



The Safety Association for Canada's
Upstream Oil and Gas Industry

Lease Lighting

Guideline

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By industry, for industry





The Safety Association for Canada's
Upstream Oil and Gas Industry

ENDORSEMENT

This document was developed by industry for industry. Enform gratefully acknowledges the support of the endorsing organizations in the development of this document.

- CAGC Canadian Association of Geophysical Contractors
- CAODC Canadian Association of Oil Drilling Contractors
- CAPP Canadian Association of Petroleum Producers
- CEPA Canadian Energy Pipeline Association
- PSAC Petroleum Services Association of Canada
- SEPAC Small Explorers and Producers Association of Canada

ABOUT ENFORM

Enform is the upstream oil and gas industry's advocate and leading resource for the continuous improvement of safety performance. Our mission is to help companies achieve their safety goals by providing practices, assessment, training, support, metrics and communication.

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Enform gratefully acknowledges the many individuals who volunteered their time and effort to complete this document.

DISCLAIMER

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PREFACE

Purpose

The purpose of this document is to provide the upstream petroleum industry with guidelines on lighting to enhance the safety of operations on onshore oil and gas lease sites during the hours of darkness.

Audience

The intended audience of this document includes:

- Oil and gas lease site operators
- Drilling and petroleum service contractors who carry out work on lease sites

Scope and Limitations

The *Lease Lighting Guideline* focuses on outdoor lighting requirements for:

- Mobilization and demobilization of drilling equipment on a lease site
- Ancillary drilling activities
- Any lease site servicing operations (e.g., snubbing, cement pumping, well testing, stimulation, coiled tubing operations, wireline, etc.)

It is not intended to address the lighting requirements for activities that occur on the rig floor or in indoor structures or shacks. It also does not include activities related to road and lease construction or reclamation.

This document assumes that lighting is only required in areas where operational activities and the movement of people and/or equipment take place during the hours of darkness.

It also assumes that there are environmental benefits and energy efficiencies to be gained. These gains may result from minimizing or avoiding lighting areas of the lease where there is never any human activity during hours of darkness, and from lighting operational areas only when operations are actually under way.

The intent of this guideline is to:

- Clarify roles and responsibilities for lighting on leases
- Assist operators and contractors with determining minimum lighting requirements for work activities on the lease

- Improve the safety and security of people and property on lease sites by increasing the attention paid to outdoor lighting

This guideline is not intended to override the requirements relating to operations during hours of darkness set out in *Industry Recommended Practice 4: Well Testing and Fluid Handling* and *Industry Recommended Practice 15: Snubbing Operations* (see especially 15.7.7.1). The guidance on lighting for various operations, including the mobilization and demobilization of drilling or service rigs, assumes that other hazards and the cumulative risk of operating during hours of darkness have been assessed and accounted for in the decision to proceed with these operations.

The guideline is based on engineering judgment, accepted good practices, and experience. This guideline is meant to allow flexibility and must be used in conjunction with competent technical judgment. It remains the responsibility of the user of the document to judge its suitability for a particular application.

If there is any inconsistency or conflict between any of the guidance contained in the guideline and the applicable legislative requirement, the legislative requirement shall prevail.

Acknowledgements

This document is a set of guidelines compiled by knowledgeable and experienced industry and government personnel.

The document was developed under the auspices of the Drilling and Completions Committee (DACC) and published by Enform as an industry guideline.

1 RESPONSIBILITIES

1.1 Operator Responsibilities

The operator on a lease is responsible for overall lease lighting requirements for ongoing lease operations (in accordance with section 2.3). Lease lighting assessments may be considered during the job planning stage. Based on that assessment, lighting requirements may then be fulfilled using a combination of fixed and/or portable lighting to cover operations as they shift and evolve.

The operator is responsible for ensuring that general lighting is provided in any common areas shared by multiple contractors for any required operations during hours of darkness (in accordance with section 2.3). The immediate vicinity of the wellhead and tank farms are prime examples of common areas.

In the event that an operator supplies equipment for one or more contractors, the operator is responsible for ensuring lighting is provided for the operation of this equipment in accordance with section 2.3. This guideline does not specify how an operator provides the lighting. In particular operations, the supply of this lighting could potentially be subject to a contractual arrangement between the operator and contractor(s) using the equipment.

1.2 Contractor Responsibilities

Contractors that bring equipment on site in order to engage in specific tasks are responsible for ensuring lighting is provided for the safe operation of this equipment (in accordance with section 2.3). This guideline does not specify a supplier for the lighting, as a variety of contractual arrangements may be used to ensure sufficient lighting. Depending on the nature of the operation, arrangements may include making portable lighting available to provide task-specific lighting as operations shift and evolve.

If a contractor's operation involves an area outside of the scope of their equipment-specific lighting, and/or their operational area overlaps with that of another contractor, the contractor is responsible for communicating site lighting requirements to the operator. The operator and affected contractor(s) should conduct an assessment to determine whether any modification to the lease lighting is required in accordance with section 2.3. All parties involved should reach an agreement to ensure lighting requirements are met before undertaking these operations.

1.3 Responsibilities during Rig Moves

Ensuring that lighting is sufficient during rig moves conducted during hours of darkness is the joint responsibility of rig transport contractor(s), lease operator(s), and any other contractors involved in the operation. All parties involved should reach an agreement to ensure lighting requirements are met before undertaking these operations. Lighting requirements should be established based on an agreed-upon assessment of the anticipated conditions on the lease site(s) and any unique operational demands, and in accordance with section 2.3.

1.4 Hazard Assessment and Control

All operators and contractors engaged in operations during hours of darkness are responsible for communicating to their workers the importance and necessity of lighting to reduce risk during these operations. The nature of the operations and safety management system should determine how best to increase awareness of lighting requirements.

For example, employers may:

- Create a formalized safe work practice for operations during hours of darkness
- Ensure that the availability, location, and training on the use of additional portable lighting is communicated to all employees
- Ensure employees engaged in activities during hours of darkness are trained on the specifics of lighting application and maintenance
- Include lighting as part of orientation or training on hazard identification and assessment
- Develop and implement a formalized maintenance plan on all lighting fixtures
- Make lighting an identifiable consideration during incident investigation

Operators and contractors on a lease site engaged in operations during hours of darkness are responsible for conducting a documented on-site hazard assessment during hours of darkness to ensure that minimum lighting requirements for safe operations are met. Whenever possible, this assessment should be conducted during the transition from twilight to hours of darkness or before commencing operations during hours of darkness.

The hazard assessment may include, but not be limited to, identifying and assessing the following considerations and risk factors:

- Type of task(s) / active task area(s) (align with Table 2: Light Levels for Oil and Gas Lease Sites)
- Shadows in areas of high activity
- Excessive glare or reflected glare from a light source
- Required sightlines (e.g., to establish eye contact, hand signals, non-verbal communication)
- Mitigation of excessive light spillage outside the lease site, especially onto public roadways or environmentally sensitive areas

Operators and/or contractors involved in extended lease site operations should systematically monitor or conduct periodic field inspections of their operations during hours of darkness to ensure lighting levels continue to meet the requirements of the operations being carried out.

All employers that provide lighting on a lease site are responsible for ensuring that they are familiar with and follow electrical codes, regulations, and standards for the classification of lights and supporting electrical systems and connections, where particular classifications are required. These include but may not be limited to:

- Canadian Standards Association. 2012. CSA Standard C22.1-12. *Canadian Electrical Code Part I, Safety Standard for Electrical Installations*.
- Safety Codes Council. 2006. *Code for Electrical Installations at Oil and Gas Facilities*, 3rd ed. (An easy-to-use and well-illustrated guide that applies the *Canadian Electrical Code* and its classification of locations and zone to typical drilling rigs, service rigs, and other oil and gas lease site operations.)
- Alberta Municipal Affairs – Safety Services. October 2009. *Electrical Safety Information Bulletin STANDATA for CEC-10 [rev-7]*. (See especially “Grounding and Bonding at Oil and Gas Drilling or Servicing Operations,” pages 6-9.)

