Induction Lighting Case Study
Industrial Materials Preparation Area

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Industrial Materials Preparation Area - Lighting Case study[1]

A composite materials and structures fabrication company was located in an older industrial warehouse, with high ceilings. The pre-production area, where materials are measured and cut, was poorly lit by mercury vapour High-bay fixtures. Staff had great difficulty seeing measurements and cut-line marks, particularly on carbon-fibre material.

The company specializes in high quality, close tolerance, composite structures made from fibreglass or carbon fibre materials. These structures include large and complex flight simulator shells, and wind turbine blades with complex topology all of which must be made with very high precision.

Facility:

The composites company's manufacturing facilities occupy a total space of 2,972 square meters (32,000 square feet). Only the lighting in the pre-production area, where materials to be assembled and laminated are measured, and cut to size, was renovated.

The pre-production area has white painted cinder brick walls and a white painted ceiling with unpainted steel beams covered in a reddish primer coat. The height of the space from the floor to the bottom of the steel beam trusses is 5.5 meters (18 feet).

Before: The pre-production area where materials to be laminated are cut and measured (work tables and benches have been removed to facilitate a lift to reach the lights). Five of the mercury vapour High-bay lights that were replaced can be seen in this photo.

The area was lit by eight, poorly placed, 400 watt, Mercury Vapour High-bay lighting fixtures (see initial measurements diagram). In addition to the High-bays, there were two surface mount, 250 Watt, incandescent security lights attached to the steel ceiling and connected to the power supply by means of plugs and sockets. These lights were on a breaker, and were operated

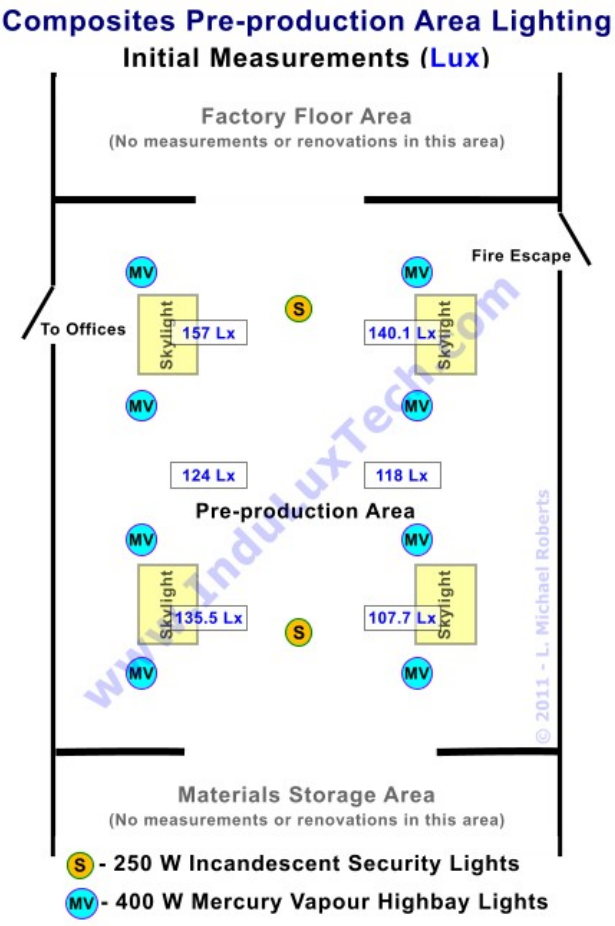
24/7. There are also four large glass skylights located in the ceiling over part of the pre-production area (see diagrams) which allows some natural lighting into the pre-production area during the daytime.

Initial Measurements:

The initial average lighting level was determined by taking measurements using a calibrated Cooke Cal-Light meter measuring in Lux.[2] Due to the presence of the skylights, all light level measurements were performed after dark so that light from the skylights would not affect the illumination measurements.

Light levels were measured, at floor level, in six locations spaced evenly between the existing Mercury Vapour High-bay fixtures (see diagram on right). The measurement locations were marked with tape on the floor so that they could be used again for the "after" light level measurements once the lighting renovations were completed.

The initial light readings of 157, 140.1, 124, 118, 135.5 and 107.7 Lux were added, and then divided by 6, to give an average light measurement of 130.3 Lux in the space (see the diagram on right - Lx = Lux).



