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Upgraded Rig Lighting Improves Night Time Visibility While Reducing Stray Light and the Threat to Dark Skies in West Texas

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Abstract

McDonald Observatory, part of the University of Texas at Austin, is a world-class astronomical-research facility representing hundreds of millions of dollars of public and private investment that is increasingly threatened by nighttime lighting from oil-and-gas-related activities in and around the Permian Basin. Established in the remote Davis Mountains of West Texas in 1932, the observatory is home to some of the world's largest telescopes and it has continued as a world-renowned research center. Dark night skies are crucial to its mission. Since 2010, however, the sky along the observatory's northern horizon, in the direction of the Permian Basin, has been steadily and rapidly brightening, due to new exploration for oil and gas. The pace has been accelerating: More than 2,000 applications were filed over the past year to drill in the region. In 2011, the State of Texas enacted a law that instructs the seven counties surrounding McDonald Observatory, an area covering some 28,000 square miles, to adopt outdoor lighting ordinances designed to preserve the dark night skies for ongoing astronomical research at the observatory. Most had already done so voluntarily, but additional effort is needed throughout the area to address fast-moving energy-exploration activities.

A joint project between McDonald Observatory and Pioneer Energy Services (PES) has demonstrated that many of the adverse effects of oilfield lighting can be mitigated, without jeopardizing safety, through proper shielding and aiming of light fixtures. Beginning July, 2013, PES granted the observatory access to a working rig, Pioneer Rig #29. Every time the rig moved to a new location, there was an opportunity to install shields, re-aim floodlights, and evaluate effectiveness.

This joint project demonstrated that, in many cases, nighttime visibility on the rig can be significantly improved. Many light fixtures, which had been sources of blinding glare due to of lack of shielding, poor placement, or poor aiming, were made better and safer, using optional glare shields that are offered by manufacturers for a variety of fixture models. Proper shielding and aiming of existing fixtures improves visibility and reduces wasted uplight. New lighting systems that take advantage of light-emitting-diode technology also promise better directionality, reduced fuel consumption, and darker skies overhead.

The oil-and-gas industry has been lighting its exploration and production activities in much same way for more than 100 years, with little to no consideration of environmental impacts. The opportunity exists

to adopt new lighting practices and technologies that improve safety, reduce costs, and help preserve our vanishing night skies so that important ongoing scientific exploration can continue.

Introduction

Established in the Davis Mountains of West Texas in 1932, the McDonald Observatory includes two research telescopes atop Mt. Locke at 6,791 feet and the Hobby-Eberly Telescope (HET) atop nearby Mt. Fowlkes.

Fig. 1 is a photo taken during the construction of the 82-inch telescope, which was the second largest in the world when it was dedicated in 1939. The 9.2-meter (362-inch) HET is the largest telescope in North America (Fig. 2). Examples of breakthrough science at McDonald Observatory are numerous. For example, the most massive black hole ever detected, some 17 billion times the mass of our Sun, was discovered using the HET in 2012. Additionally, hundreds of extra-solar planets have been verified with McDonald telescopes. Every clear night of the year, astronomers at McDonald Observatory are working to capture light from extremely faint, distant objects, to advance our knowledge of the Universe.

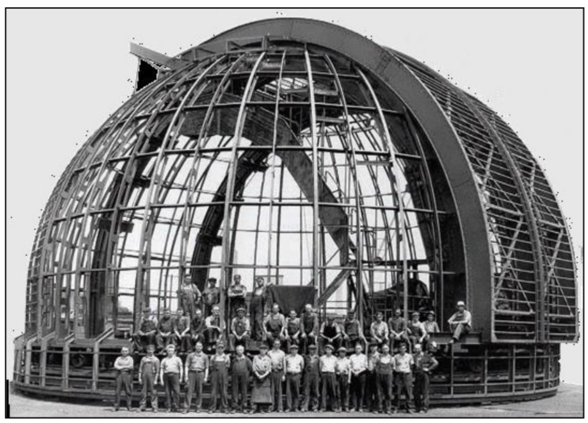

Figure 1—Dome shell and construction crew of the original Otto Struve 82″ telescope (1934).