Note: Some companies may also be interested in the following publication: Canadian Standards Association. 2009. CSA Standard C22.4-09. *Canadian Electrical Code Part IV, Objective-Based Industrial Electrical Code*. This standard provides an objective-based code that allows companies with a safety management system and the requisite engineering resources to apply innovative solutions to the design, installation, operation, and maintenance of electrical equipment in their industrial applications. As regulations and standards continue to evolve and emerge, it is important for companies to remain vigilant and ensure that they are familiar with all applicable regulatory requirements and best practices.

2 DETERMINING MINIMUM LIGHTING REQUIREMENTS

2.1 Background on Light Measurement

Illuminance is the measure of “how bright” a working area is. The metric (SI) measure of illuminance is the lux (foot-candle in the Imperial System). In basic terms, a lumen is the measure of the intensity of light, while lux measures that intensity in terms of the area over which it is spread ($1 \text{ lux} = 1 \text{ lumen/m}^2$). By way of analogy, if one litre of water is spread over one square foot, the water is a certain depth. If that one litre is spread over one square metre, the depth is much shallower.

The following table provides approximate lux values for various lighting conditions.

Table 1: Examples of lux levels in everyday life

Environment	Typical/Approximate Illuminance
Full moon on a clear night	0.27 lux
Dark limit of civil twilight	3.4 lux
Nighttime on suburban residential street	5 lux
Well-lit main street at night	10 lux
Light level 10 feet from a tall living room lamp with a shaded 60 watt incandescent bulb	15 lux
Light level available for reading if seated next to the same shaded 60 watt lamp	30 lux
Light range in a 10 foot x 10 foot room lit with a single bare 60 watt incandescent bulb	30-45 lux
Light range in a 10 foot x 10 foot room lit with a single bare 100 watt incandescent bulb	50-80 lux
Light range in a 10 foot x 10 foot room lit with a pair of 60 watt incandescent bulbs	70–90 lux
Very dark overcast day	100 lux
Recommended office lighting	320 lux
Full daylight (not direct sun)	10,000–25,000 lux

If it is necessary to convert illuminance to or from metric, use the following conversion factors:

- 1 foot-candle = 10.76391 lux
- 1 lux = 0.09290304 foot-candle

In existing national and international lighting standards for workplaces, illuminance is usually the key measure of adequate lighting. However, there are other considerations and measurements, such as glare rating, illuminance uniformity, and colour rendering.

2.2 Existing Lighting Standards

The internationally recognized workplace lighting standards that provide recommended illuminance values for industrial and outdoor work sites include:

- Illuminating Engineering Society of North America. 2001. ANSI/IESNA RP-7-01. *Recommended Practice for Lighting Industrial Facilities*.
- Commission Internationale De L'Eclairage / International Commission on Illumination. 1998. CIE 129–1998. *Guide for Lighting Exterior Work Areas*.
- Commission Internationale De L'Eclairage / International Commission on Illumination. 2005. CIE S 015/E:2005. *Lighting of Outdoor Work Places*.

2.3 Applying Existing Standards to Oil and Gas Lease Sites

ANSI and CIE standards do not provide direct guidance on lighting temporary or isolated work sites that must generate electricity locally (the type of work site common in the upstream petroleum industry). Such an environment presents unique challenges, especially with respect to uniformity of lighting.

The ultimate goal is not to meet an arbitrary standard. Rather, the goal is to provide sufficient lighting to mitigate risks and operate safely at night. The focus of lighting should be the areas of the lease where the operational tasks and the movement of people, vehicles, or equipment are actually taking place.

The goal is to accomplish this while:

- Minimizing or avoiding lighting in areas of the lease where there is never any human activity
- Lighting operational areas only when operations are actually under way

The following guidance on lighting is not a substitute for the critical judgment of supervisors and workers on the level of light they require to work safely.

The lux values in the guidance on lighting in the following table are based on the ANSI/IESNA RP-7-01 and CIE S 015/E:2005 recommended illuminance values (see further Appendix A: ANSI and CIE Illuminance Standards Transferable to Upstream Petroleum Lease Site). Work activities and environments in these tables that were roughly equivalent to the activities and environments on an oil and gas lease site were then field tested to arrive at the following table (Table 2: Light Levels for Oil and Gas Lease Sites).

Employers on a lease site (operators and contractors) should refer to the following table to assist them in determining, providing, and testing the lighting requirements for the various tasks and work areas under their responsibility.

Table 2: Light levels for oil and gas lease sites

Activity Type / Work Area / Movement Area*	Average Level of Illuminance
<p>Level 1</p> <p>Areas used infrequently, activities requiring minimal visual acuity, and pedestrian traffic areas</p> <p>Examples:</p> <ul style="list-style-type: none"> • Walking from shacks to task site • Moving between task sites • Staging areas accessed infrequently at night 	5 lux
<p>Level 2</p> <p>Areas accessed semi-regularly during a typical shift, and activities and tasks requiring minimal to moderate visual acuity</p> <p>Examples:</p> <ul style="list-style-type: none"> • Walkways, stairs, and ladders used infrequently • Areas in which piping is laid (e.g., flares lines, steam lines, wellhead plumbing, flow lines) • Tank farms • Tasks requiring the ability to read larger labels • Manual loading and unloading • Single unit unloading and loading a load • Egress routes 	10 lux
<p>Level 3</p> <p>Areas accessed multiple times during a typical shift, and activities and tasks requiring moderate visual acuity</p> <p>Examples:</p> <ul style="list-style-type: none"> • Walkways and stairs used regularly • Walkways above mud tanks • Task requiring the ability to read smaller labels • Task requiring ongoing inspections of pipes or fittings for leakage • Loading and unloading with front-end loader • Multiple units loading or unloading simultaneously • Moving and spotting large equipment 	20 lux

Activity Type / Work Area / Movement Area*	Average Level of Illuminance
<p>Level 4</p> <p>High-movement areas, and activities and tasks requiring high levels of visual acuity</p> <p>Examples:</p> <ul style="list-style-type: none"> • Wellhead (immediate vicinity area) • Any task requiring the reading of gauges/digital displays • Tasks requiring more detailed inspection of pipes or fittings • Positioning, assembly, and disassembly of large equipment on location • Lifting and lowering of loads with crane/boom truck <p>(Note that provincial OH&S regulations require a lighting level of 54 lux measured 50 cm above the travel surface during swabbing operations [AB OH&S 780(6); BC OH&S 23.65 (a)])</p>	50 lux
<p>Level 5</p> <p>Activities or tasks requiring ability to see fine details</p> <p>Examples:</p> <ul style="list-style-type: none"> • Mechanical repair tasks • Makeup or teardown of equipment with small parts • Fixed control panels 	100 lux
<p>Level 6</p> <p>Activities or tasks requiring ability to see very fine details</p> <p>Examples:</p> <ul style="list-style-type: none"> • Repairing electric motor (i.e., fine coil wiring, etc.) • Repairing electric circuitry 	200 lux

*Note: This table assumes that lease areas not accessed at night or areas with intermittent operations where lighting can easily be turned on and off would not normally be lit.

2.4 Measuring Illuminance

The human eye adjusts rapidly to changing lighting conditions, making it difficult to gauge illuminance variations at night (e.g., the difference between 20 lux and 50 lux, or 50 lux and 100 lux). A lux meter is a reasonably priced tool that is relatively simple to use and that can provide a more precise reading on illuminance.

Lux meters can be very sensitive to the angle at which they are held. When measuring light levels at various tasks or in various areas, it is important to be as consistent as possible in holding the meter at a horizontal or vertical angle, as appropriate. Take multiple readings to get a sense of the average illuminance of an area.

Lux meters are also a helpful tool in redesigning or adjusting existing light fixtures to achieve better overall illumination of work sites or areas. Again, a metered lux reading is not a substitute for experienced critical judgment on the level of light required to carry out tasks safely and comfortably.

- Employers should use a lux meter in developing, designing, and inspecting their lease lighting infrastructure.
- Anyone using a lux meter should refer to the manufacturer's instructions for the maintenance, calibration, and use of the device.
- CIE S 015/E:2005 or ANSI/IESNA RP-7-01 should be consulted for detailed lighting design criteria and precise measurement techniques.

