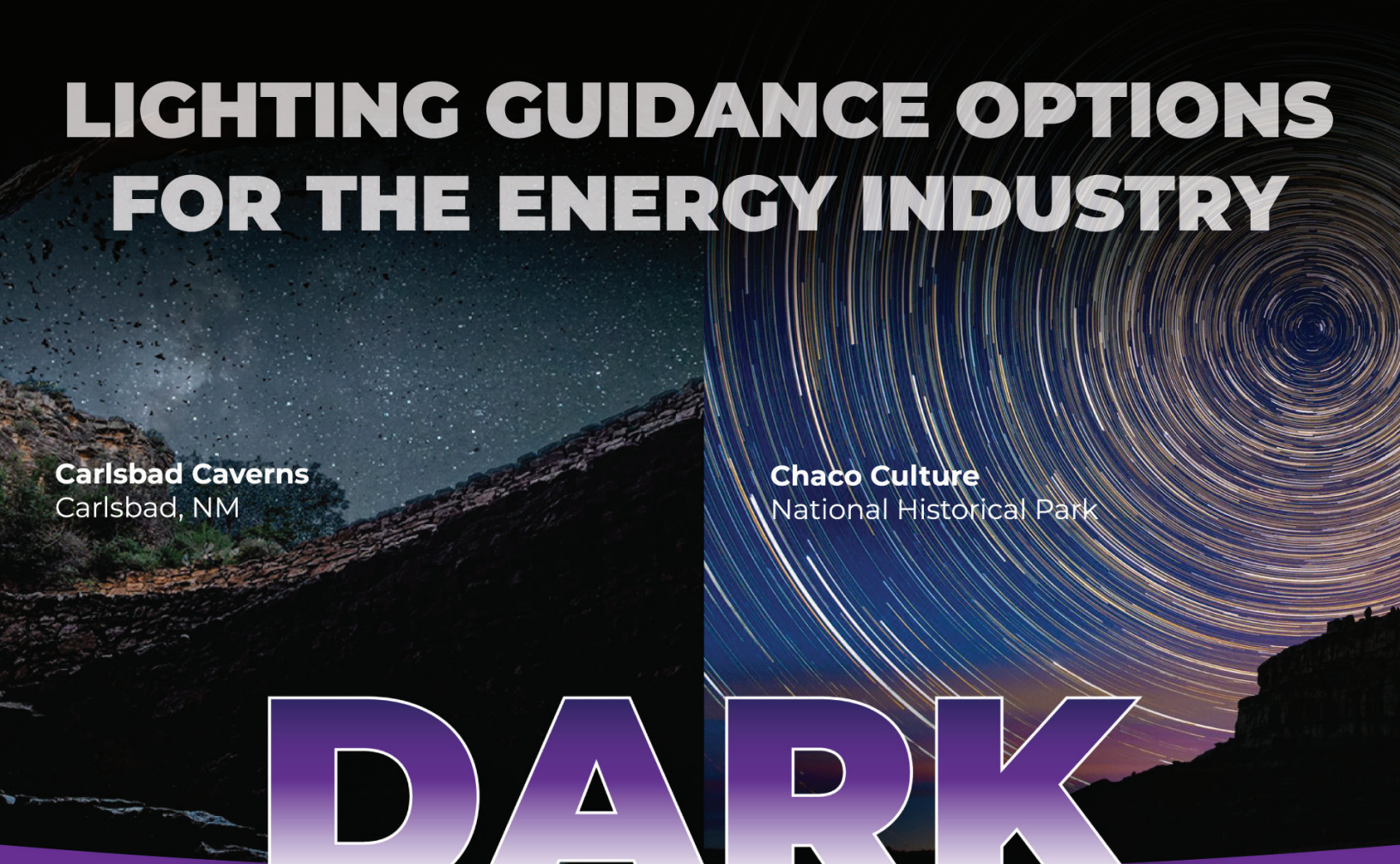
LIGHTING GUIDANCE OPTIONS FOR THE ENERGY INDUSTRY



Carlsbad Caverns
Carlsbad, NM

Chaco Culture
National Historical Park

DARK

FOR THE PARK ALLIANCE

A COLLABORATIVE INITIATIVE TO MAINTIAN NIGHT SKY QUALITY IN SOUTHEAST AND NORTHWEST NEW MEXICO

ALLIANCE MEMBERS

NMOGA
NEW MEXICO OIL AND GAS ASSOCIATION

NATIONAL PARK SERVICE

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

COMMISSIONER STEPHANIE GARCIA RICHARD
NEW MEXICO STATE LAND OFFICE

DarkSky
NEW MEXICO
CHAPTER

DarkSky
INTERNATIONAL

McDonald Observatory
The University of Texas at Austin

Lighting Guidance Options for the Energy Industry

Franklin Mountain Energy New Mexico site featuring Dark Skies-friendly lighting designed to maintain safety and security and night sky quality. (Image courtesy of Stephen Hummel, McDonald Observatory)

Formed in 2023, the "Dark for the Park Alliance" includes: Carlsbad Caverns National Park, Chaco Culture National Heritage Park, New Mexico Oil and Gas Association (NMOGA), Bureau of Land Management (BLM), New Mexico State Land Office (NMSLO), Apache Point Observatory, University of Texas McDonald Observatory, Dark Sky International (DarkSky) and its New Mexico chapter, and other stakeholders in southeast and northwest New Mexico. Carlsbad Caverns and Chaco are the anchor parks for this initiative, located within the two main oil and gas development basins in New Mexico. This initiative is based on the successful collaboration of McDonald Observatory and industry using education and recognition to promote appropriate lighting and preserve dark skies.

The following Lighting Guidance Options document is a result of the "Dark for the Park Alliance" and based on the Five Principles for Responsible Outdoor lighting. This document is specifically designed for oil and gas operations in the Permian and San Juan Basins in Southeast and Northwest New Mexico but can benefit other industries and regions as well.