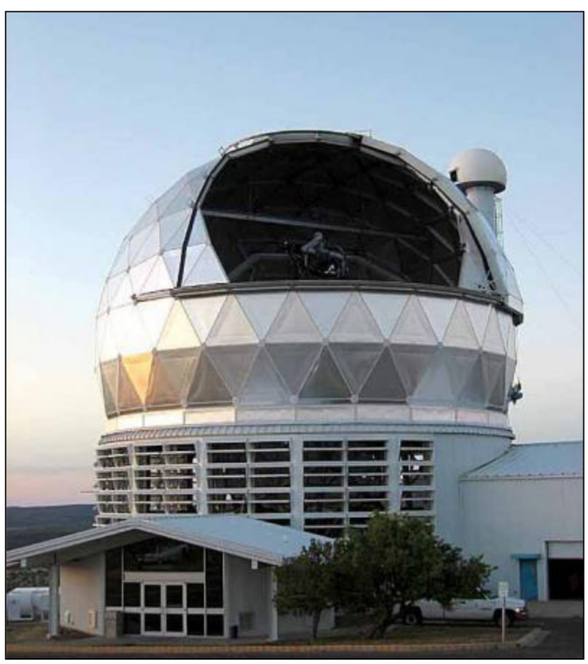

Figure 2—Hobby-Eberly Telescope

The HET is currently undergoing a $38-million upgrade to study "dark energy," a mysterious force propelling the accelerated expansion of the Universe, which is key to understanding the fundamental forces underlying all of the physical sciences. To study dark energy, the HET will need to capture light — only a few dozen photons per hour — from galaxies in the act of forming some 10 to 12 billion years ago. Skyglow from the unshielded lights of nearby oil-and-gas installations threatens McDonald Observatory's the dark-energy project and other operations.

Light Encroachment

McDonald is home to some of the darkest skies remaining in North America for any major observatory, a factor that is critical to the success of cutting-edge astronomical research. Since 2010, however, the sky along the observatory's northeastern horizon, looking toward the Permian Basin, has been steadily and rapidly brightening, due to a surge in energy exploration and production and associated activities. Fig. 3 is an image showing oilfield skyglow as seen from Mt. Locke in 2014.

Figure 3—Oilfield-related skyglow as seen looking to the northeast from McDonald Observatory in 2014.

A high deck of clouds over the region acts as a screen as the light projects onto the sky, showing the extent of the problem. Some of this skyglow originates from oilfield-specific activities such as drilling, flaring, and completion operations, most of which are mobile (Fig. 4). There are also numerous new storage facilities and disposal wells that shine nearly as much light skyward as they do onto the ground. In addition, some of the new skyglow is coming from related commercial activities, such as new hotels, residences, and chain stores. While the exact level of contribution from each of these areas is hard to quantify, the combined effect of all this additional uplight has encroached significantly on the skies over McDonald Observatory and poses an imminent threat to astronomical research at the observatory. Fig. 5 shows the increase in the number of lighting sources in the Permian Basin northeast of the observatory from 2010 to 2012.

Figure 4—Multiple sources, rigs, flares, completions, storage, etc., contribute to skyglow over the Permian Basin