3 PRACTICES FOR ENHANCING OVERALL LIGHT QUALITY

3.1 Enhanced Light Quality Can Improve Worker Safety

Light quality plays a role in workplace health, safety, productivity, and morale. Improving overall light quality can improve hazard identification, enhance overall mental alertness, reduce eye strain and fatigue, and improve operational efficiency.

Illuminance is one component of light quality. However, glare and uniformity of lighting are also factors in overall light quality. A light that provides a great deal of illuminance but also creates a blinding glare for workers does not enhance safety.

Colour rendering is also a factor to consider in any operations where it is necessary to differentiate colours (e.g., safety labels, emergency signs, etc.). The colour rendering index is a quantitative measure of the ability of a light source to reproduce the colours of various objects faithfully in comparison with an ideal or natural light source. An incandescent lamp has a Colour Rendering Index (CRI) close to 100. Colour rendering is less of a concern on lease sites that use mostly fluorescent, metal halide, and high-pressure sodium lamp types because these generally provide acceptable colour rendering qualities (colour rendering index ≥ 20).

3.2 Guidelines for Enhanced Light Quality

The following guidelines are designed to encourage practices that enhance overall light quality for lease operations during hours of darkness. Appendices B, C, and D provide practical suggestions on how to enhance lease lighting.

Light fixtures on an operational lease site should be of sufficient number and wattage and be strategically placed, adjusted, maintained, and cleaned so as to:

- Maximize their overall illuminance
- Minimize glare
- Minimize shadows and uneven lighting

Note: There are multiple ways to achieve these results. For example, higher towers reduce shadows and glare. Higher-wattage light fixtures can produce higher light levels at greater distances. Providing additional light from different directions reduces shadows and uneven lighting. Consult Appendix B for further suggestions on how to enhance overall light quality.

Portable light fixtures should be made available when tasks require more light than is provided by permanent light fixtures on the lease site. Consider having a number of additional lighting options available on a lease site that are relatively easy to access and use for tasks that require additional light.

Lease site operations that require the use of trucks or heavy mobile or static equipment should be supplied with enough light fixtures of sufficient illuminance. These should be strategically placed and adjusted so as to:

- Maximize the safety of workers around the vehicles and equipment
- Enhance the safety of the operations conducted with that equipment

Note: For suggestions on how to improve light quality during operations using trucks or mobile equipment, see Appendix C. Consult provincial and federal motor vehicle or transportation regulations when adding light fixtures to vehicles that will travel public roads.

Light fixtures mounted on mobile or static equipment should be secured, maintained, and cleaned to maximize their effectiveness.

When loading, unloading, or moving equipment on a lease site during hours of darkness, all employers involved in the operation should have a plan to maximize lighting for the duration of the operation. This plan may include but not be limited to the following considerations:

- Putting up lights as a first step before any operations begin on a lease site and taking down lights as a last step
- Providing additional temporary lights to compensate for the loss of lighting as generators and equipment are powered down or dismantled
- Providing additional lighting for areas involving safety-critical tasks identified in the hazard assessment (e.g., drawworks, pinning derrick, installing top drive, or positioning equipment over wellhead)
- Providing portable light fixtures or vehicle-mounted lighting to address hazards created by shadows
- Identifying hazards that may not be seen during hours of darkness and taking steps to mitigate the risk they present (aside from the hazards presented by equipment, consider natural hazards on the lease site and its egress routes—e.g., large hidden boulders or holes on a zero-disturbance lease site)

Note: For additional suggestions on how to enhance lighting during a night time rig move, see Appendix D. As noted above, provincial and federal motor vehicle or transportation regulations should be consulted when adding light fixtures to vehicles that will travel public roads. In some cases, these fixtures may need to be covered once off the lease site.

APPENDIX A: ANSI and CIE Illuminance Standards Transferable to Upstream Petroleum Lease Sites

RECOMMENDED ILLUMINANCE VALUES FROM ANSI / IESNA RP-7-01

The following tables represent activities that are roughly equivalent to those undertaken on upstream petroleum lease sites in terms of lighting requirements (electric generating station – exterior), working areas (logging), or risk activities (petroleum, chemical, and petrochemical industry process facilities).

Table A-1: Recommended illuminance values for industrial areas/activities – outdoor (examples from Figure A2-2 of ANSI / IESNA RP-7-01)

Area/Activity	Illuminance
Electric generating stations – exterior	
Boiler areas	
Catwalks, general area	20 lux
Stairs, platforms	50 lux
Ground-level areas, including precipitators, FD and ID fans, bottom ash hoppers	50 lux
Cooling towers	
Fan deck, platforms, stairs, valve areas	50 lux
Pump areas	20 lux
Fuel handling	
Barge unloading, car dumping, unloading hoppers, truck unloading, pumps, gas metering	50 lux
Conveyors	20 lux
Storage tanks	10 lux
Coal storage piles, ash dumps	2 lux
Logging	
Yarding	30 lux
Log loading and unloading	50 lux
Log stowing (water)	5 lux
Active log storage area (land)	5 lux
Log booming area (water) – foot traffic	10 lux
Active log handling area (water)	20 lux
Log grading (water or land)	50 lux
Log bins (land)	20 lux

Table A-2: Recommended illuminance values (maintained on the task) for specific industries (examples from Figure A2-3 of ANSI / IESNA RP-7-01)

Petroleum, Chemical, and Petrochemical Industry		
I. Process areas	Elevation	Illuminance
A. General process units		
Pump rows, valves, manifolds	Ground	50 lux
Heat exchangers	Ground	30 lux
Maintenance platforms	Floor	10 lux
Operating platforms	Floor	50 lux
Cooling towers (equipment areas)	Ground	50 lux
Furnaces	Ground	30 lux
Ladders and stairs (inactive)	Floor	10 lux
Ladders and stairs (active)	Floor	50 lux
Gage glasses	Eye level	50 lux
Instruments (on process units)	Eye level	50 lux
Separators	Top of bay	50 lux
General area	Ground	10 lux
II. Nonprocess areas		
B. Boiler and air compressor plants		
Outdoor equipment	Ground	50 lux
C. Tank fields (where lighting is required)		
Ladders and stairs	Floor	5 lux
Gaging area	Ground	10 lux
Manifold area	Floor	5 lux
D. Loading racks		
General area	Floor	50 lux
Tank car	Point	100 lux
Tank trucks, loading point	Point	100 lux
F. Electric substations and switch yards		
Outdoor switch yards	Ground	20 lux
General substation (outdoor)	Ground	20 lux
G. Plant road lighting (where lighting is required)		
Frequent use (trucking)	Ground	4 lux
Infrequent use	Ground	2 lux

RECOMMENDED ILLUMINANCE VALUES FROM CIE S 015/E:2005

Table A-3: Lighting requirements for safety and security (from Annex A of CIE S 015/E:2005)

Risk Level	Illuminance
<p>Very low risk, e.g.:</p> <ul style="list-style-type: none"> • Storage areas with occasional traffic in industrial yards • Coal fields in power plants • Timber storage, sawdust, and wood chip fields in sawmills • Occasionally used service passages and stairs, waste water cleaning and aeration tanks, filter and sludge digestion tanks in water and sewage plants 	5 lux
<p>Low risk, e.g.:</p> <ul style="list-style-type: none"> • General lighting in harbours • Areas of risk-free process and occasionally used platforms and stairs in petrochemical and other hazardous industries • Sawn timber storage areas in sawmills 	10 lux
<p>Medium risk, e.g.:</p> <ul style="list-style-type: none"> • Vehicle storage areas and container terminals with frequent traffic in harbours, industrial yards, and storage areas • Vehicle storage areas and conveyors in petrochemical and other hazardous industries • Oil stores in power plants • General lighting and storage areas for prefabricated goods in shipyards and docks • Regularly used stairs, basins, and filters of clean water plants in water and sewage plants 	20 lux
<p>High risk, e.g.:</p> <ul style="list-style-type: none"> • Building foundation holes and working areas on the sides of the hole at building sites • Fire, explosion, poison, and radiation risk areas in harbours, industrial yards, and storage areas • Oil stores, cooling towers, boilers, compressors, pumping plants, valves, manifolds, operating platforms, regularly used stairs, crossing points of conveyors, electric switchyards in petrochemical and other hazardous industries • Switchyards in power plants • Crossing points of conveyors, fire risk areas in sawmills 	50 lux

Note: Ensure that any lighting added is suitable for the work environment in which it is to be used.