The vision of success for the New Mexico "Dark for the Park Alliance" are to:

- **Maintain or increase night sky quality at Carlsbad Caverns National Park and Chaco Culture National Historical Park**
- **Maintain safety and security of operations**
- **Educate through this "Lighting Guidance Options" document**
- **Educate that solutions can be simple, low cost, and mutually beneficial to operations and night skies**
- **Encourage participation and success through Night Sky Recognition Programs**

This document serves as a guide for options for permanent lighting provided that safety and security aspects are upheld.

Safety, security, or functional considerations, outlined by API, IES, OSHA, FAA, and other agency regulations governing lighting standards, may dictate lighting plans or practices that result in lights other than recommended in this document.

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Much of the following was adopted from DarkSky International, McDonald Observatory “Recommended Lighting Practices: A collaborative effort to preserve West Texas’ Dark Night Skies”, and Bureau of Land Management, “Best Management Practices for Reducing Visual Impacts of Renewable Energy Facilities on BLM-Administered Lands” (BLM/WY/PL-13/013+1340).

The Five Lighting Principles

With visibility as the goal, permanent lighting can be designed and installed to minimize night-sky impacts and still serve its purpose during both construction and operations. DarkSky and the Illuminating Engineering Society (IES) recommend Five Lighting Principles (see below).

Safety and security must be considered first and foremost in lighting practices for any facilities, operations, and access roads for the health, safety, security, and environment of the workers, equipment, and surroundings for these often 24-hour operations. Please review API, IES, OSHA, FAA, and other agency regulations governing lighting standards to align all objectives for lighting (see “References: Lighting Standards” in this document).

