Oilfield Lighting Can Coexist With Dark Skies

A REPORT

Pioneer Drilling Rig #29 and McDonald Observatory

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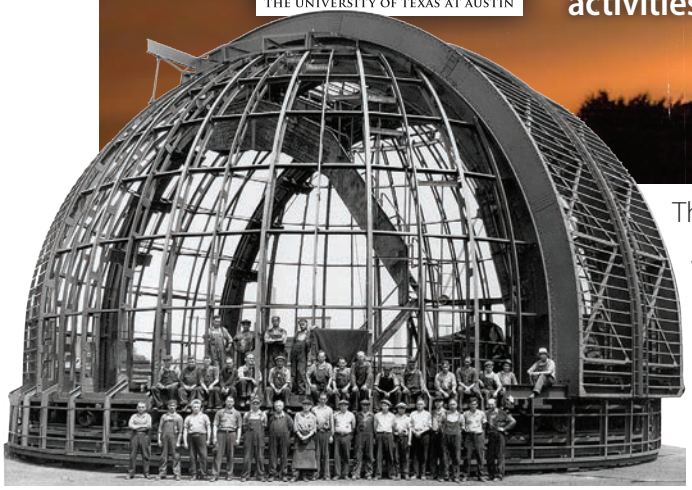


Shell and construction crew of the original Otto Struve 82" telescope, 1934.

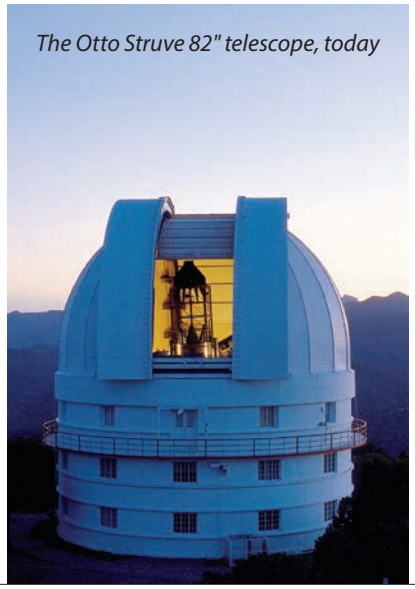
Oilfield skyglow as seen from McDonald Observatory (above) 2014.

There are city, county, and state laws in place, most of which were written and enacted decades ago, designed to protect the dark skies for the observatory by regulating outdoor lighting in the seven county, 28,000 square mile region surrounding this University of Texas facility. Enforcement is difficult, and voluntary compliance is sought as energy exploration and production increasingly moves into the area. Dark sky-friendly outdoor lighting practices have the advantage of promoting better nighttime visibility and cost efficiency for the oil and gas industry.

Established in the remote Davis Mountains of West Texas in 1932, the McDonald Observatory sits atop Mt. Locke at 6,800 feet. Its 82-inch telescope was second largest in the world in 1939, while today, the 400-inch Hobby • Eberly Telescope (HET), the largest in North America. The HET is undergoing a $30 million upgrade to study Dark Energy, the mysterious force that propels the accelerated expansion of the universe. The most massive black hole ever detected, some 17 billion times the mass of our Sun, was discovered using the HET in 2012. And hundreds of extra-solar planets have been verified with telescopes at McDonald.