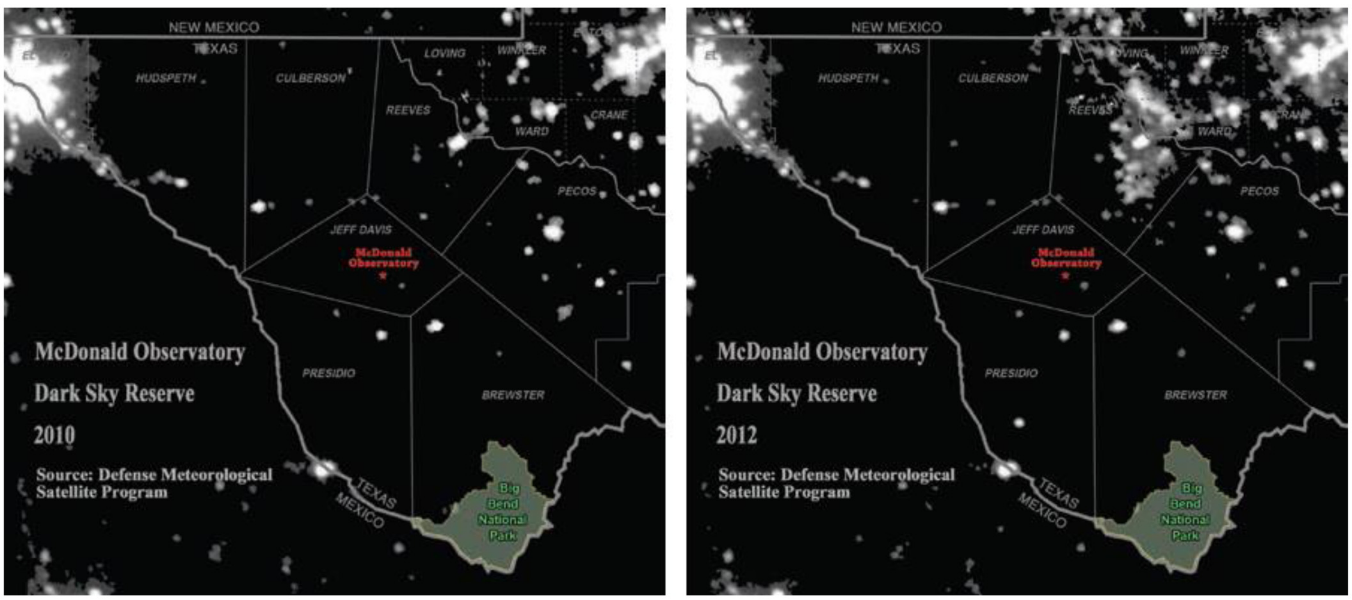

Figure 5—Between 2010 and 2012, the number of lighting sources northeast of McDonald Observatory increased dramatically.

In 1978, the Texas Legislature authorized the seven counties surrounding the observatory to adopt outdoor lighting ordinances to protect dark skies. Six of those counties, and most of the cities in the region, did so voluntarily. In 2011, the Legislature enacted, and Governor Perry signed, HB2857 making the adoption of outdoor-lighting ordinances mandatory in the seven counties, creating the largest dark sky reserve in the world (Fig. 6).

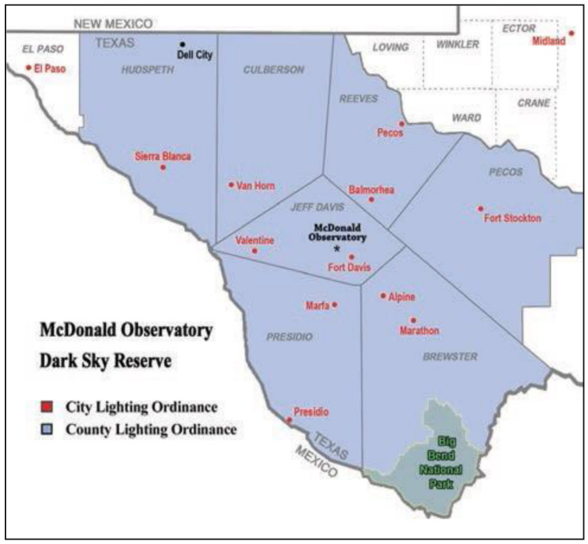

Figure 6—McDonald Observatory Dark Sky Reserve

Pioneer Rig # 29

Pioneer Energy Services (PES) of San Antonio, is committed to setting an example for its industry to show that upgraded and properly aimed lighting systems are fully compatible with safe, efficient oilfield operations and can be put in place with minimal cost and effort. Since July 2013, PES has been working with McDonald Observatory on a joint demonstration effort, granting observatory employee Bill Wren access to one of its working rigs, PES #29, to study lighting. For all intents and purposes, Rig #29 was chosen randomly, as an example of a typical drilling rig. The light fixtures in use at the beginning study were representative of lighting found commonly throughout the oilfield.

Every time the rig moved to a new location, there was an opportunity to safely install shields, re-aim floodlights, and evaluate the effectiveness of the resulting light. The goal is to mitigate excessive uplight without jeopardizing safety.

In fact, it has been shown that, in many cases, nighttime visibility on the rig can be significantly improved. PES is only one company, but they are already seeing the benefit of upgrading their lighting practices, and they intended to implement the upgrade company-wide.

Safety and Glare

Safe nighttime operations are crucial in the oil-and-gas industry, and such operations depend on good visibility. Many light fixtures commonly used in the industry actually interfere with optimal visibility, because they are sources of blinding glare, due to lack of shielding, poor placement, or poor aiming. For example, during an early visit to Rig #29 by Bill Wren, workers pointed out a “360” light (a blast-resistant, teardrop shaped globe surrounded by a wire mesh), that caused poor visibility at the rig’s central display console due to its placement and lack of shielding. The workers, in an effort to see the display console better, had added a makeshift glare shield to this fixture: a rag stuffed between the wire mesh and the globe (Fig. 7).