Table A-4: Petrochemical and other hazardous industries (from Table 5.10 of CIE S 015/E:2005)

Type of Area, Task, or Activity	Illuminance
Handling of servicing tools, utilisation of manually regulated valves, starting and stopping of motors, lighting of burners	20 lux
Filling and emptying of container trucks and wagons with risk-free substances; inspection of leakage, piping, and packing	50 lux
Filling and emptying of container trucks and wagons with dangerous substances, replacements of pump packing, general service work, reading of instruments	100 lux
Fuel loading and unloading sites	100 lux
Repair of machines and electric devices	200 lux (use local lighting)

Appendix B: Suggestions for Enhancing Light Quality on Lease Sites

The following suggestions on enhancing light quality on lease sites are based on the advice of lighting experts and experienced oil and gas operational personnel. Operators, in particular, and larger contractors are encouraged to engage lighting experts in order to optimize their lease lighting strategies. The goal is to maximize illuminance, minimize shadows and glare, and ensure tasks are lit in a way that meets the minimum illuminance values set out in Table 2 with the least amount of overall power consumption.

USE ADDITIONAL PERIMETER LIGHT TOWERS.

One tower is typically not enough to provide sufficient illuminance and address shadows. Large buildings and equipment between the towers create shadows. Multiple towers contribute to each other's illuminance levels and reduce shadowing, especially in the operational and high-traffic areas of the lease. The sufficiency of two, three, or four corner towers or some other perimeter lighting configuration should be a risk-based decision, backed by a hazard assessment carried out under conditions of hours of darkness.

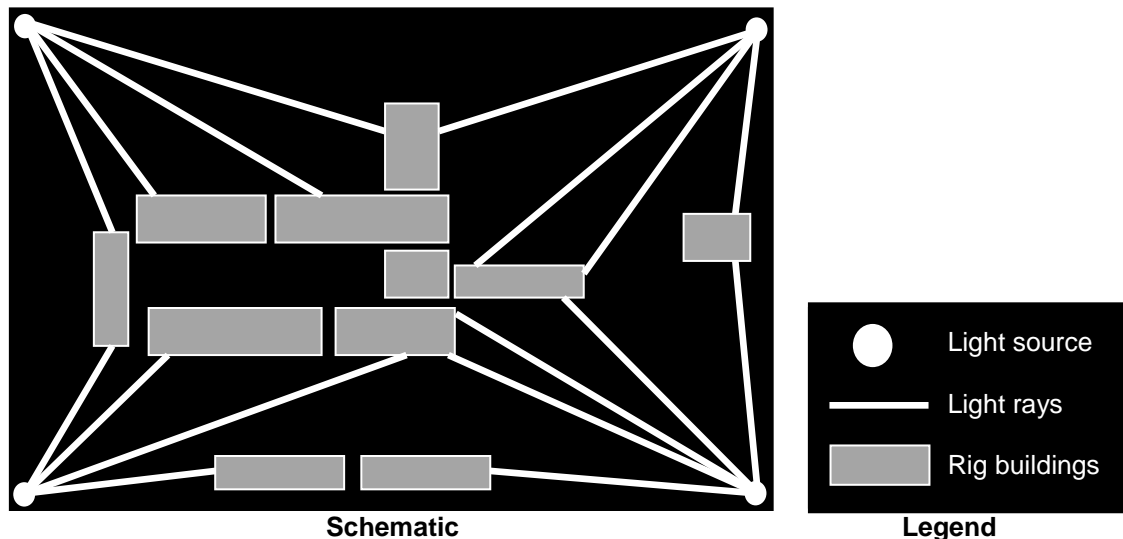


Figure B-1: Example of light spread with four towers (Adapted from Dustin Jack, *Light Study*, 2009)

INCREASE THE HEIGHT AND POWER OF THE LIGHT TOWERS.

Higher towers reduce shadows and glare. Higher-wattage fixtures can produce higher light levels at greater distances. Systematically ensuring that telescoping stands are fully extended in every instance can improve lighting in some cases.

INCREASE THE NUMBER AND HEIGHT OF LIGHTS MOUNTED ON LEASE BUILDINGS.

The tops of buildings and structures can be used as high points to mount additional lights for strategic task or movement areas or areas shadowed by main lighting fixtures. The higher lights can be elevated, the more effective they become at raising and evening out overall illuminance.



Figure B-2: Increased light spread from lights mounted on high towers (Dustin Jack, *Light Study*, 2009)

IMPROVE THE ANGLE OF LIGHT FIXTURES.

A light meter can provide insight into optimal angles for a light fixture. For example, a light fixture pointed directly downward may produce 200 lux of light in the immediate vicinity of the fixture. However, 10 metres away, the illuminance may drop to below 20 lux. Adjusting the angle slightly upward spreads the light more evenly, improving overall lighting and power consumption. However, adjusting the angle too far is counterproductive if the light spills beyond operational areas or becomes a source of glare.

INCREASE THE NUMBER AND WATTAGE OF WALL-MOUNTED FIXTURES ON SHACKS AND BUILDINGS.

Light fixtures on shacks and buildings offer the advantage of providing light precisely where the greatest amount of foot traffic and other activities take place. They can also contribute significantly to overall lease lighting and reducing shadows created by more high-power light towers. However, as is always the case with optimal lighting, creating more even lighting at moderate levels is preferable to creating unnecessary light “hot spots,” especially away from peak operational areas. To increase system efficiency, employers might also wish to explore the use of motion sensors for areas used only infrequently.

Provide workers with readily available, easy-to-use, and easily portable light standards.

Workers who have easy access to lighting solutions will use these instinctively when tasks require additional light. To maximize usage of portable lights, employers should:

- Have a variety of portable lighting solutions (from simple battery-operated to plug-in or even more heavy-duty generator-driven light stands)
- Keep portable lighting solutions in known locations that workers can access
- Regularly encourage workers to use these as required
- Research emerging portable lighting solutions available on the market

IMPROVE MAINTENANCE ON EXISTING FIXTURES.

Over time, lights degrade and offer a reduced level of illuminance. Even more significant in a field context, however, is the loss of light due to dirty light fixtures. Systematizing light maintenance and cleaning can improve light levels without requiring additional power consumption.

Be aware of the loss of performance of light fixtures in cold conditions.

Fluorescent lights are an efficient and effective lighting choice in many circumstances, but their light output can decrease in cold air temperatures. This tendency may need to be factored into design considerations.

Appendix C: Suggestions for Enhancing Light Quality During Operations Involving Trucks or Mobile Equipment

The following suggestions on enhancing light quality during operations involving trucks or mobile equipment are based on the advice of lighting experts and experienced oil and gas operational personnel. Companies involved in these types of operations are encouraged to engage lighting experts in order to optimize their lease lighting strategies. The goal is to maximize the safety of workers operating around these vehicles and equipment and to significantly enhance the safety of the related operations.

MAINTAIN AND CLEAN ALL EXISTING VEHICLE- OR EQUIPMENT-MOUNTED LIGHTING.

In many cases, operations can be much more adequately lit simply by ensuring that all vehicle- and equipment-mounted lighting is fully functional. Systematic light inspection, maintenance, and cleaning can considerably improve the light available from equipment-mounted lighting.

INCREASE THE NUMBER OF ATTACHED LIGHTING FIXTURES (ESPECIALLY LED LIGHTING FIXTURES).

Consider adding LED lighting fixtures to trucks and other equipment. LED lighting is very rugged and can survive vibration and cold, harsh temperatures. These fixtures are designed to run on 12 volt or 24 volt systems. Remember, however, that provincial and federal motor vehicle and highway regulations may require that these lights remain covered while on public roadways.