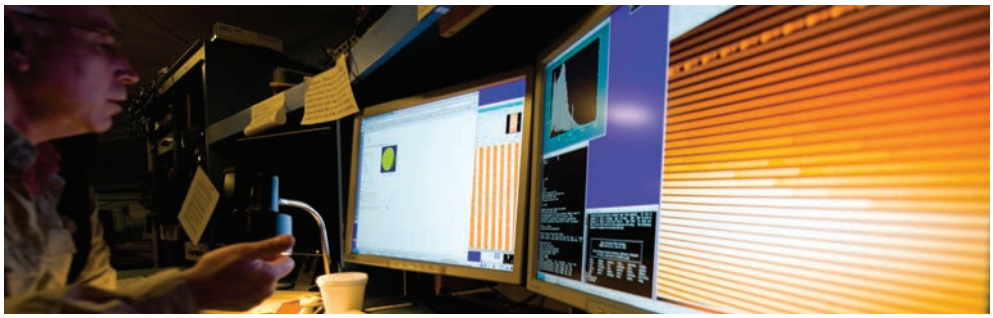
The observatory has an extremely active public outreach program with some 75,000 visitors a year attending daytime tours and evening star parties hosted by the observatory's visitors center. Additionally, each summer hundreds of science teachers from around state and the nation participate in formal, accredited teacher workshops. They return to their schools with dozens of hands-on activities for use in their classrooms to help excite students about astronomy.

The goal is not necessarily to raise new generations of



The Otto Struve 82" telescope, today

astronomers, per se, but given all of the scientific and engineering disciplines that come together at the observatory, early interest astronomy may lead students to pursue a wide variety of technical fields.



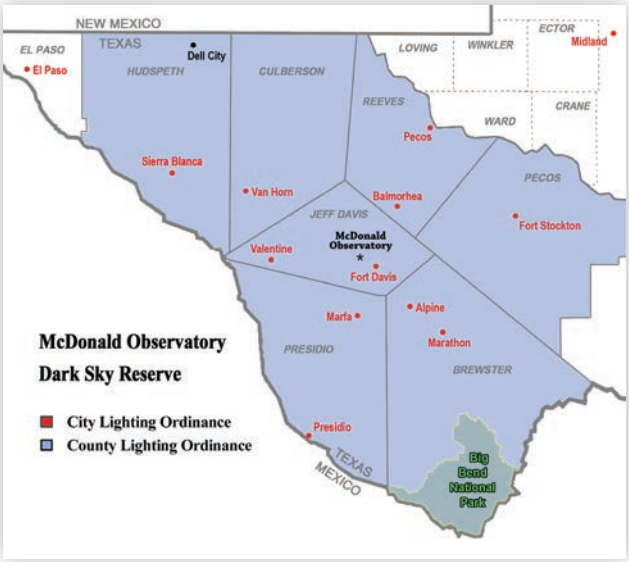
McDonald is home to darkest skies remaining in North America for any major observatory, a factor that is critical to the success of cutting edge astronomical research. But since 2010, the sky along the observatory's northeastern horizon looking toward the Permian Basin has been steadily and rapidly brightening from increasing energy exploration and production and associated activities.

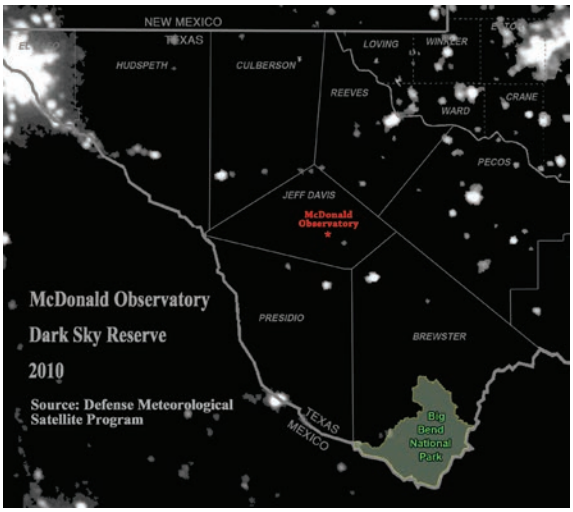
A high deck of clouds over the region acts as a screen as the light projects onto the sky showing the extent of the problem (see photo, p. 1, top).