Lighting Renovation Objectives:

The primary objective was to raise the lighting levels in the area significantly, while improving colour rendering. Colour rendering was especially important as the carbon fibre material used in some of the fabrication work is black and thus details of measurement marks needed for cutting were difficult to see under the existing mercury vapour lighting. Reduction of electrical power consumption by the lighting in the pre-production area was a secondary objective.

Logistics:

The lighting renovations were performed over a weekend, with initial light measurements made on Friday night, electrical work performed on Saturday and Sunday during the day, and final light measurements made Sunday night after dark. This approach, while more costly for electrical contracting work due to overtime rates, was chosen so as to minimally disrupt the company's production schedule.

Lighting Renovations:

All eight of the existing Mercury Vapour High-bay fixtures, installed as 2 rows of 4 fixtures, located approximately 5.5 meters (18 feet) above the floor (see diagram on previous page), were removed and recycled. It was determined that the new magnetic Induction lamp[3] High-bay fixtures would be installed such that the bottoms of the fixtures would not protrude below the steel beams. This preserved the the height in the manufacturing facility, while

eliminating some shadows cast by the steel beams due to poor placement of the original mercury vapour high-bay lighting fixtures (some were located above the steel beams).

Fifteen, 200W, 4,100K, magnetic induction lamp indoor High-bay lighting fixtures with open bottoms (no lens or diffuser) were to be installed in the same pre production area, in an evenly spaced five by three grid array.

The two existing 250 watt incandescent bulbs (safety/security lighting) were removed and the electrical contractor then rearranged the locations of the surface mounted outlets, and installed an additional outlet such that the three outlets were relatively evenly spaced across the length of the area. Three, 40 watt, 4,100K induction lamp fixtures were installed adjacent to the sockets as replacement safety/security lights. Note that the security lights were placed non-symmetrically (see diagram) so that they would provide some light spill into the materials storage, and factory floor areas, located at either end of the pre-production area.

Final Measurements:

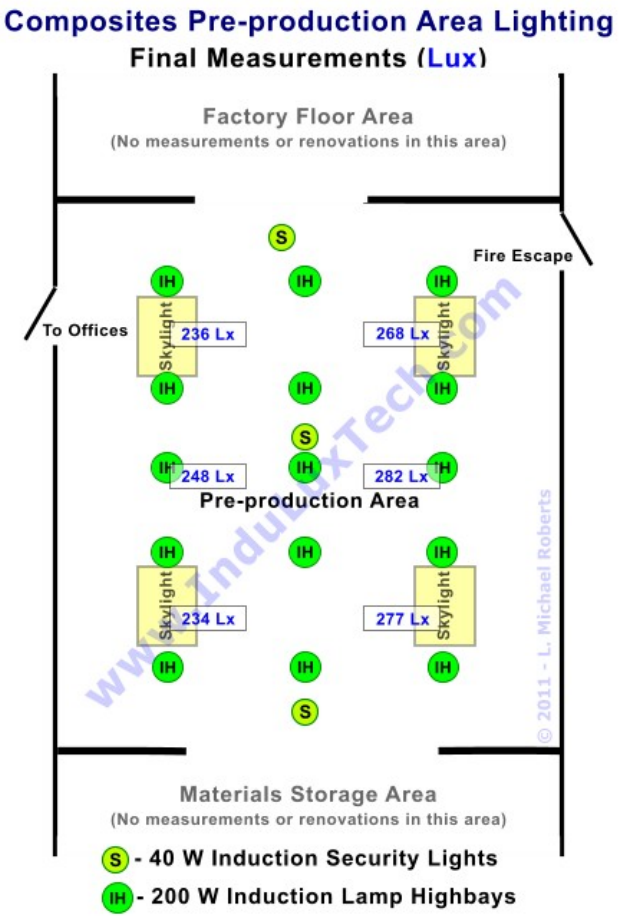
Detailed light level measurements were taken after the new lights were installed - again at night so as to eliminate the effects of daylight from the skylights. The measurements were taken at the same locations on the floor of the manufacturing area (previously marked with tape) as used before, with the same Cooke Cal-Light meter, and were taken in Lux (Lx).

The readings of 236, 268, 248, 282, 234 and 277 Lux were then added and divided by six to give an average light level reading of 257.5 Lux in the space (see diagram on next page).