Many of these principles can be achieved through simple and cost-effective solutions, such as tipping lights downward or installing a light shield to minimize light ‘trespass’ upward or outward to non-work areas. In some cases, existing light fixtures can be modified or may already meet DarkSky guidelines. DarkSky has a database of DarkSky Friendly Lighting options for pathways, signage, wall mounts, etc. (https://darksky.org/what-we-do/darksky-approved/).

The recommended goal is simple: Light where you need it and no more

Principle 1: Useful

Recommend to: Use light only if it is needed: All light should have a clear purpose

It is recommended that a lighting plan be prepared documenting how lighting will be designed and installed to minimize night-sky impacts.

Consider preparing a lighting plan: A lighting plan documents how lighting will be designed and installed to maximize safety and security and minimize impacts on the night-sky during construction and operations.

A lighting plan should include:

- A detailed drawing or 3D rendering showing the areas and equipment to be illuminated with locations and types of fixtures. The anticipated illumination levels based on vendor photometry data should be shown at various distances from each fixture as well;
- Areas of special lighting considerations such as access and egress path lighting should be clearly identified;
- Design intent statement to include downward facing and shielding to eliminate up-light, glare, and light spill to offsite locations, and restricting lighting usage to certain time periods;
- Fixture specifications to include ideally <3000K color temperature, nominal lumen rating per fixture, any adjustable settings (internal dimmer settings), and any mounting bracketry needed to obtain a downward aiming position;
- Number of lights and lumen output of each; minimum number of lights and the lowest luminosity consistent with safe and secure operation of the facility;
- Alternatives to lighting, such as retro-reflective or luminescent markers;
- A process for promptly addressing and mitigating complaints about lighting impacts

Consider conducting a light study of an existing operation: As an alternative to a formal design study prior to lighting installation, a light study can be conducted to an existing operation. This process will involve a lighting inventory (i.e. listing each fixture type and count) as well as measuring light levels with a handheld light meter at various locations across the operation and documenting the actual illumination levels. The goal of a light study is to understand the effects of lighting source types and light levels on the visual performance of workers performing critical visual tasks and assessing sites for safety and security. Study results often inform lighting level recommendations and modifications. Fixtures may need to be changed or added to achieve desired results. A follow-up study should be conducted after adjustments and corrections are made to confirm the results.

Principle 2: Targeted

Recommend to: Direct light so it falls only where it is needed

Aiming: Direct Lights Properly to Eliminate Light Spill and Minimize Glare

Permanent lighting should be mounted properly and directed to focus light only on the intended area and to avoid light spill and offsite light trespass. Lights pointing upward or horizontally should be avoided.

Before & After — Triple Crown Gas Plant (Wittenbach/ Wren Cimarex/ Chevron/McDonald Observatory)

Shielding: All permanent lighting should be shielded (i.e., not emitting direct or indirect light above an imaginary horizontal plane passing through the lowest part of the light source).

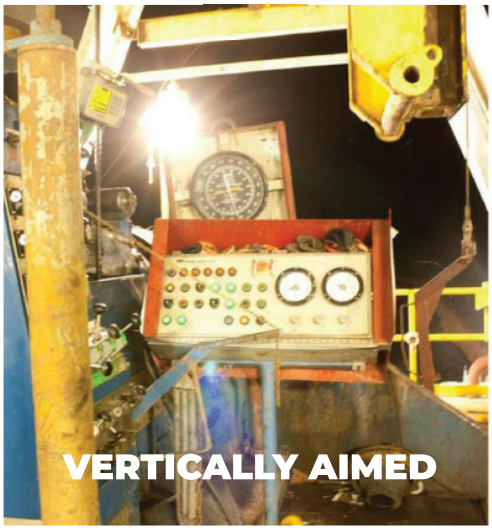
DarkSky International recommends that no more than 5% of total light output be emitted more than 80 degrees from nadir (i.e., 10 degrees below horizontal plane).