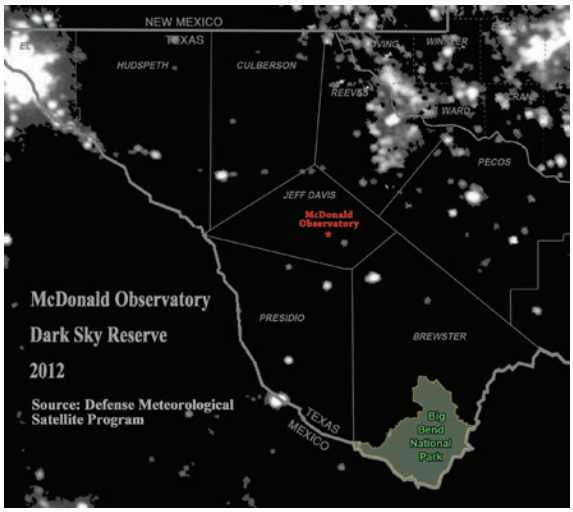
It's difficult to quantify how much of this skyglow originates with oilfield specific activities such as drilling, flaring, completion operations, most of which is mobile (see photo, p. 3), and how much comes from related commerce such as new hotels, residences, and chain stores.

There are numerous new storage facilities and disposal wells that shine nearly as much light skyward as they do onto the ground. The combined effect of all this additional uplight poses an imminent threat to astronomical research at McDonald Observatory.

In 1978, the Texas legislature authorized the seven counties surrounding the observatory to adopt outdoor lighting orders to protect its dark skies. Six of seven counties, and most of the cities in the region, did so voluntarily. In 2011, Governor Perry signed







In two short years, the increase in light pollution is obvious, and increasing rapidly with the boom in energy production.

HB2857 making the adoption of outdoor lighting ordinances mandatory, creating the largest dark sky reserve in the world (see map on p. 2).

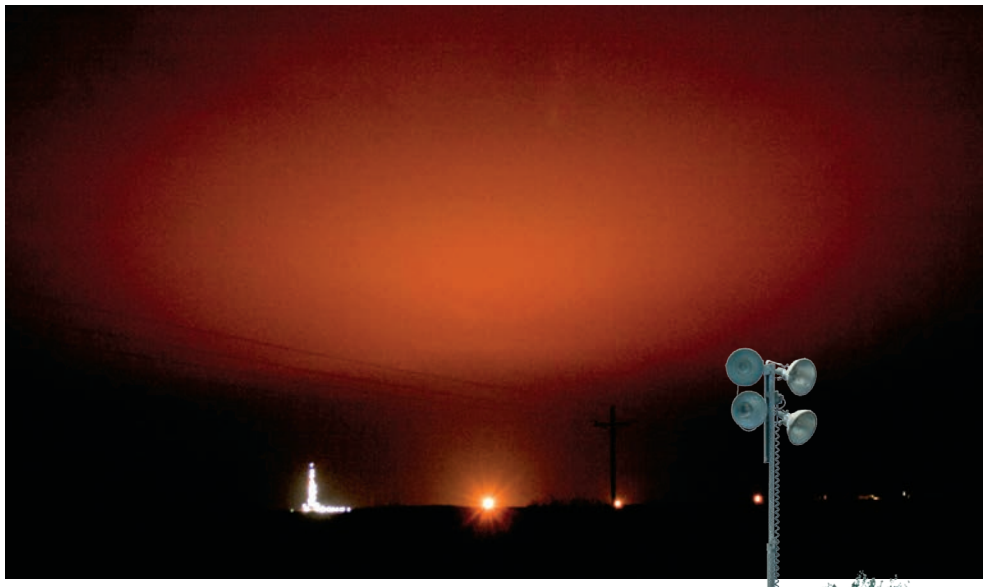
PIONEER RIG#29

Pioneer Energy Services (PES) of San Antonio, a company that may soon drill in the protected area, intends to set an example by upgrading their lighting systems by adding glare shields and aiming lights downward.

As part of a joint demonstration project, McDonald Observatory was granted access to a working rig, PES Rig#29, beginning in July, 2013. For all intents and purposes, Rig#29 was chosen randomly. It is an example of a typical drilling rig, and the light fixtures in use are representative of lighting found commonly throughout the oilfield.