MOUNT LIGHT FIXTURES ON TRUCKS AND EQUIPMENT AS HIGH AS POSSIBLE.

When adding or adjusting light fixtures on trucks or equipment, select the highest point of the vehicle and aim the light downward to improve the lighting around the vehicle or equipment. Telescoping mounting products are also available to elevate the fixtures even higher. However, with any telescoping product on a vehicle, consider the increased risk of contact with overhead lines. Weigh the advantages of more vertical light and a broader lighting area against the risk of overhead contact.

PROVIDE ADDITIONAL PORTABLE LIGHTS FOR KNOWN RELATED OPERATIONS.

Where the lighting requirements for a task or tasks associated with particular equipment are best known to the companies supplying this equipment and operational support, it is a good idea for these companies to supply the necessary additional portable lights required to light their operations. These lights need to be easily accessible, ready to use, and easy to operate.

Appendix D: Suggestions for Enhancing Light Quality During Rig Moves

The following suggestions on enhancing light quality during rig moves carried out in hours of darkness are based on the advice of lighting experts and experienced rig-moving personnel. Factors such as the scale of the move and the number of personnel on site during the move should be considered in lighting decisions. Companies involved in these types of operations should engage lighting experts in order to optimize their lease lighting strategies. The goal is to maximize the safety of workers and minimize equipment damage during these rig moves.

Adequate lighting is only one factor among others in making a decision to proceed with a rig move during hours of darkness. The following suggestions assume that the decision to proceed has considered other associated hazards and risk factors.

USE ADDITIONAL LIGHT TOWERS.

Shadows are a real challenge for rig moves carried out at night. Having multiple light towers instead of one can eliminate most of the shadows and greatly enhance overall lighting. Also consider optimal placement of light towers. Placing towers on the lease sides rather than in the corners may provide better overall lighting. Operators and contractors involved in night rig moves may also consider different lighting requirements under fresh snow conditions versus lighting requirements when snow is not available to enhance light quality.

Mounting all light towers as high as possible also maximizes illuminance and minimizes shadows.

ENSURE THE AVAILABILITY OF PORTABLE LIGHTING.

Portable lighting that workers can easily hook up and move can make the most difference in terms of getting light where and when it is needed in the move process. If workers can simply and strategically place lighting where it adds the most light without getting in the way of the immediate operations, they will do so. Existing and emerging products on the market fulfill these criteria (see Appendix E: Portable Lighting Solutions). Mounting additional lights on pickup trucks may also serve as a portable lighting solution. It is important to remember, however, that provincial and federal motor vehicle and highway regulations may require that these lights remain covered while on public roadways.

STRATEGICALLY DISMANTLE AND DE-ENERGIZE LIGHTS, LEAVING THE BEST SOURCE(S) OF LIGHT ON FOR THE LAST TASKS THAT REQUIRE IT.

Wherever possible, to leave lights on as long as possible. For example, if the rig itself is providing a large portion of the lighting for the lease area, it should be the last building to be completely de-energized.

CONTINUE TO POWER RIG LIGHTS THROUGHOUT THE MOVE WITH A PORTABLE GENERATOR.

If possible, consider moving the rig while powering the existing lights on the rig with a portable generator. This can enhance safety during transport between lease sites as well.

INCREASE THE IMPACT AND REDUCE THE GLARE FROM LIGHTS MOUNTED ON MOVING TRUCKS.

Rear-facing truck-mounted lighting is critical for loading and unloading operations. Increasing the number of these lights may enhance operations. However, the lower these lights are mounted, the greater the likelihood that they will also produce a blinding glare for workers operating behind the truck. Using a diffuse lens rather than a clear lens can address some of the glare issues. Mounting these as high as possible can both improve the light they provide to the operation and reduce horizontal glare for workers behind the vehicle. However, also consider the increased risk of accidentally striking overhead lines and transportation regulations that may apply once these trucks move off the lease site.

Appendix E: Portable Lighting Options

Efficient portable lighting options are key to cost-effective lighting. Traditional portable light towers are among the most common in the oil and gas industry. However, there are constant innovations in the development of effective portable lighting solutions. This guideline does not endorse any particular solution or brand, but companies should consider emerging solutions for lease lighting that is more effective, efficient, easy to use, and safe. Most new lighting solutions will offer both benefits and offsetting negative factors. Both need to be considered in choosing how best to address portable lighting needs on lease operations. And always keep in mind electric code classification on oil and gas lease sites.

TRADITIONAL PORTABLE LIGHT TOWER

A portable generator with a hand-cranked light tower is by far the most common portable lighting solution for larger operational areas on a lease site.



Figure E-1: Portable light tower

INFLATABLE LIGHT TOWER

Inflatable light towers are an emerging lightweight temporary lighting solution. Designs may vary, but a light tower such as the example below can be packed by one person. This particular example is designed to be plugged into a 110 or 220 volt power supply or generator. The inflatable tower is made of nylon and has a metal halide light housed at the top. One limitation of inflatable towers is that they do not work well in high winds.



Figure E-2 and E-3: Inflatable light towers

SELF-RIGHTING LIGHTS

Self-righting lights are a simple, durable, portable light solution. They are marketed primarily to construction companies. They are manufactured to use halogen or metal halide bulbs of varying wattage and may come with a carrying handle, internal ventilation to keep the light cool, and optional reflector shields for directional light. One limitation is their low height.



Figure E-4: Self-righting light

PORTABLE LIGHTING DESIGNED FOR EXPLOSIVE ENVIRONMENTS

The offshore oil industry has produced portable lighting that is specially designed to meet the demands of highly explosive environments. For certain operations, having such a solution on hand is a best practice.



Figure E-5: Portable fluorescent lights designed for explosive environments



Figure E-6: Rechargeable handheld LED designed for Class 1, Div 1 environments (adjustable to serve as work light or floodlight)

INDUSTRIAL LED LIGHTING

LED lighting solutions for industrial applications continue to emerge on the market. These can provide a significant power saving while being more durable and resistant to cold weather than traditional metal halide bulbs. LED lighting solutions may eventually replace more permanent floodlight standards as well as provide a variety of portable lighting solutions, given that they can provide significant light from battery power.



Figure E-7, E-8, E-9: LED floodlights (140 watt floodlight version replaces a traditional 450 watt bulb)



Figure E-10: Class 1, Div II LED designed for petrochemical industrial sites



Figure E-110: Vehicle-mounted 12 or 24 volt LED floodlights with telescoping extension mast

Appendix F: Computer Modelling to Improve Lease Lighting Design

Companies committed to improving lease lighting may benefit from innovations in lighting design.

In 2009, Cenovus Energy performed a light engineering analysis on an existing drilling operation. 3-D computer modelling made it possible to experiment with multiple lighting solutions without having to expend resources on equipment and personnel to field test each of these solutions. This approach allows field testing to be reserved for optimal solutions that offer the most improvement at the lowest cost.

The following highlights from the Cenovus Energy analysis show what can be accomplished with this approach to lighting design. (The 3-D computer modelling was performed by Rudy Ponce. The final report was authored by Dustin Jack of Cenovus Energy. The images are the property of Cenovus Energy Inc.)