Principle 2: Targeted (continued)

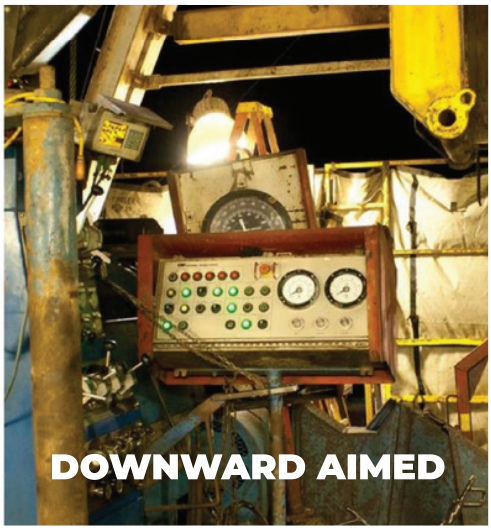
Aiming:

Downward-aimed and shielded light can reduce light trespass and glare to improve visibility of the console.

Before ☒



After ☑



Shielding:

Shielded light at right puts light where it is needed

☒

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(source: modified from Wren and Locke, "Upgrading Rig Lighting Improves Night Time visibility While Reducing Stray Light and the Threat to Dark Skies in West Texas", 2015)

Limitations: To ensure safety and security, illumination levels should adhere to recommendations from accredited professional bodies (e.g., IES, API, OSHA), tailored to the specific task and environmental setting. Limitations: Functional considerations may dictate lighting practices that result in lighting other than recommended.

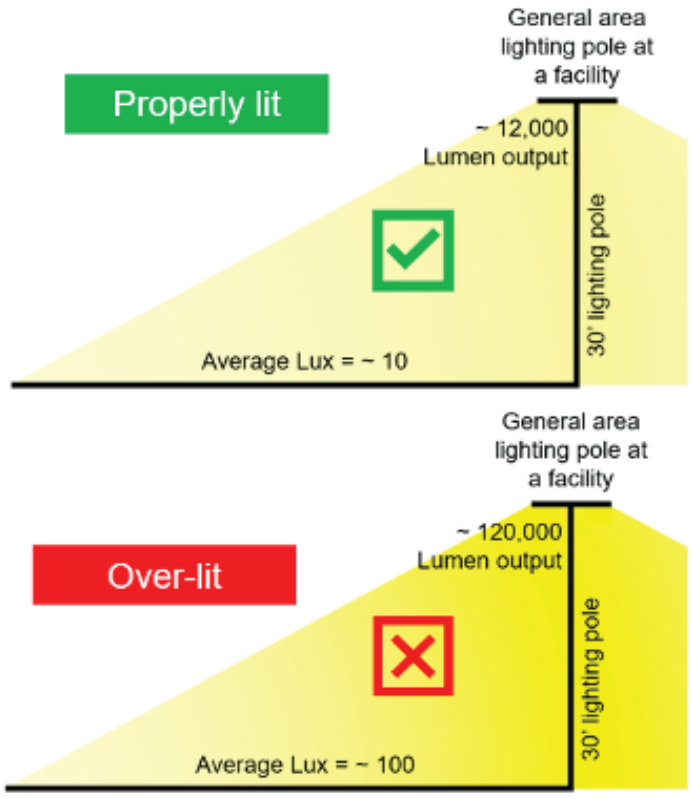
Principle 3: Low Level

Recommend to: Light should be no brighter than necessary.

Illumination levels should follow recommendations from an accredited professional body (i.e. IES, API and OSHA) as appropriate for the task and environmental setting. When buying lights, be aware that lumen is a measure of total lighting output from a source, whereas recommended values are often in lux or foot-candle, a measure of lighting at a location. Use of a simple hand-held lux meter may be needed to properly assess lighting levels at a given location.

Limitations: To ensure safety and security, illumination levels should adhere to recommendations from accredited professional bodies (e.g., IES, API, OSHA), tailored to the specific task and environmental setting. Limitations: Functional considerations may dictate lighting practices that result in lighting other than recommended.