Every time the rig moves to a new location, there is 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 demonstrated that in many cases nighttime visibility on the rig can be significantly improved. PES is only one company, but they see the benefit of upgrading their lighting practices.

Workers discussing the danger of makeshift glare shields.



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

Light towers such as the above are found throughout the oilfield.

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SAFETY and GLARE

Safe nighttime operations depend on good visibility. Many light fixtures are sources of blinding glare due to of lack of shielding, poor placement, or poor aiming.

During an early visit to Rig#29, workers pointed out conditions of poor visibility due to glare from an unshielded and poorly placed fixture, what rig hands refer to as a "360" light, a blast resistant, teardrop shaped globe surrounded by a wire mesh. The light was in the direct line of site of gauges and controls the driller must see for safe operations. The fixture had been fitted with a makeshift glare shield, a rag stuffed between the wire mesh and the globe (see photo at left).

SHIELDING THE "360" LIGHT

Most lighting manufacturers offer optional glare shields, or "reflectors", for a variety of fixture models. Such is the case for the AZZ brand light on Rig#29.

A 360 fixture fitted with one type of optional shielding.

The overall effectiveness of shields 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.

Fixtures are taken down every few weeks when the rig moves and reinstalled at the new location. Taller poles are too cumbersome for frequent moves, so the large, deep shields are inadequate for these lights at low mounting heights. However, the same fixtures mounted around the outside of the rig over stairways provided more illumination on the stairs when fitted with the deeper shields (see photo, below left).

This particular fixture is yoke mounted and can be fitted and aimed with the 30-degree shield option offered by the manufacturer (see photo, p.6). These succeeded in reducing glare and providing adequate coverage, even with lower mounting height. They also have the advantages of being less expensive, fiberglass instead of spun aluminum, smaller for less wind loading, less likely to be damaged during transport, and easier to replace. Extra shields can be kept on hand.

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 when re-oriented back down to the ground.

Installing shields on floodlights also provides an opportunity to re-aim them, although 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 with adjustable floodlights on extendable masts typically up to 30 feet high, with clusters of four high intensity fixtures.

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

Before (above) and (right) after shielding the 360. The result is a less harshly lit area making monitoring equipment easier to read with less eye strain and an overall safer workspace.

Typical field lighting in left side of this photo: Unshielded fixture produces glare, creates bigger, brighter skyglow, and makes handholds harder to see.

On this side, after shielding this 360 floodlight, the lighting on the starway actually improves. It's better, safer, because there is more light — where it ought to be.

Before shielding the 360 (left), light begins to play out toward the bottom of the stairs. After shielding (below) stairs are now well lit, better for the skies, safer for the workers.

that's how it will remain for its useful lifetime.

Mounting height is again a major factor in determining the area of coverage. 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 down, towers must be positioned closer to the center of the site as illumination is now 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.

CONCLUSION:

The major oil and gas producers all have firm commitments to safety, cost efficiency, and environmental protection. Careful and innovative use of lighting, especially LEDs, can improve all three. Efforts to convince major producers 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.

RECOMMENDATIONS:

1) **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 flood-light aimed horizontally shines half of it's 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. Once a light has been aimed the first time its used, it is likely that is how it will remain for its useful lifetime.

2) **Shielding** All light fixtures in use at a given facility can be inventoried, their make and model identified, and fitted with optional manufacturer shields.

   Shielding floodlights, almost without exception, increases safety by reducing glare.

   Fixtures can be aimed downward when shielding is installed such that no light shines above the horizon.

   Shielding for other styles of fixtures is also effective for reducing glare, but adequate coverage below the fixture depends on the extent of shielding and mounting height. Many lights are mounted high around the outside perimeter of the main rig platform and are intended to light stairways and the ground below. Shielding these fixtures also has the desired effects of reducing glare and increasing illumination in the area around the rig.

3) **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, 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, hampers nighttime visibility, and scatters more off particles in the air.

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