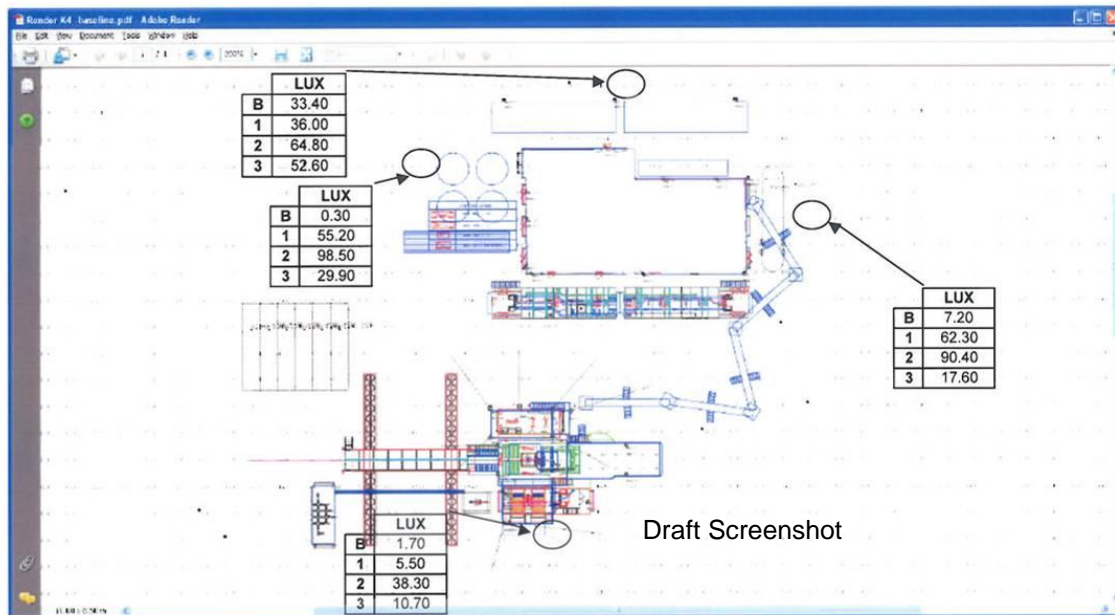


Figure F-1: Baseline layout with lux level values for all options (Dustin Jack and Rudy Ponce, *Light Study*, 2009)

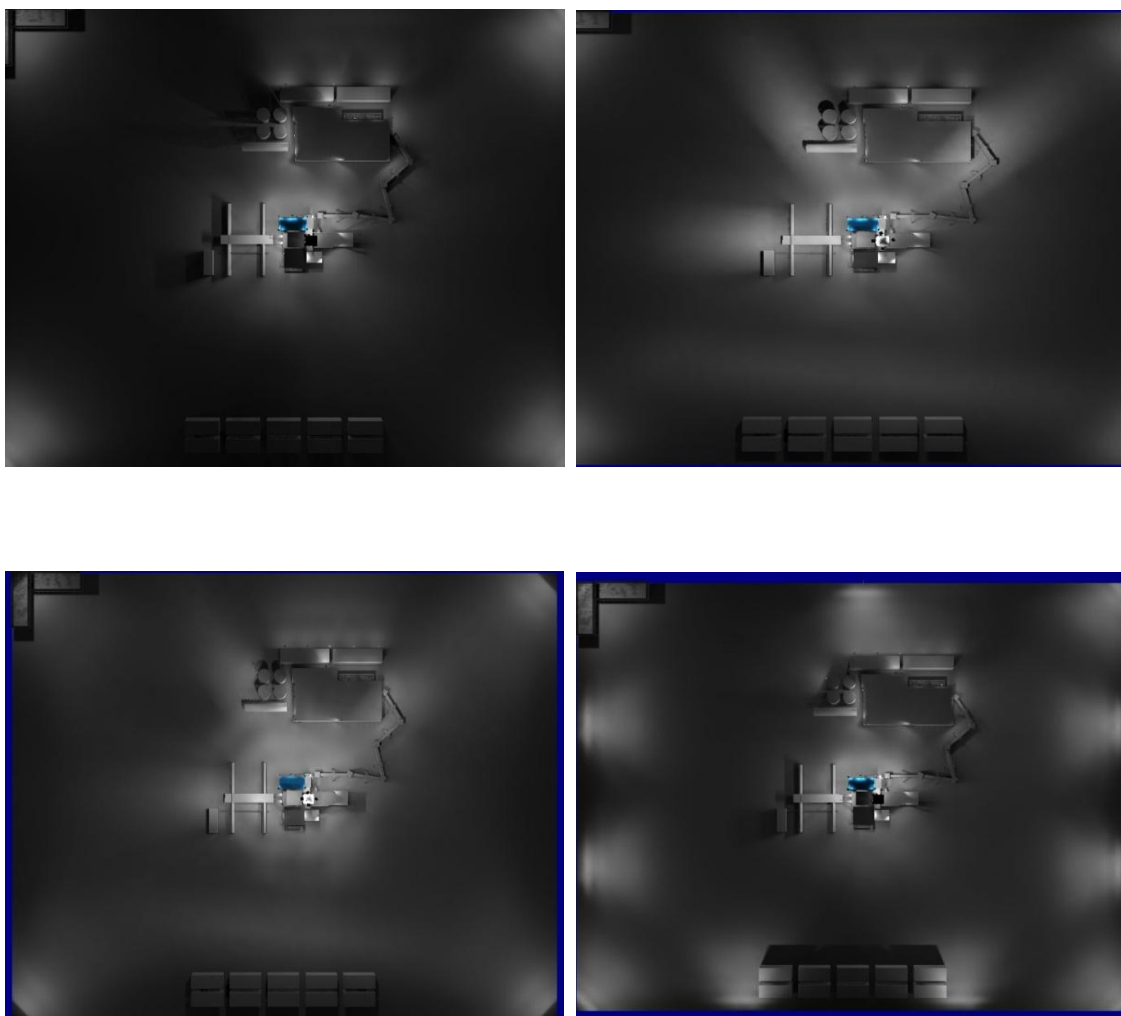


Figure F-2, F-3, F-4, F-5: Overhead views of baseline and three options (*Dustin Jack and Rudy Ponce, Light Study, 2009*)

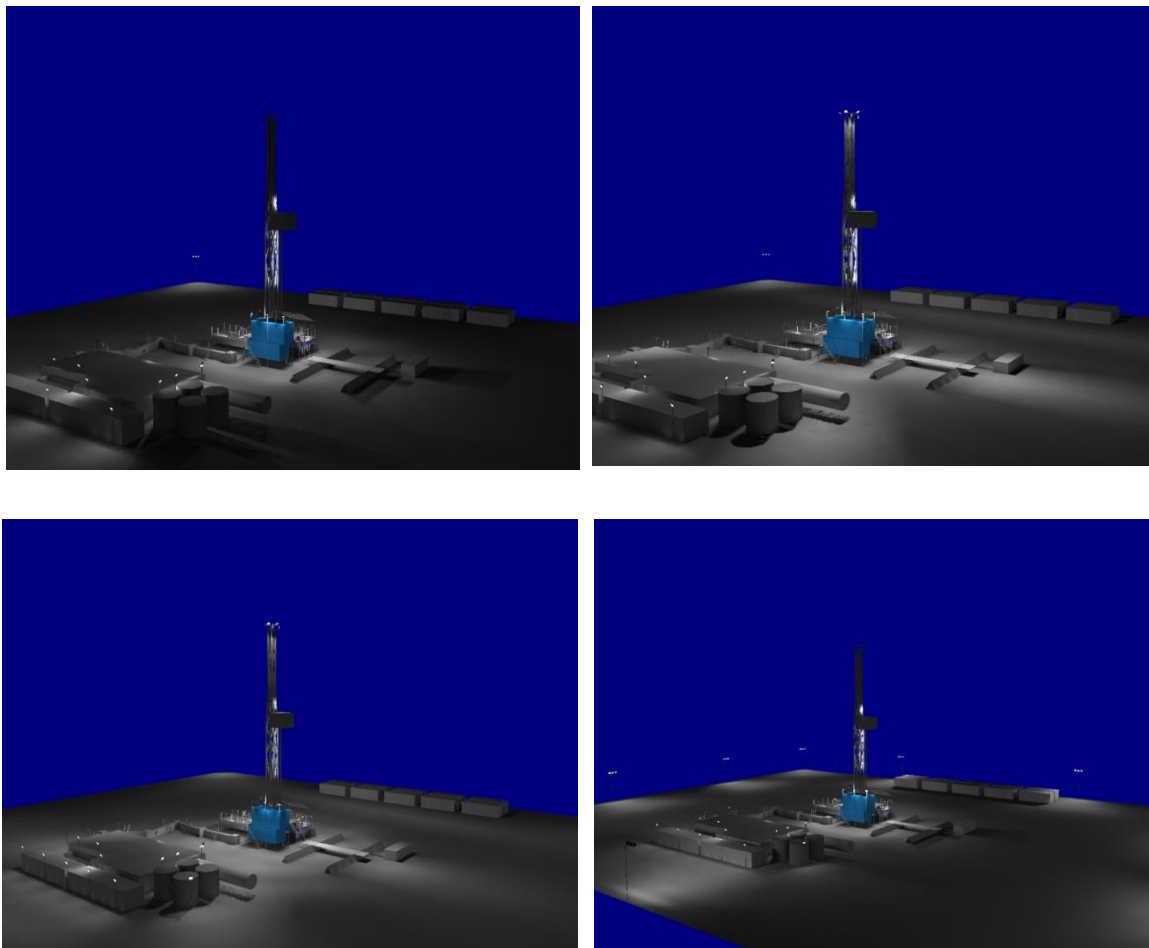


Figure F-6, F-7, F-8, F-9: Side-angle views of baseline and three options (*Dustin Jack and Rudy Ponce, Light Study, 2009*)