Example of a properly lit vs over-lit general area: API standard for average illumination levels of a General Area is 10 Lux measured at ground level. DarkSky International recommends that lighting levels be no more than 25% above recommended levels in areas above 10 lux, and no more than 50% below 10 lux.



Principle 4: Controlled

Recommend to: Use light only when it is needed.

Consistent with safety, security, and functional requirements, controls such as timers, motion detectors, or offsite controls can ensure that light is available when it is needed and dimmed when possible.. If safety, security, and functional requirements are met, an option includes 'Always on' low lights that brighten when needed.

Before implementing this lighting option, it is essential to consider the safety and security aspects of 24-hour operations.

Limitations: To ensure safety and security, illumination levels should adhere to recommendations from accredited professional bodies (e.g., IES, API, OSHA), tailored to the specific task and environmental setting. Limitations: Functional considerations may dictate lighting practices that result in lighting other than recommended.

Image courtesy of darksky.org.

Principle 5: Warm Colored

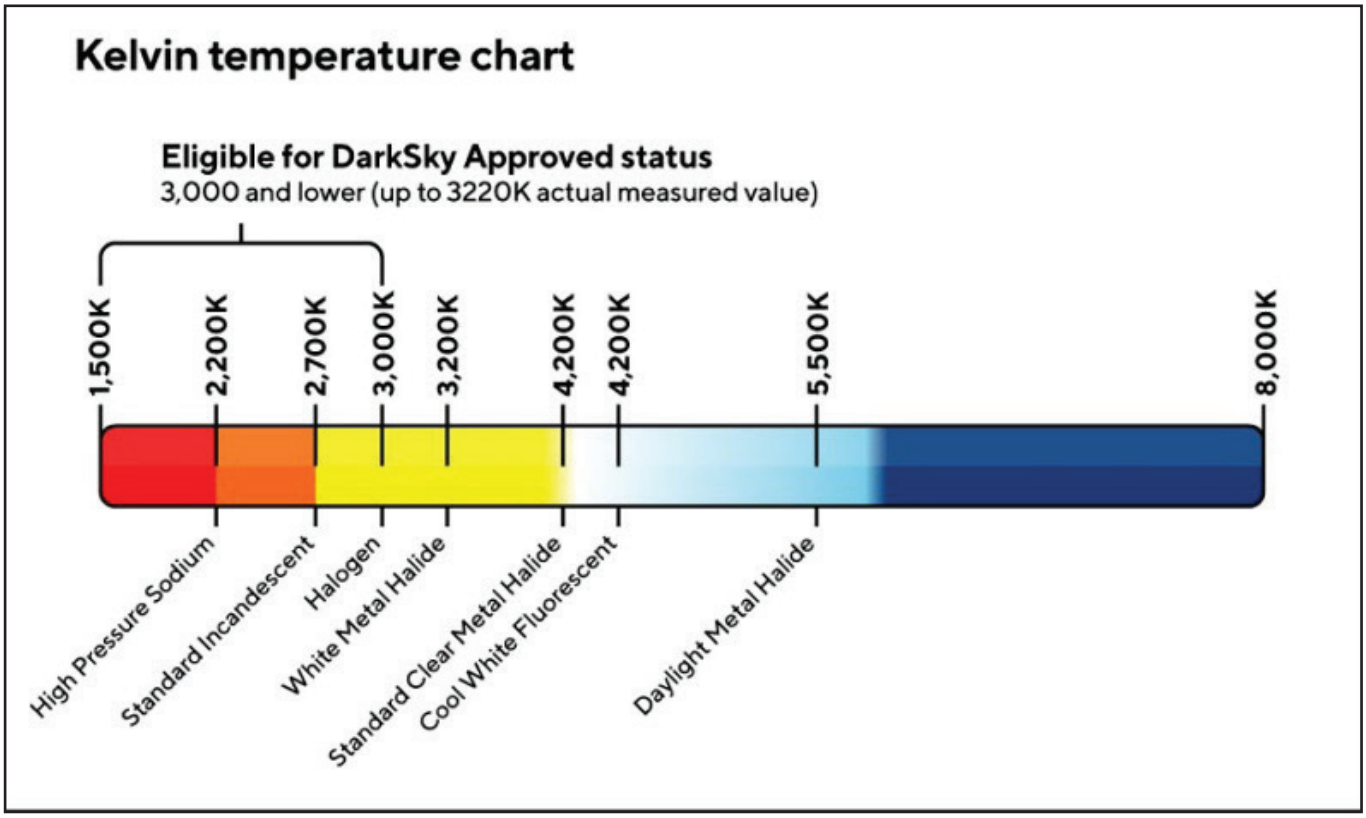
Recommend to: Use warmer color lights where possible

