farther, stabilize the patient, and package and lower the patient.

Wind Farm Rescue Teams

OSHA regulation 1926.502(d)(20) states, "The employer shall provide for prompt rescue of employees in the event of a fall or shall assure that employees are able to rescue themselves."

Based on the requirements of this regulation, wind farm operators organize their own rescue teams. In addition to the requirement for timely rescue, the wind farm operators have recognized that the hazards found in wind turbines present unique contributing factors with off site emergency responders (e.g., the local fire department plan for rescues).

Some of the challenges associated with wind turbines include limited space, uneven surfaces, and access through hatches. When setting up haul systems, you may find anchor points are limited. As a result of these challenges, many wind turbine operators use an automatic descent-control device. These devices can be used, with certain limitations, to haul and belay the patient. Other wind turbine operators use a more agile system based on traditional industrial or high-angle rescue equipment. Even though these systems are easier to operate and are prebuilt to some degree, they offer a wide range of capabilities and will use stronger components. This system typically consists of a belay arrangement that includes at least one setup for hauling, pulleys for a change of direction, and multiple anchors. In addition, many operators require a redundant belay at all times.

The rescue teams on wind farms are trained in fall protection, anchor selection, rescue equipment use, basic first aid, CPR, and use of an automated external defibrillator. In some locales, the members of the rescue teams are also members of their local volunteer fire departments. Because of their regular jobs, they also maintain a high level of competency in turbine operations, including confined space entry and control of hazardous energy.

Fire department involvement in rescues from wind turbines varies from location to location. In some cases, based on the department's policies and capabilities, they may not be involved in wind turbine rescue. Each wind farm operator is required to develop their own rescue plan as part of their fall-protection program. This plan, in most cases, will include interaction with the local emergency responders. However, most wind farm operators are committed to the prompt rescue of their workers and believe that the best chance for getting an injured worker to advanced medical care is to maintain rescue services on site.

As you can see, the members of these teams are well trained. Additionally, the wind farm operator who provided input for this article stated that it is their current policy that their rescue teams participate in a minimum of four training sessions per year, with each training session covering a different area of the turbine. They also require their rescue teams to conduct at least one emergency drill annually. In many cases, the local emergency responders are invited to participate in these drills even though these annual drills are intended to maintain the proficiency of the operator's rescue team. These drills also provide local emergency responders with the opportunity to familiarize themselves with rendezvous points and helicopter landing zones and exchange information such as maps or local phone numbers.

The wind farm operator also added, "As a rescuer, it is important to focus on a thorough assessment of the work environment and job scope prior to engaging the situation. The project manager or foreperson should be a reliable source of information when responding. Check for job safety analysis, confined space permits, locks/tags, overhead hazards from falling objects, etc. This sounds complicated, and it can be at times, but these workers are trained and qualified to assess and eliminate each of the hazards they are expected to encounter, as should the responder."

Preincident Preparation

As with any technical rescue, preplanning is extremely important. This is especially the case with any high-angle rescue, which can be complex and dangerous. Incident occurrence is minimal but extremely newsworthy. Scrutiny will be focused on you. Your team must arrive with appropriate equipment within an acceptable timeframe with sufficient skilled personnel and resources to complete a successful mission. This includes ropes of adequate length and strength along with the associated hardware and software.

Your preplan should include site access, vehicle parking and staging areas, confined space dimensions, anchor points, personal protection, and patient packaging. Your team should train often to maximize performance and minimize errors. This will also streamline your operations. As you exercise your plan during training events, revise and improve it to advance performance and minimize extraction times. As you build your plan, you may also consider consulting with your local search and rescue team, as its members may be able to provide some suggestions based on their rope rescue experience.

Team members should receive training in high-angle rescue from a reputable training provider. This can include state fire training organizations as well as private companies. Training should be in accordance with National Fire Protection Association (NFPA) 1006, Standard for Technical Rescuer Professional Qualifications, and NFPA 1670, Standard on Operations and Training for Technical Search and Rescue Incidents. This training should include, but not be limited to, the following:

- Rope system anchors.
- Evacuation litters.
- Rescuer and patient packaging.
- Lowering and raising systems.
- Mechanical advantage systems.
- Fall protection and/or limiter systems.

Once your personnel are trained, they should practice their techniques on a regular basis to remain proficient. All training should be documented and include attendee signatures, and files should be maintained of all training in the event of an investigation after an incident.