Figure 7—Workers discussing makeshift glare shields on a “360” fixture

Shielding the “360” light

Most lighting manufacturers offer optional glare shields, sometimes called “reflectors,” for a variety of fixture models, including the AZZ-brand “360” light on Rig #29. One type of shield, a deep, full-cutoff version (Fig. 8) was tested but shown to be less than optimal for the particular situation at the center of the rig.

Figure 8—A “360” fixture fitted with a deep shield, which works well at greater mounting heights over stairs

The overall effectiveness of a given shield depends on mounting height, the extent of the shielding, and aiming. Initial tests shielding “360” lights with large shields resulted in reduced glare, but many fixtures are mounted too low to provide adequate illumination over large areas. While a taller mounting pole could have improved coverage, fixtures are taken down every few weeks when a rig is moved, then reinstalled at the new location. Taller poles are too cumbersome for frequent moves, so, since low mounting heights are needed in the areas at the center of the rig, the large, deep shields are inappropriate for these types of uses.

A better solution for central, low-mounted fixtures like the AZZ-brand "360" light (which is yoke-mounted) was found to be the 30-degree-shield option, also offered by the manufacturer (Fig. 9). These 30-degree shields succeeded in reducing glare (greatly improving visibility at the rig's central display console) and in providing adequate coverage, even with lower mounting heights. Being made from fiberglass instead of spun aluminum, they are less expensive, easier to transport, less likely to be damaged in transport, and easier to replace, and, being smaller, they have less surface area for wind-loading. Extra

Figure 9—The same fixture fitted with optional 30-degree shield, which works better for lower mounting heights

Figure 10—The shielded light at the right reduces glare and improves visibility of the console.

shields can be kept on hand. Fig. 10 shows the unshielded “360” light on the left, and the fixture fitted with a 30-degree shield, on the right.

However, the same “360” fixtures, at greater mounting heights around the outside of the rig over stairways, which produced blinding glare when unshielded, were found to provide more even illumination for the stairs when fitted with the deeper shields, while producing less glare and wasting much less light upwards into the sky (Fig. 11).

Figure 11—Before shielding, the left photo shows that the light fades toward the bottom of the stairs. The photo at the right shows well-lit stairs all the way down.

Floodlight options

Manufacturers typically offer optional shields or visors for directional floodlights as well. Shielding proved effective in reducing glare and reflecting light that was being wasted skyward back down to the ground. Installing shields on floodlights also provides an opportunity to re-aim them. It is more effective to point floods at night, directing light to where it is needed.

Light towers

Mobile light towers, like those widely used for drilling and completion operations, are generators on wheels combined with adjustable clusters of four high-intensity floodlights on extendable masts, typically up to 30 feet high. (Fig. 12).

Figure 12—Light towers similar to the above are found throughout the oilfield

Aiming these floodlights down is critical to reducing glare, putting more light on the work site and less light into the sky. Proper aiming of these floodlights when the units are first deployed is important. Once a light has been aimed the first time its used, it is likely to remain unchanged for its useful lifetime. Mounting height is again a major factor in determining the area of overage. Typical practice is to locate towers around the outside perimeter of a site and point the lights inward. In order to maintain adequate coverage with floodlights aimed downward, however, towers must be positioned closer to the center of the site since illumination will now be greater in the area around the tower instead of only in front of it. Care must be taken with light tower placement so as not to impede traffic flow around the site.

Summary

The photo in Fig. 13 gives an interesting comparison. The left side shows typical rig lighting. In it, unshielded fixtures produce glare, create more skyglow, and make handholds and equipment harder to see. On the right, shielded lights reduce skyglow while placing more light where it is needed actually improving visibility on the stairway.