When accurate color rendition is not required (e.g., roadway, basic security), lighting should be amber in color: less than or equal to 3000K color temperature to be DarkSky approved, or <3500K if safety and security recommendations are not met by the 3000K color temperature recommendation.

When white light is required for accurate color rendition, it should be less than or equal to 3500K color temperature (warm-white), preferably less than 3000K to be DarkSky Approved.

Note: Sourcing and long-lead times for a preferred lighting color temperature may result in non-DarkySky approved lighting color temperature.

Limitations: To ensure safety and security, illumination levels should adhere to recommendations from accredited professional bodies (e.g., IES, API, OSHA), tailored to the specific task and environmental setting. Limitations: Functional considerations may dictate lighting practices that result in lighting other than recommended.

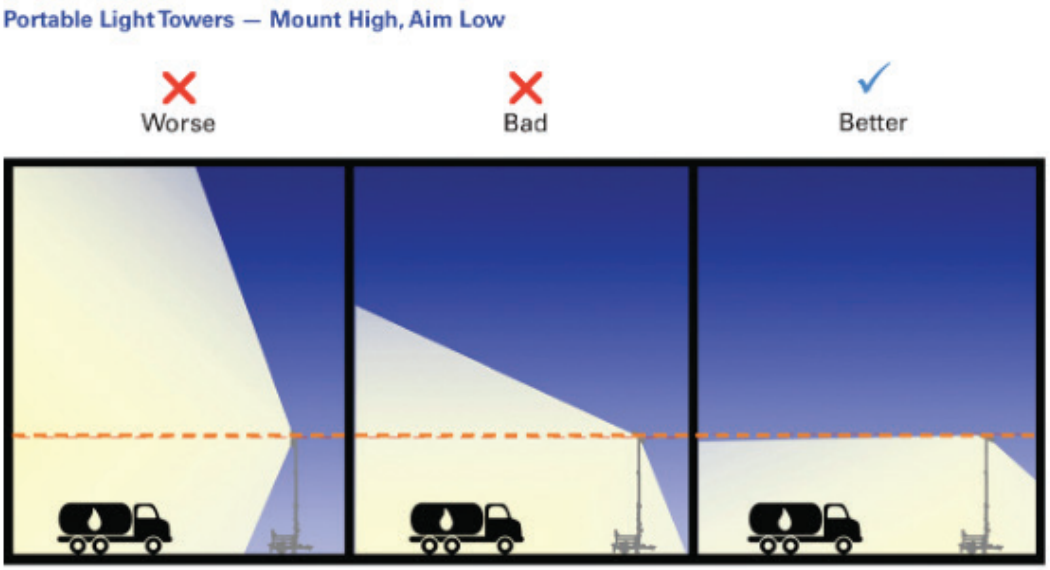


(source: https://darksky.org/what-we-do/advancing-responsible-outdoor-lighting/our-positions/)

Temporary Lighting

When possible and consistent with safety and security requirements, lighting should be optimized during construction and operations. When temporary lighting is necessary, options include mounting portable light towers high and aim them low to maximize light output on desired target and reduce glare.