When responding to an incident, the fire officer must consider all of the information provided by dispatch to determine the need for additional resources. The fire officer should attempt to determine whether the incident is a rescue or a body recovery and adjust the team's efforts accordingly. Remember to rotate crew members, rehab, feed, and allow for body temperature adjustment for heat or cold exposures. Also, consider that long duration extractions may include life support efforts by qualified individuals.

Equipment

Many departments cannot afford to have a fully equipped USAR vehicle, and in other areas a USAR

team may have an extended response time. Departments with wind turbines in their response areas should consider acquiring their own high-angle rescue equipment. Actual required equipment will depend on your department's individual needs, but suggested equipment that can be used for rescues on a wind turbine includes the following:

1. Two static kernmantle ropes (300 feet by ½ inch, NFPA compliant).
2. Two static kernmantle ropes (150 feet by ½ inch, NFPA compliant).
3. Two static kernmantle ropes (20 feet by ½ inch, NFPA compliant).
4. Two figure eights with ears or brake bar rack (NFPA compliant).
5. 15 carabiners (general use, NFPA compliant).
6. Two multipoint collection devices.
7. Two load releasing devices (one commercial or field assembled device used to anchor and release tension from rope rescue systems, with general use NFPA-compliant carabiners).
8. Six pairs prusik loops (rope specific, 8mm minimum).
9. Two mechanical ascenders (general use, NFPA compliant) (OPTIONAL).
10. Three rescue pulleys (two-inch or four-inch, one to be prusik minding).
11. One litter and complete prerig.
    a. One litter basket (rated for horizontal and vertical lift).
    b. One prerig (commercial or preassembled with general use NFPA-compliant carabiners).
12. One webbing kit. (Note: All webbing must be military specification Nylon, 4,000-pound-minimum tensile strength. Each length must be the color indicated.)
    a. Six one-inch by five-inch green webbings.
    b. Six one-inch by 12-inch yellow webbings.
    c. Six one-inch by 15-inch blue webbings.
    d. Six one-inch by 20-inch orange webbings.
13. Two edge protections (commercial rollers, canvas tarps, split firehose, or any combination of each).
14. Two commercial harnesses (Class III).
15. One victim harness.
16. Six steel pickets (one-inch by four-foot).
17. Two pickoff straps (one webbing strap with one "D" ring at one end and one "V" ring adjuster on the webbing strap. Webbing: minimum 1¾-inch wide by 42-inch long with a 10,000-pound rating and 5,000-pound hardware rating).
18. One etrier set.
    a. Two etriers (rescue rated).
    b. Two mechanical ascenders (general use, NFPA compliant).
19. One anchor kit.
    a. 25 concrete wedge anchors (½-inch by 5½-inch).
    b. 25 female drop forged H/D eye nuts (½-inch by course).
    c. One wrench (per manufacturer's specifications).

Rescue Drill

In March 2014, multiple engine companies, along with both USAR companies, Truck 65, and Helicopter 407 of the KCFD, converged on a wind turbine in the Tehachapi foothills. Representatives

from Terra-Gen and General Electric ("operators") worked with the training staff to set up a training day using a wind turbine. The Tehachapi Valley Fire Crew, a fuels crew for the KCFD, was called in to set up a landing zone for Helicopter 407, which was able to land a few hundred feet from the wind turbine.

The operators gave a briefing on how the wind turbines operate and the associated hazards prior to giving KCFD personnel the opportunity to look inside the wind turbine. Once the operations inside of the tube were explained, personnel went outside to observe the operators lower a simulated victim (mannequin) from the top of the nacelle.

Personnel assigned with the USAR teams were then tasked to climb to the top of the tube, locate and package the victim, and lower the victim to the bottom of the tube. Although the rescue teams from the wind farms had the equipment to conduct this rescue, each rescue team used its own rescue equipment for liability reasons. Once the rescue was completed, USAR personnel then had the opportunity to rappel to the bottom of the tube to maintain their skill level.