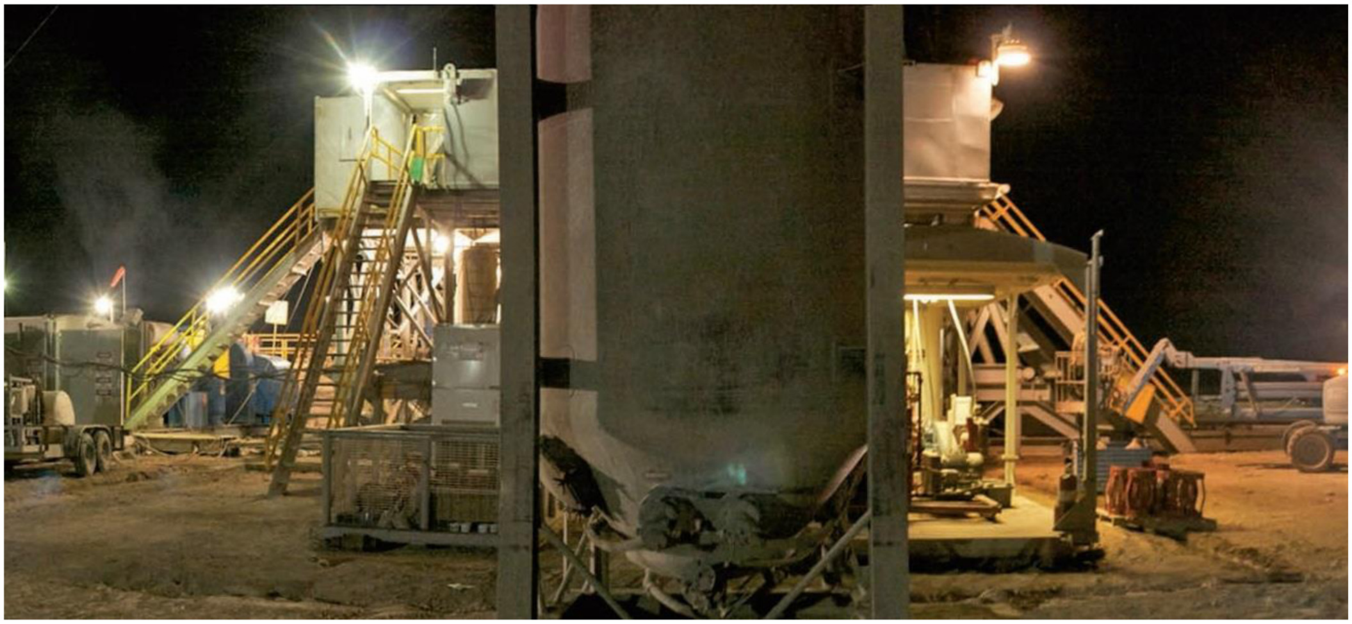

Figure 13—Unshielded fixtures, shown at left, contribute to skyglow and produce glare making it harder to see. Shielded lights, shown at right, put more light where it is needed, reducing skyglow and improving visibility.

Conclusions

The major oil and gas producers all have firm commitments to safety, cost efficiency, and environmental protection. Low-cost, easy-to-implement steps can improve all three. Efforts to engage major producers in the effort to preserve dark skies should include Environment, Health, and Safety officers along with Public Relations departments. Lighting nighttime operations in a manner that increases visibility and reduces skyglow is a win-win proposition for the oil industry, for astronomy, and for the public.

Recommendations

Replace existing fixtures

Replacing old fixtures with new ones designed and installed to direct light onto the work and away from the sky and workers eyes is the best solution.

Re-aim existing fixtures

Much can be accomplished without any additional hardware by re-aiming existing fixtures. Many, if not most floodlights in the oilfield are pointed toward the horizon. A floodlight aimed horizontally shines half of its light up, away from the ground and into the sky. Aiming the fixtures down puts more light on the worksite, reduces glare, and increases visibility. Attention must be given to proper aiming when fixtures are first installed and put to use.

Shielding

All light fixtures in use at a given facility can be inventoried, their make and model identified, and fitted with optional shields available from the manufacturers. Shielding floodlights, almost without exception, increases safety by reducing glare. Fixtures can be aimed downward when shielding is installed, so that no light shines above the horizontal plane.

LEDs

The LED revolution presents an excellent opportunity to re-light all aspects of the industry with greater attention to safety and visibility. LED fixtures offer more cost-efficient, solid-state control, longer life expectancies, and better directionality for glare control, as well as optional motion sensors and built-in security cameras. The color temperature of LEDs should be limited to 3,000 Kelvin, as “hotter,” bluer light contributes to glare and hampers nighttime visibility.