Limitations: To ensure safety and security, illumination levels should adhere to recommendations from accredited professional bodies (e.g., IES, API, OSHA), tailored to the specific task and environmental setting. Limitations: Functional considerations may dictate lighting practices that result in lighting other than recommended.



Wren/McDonald Observatory

RESOURCES

Lighting fixtures: The "DarkSky Approved" program provides objective, third-party certification for lighting products, lighting designs, and installed lighting projects that minimize glare, reduce light trespass, and reduce light pollution. To be certified by DarkSky, they must:

- Restrict the amount of upward-directed light
- Avoid glare
- Avoid over-lighting
- Utilize dimming and other appropriate lighting controls
- Minimize short-wavelength (bluish) light in the nighttime environment

What to order: More information: Go to https://darksky.org/what-we-do/darksky-approved/ for information on DarkSky Approved Lighting fixtures, and DarkSky Approved lighting designs, including for Oil and Gas facilities developed in collaboration with NMOGA and Franklin Mountain Energy. Be aware that only certain models of lighting fixtures are DarkSky Approved.

Lighting Standards:

Illuminating Engineering Society. ANSI/IES RP-7-21+E1, "*Recommended Practice: Lighting Industrial Facilities*", New York: IES; 2021.

Occupational Safety and Health Administration (OSHA). Standard 1910. "*Occupational Safety and Health Standards*", https://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910TableofContents

Occupational Safety and Health Administration (OSHA). Standard 1926. "*Safety and Health Regulations for Construction*", https://www.osha.gov/laws-regs/regulations/standardnumber/1926/1926TableofContents

(Currently not available; use the most recent API or other standard) T. Griffith and M. K. Toney, "21st Century petrochemical electrical practices-API RP 540 fourth edition", pp. 309-317, Industry Applications Society 46th Annual Petroleum and Chemical Technical Conference, San Diego, CA, USA, 1999

Sources:

Bureau of Land Management, "*Best Management Practices for Reducing Visual Impacts of Renewable Energy Facilities on BLM-Administered Lands*" (BLM/WY/PL-13/013+1340)

Dark Sky International, https://darksky.org/, public outreach materials

Department of Defense "*Unified Facilities Criteria (UFC): Interior and Exterior Lighting Systems*"; UFC 3-530-01, APPROVED FOR PUBLIC RELEASE, DISTRIBUTION UNLIMITED; 09 February 2023

Illuminating Engineering Society (IES), https://www.ies.org/

McDonald Observatory, "*Recommended Lighting Practices: A collaborative effort to preserve West Texas' Dark Night Skies*" https://mcdonaldobservatory.org/sites/default/files/pdfs/OG_LightingPractices_2mb.pdf

U.S. Department of Energy. "*Lighting Controls; Energy Saver*" https://www.energy.gov/energysaver/lighting-controls

RESOURCES

Wren, B and Locke, S "*Upgraded rig lighting improves night time visibility while reducing stray light and the threat to dark skies in West Texas*", SPE-17492-MS, 2015

Recognition Programs:

- Become publicly acknowledged for following these recommendations.
- New Mexico: Options include DarkSky International certification, recognition from Carlsbad Caverns on efforts, and/or McDonald Observatory
- DarkSky International: Coming soon to https://darksky.org/what-we-do/darksky-approved/
- Texas: McDonald Observatory hosts a recognition program to promote appropriate lighting and preserve West Texas dark skies: https://mcdonaldobservatory.org/pages/lighting-recognition-program.

Support the effort: New Mexico DarkSky (nmdarksky.org): Become a member today.
Founded in June 2023, the New Mexico chapter of DarkSky International "seeks to restore and preserve New Mexico's ancestral heritage of majestic, star-filled skies and dark nighttime environments. The chapter provides a local channel to DarkSky International, and all DarkSky International members with a New Mexico address automatically are chapter members.