During the drill, several observations were made, including the following:

- Fire departments should not depend on the wind farm rescue teams to execute the rescue. It is important that fire departments be trained in this type of rescue in the event wind farm rescue teams are unable to respond.
- Whenever someone is working in the wind turbine, all of the systems must be locked out. However, the turbine blades may be "pin wheeling." Anytime entrance is made to the hub of the blades, the braking system will be applied and the blades will not be turning.
- In addition to training USAR teams on rescuing victims from the wind turbine, the teams also need to be trained in the use of the fall-protection equipment specific to that wind turbine. This may require the fire department acquire the appropriate fall-protection equipment, such as ascenders.
- Larger wind turbines, those more than 300 feet in height, may be equipped with a service lift inside. This can be used during rescue, and personnel should be familiar with its operation before a rescue is needed.
- The appropriate equipment necessary for an employee to self-rescue is carried into each tower.
- Workers can also be found in the hub for the blades.
- It is possible for the wind turbine to experience a power failure. Rescue teams should plan in advance for the capability to illuminate the interior of the tube.
- All workers inside of the wind turbine are equipped with some form of communications, usually a cell phone. This provides the opportunity for emergency responders to communicate directly with the wind farm rescue team. Dispatchers should attempt to secure a contact number and provide this to the company officer so that a communication link can be established prior to arriving on scene.
- Operators will continually monitor the wind speed. Certain operations in the wind turbine may be curtailed based on wind speeds.

As part of your preincident plan with the wind farm operator, include having the operator assign a guide to lead you into the incident. Remind them that more than one emergency vehicle will be responding, so several people may be required to support this function.

For additional information on the Kern County Fire Department's wind turbine pre-incident plan, contact Deputy Chief John Silliman at (661) 391-7000.