The Initial average measurement of 130.3 Lux was multiplied by the S/P Ratio of 0.80 for the mercury vapour lamps yielding an adjusted average light level of 104.2 VEL (Visually Effective Lux[4]).

The average of 257.7 Lux under the 4,100K induction lamps was multiplied by an S/P Ratio of 1.62 to yield 417.4 VEL. Naturally, staff work on tables and benches, which are above the floor, thus they will experience even higher light levels on the working surfaces.

This renovation of the pre-production area lighting represents an increase in average lighting levels of about 98% in meter Lux or about a 300% increase in VEL (Visually Effective Lumens).



Comparison of Electrical Power Consumption:

The initial lighting consisted of eight 400 watt mercury vapour High-bay fixtures, plus 50 watts each for "core & coil" ballast overhead, for a load of 450 watts per High-bay fixture; a total High-bay load 3,600 watts (3.6 kWh). In addition, there were two 250W incandescent security light fixtures adding 500 watts, for a total load in the production area of 4,100 watts (4.1 kWh).

The renovated induction lighting system consists of fifteen 200 watt induction lamp High-bay fixtures with a Cos-Phi of .98, therefore each fixture consumes only 202 watts of power for a total of 3,060 watts for the High-bays (3.06 kWh). The old incandescent security lights were replaced with three 40 watt induction fixtures with a ballast overhead of 2 watts each or 42 watts per fixture - total for the security lights 126 watts (.126 kWh). The grand total of the renovated induction lighting installation is 3,186 watts (3.19 kWh) - a savings of 914 watts (0.914 kWh).

After: The composites pre-production area where materials are cut and measured is shown after upgrading the facility to induction lamp High-bays. Nine of the induction lamp High-bay light fixtures and one of the security light fixtures can be seen in this photo.

Based on local electrical energy costs of $0.12 per kWh, with an average usage of 50 hours per week and 50 weeks per year, the estimated energy cost savings is only $274.20 per year.

The design objectives were met, with a dramatic increase in lighting levels, which is expected to save much more money than the power consumption reduction. The major savings will come from reducing material cutting and measurement errors, as well as increasing employee productivity and reducing absenteeism.

Summary:

The original Mercury Vapour High-bay lights and the incandescent security lights, which consumed a total of 4,100 watts (including ballast overhead), were replaced with a mix of magnetic induction lamp 40 watt fixtures and 200 watt induction lamp High-bay fixtures. The lighting electrical load (including ballast overhead) was reduced from 4,100 watts to a total of 3,186 watts (3.186 kWh) - a savings of 914 watts (.914 kWh) or about 22%.

The average lighting levels in the pre-production area were increased from 130.3 Lux to 257.5 Lux – an increase of about 98%. When corrected for S/P Ratio, the increase was from 104.2 VEL to 417.4 VEL - about a 300% increase in VEL.

In addition, the company will realise additional dollar savings through a reduction in operational and maintenance costs provided by the induction lamps.

- **Electrical load was reduced** from 4,100W to 3,168W - about a **22% energy savings!**
- **Average light levels were improved** from 130.3 to 257.5 Lux - about **98% brighter!**
- Adjusted for S/P Ratio, **the new induction lighting produced 417.4 VEL - about a 300% increase in VEL!**

Composite "Before & After" Photo: The left half of the image shows the lighting in the area before renovations. Note the greenish cast (wall onleft) to the lighting, which is characteristic of the Mercury vapour lamps in the High-bays.
The right half of the photo shows the same area, after the magnetic induction lighting High-bay lamps were installed. Note the higher light leves and more natural colour rendering.

Most importantly, this facility has created a **more productive work environment** for their entire staff where **errors in measurements, material cutting, and re-works will be significantly reduced due to the increased light levels.**

References:

1. NOTE: This article is an edited extract from the "Case Studies" chapter in the forthcoming book "The Induction Lighting Handbook - By: Michael Roberts"
2. Cooke cal-LIGHT 400 -http://www.cookecorp.com/light-measuring-systems/cal-light-400/
3. For more information on Magnetic Induction Lamps (Induction lights) see the "How Magnetic Induction Lamps Work" publication available on-line at http://www.induluxtech.com/Library.html
4. For more detail on S/P Ratios and VEL (Visually Effective Lumens/Lux) see pages 11~17 in the publication "The Science behind Induction Lighting" at http://www.induluxtech.com/Library.html

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