Appendix G: An Illustrated Guide to Operator and Contractor Responsibilities

The following diagrams illustrate the guidance on operator and contractor responsibilities outlined in section 1 of this guideline. (The stylized overhead views of the lease site during hours of darkness are for illustrative purposes only and are not to be taken as technically accurate or prescriptive.)

BASELINE LIGHT LEVELS

Baseline average light levels for various movement/task zones on the lease site are set according to Table 2 in section 2.3. This table is designed to provide an objective third party standard that both operators and contractors can consult to guide their field practices and contract negotiations regarding lighting on a given oil and gas lease site.

While the table is subject to interpretation in the field (it is impossible to be fully exhaustive), when applied with the sound judgment of experienced safety professionals, there may be a degree of variance. Negotiations over lighting should not have to revisit what counts as “adequate” for lease site tasks and activities.

Once the amount of required lighting has been determined, operators and contractors can discuss who provides what (and when) for lighting the lease site.

Note: With a standard in place, contractor demands and practices and operator provisioning of lighting now have a test of reasonableness—all parties are held accountable.

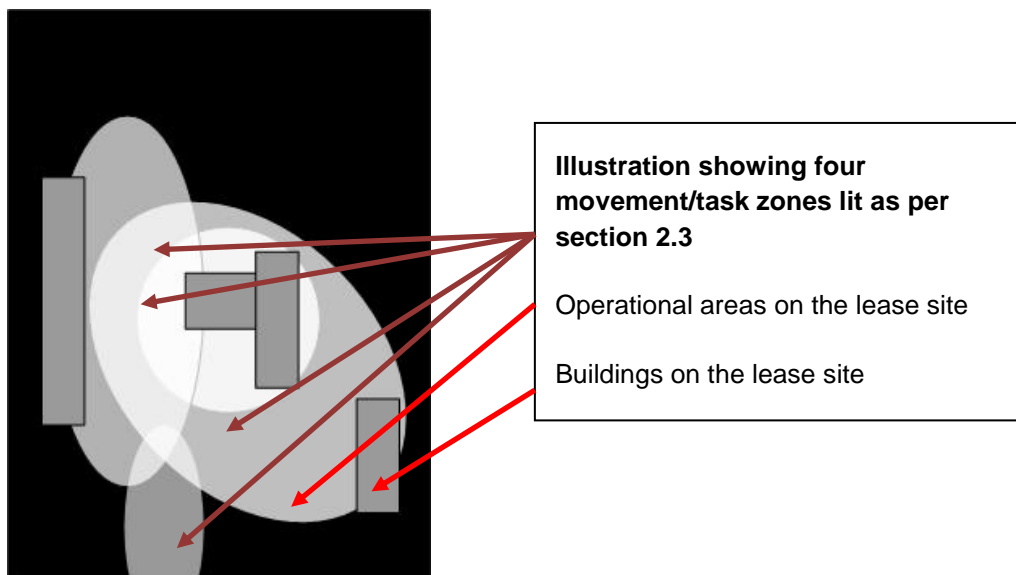


Figure G-1 : Schematic of a lease

BASIC OPERATOR RESPONSIBILITIES

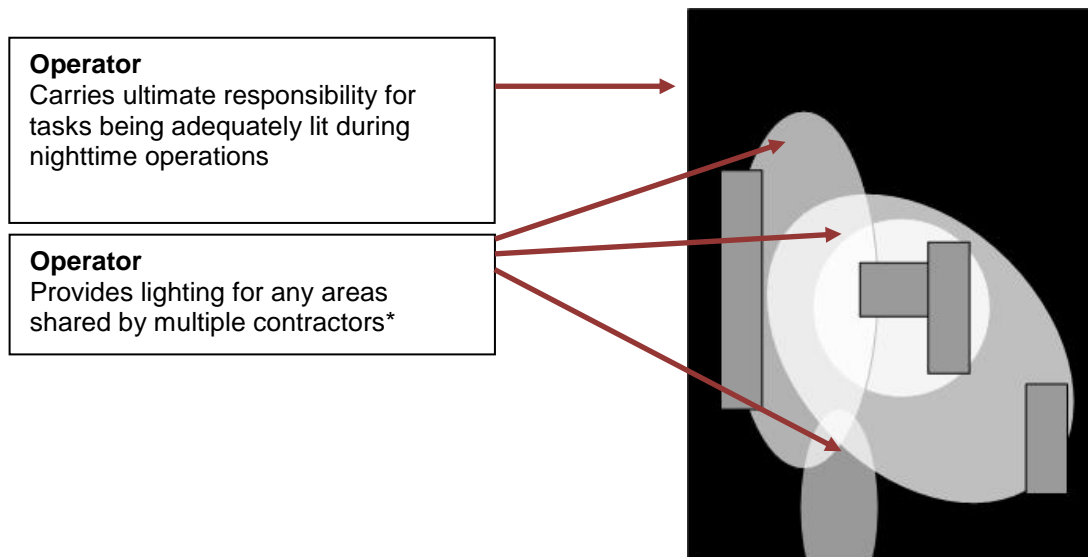


Figure G-2 : Basic Operator Responsibilities

*The *Lease Lighting Guideline* does not make recommendations on *how* an operator provides lighting. It offers guidance for illuminance values and calls for optimization with respect to shadows and glare; it does not specify means.

ADDITIONAL OPERATOR RESPONSIBILITIES (IF SUPPLYING EQUIPMENT ON LEASE SITE)

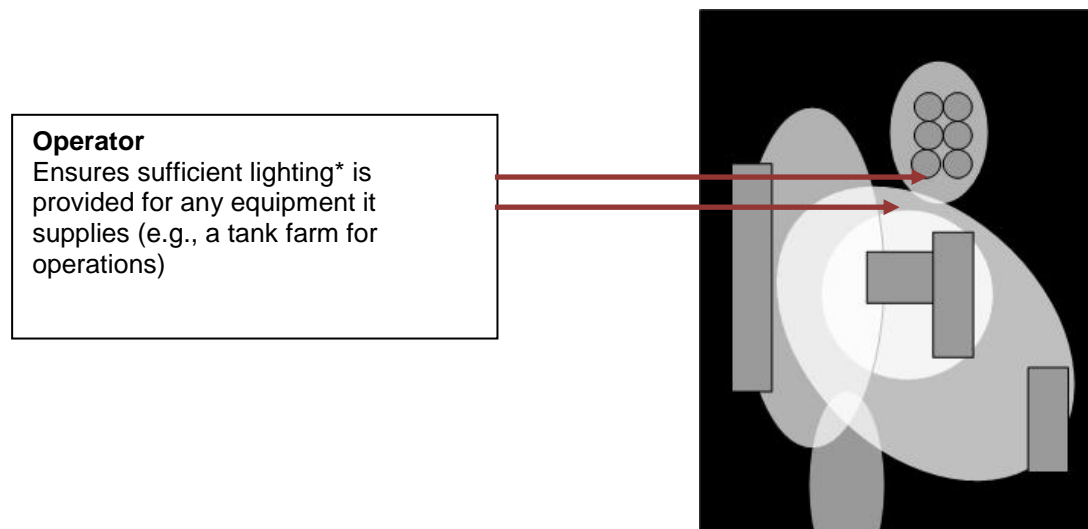


Figure G3 : Additional operator responsibilities (if supplying equipment on lease site)

*The *Lease Lighting Guideline* does not make recommendations on *how* an operator provides lighting. A variety of contractual arrangements may be used to ensure that sufficient lighting is provided.