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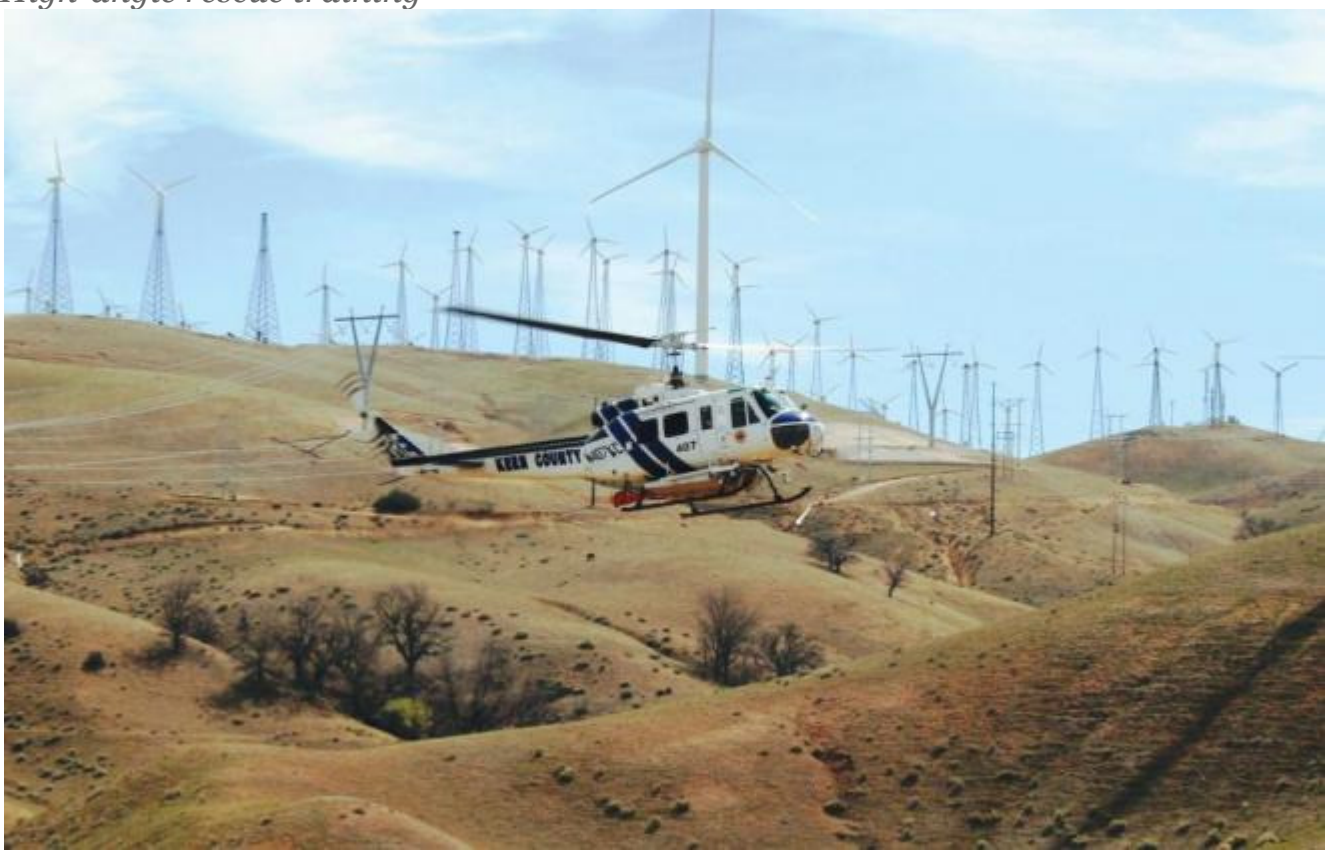
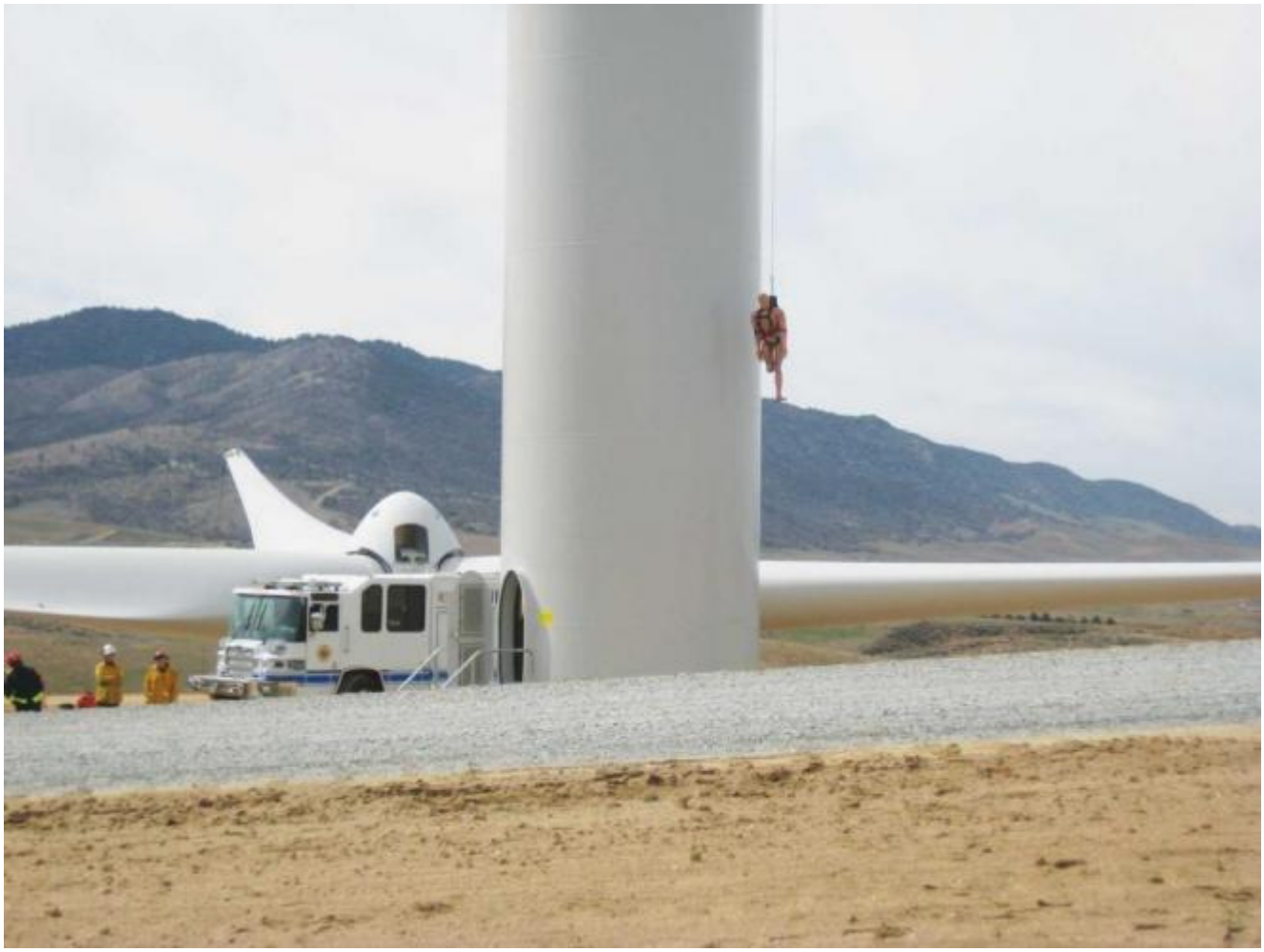
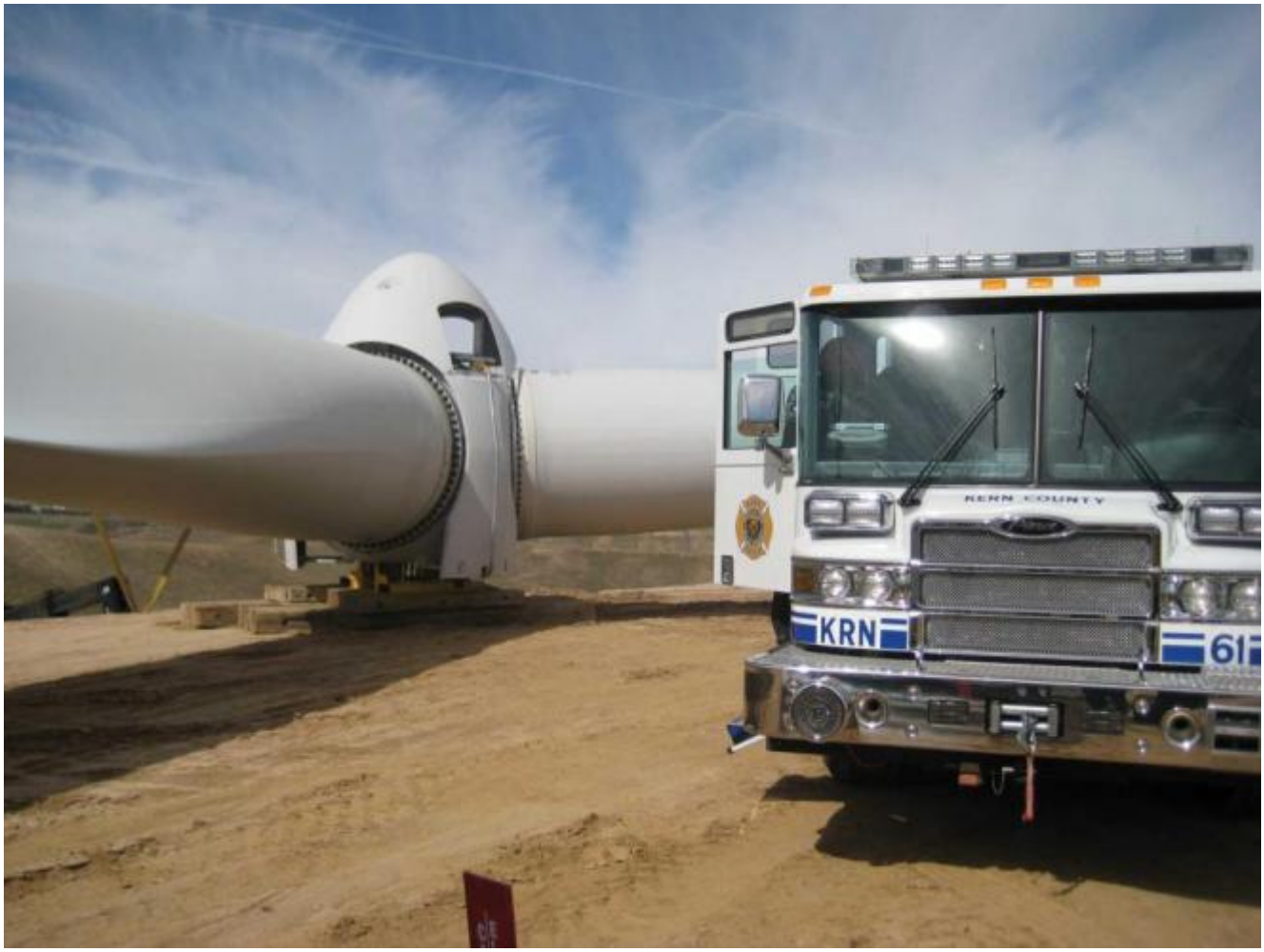


As the wind turbines were being built, large numbers of workers were employed. Most of the workers were trained in high-angle rescue and were a valuable assistance to KCFD rescue personnel during that type of rescue. (Photo by author.)



Departments with wind turbines in their response areas should consider acquiring their own high-angle rescue equipment. (Photo by Kern County Fire Department.)



In March 2014, multiple engine companies, along with both USAR companies, Truck 65, and Helicopter 407 of the KCFD, converged on a wind turbine in the Tehachapi foothills. (Photo by Kern County Fire Department.)

Inside of the tube is a fixed ladder that extends from the ground level up to the bottom of the nacelle. The ladder is equipped with fall-protection equipment consisting of an ascender that can

be attached to the rescuer's harness and then hooked onto a cable mounted on the ladder. (Photo by author.)