CONTRACTOR

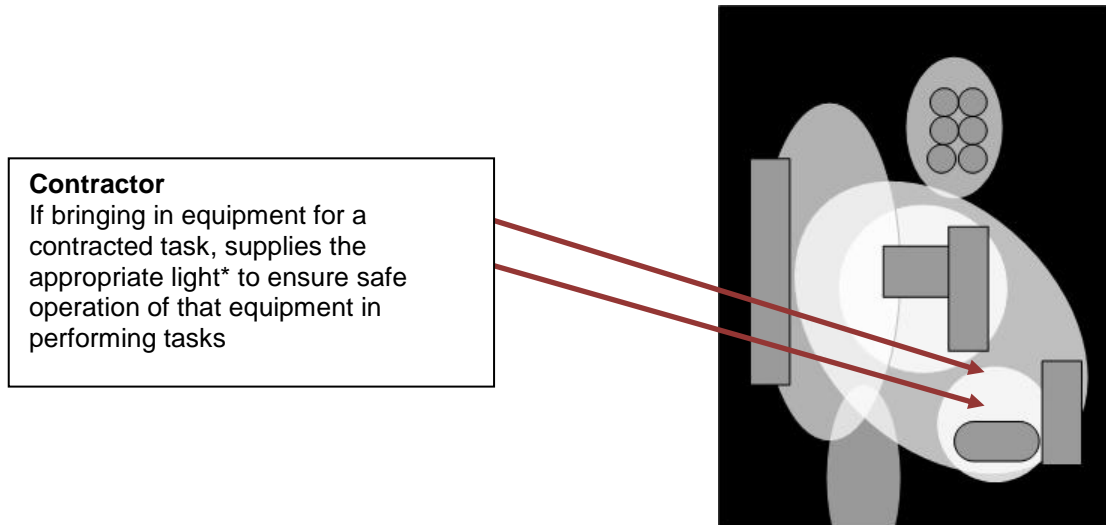
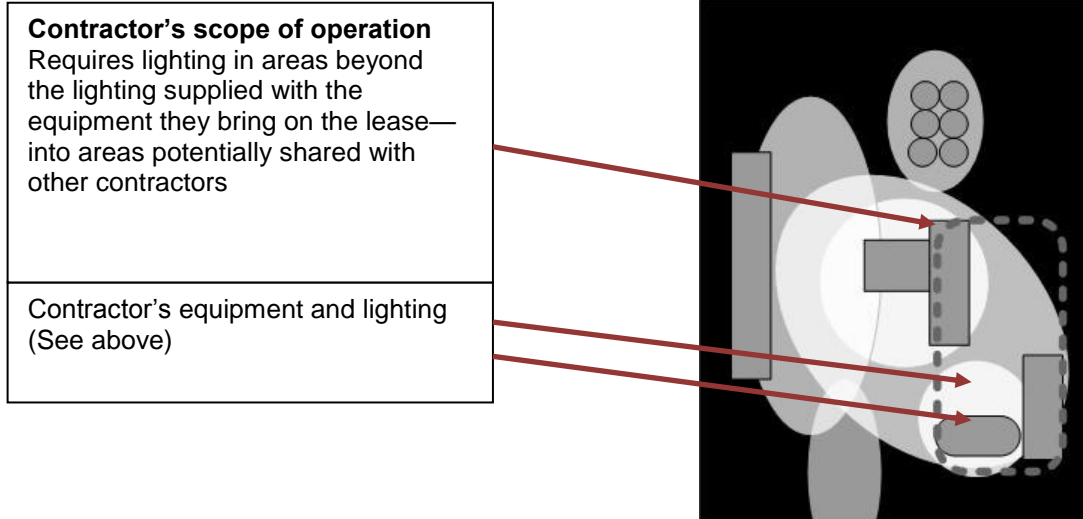


Figure G-4 : Contractor responsibilities

*The *Lease Lighting Guideline* does not make recommendations on *how* a contractor provides lighting. Aside from owning their own lighting equipment, a variety of contractual arrangements may be used—for example, with equipment rental agencies, with other contractors on site, or even with the operator.

OPERATOR + CONTRACTOR(S)



In this scenario:

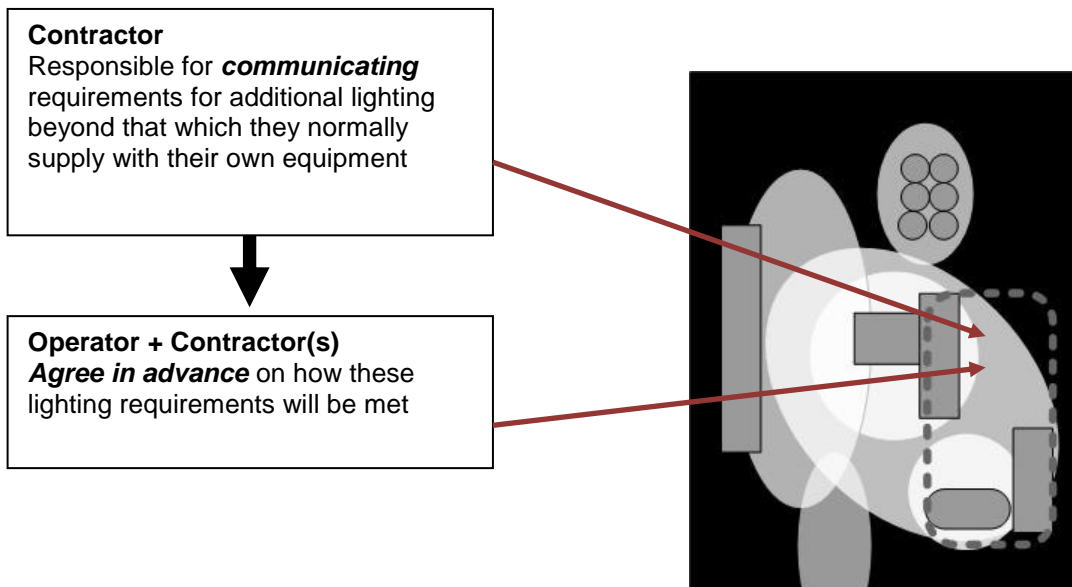


Figure G-5 : Operator and contractor(s)

Glossary

ANSI: American National Standards Institute.

ERCB: Energy Resources Conservation Board.

CIE: International Commission on Illumination.

Common areas: Those portions of the lease site used or traversed by multiple employers, or shared sites for specific tasks.

Contractor: Any person or employer on a lease site who has been contracted by the operator or another contractor to carry out a specified task or set of duties on the well site.

Hours of darkness: This guideline follows the standard definition for “hours of darkness” used in multiple pieces of occupational health and safety legislation in Canada. For example, “hours of darkness” means the period from 30 minutes after sunset to 30 minutes before sunrise, or at any time when, because of insufficient light or unfavourable atmospheric conditions, persons or vehicles cannot be seen at a distance of 150 metres” (*Alberta OH&S Code 1. Definitions*).

IESNA: Illuminating Engineering Society of North America.

Lux (lx): The SI (International System of Units) unit of illuminance. One lux is one lumen per square metre (lm/m²). One lux is equal to the illuminance provided by an ordinary wax candle or the amount of visible light per square metre incident on a surface.

1 lux = 1 lumen/square metre = 0.093 foot-candles (1 foot-candle = 10.76 lux).

Operator: Typically the owner of the lease site. When a well has more than one owner, usually only one owner is designated as the operator—most often the licensee of the well. The term “operator” has this meaning throughout this document.

Twilight: The point where artificial illumination is required to read outside; it is roughly equivalent to “civil twilight,” which is defined as the time period when the sun is between 0° and 6° below the horizon at sunrise or sunset.

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